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DECEMBER
1959
The Wisconsin

engineer

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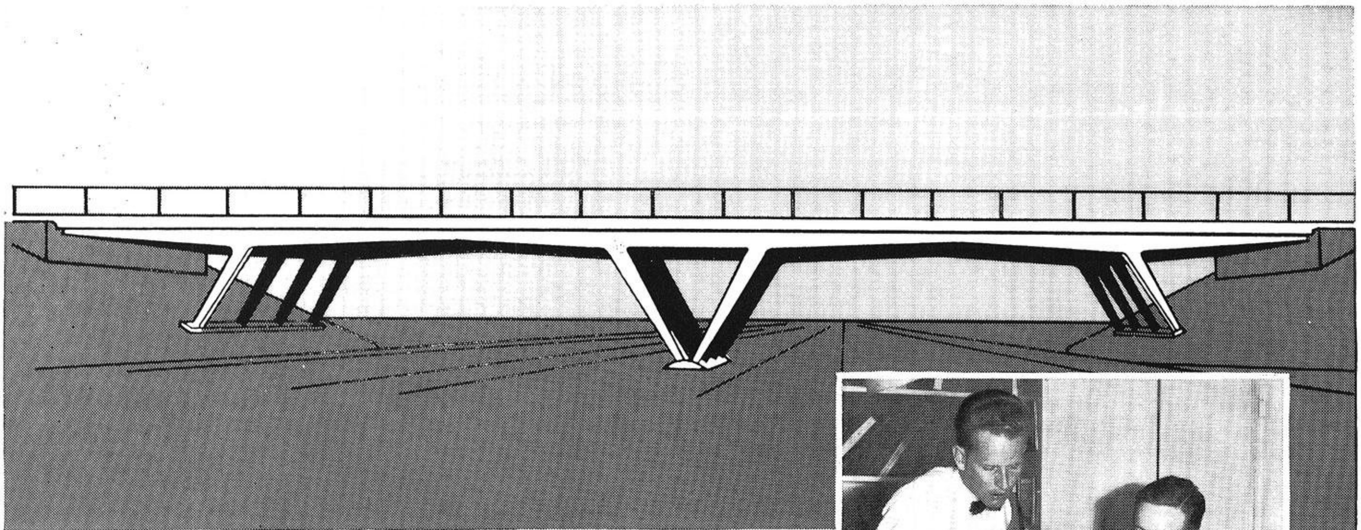
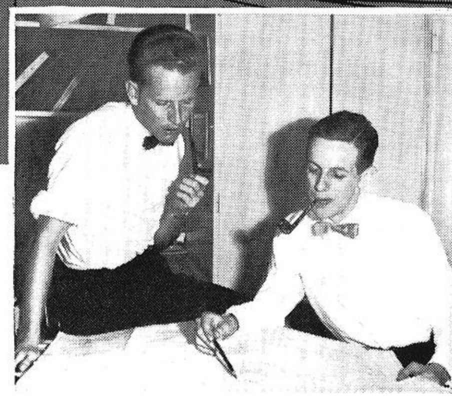
Speed Control Instrument
The Camera
Aluminum in Autos
Sound Reproduction





1st Award—$4,000—Student Class

Niels Jorgen Gimsing, Hattensens Alle 11, Copenhagen, Denmark
Technical University of Copenhagen (Graduate)
and
Hans Nyvold, Ulrikkenborg, Alle 62, Lyngby, Denmark
Technical University of Denmark (Graduate)

These students won $9,000 for bridge designs

American Bridge Division of United States Steel recently awarded $44,000 in world-wide competition for the best designs of small steel bridges. Professional engineers *and* college engineering students participated. Designs came in from 50 states and 40 foreign countries. From these entries, 15 winners were chosen, eight professional awards and seven student awards. They were selected under the supervision of the American Institute of Steel Construction. The judges were prominent consulting engineers and architects. They judged the designs on the basis of originality, economy, appearance and the utilization of steel. The bridges had to carry two-lane traffic over a four-lane interstate highway in accordance with AASHO standards. In addition to the winners, many of the designs entered were so outstanding that they will be published later.

Bridge design is a good example of what can be done with steel and imagination. But, it's only one example. There are thousands of other uses for steel . . . and it takes thousands of men to make and sell steel. If you want to know about engineering opportunities at U.S. Steel, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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1st Honorable Mention—$2,000 Student Class
James C. Costello

21 Leeson Park, Dublin, Ireland University College, Dublin, of the National University of Ireland

2nd Honorable Mention—$1,000—Student Class

James A. Wood **Jack A. Berridge** **William O. Evers**

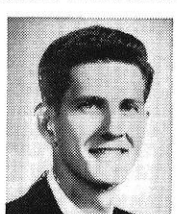
Graduates of California State Polytechnic College, San Luis Obispo, Calif.

3rd Honorable Mention—$500 Student Class
Troy R. Roberts

Route 5, Neosho, Missouri
University of Missouri School of Mines and Metallurgy (Graduate)

3rd Honorable Mention—$500 Student Class
Harland C. Zenk

Truman, Minnesota
South Dakota State College (Graduate)

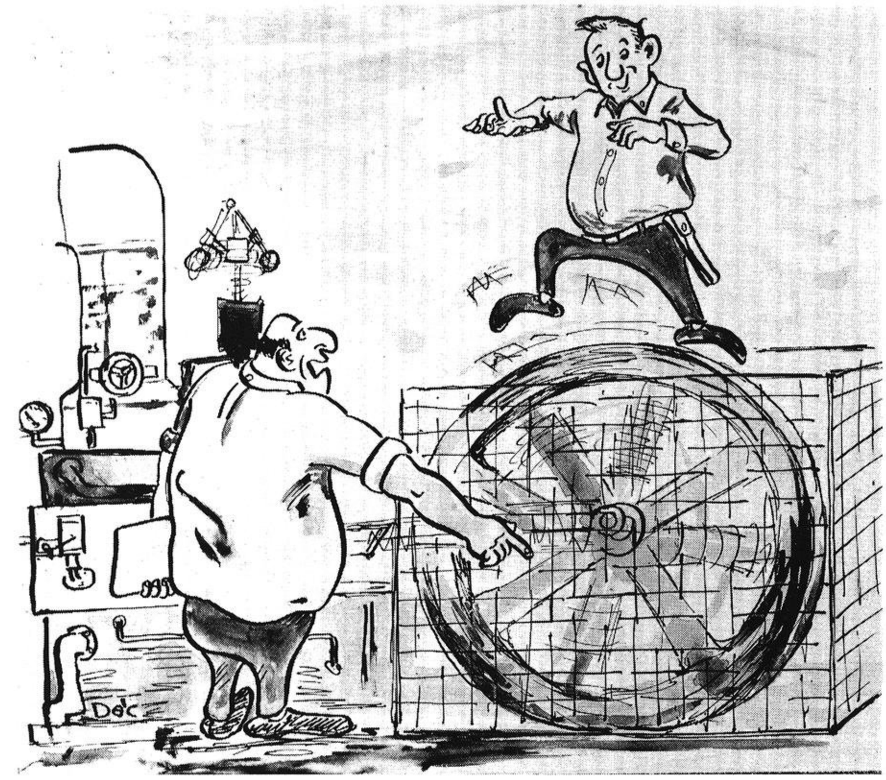


3rd Honorable Mention—$500 Student Class
Albert C. Knoell & Rodger K. Gieseke

Drexel Institute of Tech. (Graduates) Philadelphia, Pa.

3rd Honorable Mention—$500 Student Class
Joseph A. Yura

629 North 23rd St., Allentown, Penna.
Duke University (Graduate)—Durham, N.C.



Aw Right Stupid! Dat's not what I meant by being familiar with the equipment!

SEASONS' GREETINGS

from the Staff

Volume 64 DECEMBER 1959 Number 3

WISCONSIN ENGINEER

The Student Engineer's Magazine

FOUNDED 1896

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Cover

The competent engineer uses three languages—written, mathematical and graphical. His assignments sometimes dictate that he use one, or perhaps two, of these languages more often than another. Yet, all three must be at his command. For the engineer visualizes the forces of nature, he creates in his mind a product or process, and finally he must communicate his thoughts to others. The choice of his means of communication may be determined not by his preference but by the subject matter or by the recipient of the information...

In this issue's cover design by artist Carol Schiffleger, the engineer's knowledge and use of the written language are symbolized by the pen and ink. The cover also expresses the wishes of the staff in this joyous season.

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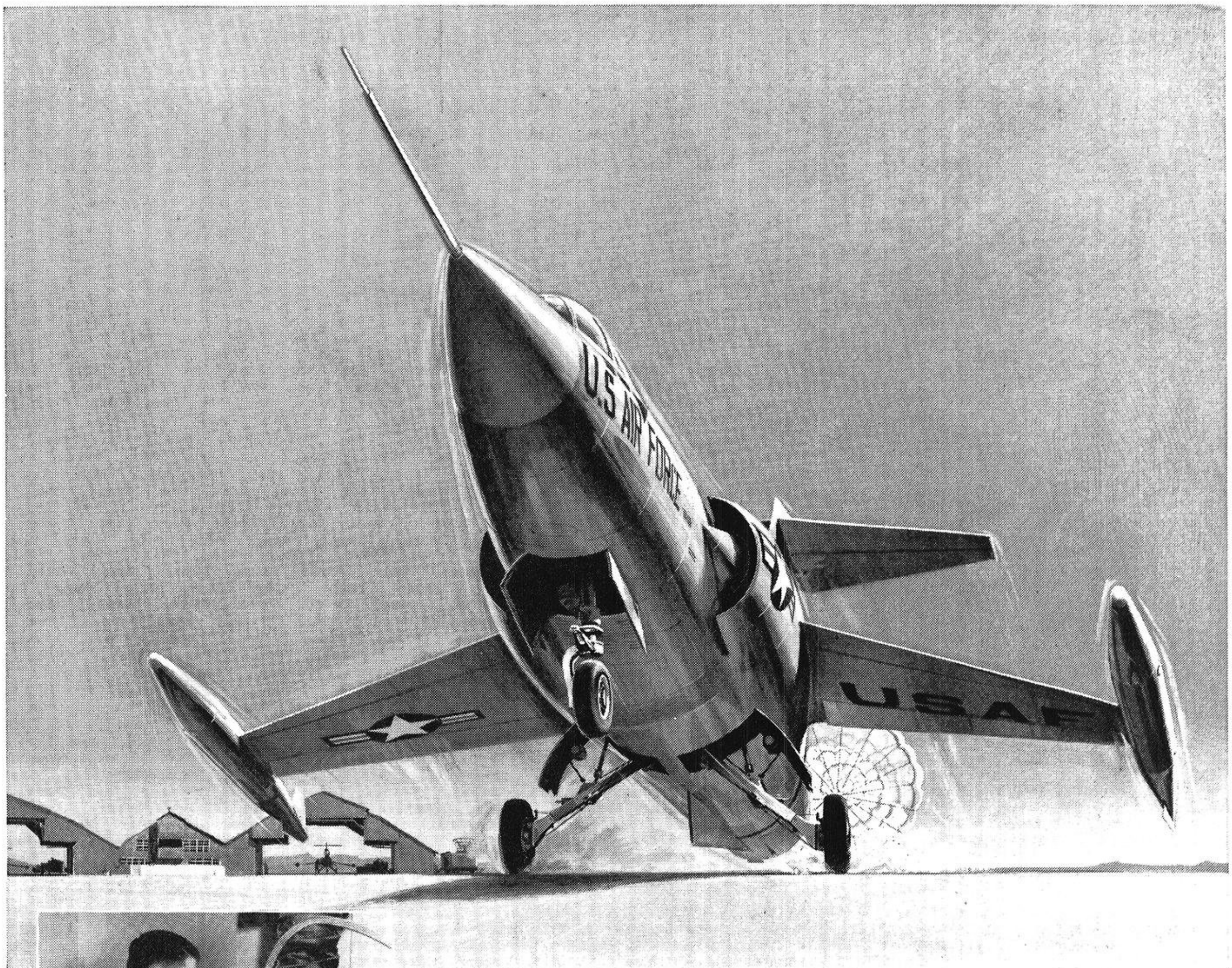
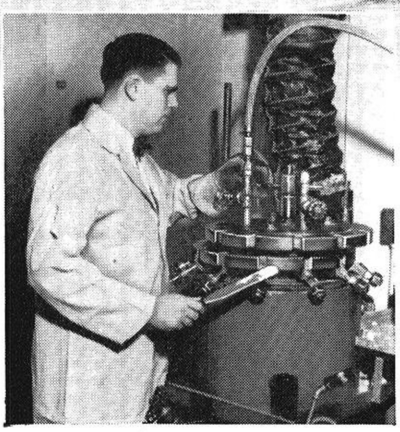
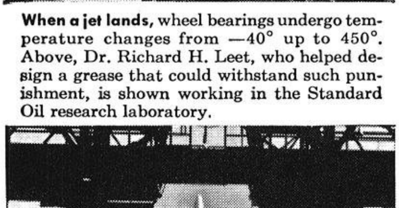


At one time, grease used in wheel bearings of supersonic jet planes would melt during landings—would even catch fire! Now this has been solved by a revolutionary new grease developed by Standard Oil research.



When a jet lands, wheel bearings undergo temperature changes from —40° up to 450°. Above, Dr. Richard H. Leet, who helped design a grease that could withstand such punishment, is shown working in the Standard Oil research laboratory.



Rockets and missiles have moving parts that must be lubricated at temperatures from —65° to 450°. Another special Standard Oil grease can do this job without breaking down.

Meet the man who put the grease in *greased lightning!*

When men started probing into space and flying at speeds faster than sound, they met a new and baffling lubrication problem.

Existing greases were good either in cold or heat, but not in both. A grease was needed that would not break down under extreme changes in temperature—from bitter cold one minute to blow-torch heat the next.

Lubrication experts in the research laboratories of Standard Oil, headed by Dr. Richard H. Leet, had foreseen the need for such a grease. And when America's future jet growth hinged on the development of a revolutionary new grease, it was ready—as the result of a five-year research project.

Because of the unique qualities and great versatility of this new grease, it is also being used in industry, serving more efficiently and more economically than previous greases under conditions of extreme heat and extreme cold.

It is another example of a major contribution to progress from Standard Oil's research laboratories. Other examples of the same thorough and painstaking research are the gasolines and oils millions of motorists buy daily at Standard service stations throughout the Midwest and Rocky Mountain region.

What Makes A Company A Good Citizen? One gauge is a company's usefulness...its contribution to the general welfare. Through research, Standard constantly strives to develop products that will strengthen America's defenses and help millions of people in their work, in their homes, and on the road—today and in the future.

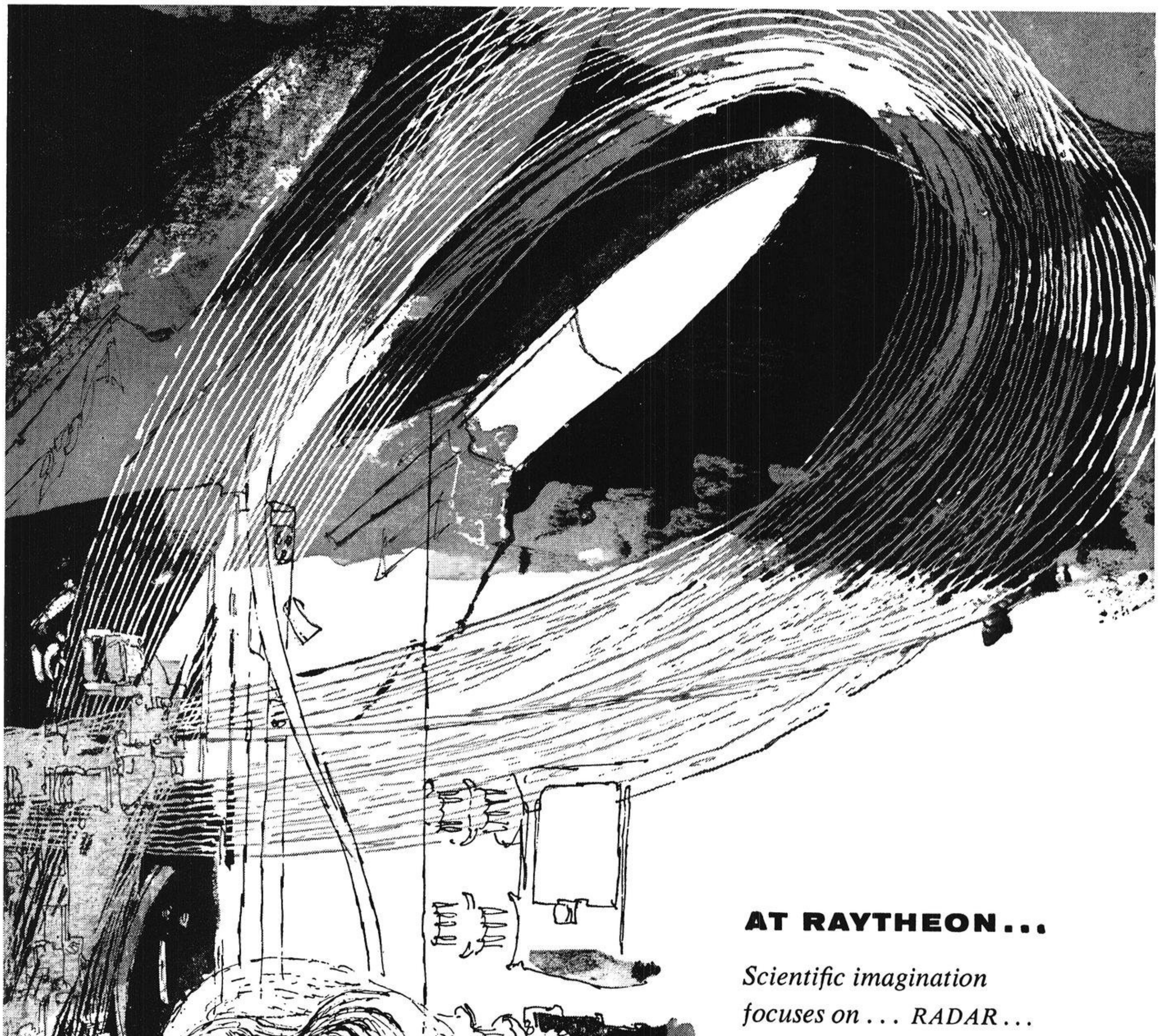
100TH ANNIVERSARY OF THE OIL INDUSTRY 1959 70TH ANNIVERSARY OF STANDARD OIL CO.

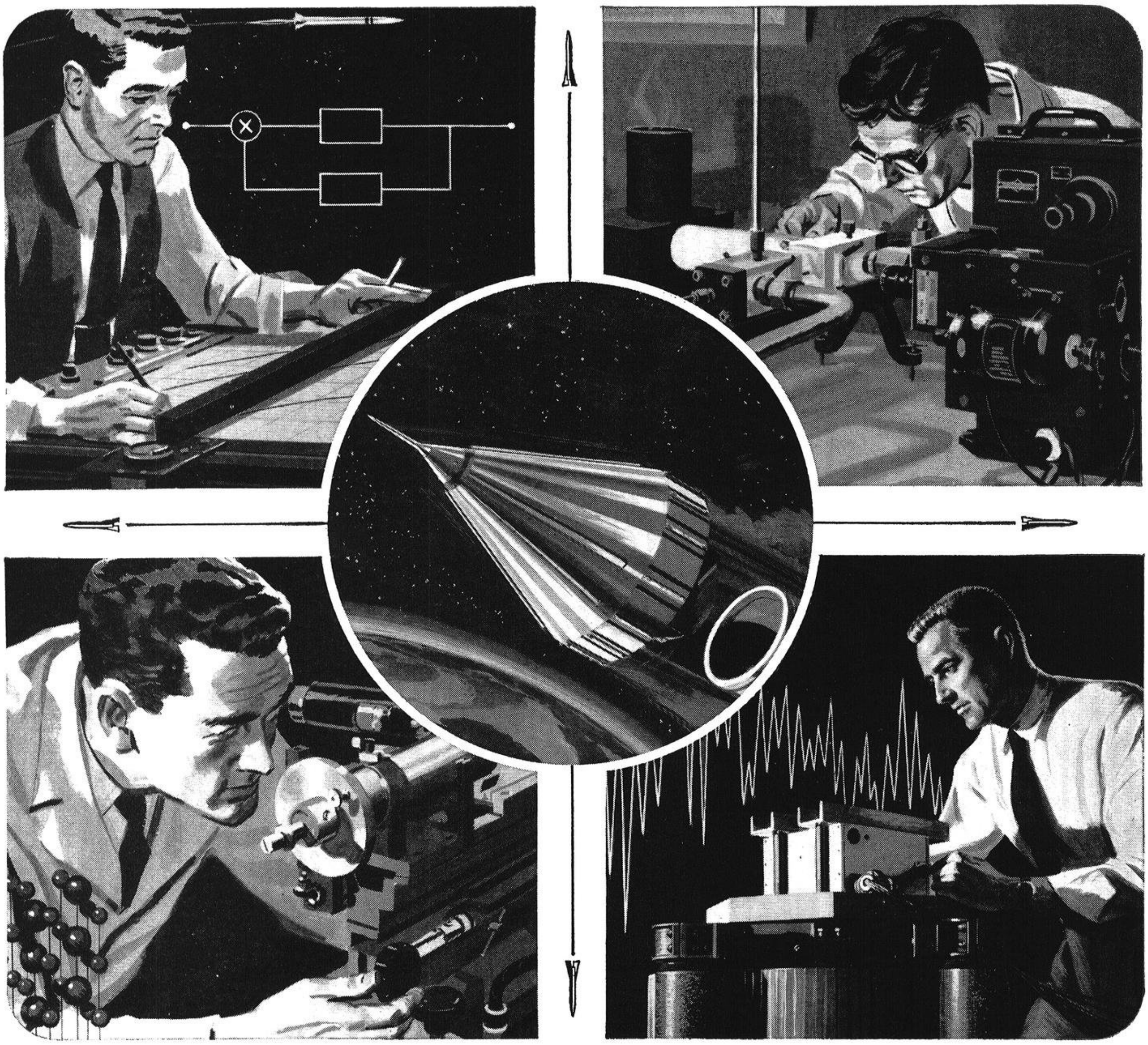
STANDARD OIL COMPANY

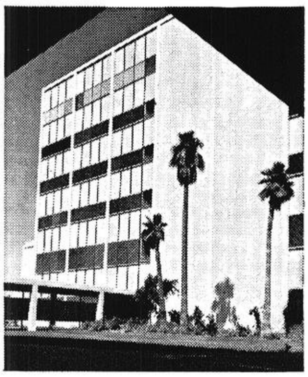
STANDARD

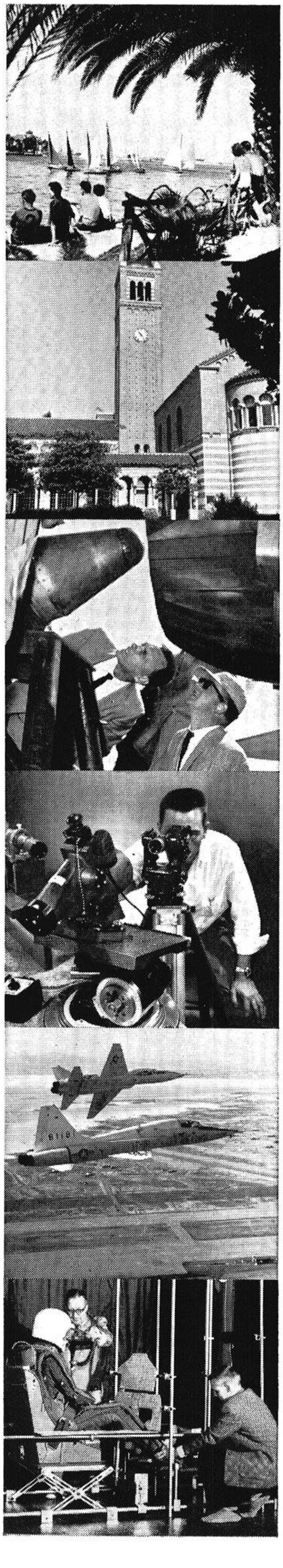
THE SIGN OF PROGRESS... THROUGH RESEARCH

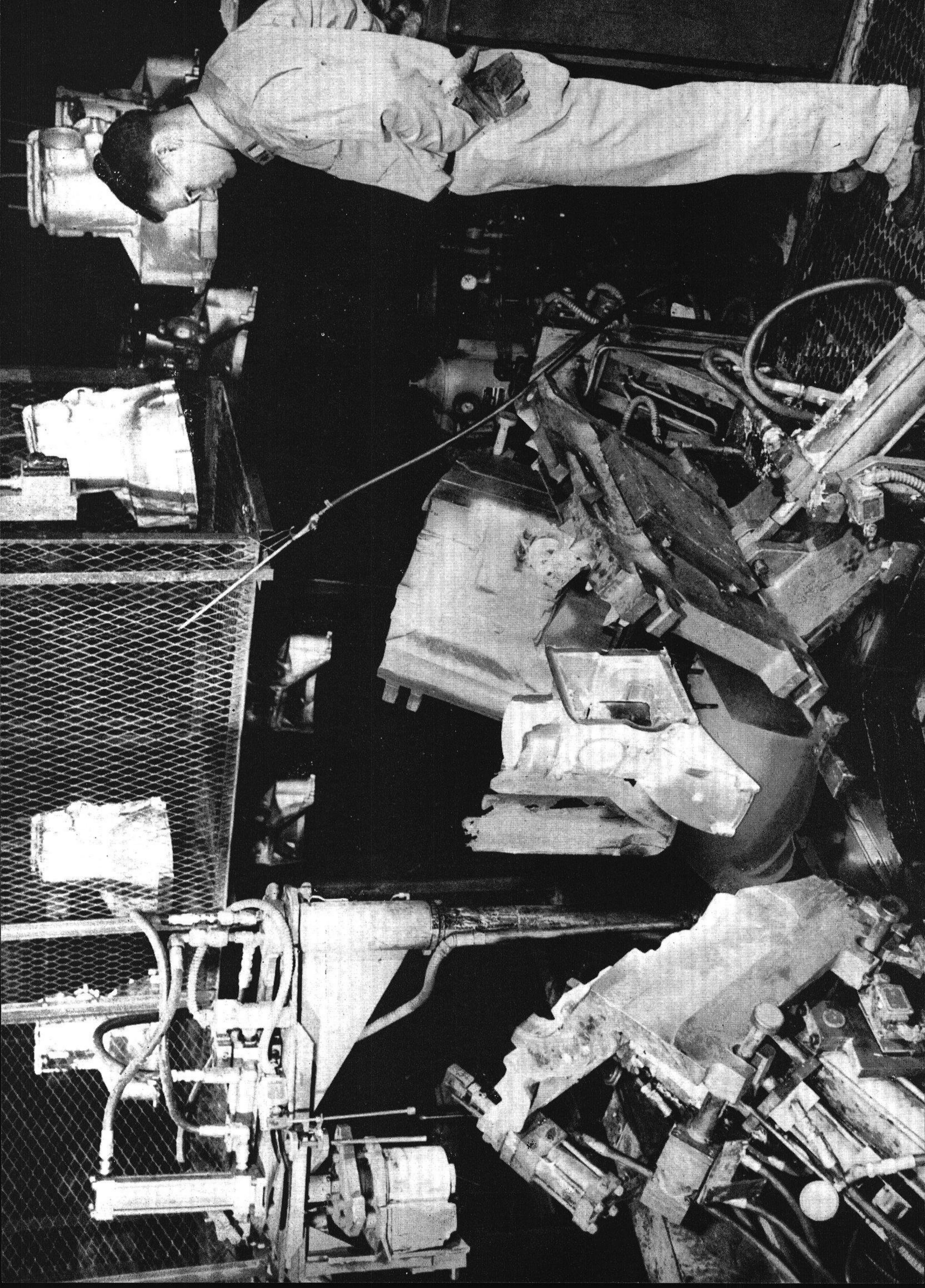
H Boyle











Rambling WITH THE EDITOR

Editorial

There once was a fellow named guesser
Whose knowledge grew lesser and lesser.
It at last grew so small
He knew nothing at all,
And now he's a college professor.

