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The WISCONSIN ENGINEER

Ah Spring!

April, 1942

Atom Counting

Messerschmitts ★ Illumination

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

"TO PROVIDE FOR THE COMMON DEFENSE, TO PROMOTE THE GENERAL WELFARE"

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"An Engineer's Company," Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

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In This Issue . . .

Emil, the sleeping beauty on our cover, has been overpowered by the buzzing and chirping of the bees and birds. Poor Emil! He was studying for an E.E. quiz. But, as always, in spring a young man's fancy turns to thoughts of sleep. Ah, spring! Ah, sleep!

Robert Hodgell is Emil's creator. Bob is the executive editor of the Badger, but he has found the time to make the caricatures, and we're very pleased with them. Thanks, Bob.

Although the data is more than a year old, the article on the Messerschmitt Menace is interesting reading. Undoubtedly the American engineers are the best, but the Axis designers are no slouches.

Please don't pass by Martin Kaplan's article, Sight and Light, because of its forbidding length. The eye is explained in all its details especially for you engineers. Methods of artificial lighting, industrial illumination for maximum efficiency, glare and its cure; all are explained in this informative discussion on page 8.

Close cooperation between the Departments of Physics and Agricultural Bacteriology has enabled the atom counter to be put to use in the study of nitrogen fixation. Mass Spectrometers, or atom counters, similar to the one built here, are finding many applications in the field of chemistry, both theoretical and applied. The purpose of the Mass Spectrometer is to sort the particles of a substance according to their molecular weights and to find their relative concentrations.

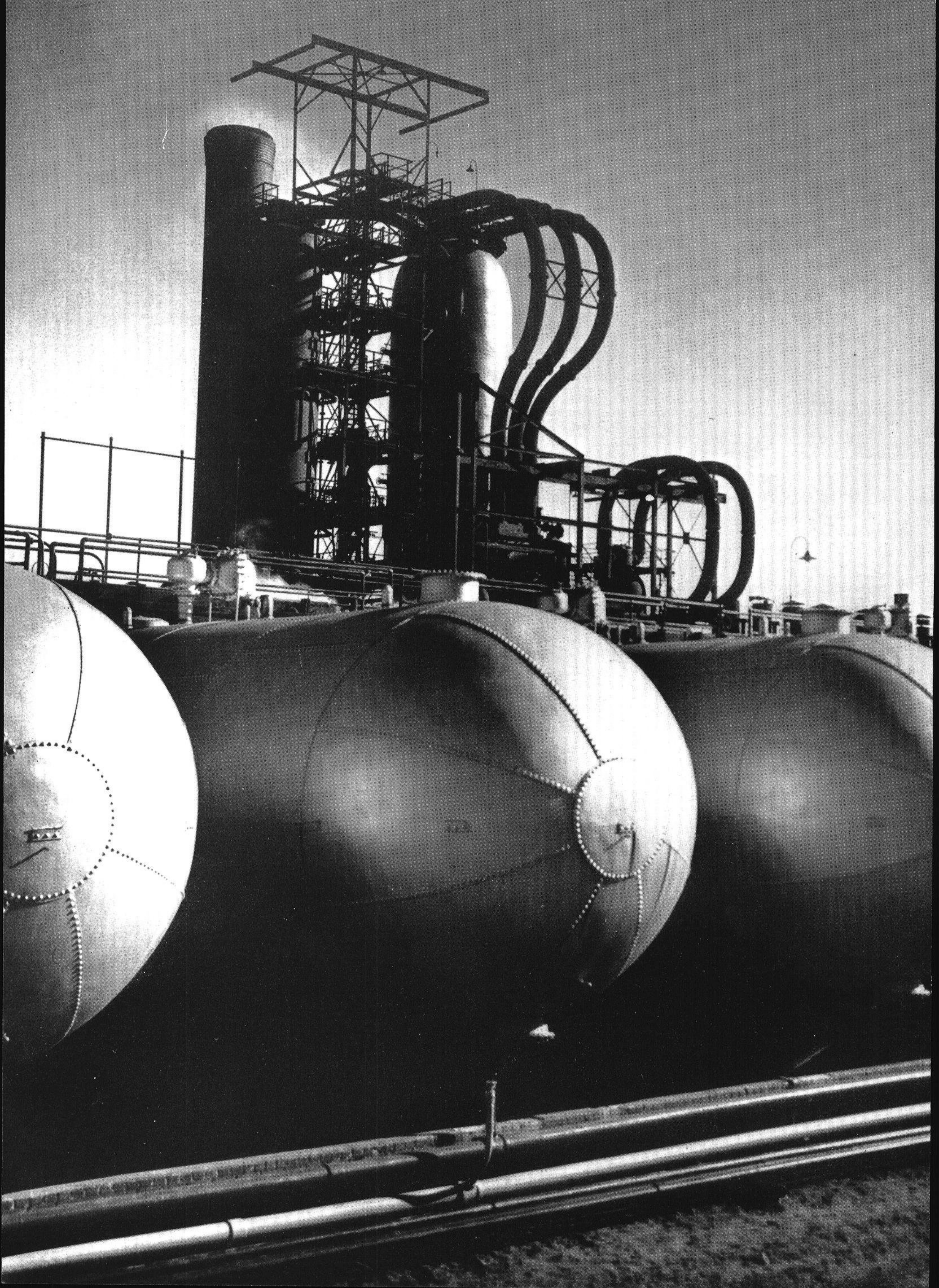
Ours is not the only engineering college magazine. Homer Schneider has reviewed some of the others and recommends several of their articles as good stuff. All the magazines mentioned can be found in the engineering library. Page 14.

Summer school will be longer this year. Dean Johnson gave us the information only a few days ago, and you'll find the particulars on page 18. Aside from the fact that Madison is so very hot during July and August, all who attend ought to have a great time. It's something of a shock to see a professor in shirt sleeves, but the students wear T shirts, and that sort of evens things up.

What's your E.Q. (engineering quotient)? The editor had a tough time with the sixth question, but his Ps was right up in there by virtue of a high draft number. Other factors will immediately come to mind for the mechanicals, and their use is encouraged in calculating an E.Q. Try this representative quiz on page 20.

Back in October we ran a picture of the dean's secretaries. That issue was a sellout, and there has been an insistent demand for more. We give you another pin-up on page 24.

The cover picture of the Union terrace is through the courtesy of Meuer Photoart House.



MESSERSCHMITT MENACE

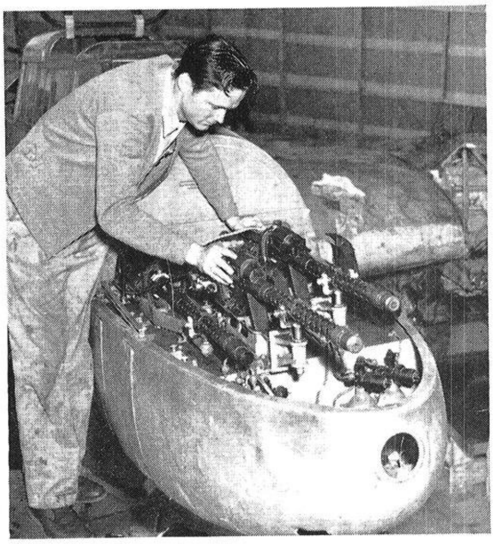
Illustrations and Data Courtesy Vultee Aircraft, Inc.

by Gordon Erspamer, met'44

MESSERSCHMITT! A thrill of terror shook the anti-Axis world when the full fury of Germany's thunderbolt of the skies was unleashed upon its outmoded air forces. One of the "secret weapons" which Germany's technicians had evolved for Adolf Hitler's world thrust, the Messerschmitt fighter for a time threatened to sweep Britain's Royal Air Force out of the skies. While Britain's designers worked feverishly to produce a fighter capable of battling the Messerschmitt on even terms, America began to ask uneasy questions. Had Germany, then, stolen a march on the world's aviation experts in those apparently secure pre-war days, and produced a military airplane of superior design, upon whose wings the Nazi Luftwaffe has ridden to its sensational victories?

Disquieting rumors reached the United States—about self-sealing gas tanks, aviation cannon, and others. But our designers could only speculate until March, 1941, when a Messerschmitt 110 multiplace fighter was shot down over England with very slight damage. At the urgent request of United States aeronautical engineers this air weapon was carefully dismantled and shipped to the United States for detailed investigation and analysis.

Shipped on the freighter Montanan, the eagerly-awaited bundle from Britain arrived in Los Angeles by way of the Panama Canal in April. After being set up and assembled, long range inspection shows a fairly large airplane for the fighter class—being a twin-engined, three-place, low-wing monoplane of high quality all-metal construction. Its overall span is 53 feet, 5 inches; overall length is 40 feet, 6 inches, with a wing area of 414 square feet. The gross weight, loaded, is approximately 15,000 pounds, and maximum speed at 19,000 feet is estimated at 365 m.p.h. This big bimotored destroyer, designed for combat and escort work, has a range of 800 miles and seats a crew of three—pilot, radioman, and gunner. Upon closer examination, the first impression received is one of terrific striking power. The Me-110 is solely a "blitzkrieg" weapon—one in which all defense is subordinated to obtain a maximum of offensive power. There is practically no defensive armament to be found. Four 7.92 mm. Rheinmetal Borsig machine guns and two 20 mm. Mauser cannon, tightly packed into the nose of the fuselage, provide heavy fire power. A quickly detachable external bomb rack designed to carry two 550-pound bombs is provided for use on missions where the principal objective is attack of ground concentrations.



Offensive Armament. Center Hole Contains Camera.

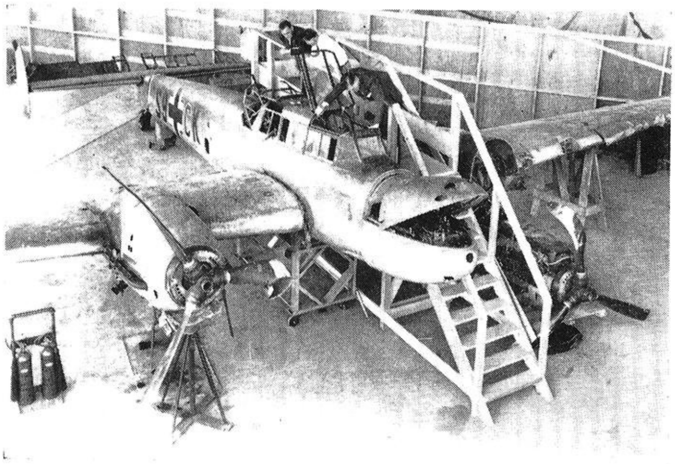
These contrast sharply with the single flexible machine gun supported on a primitive mount in the aft cockpit. The almost total absence of defensive armament indicates that S9CK, squadron designation of the Me-110, was designed with a dual goal in view: the first, to provide a military airplane carrying heavy striking power; the second, to produce a standard model with mass production possibilities that would permit its manufacture in such quantities that the enemy could be overwhelmed by sheer numerical superiority.

How well the German engineers achieved their objectives is clearly evident. Considering attacking power first, let us focus attention upon the armament. All of the offensive armament is concentrated in the nose, with none being situated in the wings. The four fixed machine guns, 7.92 mm., are closely fitted into the upper portion of the fuselage nose, and are belt-fed from ammunition boxes occupying the lower portion of the nose. Two 20 mm. Mauser cannon are directly beneath the radio operator's cockpit in convenient position for loading. These cannon are a new innovation in aviation armament, and have been copied by the newer British and American models. They use reflector sight aiming and fire at the phenomenal rate of 900 rounds per minute. This fire power is easily the equivalent of the eight banked Browning .50 caliber gun installation carried by the British Spitfires and Hurricanes. A gun-sight mount equipped with transverse and vertical adjustment is fitted to the upper center of the pilot's instrument panel.

The lone concession to defense, a single flexible machine gun, is mounted in such a crude manner that the indicated conclusion is that it was added merely as an afterthought. An Arado universal mount is bolted to the fuselage frame by means of a support plate. This plate provides for locking the entire mount in vertical, or in positions up to 30 degrees each side of vertical, the entire gun swiveling or tilting in its yoke support. The complement of offensive weapons is completed by a quick-detachable, electrically operated bomb rack fitted to the lower portion of the fuselage, carrying two 550-pound bombs. Release and arming are electrically controlled. The first goal of the Nazi technicians has definitely been achieved.

Now let us consider the Messerschmitt's mass-production possibilities. Design was planned, with standard parts readily interchangeable, to roll Me-110's off the assembly line like Ford V8's. The Messerschmitt's basic structure has been simplified to eliminate complicated assemblies and parts. Production economy is achieved by loosening up manufacturing limits to the fullest possible extent. For instance, the close dimensional tolerances required for interchangeability of wing fillets have been eliminated by piercing large attaching holes in the fillet itself, and using attaching strips to clamp them in place against the fuselage and wing panel.

From this and similar structural design features, it may be assumed that the Messerschmitt-produced parts fall considerably short of the manufacturing accuracy required of American airplane parts, but are made completely interchangeable through the use of various compensating design features. The result is that the general design and construction of S9CK compare favorably with the best of American-produced airplanes. Score a complete success for Nazi Germany's production engineers.



Dismantling the Messerschmitt

To consider its structure in detail, we shall take up wing construction, fuselage, equipment and service features, and power plant installation. The all-metal wing is the monospar type, composed of two detachable panels with removable wing tips. The basic construction consists of an I-beam, located at about 40 per cent of the chord. It comprises a shear plate riveted to aluminum-alloy angle spar caps, with hat-section vertical stiffeners; Z-section stamped ribs spaced about 10 inches apart; span-wise hat-section stringers; and flush-riveted smooth skin. Conspicuous departure from conventional practice is the complete absence of rear beam, with aileron and flap loads being transferred directly to the ribs.

Each wing panel is connected to the fuselage by a four-point attachment between the wing inboard bulkhead and the fuselage structure. The bottom of the wing spar is connected by a large diameter bolt passing through a clevis fitting, while a large stud, extending through a boss riveted to a cross tube within the fuselage, connects the top. Other clevis joints provide for taking out primary torsion loads and carrying the aileron and flap torsion loads into the fuselage.

Ailerons and wing flaps are both constructed in the same manner with a conventional beam, metal nose skin, riveted ribs, and cloth covering. The wing flaps are similar to the American N.A.C.A. slotted types, extending from fuselage to aileron, and are interconnected with the adjustable stabilizer to trim automatically when the plane is landing. Power operation is provided by a hydraulic actuating cylinder. Automatic wing slots fitted to the wing leading edge further reduce the landing speed.

Stabilizer

The all-metal horizontal stabilizer is formed from symmetrical halves, riveted and bolted together in simple fashion. A cast magnesium nose piece of small section is attached to it with flush screws. The basic construction of the horizontal stabilizer can best be understood by visualizing a conventional structure of front and rear channel-section beams, pressed ribs, and cover sheets. This is sliced along the chord line to give an upper and a lower half; the cut edges of the ribs and beams in each half are provided with flanges, so that each becomes a Z-section.

