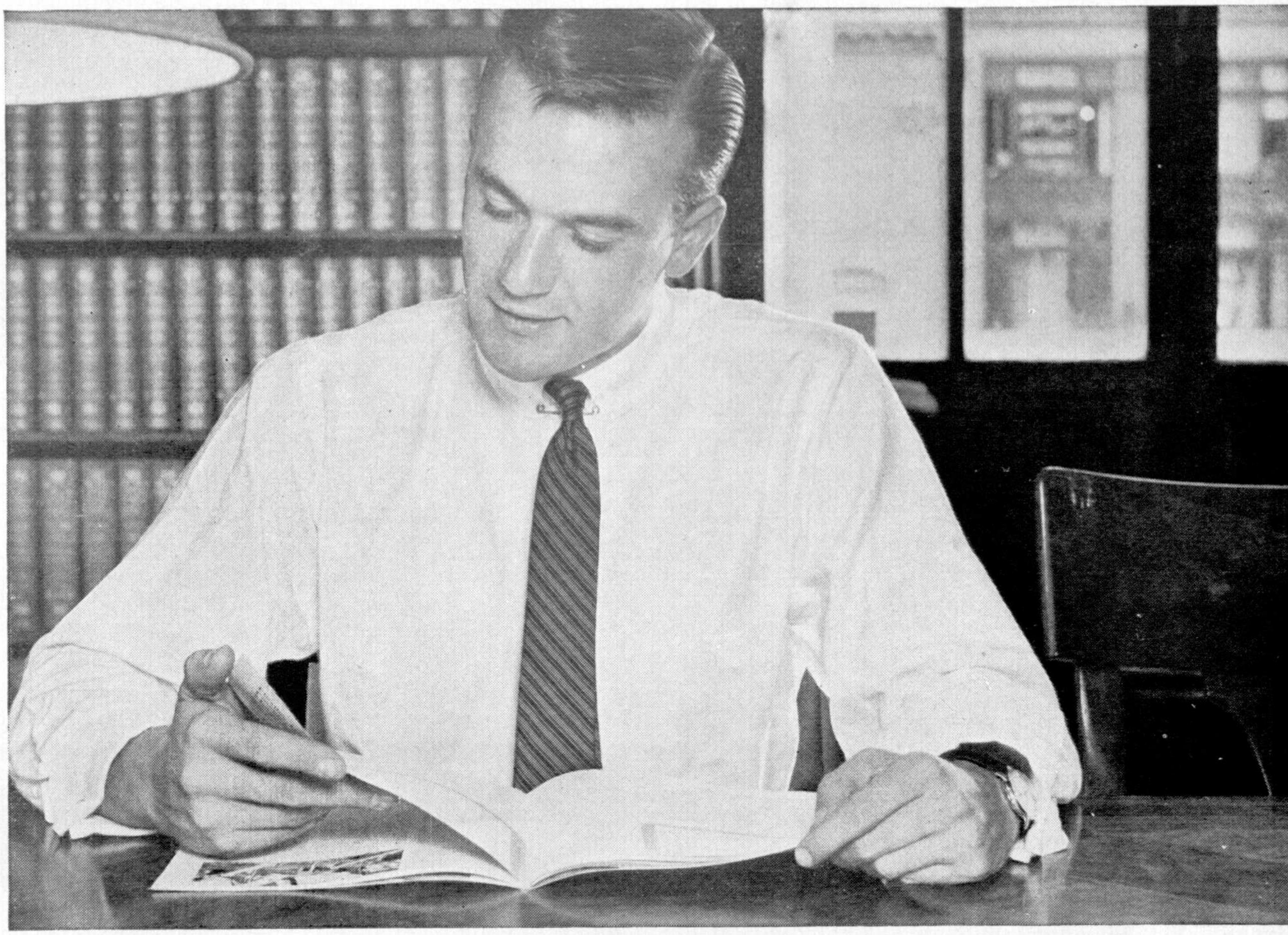
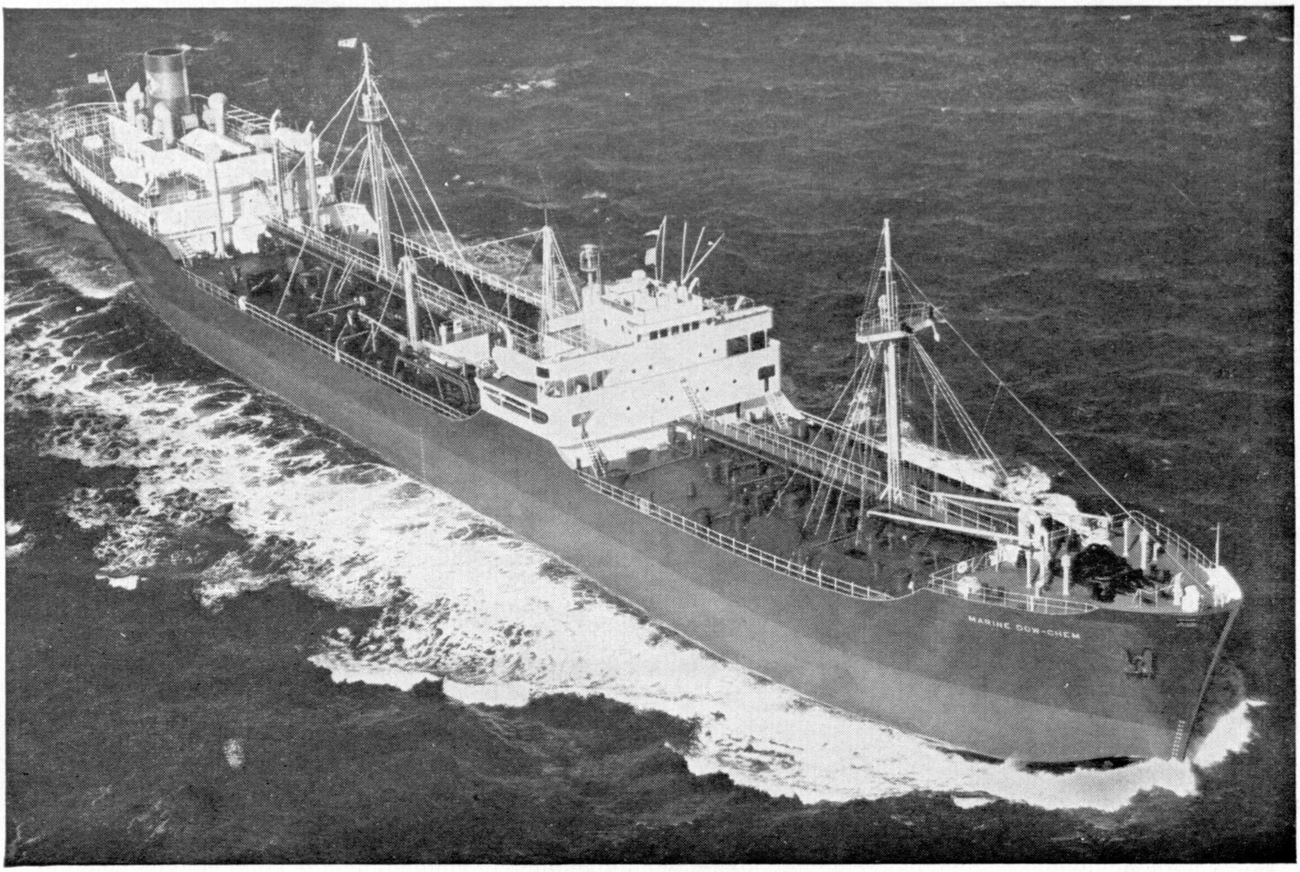
Spartan Engineer

VOLUME 8 NUMBER 1 NOVEMBER, 1954 PRICE 25c





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DOW

Spartan Engineer

ARTICLES

FEATURES

Published four times yearly by the students of the SCHOOL OF ENGINEERING, MICHIGAN STATE COLLEGE, East Lansing, Michigan. The office is on the third floor of the Union Building, Phone ED 2-1511, Extension 251. Entered as second class matter at the Post Office in Lansing, Michigan, under the act of March 3, 1879.

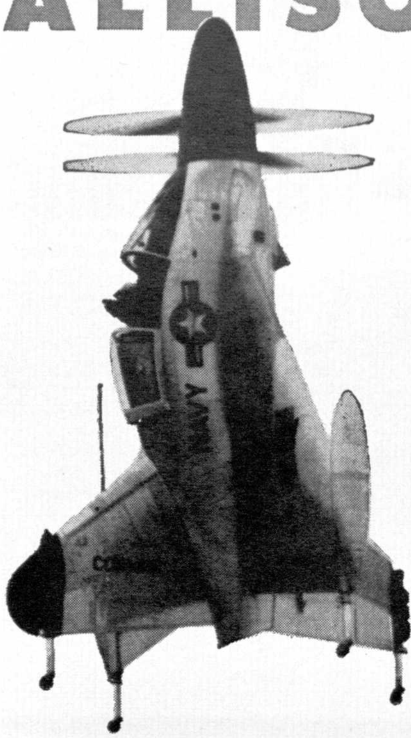
Address Mail to: P. O. Box 468, East Lansing, Michigan