ANONYMOUS

After receiving storms of protest as a result of my satirical comments on students' determination to "not get an education" in the November issue, I feel it is my duty to even matters and hear some protest from the instructors also. With this introduction I will embark on these simple rules on HOW TO NOT GIVE AN EDUCATION.

1. When lecturing to a class, it is important to slur words, mumble to the blackboard, write illegibly, and block the students' view with your huge hulk of a body.
2. Always lecture and teach exactly what is found in the textbooks. It is foolish to expect that engineers can read. Twelve years of secondary education hasn't taught them the difficult process of perusal.
3. Never give a student extra time for "ANY" work. There is no reason why your student shouldn't be doing thermo problems while on his honeymoon, waiting for news of becoming a father, interviewing for a job, having an arm amputated, studying for tomorrow's exams in seven of his eight courses, or writing an editorial for the *Wisconsin Engineer*.
4. When students hand in problems or complete exams, don't worry about ever correcting or handing them back. Students might review them and raise the curve on the final. In report courses never give the reports a grade; just give them a check. Let them think they are doing well until the final, and then tell them they must write a 101 on the final in order to pass the course.
5. When you have a hard night at home, a bad night at poker, or an over-enthusiastic interest in a TV Western and don't get your lecture for the next morning planned, give them a quiz. It gets you off the hook, even though you haven't taught them anything to quiz them on.
6. Never give any kind of practical examples. If you have had industrial experience, keep it a secret. If you are unfamiliar with industry, make no attempt to gain practical experience which you could pass on to your students.
7. Always avoid looking at your students when explaining material. By talking with them instead of at them you might perceive which matters they are having trouble understanding. Talk in an incomprehensible vocabulary so that if you make mistakes, they won't know what you're talking about, thus eliminating the possible discovery that you may have been wrong.
8. When students from another engineering department come over to take a basic course in your field, make it unmercifully hard. Show those idiots from other departments that yours is the most difficult of the engineering majors. Another good practice is to spend valuable lecture time degrading the other engineering departments.
9. A good morale booster for yourself is to snow the students with your vast knowledge by pulling long formulae out of your head without explaining their origin or derivation.
10. When the semester draws to a close, remember to include everything on the final exam which you have neglected to teach your students during the course.

Follow the above practices, and you will be wasting the students' valuable time, and you will certainly "not give an education." By avoiding these methods you might develop the students into the technically competent engineers our country so sorely needs.

DONALD D. ROEBER
Editor

One of the largest aluminum parts now being used in the automotive industry is the automatic transmission casing produced by Ford Motor Company at its Sheffield, Ala., plant. The 24-pound, bell-shaped cases are cast in complex, three-sided permanent molds at the new facility which turns out 67 different aluminum parts. Redesigning and use of the light metal casing enabled Ford engineers to reduce the weight of the 1959 Ford automatic transmission by about 50 pounds. The new 2-speed automatic transmission, completely installed with all linkage, now weighs only about 18 pounds more than a standard-shift transmission.

—From News Department, Ford Motor Company, Dearborn, Michigan

THE CAMERA—

What to know before selection of a still camera

by James H. Fraser me'60

BASICALLY the camera is very simple; merely consisting of a light tight box with a film in the back and an opening in the front for the image to come in. The opening, on a practical camera, consists of a lens mounted so that it can be moved back and forth for focusing, a diaphragm to control the size of the opening, and a shutter to control the length of time the lens is transmitting light to the film.

The Lens

A lens may consist of one piece of glass or many pieces carefully ground and fitted together. The speed of the lens is determined by comparing its diameter to its focal length. This comparison is expressed as f/number; an f/8 lens being one whose diameter is one-eighth its focal length. The speed of a lens is a measure of its light transmitting ability; speeds range from f/1.1 for the most expensive cameras to f/16 for box cameras. The relative speed of any two lens openings varies inversely as the square of their f/number. From this it can be seen that an f/2 opening transmits 16 times as much light as an f/8 lens.

Focusing

Cameras are focused in one of three ways: by a footage scale on the camera, by a rangefinder, or by ground glass focusing. With the footage scale, the camera to subject distance is either estimated, measured by use of a separate rangefinder, or measured with a tape. A rangefinder is an optical device used to measure distance. The principal is that a person looking in the eyepiece sees part of the object directly through the hole in mirror 1 and the rest of the object is reflected onto mirror 1 by mirror 2. For an object at a certain distance from the rangefinder there is only one position of mirror 2 that will give a continuous image of the object. In a rangefinder mirror 2 is mounted on a movable axis and the mirror is controlled by a knob that is calibrated in distance for its various positions. If the rangefinder is built into the camera and moves the lens back and forth as the image is lined up it is known as a coupled rangefinder. The third way of focusing a camera is through the use of a ground glass. If a piece of ground glass is put in the position the film ordinarily occupies and the shutter opened the image can be seen on the ground glass. If the image is focused on the glass, the glass removed, and the film replaced the camera will be set as far as focusing is concerned.

The Shutter

The shutter can be of two types, either a between the lens type or a focal plane type. Both types get their names from their position in the camera. The between the lens type usually consists of leafs which spring apart and then snap back together. On simple cameras there may be just a single blade which uncovers and then recovers the opening; this type is not effective at high speeds because it allows part of the lens to be uncovered for longer periods than the rest. Focal plane shutters consist of a curtain of metal or cloth which has a slit in it. This curtain is moved across in front of the film exposing only a portion of it at a time. This type is not used at slow speeds for pictures of objects that have motion because a distorted picture results. Shutter speeds are expressed as fractions of a second and range from 1 second to 1/2000 second.

The Viewfinder

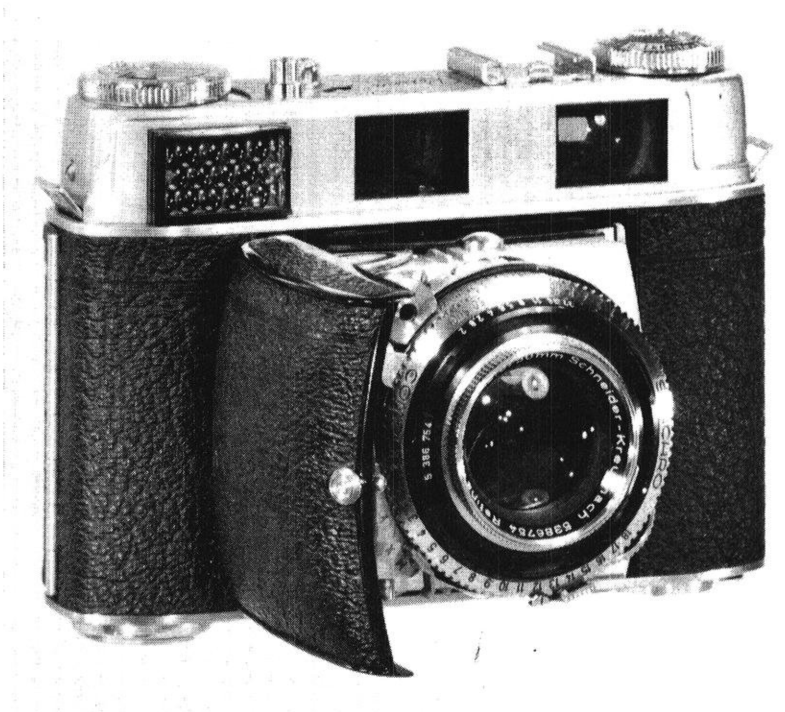
Another necessary part of the camera is the viewfinder which is used to aim the camera at the subject. Direct viewing cameras are those which have a simple type of viewfinder to aim the camera. The direct viewing viewfinders are one of two types, those which are held in front of the eye and viewed looking straight ahead (eye level) and those which are viewed looking downward (waist level). These viewfinders are made of plain glass or simple meniscus (one piece) lenses.

The other type of viewfinder is the reflex type in which the subject is viewed through a lens; either the lens used to take the picture or another one of equal quality. It is constructed very similarly to the waist level finder just mentioned. In this type of viewfinder the image of the object is focused on a ground glass that is the same size as the film and the same distance away from the lens as the film, but placed at 90 degrees to the lens, the image being bent by a mirror or prism. The name reflex comes from the bending of the image by the mirror.

The Box Camera

The most widely used and the easiest to use camera is the box camera. Most cameras of this type have a body made of plastic or metal, a simple fixed focus lens rated between f/11 and f/16, a single speed shutter in the range of 1/40 to 1/60 second, and a simple viewfinder. In addition to this most box cameras are equipped with some sort of flash synchronization to enable pictures to be taken under poor lighting conditions.

The cost of these cameras ranges between $5.00 and $30.00. Accessories available include flash attachments, close up and cloud attachments, and cases. The main advantages of the box camera are its ease of use and low cost. It is extremely easy to use—all that has to be done is aim it at the subject and snap the shutter. The lens opening, shutter speed, and focusing are all permanently adjusted for average conditions. Some of the limitations of the box camera are the inability to take action pictures because of the fixed shutter speed and the inability to take pictures closer than 6 to 8 feet without special attachments. Most of these cameras use 127, 120 or 620 film which give from 6 to 16 negatives per roll. All of them use either black and white or negative type color film. Some of the newer models have another faster lens opening which allows taking of positive color pictures (slides) and other types of pictures in cloudy weather.

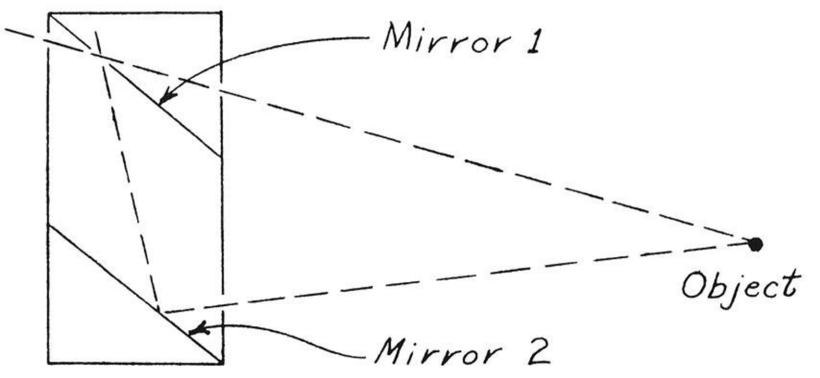


This is an example of a 35 mm roll film camera.

Roll Film Cameras

A more flexible camera and a very popular type is the roll film camera. There are two types of roll film cameras; the folding type with the lens mounted on the front of a bellows and less commonly the box type with the lens in a helical mount. This camera, as well as all cameras described after this, is available with adjustable lens openings, focusing lens, and adjustable shutter speeds. Roll film cameras are available in a wide range of models ranging from non adjustable models similar to box cameras to models for exacting work. In the medium price range lenses are available from f/3.5 to f/6.3 and shutter speeds to 1/200 second. The most expensive models have finer lenses and faster shutters. Focusing methods range from footage scales on the cheaper models to coupled rangefinders on the better models. Prices range from $10.00 for the simpler types to $500.00 for the most expensive professional models, but most are in the $40.00 to $100.00 range. Roll film cameras usually use 120 or 620 film, which is available in black and white and either positive or negative color film. Accessories available include: filters, close up lens, flash, and adapters for other sizes of film.

The roll film camera is very compact when folded up and opens quickly for use. An adjustable roll film camera can make good pictures under a variety of conditions. Action and available light (pictures taken under poor lighting



This Diagram shows how the range finder works.

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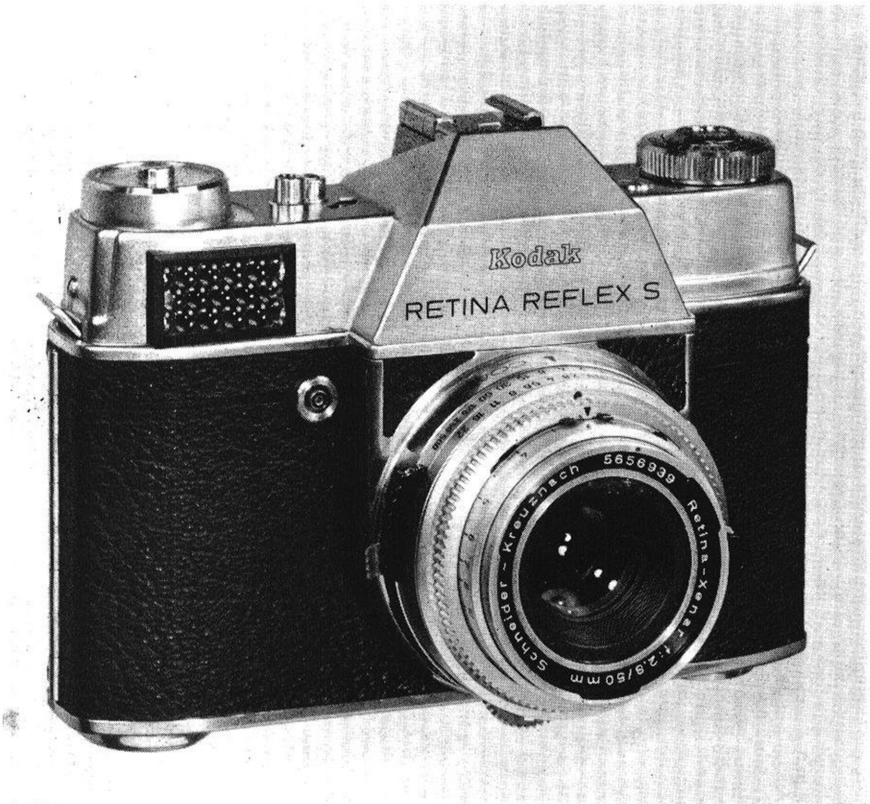


This is an example of a single lens reflex camera that uses 35 mm film.

(Continued from last page)

conditions with the existing light) pictures are possible with better models of this type. The camera is limited because no interchangeable lenses are available for it, which prevents the taking of telephoto and wide angle pictures.

35 mm Cameras

The most popular of the adjustable type cameras is the 35 mm camera which is the most versatile camera made and has been used for almost every type of picture conceivable. The camera gets its name from the size of film it uses—35 mm movie type with perforated edges. Because of the size of the film (about one inch wide) 35 mm cameras are usually very small and are sometimes called miniature cameras. Most 35 mm cameras have an f/4.5 or faster lens, shutter speeds of at least 1/200 second, and all but the most inexpensive have coupled rangefinders. The more expensive models have shutters with speeds to 1/1200 second and the fastest lens made f/1.1.

The price range is from $25.00 to over $500.00. A wide variety of accessories are available including: filters, close up lenses, flash and copying attachments. 35 mm film comes in 12, 20, and 36 exposure cartridges which provide plenty of exposures without having to change film. Film is available in black and white, and color with both positive and negative type available for each. Because of the small size of the film and the length of the rolls, 35 mm film is very inexpensive when considered on the cost per picture basis.

Because of the short focal length of the lens, 50 mm, it is possible to make lenses of extremely high speed for the 35 mm camera. Lenses of these speeds, f/2 and faster, are not made for larger cameras because of their size, difficulties in production and extremely high cost. Because of this the field of available light photography is dominated by the 35 mm camera. Inherent with the focal length of the lens is great depth of field, which enables focusing, at the same time, on subjects both close to and far away from the camera.

Another feature of this camera is that many models are available with interchangeable lenses. These lenses, which are available in wide angle and telephoto models, increase the versatility of the camera greatly. Many 35 mm cameras have other features such as (1) built in light meters to determine the correct exposure, (2) single stroke film advance which enables one to take pictures in rapid succession, (3) built in self timer that enables the photographer to get into the picture. The only limitation the 35 mm camera has is that because of the small size of the film it cannot be retouched and enlargements are always necessary to see the pictures. Also the long rolls of film are inconvenient when only a few pictures are taken and the results are wanted before the rest of the film can be used.

Press and View Cameras

Press and view cameras are the largest type of still camera made. The press camera is usually smaller than the view camera and is primarily used in the field while the view camera is primarily used in the studio and for landscapes and similar types of pictures. Press cameras have fairly fast lenses, f/3.5 to f/6.3, very fast shutters and are used for almost every type of picture. They are commonly made into three negative sizes, 2¼ x 3¼, 3¼ x 4¼, and 4 x 5. The 4 x 5 is used where large negatives, that can be easily retouched, are needed also where large contact prints (prints the same size as the negative) are desired. The smaller sizes are easier to handle and more compact to carry. Press cameras are usually used with sheet film, although they can be adapted for use with roll film. Either focal plane shutters with speeds to 1/1200 second or between the lens shutters with speeds to 1/800 second can be used. Focusing is accomplished by use of the footage scale, ground glass, or coupled rangefinder.

Prices range from $30.00 for the cheapest model without lens or shutter on upward depending on the accessories desired. There are a wide variety of accessories available including (1) adapters for roll film, (2) film packs, (3) Polaroid film, and (4) rangefinders that can be used in the dark. Many types of accessory lenses are available, including extreme wide angles and telephotos. One feature of the press camera is choice of viewing available—ground glass on the back of the camera or direct viewing on top. The bellows of the camera can be lifted, dropped, tilted, or shifted for correction of distortion or special effects. The bellows can be extended foreward for extreme close-ups. The limitations of the press camera are its bulkiness and high cost of film.

The view camera is available in sizes from 4 x 5 to 16 x 20. Because they are so bulky, they use such large and expensive film and are suited to only a few subjects; the use of view cameras is limited to professionals and a few highly advanced amateurs. They are priced from $20.00 without lens and offer features much the same as press cameras except on a larger scale.

Single Lens Reflex Cameras

There are two types of reflex cameras, single lens reflex cameras and twin lens reflex cameras. On the single lens reflex focusing and viewing are accomplished by the reflex method as described before. The complication is that since there is only one lens, the mirror must be moved out of the way while the picture is being taken. This is done by hinging the mirror and having it fold out of the way an instant before the picture is taken. This means that there is an instant when the subject is not in view and to some people this is irritating, although it does not limit the use of the camera in any way. The shutter is of the focal plane type since it must be behind the mirror so as not to cut out the image while focusing and aiming the camera. These cameras are available in 35 mm, 127, 620, and 120 and are all constructed the same basically, the faster lenses being available on the smaller sizes. The advantage of the single lens reflex is that one can see exactly what he is taking; there is no parallax or difference of subject seen by the viewfinder and the lens. This is the reason that these cameras are used extensively in medicine and scientific research. The depth of field is always visible in the viewfinder also. Other than these features, single lens reflex cameras have about the same features as other cameras using the same size film.

This is an example of a twin lens reflex camera that uses 120 or 620 film.

Twin Lens Reflex Cameras

The twin lens reflex camera differs from the single lens reflex in that it has a lens for viewing and focusing and another separate lens for taking the picture. Most cameras of this type use 120 or 620 film, although the 127 size is gaining popularity. The fastest lens available for this camera is f/2.8; shutter speeds up to 1/400 second are common. The price range for this camera is from $25.00 to $250.00.

One advantage of the twin lens reflex is that the exact image is in sight throughout the picture taking cycle. The waist level finding that is an inherent property of the reflex type camera is supplemented with an eyelevel finder on some models and some models can be adapted for use with 35 mm film. Limitations of this type of camera are: (1) parallax at close distances and (2) no interchangeable lenses are available for most models.

"Picture in a Minute" Cameras

Since its introduction shortly after WWII the Polaroid Land Camera has been a huge success. Its feature is that it develops the print in the camera in one minute and therefore meets the need of the person who does not like to develop his own pictures or wait to get them back from processing. Polaroid cameras are of the folding type and are available with either f/4.7 or f/8 lenses and shutter speeds to 1/100 or 1/300 seconds. Polaroid cameras range in price from $72.75 to $169.50. Films are available in the normal black and white type and in black and white transparency type. A wide variety of accessories are available.

Subminiature Cameras

Subminiature cameras were once used only for police work or as a novelty, but recently they have been developed into quality cameras capable of taking good pictures. They are called subminiature cameras because they are smaller than the 36 mm miniature camera. There are many styles from the box type to a highly advanced camera. Most of them use film of the 16 mm movie type or a special film of small size. Because of their small

(Continued on page 47)

The Increasing Importance of Aluminum in Automotive Industry

by Edmund R. Reif me'60

AFTER years of playing only a small part in the American automotive industry, aluminum is rapidly gaining much consideration and will undoubtedly become of major importance to the industry within the next few years.

Until now, production applications of aluminum in the auto industry, despite their excellent design factors, have lagged because of two principal reasons; the first being the lack of components designed to take advantage of the specific properties of aluminum, and the second being the failure to apply mass production techniques to the processing of this metal in the automobile plants.

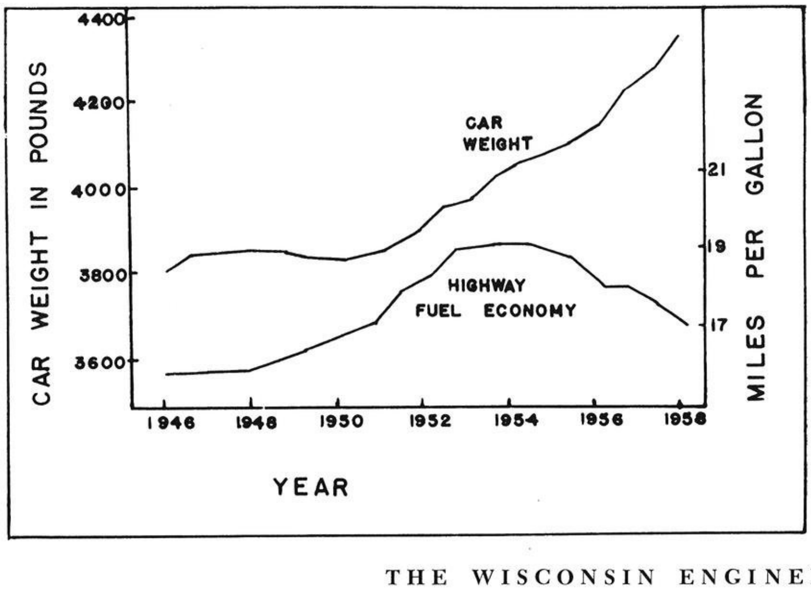
The intent of this article is to make evident the vast importance of aluminum by elaborating on such factors as the current weight trend of passenger cars, the metallurgical, production and cost problems of aluminum, and the current and probable future uses of this light metal in the auto industry.

Automobile Weight

In spite of the fact that the automotive industry has increased automobile engine efficiency over the years, and is continually striving to increase this efficiency for the future, the industry is at a point where the trend in overall economy in miles-per-gallon is continually decreasing. There are several reasons for this situation. Car buyers have developed a liking for more pleasing, but not always most efficient, automatic transmissions, for greatly increased performance in terms of ability to accelerate rapidly, and for an ever increasing number of power operated accessories. But the most insidious factor is the yearly increase in vehicle weight.