The empennage movable surfaces are conventional beam and rib construction with cloth covering and a controllable, servo-acting tab is provided on each. The flush-type covering is sewn to cloth tacking strips riveted to the side of the ribs.

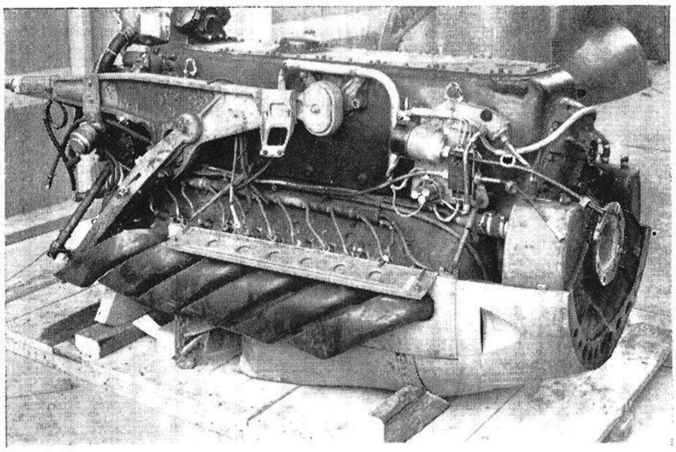
Fuselage

The semi-monocoque fuselage structure is built in two symmetrical halves, each consisting of curved aluminum-alloy sheets with the ends of each alternate sheet being formed with integral Z-section bulkhead rings. These are flush riveted to form a structure that is noticeably clear of internal structural cross-members. The two halves are riveted together along the upper and lower centerlines to form the complete structure. Reinforcing longerons are provided in the upper and lower portions of the structure at the cockpit opening, and hat-section stringers extend the length of the fuselage. A noticeably small variety of sheet gages and section forms are used, with heavy gage skin being relied upon for strength in order to avoid production complications which would arise from a variety of internal strengthening members. The fuselage is of comparatively small cross-section, to the extent that the pilot's cockpit is uncomfortably cramped. The cockpit is covered by an enclosure of the canopy or "greenhouse" type arranged to swing the top aft and up while the side panels fold down; the aft portion of the enclosure is in the form of a hood so arranged to tilt upward and slide forward to provide for flexible gun operation. It is not bullet-proof, and the overturn structure common on American military aircraft is entirely absent.

Each leg of the fully retractable main landing gear comprises a pivoted cantilever strut, arranged to swing aftward and up into retracted position within the engine nacelle fairing. Fairing doors completely enclose the wheels in retracted position. Operation is accomplished by a hydraulic actuating cylinder. Contrary to American design practice, the landing gear is not provided with locks for either extended or retracted position, with hydraulic fluid pressure being relied upon to hold the gear in position. A compressed air system provides for emergency operation, with air being stored under extremely high pressure in a small cylinder.

A simple cantilever strut, rigidly fixed to the fuselage aft bulkhead, provides for the non-retractable tail wheel. The tail wheel is non-steerable and is probably provided with a centering cam within the shock-absorber cylinder. Conventional stick and rudder-pedal flight controls are fitted in the front cockpit only, with individual toe action provided to operate the hydraulic wheel brakes.

Four leak-resistant fuel tanks are provided, one before and one behind the wing spar, inboard of each engine.



Daimler-Benz Power Plant

There is space provided outboard of each engine for two additional tanks. The total normal fuel capacity with four tanks is about 340 gallons; with a maximum capacity, using six tanks, of about 480 gallons. A detailed examination of the leak-resistant fuel tanks has not been made; but they appear to be of typical German construction, using a riveted fiber tank as the base. This tank is protected with a thick outer casing in the form of a rubber "sandwich" comprising several layers of pure rubber held between inner and outer layers of tough, vulcanized rubber. An interesting feature is the supporting frame, composed almost entirely of molded plastic parts. This is obviously to protect the tank from jagged metal fragments, should the frame be pierced by a bullet.

Extensive use is made of shielded wiring, with conduit used only where mechanically necessary for protection. Connector blocks and plugs are used throughout the plane, and fuses have apparently been entirely replaced by circuit breakers. Attachment of wiring to the structure is by narrow metal bands joined by a crimp, rather than by the clamps customary with American aircraft.

A bewildering array of radio equipment is installed, apparently comprising long and short wave transmitters and receivers, radio compass, and blind landing equipment. A complete installation of flight and engine instruments is to be seen, including a German version of our well-known Sperry artificial horizon. An interesting remote indicating compass is provided, actuated by a large compass placed well aft in the fuselage, and electrically connected to indicators in the pilot's and radio operator's cockpits. This is well in advance of United States current practice. Also found is a Sperry-type blind flying panel, turn and bank indicator, tachometer, temperature and pressure gauges, and a sensitive rate-of-climb instrument.

No Carburetors

The power plants are 1,150 horsepower Daimler-Benz DB. 601, liquid-cooled, 12-cylinder, geared, Vee-type, inverted, gasoline-burning engines. They have a displacement of approximately 2,069 cubic inches, and are able to develop their maximum horsepower to altitudes of about 20,000 feet through the use of a multi-speed, hydraulically controlled supercharger. The take-off rating is said to be 1,360 horsepower. Each engine weighs approximately 1,600 pounds. Like all German airplane engines, these substitute direct injection of the fuel for carburetors, so Bosch fuel injectors are mounted between the cylinder banks; they spray fuel into the cylinders at a point directly opposite the spark plugs, which are in pairs along the outside of the cylinder banks. This enables the motors to burn poor fuel with vast economy. Fuel of approximately 87 octane is used.

Variable Pitch Propeller

Each engine drives a V.D.M. propeller, of the 3-blade type. Each is a German-built, constant-speed propeller, electro-mechanically controllable to full-feathering position and about 11 feet in diameter. An automatic electric timing device prevents the engine's being operated at take-off power for more than a few minutes, and a propeller governor is provided.

The long, narrow coolant radiator for each engine is mounted beneath the wing at a point outboard of the engine nacelle, and just forward of the wing flap. The radiators extend upwards for the depth of the wing, a construction made possible by the absence of a rear spar, and are provided with a controllable air exit shutter. A mixture of 50 per cent water and 50 per cent Prestone is used as the coolant.

A rather small oil cooler is mounted beneath each engine, and connected to a leak-resistant oil tank of approximately 11.5 gallons capacity. The fuel to oil ratio of approximately 21 to 1, indicates that the Daimler-Benz engines have a low oil consumption.

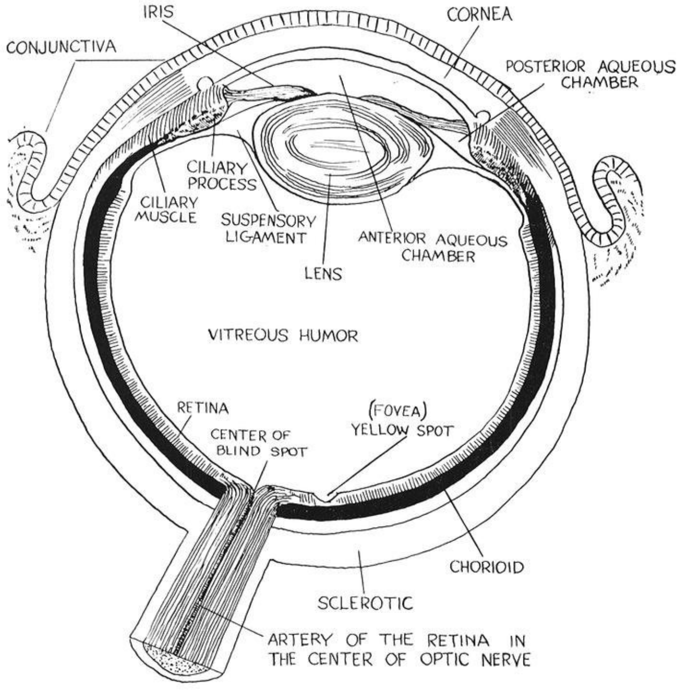
Our aeronautical engineers have only two criticisms of the Me-110. One is the absence of adequate armor for the cockpit and the other is a vulnerable blind spot in the belly. Their report concludes that it is approximately the equal of America's and Britain's best military aircraft.

SIGHT AND LIGHT

by Martin Kaplan, e'42

THE prime purpose for illumination is good vision. It is therefore helpful to an engineer to understand the function of the human eye and to use this knowledge in judging his final design.

Fig. 1 shows a vertical section through the lens, retina, and optic nerve of the human eye. Light enters through the transparent conjunctiva, cornea, and anterior aqueous chamber and passes through that portion of the crystalline lens not covered by the iris. From here it passes through the colorless fluid known as the vitreous humor until it impinges upon the photosensitive retina. The elements of light or light rays are then transformed into electrical potentials by the widely distributed rods and cones in the retina in much the same manner as if these elements were supersensitive photoelectric cells. Each photocell (rod or cone) is connected through its appropriate nerve center to the maize of nerves collectively called the optic nerve. Rod and cone connections differ, cones having series individual connections to the optic nerve and rods having series parallel connections whereby several are finally joined to one element of the optic nerve. The optic nerve is much like a telephone cable with thousands of tiny concentric cables placed side by side and bound into one compact unit.



Drawn by Fred Carpenter

Fig. 1—Eye in Cross-Section.

The two optic nerves pass beneath the cerebrum until they reach its posterior region where each optic nerve separates into two equal groups. One group from each nerve terminates in the left half of the cerebrum and the other group from each optic nerve terminates in the right half. This gives each eye equal representation in both lobes of the brain. It is in this part of the brain, the part which does all of the thinking, that the inverted image in focus upon the retina is finally interpreted in its correct position. The electric impulses are not reconverted to light in the brain but are utilized as electricity which stimulates the brain cells. As will be seen later, above certain illumination levels the brain stimuli are limited by various automatic processes; however, this is not true if the illumination level increases too rapidly.

The Iris

The iris functions automatically in much the same manner as the variable aperture of a camera, covering more or less of the lens as the intensity of illumination incident upon it increases or decreases. The iris has a dual system of annular and radial muscles which are supposed to be controlled by two separate sets of nerves from the brain. The annular muscles close the aperture and the radial muscles open it. A mechanical interpretation of the iris is given in Fig. 2. As shown, the iris is nearly closed as it should be under moderate light intensities. Actually, the muscle cells are analogous to the plates of a simple electrometer, contracting with a force proportional to the electric charges upon them. However, to facilitate illustrating the nerve control of the iris muscle systems, electromagnets with movable iron cores have been used. Each muscle contains its own power supply and the nerve acts only as a voltage regulator.

Lens

The lens is a simple crystalline convex structure which is, to a certain extent, self-focusing. Muscles around its periphery contract for distant vision causing a radial tension in the lens which increases its diameter and decreases its thickness and surface curvature. The focal length increases with the decrease in surface curvature and the inverted image of the distant object will be in focus on the retina of a normal eye. For near vision the lens muscles relax, thereby increasing its thickness and surface curvature and decreasing its focal length whence the inverted image of the near object will be in focus upon the retina. Vision is further complicated by the fact that each of the eyes must see an image at the proper angle or the brain picture will be confused by two images improperly superimposed.

The lens is not corrected for spherical or chromatic aberration. Spherical aberration is partially offset by the shape of the retina. However, light composed of several wave-lengths cannot have all its components focused simultaneously on the retina. Take the extreme case of a white object illuminated by a narrow band of monochromatic blue and a narrow band of monochromatic red in such relative intensities that the retina is equally sensitive

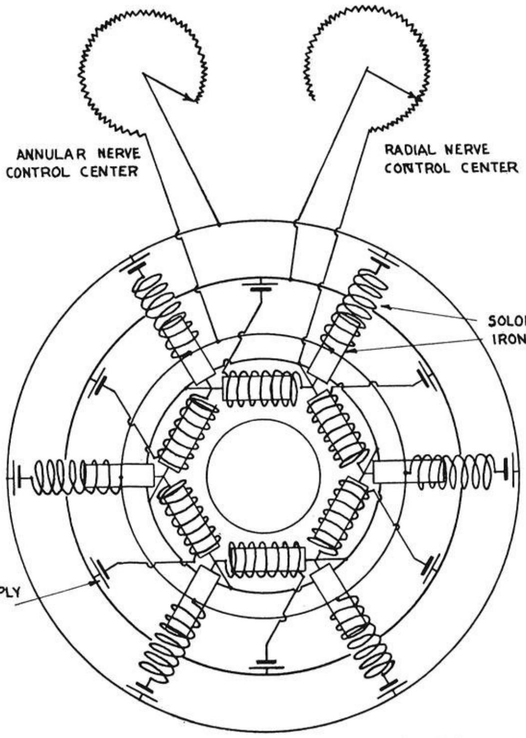


Fig. 2—Mechanical Interpretation of the Iris.

to both. An image will be formed by each of the red and blue lights at different distances from the focal center of the lens. Because of its automatic nature, the lens will be motivated to focus first one of the images upon the retina, and then the other. The eyes will tire rapidly under such illumination and the image will be blurred.

Near-sighted and far-sighted eyes are usually mis-shaped eyeballs, being too long or too short, respectively. Unless proper correction is made with an auxiliary lens, the lens of a mis-shaped eye will become inactive through lack of exercise. As the eye increases in age, the lens becomes set and the muscles which act upon it become weak, thereby giving rise to the need for bi-focal auxiliary lenses.

Retina

The retina is a composite and complex system of photo-sensitive nerve endings which line the inner surface of the eye. A diagramatic sketch similar to an equivalent circuit is shown in Fig. 3. The rods and cones are classified as such because their ends are respectively cylindrical and conical in shape. In the human retina there are many more rods than cones. The approximate ratio is 8 to 1 except in the region of the fovea which is almost entirely composed of cones. In the region of the fovea, a small depression in the retina upon which falls that portion of the visual field of greatest interest, the cone density is high, supposing to be of the order of 140,000 to 160,000 cones per square millimeter. Although color vision is not clearly understood, it is supposed that the cones are entirely responsible for this refinement. The rods are supposed to react to light, irrespective of its color, only as a function of the illumination level.

At the lowest levels of illumination, the supersensitive rods extend closer to the surface of the retina and account for all of the vision. At these low levels the cones are insensitive, and since the fovea is composed entirely of cones, visual acuity is very poor. In optics, fineness of image detail is known as visual acuity.

The eye intercepts a large solid angle between 120 to 150 degrees horizontally and between 80 and 120 degrees vertically, which is known as the field of vision. At approximately the center of this field is the foveal region of about 3 degrees in which, at any normal illumination level, the visual acuity is infinitely higher than that of the surrounding retina areas.

The fovea is the most exercised portion of the retina. This small area does perhaps 90 per cent of the seeing job. Whenever one "looks at" an object, his foveas are receiving the image.

Because the fovea is composed entirely of cones, and because cones are insensitive to low levels of illumination, visual acuity has been used as a measure of illumination level. If it were not for orientation and nocturnal vision, the retina need only contain the fovea, for the rest of the retina cannot "see" distinctly.