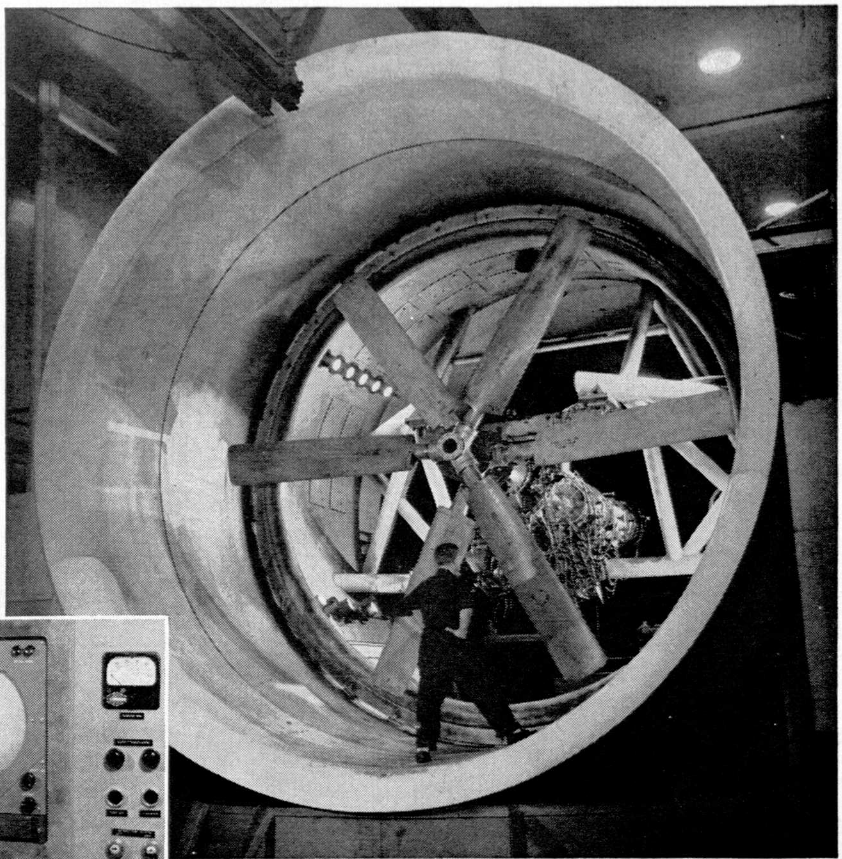
Publishers representative

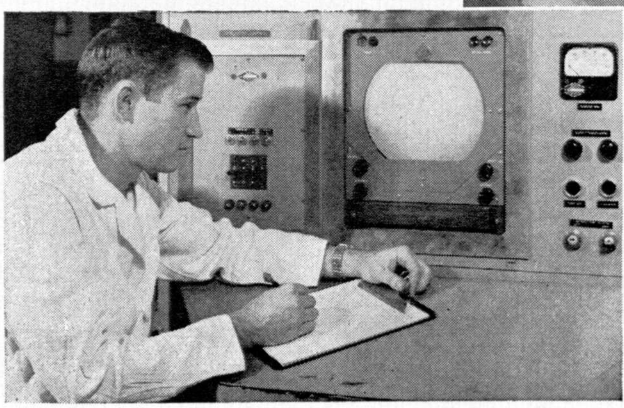
Littell-Murray-Barnhill, Inc.
101 Park Avenue, New York
605 W. Michigan Avenue, Chicago

Subscription rate by mail $1.00 per year.
Single copies 25 cents.

ALLISON Engineers Pioneer VTO Power Plant Development







GEORGE D. KEMP, who received his B.S. in Mechanical Engineering from Colorado A. and M. last June, is shown recording data on the engineering log sheet from the industrial TV screen in the VTO test cell. George—now in the Test Operations group in the Experimental Test Section at Allison—is working on the T40 turbo-prop engine which powers the Convair XFY-1 and the Lockheed XFV-1 vertical take-off aircraft.

● Early in '51, Allison undertook the power plant development for vertical take-off airplanes following the Navy's request for a high-power, low-weight turbine engine which could be adapted to vertical operation.

With modifications, the Allison T40 turbo-prop engine—with its extremely high power-to-weight-ratio—was selected to do the job. The vertical operation necessitated basic design changes, such as changing the oil system so it would function in both vertical and horizontal positions. Too, it was necessary to modify the reduction gear, giving a higher propeller RPM and increased thrust. And, with the specially designed propellers required by the VTOs, the control system was redesigned.

Then, to test the engine, a radically new test stand was designed and built. Allison engineers converted a test stand previously used for low horsepower reciprocating engines to one (shown above) capable of accommodating VTO engines in the various positions from horizontal to vertical. With the huge 72,000 pound tunnel completely enclosing the engine and propeller, a television was installed in the control room so engine operation could be observed in any tunnel position.

The VTO power plant project is typical of the variety of challenging problems handled by the Allison Engineering staff. And, because it is continually pioneering in advanced engineering developments, Allison needs additional technically trained men, especially young graduate engineers. Why not plan now for your engineering career at Allison. Write for information:

R. G. Greenwood, Engineering College Contact,
ALLISON DIVISION, General Motors Corporation, Indianapolis 6, Indiana.

Editorially Speaking

Another school year is well under way. For some of you it is your first at Michigan State. Others of you will be leaving at the end of the year. Whether you fall into one of these categories, or somewhere in between, you are probably wondering what the future holds in store for you. It would be wise to do more than just wonder however, since, to a large extent, your future will depend on what you do now.

Time has a way of passing rapidly and the future is soon upon us. That future can be shaped by making sure what you want to do and then working toward that goal. Just deciding what type of work you would like to do is not enough, for there are many different jobs open for a person with any given type of training.

One of the best ways to find out about the various possibilities in any profession is through the different companies in that field. Here at Michigan State you have one of the best opportunities that will ever present itself for gaining information about jobs. There are representatives from many different companies on campus at various times who are always glad to tell you what job opportunities their companies have to offer. Far too few students make use of this excellent way of gaining information.

These people, while primarily interested in students who will soon be looking for jobs, are also interested in keeping a supply of students coming up during the future years. They are always glad to inform you on the different job possibilities for in doing so they are helping you to select the type of work which you will most enjoy and by enjoying your work, you will be able to do a better job.

Make use of this opportunity and you will be taking a big step towards shaping your future into what you will most enjoy.

jrs

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. K. Hodnette, Vice-President and
General Manager, Apparatus Products,
Westinghouse Electric Corporation

To the young man with a vision of success

Success means different things to different men. It can mean professional recognition, or great achievement, or exciting work, or many other things. Whatever its special meaning to you—keep its image in your mind, for you are already well on the way to achieving it!

If you are *determined* to become a research scientist, you *can* be. If you have a burning ambition to become a sales engineer, you can be. If you have your sights set on a top executive spot, you'll be there someday. One might think a large company like Westinghouse would have more pressing things to think of than the ambitions of its young engineers. On the contrary, nothing is more important . . . for our professional people are our biggest asset.

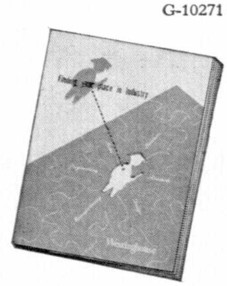
Here at Westinghouse, intensive efforts are made to help our professional men realize their individual goals—through extensive training programs, study programs leading to advanced degrees, leadership programs, and guidance in professional development. You are treated as an individual at Westinghouse.

If you have the will, and are prepared, we can show you the way.

G-10271

For information on career opportunities with Westinghouse, consult Placement Officer of your University, or send for our 34-page book, *Finding Your Place in Industry.*

Write: Mr. J. O. Campbell, Regional Educational Co-ordinator, Westinghouse Electric Corporation, 306 Fourth Ave., Pittsburgh 30, Pennsylvania.



YOU CAN BE SURE...IF IT'S
Westinghouse

Selecting Your Employer

By R. H. Earle, Chief Engineer
Central Plant, Line Material Company

The engineering student who is about to graduate and start on his working career often is confronted by so many job openings that he has difficulty in selecting the best one. Obviously, he wants to choose the position which offers him the best opportunity to develop his talents to the utmost, contribute the most to the organization he selects, and receive in return the greatest compensation in the form of recognition, personal enjoyment in his work, and his salary.

The young engineer's problem bears a striking similarity to that of a man who has some money to invest on a long-term basis and wishes to purchase common stock in the business concern which will give him the greatest return over the long pull.

Investment counsellors have some guides that they follow in advising prospective investors. The counsellors point out, as good investment possibilities, companies that are in a growing and an essential industry, have financial stability, and are operated by a seasoned management. It is interesting to see if these same guides could not be followed by the young engineer selecting a job.

One of the first things the young engineer and the investor have to decide is to what degree they wish to speculate because there is no such thing in the business world as absolute security, either for the money invested in a business or for the men that make up the organization.

The investor who is young, healthy, and financially independent, even during emergencies, can afford to take greater risks with his common stock fund than could, for example, an older man with family responsibilities, limited resources, and few years to recover from any financial losses he might experience. Likewise, the young engineer who is healthy and financially independent can afford to take a greater risk in the selection of a job than a young man who is married, has a family, and is solely dependent upon his monthly salary.

I believe that most young engineers and most long term investors in common stocks can take a so-called "businessman's risk," because they are both looking for a moderate amount of security. Engineers and investors seek an opportunity for progress through growth of the company with which they are associated.

At this point it might be interesting to trace the history of a typical company or typical industry in our economic system today.

The usual pattern is for the early stages of an industry to be quite hazardous from a financial standpoint and very speculative for both the investors and the employees. For example, the very earliest railroads that were built shortly after the steam locomotive was invented were very hazardous ventures and, undoubtedly, much money and many jobs were lost in the early stages.

Very often in these early stages there is not a market yet for the product being sold. Further, there has not been engineering design data accumulated to the point that a thoroughly satisfactory product can be designed and produced. The result is likely to be frequent customers' complaints and consequent losses from replacing defective products. As the industry and the companies in it gain more experience, establish a market for the product, and accumulate know-how and facilities, a reasonable measure of stability gradually evolves. The industry then enters a so-called "growth" period. If the product or service has a wide appeal, the market develops rapidly, and for some years shows no sign of saturation. During this period the industry and the companies in it are likely to grow at a more rapid rate than business in general.

Gradually as enough companies get into the business to supply the market adequately, the market approaches a ceiling and is ultimately made up of two parts: first in the replacement of products that have already been sold and have been worn out in service; second in supplying new buyers who have never owned the product before. This latter part of the market is pretty well geared to the increase in population. As conditions change and new products gradually supersede the existing product, the market levels off and then begins to decline. The classic example is the buggy whip business which was undoubtedly thriving 100 years ago but has now practically disappeared because of the automobile superceding the horse and buggy.

The foregoing history is quite typical of most industries and the companies that form it.