Curb weight of the average passenger car increased from approximately 3800 pounds in 1946 to 4400 pounds in 1958. Highway fuel economy improved until 1954, when the trend reversed. The latter trend is of great concern to the auto industry and provides real incentive for the use of light metals. Until 1954, most car manufacturers were able to keep up with the increasing performance and weight, and still show an increase in miles-per-gallon. Since that time, however, there has been a losing battle to try to offset the increasing car weights by improving engine efficiency.

One important way to improve economy is to reduce the weight of the automobile, and a good place to start is with the engine.



An aluminum engine can weigh up to 200 pounds less than its cast iron counterpart. This would greatly help to reduce total car weight because of the corresponding decrease in weight in a number of other chassis components that would follow. With less weight to move, performance is increased, braking problems are less serious, and smaller and less expensive tires can be used. There are also the advantages of a lighter, more easy to handle car and lowered fuel octane requirements.

The use of aluminum for engine construction is not new. Aluminum engines have been produced in the past and have actually been used in a few instances in this country. They currently are being used in a number of passenger car applications in Europe. Aluminum has been used almost exclusively in aircraft engines, but here the application minimizing the weight is far more important than cost. Such is not the case in the auto industry where weight and cost are both major considerations.

Today, the use of light metals is not only technically possible but also economically feasible. One important new development which makes aluminum especially attractive to the auto industry is the development and application of high-wear-resistant alloys which eliminate the need for cylinder liners.

Most car manufacturers are optimistic about the future of aluminum engines and believe that they are aware of all the major problems still to be resolved. Auto makers are continuing to do research on these engines. One should not conclude, however, that all the problems have been satisfactorily solved. It takes many years, millions of passenger car miles, and vast production experience to bring out all the problems and find satisfactory solutions to all of them. Some of these problems are technical, other economic, and still others involve customer reactions to the end product.

From a materials and production standpoint, the final adoption of any one metal over another is governed by the successful solution of a number of problems. Some of the most important problems are those dealing with availability, metallurgy, production, and cost.

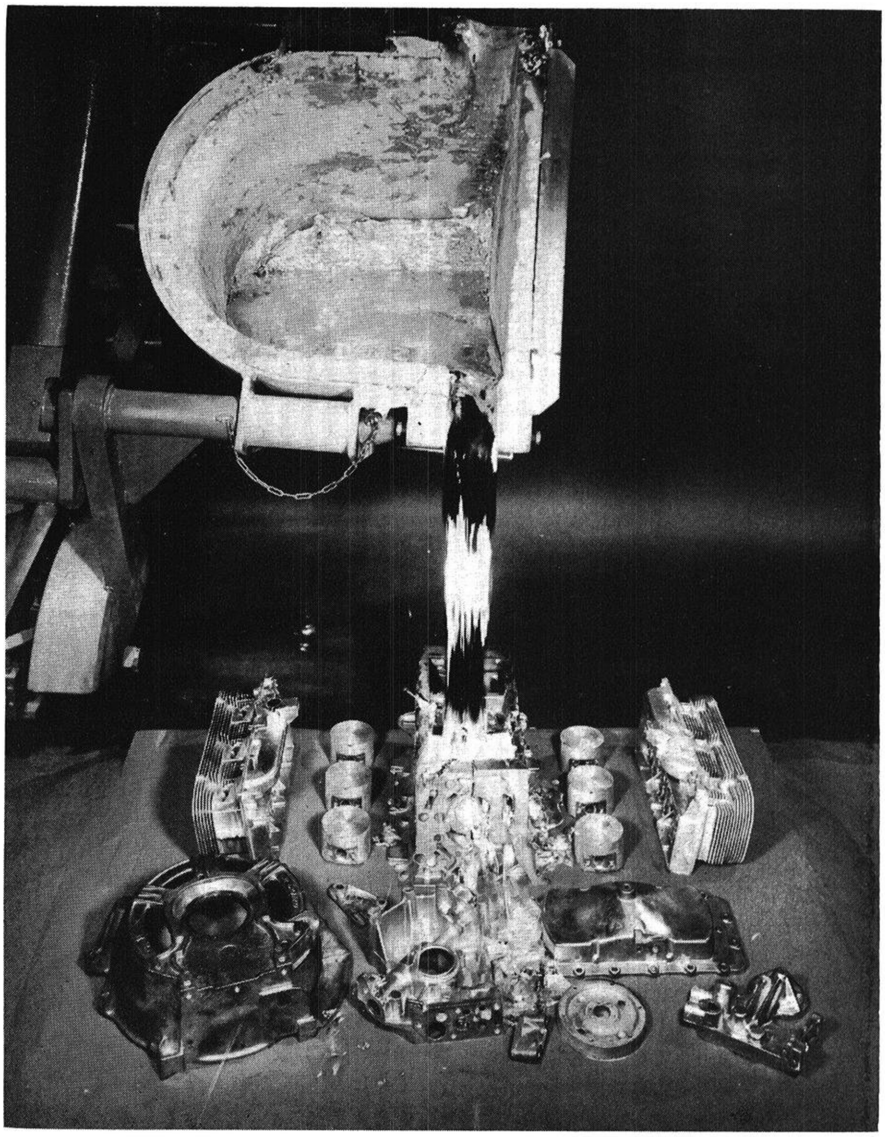
The Problem of Availability

Supply of aluminum has not been steady since World War II, but the situation is being remedied by a huge, long-term, capital investment program. The key to volume use of aluminum by car manufacturers is the assurance of a stable, adequate supply. With the high production requirements of the auto industry, the unstable aluminum market of the past few years could not assure an adequate and continually increasing supply of aluminum. Today, molten aluminum contracts guarantee the supply for both the present and future needs of the various car manufacturers. The location of new auto plants near an aluminum reduction plant permits pouring of molten metal from the reduction cells at the reduction plant into insulated ladles mounted on platform trucks for immediate delivery to a nearby auto plant. The new Ford plant at Listerhill, Alabama, the General Motors plant at Jones Mill, Arkansas, and the proposed Chevrolet plant at Massena, New York, are all located, or to be located, near aluminum reduction plants.

Metallurgical Problems

During the development of the experimental aluminum engines,

(Continued on page 40)



Chevrolet–Massena aluminum castings—Molten aluminum pours from a ladle into two Corvair crankcase halves and spills onto other castings produced at Chevrolet Motor Division's new aluminum foundry at Massena, N.Y. Besides the crankcase parts, which form the Corvair's engine block, other parts shown include cylinder heads, pistons, a clutch housing, rear end housing and crankcase cover.

Progress in Sound Reproduction

by Richard Batterman '61

Our modern stereophonic and high fidelity phonographs are the latest in a series of improvements on the first phonograph made by Edison.

THE process of hearing recorded sounds consists of a series of transformations from mechanical vibrations to electrical impulses. When we place the tone arm of a phonograph on a record, the needle, or stylus, vibrates in the groove of the record, and the cartridge changes these minute vibrations into tiny electrical impulses. These are then amplified by a series of vacuum tubes in the power amplifier. Another transformation takes place when these amplified impulses drive the coil of the loudspeaker. It is the job of the loudspeaker to cause the air to vibrate in the manner it did during the recording session, and it is our ears that finally relay these vibration to our brains. Only after this rather complex series of transformations may we hear the recorded sounds.

In order to record sounds, their kinetic vibrations must be put into a potential form. In the disc record the potential vibrations are in the configuration of the groove. When the disc is rotated, the stylus follows this configuration. Being forced to vibrate as it travels along the groove, the stylus changes the potential vibrations into kinetic energy. This process was first discovered in 1877 by the American inventor, Thomas Edison. His invention consisted of a rotating cylinder of hard wax with a cutting tool depressed slightly into the wax. He found that sounds, if loud enough, caused the cutting tool to vibrate up and down, cutting hills and valleys within the groove. He also found that a large horn with a mica diaphragm coupled to the cutting, increased the amplitude of the vibrations so that softer sounds could be recorded as well as the louder sounds.

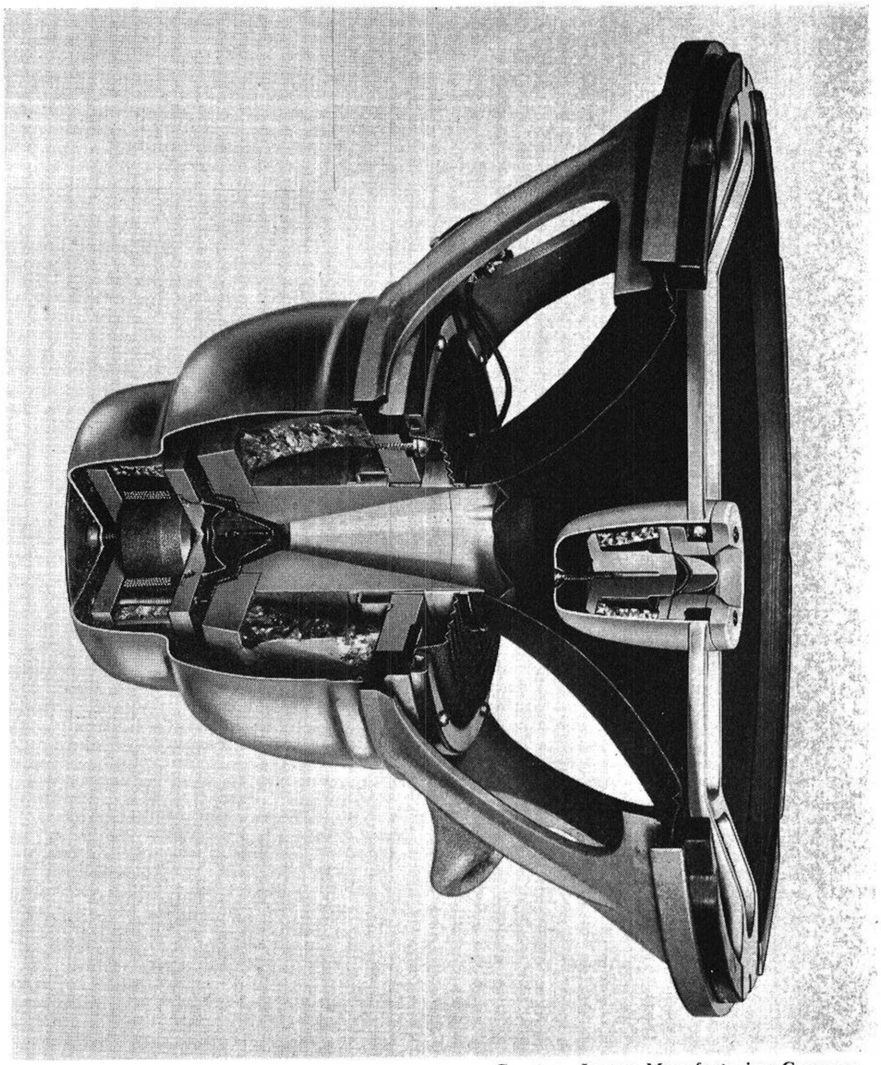
Ten years later, Emile Berliner patented a system of recording which utilized a lateral movement of the cutter, rather than the vertical movement. This new method also used a thin disc in place of the cylinder. This was the only major mechanical change in the history of the methods of record making. With the advent of the vacuum tube, however, gradual improvements in the quality of recorded sound have been taking place. Since that first invention of Edison's, the horn has been replaced by the condenser microphones and the mica diaphragm has been replaced by the power amplifier.

The heart of the phonograph is the stylus-cartridge combination. Paradoxically, it is the least understood component of the phonograph in spite of the fact that it is the simplest. There are three basic types of cartridges used in phonographs-the piezoelectric, the magnetic, and the capacitive. Their operation is as follows:

1. The piezoelectric cartridge has either a rochelle-salt crystal or a ceramic element which is flexed by the stylus, causing a current to flow which is proportional to stylus displacement.
2. The magnetic cartridge may consist of a moving magnet which, due to stylus vibration, is forced to and fro through a coil, thus inducing a voltage as the magnetic lines of force are cut. Two other variations of this are—to fix the magnet and have the coil move with the stylus or, to fix both coil and magnet while a piece of Mu-metal moves between the poles of the magnet, varying the reluctance of the magnet, and inducing a voltage in the coil.
3. The capacitive cartridge is unique. The stylus varies the capacitance of an rf oscillator, frequency modulating it. The modulation varies the oscillator's plate voltage and thus develops an audio output proportional to the stylus displacement.

Most people know what an amplifier does even though it is the most complicated component of the phonograph. Its purpose is to increase the amplitude of the impulses to such an extent that they are strong enough to operate the loudspeaker.

The operation of the loudspeaker is somewhat simpler. The cone carries a ring wound with fine wire, called the voice coil, which normally rests in a strong magnetic field between the poles of the magnet. When the fluctuating impulses from the amplifier pass through the voice coil, the coil vibrates, forcing the cone with it, producing sound waves.



—Courtesy Jensen Manufacturing Company

Cutway of a high fidelity speaker, showing its many parts.

High Fidelity and Stereophonic Sound

Ever since the first crude phonograph, people have remarked that they could not tell the difference between the recorded and the original performance. These people were so amazed at the miracle of sound reproduction that the need for improvement was non-existant. This seems ridiculous when we play those old recordings over our much improved equipment and find the sound is lacking in frequency range, dynamic range, and in definition. That is, we have trouble telling instruments apart because so many of their defining overtones were simply not able to be recorded with the old equipment.

Improvements in the quality of sound reproduction have resulted in some very fine high fidelity systems. Over these sets, the sound from a long playing, hi–fi record is very clear, all the instruments and their overtones are heard, and the surface noise, which was always present on the 78 rpm records, is negligible. Some interesting facts about record wear point out the reason why the slower, 33 1/3 rpm record has become the standard today. Since the stylus is concentrated on such a small area, the pressure it produces on the groove is as much as 50,000 lbs./sq. in. and the temperatures created are frequently over 1000 deg. F. It is obvious that the increased heat of friction, caused by the faster 78 rpm speed, would cause grooves to wear at far greater rates.

Although hi–fi enthusiasts have always been proud of the fact that their equipment was capable of reproducing wide frequency ranges, great dynamic ranges, and tonal presence, they realized the short-comings of their sets when they attended a concert where the sound was spread across the entire width and depth of the stage. Over their sets, all the instruments sounded as though they were in the same spot in the orchestra, leaving much to be desired in the trueness of the playback.

The human ears, with their ability to define direction and space by sorting out sound sources and room echos, do more than place the sound to the right or left—they add dimensionality to sounds coming from more than one spot. This principal was recognized and used in some of the earliest experiments in the reproduction of sound. Among these was one of particular

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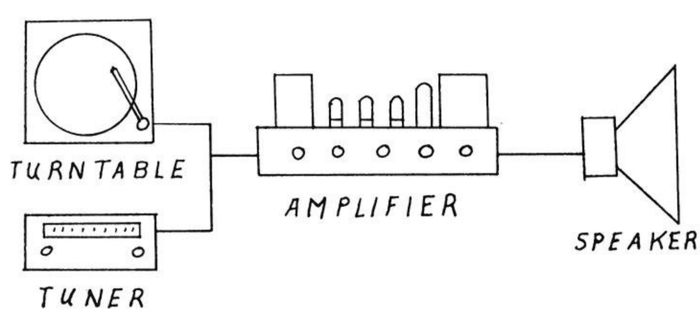


A simple diagram of a high fidelity set.

The Speed Control Instrument System

by David R. Hotchkiss me'60

A means of providing the pilot with precise, reliable, and continuous information about the lift of his wings in the critical take-off and landing speed ranges.

EVERYONE knows what lift is. Lift is the mysterious force that keeps airplanes in the air. But lift is more than that; it is known to aeronautical engineers by the equation:

$$L = C \frac{D}{2} SV^2$$

where L is the lift, C is the coefficient of lift, *D* is the density of air, S is the effective area of the air foil, and V is the velocity. C varies with changes in the angle of attack, resulting in changes in lift. The angle of attack is the angle that the chord, or centerline, of the wing makes with the air through which the airplane is passing. The maximum lift available will change with changes in the position of the flaps; therefore, this factor must be accounted for in lift instrumentation.

Consequently, to be effective and accurate in measuring lift, any indicator must take into effect changes in the coefficient of lift, air density, configuration (here referring to extension of landing gear, flaps, etc.), or speed. How is this done? Basically, the primary measure of lift is measured in the wing pressure pattern of the wind flowing over the wing. The lift is measured at the airflow division point, or stagnation point, as it is so often called.

Stagnation Point

As the wing slices through the air, it causes the air to divide and flow either over the top or under the bottom surfaces of the wing resulting in two related aerodynamic phenomena: (1) where the air is divided there is a definite impact point, a point of flow division called the stagnation point; and (2) the position of this point shifts in exact correlation with any change that alters either the character or the flow of air over the wing.

For instance, a change in air density, angle of attack, power, or gusts of wind will alter the relative position of this point of division of air flow. Changes in the position of this point are measured for the Speed Control by the lift transducer.

COMPOUNDS OF THE SPEED CONTROL

The Speed Control consists of four main parts. They are the lift transducer, the flap potentiometer, the lift computer, and the speed control indicator.

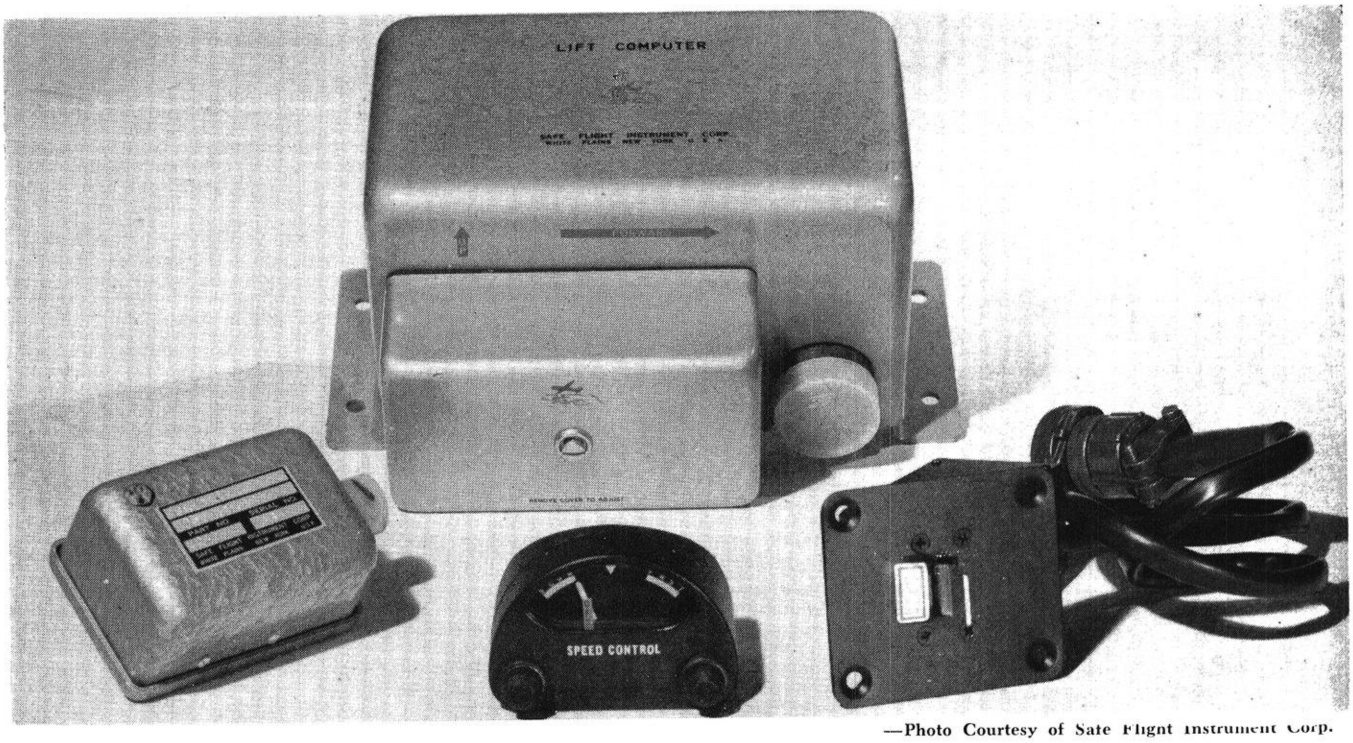
Lift Transducer

Changes in the location of the stagnation point are detected by the lift transducer through a small stainless steel vane, less than an inch long, which is located on the lower side of the wing's leading edge. Spanwise, the location of the vane is slightly ahead of the middle of the aileron span. The vane is actually located below the normal stagnation point so that the flow detector remains in the down positions in all safe flight conditions.

When an unsafe flight condition arises, the change in the location of the stagnation point will move the vane upward. Movement of the vane upward by change in airflow or angle of attack results in changes in the magnetic field located in the unit. Changes in the magnetic field induce a current in the wires of the unit, the signal then being fed to the lift computer.

Flap Potentiometer

At the same time, another signal is being generated by the flap potentiometer. The flap protentimeter will generate a signal which will tell the lift computer what position the flaps are in. It is necessary that this be done because the lift increment from the flaps and the position of the stagnation point are not always directly related. The shaft of the flap potentiometer is mechanically connected to the wing flaps. As the shaft rotates with the rotation of the flaps, an



—Photo Courtesy of Safe Flight Instrument Corp.

Components of the Speed Control: top, lift computer; bottom from left to right, flap potentiometer, Speed Control Indicator, and lift transducer.

electric current is generated through changes in the magnetic field. The signal is then sent to the lift computer.

Lift Computer

The lift computer is composed of basically two parts: a thrust transducer and an electrical resistance bridge. The thrust transducer measures the forward acceleration through the use of an accelerometer mounted on the pitch gimbal of a gyroscope so as to be maintained at all times in the horizontal plane. The electrical resistane bridge balances and integrates the signals from the lift transducer, flap potentiometer, and the thrust transducer.

The lift computer unit can be installed in any fuselage location that is convenient for inflight adjustment. Two adjustments can be made in the unit. One is the null point which allows the pilot to adjust the needle of the Speed Control Indicator, to indicate any desired percentage of lift at a particular point on the dial of the indicator. The other adjustment regulates the air speed spread of the arc. Maximum reading would be a forty mile-per-hour spread of the arc, with a ten mile-per-hour override at each end. The whole range of the band spread can be turned down to represent only one mile-per-hour if desired. The electrical signal generated by this unit is then sent to the Speed Control Indicator for pictorial presentation to the pilot.

Speed Control Indicator

The Speed Control Indicator is a small voltmeter-type needle indicator which is located directly in front of the pilot on the instrument panel. It can be located in either the standard 3⅛ inch cutout in the instrument panel or on top of the instrument panel. The location on top of the instrument panel is preferred for ease of observation during the landing approach. The Speed Control indicator shows on its tri-colored dial the correct speed to be flown to obtain maximum lift.

The indicator has a built-in safety feature in that the pilot will be automatically warned of malfunctions of the system, such as power failure or an open circuit, by the appearance of the warning flag on the face of the indicator.

TYPICAL FLIGHT USING SPEED CONTROL INDICATION

Take-off

Take-off using the Speed Control Indicator system is a simple procedure, regardless of aircraft weight, wing flap position, or wind. Assuming the system has been properly adjusted to the correct speed, the pilot merely watches the needle swing slowly from the slow range, on the left side of the indicator, toward the fast range on the right, as the airplane picks up speed as it rolls down the runway. As the needle reaches the center position, indicated by the inverted white triangle on the Indicator, the airplane is ready to fly, and the pilot applies pressure to the control column to raise the nose of the airplane to take-off altitude.

