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MARCH • 1941

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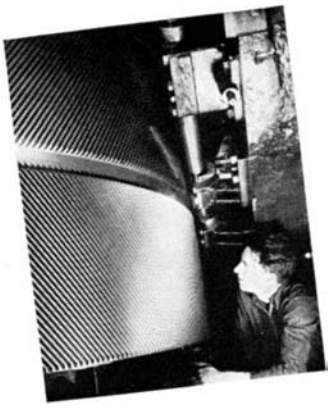
WOLF CHILDREN



IN production of marine reduction gears, tons of steel must be handled as delicately as the mechanism of a fine watch. Our cover picture, by Westinghouse, shows one of these gears being inspected. The allowable error in the spacing of the huge gear teeth is 1/10,000 of an inch. These marine gears are used for reduction of speed between turbine and propeller. The slightest discrepancy in machining of the reduction gears will give rise to noise and vibration.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

MARCH • 1941

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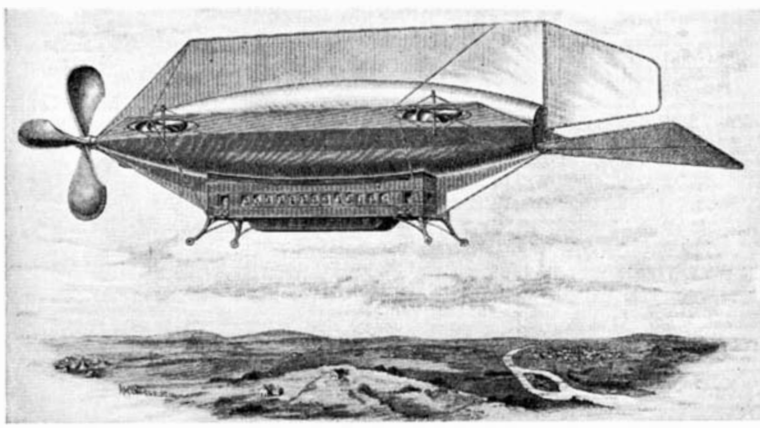
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of March, 1891)

CANAL—" In spite of the disaster that has overtaken the work at Panama, there is every reason to feel encouraged by the progress that has been made at Nicaragua. The latter route was equally open to the French engineers, and it is safe to say that, with half of the money which has been irretrievably sunk at Panama, they might by this time have had in successful operation a practical ship canal for the largest vessels through Lake Nicaragua to the Pacific Ocean."

AIR SHIP—"In the popular belief, the flying machine is next to an accomplished fact, and no very great surprise probably would be occasioned if the announcement were to be made to-morrow morning that a line of air ships had commenced to run between Chicago and New York. We are sorry, however, to be obliged to dash the hopes of a confiding public. . . . Looking at the subject from a practical point of view, our people are likely, for some time to come, to be confined in their locomotion to the actual earth's surface, and to railway cars that make only from fifty to seventy-five miles an hour. But there are various schemes for air flying, and they look fine on paper. One of these paper enterprises has been widely made known in Chicago. It is styled the Pennington air ship. Twenty millions of dollars is the modest amount of the capital. A few of the shares have been reserved for sale to a hungry public. Those who have a dangerous surplus of cash on hand can promptly reduce it by investment in this deceptive and visionary scheme." [Illustration at right. *Ed.*]



INSECT USE—"An electric apparatus supplies a strong light which attracts the insects and moths; a suction fan worked by the electric current draws them in when they approach the light, and carries them into a small mill, also worked by the electric current, where they are ground up and mixed with flour and thus converted into poultry food."

SOLUTION WANTED—"Among the scientific problems that await solution was that described by Prof. Elihu Thomson, to wit, a direct method of obtaining electricity from fuel. The present method necessitates the interposition of the steam engine, in which even under favorable conditions scarce more than ten per cent of the theoretical energy of the coal is recovered in mechanical power, this suffering diminution again at the wire end of the dynamo."

GREAT GUNS—"In France the great company known as the Forges et Chantiers de la Mediterranee, at Havre, under contract with the Japanese government, have produced some large Canet guns for the war vessels of that nation, which must be conceded to stand at the present time in the front rank. Japan may be said to beat the world in the actual power of her heavy guns. . . These guns weigh 66 tons, 12½ inches bore, 41 feet 8 inches length, maximum weight of projectile 1,034 pounds, powder charge 562.2 pounds, muzzle velocity 2,262 feet per second. . . Maximum range over 13 miles. Twenty rounds were fired in the test."

PHONOGRAPH—"One of the mechanical curiosities of the gramophone is the fact that the etched record itself is the screw which propels the diaphragm from periphery to center, for the stylus resting in the groove by gravity or slight pressure not only is vibrated, but following it and being able to move freely, is led along to the center and to the end of the etched record automatically. This places the gramophone reproducer in the realm of extreme simplicity, and beyond the necessity of repair under ordinary every-day conditions."

NEW YORK DEFENSE—"The government has recently commenced the work of locating batteries at Sandy Hook, to take the place of the old fort at that point, begun in 1858. Between that date and 1867 it is said over $1,000,000 were expended on this fort, which was to have been one of the most formidable in the world, but has become obsolete by the vast development which has taken place in modern heavy ordnance. The new batteries are designed to have twelve-inch guns and sixteen-inch mortars. with a range of from nine to twelve miles."

BOTTLES—"It is computed, in recently made statistics, that the glass bottle production of the world amounts to a daily output of a little over eleven million bottles."

TROLLEY CARS—"The overhead trolley system of electrical traction is not, so it would seem from report, by any means satisfactory; at least, in its present stage of development. Complaints come from many quarters that it is insufficient and uncertain. Much snow or rain and much leakage have come to be synonymous terms in street railway parlance.

WIRELESS FORERUNNER—"Mr. Branly has recently found that the spark of a Holtz machine or induction coil has a remarkable effect in temporarily decreasing the resistance of certain badly conducting mixtures, such as powdered or oxidized metals, or pastes formed by immersing filings of iron, copper, or other metals in a non-conducting fluid. . . The diminution of resistance of such conductors may last for as long as 24 hours, unless the substance is disturbed by vibrations, in which case the high resistance is restored."