The rods are remarkably sensitive to low levels of illumination and will, under normal conditions, function long after the illumination level has fallen below the point at which the photo-electric cell fails to react. In addition to the lack of visual acuity at low levels, there is also no sensation of color. What vision prevails is purely of a black and white nature. As the level of illumination in-

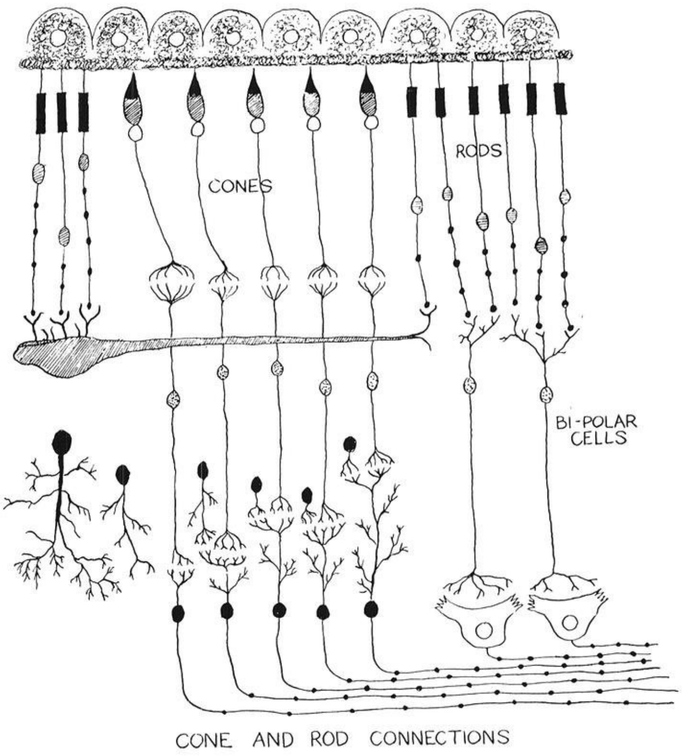


Fig. 3

Drawn by Fred Carpenter

creases, the rods withdraw behind the protective surface layer between the cones. Concurrently the iris muscles contract to further protect the rods; this also increases the sharpness of focus because the central portion of the lens is more correct optically than its outer extremities. At this level the cones are fairly sensitive and carry a fair share of the "load." As the level increases, the rods withdraw until the light reaching them is but a very small fraction of the total light reaching the retina.

It is thought that the pigment layer in the retina supplies vitamin "A" to the rods. From the vitamin A the rods synthesize a photosensitive chemical compound known as visual purple. Light bleaches the visual purple and supposedly causes a galvanic e.m.f. to be generated. Vitamin A and other chemicals are formed by the bleaching action, the latter being carried off by the blood and the vitamin A being returned to the pigment or re-synthesized into visual purple. Thus not all of the vitamin A is lost in the seeing process, and a balanced diet will usually supply enough vitamin A to supply the losses both in the eyes and in other parts of the body.

When fine details must be seen under artificial illumination, such light must be more intense than for visual tasks where the objects are relatively large. This might be traced to the fact that at low illumination levels rod vision is sufficiently acute to make out the large details, whereas if the object is small, much higher visual acuity is necessary, requiring concentration at the fovea and consequently cone vision.

The Effect of Light

It has been often mentioned that the human eye was evolved in sunlight and that the illumination from this source often reaches a level of 10,000 foot candles. The conclusion drawn from this fact is that the intensity of artificial illumination cannot be too high. It might be well to mention that during its evolution the eye was also subjected to the illumination of cloudy days when the sun could not be seen, and to winter days when snow was on the ground. Even Neanderthal Man had a crude form of shelter, so the human eye cannot be said to have evolved entirely in sunlight. And if Early Man was awake more than twelve hours a day, his eyes must have changed to accommodate for the low levels of illumination of the moon. It is known that the diurnal vision of some animals requires high levels of illumination in the daytime and low levels at night. This temporal effect causes these animals to shun even moderate illumination at night because their eyes are not accustomed to light of such intensity at that time. Yet these same animals will move about with relative ease with only moonlight to guide them. The same may be true of the human eye to some extent, so that if high levels of illumination prevail at night when the eye expects a relatively low level, discomfort to some extent may result.

Incandescent light has, unfortunately, a large percentage radiation of infra-red. While these rays are invisible, it must be remembered that they impinge on the retina. The lens focuses these rays just as it does visible rays and because of their intensity, an uncomfortable burning sensation frequently ensues. Of course the percentage of infra-red is about the same regardless of the illumination level, but under high intensities the quantity and not the

Fig. 4—As the Saboteur Sees the Plant.
—Courtesy Westinghouse

percentage is the damaging factor. All of the light is not converted into electricity. Much of the visible light energy is lost in the form of heat which adds its effect to the infra-red light. The much sought "Cold Light" would eliminate most of this infra-red radiation, but if its intensity were too high, the heat losses in conversion might still prove to be damaging.

Light can be monochromatic or polychromatic. Pure white light is composed of all colors of the visible spectrum. When white light is presented to the eye in the proper proportions of color components, the lens will focus a relatively clear image at the color corresponding to 0.556 microns (yellow), and there will be very little "hunting" for focal length. In polychromatic artificial light that is not white, the lens will hunt for the average focal length that gives clearest vision. Continuous hunting causes eyestrain and may, in extreme cases, be injurious. However, polychromatic artificial light must be used if colored objects are to be seen as they appear in daylight.

Another color problem frequently confronting the illuminating engineer is the blending of artificial light with daylight. The incandescent tungsten lamp, perhaps the best artificial light source from a vision standpoint, does not contain the same proportions of colors as daylight, and attempts to blend them sometimes result in light which causes eyestrain. The most successful blending may be obtained by using some such arrangements as venetian blinds whose louvers reflect the direct rays of sun or bright daylight to the ceiling and walls. The light will be reduced by the reflection factors of the blinds and the walls, but the remaining light will have better color composition for blending with incandescent light. While this is not always economically justified, it might be argued that productivity under the better light will be greater; and that the money saved in an unsuccessful attempt to blend daylight and incandescent light might result in poor eyesight which no saving could justify.

It is of interest to note that accidents in shops frequently occur in the twilight hours and more often than during the rest of the working day or night. Most of these accidents are minor, such as finger injuries. Amputations are not infrequent, however.

The difficulty in blending artificial light with twilight lies in the physiological functioning of the eye itself. The twilight together with the artificial illumination is of a sufficiently high level to contract the iris and bury the rods deep in the retina. At the same time the combination is not sufficiently intense to result in good visual acuity with pure cone vision, a condition prevailing only under good artificial illumination alone. This theory is confirmed by the fact that if the shades be drawn, the iris will open, the rods will extend, and better visual acuity will result if the illumination derived from the artificial source is adequate. When twilight is insufficient for the visual task, a good artificial illuminating system should be used and no attempt should be made to blend it with the waning daylight.

Glare

This factor is so important that it should be printed in cardinal red, bold-face type on every page of every book or pamphlet dealing with lighting and illumination.

Glare is stray light which reduces visual acuity. Direct glare is stray light in "the direct line of vision," which means that it falls on the fovea. This is most serious because it produces direct interference with the light from the point of major interest and causes the rods to withdraw and the iris to contract to such an extent that the rest of the field of vision becomes dark in comparison. If direct glare is sufficiently intense, it may cause a sensation of pain and if endured over a period of time, it may cause permanent damage to the fovea. Fig. 4 illustrates how direct glare has been used as an aid in protecting a defense plant at night against sabotage. To the saboteur, the object of major interest is some part of the factory, but because of the intense direct glare, his objective, the armed guard and the entire background seem black in comparison. Notice also the reflected direct glare from the ground at right center. Fig. 5 shows what the guard sees. Here the same luminaries of Fig. 4 illuminate bright objects against a black background providing the guard with excellent visual acuity. The saboteur has very little chance to accomplish his purpose against such odds.

Fig. 5—As the Policeman Sees the Saboteur.
—Courtesy Westinghouse

Light may be reflected from an illuminated surface and cause direct glare as was seen in Fig. 4. Perhaps the most common case of reflected direct glare is the specular reflection on a poorly illuminated printed page. Here direct glare is more intense if the surface is glossy than if it is rough. The best illumination for reading at the present time is obtained from the popular I.E.S. study lamp. It consists of a single or double filament lamp enclosed in a semi-indirect parabolic reflector and covered by a translucent shade. The two filaments of the double filament lamp can be heated separately or together, thereby giving three levels of illumination. The direct rays from this luminaire are well diffused. Most of the indirect light output is diffusely reflected from the ceiling and walls, resulting in a high level of illumination (semi-locally) with practically no glare or shadow. The direct rays reflect specularly from a glossy paper, so it is well to have the lamp in such a position that these rays do not fall within the field of vision.

It might be mentioned as a matter of interest that snow-blindness is the result of prolonged direct glare of light reflected from white snow. A photographers' flash produces direct glare after which considerable time is necessary for visual acuity to return.

In an artificially lighted room, the objects which most frequently produce reflected direct glare are mirrors, glass-covered pictures, unshaded window glass, improperly shaded portable lighting fixtures, and spotty illumination of walls.

Indirect glare is not as serious as direct glare, although it is fully as important as the considerations of color of light, illumination level, and lighting distribution. Indirect glare is stray light which falls upon the retina outside the foveal region. Its action is to reduce visual acuity. Any light incident upon the retina has its effect in closing the iris and in reducing the amount of desirable light on the retina. A sensation of annoyance and distraction accompanies indirect glare, and the eyes will tire rapidly under these conditions.

Remedy

Direct glare may be eliminated by placing the luminaires out of the line of direct vision. Indirect glare is not so easy to eliminate. Because the eye has such a broad field of vision, any object or surface that is much brighter than its surroundings but not in the direct line of vision

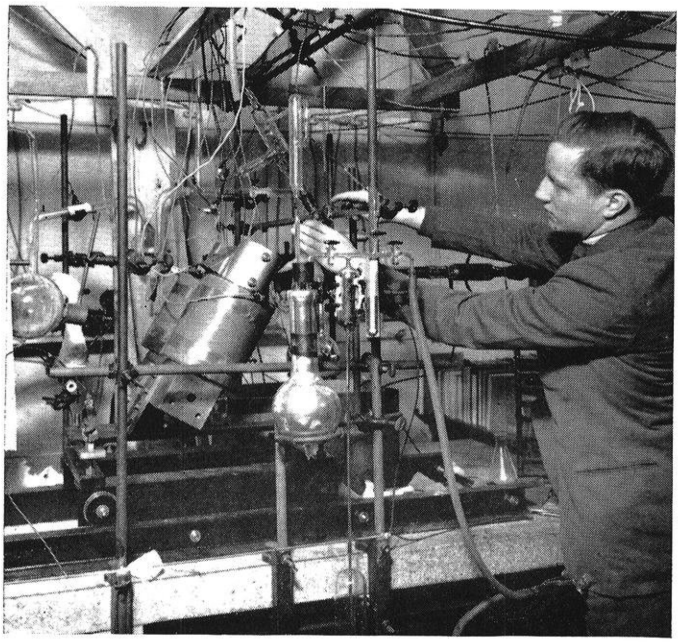
(continued on page 32)

ATOM COUNTING

by Joe Hull, e'43

ON THE ground floor of Sterling Hall among some of the denser jungles of wires, atom busters, atom twisters, and what not, there has appeared within the last several months a new atomic instrument of great engineering significance: a mass spectrometer, otherwise known as the "atom sorter." Until the last few years the mass spectrometer had been the tool of the physicist only, having been used in studying nuclear packing effect, element transmutation, and even the age of the earth. But now the fate of the atom sorter is rapidly becoming the fate of the electronic vacuum tube: engineers are commercializing it, allowing the physicist to look for something new. Already the Westinghouse Electric and Manufacturing Company is marketing a mass spectrometer which is finding its way into a number of industrial laboratories, especially in the oil industry. Chemistry and biochemistry are using it in the study of complicated chemical and biological reactions as well as in tracer work by the use of separated isotopes.

This instrument, patterned after one developed by A. O. Nier of the University of Minnesota, was built and is operated by Fred Eppling, a graduate physics student,



The Mass Spectrometer and Its Builder, Fred Eppling.

under the direction of Dr. H. B. Wahlin of the Physics Department. It is being used with the cooperation of P. W. Wilson and R. H. Burris of the Department of Agricultural Bacteriology in their study of nitrogen fixing bacteria. The construction of the instrument required great care. Successful operation requires expert servicing, the lack of which in the past has caused the failure of many similar mass spectrometer projects. The instrument at Wisconsin, however, has been operating successfully for three months; and according to Dr. Wilson and Dr. Burris it has yielded many good results.

The purpose of the mass spectrometer is to sort the particles of a substance according to their molecular weights and to find their relative concentrations. It is most frequently used to find the relative abundance of the various isotopes of an element in a substance. The sorting action of the spectrometer operates on the principle that the paths of electrically charged particles, moving with different momenta in a magnetic field, are bent into circles of different radii as given by the following equation:

$$(1) \quad r = \frac{mV}{He}$$

where r = radius of the curvature of the path
m = mass of particles
H = magnetic field strength
e = the charge of the particles

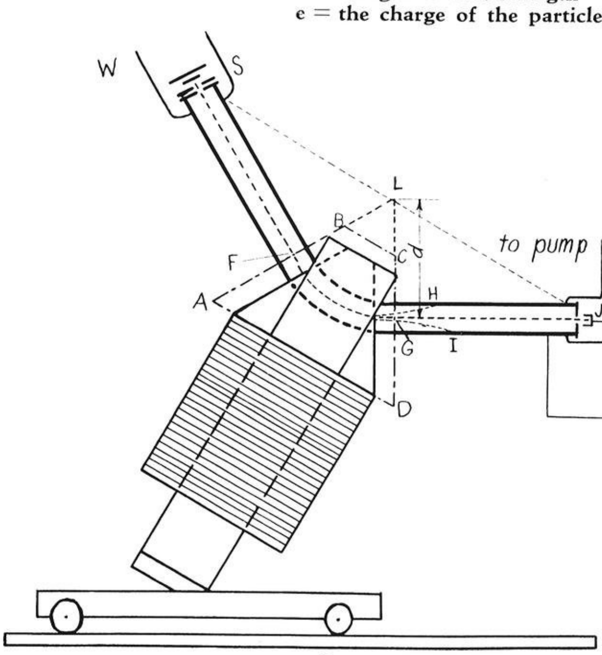


Fig. 1—Mass Analyzer.