Climb-out

After breaking ground, the pilot simply keeps the needle centered under the white triangle as the plane climbs and the airplane will be climbing at the maximum rate of climb. Too steep a rate of climb will be shown immediately on the Speed Control Indicator by a needle deflection to the left, the slow range, indicating that the airplane is approaching a stall. Too shallow a rate of climb would be indicated by a deflection to the right, the fast range. While climbing out too shallowly is not as serious as climbing out too steeply, maximum performance is not be-

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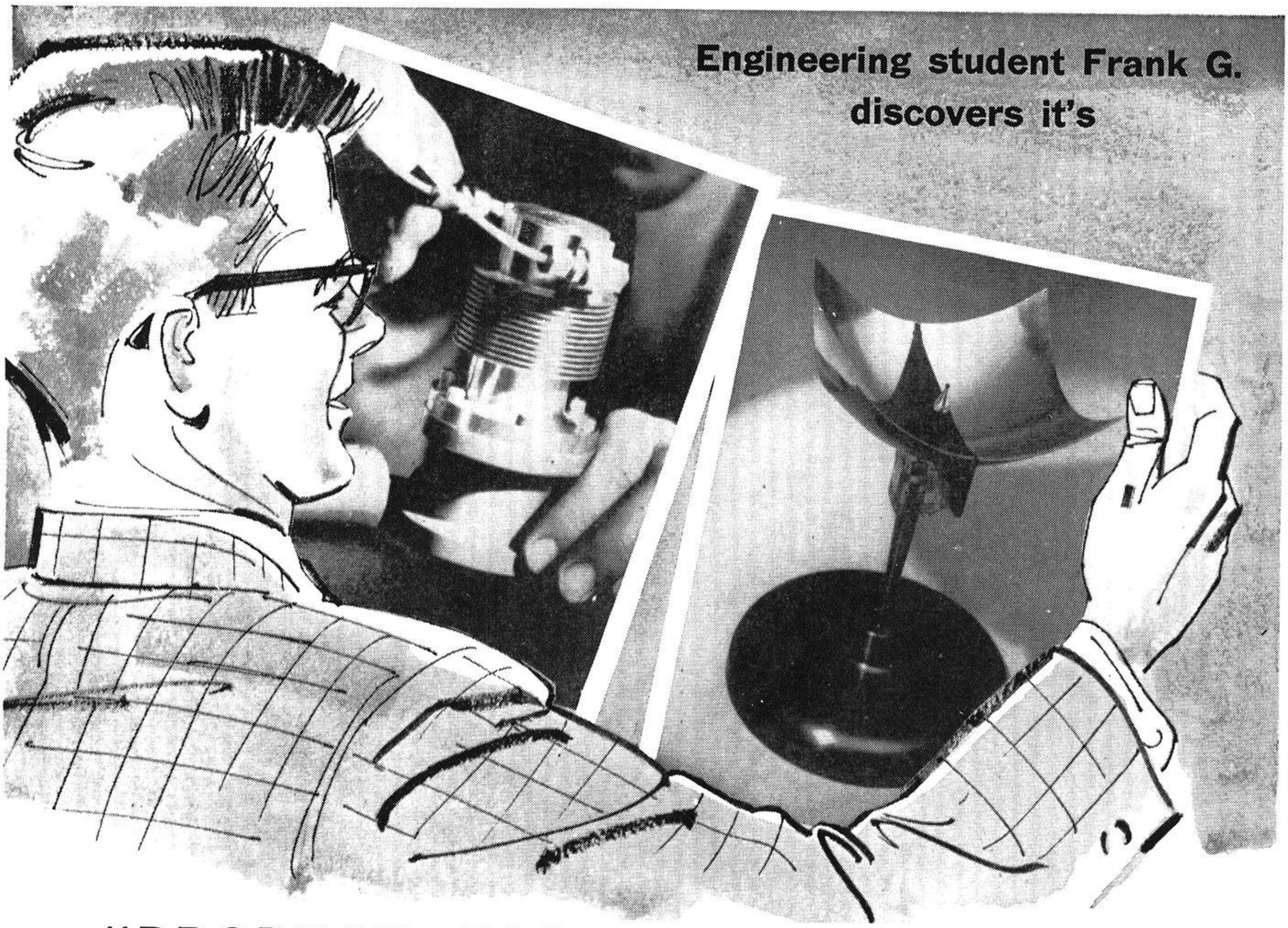

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Ropes of Steel

by Clark Sholts me'60

The use of wire ropes and steel cables is increasing in importance in all parts of modern industry, Here, the author discusses the manufacturing processes, products, and uses in obtaining these ropes of steel.

A WIRE ROPE is a helical arrangement of strands of wire woven around a solid core. This setup provides a strong durable, wear resistant steel product which is finding more uses in the growing trend toward higher force applications. Steel cables, produced in a manner similar to wire ropes, is also increasing in use in many industries. Since both products are produced by spinning individual wires around a center, the resemblance and characteristics of a rope are obtained.

In the discussion that follows, the entire manufacturing process, is described from the introduction of raw materials to the final wire product. Any confusing terms or concepts dealing with wire rope design, strength, and wearing qualities are explained. Since variation of the winding procedure produces different types of ropes and cables, an analysis of the final products and their uses is covered at the end of the article.

Production of Raw Materials

Wire rope starts its production at the blooming mills of a steel mill were the raw materials are produced. Here the ingots of iron are rolled in a white-hot condition through high pressure rolls. The ingots are reduced to billets which are sent to the wire mill. These rectangular shaped pieces of steel with a 4 by 4 inch square cross section are then reduced to ¾ by ¾ inch rods. The rods can be of any shape, namely, square, oval, or round. After they have been reduced to ¼ inch square rods, about ¼ mile long at the finishing mills, they are attached to drums and wound into coils. The coils are then sent to the wire drawing mill.

Wire is formed from the rods which are received from the wire mills. All coils of rods are cleaned of scale, oil, and dirt by soaking them in a tank filled with a weak solution of sulfuric acid. Next, they are placed in lime filled vats, after which they are taken to the drying ovens and thoroughly dried. Wire is generally accepted as steel rod smaller than 1/5 inch in diameter. Wire may be coated with many materials, depending upon the qualities of corrosion, wear, resistance, etc., desired.

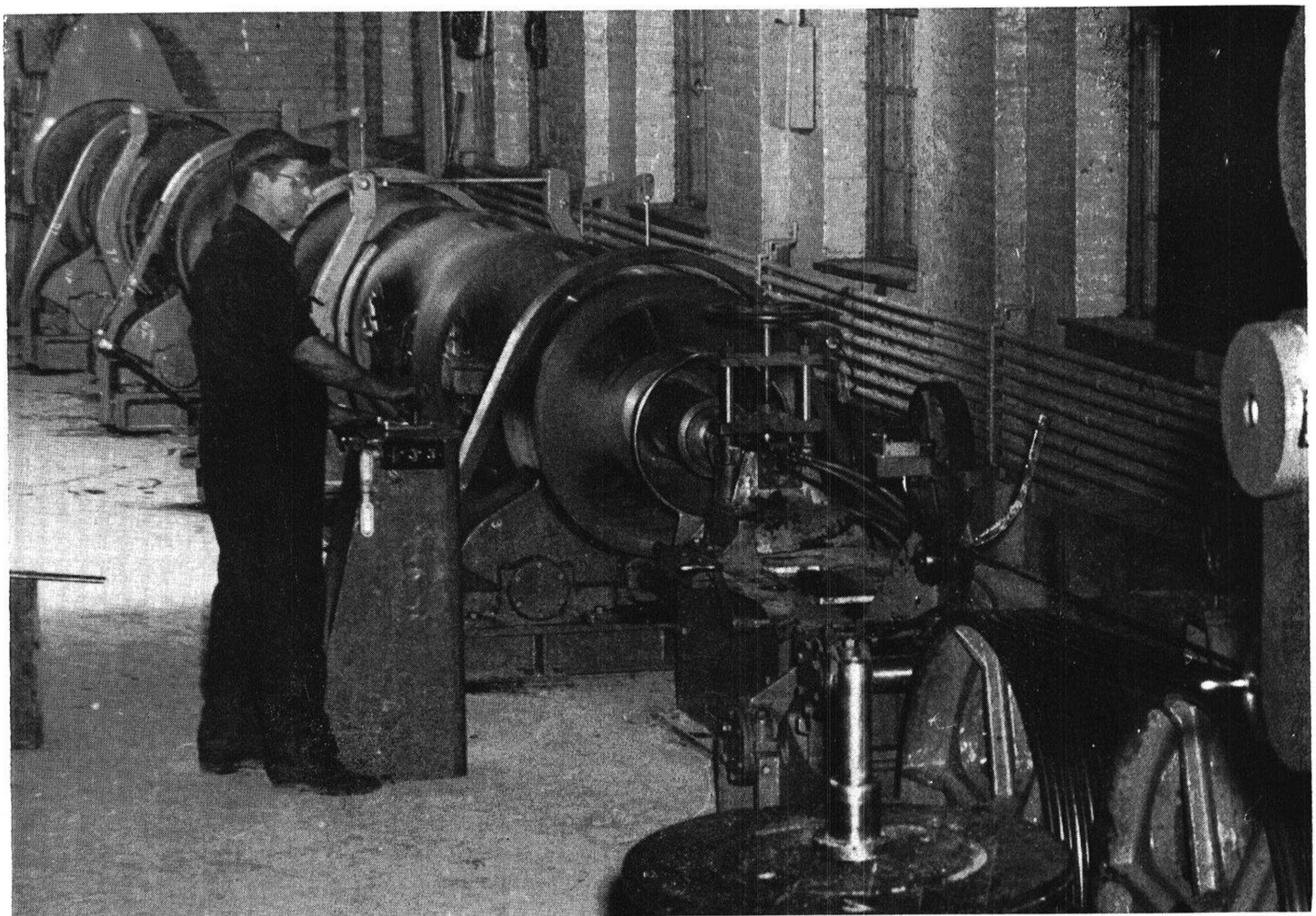
At the present time, all wire is made by the drawing process. This produces a thinner wire of greater tensile strength than is obtained from rolls. Wire is drawn through chromium steel dies having round die holes. The wire is wound around a cast iron drum as it is drawn through the die.

After being drawn through several dies, the wire becomes hard and must be annealed. The wire, which is defined as metal elongated into threadlike form of thickness varying from ¼ to less than 1/000 inch, is then spun into wire ropes.

Wire Rope Production

Wire rope is a helical arrangement of strands of wire wound around a core or center. Producing wire rope is merely a case of spinning wire into strands and then spinning the strands into rope. The spools of wire are placed in floating cradles in the wire stranding machine and then through a die in the head of a strander.

Revolving the spinning machine results in the helical arrangement of the wire and strands. The die



—Courtesy of American Chain & Cable Company Inc.

To fabricate the strand, wires are wound on bobbins which are placed in a stranding machine. The strander revolves and the wires are layed into a strand.

plate causes the strands to be compressed together into rope. The wire rope is then wound on spools and is ready for sale.

The end result of all these processes is a group of steel wires wound into a rope often ½ inch in diameter.

The Design and Appearance of Wire Rope

Strength of wire rope is naturally governed by the steel from which it is made and the manufacturing processes used. Stresses in wire ropes and steel cables are tremendous. Wire ropes are designed to withstand up to 120,000 pounds per square inch. For hundreds of years, wire rope were made by forcing a large number of strands into rope. This caused the ropes to crinkle and wear out prematurely. The stresses set up by the individual wire in the rope lowered the yield strength of the metal, therefore lowering the load carrying capacity of these ropes.

In 1924, preforming was developed. Preforming added another step in the manufacture of wire rope which forms the strands and individual wires into the helical shape they will assume in the finished rope. A rope free of internal stresses and hence, one with greater load carrying capacities in thus produced.

Wear in wire ropes is of great importance because it shortens the 'life' of the rope. Types of wear that are experienced in wire ropes:

1. wear caused by abrasion between the rope and some foreign surface,
2. wear caused by the individual strands and wires sliding over each other, and
3. corrosive wear.

To combat abrasive wear, stronger and larger wires are used on the outside layers of the ropes. Oil is used to diminish internal wear. Like any machine, a rope will work more efficiently if all its parts are properly lubricated. Corrosive wear is lessened by coating the wire strands with marline or other corrosive resistant material. Adding molybdenum, chromium, or tungsten to the steel after it has been tapped for the open hearth or electric furnace strengthens the metal and improves its corrosion resistance.

Design of wire ropes, like any other important and versatile machine, is always being changed and improved.

Elements of Wire Rope

There are many terms and elements of wire ropes and steel cables that are of such importance that they should be understood. They include:

1. *Lay* refers to the direction of twist of the wires in the strands and of the strands in the finished rope. If the strands in a rope are twisted to the right, the rope is known as right lay rope;

(Continued on next page)

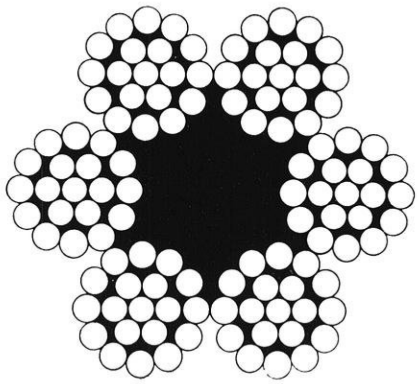
conversely, if twisted to the left, as left lay rope. If the wires in the strands are twisted in the same direction as the strands, the resulting rope is known as lang lay rope; but if the wires in the strands are twisted in a direction opposite to the direction of strand twist, the rope is classed as a regular lay rope. The lay determines many of the wearing abilities of wire ropes.

2. A *Strand* consists of a specific number of wires of predetermined sizes, laid in layers around a center wire in a given design or construction. Each wire in a strand performs a specific function. The intermediate layer of wires serves as a supporting arch for the outer layer of wires which absorb the wear and tear of contact with sheave drums and other surfaces. Each wire carries a film of lubricant to prevent chaffing and nicking the wires around it. Each construction is so designed that a breathing space exists between wires, permitting each wire to move in coordination with the wires adjacent to it.

3. *Length of Lay* indicates the distance in which a stand makes one complete turn around the core of the rope. It is measured in a straight line parallel to the center line of the rope. The unit of measure is directly related to rope diameter and hence, is a basis for proper comparison of ropes of different diameters. The shorter the length of lay, the more flexible the rope.

4. *Diameter* is measured between the extreme edges of the strands of the rope. If the diameter is measured incorrectly, the rope will wear and lose its strength rapidly.

5. *Core* is the heart of the wire rope around which the strands are laid. It has the important function of supporting the strands in their relative positions throughout the life of the rope. Fiber cores are made of hemp and are used when the rope is to have a long service life. The other type of core, used today in wire ropes and steel cables is the independent wire rope core. The independent wire rope cores are used when great strength is needed, although they have the very detrimental and frustrating disadvantage of causing wear of the strands of the rope.



Suppose an order called for a rope having 6 strands of 19 wires each. First, 6 separate 19 wire strands are made. Next, these six strands are layed around a core. Cores may be of various types.

Types of Wire Ropes

Wire ropes and steel cables are produced in a great variety of cross-sectional shapes. Each shape is designed to meet the needs of a specific industrial application.

Round strand ropes are the most common form of wire rope. These ropes are classified as to the number of strands and wires within each strand. Ropes are the cheapest to buy, since they are the least expensive to manufacture.

Flattened strand rope is particularly suitable where severe conditioning of abrasion and crushing are encountered. These ropes also have ten per cent higher strength than the round strand ropes. The very large surface of contact permits the abrasive wear to be distributed over a greater number and length of wires. The wearing surface is 100 per cent greater than in round strand ropes. The triangular shape of the strands promotes better resistance to crushing.

Flat wire rope is made of a number of ropes laid side by side and held in position by soft iron wires. The individual ropes are made of four strands of seven wires each, alternately right and left lay to avoid twist or curl in the finished rope. The advantage of a flat wire rope is that it will bend upon itself, requiring a drum only slightly wider than the rope. It is used principally in short lengths where there is little space between load and hoisting drum. Typical uses are in dam gates and locomotive drop pits.

Strand wire rope is, as the name implies, one strand of wire which comprises the whole rope. Strand wire used in bridges is furnished in varying numbers from 19 to 161, and is used because of its higher unit strength and lower cost. Almost any form desired can be produced by the wire rope manufactures, although cost should by estimated if other than standard shapes are necessary.

Industrial Uses

The uses of wire ropes and steel cables are so varied and numerous that an article could be written on each. This article will discuss some of the uses in industries which depend on wire ropes and steel cables to a larger extent for their growth and income.

In the mining industry, extensive use of wire ropes has evolved from the need of a machine of high strength, light weight, and good wearing qualities. The development of new methods in deep mines, the growing trend toward strip mining and the operation of new, more powerful, dredges, depend on wire rope in an over increasing degree.

Because of the adverse working conditions in the mines, the wire ropes must be assigned large safety factors. Safety factors are the ratio of the rope's strength to the actual load. Thus, a wire rope with a strength of 10,000 pounds per square inch loaded with 2000 pounds would operate with a safety factor of five.

Every wire rope is subjected to wear, fatigue, and crushing. Wear is caused by abrasion of the rope rubbing against some foreign material or the strands adjacent to each other. In the design, this is lessened by using large diameter outer wires on the strands and by alloying the metal with elements which will impart new strength to the steel (manganese or chromium). Fatigue, which is the repeated bending in opposite directions of a wire, can be lessened by using the rope in such a way that the loads would be applied steadily. Crushing can be almost eliminated by the use of steel cores.

The oil industry is typical of the industries which are almost entirely dependent on wire ropes for

(Continued on page 47)

SCIENCE HIGHLIGHTS

Don Norris ee'60

FOUR articles are featured in the Science Highlights column for December. The completion of an 84-inch telescope mirror blank for the Kitt Peak Observatory is revealed. The winning entry in the Steel Highway Bridge Design Competition is announced and a description of the bridge is given. A prediction of supersonic passenger transports in the foreseeable future is made by an aircraft executive. Finally, a new development in the manufacturing of printed wiring cards is discussed.

MACH 6 TRANSPORT PREDICTED

An aircraft executive has recently predicted that the day is coming in the foreseeable future when airlines will whisk passengers 6100 miles from Amsterdam to Los Angeles in just 98 minutes elapsed flying time. At that speed, averaging 62 miles a minute, air travelers of the future conceivably could arrive (by sun time) in California six hours before they left the Netherlands. They could even see the sun rise in the west following an after-dark takeoff.

The 4730-miles per hour vehicle of the future might resemble a skin diver's foot flipper, or a finned electric shaver. Able to take off and land vertically, the Mach 6.0–7.0 transport could be wingless. (Mach 1 is the speed of sound.) This vehicle could utilize a flattened, all-body configuration in which the entire nose section serves as an inlet for the primary ramjet propulsion system. Airflow would be diverted in ducts around a central passenger cabin to rear discharge nozzles and deflected vertically for takeoffs and landings. Small fins would provide stability and control.

Designers of the missle-like transport will profit from operational experience of today's military planes. Those of the free world amass nearly 500,000 supersonic hours annually. Further research is necessary to settle the winged-versus-wingless question. Design studies have been completed on both types. Each would cruise at speeds up to Mach 7.0 and have a range of 4000 miles with reserves. An advantage of the wingless craft would be structural weight improvement, particularly important at the elevated temperatures accompanying high Mach number speeds. Offsetting the weight advantage, however, is the slightly superior aerodynamic efficiency of the winged type.

Beyond the era of current turbojet transports which operate at high subsonic speeds, design of a Mach 3.0–3.5 airliner using conventional but advanced jet engines is considered to be the next step. For the future clearly attractive payloads will be realized at speeds of Mach 5.0 or above, resulting in practical and economic operation.

A "dual cycle" engine, convertible from turbojet to ramjet, will meet powerplant requirements for the Mach 3.5–5.0 airplane. Almuminum alloys, today's standard primary structural material, will be replaced by stainless steel and titanium. The convertible engine theoretically would use a ramjet configuration for operation at speeds above Mach 3.0, and the turbojet principle (compression, fuel-air mixture and combustion) for all other operating speed ranges.

WINNING BRIDGE DESIGN ANNOUNCED

Allan M. Beesing, a registered professional engineer from Buffalo, N. Y., has been named winner of the $15,000 top professional award from among 300 entries in the Steel Highway Bridge Design Competition sponsored by American Bridge Division, U. S. Steel Corporation. The object of the event was to stimulate more imaginative, effective, and economical use of strong, modern steels in overpass structures that must bridge superhighways at frequent intervals. It is estimated that more than 41,000 bridges will be needed for the network of interstate and defense highways the nation will build in the next 15 years.

Consideration for the safety of highway travelers enhances the original, economical, and appearance features of Mr. Beesing's award-winning design. His plans show a graceful arch of welded steel girders which bridges in a single span a four-lane divided highway. Skillful combination of carbon and high strength steels eliminates the need for a center pier.

Absence of a center support in the median strip benefits the high-speed highway traveler in two ways: it removes a potential safety hazard, and it gives a clear view of the road ahead at all points. As an added safety feature, the abutments at the ends of the span are placed well up on the slopes of the highway embankments.

The main span of the bridge is 160 feet long and requires 111 tons of steel. The composite-action, slab-type roadway supported by the steel span requires 130 cubic yards of concrete.

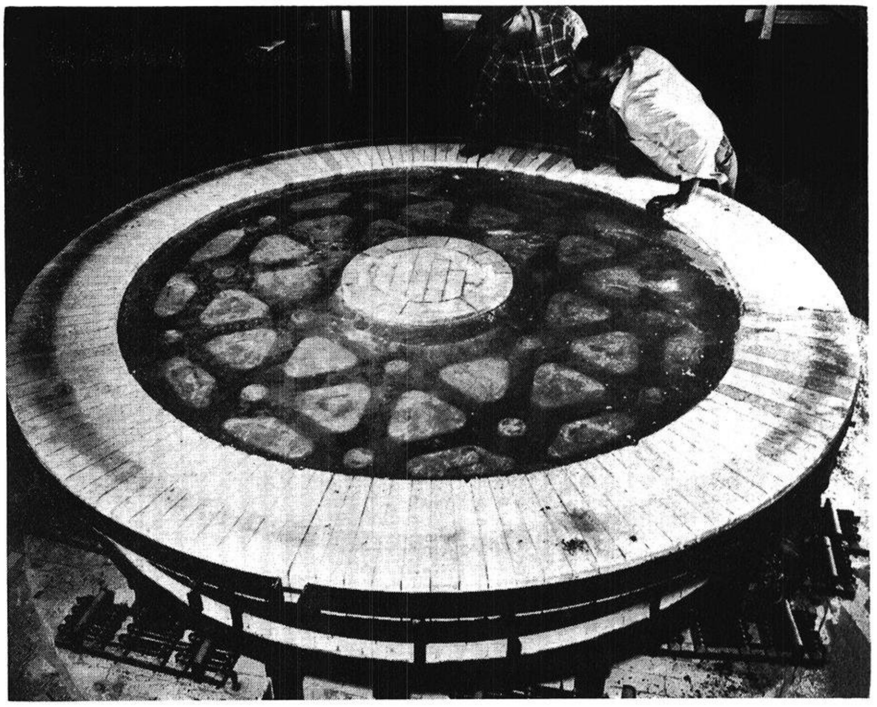
In describing other features of his entry which contribute to its strength, trim appearance, and overall economy, Mr. Beesing stated:

"The original concept consists of . . . developing a single-span, substantially fixed-end structure which engages concrete abutments. The abutments not only perform their ordinary functions, but resist the end moments, also. The fixed-end principle lends itself admirably to the development of a slender, graceful bridge with shallow depth at the center and increasing on a parabolic curve to a greater depth at the abutments. The girders are proportioned to provide resisting moments at the center and ends."

"*Tri-Ten* steel, used for flange plates, provides considerable advantage over structural grade carbon steel both in appearance and cost. *Tri-Ten* contributes to the slenderness of the structure, which in turn effects a real saving in the height of approach embankments. To give the bridge a clean appearance, all intermediate web stiffeners are placed on the inside faces of girder web plates."

"Carrying on from the visible portions of the steelwork, the moment connection resting behind a cheek wall reveals a novel part of the design. The eight-foot depth girder bears and pivots on a main bearing and extends beyond to an inverted bearing retained by a cap plate and four 3¼ inch diameter *T-1* high-strength steel bolts. This device of a pivot and four high-strength bolts is capable of resisting the maximum moments which can be transmitted."

"Composite action and continuity has been taken advantage of in figuring the stringers and transverse floor beams. Composite action gives great rigidity and reduces deflections considerablv. The structure is comparatively free of complicated fabrication and lends itself to speedy erection."



4000 pound mirror blank being examined at Corning, N.Y., before shipment to Tucson, Ariz.

84-INCH TELESCOPE MIRROR BLANK COMPLETED

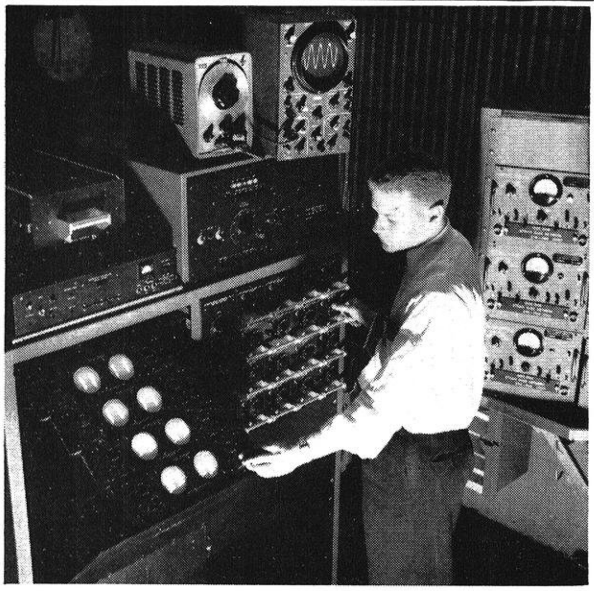
An 84-inch telescope mirror blank for the new Kitt Peak National Observatory, under construction 40 miles southwest of Tucson, Arizona, has been recently completed. The disk, packaged in a special felt-lined crate, has been shipped by railroad to Tucson. There an optical shop has been set up for grinding and polishing the 4,000 pound mirror blank. The job is expected to take 24 months. The final precision finishing, involving removal of a few millionths of an inch of glass, will be done after the mirror has been installed in the telescope and fixed on a star. This work is expected to take another year.

The big glass disk made by Corning Glass Works will join two other giant Corning mirrors in probing millions of light years into space. The 200-inch disk —world's largest—at the Hale Observatory atop Palomar Mountain in California, was cast 25 years ago. A 120-inch mirror, now in use at the Lick Observatory on Mount Hamilton in California, was cast in 1933. The 84-inch disk is the largest of six glass mirror blanks made for the Kitt Peak Telescope. It is the biggest piece of glass ever produced by placing solid chunks of glass on a mold and sagging them into a single piece under intense heat. Both the 200-inch and 120-inch mirror blanks were made by ladling molten glass into the molds. Engineers said the sagging process reduced bubble inclusions and proved less complicated and less costly.