OUR *Point* OF VIEW

TIME IT WAS SETTLED

THAT perennial question—which freezes quicker, hot water or cold?—is back again and will keep on coming back at us unless it is at last inescapably settled. Generally people seek an answer to this question by the method of pure reason. Recently, however, a number have made actual experiments, thus asking Nature herself. Receptacles of hot and cold water set on winter porches or in electric refrigerators certainly ought to give positive and unequivocal answers—so it would seem. Let us see whether they do.

One of our readers, Mr. Whit Wellman of Carmel, California, set trays of hot and cold water in his Frigidaire and says that the hot sample became hard ice half an hour before the cold had begun to freeze.

Another reader, Mr. Edward P. Arthur, of Altadena, California, placed in a Sierra Madre Frozen Food Cabinet at 3 to 5 degrees, Fahrenheit, identical glasses of cold city water and some of the same water that had first been boiled 15 minutes. Ice crystals formed first in the cold sample but the hot sample froze solidly first.

In the meantime, professional scientists had been trying the experiment. Professor Joseph O. Thompson, Amherst College physicist, asserted in *Science* that, of the two, the hot water will freeze first.

Dr. M. W. Lyon, pathologist at the South Bend, Indiana, Clinic, described an experiment in which the cold sample froze much sooner than the hot.

Professor G. Wakeham, University of Colorado chemist, set out identical pie tins and identical cylinders of brook water at 10, 20, 30, and 93.3 degrees, centigrade, on a porch at -14 to -17 degrees, centigrade. The cold water froze first in all except one case.

Dr. Willis R. Whitney of the General Electric Co. put a liter of water, already chilled to the freezing point, or 0 degrees, centigrade, and later on, a liter of boiling water, in an electric refrigerator (presumably G. E. made—*Adv.*) and found that, within an hour, more of the hot than the cold had frozen.

Three times the present writer set out equal volumes of cold, and just-boiled city water in tin pans and glasses on a porch. Ice formed first in all the cold samples, including one boiled 15 minutes.

Thus the tally: hot, hot, hot, cold, cold, hot, cold—what's wrong?

Nothing. Nature every time obeyed her own laws—she always does—but probably none of the seven experimenters performed quite the same experiment. Each introduced variables and the evidence is that the experiment often gives as its answer either hot or cold on the teetery basis of rather small variables. Possible factors contributing to the contradictory results include:

Professor Thompson's explanation that the hot water cools rapidly because of its rapid evaporation and loss of heat by radiation.

Professor Wakeham's suggestion that the shape and heat capacity of the receptacle are critical.

A suggestion by Robert S. Casey, Fort Madison, Iowa, that heating certain samples expels dissolved gases, decomposes bicarbonates, precipitates compounds, raising the freezing point.

Professor Thompson further points out that the hot sample, before freezing, loses an amazing percentage of volume (the writer found about 12 percent!) by evaporation, and thus gains in ratio of cooling surface to volume. He calls this the dominant role. He also says his hot samples were 100 degrees hot—boiling. (In kitchens, hot water pipes are said to freeze and burst first. Yet evaporation cannot occur here at all. Possibly this is very largely a different problem.)

All these experiments, while still far ahead of the commoner method of seeking the answer by logic and heated dispute, were more or less casual, while the question becomes more complex, ramified, and critical the more it is tested. We think, therefore, it would be well worth while for some physicist to make such extensive, thorough, and downright painstaking experiments, stopping here and there to run down every tricky ramification, as would really *surround* this question, and then publish every governing detail.—*A. G. I.*

PLASTICS DON'T DIE

SO MANY different plastics have marched out of the laboratory during the past few years that fear has been expressed in some quarters that much of the development has been in vain, that there are too many plastics for the jobs to be done. Ureas, vinyls, alkyds, aminos—these are the general classifications into which fall the wide variety of plastics now available. And within these classifications are sub-groups by the dozens. Doesn't it seem likely, then, that new plastics should replace old, render first-comers obsolete?

Were it not for the fact that so many jobs can be done by plastics—and done better than with any other material—such an assumption might prove correct. As one industrial chemist has put it, however, "no plastic has ever died." In other words, any plastic that has proved commercially practical has always found a niche which it fills to satisfaction. New plastics may come along and reduce the number or size of the niches, but so varied are the uses to which these products of chemical research may be put that there is always some one purpose for which a certain plastic is best fitted.

Such a situation provides added stimulation to research workers. The urge to create can oftimes be curbed by the knowledge that the field of applications is limited or over-filled. But when assured that industry can absorb the results of new knowledge, can find practical uses for new products, the research laboratories go forward with undiminished zeal. The plastics field is but one shining example; throughout the broad horizons of industry the laboratories are constantly adding new materials that are being turned into practical, everyday useful articles which make for richer, fuller lives for us all.—*A.P.P.*

Personalities in Science

JAMES HILLIER

Mr. Hillier (foreground) at the electron microscope with Dr. Vladimir K. Zworykin

CLOSELY interwoven with the development of the electron microscope, most effective tool ever to be placed in the hands of research scientists, is the name of young James Hillier, who was born in Brantford, Ontario, Canada, in 1915. Mr. Hillier's early interest in science may largely be attributed to his father, an engineer of scientific bent. When Jim was only 11 years of age, the elder Hillier presented him with a refracting telescope. That instrument shared the fate of most other things that fell into the youth's hands—it was taken apart. Investigation soon disclosed that the compound eyepiece could be used as a microscope.

During high-school days Jim Hillier became intensely interested in radio and photography, hobbies that he still continues to pursue as time permits. These interests, however, never excluded his studies of microscopy which now have carried him so far into the infinitely small that seeing an actual molecule seems to be a possibility just around the corner.