Fig. 1 illustrates the sorting principle. Molecules of the sample to be tested are pumped into the low pressure ionizing chamber at W. At the source, S, they are electrically charged and are accelerated to a high velocity. The ionized particles then move in a straight line along the relatively field free path, SF, and enter the mass analyzer, which is nothing more than a deflecting magnetic field[1] and a receiving electrode. From F to G the ionic path is an arc of a circle of radius given by equation (1). If the radius happens to be equal to d, the particles emerge from the magnetic field at G, move along

[1]Due to the fringing flux the boundary of the magnetic field is larger than the pole face. The integrated effect of the flux on the particles has been shown to be equivalent to having a uniform magnetic field with a boundary extending approximately a pole gap width beyond the physical boundary of the poles. This equivalent field is shown by the dotted lines, ABCD.

the horizontal line, GJ, and strike the collecting cup J. The rate at which the ions strike the cup is indicated by the potential measuring device, E, and is proportional to the amount of the focused isotope in the sample. Particles having less momentum travel in the arc of a smaller circle and strike the side of the tube at H, while particles with more momentum strike the side of the tube at I.

Fig. 2 is an enlarged view of the ion source and accelerator. Elecrons are emitted from filament, F, and are accelerated to the adjacent plate by the potential of an ordinary radio B battery. About 10 per cent of these electrons pass through the slit, S, and move along the line, ST, ionizing the molecules of the gas sample. A small potential difference between the plates A and B slowly accelerates the newly formed ions toward the plate B, and a fraction of them pass through the slit, S_2. Between the plates B and C there exists a large potential difference which accelerates the ions to a high velocity. A fraction of these high velocity ions then pass through the slit, S_3, to the mass analyzer. By this arrangement all equally charged ions possess very nearly equal kinetic energies as they leave S_3, making the mass selectivity of the spectrometer very high.

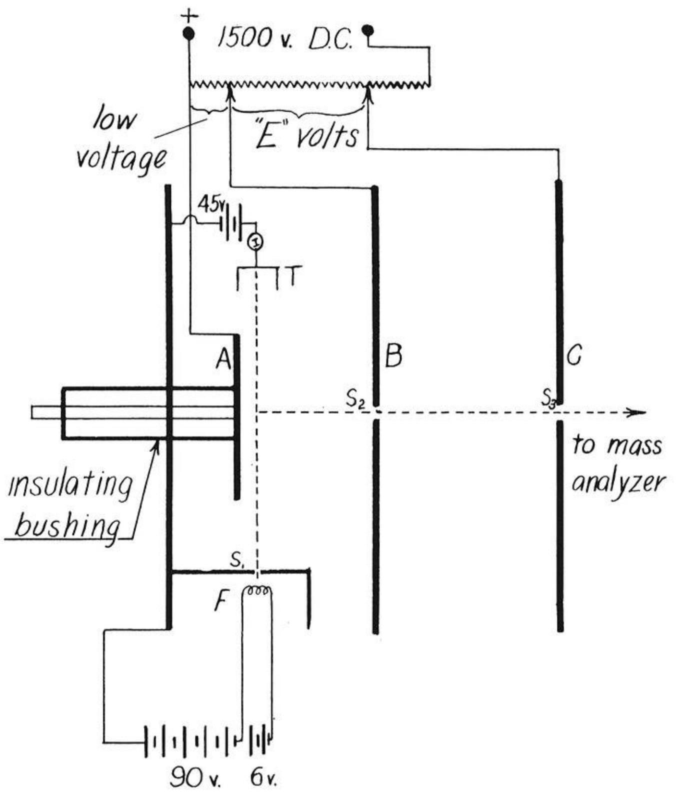


Fig. 2—Ion Source and Accelerator.

Equating the potential energy lost by an ion as it moves along the path S_2, S_3 to the kinetic energy gained:

$$Ee = \frac{1}{2} mV^2; \quad (2Eem)^{\frac{1}{2}} = mV$$

Thus at a given voltage E, if the charge of each ion is the same, the momentum of the particles, mV, is proportional to the square root of the masses. But since for a given field the mass analyzer focuses only the ions having a certain momentum, the mass of the focused particle depends only on the accelerating voltage, E.

$$(2) \quad m = \frac{(mV)^2}{2\,Ee} = \frac{K}{E}$$

The value of the proportionality constant, K, may be easily found by focusing a known ion. Hence when the voltage, E, is varied, and the potential measuring device registers a "peak," the magnitude of this peak is a measure of the relative concentration of focused ion, and the voltage, E, indicates the ionic mass.

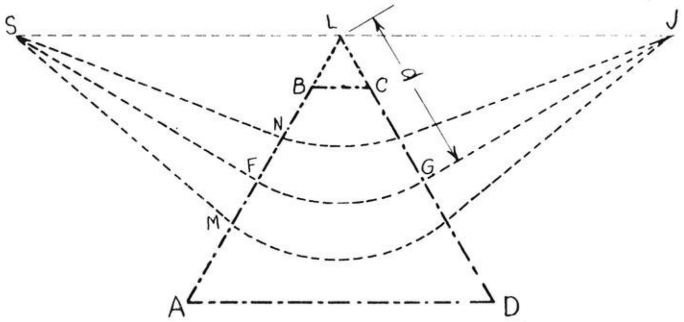


Fig. 3—Automatic Focusing Principle.

An interesting feature of this type of mass selector is its automatic focusing principle. Ordinarily an ionic stream diverges because of the mutual repulsion of the particles. This would cause flattened peaks in a mass spectrometer and consequent errors in mass measurements. But if, as in Fig. 1, the points S, L, and J lie in a straight line, the particle stream will be automatically focused on the collecting cup, as may be seen from Fig. 3. Particles entering the field at N travel through less field and are deflected less, while particles entering at M are deflected more, causing the ion stream to converge at J.

The potential measuring device, E, consists of a DC electronic vacuum tube amplifier which must have a very high current amplification because of the low ionic currents to be measured (about 10^{-15} amperes). For this purpose a special electrometer type of tube, D96475, is used, which is made by the Western Electric Company for such special applications. The sensitivity of the combined amplifier and galvanometer is about 100,000,000 mm. deflection per micro-ampere of ionic current.

Tracer work in biochemistry is one of the most interesting applications of the mass spectrometer. One problem is to find where a certain substance goes in the body of a rat after feeding. The substance, an amino acid, $C_2H_5O_2N$, is synthesized by using an isotope of one of the elements. Carbon of atomic weight 13 is frequently used because it occurs naturally in a low concentration (1.09%). The synthesized amino acid is then fed to the rat; since the isotopic carbon possesses the same chemical properties as ordinary carbon, the synthesized amino acid is normally digested. After a period of time different parts of the rat's body are examined by means of the spectrometer for the isotope. Its abundance indicates to what extent that part of the body is utilizing the acid.

In the nitrogen fixation studies of Drs. Wilson and Burris of the Agriculture Bacteriology Department, nitrogen-fixing bacteria are placed in flasks in which favorable living conditions are maintained. An atmos-

(continued on page 29)

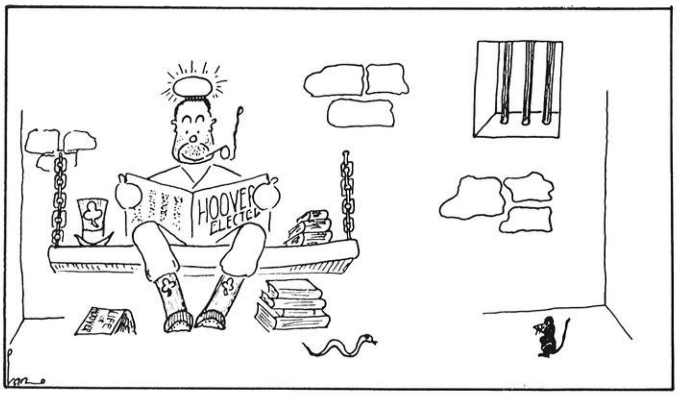
Let's look at . . .

THE MARCH MAGAZINES

by Homer K. Schneider, e'42

IF YOU were to rush into the Engineering library this very minute you would find on the magazine shelves the publications of the country's engineering colleges. The magazines are the exchanges of the Wisconsin Engineer, and they will be placed in the library every month for your use. Most of them are members of the ECMA, the Engineering College Magazines Associated; all of them are student publications.

The purpose of this page is to briefly review most of the March issues in our hands at the time of writing and to pick out for your perusal articles of general appeal. In the magazines you will find articles dealing with subjects in your own field which might be of great help in preparing papers or for class reference. It's always interesting to know the happenings of other campuses and to compare their problems and solutions with yours. Most of the other magazines have joke pages, too. Or didn't we have to say that?



You Can Aiways Find Time to Read.

Arkansas came out with the largest issue in its history—a special St. Pat job with green pages and a queen. One of the civils was also worried about bombproof structures, and the story of St. Pat at Fayetteville is included.

Cornell came out with an army-colored cover last month and an interesting article about the naval ensigns' reactions to Cornell. Twelve of the men quartered there were interviewed, one of them a former U.W. student. The ensigns, sent to Cornell to study Diesels, expressed complete satisfaction with the apparatus, facilities, and coeds. Living costs seemed unreasonable (Ithaca, N. Y.) to them and their welcome seemed not too warm at first. But after their first week most of them were pleasantly surprised to find to what extent social events and participation had been planned. Wonder how our navy men feel about Madison?

The **Iowa Engineer,** an admirable magazine under the leadership of hard-working Ed Sheridan, features "It Might Happen Here," an excellent paper on bomb destruction of cities. The illustrations of London buildings speak for themselves. Bomb shelters furnish a problem for engineers as well as for other mortals.

Kansas State put out a big, beautiful 60-page special Open House issue with a cover in full color, which undoubtedly drew the editorial envy of the other colleges including us. Several of the technical schools stage an annual "Open House," less pretentious than our exposition but with the emphasis upon hospitality rather than upon money-making. The article on plastic plywood as a substitute for airplane metals is worth looking into.

The **Marquette Engineer** is the calloused butt of countless causticisms from us, due to Editor Brendler and his "Remember when Marquette beat the pants off Wisconsin" complex. This issue does feature some rather interesting ad plates and a pretty shade of green on the cover, however. "The Atom Says Uncle" by a chem engineer is a well-written and understandable article on the cyclotron.

The **Minnesota Technolog** usually has articles of general student interest, and a decaying joke page. The two-page bit on relativity is recommended reading.

St. Pat filled several pages of the **Missouri Shamrock.** The St. Pat tradition started at Missouri in 1903 and has spread remarkably. In the "We Started It" article Wisconsin is lauded for "the admirable manner in which they have dealt with the shysters." Other article titles are "What Women Think of Engineers Or Do They?" "Knights of St. Patrick," and "Wow!" the last named being an illustrated story of photogenicity.

Montana should deserve your attention for the writeup on the "Engineers' Fun Nite," a worthy institution if we ever smelled one. Something like this would do well here to replace the deceased minstrel show. There's something spontaneous about such affairs — participation in them does not have to depend upon righteous harranguing and a heavy sense of duty.

North Dakota State has a good, meaty issue. A well illustrated article on "Flying Wings" appears. By all means take a look at "Four Years, For What?" If the author is correct, the greatest percentage of engineers listed in Who's Who comes from the bottom ten per cent of their class, as compared to the other nine deciles. He interprets this to the misdirection of the engineering curriculum rather than to the superiority of the flunking student. In lighter vein is "Date'm Thermodynamically" by one Mr. Zilch.

(continued on page 26)

SENIOR STAFF...

CARL WULFF . . .

For the past two semesters Carl Wulff has been our circulation manager. Carl is the fellow who built up the alumni subscriptions in a large scale fashion, and the results of his campaign were well worth while.

Carl Wulff

He comes from New Holstein, which is a small, very small, town in Wisconsin. It's near Kiel, he says, and that immediately helps us to locate it.

Carl has been active in a great number of extra-curriculars here on the campus. In his first years he took part in the service projects which were sponsored by Alpha Phi Omega, a scouting fraternity. Pershing Rifles took up his spare time until the CAA courses were offered. Carl completed both the primary and secondary courses.

As an upperclassman Carl is a member of almost all the honoraries—Pi Tau Sigma, Tau Beta Pi, Phi Kappa Phi, to name a few. He also has a Wisconsin Engineer service key, which represents the summit attained.

After graduation, it's the army for Wulff. He will be sent to Fort Belevoir in Virginia for further training as an army engineer.

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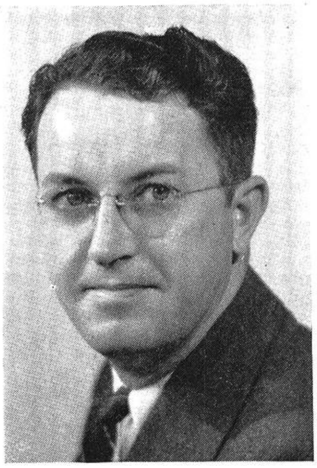
ROY McINTOSH . . .

Roy, a senior metallurgist, has been the Alumni Notes editor for the past year and a half. Due to his excellent work, the Engineer received an award last fall for the best Alumni Notes section in the E.C.M.A. which is an association composed of the leading engineering college magazines.



Roy McIntosh

Roy has been on the move most of his life, for he graduated from high school at Ludington, Michigan, and moved to Racine where he worked for several years heat treating tools. He attended Phoenix Junior College, Phoenix, Arizona, for a year before coming to Madison. During the summers he worked in the heat treating department of the Belle City Malleable Iron Foundry in Racine, and he is going back there after graduation.

He has the distinctive honor of being the only married man on the staff of the Engineer. His hobbies include photography, art forging, and collecting and polishing rock specimens. He has been president of the Wayland Eating Co-op; and was president of the Esquire Lodge when it won first place among the independent houses for the best homecoming decorations. Secretary of the Evans Professional Group and an active member of the Mining Club, he has also found time to work on freshman orientation.