Nine pieces of glass, one weighing 2976 pounds, were melted down to form the 84-inch disk. The completed mirror blank is 13 inches thick and has a center hole of 26 inches in diameter. The huge piece of glass was recently removed from an annealing oven at one of Corning's melting plants. It had been sealed in the annealer for seven months for controlled cooling after being melted to form. The separate chunks of glass were fused under temperatures reaching

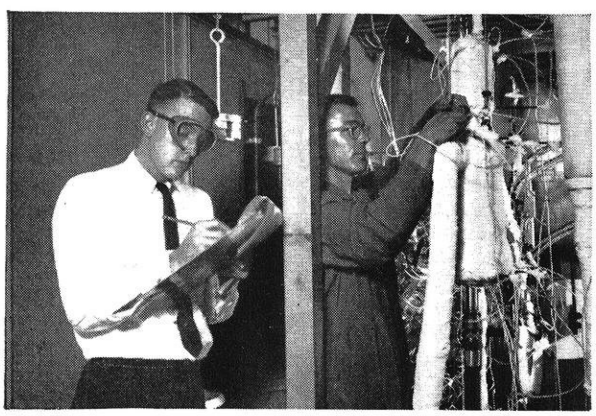
(Continued on page 32)

engineers



Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.



Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they d

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

Science Highlights

(Continued from page 29)

approximately 2300 degrees Fahrenheit. Controlled cooling was necessary to eliminate stress in the glass.

The disk is of ribbed construction on the back face. This honeycombed pattern reduces weight while retaining necessary strength and rigidity. The pattern was formed by use of ceramic cores, bolted and cemented into the floor of the brick mold. Each core had to be carefully separated from the glass. This was a ticklish job, handled after the mold bricks were removed and the disk was hoisted up and overturned.

Like the other big disks, the 84-inch mirror blank is made of borosilicate glass, selected because of its low expansion, thermal resistance, and mechanical strength. The mirror must retain its shape through time, temperature changes and mechanical stresses if astronomers are to obtain undistorted images of the stars.

The observatory atop 6,875-foot Kitt Peak will go into full operation in about three years. This installation and the National Radio Astronomy Observatory at Green Bank, West Virginia, are the first two observatories in the United States available for the use of all qualified astronomers. Supported by the National Science Foundation with federal funds, the observatories are designed to supplement existing facilities for research in astronomy.

NEW PRINTED WIRING DEVELOPMENT REVEALED

A new method for producing printed wiring directly on ceramic basis without the use of adhesives has recently been developed. The basis of the new process, which uses standard silk screening techniques for forming the pattern, is a specially formulated copper-bearing paste. Following the printing of the desired pattern on the ceramic base, the piece is fired in a two-step process, resulting in a clean, durable pattern with excellent electrical characteristics.

In present methods of production, a sheet of copper foil is usually bonded to the ceramic or plastic base with an adhesive. The desired pattern is then produced by one of several methods usually involving the removal of undesired material. The bond of the copper to the base thus is dependent on the strength of the adhesive. Often, it fails during subsequent processing operations, such as soldering or assembly.

Good bonds can also be developed when fired silver or fired molybdenum is used on ceramic bases. Silver is more costly than copper, it dissolves more quickly in molten solder than does copper, and under some conditions it is subject to migration and whisker growth. Molybdenum compositions are high in electrical resistivity and generally require electroplating to render them solderable and to improve the conductivity.

With the new process, a paste is prepared from a finely ground mixture of copper oxide and a special glass frit, blended with a standard silk screen printing vehicle. The paste is used to print the pattern on the ceramic, and the "card" is heat-dried to remove solvents. After drying the card with its pattern is fired in air at 750 degrees centigrade for twenty minutes to burn off the printing vehicle. This operation leaves a nonconducting copper oxide pattern, ready to be reduced to metallic copper.

The second firing operation is conducted at 850°C for thirty minutes, in a controlled atmosphere containing hydrogen, nitrogen, and oxygen. The hydrogen in the atmosphere reduces the copper oxides to metallic copper, while the oxygen prevents reduction of other oxides in the system and promotes good wetting of the glass frit and the ceramic. Without the oxygen present, a poor bond results.

Printed wiring cards prepared this way can be dip-soldered without bond failure, and without the use of corrosive fluxes. In tests of bond strengths, 20-gauge headed wires were attached to the pattern with an area contact about .01 square inch. Bond failure did not occur until subjected to a tension of about 2000 pounds per square inch, and even then generally involved breaking out the ceramic rather than bond failure.

With the oxygen in the controlled atmosphere, only about five percent glass frit is required in the paste to achieve good bonds. This small amount of inert material does not greatly affect the conductivity of the copper film. Resistivity of the film is in the order of 0.0015 ohms per square, which is well within requirements for typical printed wiring applications.

The process is suitable for automatic production techniques, and should prove competitive with other printed wiring methods in cost. There are other potential uses for the new copper paste in addition to printed circuits. With suitable modification of the vehicle, the copper can be applied with a brush or spray gun. When fired, these coatings form a good base for making metal to ceramic bonds, using lead-tin solders.

PUNCH-CARD SHOPPING

Future shoppers may punch cards as they walk through supermarkets. The punches will activate a system that automatically delivers the selected groceries from a stock room to the exit door. Probably following this convenience, cards will be sent to banks that will handle food charge accounts.

ELECTRIC CAR RETURNING

An electric passenger car with speeds up to 60 miles per hour and a battery range of 80 miles will soon go into production. The vehicle, which was designed for urban driving, has two 2.5-horse-power motors. They operate on batteries that can be charged on standard 110-volt ac power.

THE END

ENGINE EARS

by Bob Helm, CE '61

KHK NEWS

The Kappa Eta Kappa house has been literally alive the past month with activities, featuring post football game parties of various types. The October 17 Beatnik party, "Expresso," stands out. The party room, basement, being generously decorated with gloom and the most up-to-date lingo of the College of Complexes of Chicago provided an excellent setting. Two weeks earlier there loomed a hither-to unheard of musicians from the fraternity whose members really put out. They will entertain the entire block with music from now on.

The new pledges this semester are proving to be alive also, having a much broader education than was anticipated. Aside from doing well scholastically, their mischievous antics have been felt. We are sure that this will be an interesting semester.

The business meetings have adequately fulfilled their purpose—highlighted by an interesting and informative talk by the General Electric representative, George Coover. Mr. Coover emphasized the importance of having a particular plan in mind while going to the university and looking 18 months into the future after college. Secondly, leadership ability "in practice" at school is always considered by the perspective employer.

AIEE–IRE NEWS

The second meeting of the Student Branch of the American Institute of Electrical Engineers and Radio Engineers began on the steps of the union theater lobby where the group had its picture taken for the Badger.

Immediately following, the Student Branch joined forces with the Madison Professional Section in the auditorium of the Wisconsin Center. President Bill Dachelet entertained motions by John Nichols to acquire a full page in the Badger for the organization and by Jim Vanderhagen to have a beer and pizza meeting in December.

The program was enlightened by Dr. George Swenson's exhilarating talk on "Problems of Space Communication." Dr. Swenson, being a noted expert on radio astronomical research, EE professor, and world wide traveler, held an attentive audience captive for an hour with his far reaching knowledge on space problems.

MINING AND METALLURGY CLUB

The movie, "Challenge of Outer Space," featuring Dr. Wehrner von Braun, was the main attraction of the first meeting of the Mining and Metallurgy Club. A "Woody Woodpecker" cartoon on golfing was also shown with hilarious comments on it by Club Vice President Vladimar Petrovich. The films were selected and shown by film chairman John Tralmer.

The November 6 trip to the National Metals Show, held in Chicago, was discussed, and the trip to the American Institute of Mining and Metallurgical Engineers–Chicago chapter's Student Night, on December 10, was considered.

The members of the faculty of the Department of Mining and Metallurgical Engineering were introduced to the student members by Tom Roth and Wally Petrovich, Club President and Vice President, respectively. New faculty members include Drs. T. D. Tiemann, R. W. Dodd, F. H. Vitovec, and A. K. Kaddou.

After the short business meeting and entertainment, refreshments were served by Club Treasurer David Nelson.

TRIANGLE

One of the highlights of the fall season was the success of the Triangle football team with it tie for first place in its division. Basketball practices are being held in an effort to continue the winning efforts.

Triangle's Homecoming party, with many alumni and brothers from the Illinois Chapter in attendance proved to be a very entertaining evening. A buffet luncheon at the chapter house followed the football game.

Professor Christie, Professor Dolan, Professor Emeritus Elliott, and Dean Wendt at the ASME Banquet.

An interesting talk by Professor Duffy of Wisconsin's Solar Energy Laboratory preceded our entertaining rushing guests at a smoker recently. We would like to extend an invitation to all engineers to drop in at future Triangle rushing smokers. Notices of these smokers will be posted on all bulletin boards and on our board in the Mechanical Engineering lobby.

A. S. M. E.

The October meeting of the student section of A.S.M.E. was a joint dinner meeting held with the senior section at the Cuba Club in Madison. The meeting celebrated the fiftieth anniversary of the founding of the Wisconsin chapter of the student section of A.S.M.E.

In place of the regular business meeting many people were introduced by the master of ceremonies. The first person to be introduced was Dean K. F. Wendt, head of the College of Engineering of the University of Wisconsin, who offered his congratulations on behalf of the Engineering college. Next, Professor T. Dolan, Region Six Vice President, offered his congratulations on behalf of the national organization. Following Professor Dolan, Professor D. F. Livermore, student section faculty advisor, was introduced and he in turn introduced the following student section officers: Jerry Jennings, President; Charles Veen, Treasurer; and Sally Trieloff, Secretary. Jerry Jennings then gave a short talk thanking Dean Wendt, Professor Dolan, and the senior section for all their aid.

Professor R. J. Harker, Rock River Valley Section Vice President, then gave a talk on the history of the student section. He stated that the student section was founded in 1909 while the senior section was not founded until 1926 thus "the child is older than the parent." Also he read letters from four chapter members of the group.

The main speaker of the evening was Professor Emeritus A. G. Christie, a well-known authority in the field of heat power. Professor Emeritus B. G. Elliott, former head of the Department of Mechanical Engineering at the University of Wisconsin introduced his friend to the section. Professor Christie spoke on "Where will we be in 1975?"

After Professor Christie's Speech, Professor Dolan presented Professor Elliott with an award, on behalf of the national organization, honoring Professor Elliott for his service to A.S.M.E. and the field of mechanical engineering.

ASCE STUDENT CHAPTER

The Student Chapter of the American Society of Civil Engineers at the University of Wisconsin is composed of undergraduate civil engineering students. Professor Eldon C. Wagner of the Civil Engineering Department is the faculty adviser.

The Student Chapter of ASCE offers civil engineering students an opportunity to develop, along with their classroom instruction, the professional side of their engineering education by participation in the activities of the chapter, and by contact with their fellow students and other engineering students. Membership in the chapter assures that contacts can be made with the technical and professional progress of civil engineering and with some of the leaders who are responsible for that progress. Even more important, membership offers the chance to take part in the constructive activities carried on by future leaders of the profession. The Student Chapter supplements regular class and laboratory work, and is the only agency that can relate the professional development of students to the achievement of the ASCE.

Members of the Student Chapter are welcomed at all meetings of the National ASCE. Regular quarterly meetings are held at various cities, combining technical, professional, and social events. These are of special interest to students who recognize the importance of professional growth and contacts. Recently, a joint meeting of the student chapter and the Wisconsin senior chapter of ASCE was held at the Cuba Club in

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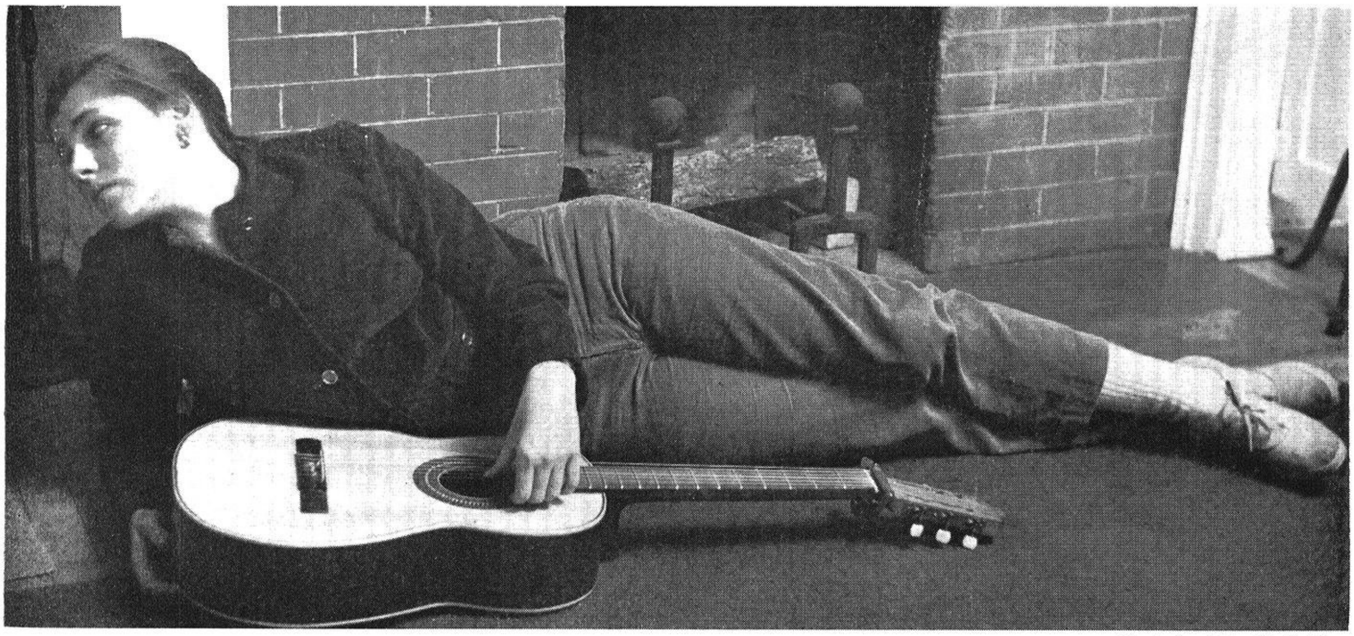


Photo by Peter N. Gold

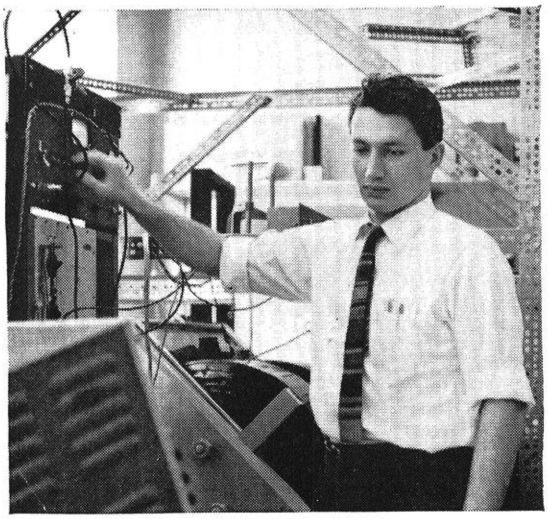
GIRL OF THE MONTH

Miss Jennifer Warren is our rather pensive Miss of the Month of December. Her home is NYC and she likes, besides guitars, of course, drama and the theater. Jennifer (please, don't abbreviate) has had experience on both sides of the stage, and actually prefers the backstage work. However, we hope that you'll approve of this performance. We do.

Basic Research at IBM

A day at the laboratory

IBM scientist Gerald Burns studies ferroelectrics to improve understanding of their basic properties.



A basic research project

"I'm using nuclear resonance to explore ferroelectrics," says IBM scientist Gerald Burns. "We're trying to discover how the ions in a ferroelectric crystal are arranged, and why and how they change position and structure with temperature changes. Ferroelectric crystals have a reversible spontaneous polarization . . . that is, they can be polarized in either of two directions, and, by the application of an electric field, polarization can be reversed."

How did Gerry Burns come to work on this problem? "I started this particular research project because it was related to other work I had been doing and I felt it would prove challenging and rewarding. Little is known about what goes on in a ferroelectric crystal—or why. Our basic objectives are to find out *what* and *why.*

"At the planning stage, the project seemed to offer a great research potential, but none of us was sure how long the project might last or what its ramifications might eventually be. It's a good example of the basic research done at IBM."

A day at the laboratory

One of the eight scientists in the Ferroelectric Research Group, 26-year-old Gerald Burns began a recent day by setting up equipment for the first daily run.

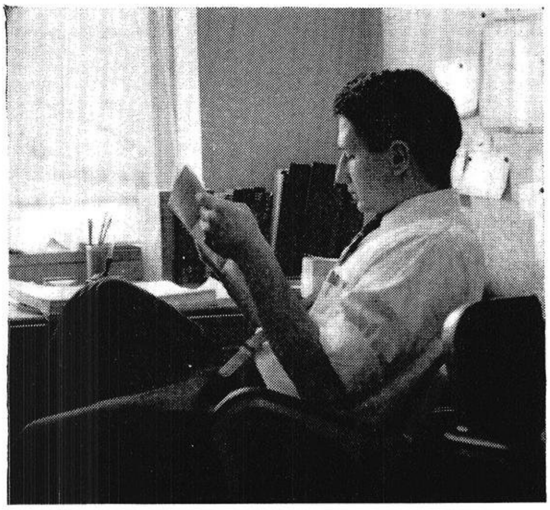
"The experiment is conceptually quite simple," he explained. "A ferroelectric crystal is placed in the tank circuit of an oscillator, between the pole pieces of a large electromagnet. The sample is surrounded by a dewar so that the temperature can be accurately regulated. Then the magnetic field is slowly decreased. When the field reaches certain values, the nuclei in the crystal absorb energy from the oscillator. The trick is to detect this absorption which is quite small. Runs at various temperatures are made, and the temperature dependence of this absorption is studied.

After setting up the first run, Gerry Burns met with the head of his group. Together, they discussed the temperature dependence of the nuclear quadrupole resonance coupling constants. Several helpful suggestions were made.

Gerry Burns then talked with chemists who grow the crystals used in the experiments. They discussed possible variations in the crystal-growing method and considered the growth of other crystals in order to broaden the experiments.

Early in the afternoon, he attended a seminar conducted by a visiting professor on the subject of the atomic structure of solids. Each week, several such seminars on a variety of technical matters are given.

After the seminar, Gerry Burns returned to set up another run at a different temperature. He also talked to a technician about building a new piece of equipment to be used in future experiments.



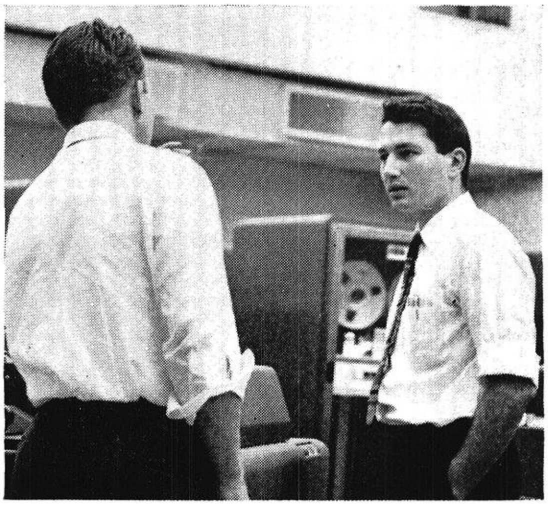
Excellent facilities and programs

"Besides these experiments, I'm also doing some theoretical calculations in the field of nuclear quadrupole resonance. The actual computations were done here at the Laboratory on an IBM 704, which can perform *in minutes* computations which would take weeks if done by other methods.

"This is one of the advantages of working at IBM. Large-scale high-speed computers are available to research scientists when needed. Furthermore you will find your colleagues always willing to help when you are stumped by a problem. Many of these men are recognized authorities in their fields. The exchange is always informative and often stimulates new ideas and approaches.

"Our Company offers many educational opportunities—both in general education and for advanced degrees," Gerry Burns said. "As an example, engineers and scientists may earn a Master's Degree in a post-graduate program conducted by Syracuse University right here in Poughkeepsie.

"We also have a very useful library. Just the other day I dropped in to pick up some technical papers I needed as source material for an article. I've already published one paper on my experiments," he noted. "You're encouraged to publish your findings and to participate in professional society meetings. It's important for a research man to work in an atmosphere where independent thinking is encouraged and where every effort is made to facilitate research investigations."



Some IBM advantages

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* * *

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Importance of Aluminum

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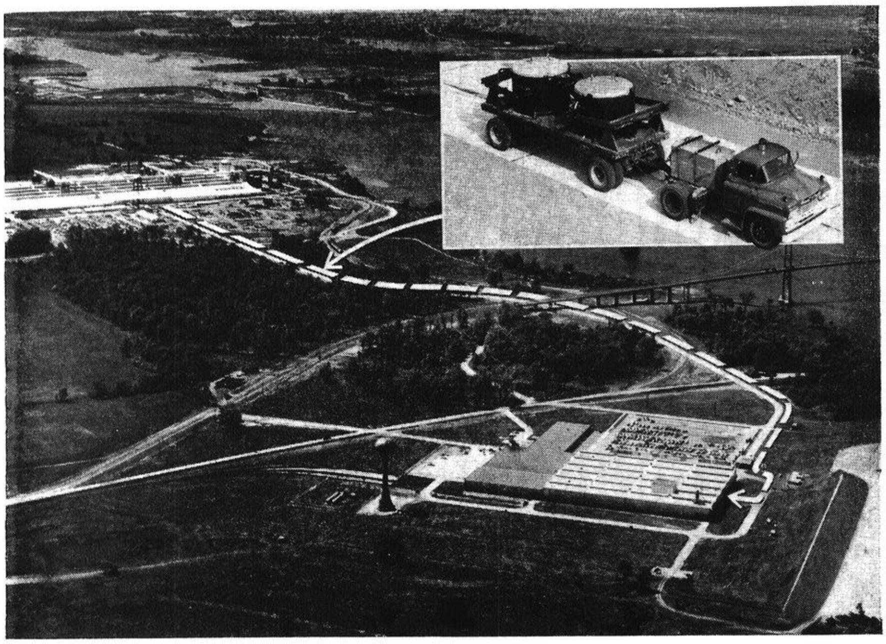


This aerial view of Chevrolet Motor Division's new aluminum foundry (lower right) at Massena, N.Y., shows the private road over which molten aluminum is delivered from Reynolds Metals Company's nearby reduction plant (upper left). A specially-equipped Chevrolet tractor and trailer (inset at upper right) hauls two 9,000-pound capacity crucibles of the molten metal over the three-quarter mile route. The Chevrolet plant makes aluminum castings for automobile engines and transmissions.

many materials were investigated in both laboratories and engines. One problem considered was to find a cylinder bore material available at a reasonable price. The previous use of chrome-plating as a wear-resistant material on cylinder bores has a main drawback of cost. Until now, the use of aluminum engines depends largely on the successful development of castable, wear-resistant aluminum alloys, or dependable coatings and sprayings which can be economically and simply applied and inspected. The many materials investigated showed varying degrees of promise ranging from very good to unsatisfactory. Among the more promising were coatings and wear-resistant aluminum alloys. Coatings included are iron plate, electrolysis nickel-plate, oxide coatings, sprayed steel, sprayed molybdenum, and sprayed aluminum and aluminum alloys.

Tests indicate all of the materials considered are better than a heat-treated gray iron which was rated at 100% wear. When the geometry and the wear conditions are changed, sometimes other problems are encountered. For example, two groups of aluminum cylinder bores, one sprayed with molybdenum and the other chrome-plated, were subjected to dynamometer testing, the molybdenum-sprayed bores showed good performance, whereas the chrome-plated bores occasionally showed excessive wear at the top of the piston ring travel. The same condition also occurred on chrome-plated cast iron bores. The wear-resistant aluminum alloys, including the high silicon materials, showed satisfactory wear characteristics when dynamometer- and field-tested. After more than 100,000 miles of service by aluminum engines in actual cars, there appear to be several solutions to wear and score problems under normal driving conditions. In the event that none of these meet all the requirements, the use of the cast iron cylinder liner can still be relied upon. Using the cast iron liner would not be an ideal solution to the problem because the goals of maximum weight reduction and minimum cost would not be achieved. However, it is not believed that reliance on cast iron as a bore material will ultimately be necessary.

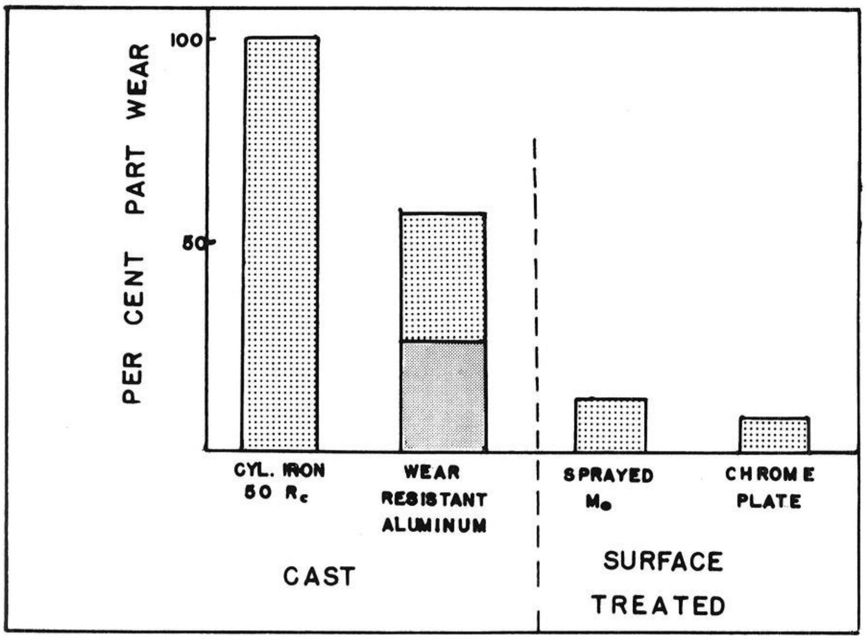
Corrosion characteristics of an aluminum engine appear not to offer any problems in the future. Aluminum cylinder heads and cylinder blocks with cast iron liners have run successfully in the past.