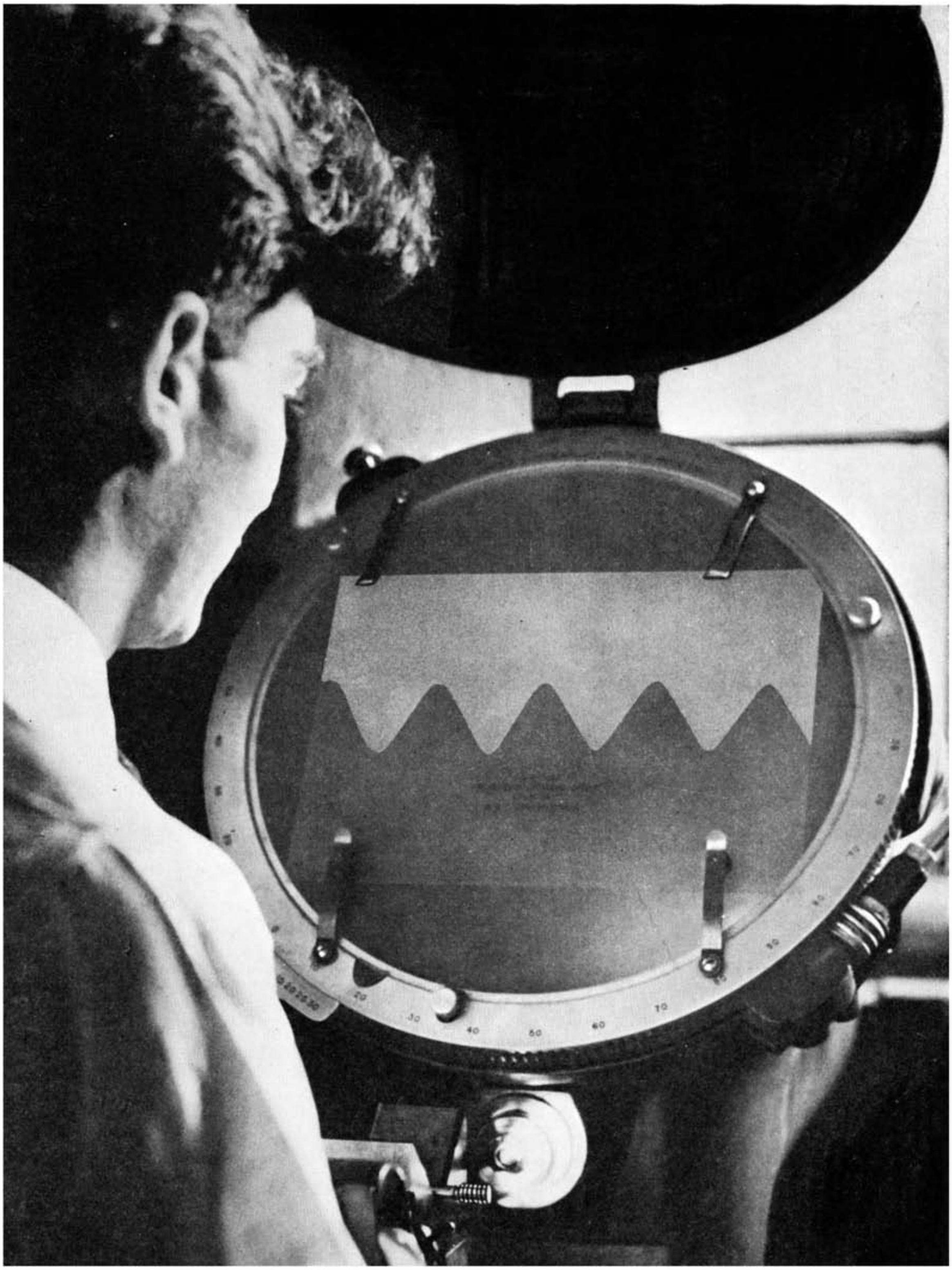
High-school was followed by the University of Toronto, where a B.A. in mathematics and physics was achieved in 1937 and an M.A. in physics in 1938. Post-graduate work, starting in 1937, introduced Mr. Hillier to the problem that has made him one of the outstanding figures in present-day applied electronics. Under the supervision of Dr. E. F. Burton, Director of the McLennan Laboratory of the University of Toronto, Jim embarked on a project which involved a thorough-going study of the then little-known electron microscope. With scant funds available, he and another graduate student carried the project to a successful conclusion. Most of the equipment available in the physics laboratory was pressed into service; where special parts were needed the two students made their own designs, went to the University machine shop and built their own equipment.

Dr. V. K. Zworykin and a group of the engineers at the Camden Research Laboratories of RCA had, because of close connection with the problems associated with television, been actively interested in electron microscopy. In February, 1940, Mr. Hillier joined the RCA, and here, under the direction of Dr. Zworykin, and with the collaboration of A. W. Vance and others, was able to develop the electron microscope from a complicated laboratory device into a compact, smoothly operating instrument that already is being seized upon by science and industry as an important means to new knowledge. (Details of the theory of the electron microscope will be found in the July 1940 issue of Scientific American.)

Modestly, Mr. Hillier belittles his own work, insisting that his contributions to the electron microscope have been merely concerned with developments and improvements. Nevertheless, the fact remains that, coincident with Mr. Hillier's entry into the field of electron microscopy, in 1937, things began to happen.

Today Mr. Hillier is setting out to rectify a seeming paradox in his life. Most research men establish their scientific reputations long after receiving their doctorate degrees. In Hillier's case, however, he achieved fame as plain "Mr." Hillier, and is now working toward a doctorate in physics.

Married and the father of two children, the eldest 3½, Mr. Hillier has applied for first citizenship papers in the United States. His intellectual recreation consists of keeping abreast of world affairs; to this he adds a fondness for tennis, a love of good music, and a mild interest in fishing. One of his earliest ambitions was to become a commercial artist; other interests preventing this, he still keeps his hand in by dabbling in drawing, particularly in pastels.



SPLITTING HAIRS IN AIRCRAFT ENGINE PRODUCTION

Even the threads of the bolts that hold parts of an airplane engine in place must be machined to close tolerances if the finished product is to give satisfactory performance. Thus is necessitated accurate inspection equipment such as this comparator shown in operation in the Cadillac plant where Allison airplane engines are being manufactured. A greatly enlarged shadow of the thread is cast on a screen, where it must line up with a master pattern or be rejected. Here one of the four connecting-rod bolts is being checked.