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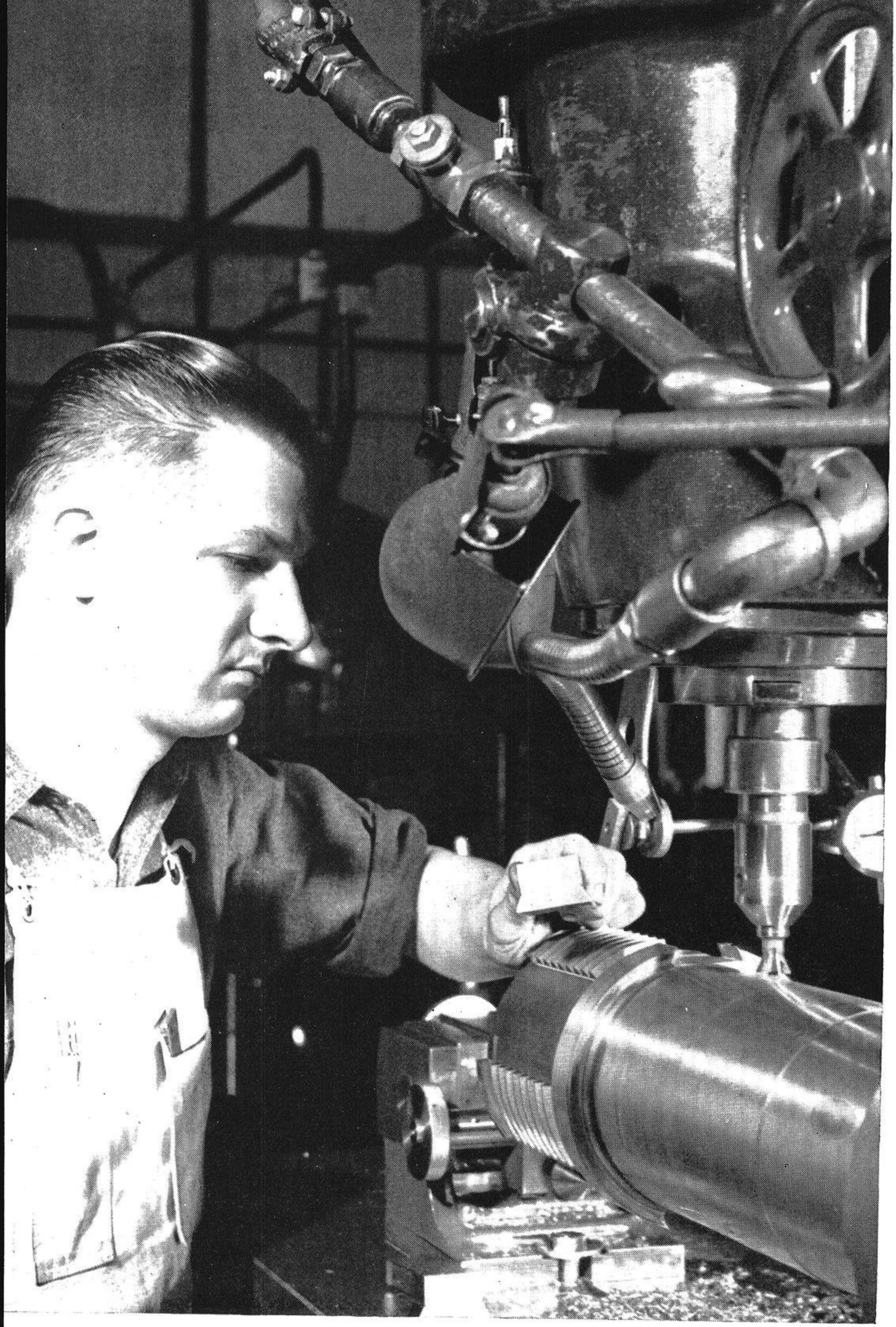
ROGER ROBBINS . . .

Roger, a senior electrical, is the humor man who has been writing our static column for the past year. He has done a good job of mixing up the king's English and of writing poetry (with the aid of Dean Johnson's secretaries). His jokes have added a touch of color to the magazine that makes it more enjoyable to read.

Roger Robbins

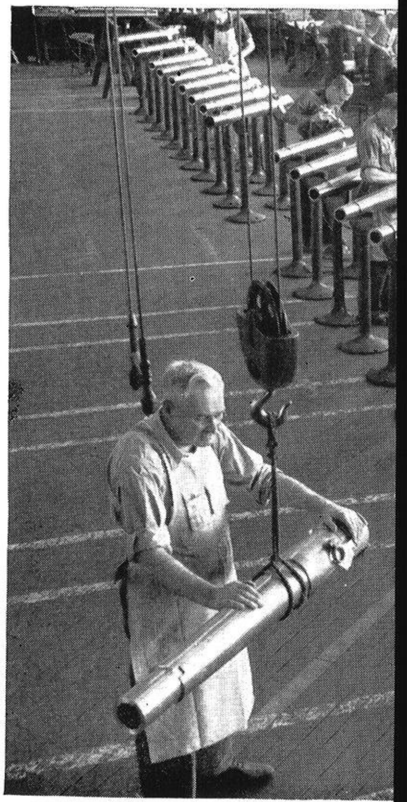
An easterner, Roger is from Belmont, Massachusetts, where he attended high school. He came to Wisconsin because he knew we had a good electrical engineering course. Last summer he worked in the general engineering department of the Commonwealth and Southern Company at Jackson, Michigan. After graduation he is going to work for Jackson & Moreland at Boston. They are one of the largest consulting firms in the country.

He has found time to participate in many outside activities and is one of the most active men on the engineering campus. Roger is president of the student chapter of the American Institute of Electrical Engineers, president of the University Religious Council, and former president of the Congregational Students' Association. At the present time he is working on the War Council. He is the only engineer on this council which represents all phases of education in the University and coordinates the student activity relative to the war. He served on the committee which drew up the War Memorial Plan; and he is now working on the details of a course on Post-War Reconstruction. A member of the Evans Professional Group and Pi Mu Epsilon, he has also found time to work at WHA and to participate in many intramural sports, of which he enjoys tennis and skiing the most.



75 M
Pack

Illustra



The 75 millimeter pack howitzer—one of our most valuable weapons because of its relatively great striking power and ease of handling. At the left is the breech end of a howitzer barrel being grooved in a special vertical milling machine. This is exemplary of the type of work being turned out by our large industrial plants.

A row of 75 m
ished under army
machines which h
locomotives before
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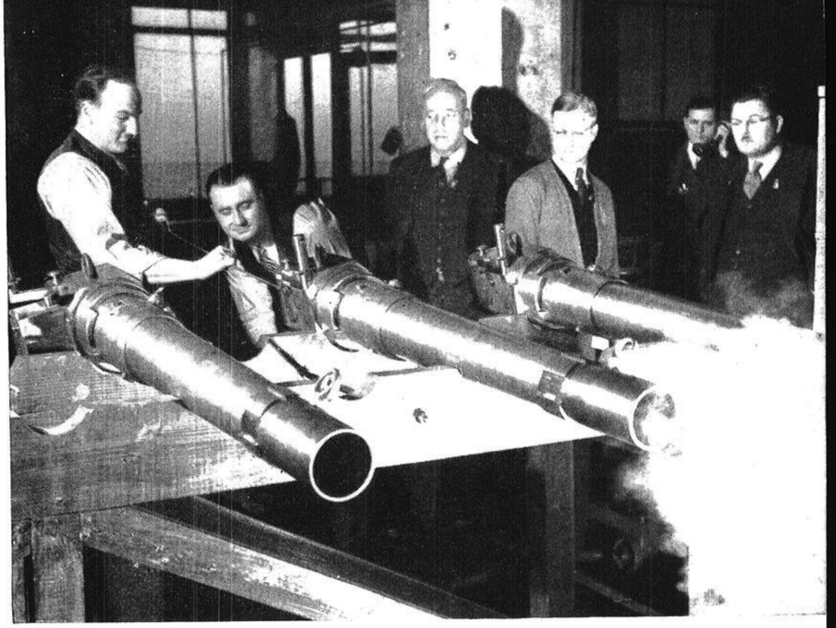
ability of parts is
assembly.

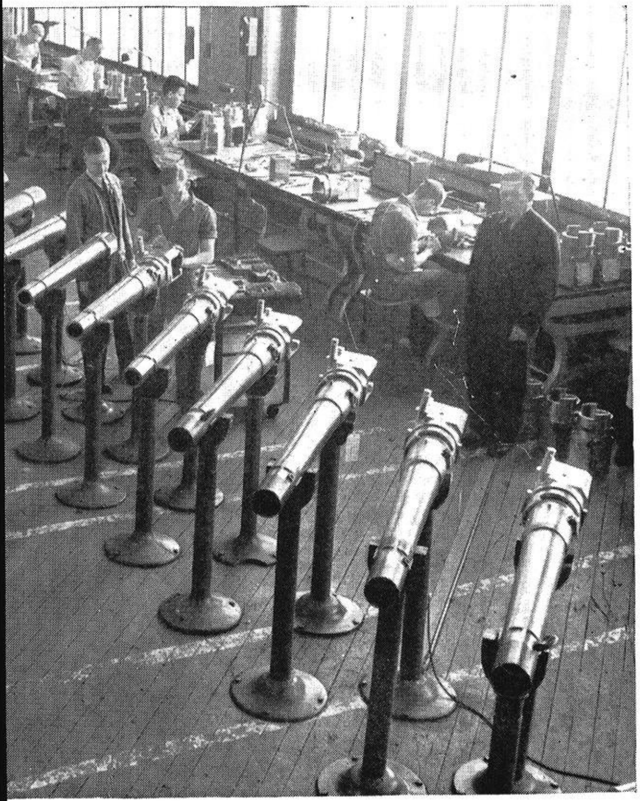
The

...Millimeter Howitzer

...ns Courtesy General Electric



After individual parts are finished by machinists and checked by army inspectors the howitzers are transferred to the assembly floor. A final check consists primarily of an inspection of the bore of the barrel by means of a "bore-scope" which reflects an image of the surface magnified 20 times. After assembly the howitzer breech machanisms are checked by actual firing. The howitzers are then ready for shipment to other manufacturers for mounting and other necessary parts.



Although airplanes and mechanized units have been adopted for ordnance transportation, the mule still is indispensable when the going gets tough. Handling is facilitated by the light weight of the howitzer. The heaviest part, the barrel, weighs only 221 pounds with the muzzle and breech hoops.

... pack howitzers being carefully hand fin... ...nspection. The guns are made largely on ...d been making motors for street cars and ... the conversion for war. Constant inspec... ... measurements and complete interchange... ...ecessary since few tools are used for field

CAMPUS NOTES

by Don Niles, m'44

SUMMER SESSION

In response to the national emergency the College of Engineering at the University will remain in session throughout the summer.

The University of Wisconsin is joining with other leading colleges of engineering in accelerating the production of engineers by operating a long summer session this year to speed up the day of graduation for those students who can attend. For example, those full-fledged junior engineering students who would normally graduate in June, 1943, will by this summer session be able to graduate in February. The tuition for the three-month session will be $48.

Students now enrolled in the College of Engineering are urged to consult their advisers immediately for detailed information concerning the courses available during the summer session so that they may promptly consider with their parents the advisability of continuing their studies without a summer's interruption. Parents of young men interested in engineering who are graduating from high school this year are particularly invited to consult the Dean of the College of Engineering either by mail or by interview concerning the advisability of entering their sons in the College of Engineering in June rather than in September.

The 12-week summer session in the College of Engineer, which will start on June 8, will provide the following courses for those who attend.

For freshmen entering from high school to take chemical or mining or metallurgical engineering, the full 10 credits of chemistry required of freshmen will be offered together with the first 3 credits of engineering drawing. For all other engineering freshmen, the first 5 credits of mathematics with the full year's work in engineering drawing will be provided.

Sophomore engineers in general will be given opportunity to complete the entire year's 10 credits of physics required in the second year together with the first 4 credits of calculus.

For junior and senior engineers, the list of subjects available is:

Chemical Engineering	8	2 credits
	114	4
	115	3
	121	3
	130	3
Civil Engineering	71	3
	175 or 176	2
Drawing and Descriptive Geometry	1	3
	2	3
	3	3
Electrical Engineering	3	4
	4	4
	7	3
	8	3
	57	2
	54	2
	155	3
	43	4
Mechanical Engineering	61	4
	65	3
	66	2
	73	2
	105	2
	107	2
	108	3
	109	3
	112	3
	124	1
Mechanics	1	3
	2	2
	3	5
	4	4
	5	3
	51	2
	52	2
	53	2

Mining and Metallurgy — No courses offered.

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CIVILS' CONVENTION

The First Annual Midwestern conference of the student chapters of the American Society of Civil Engineers will be held May 1 and 2 in Hydraulics Auditorium.

Willard Warzyn is general chairman in charge of arrangements and is being assisted by the following men: registration, Richard Green; programs and tickets, Clifford Tice and Don Eklund; luncheon, Roman Berzowski; banquet, Alfred Ingersoll; dance, Melvin Ree. Elwyn King of the University of Illinois is president of the convention. About one hundred students from the following schools are expected to attend: Iowa State University, Marquette University, Michigan School of Mines, Northwestern University, University of Minnesota, Illinois Institute of Technology, University of Illinois, Purdue University, and Rose Polytechnic Institute.

The highlight of the convention will be the symposium on Aerial Bombardment Protection. Three prominent speakers will give the latest information on bomb proof construction which was presented at a recent conference in New York.

FRIDAY

9:00-10:00—Registration.

10:30-11:00—Welcoming Addresses by President C. A. Dykstra and Dean F. Ellis Johnson; Introduction of the Conference Officers.

11:00-12:00 — Speeches by prominent engineers in this area.

12:30-1:30 — Luncheon followed by a short business meeting.

2:30-4:30—Symposium on "Aerial Bombardment Protection" by Prof. R. J. Roark, Mechanics Department; Mr. John Messmer, Construction Superintendent of Milwaukee County; Mr. Robert A. Keown, State Industrial Commission.

6:30—Banquet at the Union with Alfred Ingersoll Master of Ceremonies; Pat Norris, Dinner Speaker.

9:00—Dance.

SATURDAY

9:30-11:00—Movies on Aluminum Manufacture and Fabrication; Slides and Movies by the Western Electric Company on the History and Development of the Telephone; Movies on New Developments in Structural Welded Design by the Lincoln Electric Company.

11:00-12:00 — Inspection of the senior civil engineers' theses at the Hydraulic Laboratory.

12:30—Informal Luncheon.

(continued on page 30)


Lasher wins War on Weather!
For years, telephone cable has been hung by stiff wire rings from its supporting strand. But repeated expansion and contraction caused by temperature changes sometimes proved too much for even the best cable sheath. Fatigue cracks developed near the poles—this meant leaks—possible service interruptions—expensive repairs.
Recently, men of the Bell System developed a machine that lashes the cable and strand together in such a way that the concentration of strains near the poles is minimized. The Cable Lasher has also proved a great aid in the speedy installation of some of the new cables needed for airfields, camps, bases and war factories.
There are many opportunities in the Bell System for men with the urge—and the ability—to do a job better than it has ever been done before.
AMERICAN TELEPHONE & TELEGRAPH CO.
BELL SYSTEM
AND ASSOCIATED COMPANIES

WHAT'S YOUR E.Q.?

This quiz is scientifically designed to determine your E.Q. (Engineering Quotient). Your E.Q. is the sum of the points indicated under each question you answer correctly. If you get a perfect score of 150, you've seen the questions before and are automatically disqualified. Knowing your E.Q., you can calculate your probability of success (Ps) from equation (A), and your final average from equation (B).

Equation A: Ps=(E.Q.)(D)
where Ps is the probability of success
(E.Q.) is your Engineering Quotient
D is your draft number
Equation B: G=K/(E.Q.)
where G is your final average
K is an empirical constant depending upon your ability to guess answers and look over your shoulder while plagued with a hangover. It varies with individuals.

1. Hydraulics.

The hot water tap will fill a certain bathtub in four minutes, the cold water tap will fill it in six minutes, and the drain will empty it in eight minutes. An absent minded professor turns both taps on full, leaving the drain open, and then goes off to read a scholarly treatise on "The Psychometric Effects of Parabolic Concentrations of Cold." How long does it take for the tub to run over?