(Continued on page 28)

"Realistic Sound"

by Bill Bartley, E.E. '55

Almost everyone enjoys listening to music – whether he be a sophisticated collector of expensive, polyethlene Hi Fi recordings of classical music or an excited native in Africa hearing a short-wave radio for the first time. Music stimulates emotion; some kinds make you feel like dancing while others cause you to "day-dream" or go to sleep. However, these and the other psychological effects are *not* merely functions of the type of music, but are also dependent on another variable, *audio reproduction.*

What, then, does audio reproduction involve? The goal is to produce the most "pleasing" sound possible for the listener. Would this goal be completely fulfilled if an audio transducer (microphone), electrical amplifiers, a recording medium, and an electrical transducer (speaker or horn) could be developed which together give a flat, distortion free response? Although this is almost an impossible feat, the high fidelity industry has developed systems which, for all practical purposes, answer these requirements for frequencies below 20 cps. to those above 20,000 cps. (Note: The human ear can perceive frequencies up to about 20,000 cps.). The sound from these Hi Fi systems is very "pleasing" indeed. The average person, who has been forced to accept "radio music" (the narrow ranged audio, about 120-6,000 cps., from the average home radio or phonograph with much distortion deliberately introduced to increase efficiency) as a standard, is thrilled greatly when he perceives the high overtones and feels the true base notes which are reproduced only in a high quality sound system.

But precise reproduction without distortion of every note reaching a microphone is *not* the most "pleasing" sensation possible. When listening to an orchestra on a single channel Hi Fi system as compared to hearing the "live" orchestra, you realize there is still "something missing." Although each note is true, the audio field (in relation to the original source – orchestra – and you) is distorted and no matter how many speakers are used or where they are placed, a "spatial" distortion persists. Thus, Hi Fi which tends to eleminate non-linear, frequency, and phase distortions, is still not the "last word" in listening "pleasure"; we must go a step further and develop a system which also eliminates audio "spatial" distortion, reproducing sound with the "depth" and "perspective" that it had originally.

When we speak of "spatial" distortion we mean that the audio field is warped by the reproducing process so that the sound seems "unrealistic." We are all aware of the "binaural" effect created by the ears (similar to the binocular vision characteristic of the eyes) which allows us to subconsciously determine sound source position. Thus, at first glance, we realize that the audio position of each instrument in a hundred piece orchestra could *not* be maintained when reproduced through a single channel. The ears and complementary nerve system "compute" sound location or direction by comparing the intensity and the phase of the vibrations induced in each ear. The ratio of sound intensity (pressure) is an effective criterion for locating sounds with frequencies *above* about 700 cps. On the other hand, the alternate criterion, phase shift, is effective only for frequencies *below* about 800 cps. where the shift is greater than one cycle (speed of sound calculation). Fortunately, these criteria overlap so that we have "binaural" hearing to some degree for sounds of all "audible" frequencies; but, this also means that a reproducing system must satisfy the "binaural" criteria for all frequencies of sound produced to eliminate "spacial distortion."

Hearing sounds through a monaural (single channel) is like listening through a key hole; – all vibrations come from one point and "binaural" effects are lost. The "spatial" distortion inherent to monaural reproduction is demonstrated by comparing the audio "image" (mental) which you perceive when hearing the sources directly with the "image you get through the reproducer; the naturally wide audio field is shrunk to a point and the sounds are "piled up." And not only do we lose the "perspective" of correctly positioned sound sources but our hearing characteristics are also affected. A weak sound seems even weaker for binaural sound generates (in our mind) an auditory response curve which gives a 6-30 db. boost to weak signals as compared to that generated by both ears listening to a single channel. Consequently, *true fidelity* reproduction of the full range of audio amplitudes cannot be achieved using the Stereotype monaural "High-Fidelity" system with its "flat response."

At this point it seems pretty clear that a reproducer which eliminates "spatial" distortion will be a multi-channel system. But, how many channels? Let's first consider a reproduction system using headphones instead of speakers; this immediately limits us to two channels — one for each ear. In setting up the system it seems logical to place the two microphones about the same distance apart as our ears and, of course, we hope that the microphones used have directional properties similar to our ears (system should be essentially flat in response to allow for the natural losses in the ears.) Listening to this "binaural" reproducing system we realize that this is *no* different than hearing the sound directly; there is *no* "spatial" distortion.

We cannot hope to get any more realistic reproduction of sound than is afforded by a two-channel high-fidelity system feeding into headphones. However, many people dislike wearing phones even though several very light and comfortable models are available (mainly because of the annoying cords). Consequently, we are forced to try for a "stereophonic" system using speakers even if we must sacrifice some of the realism of reproduction. With the stereophonic system there is no limit on the number of channels. However, many tests have shown that for most small audience applications (not theater audience), additional channels over and above *two* will *not* noticeably enhance the reproduction.

The two-channel stereophonic system is the most "practical" reproducer of "three-dimensional sound" (the analogy drawn from stereoptics) for general home use. Although it is sometimes carelessly referred to as a "binaural" system, the effect is not truly binaural for the two channels are not completely isolated and some "spatial" distortion is introduced because each ear hears some sound from the oppsite speaker. In analyzing this "cross-over" condition, we might consider the "image" which would be perceived for each speaker (left and right) individually (monaural condition).

It seems, then, that what we actually hear is a "composite image" with *some* "spatial" distortion. Nevertheless, this two-channel stereophonic system gives much more realistic reproduction than is possible with monaural.

Now comes the question, "How should the transducers (microphones and play-back speakers) be placed for a two-channel system to give the most realistic effect (reduce the "spatial" distortion the most)?" If we are to make the "receiving" (play-back) geometry approximately symmetrical with that of the "sending" (recording) end, it seems that the play-back speakers should be about the same distance apart as the microphones were during the recording. Also, it seems obvious that as the listener moves back, farther and farther from the "speaker line", the "spatial" distortion due to cross-over between opposite speakers and ears increases. Thus, for the typical home living room, where we would like to place our speakers about 12-15 feet apart, the only "general" rules are that the listener be on the bisecting line between speakers (so as *not* to introduce artificial time lag between channels) and at a distance not too much greater than the speaker spacing.

We see now that in a theater this two-channel system would have no place — for it would be impossible to seat a large audience close to and on the bisecting line of two speaker horns. So for large audiences stereophonics takes a new form; we do not try to create sound location and displacement by "binaural" illusion," but instead, place a speaker at every point that a sound source "image" is to appear. Thus, sound displacement is accomplished by switching from one speaker to another and the "reality" of the reproduction is a function of the number of speaker channels used. Most of us have heard a system such as this, with varying numbers of channels, in some theater showing polarized "3-D," Cinemascope, or Cinerama motion pictures. We realize that although the reproduction by one of these systems, limited for reasons of economy, is much more "realistic" than monaural, it cannot equal binaural.

In passing, it should be mentioned that "synthetic" binaural or stereophonic effects can be created using only one channel. One approach is to deliberately introduce nonlinearity into a monaural amplifier which tends to accentuate weak signals and attentuate strong signals in a way approaching the binaural auditory linearity curve of our ears (very weak sounds are perceived at from 6-30 db. higher than on ordinary monaural). This "binaural compensation" brings in more information, corrects for high level noise, and reduces intermodulation distortion (simpler wave forms). Other "synthetic" systems call for amplitude and phase shifting networks feeding several speaker channels from a monaural recording in an attempt to add an artificial "depth." And, we are all familiar with the "echo" introduced in portions of many popular commercial records which is really a trick to simulate binaural conditions. Although all of these methods produce audio which falls far short of true stereophonic sound, they do, in general, increase the "pleasure" of the monaural listener.

Sizing it up, I think we will have to agree that multiple channel audio reproduction is "something that is here to stay." It is the music lover's ideal, a real thrill to the theater goer when combined with three-dimensional motion pictures, an aid to hearing, and is of great use to industry in studying sound engineering problems. Its greatest play will probably be in the musical recording field and use there is, without doubt, going to cause revolutionary changes in techniques. The stereotyped recording studio, unnaturally shaped and acoustically "dead," which has been used so much for monaural recording is strictly tabu in binaural recording. If the binaural recording is to sound "real" it must be made in a room that sounds "real", normally shaped with random acoustics that are natural; not some "nightmare" of a room that a monaural sound engineer dreamed up. In the words of Emory Cook (a pioneer in the Hi Fi monaural and binaural recording industry), ". . . making binaural (and stereophonic) reproductions will probably become much more of an art than the regular monaural ever was."

Agricultural Engineering Needs a Change

by Eugene T. Speller, A.E. '55

A change in agricultural engineering curricula is needed throughout the nation's colleges. This change has been in demand from working engineers for some time.

According to these professional men, the agricultural engineering curricula should be extended.

An engineering curriculum is designed to give students a knowledge of fundamental principles of engineering sciences. It should acquaint students with approved methods of engineering practice. The curriculum should be designed to give a true concept of the duties and privileges of the engineer as a citizen and as a member of his profession.

Although the courses are arranged by experienced instructors and engineers, it is impossible to design a curriculum to suit the needs of each individual student. Considering this, every effort should be made to give students time to take the additional courses they desire.

Should the student desire to further improve his speech, his writing or his knowledge of the government, he cannot do so because of the few electives he is allowed. Due to the inflexibility of the curricula, agricultural engineering students are prevented from broadening their education. The curricula must be flexible.

Let's take a look at agricultural engineering. Before the student decides to become an agricultural engineer he should be aware of the main requirements.

He needs personality, character, ambition, resourcefulness, and technical ability.

He should have a real interest in, and an affection for, the farm – its rural environment, its people, its crops and animals, its soil and open sky. This interest is developed better through actual farm experience.

The student must have the ability to apply mathematics. Merely being quick at figures is not enough. An engineer must be able to solve problems by applying the principles of mathematics.

The agricultural engineer's stock-in-trade is a knowledge of fundamental mechanics, strength of materials, and physics – as well as math.

Agricultural engineering students also study surveying, soils, and hydraulics as part of their basic training. However, the application of these fundamentals differs in each branch of agricultural engineering.

Agricultural engineering is the application of engineering principles to agriculture in five areas.

They are: farm power and machinery, farm buildings, rural electrification, soil and water management, and the handling and processing of farm products.

The graduate agricultural engineers of some schools are "jacks-of-all-trades." Michigan State is one of those schools. Those who qualify for the degree of Bachelor of Science in Agricultural Engineering here study in all five branches.

In the branch of farm power and machinery, they study the design, development, and testing of tractors and stationary power units. They also study the operation of tillage, fertilizing, spraying, seeding, dusting, harvesting, transplanting machines and processing machines.