The mechanical properties of one wear-resistant, 19% silicon-aluminum alloy was compared with automotive cylinder iron and 355 aluminum. Although the properties are not identical with those of cast iron, they are good enough for aluminum engine blocks. Even where the properties are lower than desired, changes in design can often compensate for the slightly lower properties. Since aluminum blocks and heads have been designed and run satisfactorily under a number of test conditions, there appear to be no unsolvable problems in obtaining desired mechanical properties. Furthermore, the high thermal conductivity of aluminum affords excellent paths for the dissipation of heat, thus reducing strain and distortion.

Production Problems

Since progress in the solution of all pertinent metallurgical problems has been significant, there is no reason to believe that they will not all be successfully solved in the near future.

As previously mentioned, there is a growing tendency for car manufacturers to locate substantial foundry facilities near aluminum reduction plants. Molten aluminum, or aluminum alloy, is transported from the reduction plant in insulated containers directly to the foundry holding furnaces of the auto plant, thus eliminating remelting costs. Some latitude is available in the molding methods to be used. Some designs have been directed toward a potential use of die-castings. Technical breakthroughs in die-casting techniques have made mass production of the large castings needed for engine blocks practical, although auto makers contend gas porosity is still a major problem in die-casting such large parts. The improved dimensional control of the die-casting operation holds parts to closer tolerances, reducing or eliminating other machining operations. For instance, many bolt holes need only be tapped in aluminum, whereas, cast iron would require drilling and tapping. However, cyl-



inder liners are still required as will be the case for most die-cast designs.

An alternative method of producing engine blocks is by permanent molding. A foreign made V-8 block has been produced completely on permanent mold equipment. It still requires an inserted liner. Semi-permanent mold methods could be used to produce an integral bore engine block. Both V-8 and six-cylinder blocks have been successfully cast in both green and dry sand molds. Ultimate economics will determine the final molding method, but at the present time, sand molding appears to be the most uneconomical. The high-silicon alloys of aluminum are more difficult to cast than alloys such as 355.

Obviously, since a number of aluminum engines have already been built, there are no existing impossible machining problems. There exists a general belief that all aluminum alloys can be machined at much higher rates than can presently be used for cast iron. This is not necessarily true. The very high silicon-aluminum alloys, for example, have about 50% greater tool wear than conventional aluminum alloys, while the conventional alloys can be machined at a faster rate than can cast iron. The improved dimensional accuracy of die-cast parts reduces the amount of machining required because of decreased finishing allowances. In addition, the light weight of aluminum facilitates greater ease of handling during machining operations than is possible with cast iron.

Cost Problems

A number of different cost surveys have been made and the results indicate that aluminum is competitive with cast iron. A comparison of the cast iron engine block with the die cast aluminum block previously mentioned illustrates two important economic factors; first, the improved foundry techniques, with better dimensional accuracy and permitting less subsequent machining, have reduced the prohibitive cost of aluminum, and second, although aluminum castings are considerably more expensive per pound, the greatly reduced weight of the engine offsets this disadvantage.

It should be noted that there is actually a lower weight ratio than would be predicted by the densities of aluminum and cast iron. If a liner is to be used with a particular block, the liners will increase the cost of the block and place the aluminum engine at some cost disadvantage. The cost disadvantage emphasizes the need for the satisfactory development of aluminum alloys or cheap, durable coatings or sprayings which eliminate the liner.

One authority states that if aluminum could be directly substituted for cast iron and at an equal cost, the auto maker would still profit six cents per pound decrease in weight of end product. The savings would be brought about by the decreased collateral charges, such as transportation and materials handling charges. The parts that appear feasible for production in aluminum include: pistons transmission parts, cylinder block, cylinder heads, brake drums, clutch housing, and intake manifold. The weight of these components totals 157 pounds of aluminum compared to more than 600 pounds of cast iron. The location of auto plants near aluminum reduction plants and the tremendous quantities of aluminum purchased by contract also have a considerable influence on its price.

Current and Future Applications

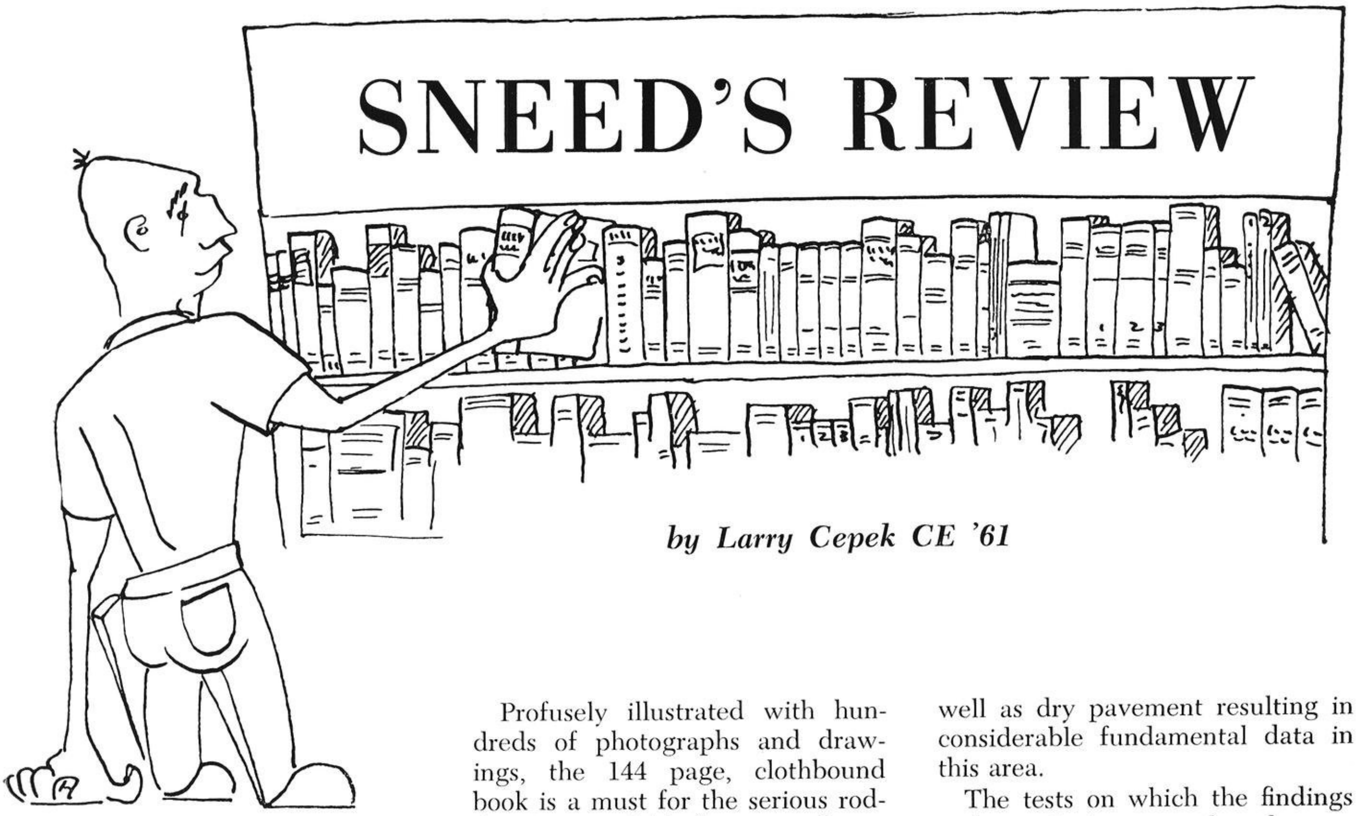
The amount of aluminum used per car has risen from the two pounds used prior to World War II to an industry average of 40.7 pounds in 1957, 52.4 pounds in 1958, and an estimated 58 pounds in 1959. Some car models, notably those produced by Chrysler Corporation, consistently use higher than average amounts of aluminum.

Some of the applications of aluminum that are now being used, or that are in the process of being used, are aluminum grilles, color-anodized aluminum as a material for interior decoration as well as for utility uses, extrusions for side panels, wheels, wheel covers, bumpers, tail lamp body trim, clutch housings, transmission housings and parts, pistons, brake drums, carburetors, battery cables, spark plug parts, front wheel brakes, cylinder heads, cylinder blocks, roofs, radiators, and intake manifolds.

The possibility that car weighs will decrease is of immense concern to the automotive industry. The actual number of pounds of ferrous products will undoubtedly be reduced as car weights come down, but more important, the increased emphasis on the weight reduction will be without any corresponding decrease in roominess or performance. Whenever possible, engineers will be trying to replace ferrous materials with light metals so that the consumer will benefit by the increased durability, greater safety, improved performance, and reduced cost.

THE END

SNEED'S REVIEW



by Larry Cepek CE '61

NEW GUIDE FOR HOT RODDERS

"How To Build and Race Hot Rods," by Griff Borgeson, is one of the best answers to date to meet the speed conscious age we live in. Here is one of the most complete guides for the hot-rodders or dragster ever printed.

Borgeson, a hot-rod and safety expert of long standing, has spared neither time nor effort in bringing to the reader interviews with the top men in hot rodding today. These experts–Les Ritchey, Chuck Potvin, Karol Miller, and many others–freely tell about their experiences, give tips on souping, tuning, supercharging, and fuel injections. Racing and driving techniques for dragsters, lakesters, sports rods, and the new craze, go-karts are fully discussed by such outstanding figures as Jim Nelson, Dode Martin, Mickey Thompson, Al Miller, and Marvin Patche, each of them a wizard in his own particular field. Construction of a dragster is shown by Scotty Fenn whose cars are record smashers at every track. Some of the other more detailed chapters are on Power Takeoffs, Crash Helmets, Roll Bars, and Customizing.

Profusely illustrated with hundreds of photographs and drawings, the 144 page, clothbound book is a must for the serious rodder. It is available from your favorite bookstore or directly from the publisher, Arco Publishing Company, 480 Lexington Avenue, New York 17, New York, for the low price of $2.50 per copy.

A rodder is sure to improve his elapsed time with this book. Following some of the advice given by the experts here, not arm chair drivers but active winners and champions, is a sure fire way of making you a winner too.

PERFORMANCE STUDIES OF STRAIGHT TRUCKS AND TRUCK TRACTOR SEMITRAILER UNITS

By A. H. EASTON
225 pages. 76 tables. 176 figures.
Engineering Experiment Station Report No. 6
University of Wisconsin, July 1, 1954
Price: $3.00

This report presents the results of approximately six years of research on motor trucks. The study covered the stability, tire wear, steering, stresses in a frame, brake timing and synchronization, pavement deflection, location of center of gravity, block tests of engines, torque build-up in a power train, and standard engineering performance tests. The latter included fuel economy, drawbar pull, acceleration, braking, tractive resistance, and cooling. The drawbar tests were conducted on ice and snow with and without tire chains as well as dry pavement resulting in considerable fundamental data in this area.

The tests on which the findings and conclusions are based were conducted on rear- and all-wheel drive straight and truck tractor semitrailer units. The semitrailers used in the tests were a standard suspension and the Ronning suspension. The brake timing and synchronization studies compared full air, air over hydraulic, and electric brakes. Also included in this report are results of tests on an electric drive truck.

Considerable attention was given to instrumentation and methods of tests as well as results with the thought that such information would be of value to students in automotive engineering and other investigators in this field.

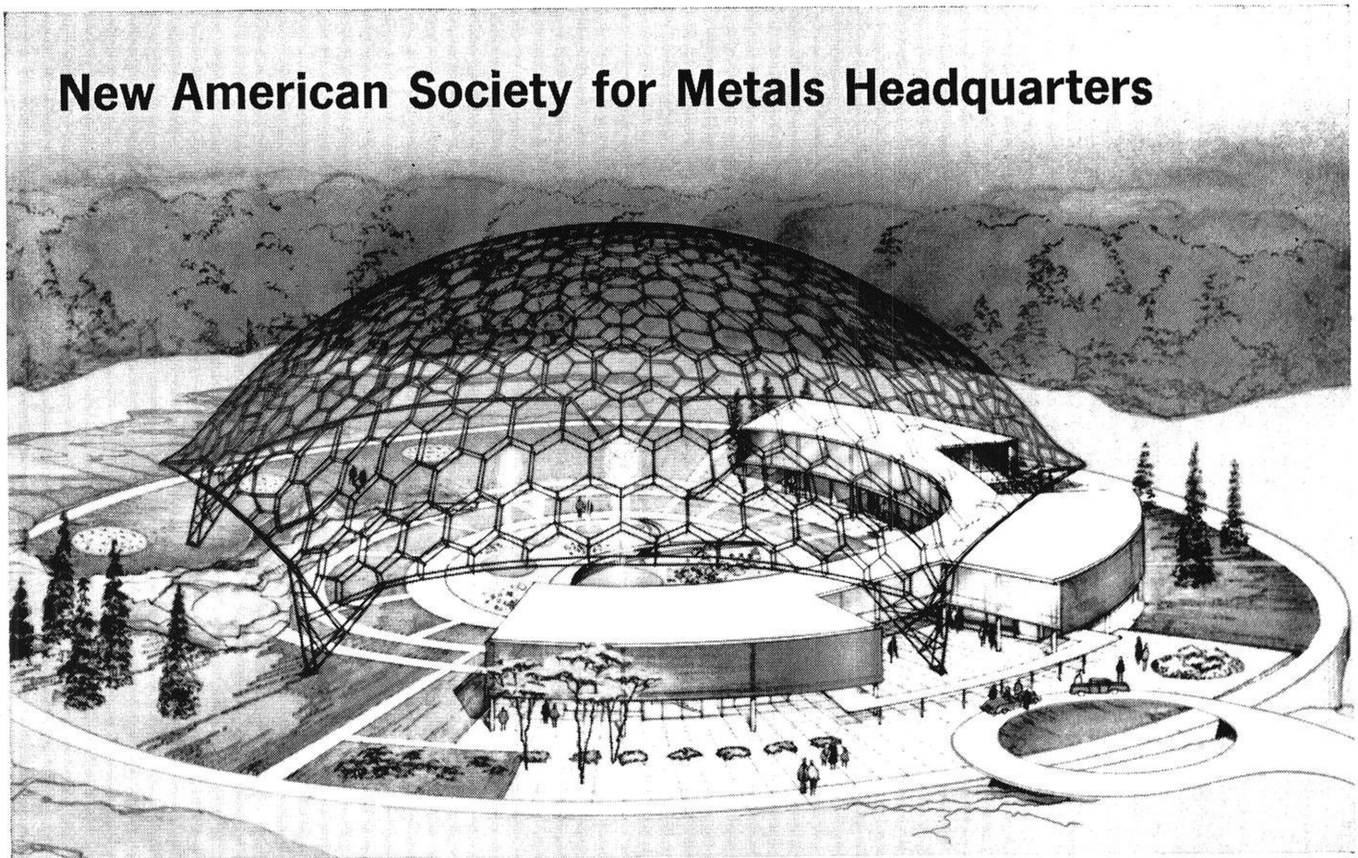
HOW AND WHERE TO LOOK IT UP

A Guide to Standard Sources of Information
By ROBERT W. MURPHY
721 pages. Price: $15.00

If an expert is a person who knows where to find information and how to use it when he finds it, this book should go a long way to making you one.

This is a reference book for finding other reference books—which is not a bad idea in this day and age. The book contains 3900 reference sources, indexed and cross-indexed (and then some) in 10,000 analytical subject references.

(Continued on page 54)



NEW HEADQUARTERS BUILDING, AMERICAN SOCIETY FOR METALS, Novelty, Ohio, east of Cleveland.
Architect: JOHN TERENCE KELLY. *Consulting Engineer:* MAYER AND VALENTINE. *General Contractor:* GILLMORE-OLSON COMPANY. *Plumbing and Heating Contractor:* SPOHN HEATING & VENTILATING COMPANY. *Dome Design:* R. BUCKMINSTER FULLER, SYNERGETICS, INC.

Imagination shows in the building — practical planning in the choice of Jenkins Valves

Metals Park . . . dramatic new Headquarters of the American Society for Metals, is a showcase for the wonderful world of metals.

The geodesic dome, "world's largest space lattice," required thirteen miles of tubing and rods in openwork trellis. It stands as a monument to man's imagination in the use of the raw elements of the earth, as symbolized in the circular Mineral Garden below. At Metals Park, metals are everywhere and everything — providing an ideal background for ASM's many services to 30,000 members in the metal industry.

You would expect men of metals to choose metal products of superiority for their headquarters. And they did — including Jenkins Valves for *all* plumbing, heating and air conditioning lines. They had good reason: superior metals give Jenkins Valves the extra stamina that makes them famous for long life and dependability.

Whenever a building is planned with the *future* in mind, it's wise to specify or install Jenkins Valves. They're the *practical* choice to assure longtime efficiency and economy — and they cost no more. Jenkins Bros., 100 Park Ave., New York 17.

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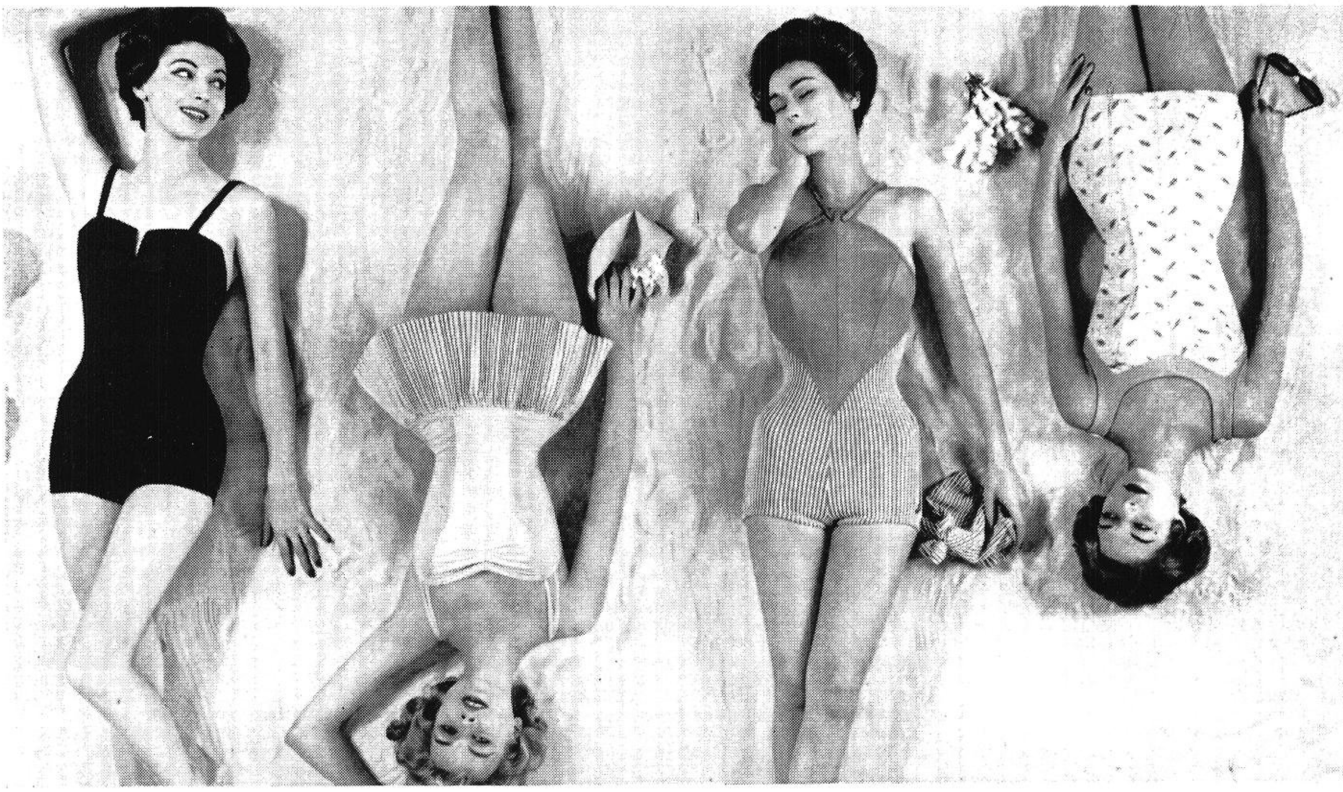
LOOK FOR THE JENKINS DIAMOND

JENKINS SINCE 1864

Jenkins Bros

NEW PRODUCTS LEAD TO BETTER JOBS AT DU PONT



COULD YOU MAKE A BETTER BATHING SUIT?

The suits these girls are wearing are made of nylon, the first truly synthetic fiber. It is a product of Du Pont research. Pure research. Applied research. And research in manufacture, research in product improvement. All require many types of skills.

You may not discover a new fiber, but as a technical man you can profit well anyway. For once a product—any product—is discovered, hundreds of technical men go to work. Pilot plants are designed. Operating procedures are devised. New plants are built. Manufacturing methods are improved. Product quality is worked on, backed by Du Pont's policy: Let's make it better . . . *still* better . . . *even* better. Discovery is but the starting shot; these later activities are the game. The players? Men of *every* technical specialty.

You'll find a teamwork atmosphere at Du Pont. Others have. Maybe that's part of the reason half of Du Pont's profits today come from products unheard of twenty-five years ago.

If you join Du Pont, the men who have worked on new products and ways to make them are the men who will teach you. You will be given an actual project assignment almost at once, and you will begin to learn your job by doing it. Advancement will come as rapidly as your abilities permit and opportunities develop. For Du Pont personnel policy is based firmly on the belief in promotion from within the company *strictly on a merit basis.*

For more information about career opportunities at Du Pont, ask your placement officer for literature. Or write us. E. I. du Pont de Nemours & Co. (Inc.), 2420 Nemours Building, Wilmington 98, Delaware.

DU PONT

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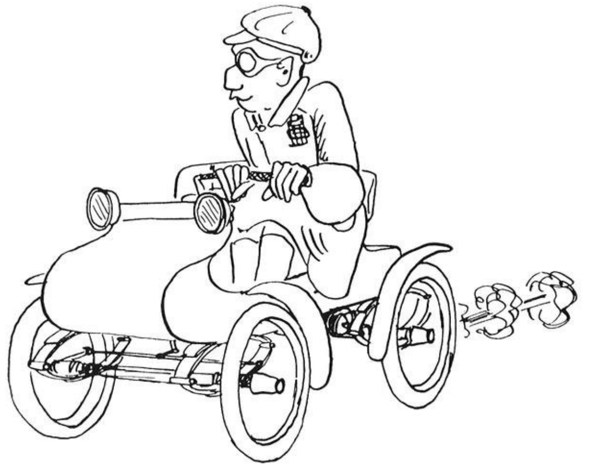

THE ENGINEER OF YESTERYEAR

by Floyd Gelhaus, EE '61

APPLICATION OF ELECTRICITY TO AGRICULTURE

February, 1907

VERY little has been accomplished in the application of electricity to agricultural operation in comparison with what remains to be done, or compared with what it is desirable to accomplish. Electricity has entered into every phase of our modern life but in this particular domain it has been the slowest to make itself felt.

At present, it is very common to find that the farmer has bought a five or ten horse-power gas engine and uses it to saw wood, separate cream, make butter, cut up feed and other such purposes, and he is finding it is also possible to have a dynamo and battery for lighting the building, and doubtless it will occur to him that, if the generator is of sufficient capacity, all these power operations can be performed much better by a motor, as the application of the power not be in the same building as the engine; in other words, it becomes a much more flexible arrangement.

Now of course when the farmer buys a gas engine and uses a generator, it will be of a very limited capacity and he will not likely undertake any very large power operations with that plant, but with power available in larger quantities from a nearby water plant, or high potential wires that go in the neighborhood, they will readily find it not only possible but advisable to use power on a much larger scale.

It seems that since the farmer is having his attention directed toward the application of scientific principles to the farm, and since manual labor on the farm is very expensive and the young men on the farm are not staying, but prefer to go to the city and become motormen, work in a livery stable or any place rather than stay on the farm, and since the time is rapidly approaching now when power in large quantities will be available, it seems certain that this development which has long been looked forward to is on the verge of realization.

GAS ENGINEERING

1904

The gas business is essentially the business for a chemist. Where do we find richer fields for investigation, or better scope for that research for economy than in this industry? Take ordinary coal gas. It is composed largely of some eight or ten substances, but there are traces of numberless organic changes, decompositions, and formations during its evolution in the retort. Ammonia, cyanogen, and tar afford unlimited possibilities to say nothing of the analysis of the crude substances, coals and oils.