97TH YEAR SCIENTIFIC AMERICAN MARCH 1941

INDIA'S WOLF-CHILDREN

Two Human Infants Reared by Wolves

ROBERT M. ZINGG, Ph.D.
Associate Professor of Anthropology,
University of Denver

• As the accompanying account of two human infants reared by wolves is extraordinary, the reader is entitled to know just how much scientific backing was required before it was accepted for publication. He may recall the unfortunate instance of last year, in which a psychologist rushed into print with poorly investigated claims concerning a South African boy nurtured by baboons; then was forced to retract his story with an admission that he had been mistaken (*Science*, Mar. 22, and June 28, 1940; also *The American Journal of Psychology*, July, 1940).

The author of the present account is a scientist in good standing; he has devoted several years, not merely to this one case but to such similar ones as could be assembled from recorded world literature (in *The American Journal of Psychology*, Cornell University, October, 1940, he discussed 31 such cases at some length, but of these the present one is the best); at least four other scientists concur formally in the genuineness of the case. These are: Prof. Ruggles Gates of the University of London, Dr. Arnold Gesell of the Yale Medical School, Dr. Francis Maxfield of the Ohio State University, and Dr. Kingsley Davis of the Pennsylvania State University. These four have contributed approving forewords to a 250-page detailed book on the present case, to be published by Prof. Zingg, author of the present article, some time in 1941. Prof. Gesell also will publish a book about it, a short, more popular account, a summary and interpretation, to be entitled "Wolf Child and Human Child."—*The Editor*. •

IN 1929, when I first heard of wolf-children, my reaction, no doubt like that of everyone else, was that such stories were stuff and nonsense. However, when the study of other scientific problems brought me back to the subject of wolf-children, I found evidence of some respectability for about 30 cases on feral or wild man.

The best of these cases is that of the wolf-children of Midnapore, India. The records on this case involve 250 pages of original documents, mostly a lengthy and carefully recorded diary of the rescue of the wolf-children and their life in an orphanage run by their rescuer. In my study of these records I have been assisted by many scientists in various parts of the world. These include the distinguished American scientists who have been studying the more recent and similarly tragic cases of two girls, one in Pennsylvania and the other in Ohio, who were rescued from attics where criminal or insane guardians had kept them sequestered since babyhood. These children were rescued at almost the same age as the eldest of the wolf-children of Midnapore, and the records are surprisingly analogous in detail.

The two wolf-children of India were first seen living as wolves among wolves on October 9, 1920, by an Anglican missionary, Rev. J. A. L. Singh. He was on a mission trip among the pagan aborigines, with Anglo-Indian companions who went with him to hunt in the tiger-infested jungles of northwest India. In an isolated village Rev. Singh and his companions were told of a "man-ghost" that lived in a high, earth ant hill, characteristic of the tropics, about seven miles from the village. To this he and his companions were directed at dusk and there made a tiger-shooting platform in one of the trees. Here they awaited the promised appearance of the "man-ghost" from the ant hill.

REV. Singh writes: "Then, all of a sudden, a grown-up wolf came out of one of the holes. This animal was followed by another of the same size and kind. The second was followed by a third, closely followed by two cubs, one after the other. Close after the cubs came the 'ghost' — a hideous-looking creature — hand, foot, and body like a human being. Close at its heels came another awful creature, exactly like the first, but smaller. Their eyes were bright and piercing, unlike human eyes. However, I at once came to the conclusion that they were human beings.

"The first 'ghost' placed its elbows on the edge of the hole, looking this side and that before jumping out, followed by the tiny 'ghost' behaving in the same manner. Both of them ran on all fours."

Rev. Singh was the only one on the platform with field glasses, so his companions could not identify these creatures as human. He continues: "My friends at once leveled their guns to shoot at the 'ghosts.' They would have killed them had they not been dissuaded by me. I held their barrels and presented the field glasses to Messrs. Rose and Richards, and told them that I was sure that these 'ghosts' were human children."

The group of witnesses again sighted the "ghosts" and wolves the next day, October 10, 1920. They tried to get the natives of that village to dig the wolves and wolf-children from their ant hill den, but the primitive villagers of this remote hinterland of India were too afraid of the "ghosts" to do so. So, the next day, they went to a distant village where the natives knew nothing of these particular "man-ghosts." Thinking they were merely to dig wolves out of their dens, the hired diggers returned with Rev. Singh and began work.

Singh writes: "After a few strokes of the spade and shovel, one of the wolves came out hurriedly and ran for his life into the jungle. The second one appeared quickly, frightened for his life, and followed the footsteps of the former. A third appeared. It shot out like lightning on the surface of the plain and made for the diggers. It flew in again. Out it came instantly to chase the diggers—howling, racing around restlessly, scratching the ground furiously, and gnashing its teeth. It would not budge out of the place.

"I had a great mind to capture it, because I guessed from its whole bearing on the spot that it must have been the mother wolf. I was amazed to think that the mother wolf had permitted the children to live and to be nurtured by them. While I stood there inert, however, the men pierced her through with arrows and she fell dead."

With the death of the last adult wolf, the diggers now dug into the ant hill, which soon fell in because it had been undermined by the wolf den beneath. Singh says it was in the shape of a kettle, plain and smooth, as if cemented; the place was absolutely neat and clean, not a sign of a bone, much less of any droppings or any other uncleanliness, and he continues: "There had lived the whole wolf-family. The two cubs and the other two hideous beings were there in one corner, all four clutching together in a monkey-ball. It was really a task to separate them from one another. The 'ghosts' were more ferocious than the cubs, making faces, showing teeth, making for us when too much disturbed, and running back to re-form the monkey-ball."

The rescuers of these human children from their wolf companions were at a loss as to what to do until someone thought of throwing over each of them the sheet-like winter garments which the villagers wore. Thus the wolves and children were separated and caught, each wrapped in a sheet with only the head sticking out. The cubs were given to the native villagers, who sold them for their wages. Rev. Singh took the children to his headquarters at Midnapore where he and his wife have for years devotedly supported an orphanage for the waifs of that region.