In the branch of farm buildings and conveniences, students study the application of engineering principles to concrete design, steel construction, and in the use of wood in farm buildings.

At M.S.C., in the rural electrification branch, students study the application, economy and convenience of electrical energy in all operations involving the use of electricity and agricultural industry.

The soil and water management branch require students to learn to design and construct drainage, irrigation and water control equipment.

In order to qualify for work in farm products processing, students must study refrigeration, ventilation and heat transfer equipment.

It can be seen that authorities at Michigan State favor a minimum of specialization. They maintain that the employment pattern of agricultural engineers shows a very broad use of their talents, not only outside a specific branch of agricultural engineering, but also beyond the entire field.

William T. Hollister, a Michigan State student who graduated with an agricultural engineering degree in June, 1954, has accepted a position with the Continental Motor Corporation, Detroit, in the gas turbine division. This is a case in point against rigid specialization for agricultural engineers, or any engineers.

Recently, an oil company wanted to employ a man trained in farm power and machinery. This man could use his training in soils to develop fuels for tractors used in various soil conditions.

(Continued on page 34)

QUARTZ CRYSTALS

How a 1¼ hour "gem-cutting" operation became an 8-minute mechanized job

PROBLEM: Preparing quartz crystals for use as electronic frequency controls calls for the highest degree of precision. So much so, in fact, that prior to World War II skilled gem-cutters were employed to do the job.

But during the war, there were not enough gem-cutters to keep up with the demand for crystals in radar, military communications and other applications.

Western Electric tackled the job of building into machines the skill and precision that had previously called for the most highly skilled operators.

SOLUTION: Here is how quartz crystals are made now—by semi-skilled labor in a fraction of the time formerly required:

A quartz stone is sliced into wafers on a reciprocating diamond-edged saw, after determination of optical and electrical axes by means of an oil bath and an X-ray machine. Hairline accuracy is assured by an orienting fixture.

The wafers are cut into rectangles on machines equipped with diamond saws. The human element is practically eliminated by means of adjustable stops and other semi-automatic features.

The quartz rectangles are lapped automatically to a thickness tolerance of plus or minus .0001″. A timer prevents overlapping. Finally, edges are ground to specific length and width dimensions on machines with fully automatic microfeed systems.

Most of these machines were either completely or largely designed and developed by Western Electric engineers.

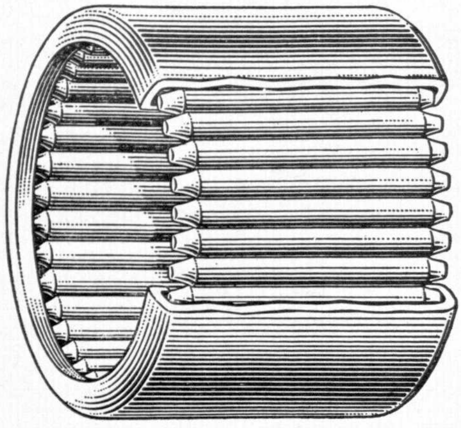
RESULTS: With skill built into the machines—with costly hand operations eliminated—this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

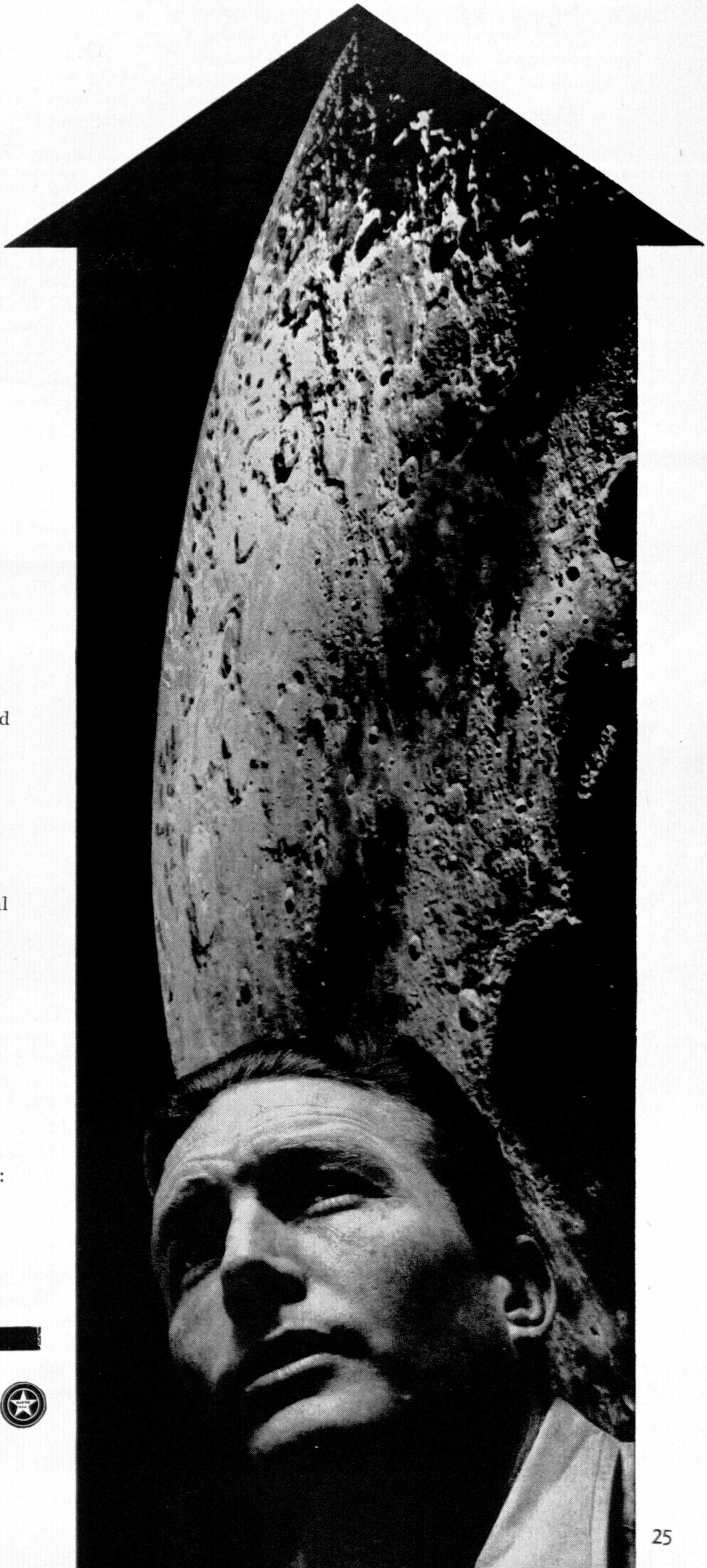
Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.





More Brain Use by Pilots

Man's brains instead of his hands will pilot tomorrow's airplane, the chief pilot of Lockheed Aircraft Corporation told the Air Transport Association conference at San Francisco.

Talking on "The Human Side of Tomorrow's Airplane" at the ATA's annual engineering and maintenance meeting, the veteran test pilot said the airplane of the future "while making fewer physical demands" on its crew and ground handlers "will make very heavy demands on their mental capacities."

Referring to the pilot, he said, "The skill of the captain of tomorrow's airplane will be expressed in minutes and his accurate use of them."

Failure of an engine in a multi-jet transport will not call for unusual flying skill or be a serious hazard, he told the ATA members. However, "Since successful operations at high altitudes (40,000 feet and higher) and high speeds (600 m.p.h. and more) require that all systems (of the plane) function continuously, the flight engineer, who will then be a 'systems manager', will assume the responsibility for the security of the flight."

He emphasized that the pressurization system of stratospheric aircraft is "as vital to survival as the structure of the airplane."

He predicted that high altitude flying will be "completely controlled traffic at all times", and not by visual flight rules, because in the upper atmosphere at high speeds the pilot's vision is not quick enough for guidance purposes or to avoid collisions.

"The growth of the automatic device and the automatic controller has been tremendous."

He foresees aerial vehicles in which "not only will most of the aircraft systems be automatic, but the navigation job will be done automatically as well."

He said, "We have almost reached that stage today when the value of minutes in the operation of tomorrow's airplane will make the automatic navigation device a necessity."

This new kind of air transport, the test pilot stated, will put increasingly heavy responsibilities on maintenance and ground crews, especially in the electronics field.

"In order to properly man the fleets of airplanes we expect to have, we must see a tremendous growth in the number of electronically qualified maintenance and flight crews. The job is a huge training problem."

He indicated that the military services "who are beginning to operate ariplanes with the characteristics of our new machine" already face this problem and the aircraft industry as well is "feeling the need for more properly qualified electronic technicians today."

Silencer for Jets

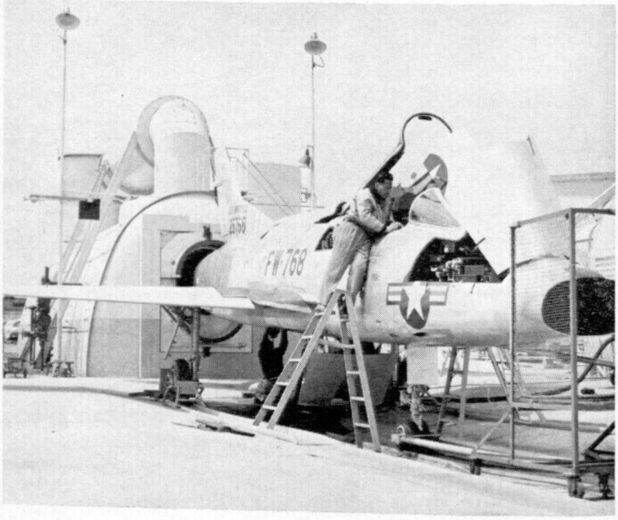
Three advanced silencer units for ground operations of the nation's newest and most powerful jet airplanes and engines have been added to sound abatement systems at fighter assembly lines.

The new facilities will be used in ground operations of the F-100 Super Sabre, first production airplane capable of exceeding the speed of sound in normal, level flight, and for acceptance testing of its Pratt-Whitney J-57 engines.

Largest of the three new silencers is a $261,000 chamber for testing the J-57 power plants. The jet engine develops 10,000 pounds of static thrust and is the nation's most powerful.

Engines operating at full power are barely audible 250 feet from the abatement unit.