Then in a works there are flue gas analysis, and numberless thermo-chemical reactions to be investigated. I have been in this business for years and have devoted a great deal of study to it, and yet to-day I feel as if I were at the threshold of an unknown world, timidly seeking light. For instance, we must find a cheap way to manufacture natural gas artifically, that is CH_4, and yet no one has so far found it.

SOME USES OF ELECTRICITY IN THE WORKING OF METALS

1904

Present methods of working metals involve the use of electrical energy in so great a variety of ways that even a reference to all of them is scarcely possible within the scope of a short paper. Perhaps the first application of electricity to the treatment of metal objects was made over half a century ago when electroplating came into vogue. Nearly every metal working plant of considerable size now has its plating department, and estimated on the basis of product turned out and on the value or ornamentation and protection against corrosion which electro-deposited coatings afford, it may well be ranked as one of the most important industries of the present time.

The magnetic effect of the electric current has recently been successfully applied in the quick-acting magnetic clutch, and the electro-magnet used for lifting and handling sheet iron is a labor-saving device of no little importance. The heating effect of the current when passing through a metal resistance has been utilized in an important machine known as the electric welder, which enables work to be welded not only more quickly and cheaply than could otherwise be done, but which also makes better welds, and does certain kinds of work that were impossible under the older methods. Other uses for electric heating are the annealing of wire, the maintaining and regulation of the temperature in tempering baths and annealing furnaces, and for case-hardening.

ELECTRICAL CONDUCTORS

June, 1905

Until aluminum became commercially practicable copper really had no rival in the field except in what might be called special cases, and though aluminum has now become a competitor, copper still maintains first place in the scale of importance.

In comparing copper and aluminum, the following facts regarding the two metals should first be noted:

	Al	*Cu*
Specific Gravity ..	2.68	8.93
Relative Specific Gravity	1.00	3.33
Conductivity (Matthiessens)	61 to 63	97 to 102
Tensile strength per square inch	20,000 to 35.000	20,000 to 65,000

On account of the lower conductivity of aluminum, the cross-sections of aluminum and copper wire or bars of same resistance and same conductivity will be in the inverse ration of their conductivity, thus an aluminum wire of 156,000 circular mils area will have the same resistance as a copper wire of 100,000 circular mils area.

Inasmuch as it is necessary to us a larger cross-section of aluminum in order to obtain equal conductivity with copper it is also necessary to take this increased size into consideration in determining the relative breaking loads. A load which would break a copper wire of 100,000 circular mils area would not break an aluminum wire of 156,000 circular mils area even though the aluminum be relatively weaker than the copper for equal sections. In order to obtain relative breaking loads, the tensile strength per square inch of aluminum should be multiplied by 156.5 and compared with the tensile strength per square inch of copper.

The self-induction in a circuit is less with large wire than with small ones, and it is decreased when the wires are placed closer together. If the wires are the same distance apart in both cases then the self-induction will be less in an aluminum circuit than in a copper circuit, and the resulting drop in voltage in the line will be slightly less; though the difference is usually quite small, it is in favor of aluminum.

The induction in one circuit caused by "transformer action" from circuit in an adjacent circuit is the same whether either or both circuits are aluminum or both are copper, provided the wires maintain the same relative positions in all cases.

The quantity of heat produced in two wires being the same the increase in temperature will be greater in the wire having less surface. The copper wire will therefore heat more than aluminum wire.

In general the conductor selected for any particular case must depend largely upon the conditions to be met since each type has certain definite fields which it can fill better than any other type can.

Ropes of Steel

(Continued from page 26)

their existance. The ropes support and drive the drills which seek the oil in the earth. Safety factors used in this field are between two and six, which is lower than the safety factor in the mining industry. Since the loads are applied more gradually, the wear by abrasion is reduced. Thus, it is evident that the growing production of oil is dependent on the progress developed in the wire rope industry.

Wire ropes are becoming increasingly important in the oil, mining and many other industries. The wire ropes, as all machines, are constantly being improved so that they will be able to meet new demands created by new products and industries. Today, wire ropes are as old as antiquity but as new as tomorrow.

THE END

The Camera

(Continued from page 15)

size high speed lenses are available at low cost. Prices range from $10.00 for the box type to $300.00 for the best models. A wide variety of special equipment and accessories are available for these cameras.

Stereo Cameras

Stereo cameras enable pictures to be taken which can be viewed in three dimensions. Stereo cameras are still selling well after their rise in popularity a few years ago. These cameras require two lenses to achieve their three dimensional effect. All models use 35 mm color film which is readily available. The lenses on these cameras are usually f/3.5 and shutter speeds to about 1/300 second are common. Prices range from $30.00 for a non adjustable model to about $400.00 for one of the better models.

Special Cameras

Other cameras such as time lapse cameras, super wide angle cameras, underwater cameras, fingerprint cameras, copy cameras, and high speed sequence cameras are available for special purposes.

Campus News

(Continued from page 35)

Madison. At the dinner meeting Professor Arno T. Lenz, chairman of the university's Department of Civil Engineering, awarded several scholarships, after which Mr. Schaefer of Armco Steel Corporation spoke on high fills over steel conduits. Some thirty University students attended the meeting.

The Student Chapter meets twice a month, in the evening. The meetings, usually held in the Wisconsin Union, consist of an interesting program followed by a short business meeting, and usually refreshments. Movies, slides, and talks presented at chapter meetings provide a practical view of recent engineering projects and developments. An example of this is the interesting talk and slides on

(Continued on page 52)

Phonograph

(Continued from page 19)

interest. It was the first demonstration of stereophonic sound techniques. Bell engineers, in 1933, broadcasted a performance of the Philadelphia Symphony Orchestra at The Academy of Music in Philadelphia, over a three channel system to Constitution Hall in Washington, D.C. Each channel included a microphone, amplifier, transmission line, power amplifier, and speaker. The great success of this experiment prompted Walt Disney to use multiple-channel audio techniques in his motion picture "Fantasia", about five years later. These and other experiments resulted in many attempts to record sounds with the goal of dimensional playback. Two of these methods survived—binaural and stereophonic techniques. The binaural method attempts to duplicate the hearing process. In recording binaurally, two microphones, spaced about eight inches apart, closely approximate the pickup characteristics of the ears. These two channels are recorded individually, first as parallel tracks on a magnetic tape, and then sometimes on two separate bands of a disc record. The latter is called the Cook Method. It consists of placing one channel on an outer band and the other channel on an inner band. The pickup is by a pair of cartridges, one for each band, which are mounted on the same tone arm. The two channels are amplified separately, with final reproduction through earphones, each feeding the proper ear. The effect is stunning. The listener experiences the same three-dimensional sensation caused by the glasses at a 3D movie. He can point to the various instruments, and more important than that, the room echos give him a greater sense of "presence" than is possible by any other means of sound reproduction.

The stereophonic method differs from the binaural technique in that widely spaced microphones are used and final playback is through loudspeakers, spaced from eight to twelve feet apart.

Four musicians, A, B, C, and D, are recorded simultaneously by two microphones, two amplifiers, but on the same tape. The tape is then played on a tape recorder with two pickup heads and two amplifier-speaker systems. Since identical sounds coming from two different spots will blend together and appear to come from a single point between the two sources—that point being determined by the relative loudness of the two sources—the instruments of A, B, C, and D will appear to be in the same positions as they were when recorded.

Although the overall effect is more realistic, neither the binaural or the stereo sound system is a substitute for the high fidelity system. Both the right and left channel of a stereo or binuaral set must be high fidelity to begin with in order to obtain sound that is true. The binaural method, although slightly more successful than the stereo method, is more expensive, much harder to keep adjusted, and has a very limited supply of recordings. Besides all this, the earphones are annoying. For these and other reasons, binaural sound is fading out of the picture as a piece of household equipment.

Quite the opposite is happening to stereo, however. This is due mainly to the newly patented, single-groove method of recording stereo on a disc. Stereophonics are not new. They have been on tape for many years, but the high cost of these tapes and their playback equipment limited its popularity. Cook's method of disc recording, which allowed only half as much playing time to be placed on each disc, also was a commercial failure.

The present boom in stereo began when, in 1956, United States manufacturers heard that British Decca (London) had developed a single-groove stereo discs system. Not to be outdone, the engineers at Westrex developed a similar system, called the Westrex 45/45 System which has now become a standard for all makers of stereo records. Remembering that in Edison's phonograph, the stylus movement was vertical and in Berliner's it was lateral, Westrex engineers combined both movements in a singe groove and designed a cartridge capable of separating movements and sending out the separate outputs to individual amplifier and speaker systems.

Among the more recent experiments with stereophonics, there is one which considers a third channel, placed midway between the two existing channels. Its purpose is to fill in the so called "hole in the middle", a phenomenon which is present to some degree in all stereo sets. Actually, only under ideal conditions will the sound from the two channel output blend perfectly to cause no empty gap between channels. The speakers must be a certain distance apart and pointed in a certain direction, the listener must be a certain distance from the speakers, and the two channels must be perfectly matched and balanced— all depending upon the characteristics of the room. Of even more importance is the fact that both channels must be in phase. In other words, the fluctuating impulses from the separate amplifiers must be travelling the same direction, at the same time, with respect to their respective speakers. One impulse cannot be pushing while the other is pulling, with proper results. The simple answer to this problem is to switch the terminals on one speaker, thus bringing the system back into phase. The only trouble with this is that phasing differs from record to record. Since it would be very unhandy to have to change terminals every time an out-of-phase record is played, the third channel is the logical answer. There are two ways in which the third channel can be added. One is to add another amplifier and speaker system which takes both "hot" leads and both grounds, combining the two signals, and playing them between the original two. This amounts to playing the monophonic version of the record at the same time the stereo version is being placed. The other method is much more economical. It simply combines the two signals after amplification, and sends them to the central speaker system. This central system may consist of one speaker, operating from both signals, or it may be two speakers, one for each channel, but both contained in the same enclosure.

Experiments have been run to determine whether people preferred the third channel, or not. The subjects were blindfolded while the engineer switched the set-up from two channels to three at regular intervals of time. The subjects were then asked to evaluate each position on a basis of comparison. Of course, they were not told which was being played at the time. This experiment gave the following facts:

1. All tested preferred the third channel for vocalists.
2. A large majority preferred the third channel for small orchestras.
3. A slightly smaller majority preferred the third channel for large, symphony orchestras.

A possible reason for more people preferring the third channel for vocalists than for symphony orchestra might be that the popular stereo discs have a much more extreme channel separation than the classical discs. The elimination of this effect could render the third channel unnecessary. As it stands now, the two channel stereophonic system, playing a well recorded disc, gives practical results, comparable to those obtained from the theoretically perfect binaural system, with its mandatory earphones.

A Look Into the Future

The present trends may reasonably be expected to continue. Since stereo has come upon the scene so rapidly, there will probably be period of consolidation and refinement. There is a proposed system of stereo recording, called the Minter System, in which the two channels are combined additively and recorded with a monophonic cutter. A 25,000 cycle note is also recorded, and this note is frequency-modulated by the two channels combined subtractively. The sum and difference signals are matrixed to produce the right and left channels. It is somewhat unfortunate that the Westrex 45/45 system has become so standardized, because the Minter System is supposed to produce a more realistic stereo sound.

The most important thing to keep in mind is that, although sound reproduction has developed to a very high degree of quality, we have by no means reached an ultimate point. If "concert-hall realism" were a reality, its effect would be decidedly disconcerting to the listener. Even the best hi-fi stereo set is incapable of reproducing the echos that surround the listener at a concert, for this would require an infinite number of channels—enough to bring sounds to the listener's ears from every possible direction.

Improvements are contantly being made, however, and a limiting value is being reached. Certainly a recorded performance will never sound better than the performance, itself. Since, with every improvement the listener becomes more critical, progress is inevitable. At present, multi-channel magnetic tape offers the best all around results. Not only is absolute channel separation possible, because of the completely independent tracks, but the recordings last much longer than the discs, always free of surface noise. Tape recordings, however, are nearly three times as expensive as disc recordings, and only the wealthy perfectionists are able to enjoy the advantages of tape. Along this line, RCA has proposed a four track, 3¾ ips tape machine designed to use preloaded tape cartridges (or magazines). These cartridges can be slipped into place without fumbling, as easily as a disc can be placed on a turntable, and should be no more costly than stereo discs handling the same amount of program material. If, and when, this system is introduced to the public, it could well mean the end of the LP disc.

THE END

HUGHES MASTERS FELLOWSHIPS. The Hughes Masters Fellowship Program offers unusual opportunities for academic training leading to a master's degree . . . and, in addition, provides each fellow with practical experience in the professional field of his choice.

Approximately one hundred new awards will be made by Hughes in 1960 to qualified applicants who possess a bachelor's degree in science or engineering. Additional awards are open to qualified applicants interested in business administration and education.

Hughes conducts extensive research and development in the scientific and engineering fields. While working for Hughes, fellows may be assigned to such areas of Research & Development as: microwave devices, parametric amplifiers, masers, infrared search and track systems, microminiaturization, antenna arrays, simulation methods, propagation, data handling, human factor analysis——and to a variety of engineering areas such as guided missiles, weapons control systems and systems analysis.

A selected group of award winners will be offered a **FULL STUDY PROGRAM.** Participants in this program will receive fellowships that permit them to attend an outstanding university on a full time basis during the regular academic year with a substantial stipend.

Other award winners will be assigned to the **WORK STUDY PROGRAM** and will attend a university sufficiently near a facility of the Hughes Aircraft Company to permit them to obtain practical experience, in a professional field of their choice, by working at the company part time each week. An appropriate stipend will also be awarded.

After completion of the Master's Program, fellows are eligible to apply for HUGHES STAFF DOCTORAL FELLOWSHIPS.

The classified nature of work at Hughes makes eligibility for security clearance a requirement.

Closing date for applications: January 15, 1960.

How to apply: Write Dr. C. N. Warfield, Scientific Education, Hughes Aircraft Company, Culver City, California.

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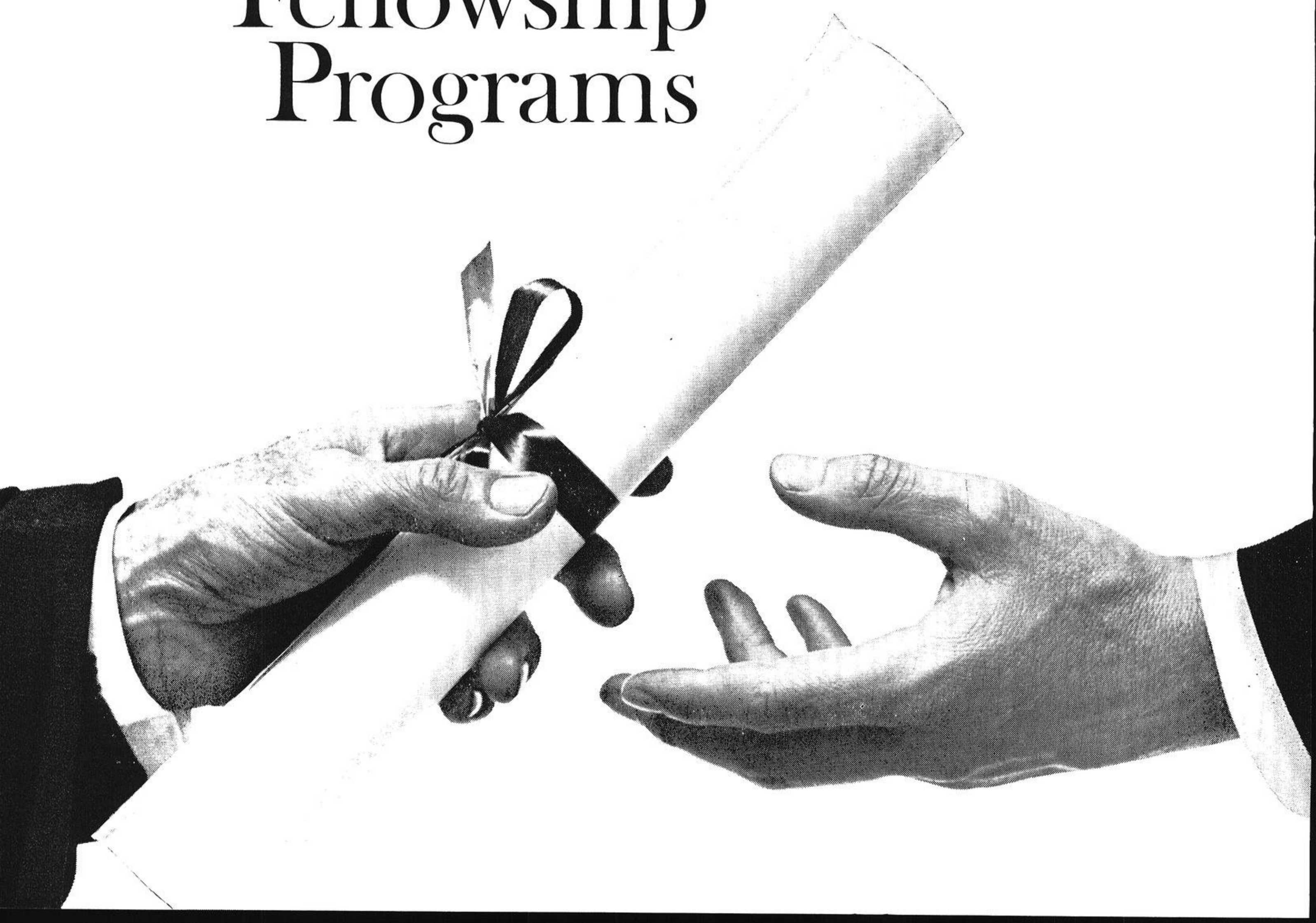
Hughes Fellowship Programs



(Continued from page 47)
"Civil Engineering in India" presented by Professor J. R. Villemonte at an October meeting. Also, several meetings each year are given over to outside speakers on technical or professional subjects.

Dates and locations of meetings are posted on the ASCE bulletin board in the Mechanical Engineering building lobby, as well as in various other locations on the engineering campus. All student civil engineers are invited and urged to attend!

SPEECH AT THE 50th ANNIVERSARY OF WISCONSIN STUDENT SECTION OF A. S. M. E.

By PROFESSOR A. G. CHRISTIE

It is difficult to realize that fifty years have passed since the Wisconsin Student Section of A.S.M.E. was organized. Yet these years have been constructive ones in engineering. Consider some of the changes that have taken place.

Travel in 1909 was by horse and carriage, street cars, and railroad trains were hauled by steam locomotives. Kerosene lamps were in general use in all but two areas where service was provided by electric lamps with carbon filaments. The limit of steam turbine size was considered to be 25,000 kilowatts.

Today, one travels in automobiles over splendid highways. Bus transportation dominates city streets. Diesel locomotives haul trains Travel by airplane is general. Horse power has replaced horses on farms. Electrical service is available almost everywhere. An order has been placed for a steam turbine of 600,000 kilowatts.

One of the most significant changes has been the growing recognition by the public of the Profession of Engineering. What are the obligations of a Profession? First, a professional man will base his opinions upon knowledge acquired by study, in the case of engineers, of the basic principles of mathematics, mechanics, the physical sciences, and economics. He reasons from fundamental premises.

The conduct of a professional engineer should conform to his organization's Code of Ethics. This is essentially a set of rules to guide his conduct in circumstances that arise in practice. A lengthy, rather verbose, Code of Ethics for Engineers has been adopted by the National Engineering Societies, including A.S.M.E. While correct in its admonitions, it is not widely read and memorized. The Code could form the subject of an interesting discussion by the Section.

A third requirement of a Professional Engineer is his readiness to place his knowledge and experience at the service of the public and his obligation to keep the public informed of engineering progress. Some of such services may be for a fee but often should be freely offered. These services may involve participation in politics and government which engineers have tended to leave to others. Yet, who is better qualified to guide national policies in regard to the application of technical developments to modern life than the engineers who develop and commercialize these?

How do student sections of A.S.M.E. serve the profession? In the first place, the Section provides a forum for the discussion of new engineering developments. Addresses can cover developmental and research work carried out at the University and by engineers in laboratories or in industry. Most men come willingly to the University to give such talks. They like to meet the students and some informality should be arranged after the meeting so that students may become acquainted with the speaker. Student members should be encouraged to discuss the address. This trains one in critically analyzing the statements made in a public address and may also bring out some important point overlooked in the original talk.

A wide circle of friends who know one's abilities, is one of the most valuable assets that an engineer can possess. When one is asked to suggest a man for a given job, it is natural to mention someone that you know and who has the necessary knowledge and experience for the job. Almost all my consulting engagements has resulted from the recommendations of friends and acquaintances. No opportunity should be lost by members of the Student Section to cultivate and widen one's circle of friends and acquaintances, particularly among engineers.

Discussions before the Section and the articles in Mechanical Engineering, keeps one informed of trends in developments. Machinery and production practices are changing rapidly. New approaches are being made to old problems and entirely new concepts are developing. In this ever-changing situation one has to grow in knowledge with these new developments. This can only be done by constant and persistant study after leaving college. Those who drop their study habits after leaving college soon become the drudges in engineering services.

You will be particularly interested in what's ahead in Mechanical Engineering? There appear to be certain developments that should be considered in choosing a line of work after leaving college.

In the first place, a disturbing appraisal of jobs has been evident in many recent groups of graduates. They appear to seek positions where "security" is the major consideration. This may be a result of family disturbances during and since the War; or, too great reliance may be placed on the "welfare state;" or, it may be due to the recent fashion of early marriage. In any case, this emphasis on security may get one into a groove where one continues throughout one's professional life.

In conclusion, I am an optimist on the future opportunities of mechanical engineers and of their accomplishments. The Profession of Engineering will receive wider recognition with greater responsibilities in the future and A.S.M.E. will take a leading part in these activities. Your Student Section can and will do splendid service in preparing men to make notable contributions in the practice of their profession when you experience difficulties, you should recall the advise of Walter C. Kerr, former president of Westinghouse, who when asked how to handle a difficult problem, replied: "Go as far as you can. Then see how much further you can go."

THE END

Sneed's Review

(Continued from page 42)

The reviewer put Murphey's book to the acid test.

First he did the most obvious; he looked up honor societies in the subject index. Very quickly he found the reference to Baird's Manual of American College Fraternities, which ". . . lists national officials of fraternities and sororities. It also includes a long list of prominent Americans and Canadians who have belonged to various fraternities."

Next, the reviewer looked up, "engineering," in the index. To his pleasant surprise, he found this general heading rather completely broken down into specific fields: accoustical, aeronautical, automotive, chemical, civil, dictionaries of, electrical, electronic, heating and ventilating, marine, materials-mechanical, nuclear, organizations, periodicals on, indexes to, plant, product, radio, and railroad.

Also listed as specific subject headings were Engineering Encyclopedia; engineers, biographical data on; and Engineers illustrated Thesaurus.

For a book that does not profess to be for technical people, this is a good one to have within arm's reach.

Summing up: "How and Where" to Look It Up is a very valuable work for any "information seeker" —from layman to educator—from engineering specialist to technical executive.

MAN'S WORLD OF SOUND

By J. R. PIERCE and E. E. DAVID, JR.
287 pages. Price: $5.00

The authors state (in the singular person), "I shall be disappointed if the reader does not enjoy this book, and if he does not learn something from it. I shall be equally disappointed if he is able to understand it in a couple of hours."

The authors will not be disappointed; what they say is completely true. After you have read this book you will come away knowing much more of speech and hearing—which is what the book is about despite its rather "catchy" title and colorful artistic dust jacket—than you did before, unless you are an expert in the subject. But even then you are liable to learn something.

The book contains a little bit of everything—physics, biology, trained singing, music, foreign languages, accoustics, electronics, physiology, anecdotes, voice typewriters, information theory, stereophonic and high fidelity sound—and then some.

It is a pretty safe bet that one day "Man's World Of Sound" will rank among this century's great scientific literary classics. Both of its authors are with Bell Telephone Laboratories. One of them, John R. Pierce, previously authored a book, published in 1956, that has already achieved great eminence: "Electrons, Waves and Messages."

Summing up: Profound though it is in spots, "Man's World of Sound" is a book you can not afford not to read. If you value knowledge, you will be glad that you did.

NEW BOOKS RECEIVED IN THE ENGINEERING LIBRARY

Benjamin, J. Statically Indeterminate Structures. 1959.

Berkely, E. Symbolic Logic and Intelligent Machines. 1959.

Birchenall, C. Physical Metallurgy. 1959.

Black, E. Graphical Communication; Drafting, Sketching, and Blueprint Reading. 1959.

Booker, H. An Approach to Electrical Science. 1959.

Booth, A. Automation and Computing. 1958.

Bouchard, H. Surveying. 1959.

Bowden, F. Fast Reaction in Solids. 1958.

Bowker. Engineering Statistics. 1959.

Brown, K. Package Design Engineering. 1959.

Browne. Introduction to the Theory of Determinants and Matrices. 1958.

Brownell, L. Process Equipment Design: Vessel Design. 1959.

Burghardt, H. Machine Tool Operation. 5th Ed. 1959.

Carrier, W. Modern Air Conditioning, Heating, and Ventilation. 3rd Ed. 1959.

Carslaw, Horatio Scott. Conduction of Heat in Solids. 1959.

Chaimowitsch, E. Olhydraulik. 2nd Ed. 1958.

Chaussin, C. Metallurgie. Vol. 2: Elaboration des Metaux. 1959.

Chemical Engineering Progress Symposium Series. No. 22 Nuclear Engineering Part V. No. 24 Adsorption, Dialysis, and Ion exchange.

Cheng, D. Analysis of Linear Systems. 1959.