The missionaries expected that a few years of association with the normal children of the orphanage would change the wolf-children from effective little animals back into human beings. The elder girl, about eight years old, was named Kamala, and the younger, aged only a year and a half, was called Amala. Rev. and Mrs. Singh decided to tell no one of their rescue from wolves lest this might later prejudice their chances of marriage, a serious thing for girls in India. Much later, however, when serious illness of the children made it necessary for a medical practitioner to know their past, the missionaries felt it necessary to divulge the facts of their rescue, and the story leaked out. It made quite a sensation locally in India, though traditions of this kind are a commonplace, as reflected, for example, in Kipling's well-known story of Mowgli. The Anglican bishop, Rev. H. Pakenham Walsh, who had taught Rev. Singh as a Seminary student, went with others to see the children and completely vouches for the authenticity of the children and for the high character of Rev. Singh. News of these wolf-children reached the world press through publication of a confidential letter to a friend in London.

Rev. Singh and his good wife were deeply disturbed by this publication, not only because it blasted any hopes of marriage of the children, but also because it plagued them with visitors, newspaper writers, and numerous letters from all over the world. To science, however, it was a providential boon that the news did come out, because, for the first time among the 30-odd cases of a similar kind recorded, we have *actual witnesses* of the rescue of the children from their life as animals among animals. No scientist would dream of actually isolating a child from all human contact, even as an experiment,

Photo from Rev. J. A. L. Singh

One of the wolf-children on all fours and scratching to get in

Photo from Rev. J. A. L. Singh

Rev. and Mrs. Singh, with Kamala, the elder of the two wolf-children, seated at their feet, after she had learned to walk and wear clothing

though there are stories of oriental potentates who do so to find out the effects of environment on heredity in human development.

Rev. and Mrs. Singh were to be disappointed in the degree of recovery in their little wild charges. At first they treated them like two newly-born human beings, as they essentially were in a human sense, though one was eight and the other a year and a half. They put the children in bed, where they had to be tied. Since they tore clothing off as savagely as wolf-cubs, their

Photo by Rev. J. A. L. Singh

Wolf-child lapping milk, learned from tame dogs after her rescue

clothing was limited to a diaper-like breach-cloth, which had to be sewed on. Like infants, they would eat only milk. They were not offered raw meat, which they craved. This craving lasted for some time, and long afterward one of them was caught eating the entrails of a chicken, which she had located far away in the garbage by the superlative animal-like sense of smell that remained with her for many months.

When they had regained some strength from a milk diet, they were allowed out of bed. They dreaded and shunned the light, but at night roamed around restlessly on all fours, the only locomotion that they knew, moaning in imitation of the howl of a wolf, the only language that they knew. Their behavior was essentially not human. They hated, feared, and shunned human beings, as would have a wolf-cub. Yet they knew animals, liked them, and were so familiar with them that they acquired their ways. They loved dogs and from them learned immediately by imitation to lap milk out of a dish and, more extraordinary, to scratch at a door for entrance after approaching it on all fours. At first, their interest, their love, and sympathy were wholly directed to animals. Rev. Singh's diary shows what a slow and painful process it was to re-orient these pitiable little children from animal interests and sympathies to human ones. In teaching them to master the upright posture of man on two legs, not only were long and complicated exercises necessary to loosen the muscles bound into the four-legged position, but it also was necessary to get them to imitate a kitten in climbing a tree in order to loosen their leg muscles further. They would never have followed a human being as they did a cat to imitate it in climbing. They even preferred chickens to human company and would follow the chickens around the compound for hours. Neither of the children ever mastered man's upright position well enough to run, but they did learn to walk upright, though somewhat awkwardly.

Retouched photo from Rev. J. A. L. Singh

The two wolf-children soon after their rescue, sleeping wolf-puppy fashion, or curled-up in a "monkey-ball," with the younger one on top

The recovery of the children was sadly hindered by the death of Amala, the younger, who was learning rapidly and from whom the less plastic older wolf-child Kamala was learning. With the death of the only creature like her in the world, the surviving girl seemed to sink into a spiritless idiocy. Few could survive such loneliness but, fortunately, she began to show a glimmer of interest in her human companions, and especially in Mrs. Singh, who always fed her.

Gradually Kamala's interest in humans increased and she developed into a pathetic little, sub-normal, but clearly not idiotic, human being. She learned to speak about 50 words and occasionally to put them in short sentences. She came to recognize and to be possessive about her clothes, though they had to be red in color to interest her. Finally she came to show concern about being clad like a human being when she went out walking with the other children, or when visitors came. She developed enough human intelligence to run errands, in addition to playing with the other children.

From the entire account it becomes clear that, while the normal baby is born with the potentialities to become a human being, in the form of a more complicated nervous system than that of animals, man actually attains this only through association with his kind in the very earliest years. Deprived of this too early, or too long, or too severely, the human child never recovers complete mastery of the upright position of man, or of language, the characteristic of man, or a complete and fully developed human personality.