14 points

2. Sociology.

In preparation for a small stag, Joe goes to Lohmaier's for four gallons of Bock beer. Fred has plenty of beer, but only two kegs; one a five gallon and the other a three. Joe brought no container, and turns to leave, but Fred insists he can accurately measure out four gallons in the five gallon container. Can he? If so, how?

16 points

3. Chronology.

Cathie is twice as old as Jane was when Cathie was as old as Jane is. Cathie is twenty-three. How old is Jane?

10 points

4. Thermodynamics.

If an isothermal process is one in which there is no exchange of heat, what is the cosine of 30 degrees?

If an isothermal process takes place with no change in temperature, what is the distance from the earth to the sun?

10 points

5. History.

If Edison invented the air brake, what is the product of the Solvay process? If Edison did not invent the air brake, what is the formula for the area of an ellipse?

18 points

6. Ceramics.

If a tile weighs nine pounds and a half a tile, what is the weight of a tile and a half?

8 points

7. Electronics.

In tuning your radio you adjust:
(a) A voice coil
(b) A variable condenser
(c) An audio transformer
(d) An electrolytic capacitor

6 points

8. Finance.

Decode the following addition, using only one number for any one letter, and only one letter for any one number. The arithmetic sum of the numerical code for SEND and MORE must equal MONEY.

```
   S E N D
   M O R E
 ---------
 M O N E Y
```

18 points

9. Geography.

Yale University is in:
(a) Connecticut
(b) Massachusetts
(c) New Jersey
(d) Vermont

8 points

10. Mechanics.

At a fair one time there was a professional weight guesser in a booth. He was approached by three merry couples who were there to see the sights and have fun. The weight guesser discovered that the three girls' combined weight was three hundred and ninety-six pounds. Dixie weighed ten pounds more than Harriet, and Harriett weighed ten pounds more than June. Now, regarding escorts, Mort weighed the same as his girl, Elmer weighed half again as much as his girl, and Ike weighed twice as much as his girl. The whole bunch weighed a half short ton. Who's who and with whom?

20 points

11. Engineering

A railroad train had a crew of three, and three passengers, traveling between Chicago and New York. The train crew is made up of an engineer, fireman, and a guard. Their names are Smith, Jones, and Robinson, but not necessarily in that order. The passengers are Smith, Jones, and Robinson, but will be referred to as Mr. Smith, Mr. Jones, and Mr. Robinson.

Mr. Robinson lives in New York. Mr. Jones' annual salary is $5,000. The guard lives halfway between New York and Chicago, and his namesake among the passengers lives in Chicago. The guard's closest neighbor is one of the passengers, and this passenger's annual salary is exactly three times that of the guard.

Smith beat the fireman at billiards.

The problem is: What is the name of the engineer?

22 points

(ANSWERS on page 26)

ALUMNI NOTES

by Arne V. Larson, m'43

The Milwaukee Chapter of The American Society for Metals has organized a War Products Advisory Committee which aims to expediate the solution of metals problems in War Supply Production.

The Wisconsin alumni on this committee are:

JOHN J. CHYLE, ch'24, who is the Director of Welding Research at the A. O. Smith Corp. in Milwaukee.

WALTER W. EDENS, MS (met) '37, who is the Chief Metallurgist at Ampco Metal, Inc., in Milwaukee.

M. A. SCHEIL, ch'27, MS (met) '29, who is the Director of Metallurgical Research at the A. O. Smith Corp. in Milwaukee.

E. J. WELLAUER, MS (met) '38, who is Director of all Metallurgical and Mechanical Research conducted by the Falk Corp. of Milwaukee.

DAVID C. ZUEGE, ch'20, MS (met) '29, who is Technical Director of the Sivyer Steel Casting Co. of Milwaukee and Chicago.

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Chemicals

NEIPERT, MARSHALL, '39, formerly plant chemist in the chlorine plant of Brown Co., Berlin, N. H., is now with the Dow Chemical Co., Midland, Mich., doing the same type of work.

BARGANZ, ARNOLD E., '41, is with the Mississippi State Board of Health, Jackson, Miss.

GOODMANN, ROBERT P., '41, formerly with the Mosinee Paper Co., Mosinee, Wis., is now an ensign in the U. S. Navy. He is resident inspector of naval material at St. Louis, Mo.

HANSTEDT, LAVERNE, '41, who was with the General Chemical Co. in New York, N. Y., is now a lieutenant in the U. S. Army and is with Co. C, 9th Battalion at Fort Belvoir, Virginia.

HARE, JAMES H., '41, when last heard from was a lieutenant in the U. S. Army at Fort Wm. McKinley, Manila, P. I.

HIGLEY, KENNETH E., '41, formerly with the Dugas Engineering Corp. of Chicago, Ill., is now an ensign in the U. S. Navy at Fort Schuyler, New York.

REICHENBERG, HAROLD, '41, is a lieutenant in the Air Corps at Hamilton Field, California.

Mechanicals

RADTKE, EDWARD, '39, who was with the Kimberly Clark Co. of Neenah, is now in Hartford, Conn., with Hamilton Standard Propellors.

UECKER, NORMAN, '39, formerly with the Northwest Engineering Co. of Green Bay, is now in Hawaii with the Sperry Gyroscope Co.

PIKE, KENNETH R., '40, is now with the Wright Aeronautic Co. of Patterson, N. J. He was with Allis Chalmers of West Allis, Wis.

GRUBER, JEROME M., '41, who was taking the student training course of the General Electric Co., Schenectady, N. Y., is now with the U. S. Army.

HILGERT, ADOLPH J., '41, is doing research in air-conditioning controls for the Johnson Service Co. in Milwaukee, Wis.

KUETEMEYER, GEORGE, '41, married Mary Ann Druml of Milwaukee, Wis. He has been transferred from the Neenah plant of Kimberly Clark Corp. to their plant at Niagara Falls, and is working in the maintenance department under Ralph E. Grobe, who received his degree in mechanical engineering here at Wisconsin in 1933.

PERKINS, ORIGEN S., '41, formerly with the Oil Gear Co., Milwaukee, Wis., is now an ensign at the Naval Ordnance Plant in Louisville, Ky.

ROBERTS, FRANK B., '41, has been transferred from the Dye Works at Deepwater, N. J., to Newark, N. J., where the duPont Co. is carrying on a development project.

SOMMER, WARREN L., '42 (Feb.), married Vivian Anderson of Madison, Saturday, March 21, 1942. He is an instructor in the U. S. Army at Fort Belvoir, Virginia.

Civils

VERNON, J. R., '18, of the Johnson Service Co., spoke on temperature control for defense industries to members and guests of the American Society of Heating and Ventilating Engineers at the Dodge Hotel in Washington, D. C.

NEEL, MERVILLE C., '20, structural engineer with the Wisconsin Industrial Commission for the past ten years, has been appointed chief engineer for the Rilco Products Company of St. Paul, makers of laminated timber products.

TUTTLE, HAROLD S., '25, has been appointed city engineer for Eagle River, Wis. He was highway commissioner for Vilas County for a number of years.

COUCH, EDMUND, '34, who has been with the Soil Conservation Service at Lancaster, Wis., for several years, has been appointed water waste inspector by the Office of Quartermaster General. He reported for duty early in March at the New York office at 120 Wall St.

OLSTAD, ORVILLE A., '35, who has been with the Air Corps of the U. S. Naval Reserve since his graduation, left for foreign service late in February.

NORRIS, SPAULDING A., '37, is with the Chicago Pump Co., in the contract engineering department.

BJELAJAC, VASO, '38, has been appointed a sanitary engineer in the Office of the Quartermaster General. He is at Key West, Fla., assisting in the design of sewer and water supply systems for the army.

POST, ARTHUR L., '39, who was "caught in the draft" a year ago, was graduated from the Air Corps Training Center at Brooks Field, Texas, on March 7 as a lieutenant in the army air corps.

MIELKE, JOHN H., '40, is reported to be with the city engineer at Waukesha.

FINTAK, GERALD G., '41, was married on March 21 to Dorothy Binder of Oshkosh. He is stationed at Atlanta, Ga., as water waste inspector with the Office of Quartermaster General.

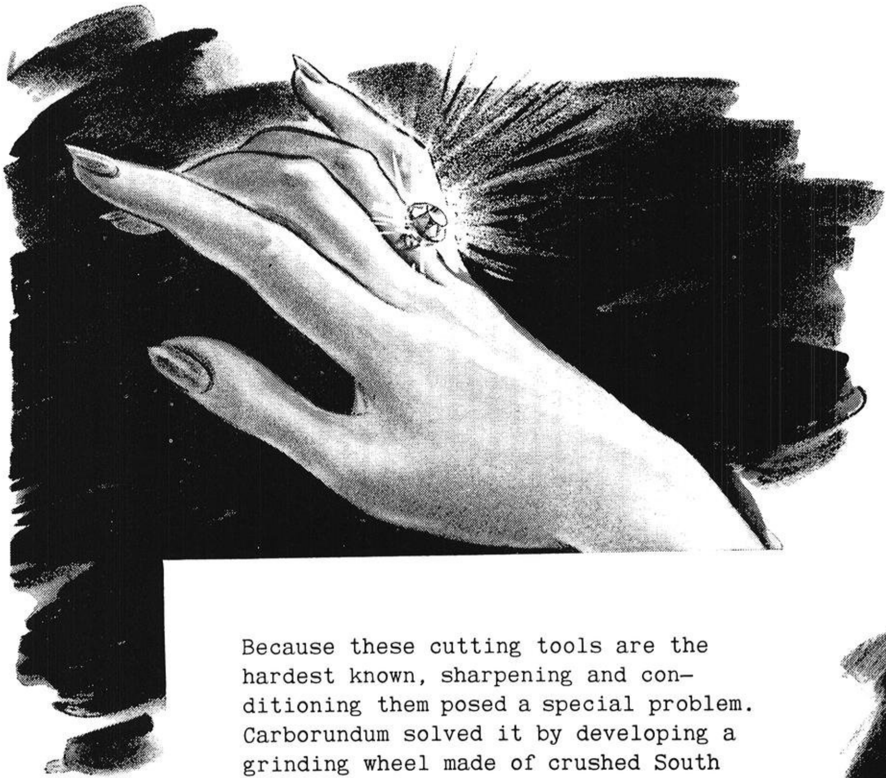
REED, RICHARD L., ex'41, is a 2nd lieutenant with the 41st Engineers at Fort Bragg, North Carolina.

JOHNSON, EARL A., '41, began work on February 26 as rodman for the Chicago & Northwestern Railway at the Sioux City, Ia., office.

MILAEGER, RALPH E., '42, is water waste inspector, Office of Quartermaster General, stationed at Boston, Mass.

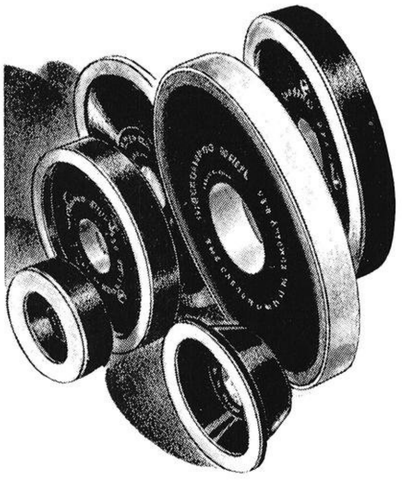
(continued on page 30)

Can you find the Weapon of War in this picture?



This is a war of machines. And one of its decisive battles is being fought in the tool rooms of America — with diamonds as weapons! For the high speed production of alloy steel parts depends on cemented carbide cutting tools. Tools so hard that only diamonds can give them the fine, true edge necessary for efficient cutting. Thus Carborundum Brand Diamond Wheels are playing a vital part in helping America re-arm.

Because these cutting tools are the hardest known, sharpening and conditioning them posed a special problem. Carborundum solved it by developing a grinding wheel made of crushed South African diamond bort. With this wheel, cemented carbide tools can be finished to a better, truer longer-lasting edge in a fraction of the time formerly required.



Development of new abrasive products to meet new needs is an old story with Carborundum. This "know how" is now speeding up thousands of defense jobs. The Carborundum Company, Niagara Falls, New York.

CARBORUNDUM
REG. U.S. BRAND PAT. OFF.
ABRASIVE PRODUCTS

Carborundum is a registered trade-mark of and indicates manufacture by The Carborundum Company.

STATIC

by Roger and "the girls"

V. Morrick — M. Bowar

We're not putting in a plug for a six-day bike race or for the American Youth Hostels. This is the first sign of spring at the College of Engineering. The blushing beauties, Mildred Bowar and Virginia Morrick, took time off from their secretarial duties at the dean's office to enjoy a little of the cool freshness of spring and to officially usher in that season when every young engineer's fancy turns to . . . you know what.

When asked to account for their delight at the advent of spring, they explained that they liked the birds, the flowers, the sailors, convertibles, moonlight and motor trips (motor boats save tires), the glints in people's eyes (no eyes in particular), and . . . just everything.

Of course, they were reminded that engineers didn't have convertibles and that they were so busy studying all the time that they couldn't indulge in motor trips and the like. Naturally they were very sad. But they soon found a partial solution to the problem, offering to carry the Spirit of Spring to every engineer through these Static pages. Their poetry is dedicated to all the shut-ins.

★ ★

My love have flew
She did me dirt;
I did not know
Her were a flirt.

To they in love
Let I forbid
Lest they be doed
Like I been did.

God made a machine, the machine made men—
Doctors, lawyers, priests, and then
The devil got in and stripped its gears,
And turned out the first batch of ENGINEERS.

★ ★

He took her in his arms
And pressed her to his breast;
The lovely color left her face
And lodged on his full dress.

★ ★

ODE TO MY SLIDE RULE

Women are babbling all the time,
Of dates, and drinks, and dresses,
Which wouldn't help at all when I'm
Computing strains and stresses.
My slip-stick conquers without a doubt
Whole hosts of sines and surds,
And helps me work in peace without
An avalanche of words.

Slide-rules are always accurate,
Women never so;
And though they're not affectionate
They never answer "No!"
So hence with women's wanton ways,
With eyebrows, lips and curls,
My little log-log polyphase
Is worth a dozen girls.

★ ★

Archibald Reginald Percival Earl
Decided one night to call on his girl;
Together they talked of their kith and their kin.
He said, "May I kith you?" She said, "You kin!"

★ ★

I loved my little flower garden
But now that love is dead,
I found a bachelor button
In my black-eyed susan's bed.