Sound of the engine during run-ups is contained by the chamber's three *feet* thick walls. Constructed of corrugated steel plates one-eighth of an inch thick and separated by tons of sand, the walls are slightly elastic and absorb the sound energy of the operations.



The sound of careful pre-flight operations, the last production step for F-100 Super Sabers, is sharply reduced in this sound abatement chamber.

A 45 *feet* long muffler, six feet in diameter, catches more of the sound and is water-cooled to absorb nearly all of the 3,500 degrees of heat produced by full-power operations. An automatic water ring sprays 480 gallons of water a minute into the muffler, where the heat so nearly evaporates the liquid that only a few wisps of steam are visible from the chamber's exhaust stack.

During the acceptance testing, the engines are operated from two instrument panels in a control room outside one wall of the test chamber. Technicians watch the operations through two large observation windows constructed of four panels of bullet-proof glass.

Mirrors mounted on the internal walls of the chamber give the technicians a clear view of each external part of the engine.

The two other units for ground operations of the F-100 Super Sabre utilize similar test chambers and silencer systems, and were built at a cost of $85,000 each. The tail pipe of the Super Sabre is fitted into an opening in the unit and surrounded by a huge "washer" of asbestos cloth. The engine is operated from the cockpit of the super-sonic fighter.

The structure reduces sound energy by the cushioning effect of the steel plate and sand, a new concept nicknamed "Elastic-Plastic Mass Control."

The slight elasticity of the walls allows the sound energy to be transferred to the sand filling where the movement of each grain absorbs and dissipates the force.

Outdoor Corridors

Snow melting coils of wrought iron pipe embedded in outside corridors of Apartments in Jamaica, New York, permit the introduction of important advances in modern apartment house construction.

Shown in the above photograph is part of the early construction of new apartments in Jamaica, New York. Snow melting coils of wrought iron pipe are embedded in all outdoor corridors of each of the apartment buildings. Corridors lead from living suits to the elevator and stairway areas, thus eliminating the need of interior hallways that often separate apartment units.

The unique adaption of snow melting lends itself to a radical departure from the traditional design features of large multi-story residences, while effecting considerable savings in building costs and future maintenance expense.

Hidden heat keeps the outside corridors free of ice and snow in winter weather and makes them practical for year-around use as the main artery leading from the living suites to the elevator and stairway areas.

Long, dingy interior hallways that block out much of the light in conventional apartment buildings are unnecessary.

Because the apartments are built for private ownership in a cooperative corporation, the full utilization of building area and absence of hall carpeting and cleaning expense represent important economies to purchasers.

Since there is no interior hallway, each living suite of an apartment extends in unbroken length from the corridor to the terrace side of the building. Large window areas at either extreme assure bright and airy rooms with a maximum of cross and through ventilation.

Supply lines for the snow melting installations lead from the main boiler room in a central building to individual heat exchangers in each building. Heated water mixed with anti-freeze is circulated through the corrosion resistant piping to melt snow as it falls and prevent ice formations.

Factory of the Future

Scientists now tell of developments in the fields of transistors and silicon rectifiers which "will produce significant changes in virtually every major industry in the country."

One new device expected to have a far-reaching effect in any application that requires the conversion of alternating current to direct current is a new type of silicon rectifier. This experimental device, which has no moving parts, has an efficiency of approximately 98 per cent – about 10 per cent better than the best motor-generator sets today.

Engineers believe the new rectifier, with modifications in size and power ratings, will find applications in computers, in aircraft, radio and television power supplies, electroplating processes, and possibly in the elimination of certain parts of motor-generator sets.

Three hundred years ago, we entered what became known as the era of the Industrial Revolution. At that time men began substituting mechanical power for animal muscle power. By World War II the art of using mechanical power had reached the point where practically all major work was being done by machines. In effect, machines took over the job of human muscles.

Today, we are on the verge of developing complete "nervous systems" for those mechanical muscles – nervous systems which will not only tell machines and entire production lines what to do, but how to do it, when to do it, and how often to do it. The use of the new materials such as silicon, germanium, and others will do much to expand the use of these "nervous systems."

With the new controls that will be made possible as the result of such developments, it is unlikely that an entire paper mill, for example, would ever be shut down because a set of brushes on a rotating regulator wore out, or that an automobile factory would lose $100,000 in production time because some control stopped working when a few drops of oil dripped on it.

The silicon rectifier is being considered for possible

(Continued on next page)

Factory of the Future

(Continued from page 27)

application in the aircraft industry because of its ruggedness and its ability to operate efficiently at temperatures as high as 392 degrees Fahrenheit and higher. Rectifiers made of other materials such as germanium have a temperature limit of 212 degrees in industrial applications.

Such developments as these in transistors and silicon rectifiers are opening new horizons for modern man. Along with other discoveries being made almost daily, they portend a new era of new and better products at lower costs and in greater quantities.

Selecting your Employer

(Continued from page 13)

Sometimes as an industry starts to decline, alert manufacturers recognize trends away from their original field of endeavor and branch out into new fields, but many do not and ultimately become casualties in the business world. This, of course, results in loss to the holders of common stocks and the employees who have made up the organization. This typical industry pattern having a speculative start, then a period of growth, the reaching of the zenith, and ultimate decline, is recognized by investment counsellors and could well be kept in mind by the young engineer selecting his first job.

In general, not very many investors nor very many young engineers can afford to take the chances of the extremely young industries and companies. It is true that our great companies of today were at one time extremely small, and those investors and employees who stayed with them have made fabulous profits or have advanced into high positions through the growth of the company.

The risk of such situations is well illustrated by the dozens of automobile companies which were formed and went bankrupt in the early days of that industry. Out of those early troubled times have grown the great automobile companies of today, some of which rank among our most stable enterprises. Manufacturing automobiles is no longer a particularly speculative line of business; investments and jobs with these companies compare favorably in security with our other leading lines of business.

If a person has the emotional make-up to be happy in very speculative situations, he can consider joining an organization in the very early speculative stage. However, he should be sure that he really has this make-up and can be happy and retain his health under prolonged conditions of extreme uncertainty. A man who is somewhat more conservative, but does not demand a maximum of security, can well consider one of the smaller companies in a growing well-established industry.

The company should have a successful record which

(Continued on page 30)

Feature Column

Fable of the Light Bulb and the Sperm Whale

Once upon a time there was a baby whale who wanted to "be somebody" when he grew up. He was serious about this, and not at all like his brothers and sisters, who were content to disport themselves by spouting water, and scaring smaller fish out of their fins.

"Your great-great-great-great-grandfather was the whale who saved Noah and made possible this modern civilization of ships and lighthouses," he was told repeatedly by his mother.

The little whale was proud of his heritage, and more than anything else wanted to be a worthy great-great-great-great-grandchild of his famous ancestor.

The little young whale grew to be a big old whale, and it seemed his opportunity for fame would never arrive. The big ocean liners were swift and powerful, and never seemed to need help. Anyway, the whale was afraid of them, and swam away when they approached.

But he was fascinated by the lighthouse near his home, and liked to swim 'round and 'round it, and admire the powerful light which served as a warning to ships at sea.

One day the impossible happened. The light went out! His kindly friend the lighthouse keeper was frantic. He had a stock of replacement lamps, but he could not get the burned out bulb out of the socket. It was stuck.

General Electric rushed out an expert, and after a hard struggle the two of them managed to remove the old bulb and insert a new one in time to keep ships away from dangerous waters.

"To keep these aluminum-based bulbs from sticking in the future we must lubricate them with hydrogenated oil from a sperm whale," the whale heard him say. "It will prevent sticking and inhibit corrosion. And besides, it's odorless, invisible, and doesn't stain fingers or clothes. Hereafter G.E. will apply this oil to all aluminum bases, so that people will be sure of trouble-free light."

The next morning the lighthouse keeper and the G-E man found the huge body of a sperm whale washed up on the beach. There was a smile on his face, as if he died knowing that he had become somebody of which his famous ancestor would have been proud.

Copy Engineering

Did you ever hear about product engineers? They are the engineers who have the overall responsibility of the theoretical, experimental, and manual work on new machines.

Much has been said about the requirements for an engineer who does production and design work. Just what is his greatest asset?

The theoretical work of a new machine includes the application of the laws of physics. These laws include thermodynamics, mechanics and strength of materials.

Product engineering also requires the application of chemistry and mathematical methods. Laws and relations that are developed from theoretical considerations must be verified experimentally.

(Continued on next page)

Feature Column

(Continued from page 29)

Experiment involves the determination of the properties of materials, the analysis of stress, strain and vibrations in complicated structures, and the performance of complete machines and units of machines. The manual work is the actual production in the shop.

Safety and economic factors must also be considered. The lowest overall cost is usually desired. Consideration must be given to the cost of design, manufacture, sale, installation and to the cost of servicing.

The production engineer's most valuable asset is his ability to copy competitive equipment without using the same patent. No company will have engineers capable of producing every new machine first. Many times a machine will be produced by one company that is yet on the drawing boards and in the minds of engineers of competitive companies.

To remain in competition the companies must produce a machine to perform the same functions as soon as possible. This usually isn't done by continuing with theory and experiment of only the company's own product.

Since companies do not invent most of the machines that they produce, they must copy from machines that are in production.

What about patent rights? That is the copy "production" engineer's job. He must produce new machinery to perform the same function, better than competitive equipment by copying from competitive equipment, yet using existing patents as little as possible.

We call this product engineering. Why not call it just copy engineering?

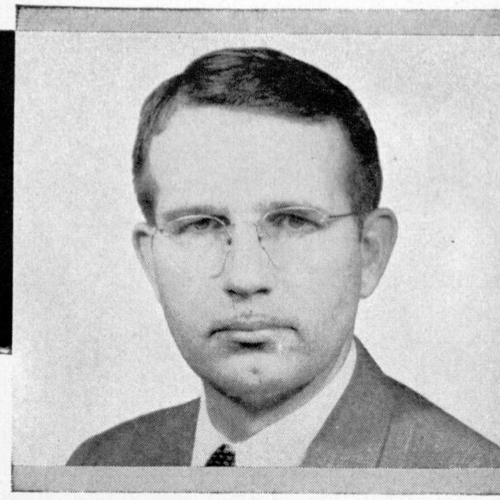
Selecting your Employer

(Continued from page 28)

means the management should have proven itself over a period of years not only to be able to manage well, but also to be progressive, and the company should be in good financial shape. It should have a history of more than average growth which frequently means that in its own industry, its line of products does not completely cover the field. Therefore, the company can grow not only as its industry grows, but also as it adds new products progressively to round out its line. These smaller companies are apt to grow faster percentage-wise than their very large competitors who have been in business so long that their line of products is virtually complete. These large companies are likely to offer a little more security, particularly in the early years of employment, but probably not quite the opportunities for advancement for the average young engineer.