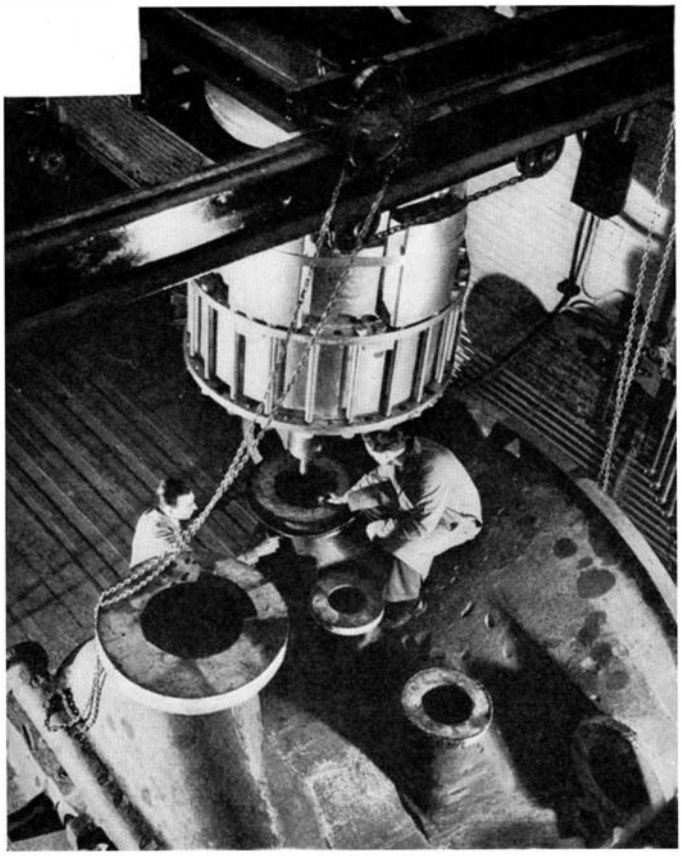
Yet the environmental factor is not supreme because by the same token even the ape, which can simulate man's upright position, cannot be taught to talk, nor does it attain a human personality. The study of the record of the wolf-children of Midnapore proves what has been indicated by other similar cases and by the rest of our knowledge—that both the environmental and hereditary factors unite in a complex interplay to develop the human being.

X-Rays Show the Way

New Equipment for Peace and War, For Use By Industry and by Medical Science

A. P. PECK

X-RAYS, born of scientific curiosity and raised by the research laboratory, are constantly under scrutiny in an effort to increase their already widespread use. A whole corner of industry is devoted to studying ways and means of producing more powerful X-ray generating equipment, better ways of applying technique, new uses for these rays that enable us to see the unseeable. From X-ray spectroscopy to the diagnosis and treatment of disease, from routine inspection of welded joints to the study of broken bones, from the industrial production line to the examination of food products ranges the applications of the rays, and the industry behind the X-ray keeps pace. Rather, it should be said, the industry keeps a step ahead, showing the way and providing the tools for others to take up and apply.



Business end of the 1,000,000 volt industrial X-ray unit being lowered into a huge steel casting to be studied

Latest of the giants in this field is the million-volt unit produced by General Electric for industrial uses. Designed for rapid inspection of huge machine parts—steel turbine castings, for example—this unit will more than pay for itself by the savings that it will effect by the detection of flaws before the machinery goes into actual service.

X-ray inspection of machine parts has, of course, been an established industrial practice for many years. Through the findings of the X-ray, it is possible to repair flaws, or to reject the part, before the defect shows up by failure of the machine and possibly causes damage far in excess of its seeming importance. With the relatively small, low-powered equipment heretofore used, the inspection process may be lengthy, out of proportion to the rest of the production schedule, but with the new million-volt unit it is possible to do in minutes what took hours with the best equipment formerly available. For example, the 400,000-volt unit which is replaced by the new installation required a one hour exposure to take an X-ray picture through four inches of steel three feet away from the ray source. With the million-volt equipment, the same work is done in less than two minutes. The former three and a half hour exposure for five inches of steel is reduced to five minutes. The exposure time is increased two and a half times for every added inch of steel to be pictured with the new unit.

Without going into the theory of X-rays, it is rather obvious that the penetrating power of the rays is dependent on several factors, primary of which is the operating voltage of the generating tube. Of importance also are the material to be penetrated and its distance from the ray source. Lead is quite opaque to the rays, air the most transparent. Well known, also, are the destructive powers of X-rays to life. They can, when uncontrolled or improperly applied, cause irreparable damage to the human body; at the same time it must be remembered that, intelligently used, they can be equally powerful in their beneficial results.

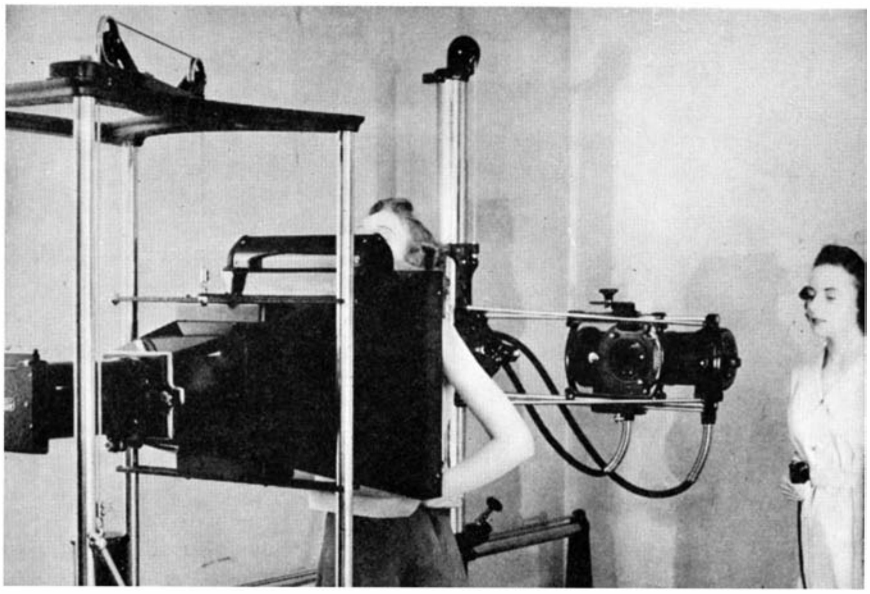
Thus every possible precaution is taken in the design of X-ray equipment to guard against trouble, and to afford every facility for ease of operation. In the case of the new million-volt unit at Schenectady, for example, a special building has been provided. The walls of the structure consist of 14 inches of solid concrete, plus 12 inches of brick on the interior, giving the protective effect of four inches of lead. The foundations of the building extend five feet into the ground. With such protection, all possible chances of personal injury to anyone working in the vicinity are eliminated.