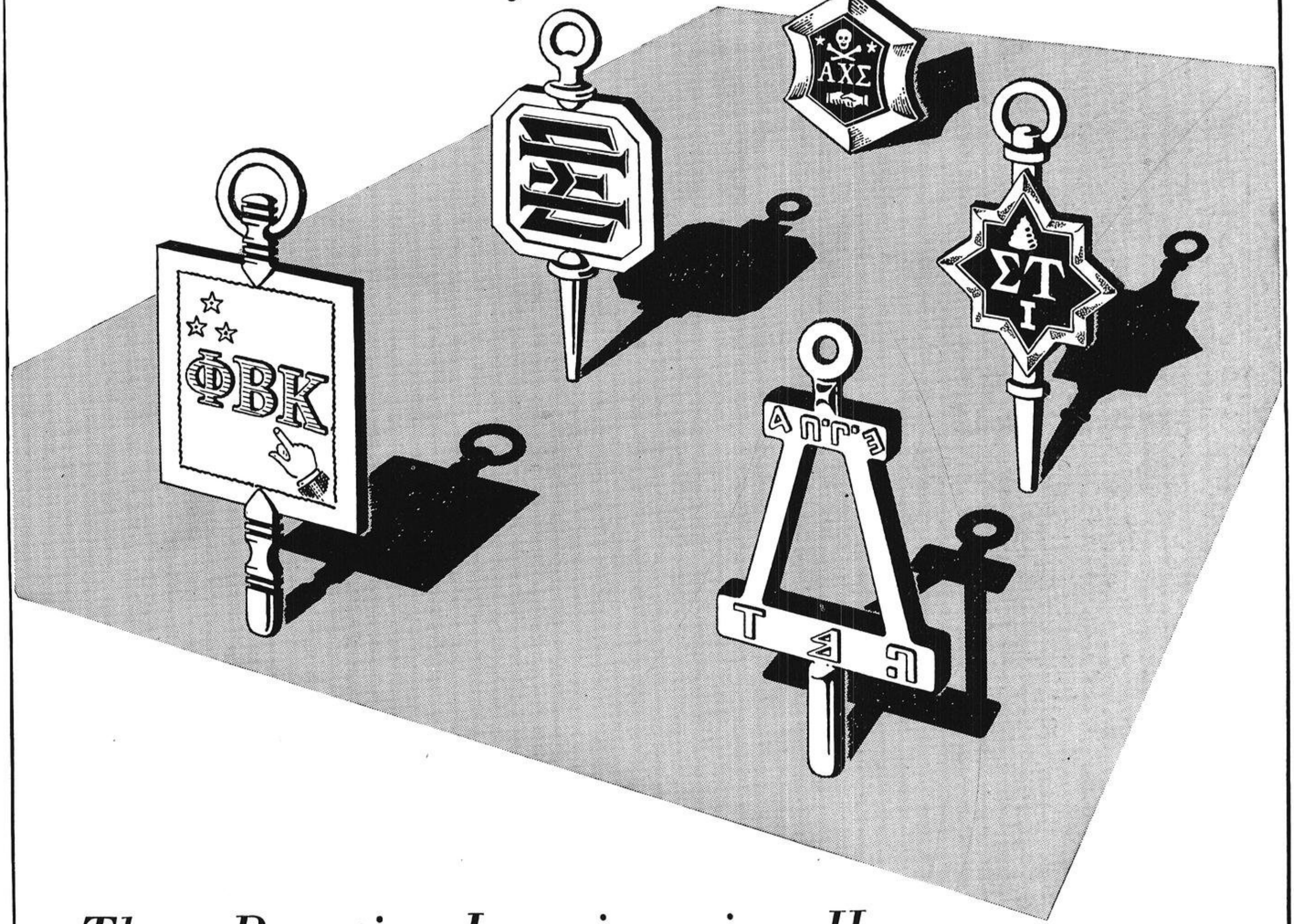
★ ★

Mary had a little lamb;
Her father shot it dead,
And now it goes to school with her
Between two hunks of bread.

★ ★

Grandpaw in a speedy car
Pushed the throttle down too far;
Twinkle, twinkle, little star,
Music by the G. A. R.

Whatever the Key...



They Practice Imagineering Here

We've been counting noses here at Alcoa, and we were amazed to discover the variety of Keys dangling from watch chains around here.

Keys don't make the man. We mention them only as a handy way of getting at the interesting fact that it takes all kinds of men and *of knowledge* to make an organization, such as Alcoa, tick.

The striking thing is, how soon most of our men shed their specific labels after they come with us only to discover how much more *exciting* it is to practice Imagineering.

There aren't any grooves to Imagineering. There aren't any limits, either. A man lets his imagination soar and then engineers it down to earth. When he comes down he is just as liable to find himself in a new department, with new responsibilities, and a new set of conditions on which to practice his Imagineering.

It is this kind of thing going on continuously for fifty years that has made Alcoa a useful business and an exciting organization in which to be.

It is what the future of Aluminum is made of.

ONE PAGE FROM THE AUTOBIOGRAPHY OF

ALCOA ALUMINUM

ALCOA ALUMINUM Reg. U.S. Pat. Off.

• **This message is printed by Aluminum Company of America to help people to understand *what we do* and *what sort of men* make aluminum grow in usefulness.**

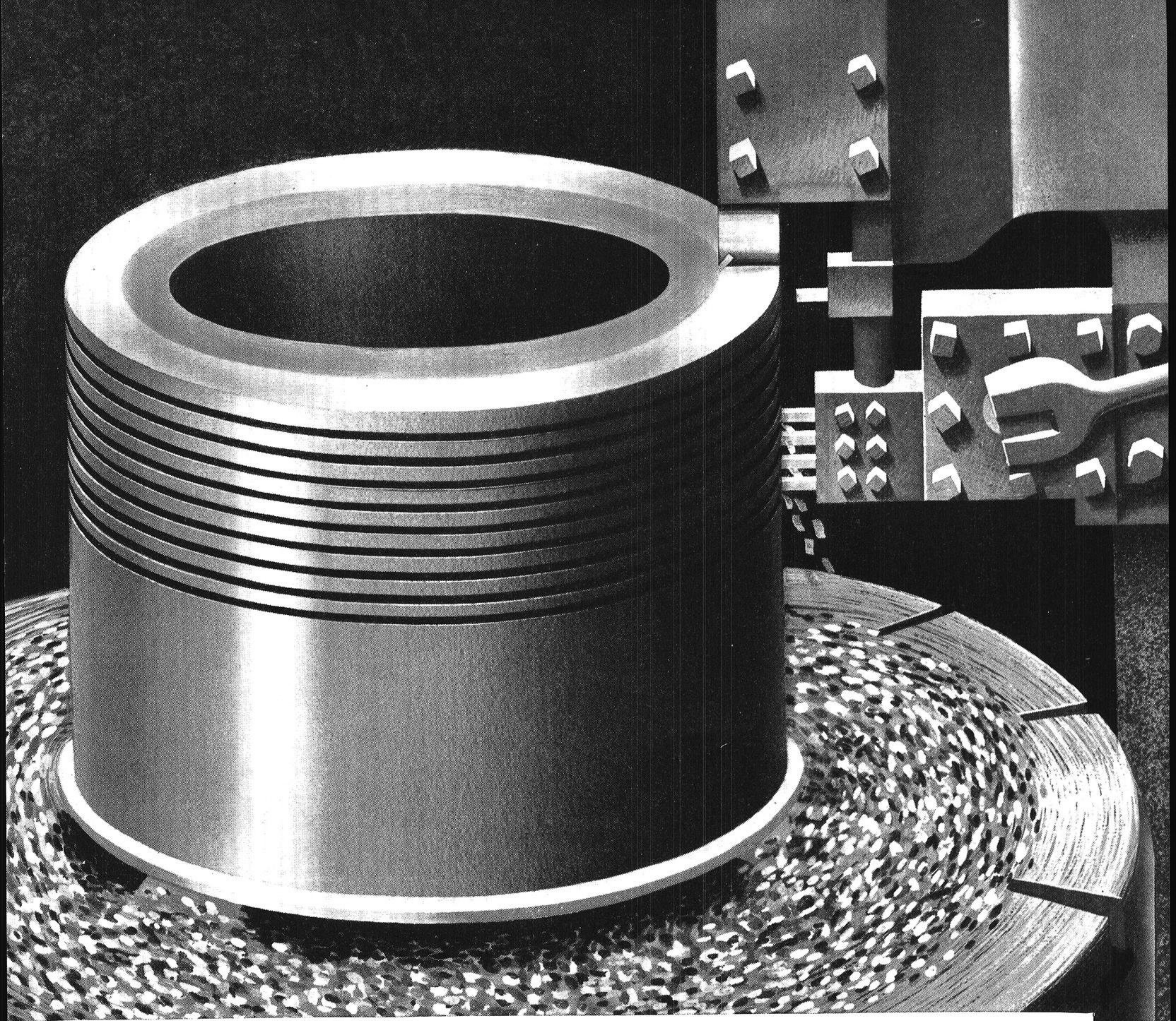
March Magazines . . . (continued from page 14)

We are especially happy to greet the **Northwestern Engineer,** the March issue being the first of the new Northwestern Technological Institute.

So there you are. Remember, these magazines are all available in the library, waiting to be worn out. And if we seemed a bit frivolous in reviewing the lighter side almost exclusively, rest assured that it is just our dark and subtle method to snare you into reading the moral treatises.

ANSWERS TO E.Q. (from page 20)

1. 3 3/7 minutes.
2. Yes. Fill the three-gallon jug and empty it into the "five." Refill the "three" and from it fill the "five" full. One gallon now remains in the "three." Empty the "five" back into the tank, pour the one gallon left in the "three" into the "five." Fill the "three" from the tank and again empty it into the "five."
3. 17¼ years.
4. 93 million miles.
5. The product of the semi-axes times pi.
6. 27 pounds.
7. A variable condenser.
8. 9567
1085
——
10652
9. Connecticut.
10. When walking, one foot is always on the ground.
11. June (122 lbs.) is with Mort (122 lbs.).
Harriet (132 lbs.) is with Elmer (198 lbs.).
Dixie (142 lbs.) is with Ike (284 lbs.). Wow!
12. Smith. Mr. Jones is not the guard's nearest neighbor, because the guard's salary cannot be EXACTLY one-third of $5,000. Does that help?



HOW TO SEE RED... AND LIKE IT!

Friction ... arch enemy of *speed* in the machining of iron and steel ... meets its match in cutting tools made of Haynes Stellite non-ferrous alloys. For these alloys ... of cobalt, chromium, and tungsten ... have the amazing property of "red hardness." Unlike cutting tools made of ordinary metals, they *keep their edge* ... and keep on cutting ... even when friction heats them *red hot*.

Making possible tougher, longer-lasting cutting tools is only one of the vital roles played by Haynes Stellite materials. Because they stand up under heat, abrasion, and corrosion, they are used to hard-face many different kinds of metal parts.

Oil well drilling bits ... steam shovel bucket lips ... heavy gears ... shafts ... airplane and truck exhaust valve seats ... crusher blades ... mixers ... plowshares ... and other pieces of equipment that must withstand steady punishment have their lives lengthened ... and their efficiency stepped up ... with welded-on hard-facings of Haynes Stellite alloys.

Use of Haynes Stellite alloys speeds up production ... lowers production costs ... saves on tool and part replacements ... reduces time lost while replacements are being made. In the fabrication of new parts, base metals can be selected for such valuable properties as strength and ductility—without particular regard for wear-resistance—because they can then be armored against abrasion, heat, and corrosion by hard-facing with Haynes Stellite alloys.

Further savings can be made by the use of these alloys because worn parts can be *renewed*, instead of being sent to the scrap pile ... thus eliminating replacement with materials hard to obtain.

Faster production ... conservation of metals ... lower costs ... these are the contributions made to industry by Haynes Stellite alloys.

• • •

The development of Haynes Stellite Company alloys and hard-facing practice has been furthered by the metallurgical knowledge of Electro Metallurgical Company, by the research facilities of Union Carbide and Carbon Research Laboratories, Inc., and by the service organization of The Linde Air Products Company—which companies also are Units of Union Carbide and Carbon Corporation.

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

KOKOMO, INDIANA — UCC — NEW YORK, N. Y.

ATOM COUNTING . . .

(continued from page 13)

phere containing nitrogen of atomic weight 15 is confined over the bacteria; and a nitrogenous compound containing ordinary nitrogen is placed in the flask. After a time the bacteria cells are examined for the abundance of the isotopic nitrogen, and from the ratio of this to ordinary nitrogen the amount of fixed nitrogen can be computed.

In many complicated chemical reactions intermediate processes are undergone and intermediate products are formed which cannot easily be analyzed by ordinary chemical means, but may be studied by means of the mass spectrometer. The reacting compounds are enclosed in a vessel with an opening through which gaseous reaction products may be periodically drawn off and examined in the atom sorter. Knowing the weights of the different particles and their relative concentrations, the nature and composition of the various intermediate products may be deduced.

Probably the most important commercial use of the atom sorter at the present time is in the analysis of complex mixtures by the isotopic dilution method. For example, to find the amount of toluene in crude oil, synthetic toluene is first made using a "tagged" element, usually carbon 13. A known amount of this toluene is thoroughly mixed with a definite amount of crude oil. A small sample of toluene is then isolated from the oil, and from the ratio of isotopic to ordinary carbon the original amount of toluene in the crude oil may be determined.

A. O. Nier has made an interesting mass spectroscopic study of the age of radioactive bearing minerals. His investigations were based on the fact that the ultimate disintegration product of radioactive substances is lead. Knowing the amount of lead present in the mineral, the ratio of the disintegrated lead isotopes (uranium lead RaG and Thorium lead ThD), the amounts of uranium and thorium, and their decay constants, the approximate age of the mineral can be computed, provided the amount of common lead impurity is known. Since the atomic weight of the common lead impurity is 207.2, while the mass of uranium lead is 206 and that of thorium lead is 208, the amount of contamination may be determined from a mass spectroscopic analysis of the mineral. Nier's results[2] are in good agreement with those previously calculated from the Pb÷U ratio. In the earlier work the contamination was computed from the atomic weight of the lead, and some empirical relationships were used.

Up to the present time the greatest hindrance to the commercialization of the mass spectrometer has been the prohibitive first cost (about $6,000) and the necessary expert servicing. However, the manufacturing companies are constantly improving it, and, like the electronic oscilloscope, a serviceable mass spectrometer may soon be available at a reasonable cost. Judging from the rapid advances of spectroscopy in the past few years it probably will become a valuable tool to science and engineering.

[2] For a detailed account of his work, see: A. O. Nier, "The Isotopic Constitution of Radiogenic Leads, and the Measurement of Geological Time," II, Phys. Rev., Jan. 15, 1939.

CAMPUS NOTES...

(continued from page 18)

ST. PAT'S BALL

Reigning over one of Polygon's most successful dances, Bill Arvold was proclaimed St. Pat at the annual engineers' ball in honor of their patron saint on the night of March 28 in Great Hall of the Memorial Union. Arvold, the chemical engineers' candidate, won this honor after a two-week "all out" campaign of ticket and button selling. He chose as his knights, four of the staunchest supporters in his drive, Carl Rowe, Ken Schultz, Bill Gehrke, and Les Massey. In addition to witnessing the investiture of these notables, the crowd of 380 couples danced to the music of Jack Rael and his campus band.

Commenting on the size of the crowd and its smooth behavior, Henry Schmalz, president of Polygon Board, remarked that the engineers had really outdone their former selves. He attributed the large attendance to the fact that the candidates and all others devoted their entire energies to the selling of tickets, since there was no exposition this year.