(Continued on page 35)

"Allis-Chalmers Graduate Training Course Gave me a head start"



says GERALD SMART

Marquette University, BS—1948
and now Supervisor of Plant Engineering,
Allis-Chalmers, Norwood, Ohio, Works

"MOST MEN graduating from college don't have a clear idea of what they want to do. These individuals are helped by Allis-Chalmers Graduate Training Course to find the right job whether it be in design, sales, engineering, research or manufacturing.

"My case is a little different, however. I started the course with all my interest centered on tool design and 'in-plant' service. The reason is that I started getting vocational guidance from some very helpful Allis-Chalmers men back in 1940."

Served Apprenticeship

"At their suggestion I had gone to school part time while working full time. This not only gave me the chance to serve an apprenticeship as a tool and die maker, and earn money, but I learned what I wanted to do after graduation.

"Then came the war and service in the Navy. After the war I finished school. By the time I started on the course in 1948, I knew what I liked and seemed best fitted to do. As a result, my entire time as a GTC student was spent in the shops.

"The 18 months spent in the foundry, erection floor and machine shop have all proved valuable background for my present job.

"As supervisor of plant engineering at the Norwood Works, I am concerned with such problems as: Plant layout, material handling equipment and methods, new construction, new production methods to be used in building motors, centrifugal pumps, and *Texrope* drives. It's an extremely interesting job.

"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

Facts You Should Know About the ALLIS-CHALMERS Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

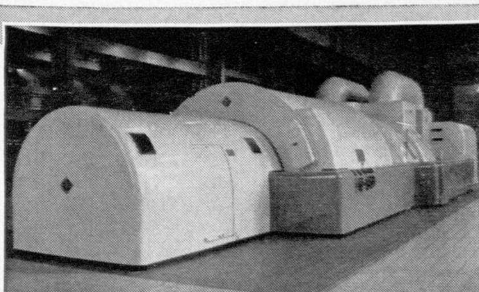
3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbogenerators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

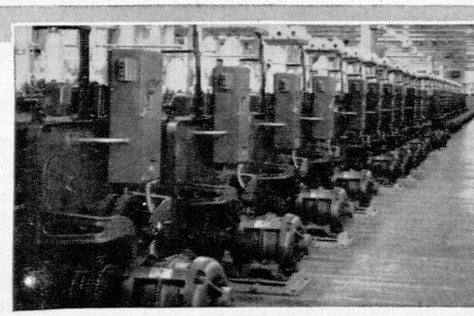
5. He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisc.



Steam turbines, condensers, transformers, switchgear, regulators are built for electric power industry.



Motors, control, *Texrope* V-belt drives—all by Allis-Chalmers are used throughout industry.

A-C ALLIS-CHALMERS

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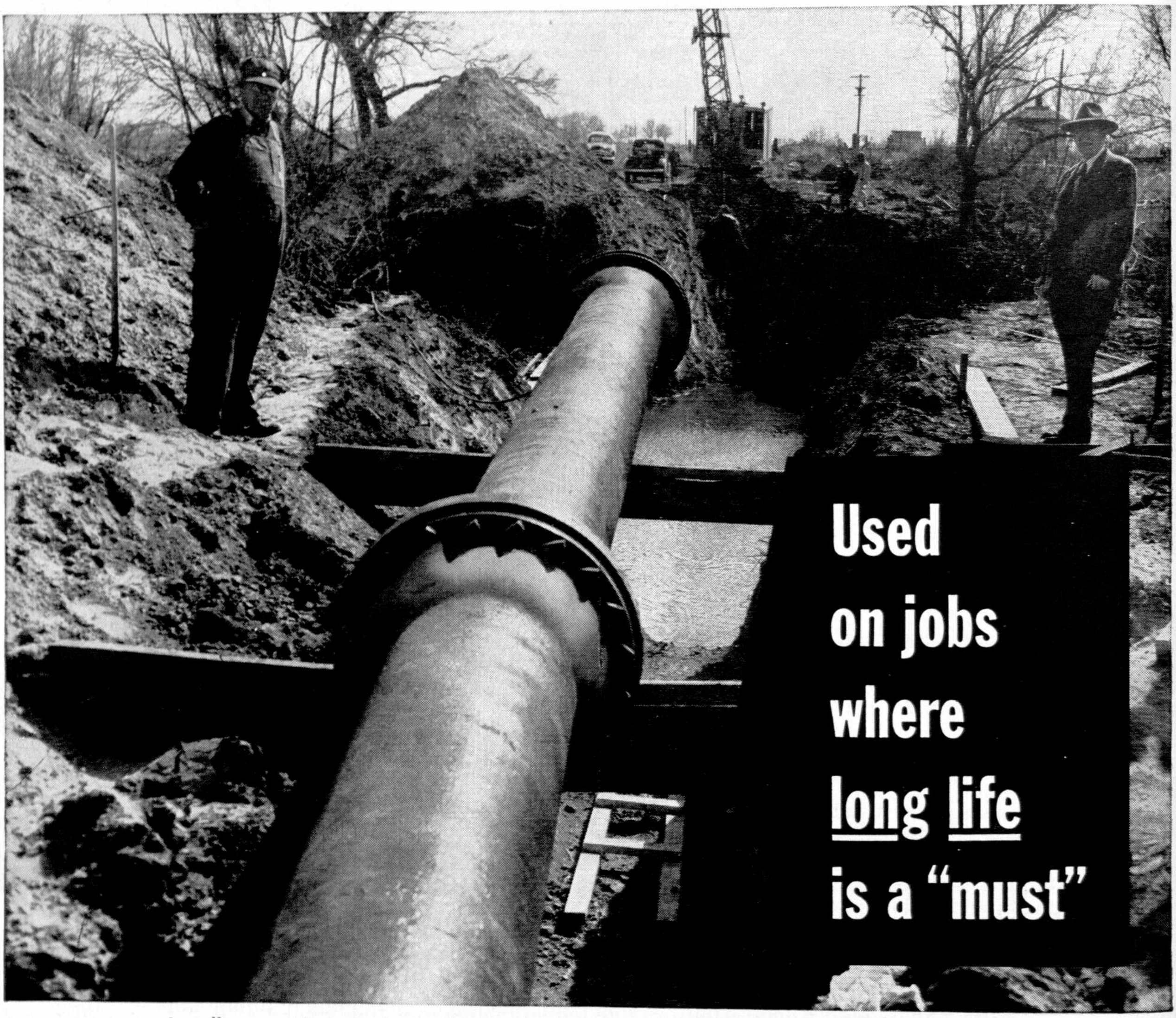
Texrope is an Allis-Chalmers trademark.



Installing cast iron mechanical joint pipe across river at Salina, Kansas, for sewer main.

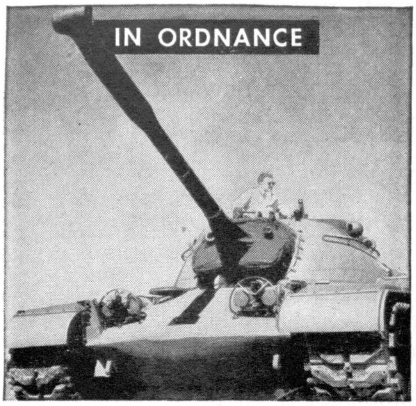
When an installation, once completed, should be as trouble-proof as planning and materials can make it — engineers rely on cast iron pipe. It has high beam-strength, compressive-strength and shock-strength. Its effective resistance to corrosion ensures long life, underground or underwater. These are reasons why cast iron pipe is so widely used for water lines in tough terrain, pressure and outfall sewers, river crossings, and encased piping in sewage treatment and water filtration plants. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.

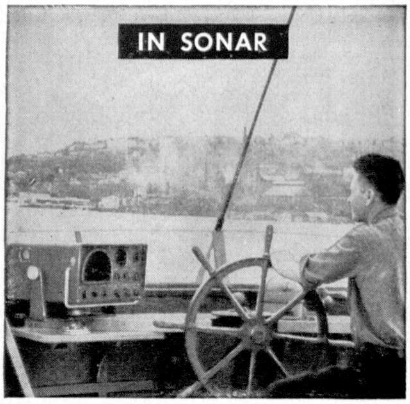
This 123-year-old cast iron water main is still in use in the distribution system of St. Louis, Mo.