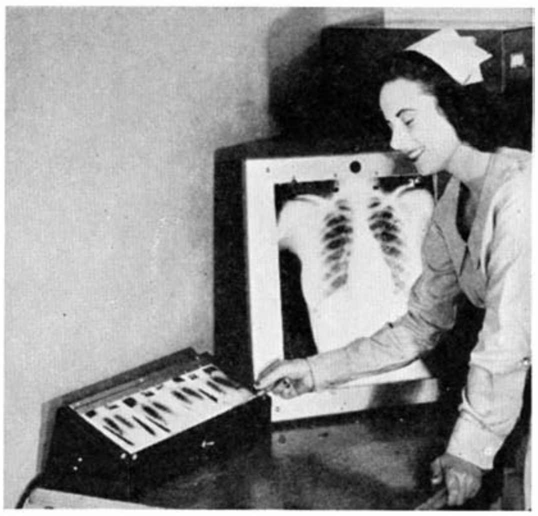
THE building itself is 100 feet long by 35 feet wide, with a huge door at one end. This door is composed of an 18-inch concrete slab encased in one-inch steel plate. In the roof is a hatchway 15 by 13 feet, with an outside gantry crane, through which can be lowered the castings of practically any commercially feasible machine. With these conveniences for bringing the work to the X-ray equipment, every advantage can be taken of the speed of operation which the high-voltage set-up makes possible.

The X-ray equipment itself—the tube and all necessary operating devices—is contained in a cylindrical tank suspended from the rails of a crane that travels the length of the building. It can be moved horizontally or vertically, and also rotated, to place it in the most convenient position for the particular work to be done.

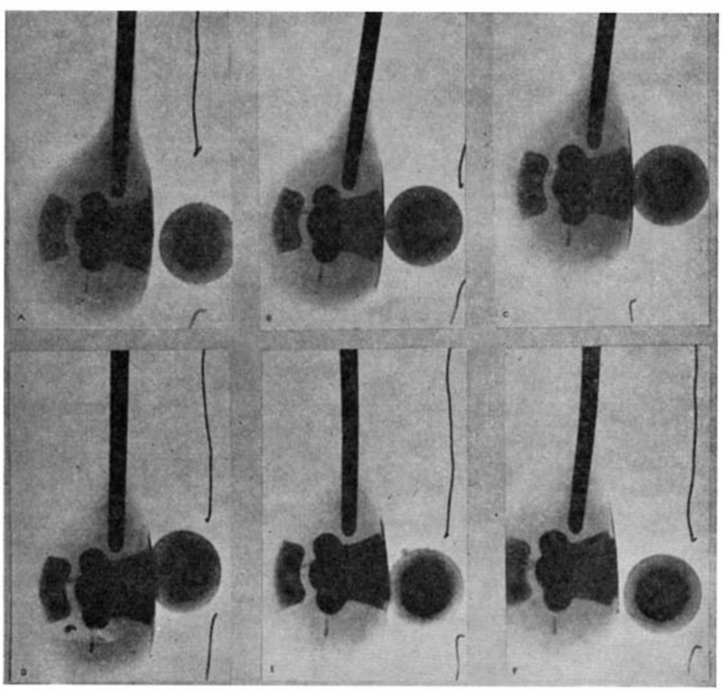
When the million-volt tube is in operation, all persons are excluded from the room, remote controls being provided so that the work can be regulated as needed. A periscope at the controlling switchboard enables the operator to make a visual check.

Because X-rays are still somewhat of a mystery—knowledge of them is by no means complete—General Electric engineers are taking advantage of this newest ray generator to add to the sum total. Around the walls of the X-ray room are placed small sections of film, sealed from visible light. After the tube has been used for a casting inspection, these films are removed, developed. Knowing where each film was located in relation to the tube, technicians chart the paths of the rays, note any departure from what is considered to be standard behavior. Additionally, men working around the building carry small sealed films on wrist straps. Periodically these films are sent to the company's medical department to determine whether the operators are receiving any exposure to the rays.





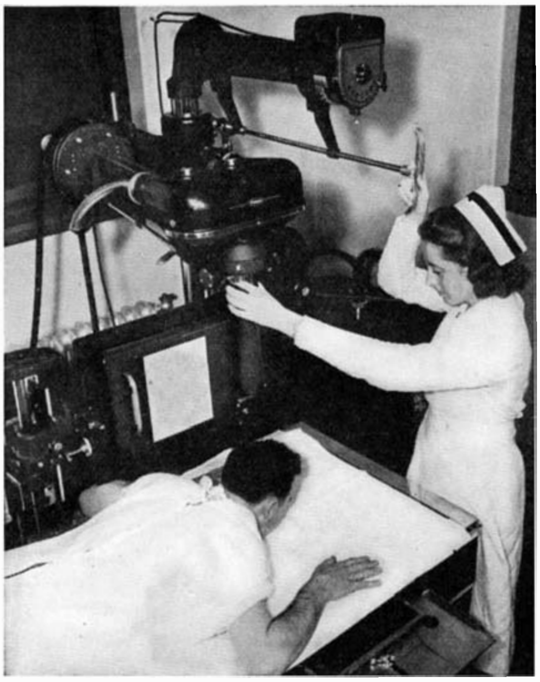
Above: **Taking "miniature" X-ray films. Camera is at extreme left. *Right:* Small negatives, on table, compared with conventional size films in background.**



High-speed X-rays of golf club and ball during impact

High penetrating power is not always the most desirable factor for certain types of X-ray work. Sometimes, for illustration, moderate penetration is all that is required, while high speed of exposure is the goal. One new development, in which X-ray photographs are obtained of a human body in 1/60 of a second, is considered to be a marked contribution to medical science. This particular machine, working at a voltage of 100,000, is equipped, according to Westinghouse engineers, with a 20-cell electrical "brain" which thinks and acts with speed and precision. Strictly speaking, the brain cells are electric relays that, once the equipment is set, function automatically and cause the machine to go through a series of intricate operations, of which the taking of the X-ray picture is only one.

Not only can this X-ray set-up take high-speed photographs, but it can also produce stereoscopic pictures, an obvious advantage to the medical profession, permitting, as it does, an X-ray view in three dimensions of any desired organ or limb. After the operator sets the simple controls for voltage, current, and exposure time, the machine does the rest. The operator has only to squeeze a trigger



Preliminary adjustment of the apparatus for taking stereoscopic X-ray photographs

and the electrical "brain" raises the voltage to the set value, makes the X-ray tube ready for use, and prepares the stereoscopic apparatus for operation. Pressure on a second trigger touches off another set of the relays, which makes a single exposure, moves the film, adjusts the angle of the tube to obtain the stereoscopic effect, and makes the second exposure. After this, the circuits automatically reset, ready for another cycle.