•

FROSH DRAWING CONTEST

As has been the custom in past years, the Wisconsin Alpha chapter of Pi Tau Sigma, national honorary mechanical engineering fraternity, is sponsoring its annual drawing contest in conjunction with the drawing department.

Required of every student enrolled in Drawing 2, the contest calls for a pencil drawing and an ink tracing of a discharge casing for a centrifugal pump. Winners will be determined by the selection of views and the technique involved. Though prizes have not yet been decided upon, they will probably be similar to last year's awards, which included a slide-rule, a handbook, and a white-face engineer's scale in that order.

Both the drawing and the tracing were due on the 9th of April, but the final decisions are not expected for another week or two. The drawings will not only represent each man's efforts in the contest, but will serve doubly as an accepted course project.

As yet, judges have not been chosen; however, it is probable that they will be taken from the departments of Machine Design, Civil, and Electrical Engineering.

•

The mechanicals will hold a joint meeting with the Rock River professional and Marquette student branches of the A.S.M.E. on April 15. There will be a dinner banquet in the Memorial Union, at which James W. Parker, the national president, will speak.

At the March 11 meeting, Prof. James H. Walton of the chemistry department gave a talk on war gases. On May 13 Dr. Gustaf Egloff will talk on petroleum.

At the April 8 meeting, Mr. Jack Emerson spoke on the subject of fuels. For their next meeting they hope to present movies by General Motors on saving cars, tires, lives, etc., and election of officers will take place at the same meeting. Twelve members went to a meeting in Milwaukee on the night of April 3 as guests of the Milwaukee chapter.

At the March 18 meeting, Mr. David Zuege of Milwaukee spoke on the design and production of steel castings. The following officers were elected for the coming year: President, Gerald Slavney; Vice President, Harry Kalvonjian; Secretary, Harold Goldfein; Treasurer, Walter Woellering; Official Dishwasher, Jimmy Jude.

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ALUMNI NOTES . . .

(continued from page 22)

Electricals

LIETZKE, VICTOR A., '40, who was working in Pittsfield, Mass., is now with General Electric at Schenectady, N. Y.

BROEKMAN, JOHN, '41, who was with the General Electric Co., in Schenectady, N. Y., is now in the army and is in the Signal Corps at Fort Monmouth, New Jersey.

PETTERMAN, JACK L., '41, has a position in the Engineering Bureau of the Taffric Department in Detroit, Mich.

•

Mining and Metallurgy

MUELLER, J. E., MS '41, with the Falk Corp., and **A. V. SMITH**, MS '42, of American Bureau of Ships, Chicago, are joint authors of a paper to be presented at the 46th annual Convention of American Foundryman's Association, Cleveland, Ohio. The paper is entitled, "Welding of Medium Carbon Steel Castings by Metal Arc Process."

RUBOW, IRVING, '37, is General Foreman of the Hull-Rust-Sellers Mines, Oliver Iron Mining Co., Hibbing, Minn.

LIBMEN, MAX, '39, now has a position in the heat treating department of the Packard Engine Co., Detroit, Mich.

It Pays To KNOW About ZINC

In the period of America's greatest industrial development, ZINC rendered indispensable service; it is reasonable to expect that it will be utilized even more extensively in the greater developments yet to come.

ZINC has now gone to war, as an essential element in every form of fighting equipment, on land and sea, and in the air. In times of peace, it is used in an almost infinite variety of applications, from the tiny elements of zipper closures to protective coatings for the hulls of the largest ocean-going ships. You can't get away from it—ZINC comes into intimate touch with the life of every individual.

The Zinc industry itself is earnestly and wholeheartedly striving to do a worthy job in supporting the nation's war program. It is also anticipating and preparing for the day when Victory is won, when new problems must be solved.

Are You, Too, Looking To The Future?

Will you be prepared with the knowledge you must have to solve the problems of the future?

ZINC is a material that it pays to KNOW about. You can get some interesting and very valuable data from these booklets, which will be sent to you free:

"The Zinc Industry"
"More Facts About Zinc"
Better write for them now.

AMERICAN ZINC INSTITUTE

Incorporated

60 East 42nd Street **New York, N. Y.**

SIGHT AND LIGHT . . .

(continued from page 11)

will produce indirect glare. Every illumination problem will have its own peculiar sources of indirect glare, and it is therefore impossible to establish a simple formula for its elimination. In some cases it cannot be entirely eliminated because of the size and shape of the room.

Indirect lighting is the ideal solution for removing both direct and indirect glare. The ceiling is out of the line of direct vision and can therefore be very bright in contrast to the rest of the room. It can be decorated with a very light color with a high coefficient of reflection, but for best results a rough matte finish will produce a highly diffused light with least glare. The walls should be well illuminated diffusing reflectors of a color somewhat darker than the ceiling. For greatest comfort horizontal reflection from the walls should not exceed 10 milli-lamberts for some illumination or 20 milli-lamberts for brightly lighted rooms. A milli-lambert is approximately equal to one foot-candle.

Unfortunately, while indirect lighting is far superior to direct lighting, it is usually more expensive to install, to operate, and to maintain. Dust and insects accumulate in the reflectors which makes frequent cleaning necessary. The reflecting walls and ceiling surfaces become dark and discolored from dirt and grease, and paints are affected by the direct rays of the sun. Larger lamps are required because reflecting surfaces absorb at least 30 per cent of the light.

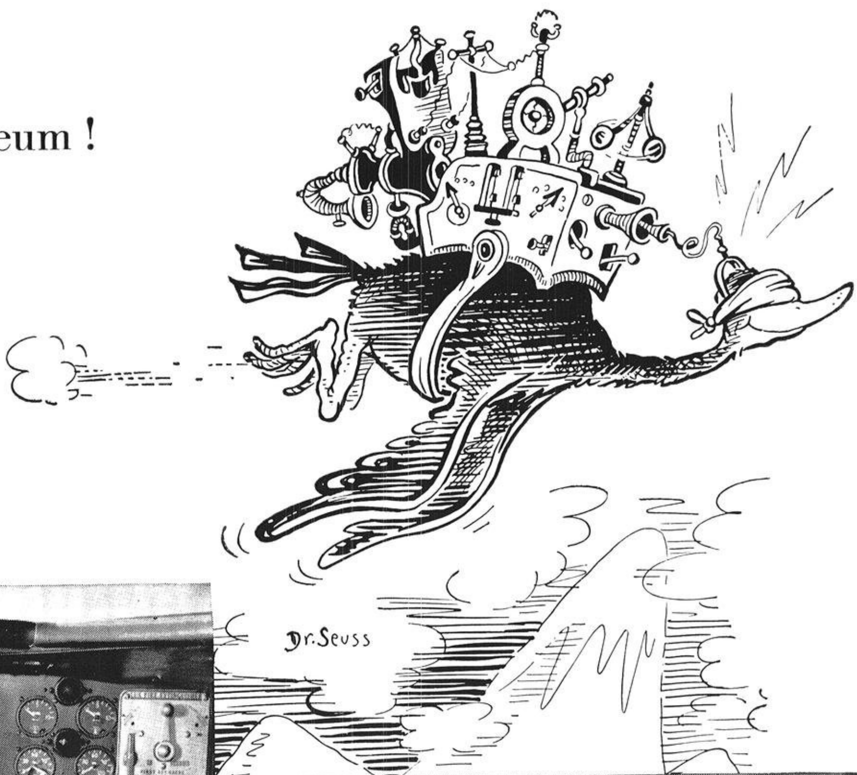
When semi-direct lighting is used, the units should be mounted as high as possible. This not only reduces glare, but also tends to increase the uniformity of the resulting illumination on the horizontal plane. Direct lighting should be used only when a high degree of visual acuity is not needed and where the units can be mounted outside the field of vision. When so mounted, their intrinsic brightness can be several hundred milli-lamberts without discomfort or glare. (Unless caused by specular reflection from other surfaces.)

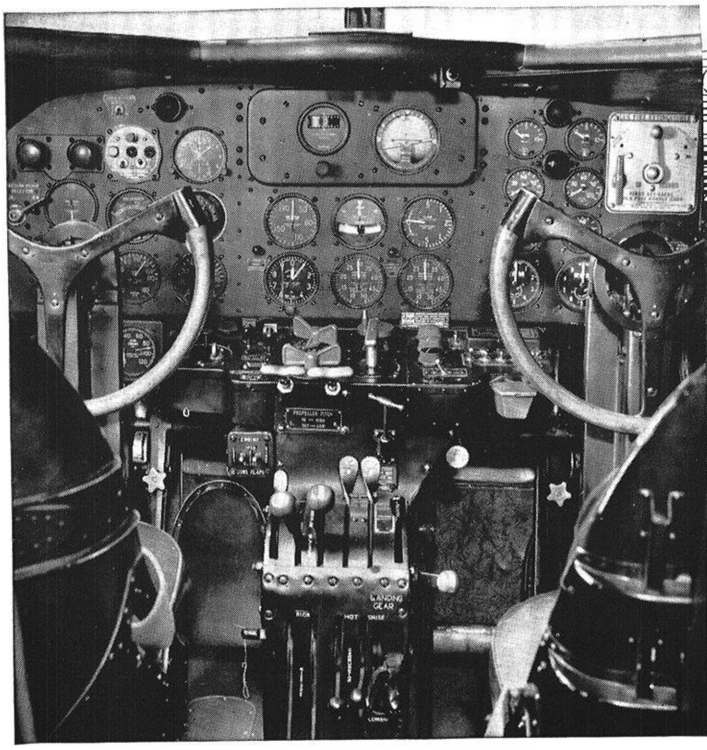
There is much that can be done to improve street and highway lighting. At present such lighting has far too much glare and relys on specular reflection and vision by silhouette. Under identical illumination, better visual acuity prevails when a white object is viewed on a black background than when an identical black object is viewed on a white background, assuming the object is small in comparison to the background. Far more light falls on the retina from the white background than from the black background, which closes the iris and reduces the amount of light on the fovea. Visual acuity is therefore reduced. For this reason vision by silhouette will always result in reduced visual acuity.

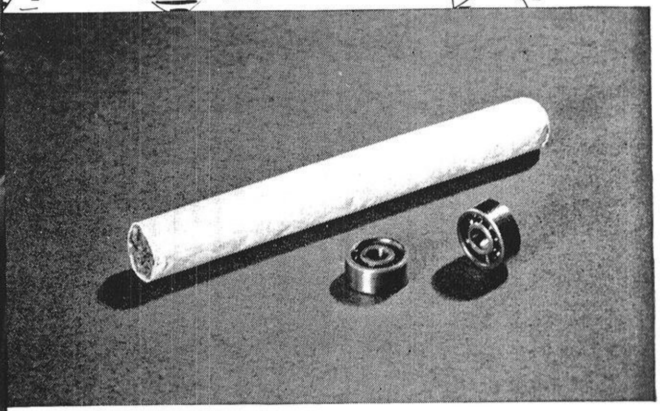
The author is indebted to Dr. P. A. Duehr of the Davis and Neff Clinic, Madison, Wisconsin, for his interest in expressing current theories of which little has been written, and to others whose works have proved helpful.

Determined Aves Crossaeum!

Determined to fly a true course instead of nothing but rolls and tailspins, the Aves Crossaeum (cross-eyed Floocus) finally overcame the handicap of Convergent Strabismus by developing a flight control independent of vision.







● Twelve New Departure aircraft instrument bearings like those above, end-to-end, equal the size of a slightly fat cigarette. Others you could hide under a match head. At left: Some of the instruments and controls in a twin-engined transport.

● That the determination of American Aircraft and Instrument makers to excel in their fields has been no figment of the imagination is attested by the fact that the quality and performance of America's swiftly growing air forces are second to none in the world. And in no small measure is this due to the superior qualities of the ball bearings used in the engines, controls and instruments.

New Departure, Division of General Motors, Bristol, Connecticut. Detroit, Chicago, Los Angeles, Seattle, New York and San Francisco.

Nothing Rolls Like a Ball

New Departure
BALL BEARINGS

3083

G-E Campus News

NAVY CLASSROOM

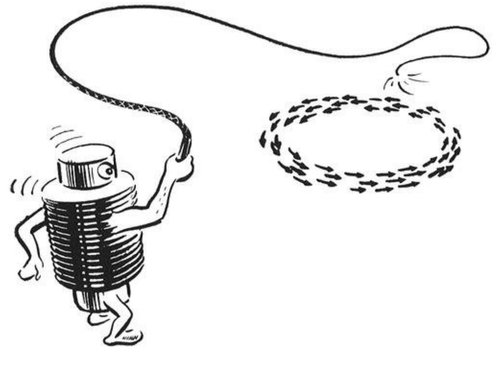
A U.S. submarine is essentially an electric-propelled vehicle, and an amazing amount of electric equipment is packed away in its steel hull. Responsibility for operation, maintenance, and repair of all this electric equipment is in the hands of two classes of petty officers—chief electrician's mates and electrician's mates first class.

For years General Electric has collaborated with the Navy in providing instruction for such men. They are shown how all kinds of equipment aboard their ships is built and assembled. Thus petty officers are better qualified both to care for electric propulsion and other apparatus in normal service and to repair it in case of emergency. This training has lately been accelerated. G-E plants are seldom without groups of these visiting Navy men, and in the past two years more than 50 petty officers have taken the "course."

100 TIMES TOO BRIGHT

In the early days of electric lights, economical city fathers used to turn out the street lamps on nights when there was a full moon. For the best blackout techniques today, even moonlight is 100 times too bright. But although air-raid wardens can't do anything about the moon, for overcast nights General Electric's illuminating laboratory has developed a special street light which produces illumination about equal to starlight.

The fixture contains a 10-watt lamp, so concealed that the only light visible comes through a circular narrow piece of plastic around the side. A projecting black canopy screens the light from the eyes of aviators. The light output, equivalent to that from a single candle flame, seems at first sight to be practically zero. But after a little time eyes become adjusted, as they do in a movie theatre, and objects can be dimly seen 30 to 40 feet away. Specifications for the new lamp are based on the experience of the British in their blackouts.



ELECTRON WHIRLIGIG

Whether you call it a "rheotron" or "betatron" or by its longer name of "induction electron accelerator," a new science tool recently built by Dr. Donald W. Kerst in the G-E Research Laboratory is one of the world's most potent merry-go-rounds. On it, electrons ride to a speed closely approximating that of light—equivalent to that produced by 20 million volts. Copper bombarded by these dizzy, super-speed electrons becomes temporarily radioactive, and other interesting possibilities are being investigated.

Dr. Kerst, young professor at the University of Illinois, got the idea for the device, built a small model, and came to General Electric to build a bigger one. Like the much-publicized cyclotron, except that it accelerates electrons instead of positive ions, the device chases the charged particles round and round in a magnetic field, adding to their speed at every revolution. Scientists are reticent about predicting what the rheotron's chief use will be, but it is promising enough so that a bigger one is being built in the G-E laboratory for speeds of 100 million volts.

GENERAL ELECTRIC

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