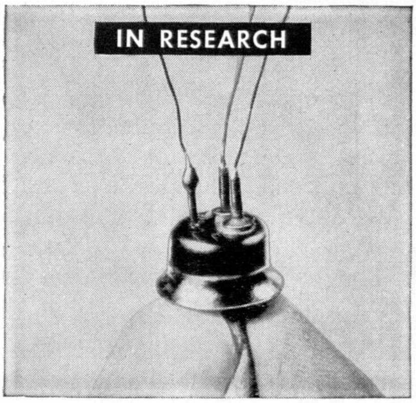
® CAST IRON

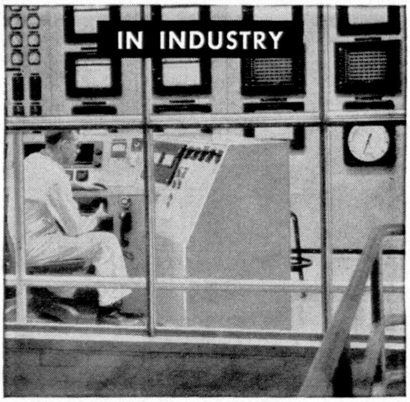
CAST IRON PIPE SERVES FOR CENTURIES

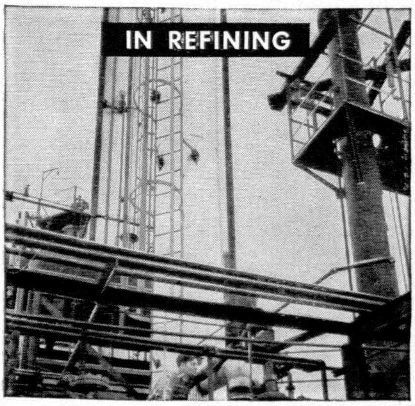
HONEYWELL OFFERS CHALLENGES UNLIMITED

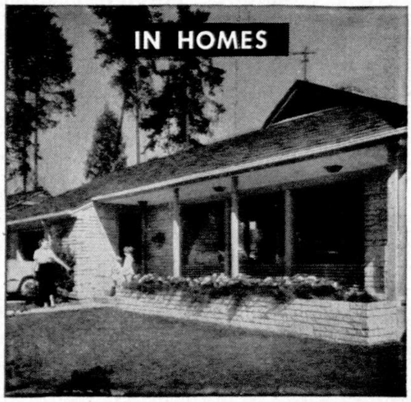


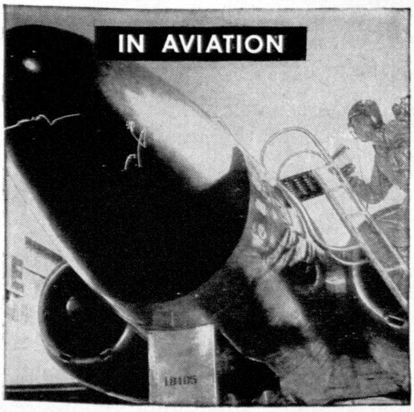












THE challenges and problems for the engineer in the automatic control field are unique in their variety and in the insight provided into all of the industries of today's modern world.

The development and manufacture of tiny transistors for electronic control . . . the design and construction of giant control valves for oil refineries . . . the challenge of finding fish with underwater sonar . . . of providing automatic flight for supersonic jets . . . temperature controls for today's modern home . . . for atomic piles . . .

These are a few of the fields in which Honeywell's several divisions are engaged, providing automatic controls for industry and the home.

These controls are made possible by the creative imagination of highly trained engineers working with the very latest research and test facilities.

With nine separate divisions located throughout the United States and with factories in Canada, England and Europe, Honeywell offers unlimited opportunities in a variety of challenging fields. Based on diversification and balance between normal industry and defense activities, Honeywell will continue to grow and expand because automatic control is so important to the world's progress. And automatic control is Honeywell's business.

That is why we are always looking for men with ideas and imagination and the ambition to grow with us. In addition to full time engineering and research employment we offer a Cooperative Work Study program, a Summer Student Work Study program and Graduate Fellowships. If you are interested in a career in a vital, varied and diversified industry, send the coupon for more information.

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Agricultural Engineering

(Continued from page 17)

According to E. W. Lehmann, head of the agricultural engineering department at the University of Illinois, there is as much difference between a job in the implement industry and a job in the farm structures field as there is between mechanical engineering and civil engineering.

Lehmann contends that most students who enter agricultural engineering have a reasonably good idea of the type of work they want to do. When they finish their sophomore year they know the branch of agricultural engineering for which they want to prepare.

Writing for the *Agricultural Engineering Journal* (December, 1952), L. H. Skromme, an agricultural engineer, says it is his "strong contention that the field of farm machinery design presents a greater challenge to an engineer's ability than any other field of engineering."

He suggests that students who intend to work in this field be given additional courses in machine design and related courses.

D. G. Carter, an agricultural engineer, wrote in the same journal, in January, 1953, that "today's buildings may be outdated in the future in the same way that older buildings have become obsolete as a result of recent changes". Striking examples of changes include the shift from the farm-sized poultry shelter to the large scale laying unit and broiler plant. Shifts from the dairy stall barn to the modern pen-type dairy barn, and from machine sheds to present-day machine storages are still other examples.

In view of these facts, Carter thinks the agricultural engineering students who prepare for farm structures work should be better trained in that field.

R. M. Salter, a soil and water specialist in agricultural engineering, states in the February, 1953, issue of the *Agricultural Engineering Journal*, that "the transition has been made from 'civil engineers in agriculture' to agricultural engineers, trained to adapt engineering principles and techniques to land, crops and related problems."

According to Salter, this is evidence of the need for additional training for soil and water engineers.

These men and those working in other branches of agricultural engineering want the graduate engineer to be better prepared for the branch in which he expects to work.

He could use his structures training to solve shelter and building problems. He might also use his knowledge of processing equipment and transporting equipment to solve fuel and lubricant problems.

Likewise, the rural electrification supervisor of a large public utility company was looking for an agricultural engineer to solve problems in planning the installation of equipment to improve labor efficiency around the farmstead.

All this points out that agricultural engineers need more training in the branch which they intend to work.

Authorities at the University of Illinois, and many others, favor specialization. They maintain that the agricultural engineer is expected to be able to function either in the farm power and machinery field or in the farm structures, soil and water engineering field.

The University of Illinois has provided two options for agricultural engineering students. The subjects taken during the first two years are the same for both options. At the beginning of the junior year the students must choose between the power and machinery option or the farm structures, soil and water engineering option.

Students often get better opportunities in the branch in which they do not plan to work. Engineers sometimes become company executives. Specialization does not prepare an engineer for an executive position.

Therefore, the agricultural engineer who specializes is limited.

The retired editor of the *Country Gentleman* is an agricultural engineer. The editor of the Nebraska Tractor Test Manual and also associate editor of a leading farm magazine, has an agricultural engineering degree from Michigan State College. These positions, as many others, are not suited for a specialist.

The curriculum, such as Michigan State College has set up, has distinct advantages over the present option system used at many colleges.

It also has disadvantages. Michigan State College students who complete requirements for an agricultural engineering degree in four years and take advanced military science can take only three electives. This also limits students to a great extent.

Students who do not take advanced military science can elect additional courses in the branch in which they expect to work. They can also take courses outside the engineering department.

These courses are important to the student and should be considered essentials in his college career by the persons who make up the curriculum.

Many students who take advanced military science would like to get more out of their college training than an engineering degree. Some would like to elect courses in journalism, government, photography, accounting and many others.

The courses required by agricultural engineering department are important. The time required to complete the agricultural engineering curriculum should be extended. This would give the student who wants additional courses in agricultural engineering and the student who wants additional courses in other departments more time to complete their education.

(Continued on next page)

Increasing the course length to five years would discourage many students who would like to become agricultural engineers. A program could be set, however, whereby some of the general agriculture and general engineering courses would be given during a summer training period on the farm or in connection with an implement company.

This would serve three purposes. First, it would give the student the much-needed experience in practical applications of engineering principles to agriculture.

Second, it would provide money for the next year's college expenses, which some students must earn if they are to continue their education.

Finally, it would give the student more time to elect the additional courses he desires – giving him a much-needed well-rounded college education.

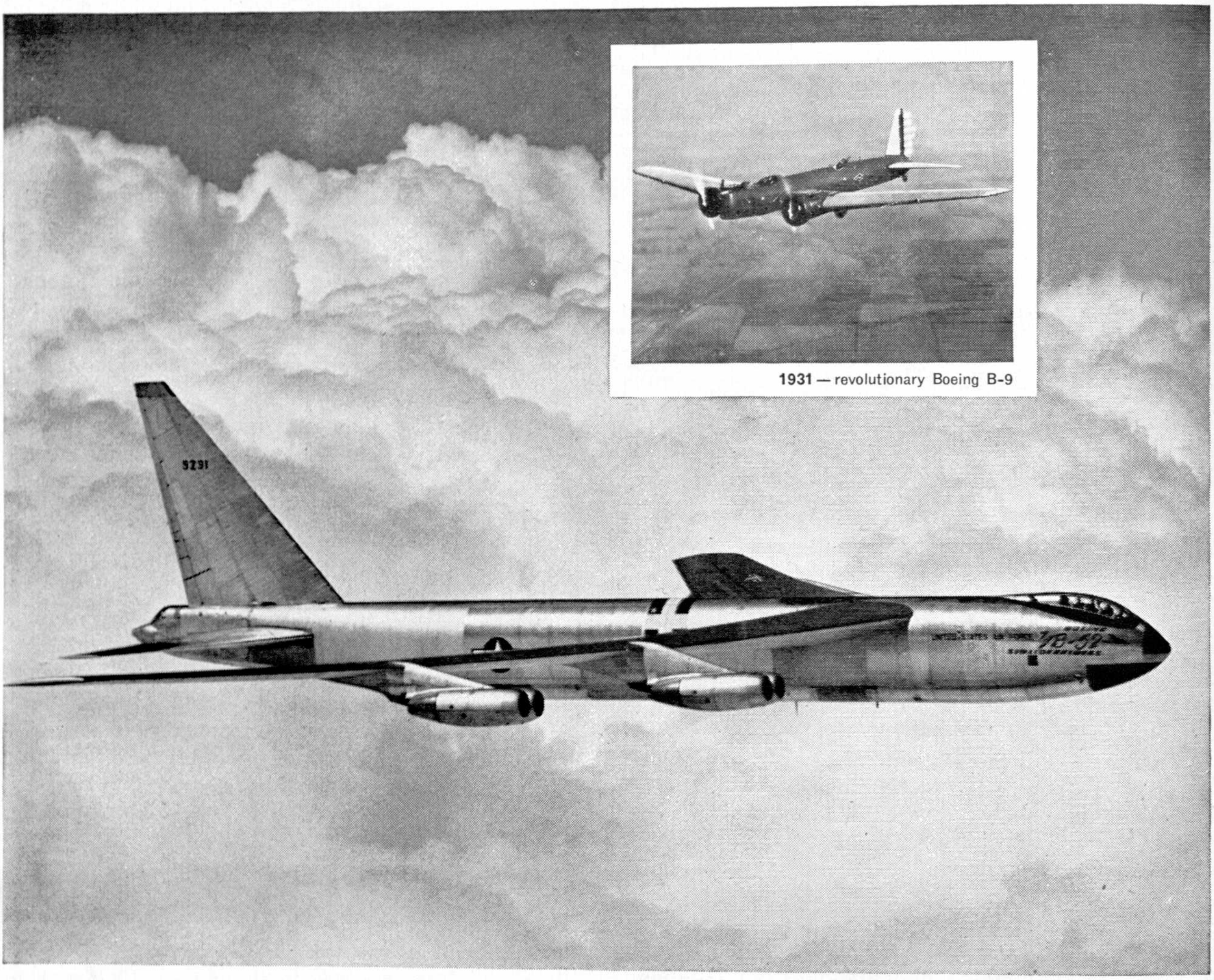
Selecting your Employer

(Continued from page 13)

The man who needs still more security to remain happy and whose inclinations are perhaps not very competitive, will probably be better satisfied in one of the largest companies in the most stable industries whose products or services find a market both in good times and bad. As a general rule, these very secure positions do not pay as much salary as the more speculative ones, but there are frequently other forms of compensation such as more favorable insurance, pension or medical treatment plans, company activities, and, above all, peace of mind of the employee.