Chestnut, H. Servomechanisms and Regulating System Design. 1959.

Conference on nonlinear magenetics and magnetic amplifiers proceedings, Aug. 6–8, 1958.

Cook, M. Science of High Explosives. 1958.

Cooper, G. Building Construction Estimating. 2nd Ed. 1959.

Speed Control

(Continued from page 21)

ing obtained. In short field takeoffs, obtaining maximum performance can be the critical factor as to whether or not the airplane clears an obstacle.

Normal Cruise

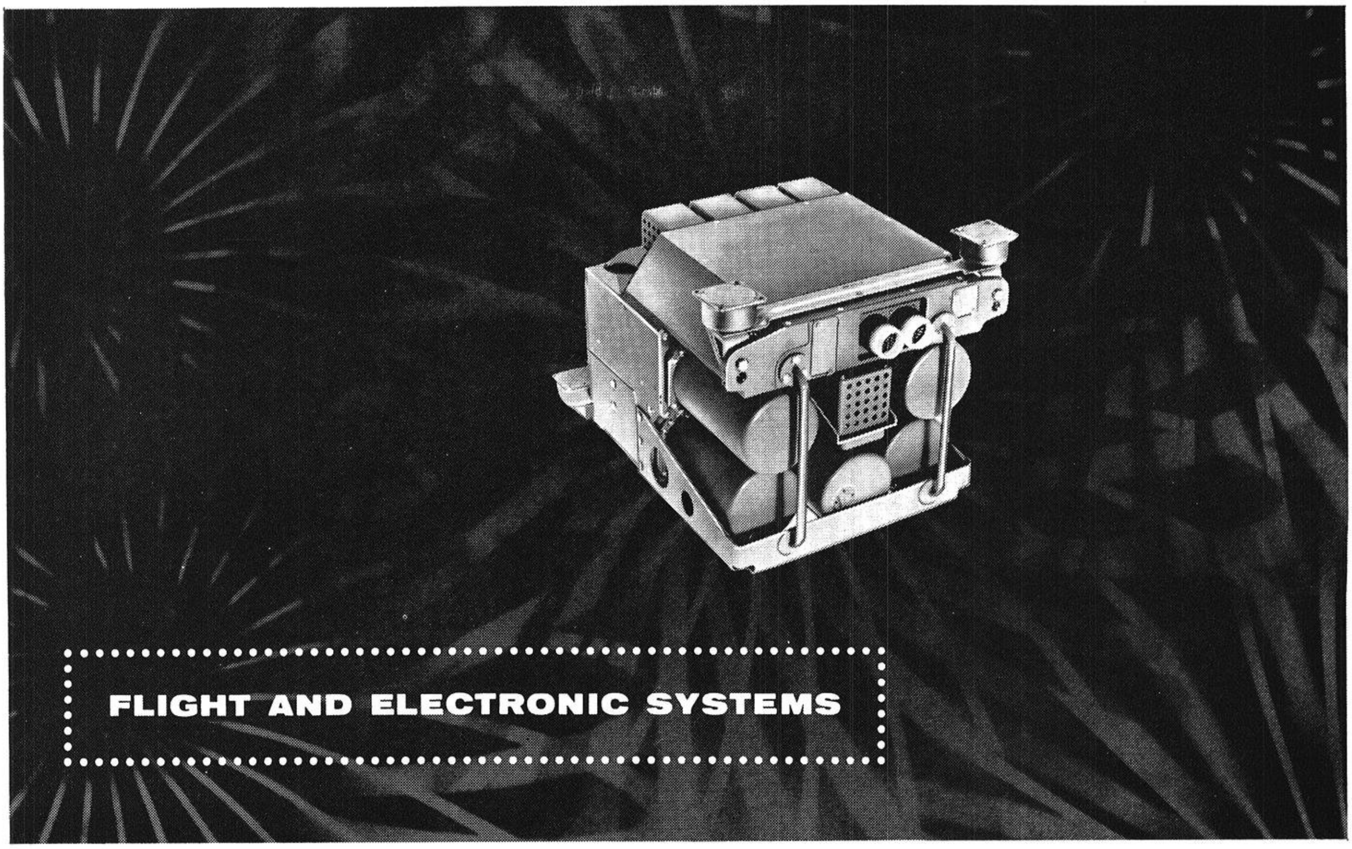
In cruising flight, the needle is normally displaced all the way to the right of the indicator. However, should the airplane approach stalling speed for any reason, the Speed Control will register the danger instantly by a sudden swing of the needle to the slow position.

Landing

In landing the pilot simply slows the airplane until the Indicator needle is centered, meaning the airplane is approaching the landing field at its optimum airspeed. Aircraft weight, wing flap position, and configuration are all automatically compensated for. The airplane is brought to the landing strip at its minimum safe speed eliminating high speed landings with the resultant excessive wear on tires and brakes excessive reverse pitch operations (using the propeller for braking by reversing the pitch of the propeller), and possible overshooting of the runway.

Through use of fundamental aerodynamic phenomena and electronics, the Speed Control indicator provides the pilot with precise, accurate, and continuous lift information. Use of the information attained enables the pilot to obtain maximum performance with extreme safety.

THE END



• Flight data systems are essential equipment for all modern, high speed aircraft. In the AiResearch centralized system, environmental facts are fed to a central analog computer (above), which in turn indicates to the pilot where the aircraft is, how it is performing, and makes automatic control adjustments. Pioneer in this and other flight and electronic systems, AiResearch is also working with highly sensitive temperature controls for jet aircraft, autopilot systems, submarine instrumentation, transistorized amplifiers and servo controls for missile application, and ion and radiation measuring devices.

EXCITING FIELDS OF INTEREST FOR GRADUATE ENGINEERS

Diversity and strength in a company offer the engineer a key opportunity, for with broad knowledge and background your chances for responsibility and advancement are greater.

The Garrett Corporation, with its AiResearch Divisions, is rich in experience and reputation. Its diversification, which you will experience through an orientation program lasting over a period of months, allows you the best chance of finding your most profitable area of interest.

Other major fields of interest include:

• **Missile Systems**—has delivered more accessory power units for missiles than any other company. AiResearch is also working with hydraulic and hot gas control systems for missiles.

• **Environmental Control Systems**—pioneer, leading developer and supplier of aircraft and spacecraft air conditioning and pressurization systems.

• **Gas Turbine Engines**—world's largest producer of small gas turbine engines, with more than 8,500 delivered ranging from 30 to 850 horsepower.

Should you be interested in a career with The Garrett Corporation, see the magazine "The Garrett Corporation and Career Opportunities" at your College placement office. For further information write to Mr. Gerald D. Bradley...

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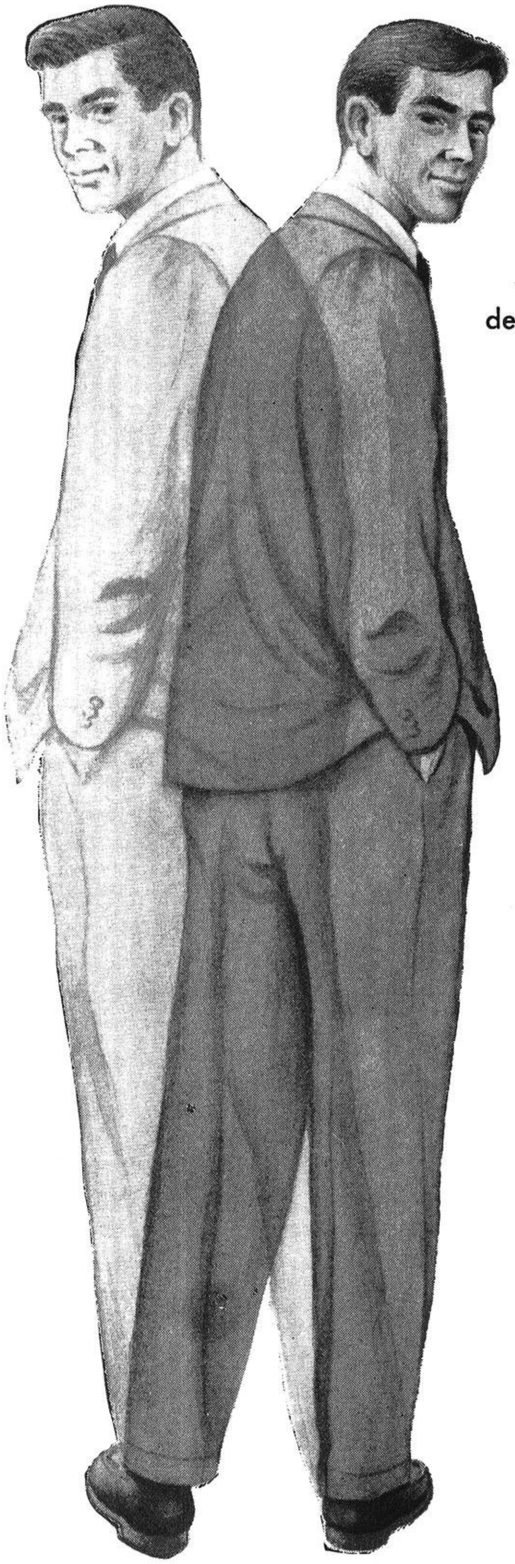

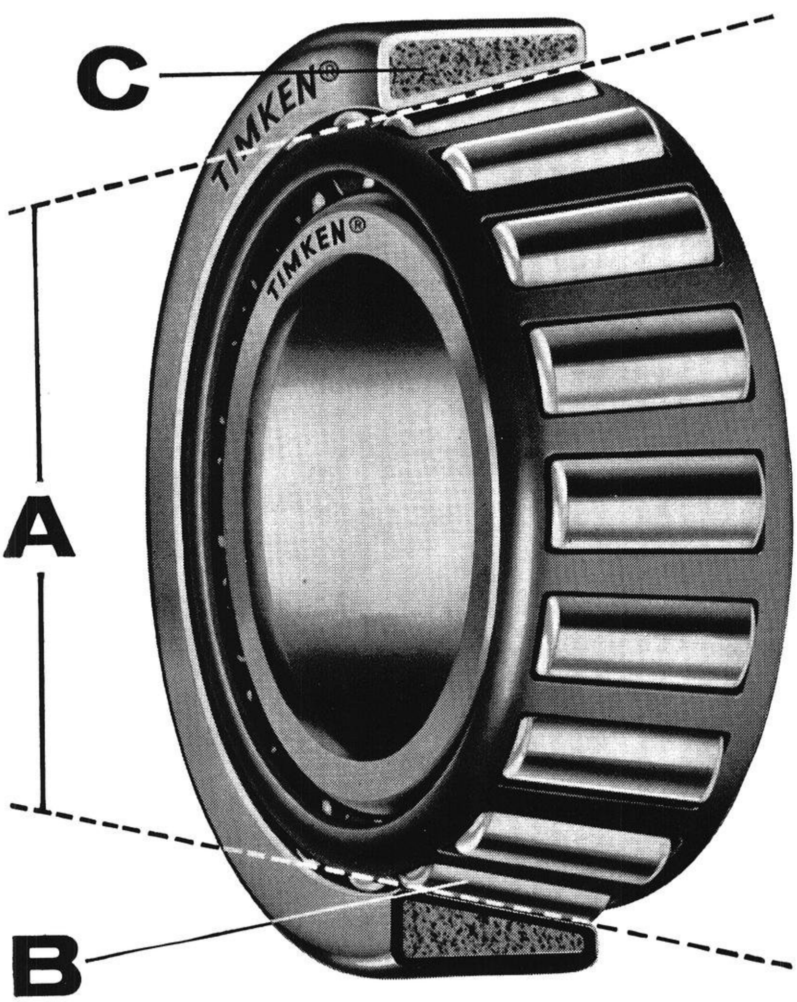

What is a Timken® tapered roller bearing?

IT'S an anti-friction bearing that's geometrically designed to give true rolling motion—and precision-made to live up to that design. Here's how you, as an engineer, can benefit from Timken® bearings:

A. *Tapered design* enables a Timken roller bearing to take any combination of both radial and thrust loads. You'll often find that one Timken bearing does the load-carrying job of two ball or straight roller bearings.

B. *Full line contact* between rollers and races gives Timken bearings *extra* load-carrying capacity. This enables a design engineer to cram maximum capacity into minimum space. And Timken bearings can be pre-loaded for accurate gear or spindle alignment.

C. *Case carburization* makes the steel of Timken bearing races and rollers hard on the outside to resist wear, tough on the inside to resist shock. This prolongs the life of Timken bearings. And the steel we start with is the best. It's nickel-rich for toughness.

What is Better-ness? It's our word for the result of the ceaseless American urge to make machines that do more, do better, do faster. Our engineers help make Better-ness possible. They've pioneered every major tapered roller bearing advance. And they work right at the drawing board with engineers of every major industry. It's exciting, rewarding work with a future.

If you would like to help create Better-ness on our engineering team, write Manager, College Relations, The Timken Roller Bearing Company, Canton 6, Ohio.

BETTER-NESS rolls on

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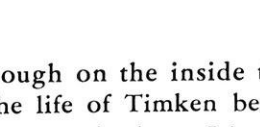

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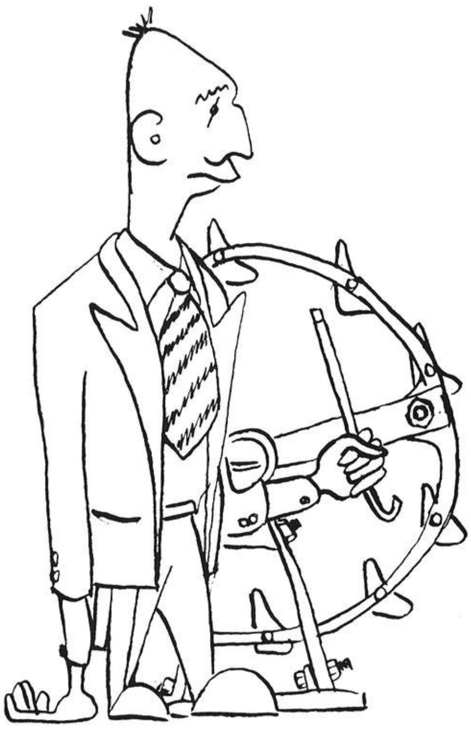
First in bearing value for 60 years



THE FERROUS WHEEL

(The Staff)

Then there was the time the good looking blonde drove down University Avenue when the rear tire went flat near the M.E. building. As she got out of her T-bird, she saw a few M.E.'s walk by and she asked, "Wonder if you'd help a girl in trouble?" One of them replied, "Sure we can. Just what type of trouble do you want to get into?"

* * *

"Do you have to keep the women inmates separate from the men?" inquired the visitor at the asylum.

"Sure!" replied the attendant. "These people here ain't as crazy as you think."

* * *

Notice to the Borden Co.

We are a little short of milk just now. . . .

Some of our best cows are out having a bull session.

* * *

A Ch. E. went to the Student Infirmary.

"Doc," he said, "I feel so terrible it makes me want to kill myself."

"Now, now," said the doctor, "You just leave that to us."

An E.E. caught his girl in an M.E.'s arms. To their startled expression he calmly said:

"I don't mind if you neck with my girl, but there's going to be a heck of a fight if you don't take your hand off my frat pin."

* * *

Student: "I got a bottle of gin for my wife."

Prof: "Sounds like a good trade."

* * *

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

M.E.: "Is that right? The first thing you know they will be trying to make the students stop too."

* * *

Then there was the young army doctor who had diagnosed the ailment of one of the men, but not knowing what to do with his limited facilities wired the base hospital: "Have a case of beriberi. What shall I do?"

The message was taken by a young technician at the base who wired back: "Give it to the engineers. They'll drink anything."

* * *

Min. E.: "My roommate says there are some things a girl shouldn't do before twenty."

Met. E.: "Well, personally, I don't like a large audience either."

Typist: "But professor, isn't the same exam you gave last year?

Professor: "Yes, but I've changed the answers."

* * *

And then there was the Comm. student who ruined the E.E.'s new calculator by dividing a number by zero and burning out the bearings.

* * *

Home from the Capitol, a businessman looked out of the window and saw a big log floating down the river. He pointed it out to his engineering friend and said, "That reminds me of Washington. There are about 10,000 ants on it and each one thinks he's steering it."

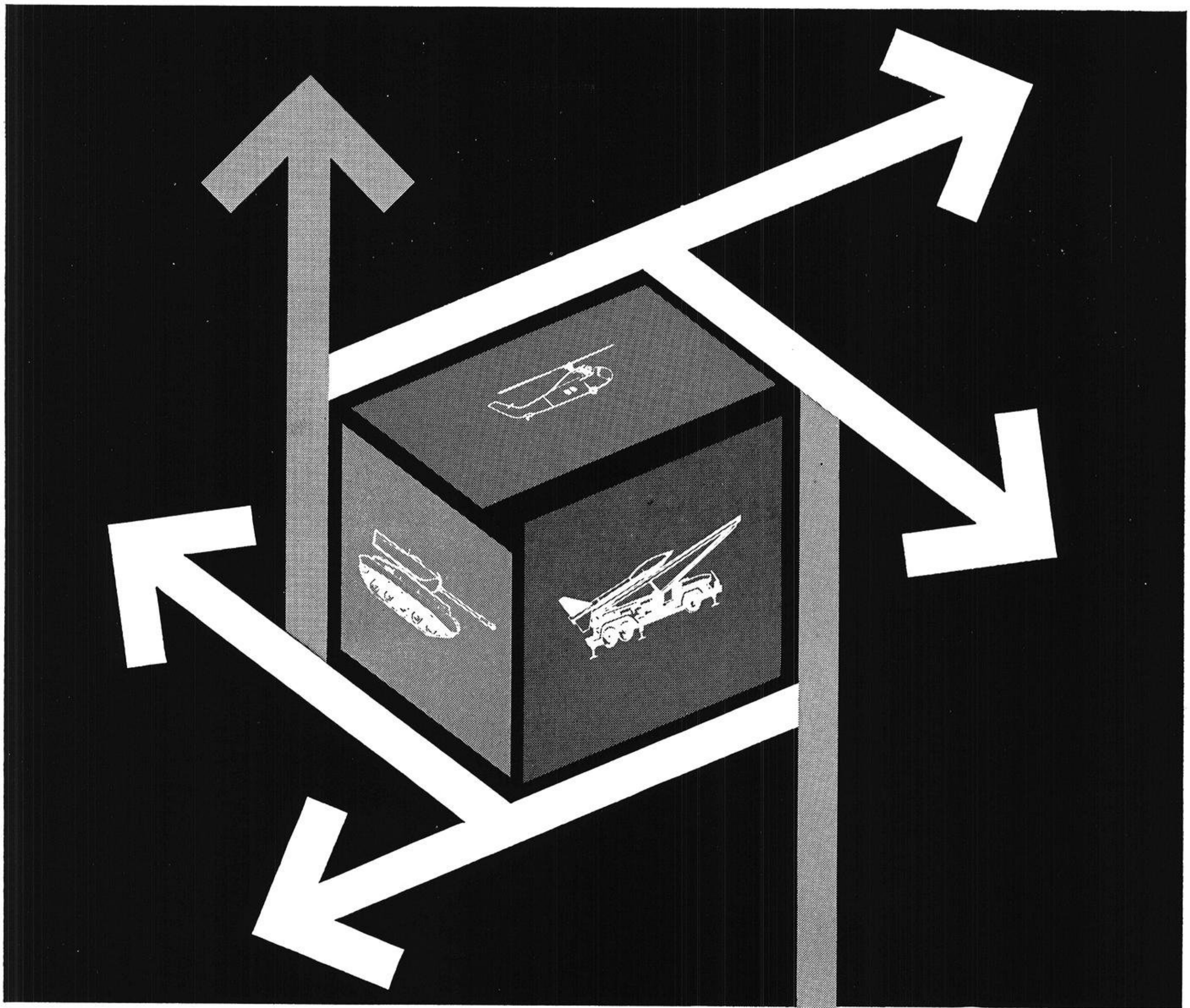
* * *

Prof.: "Give me a definition of a catalyst."

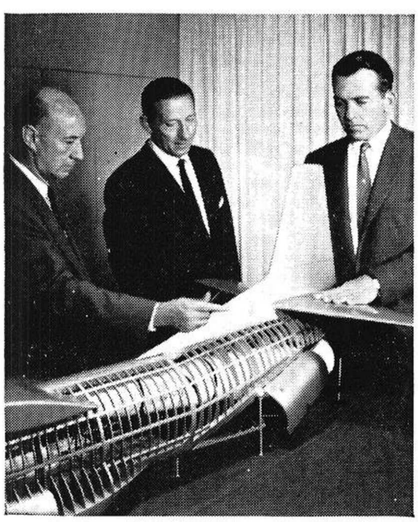
Ch. E.: "A catalyst is like a shot gun at wedding; it promotes action to take place without itself being altered."

* * *

The efficiency professor died after many years of faithful service, and the university arranged an elaborate funeral. The pallbearers were carrying the casket when suddenly the coffin lid popped up and the expert sat up and said, "If you'd put this thing on rollers, you can cut your time by 37.3%."



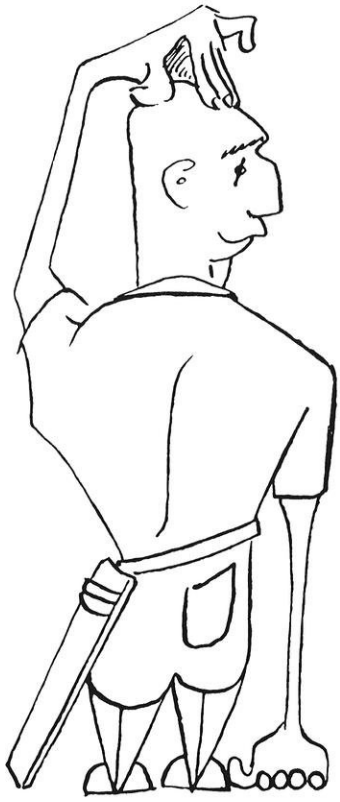
How to put wings on a warehouse



Giving overseas air bases what amounts to local warehouse service on important parts is an Air Force objective. Its present system has slashed delivery schedules up to *20 times*...saved taxpayers several *billion* dollars over the past decade. To improve it further, Douglas has been selected to develop specifications for a comprehensive Material Handling Support System involving better communications, control, cargo handling and loading, packaging and air terminal design. Douglas is well qualified for this program by its more than 20 years in all phases of cargo transport. Air logistics is only one area of extensive Douglas operations in aircraft, missile and space fields in which outstanding openings exist for qualified scientists and engineers. Write to C. C. LaVene, Box P-600, Douglas Aircraft Company, Santa Monica, California.

Schuyler Kleinhans and Charles Glasgow, Chief Engineers of the Santa Monica and Long Beach Divisions, go over air transport needs relating to advanced cargo loading techniques with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT



So You Think You're SMART!

by Sneedly, PhD '84

HONOR requires that I unequivocally deny a vicious rumor that has been circulating on the engineering campus. It is absolutely not true that I was called to the office of the Madison district attorney to answer questions concerning the awarding of the ten dollars for the first correct set of solutions to the problems. I deny that I have been giving our the solutions or even the problems to certain close friends or relatives before they appear in the "Engineer." The mere fact that my roommate won the ten dollars for the month of October means nothing and I defy anyone to prove otherwise. By the way congratulations to my cousin, Joe Sneedly of Mendota State, for winning November's prize money.

Now to more pleasant matters. Here are two little calculus teasers to put you in a happy problem solving mood for this Christmas issue. The answers are given at the end of the article.

1. Integrate the expression

$$\int \frac{d\ (\text{cabin})}{\text{cabin}}$$

2. Find the total differential of the function (Hi Ho).

As a special Christmas favor to all the campus morons, I am presenting three very simple problems this month for your solutions. All that is needed to win the ten dollars is speed in running to the mailbox with the correct answers.

1. What is the smallest number in which the digits are reversed when 2 is added to its double?

2. A man bought a watch for $103, including the tax. He paid for it in eight bills, but they were not five twenties and three ones, and there were no one-dollar bills among the eight. How did he pay for the watch?

3. If a steel band were stretched tight around the earth at the equator so that it touched it everywhere how much would the band have to be increased in length if it were placed one foot off the earth all the way around? Assume that the earth is level at the equator.

The correct answers to November's problems are:

1. The check was written for $14.32. At first this problem might seem insolvable because you can only write one equation in two unknowns. But you do have the additional information that both of the unknowns must be integers. Careful examination of the equation and a little thought should give the right answer.

2. The professor was a pedestrian for 55 minutes. The chauffeur was on the road ten minutes less than usual. This ten minutes must be composed of the time it would take to drive from the point where the professor got in the car to the railroad station and back or five minutes each way. Since the professor's train was one hour early his walking time must be one hour minus five minutes or 55 minutes.

3. The probability of the Bluesox winning the series is 13/16. This is one minus the probability of their winning just zero or one game in five attempts, or 1–(1/16 + 2/16). The computation must be made on the basis of five games even though the series might terminate before all five games are played.

Send any questions, answers, complaints, or death threats to:

SNEEDLY
c/o The Wisconsin Engineer
Mechanical Engineering Bldg.
Madison, Wisconsin

The answers to the calculus teasers:

1. $\int \frac{d\ (\text{cabin})}{\text{cabin}} = \log \text{cabin} + C = $ houseboat

2. (Hi–Ho) = Hi d (Ho) + Ho d (Hi) and a Merry Christmas to all.

One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas—meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.

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