Now suppose that the young engineer or investor has sized up the situation and has boiled his choice down to a few companies which appear to offer about equal prospects in the future, there is not much more that can be done. The final choice becomes largely a matter of chance and is relatively unimportant as far as the odds are concerned.

It appears, therefore, that the guides of the investment counsellor in choosing attractive common stocks for his client can be useful to the young engineering graduate confronted with a great many opportunities for employment. Both the investor and the young engineer are likely to do well with a growing company in a growing industry, and both will find it impossible to predict much ahead of time their exact rate of progress with extreme accuracy. Both the young engineer and the investor who are willing to take a reasonable amount of risk will find the odds in their favor if they choose an aggressive growing company in a growing industry that is well established in our economic pattern.



1931 — revolutionary Boeing B-9

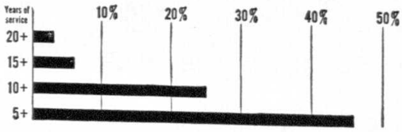
1954 — Boeing 8-jet B-52, America's outstanding heavy jet bomber

Leadership is a long-time tradition at Boeing

In 1931, Boeing engineers designed the B-9, a revolutionary low-wing bomber that could outdistance any contemporary pursuit plane.

Today, they've produced the free world's outstanding heavy jet bomber, the B-52, and America's first jet transport. Boeing also builds the record-breaking B-47 medium jet bomber, conducts a major guided missile program, and research in nuclear power for aircraft.

These growing programs mean expanding opportunities at Boeing for engineers of virtually EVERY type, including mechanical, civil, electrical and aeronautical. It also means plenty of room for advancement. Boeing, which now employs more engineers than even at the peak of World War II, promotes from within, and holds regular merit reviews to give you individual recognition.



As the chart shows, 46% of Boeing's engineers have been here for five years or more; 25% for 10 years; and 6% for 15 years, and many have been with the company 25 years or longer.

Boeing offers engineers an unusual variety of experience, from applied research to production design, from work with new materials and techniques to co-ordination of a vast subcontracting program which provides contacts with a cross-section of U. S. industry.

Boeing also helps engineers continue their graduate studies, and reimburses them for tuition expenses.

For further Boeing career information, consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Wash.

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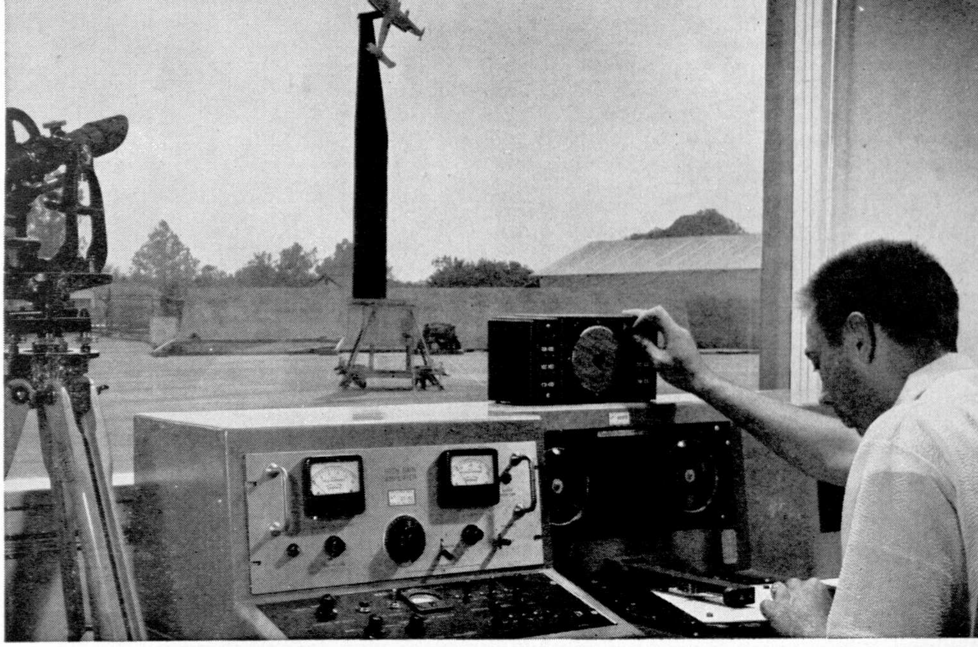
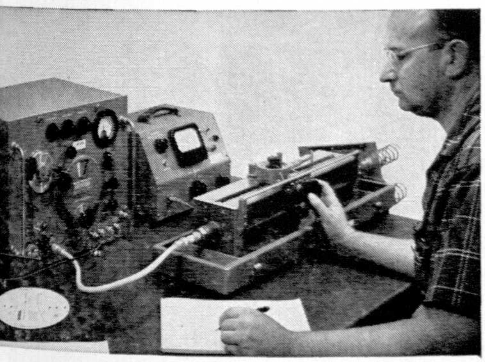


Electronics Research Engineer Irving Alne records radiation antenna patterns. Twenty-two foot plastic tower in background eliminates ground reflections, approximates free space. Tower is of Lockheed design, as are pattern integrator, high gain amplifier, square root amplifier, logarithmic amplifier.

Antenna development program at Lockheed expands

Lockheed's diversified development program presents Electronics Engineers qualified for airborne antenna design with a wide range of assignments in communication, navigation and microwaves. Antenna design is one of the fastest growing research and development areas at Lockheed.

Studies embrace virtually all types of aircraft, including the Super Constellation radar search plane—a type of aircraft developed and produced exclusively by Lockheed.



Electronics Research Engineer F. R. Zboril measures input impedance of a scale model helical antenna array used for ground tracking of missiles. Most of Lockheed's other antenna work involves advanced research studies on flush mounted antennas.

Career Positions at Lockheed

Lockheed's expanding development program has created a number of positions for Electronics Engineers and Physicists to perform advanced work in antenna design.

In addition Lockheed has a number of positions open for engineers in aerodynamics, thermodynamics, flight test analysis, structures and design to perform advanced studies on such diverse projects as: Applications of nuclear energy to aircraft, turbo-prop and jet transports, bombers, trainers, supersonic aircraft with speeds surpassing Mach 2, and a wide range of classified activities.

Program for Advanced Study—To encourage members of its engineering staff in study leading to advanced degrees, Lockheed reimburses 50% of the tuition fee upon successful completion of each course relating to the engineer's field at the University of Southern California and University of California at Los Angeles. Both universities offer a wide night school curriculum in science and engineering.

E. O. Richter, Electronics Research department manager (seated), W. R. Martin, antenna laboratory group engineer (standing), and J. L. Rodgers, electronics research engineer, discuss design of corrugated surface antenna.

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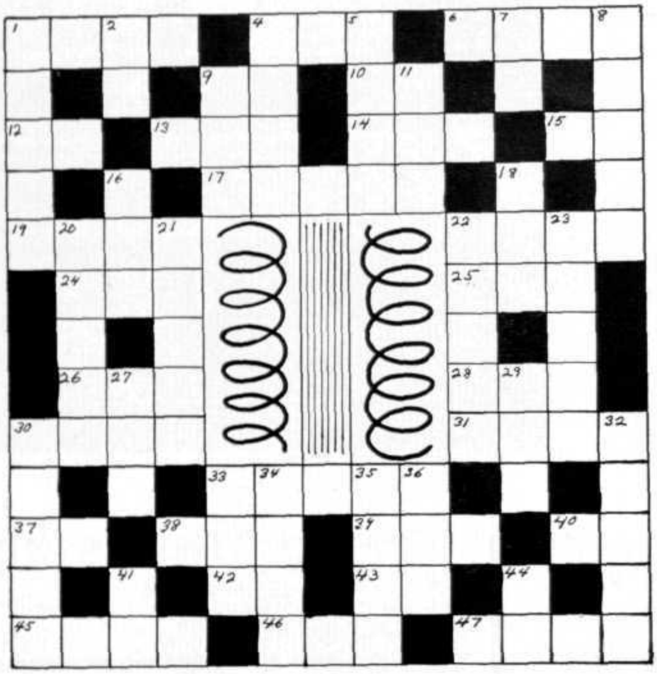
Crossword for Engineers



ACROSS

1. metallurgical fuel
4. single in number
6. tube for carrying fluid
9. element named for Scandinavia
10. direct current
12. symbol for arsenic
13. a large tank
14. an opening interval
15. symbol for element named for sea god
17. cpd of H_2 and O_2
19. the back of the neck
22. to dry up, scorch
24. used by commercial fishermen
25. obtained by distillation of coal or wood
26. side away from the wind
28. Amateur Athletic Union
30. at the back
31. appearance
33. substance of two or more metals
37. electrical manufacturer
38. by way of
39. plural of man
40. element 81
42. gas given off by radium
43. third person singular present indicative of "be"
45. hindmost appendage of an animal
46. dichlorodiphenyltrichloroethane
47. principal

DOWN

1. series of links or rings
2. inert gas
4. prefix meaning eight
5. cutting part of a knife
7. in a higher position
8. a gradual decrease of thickness
9. cutting tool with toothed edge
11. wheeled vehicle
16. higher form of monkey
18. body of water
20. formed by the intersection of two lines or planes
21. anhydride of the alcohols
22. water vapor
23. to dispute
27. organ of hearing
29. assist
30. not wrong
32. artificial clothing fibre
33. the atmosphere
34. solid part of the earth's surface
35. leave out
36. affirmative
41. element with atomic wt of 209
44. element 20