From the electrical standpoint, one of the most remarkable features of this particular X-ray setup is the fact that a current of some 200 amperes is turned on and off in the space of 1/60 of a second without the slightest arcing or burning in any part of the circuit. This is accomplished by the use of an Ignitron tube, an alternating-current operated vacuum tube that eliminates mechanical contacts which would always tend to give trouble. When this X-ray machine is operating at maximum power, 60 horsepower of energy is momentarily released. Hence the need for accurate control of the circuits. Were the power to be prematurely applied, an X-ray tube worth $1000 would be completely ruined.

While exposures of 1/60 of a second are considered to be the highest practical for medical use, there are other purposes for which even higher speeds are desired. For example, much can be learned about the action that takes place when a rifle bullet penetrates a solid object, if the X-ray picture can be taken at sufficiently high speeds to "stop" motion. Just this has been done.

In the conventional X-ray tube there are two major elements — the cathode, from which electrons are emitted, and the anode or target, at which these electrons are aimed. When the electrons strike the target, the X-rays are emitted. In the new high-speed tube, a third element has been added. This is an auxiliary electrode which serves to start the discharge of electrons, acting as a trigger. In operation, the high-speed tube is energized from a bank of condensers that have been charged to about 90,000 volts. The circuit is so arranged, however, that even after the condensers have been charged to the desired voltage they cannot discharge their current through the X-ray tube until an additional, although small, electrical impulse is provided.

This impulse is created by breaking the timing circuit, whereupon the slight addition to the main voltage in the condensers is sufficient to energize the tube. Therefore the timing circuit is so arranged that the action to be photographed serves to make the necessary break. A rifle bullet, a flying golf ball, any similar moving object, breaks a strand of fine tungsten wire which, in turn, interrupts the timing circuit. The needed impulse is created, the condensers discharge through the X-ray tube, and the exposure is made. The tube receives a momentary jolt equal to about 2000 amperes at a pressure of some 90,000 volts, but only for a millionth of a second. So powerful are the X-rays thus generated, so fast is the photographic film employed, that in this tiny fragment of time the moving object is, to all practical purposes, stopped in its tracks and X-rayed in exactly the position that it happens to be in at the time of breaking the circuit.

Most of the work so far discussed involves the co-operation of photography and X-rays. It must be understood, however, that the penetrating effects of the rays can be rendered directly visible without the intermediary of the photographic film. If X-rays are permitted to impinge on a screen coated with certain chemicals, that screen will fluoresce or glow in direct proportion to the power of the rays. Thus, if an object is interposed between the source of the rays and the screen, an image of the object will be seen on the fluorescent surface. And this image will, within the limitations of X-ray penetration, reveal the internal structure of the object. The screen is known as the fluoroscope and is widely used where only cursory study of an object is desired, or where there is no need of making a permanent photographic record.

In the past it has been common X-ray photographic practice to make full-size negatives, with consequent high cost, difficulties of handling, bulk in filing, and so on. This, of course, was made necessary by the technique; no camera is used in conventional X-ray photography. The object is merely placed between the ray source and the negative and the exposure is made. Attempts have been made in the past to hurdle the obstacles of large-size negatives by photographing the image on the screen of the fluoroscope, but only very recently have these attempts been successful.

Several factors limit this photographic endeavor. The fluorescent

Lead spots on a contact spectacle lens serve to aid the surgeon in locating position of foreign bodies in the eyeball

screen must have maximum brilliancy, the photographic film must be highly sensitive to the color of the screen, the camera lens must be fast. After much experimental work the first two of these problems have been solved and special lenses of wide aperture have been designed and ground. Net result is that it is now possible to photograph the image on a fluorescent screen, using a four- by five-inch negative, and to obtain what are termed "miniature" X-ray films that are completely satisfactory for many purposes.

These miniature films already are being employed for group examinations in the constantly waged battle against tuberculosis. The Army has ordered a number of machines especially designed for this technique, and will use them to weed out rapidly the physically unfit among volunteers and draftees. It is stated that the cost of X-ray photographs with the miniature system is about 1/10 that of the conventional method, with the added advantages of speed of operation, ease of handling, and reduced space needed for storing the films.

OTHER new X-ray equipment of military importance includes a portable field outfit which, it is claimed, can be used to examine wounded soldiers at the rate of one a minute, thus speeding up tremendously the location of bullets or shell fragments in the body. Major A. A. deLorimer, inventor of the unit and Director of Roentgenology at the Army Medical School, Washington, D. C., states that the equipment can be set up in 10 minutes in the field and put in immediate use. In actual practice, regulation army stretchers will serve as the table top for the X-ray unit, the stretcher bearing the patient being placed directly on the frame of the unit and removed after the examination is made. This makes it unnecessary to disturb the wounded man and increases the speed with which the examinations are made.

Interesting as an example of the ingenuity employed in making X-rays of even greater service to humanity is the eye "mapping" method of Dr. Raymond L. Pfeiffer of the Eye Institute of Presbyterian Medical Center, New York City, recently announced by Westinghouse. By this system it is possible not only to detect the presence of splinters imbedded in the eye, but also to locate their exact position. A contact lens is placed over the injured eyeball. On the lens are four lead dots. X-ray photographs reveal the splinter and also record the dots, thus showing the relative positions of each, and make it possible for the surgeon to determine just what procedure must be followed for best results. Two exposures are made, one from the front of the head and one in profile, the two negatives, taken together, making it possible to obtain highly precise measurements.

What will be the next forward step in X-ray technology is almost anyone's guess. There is hardly a field of human endeavor that has not already been touched by these penetrating rays, yet to say that the most powerful present-day machine will not eventually be dwarfed by one of even greater magnitude would be to deny the value of the very basis of industrial progress—the research laboratory.

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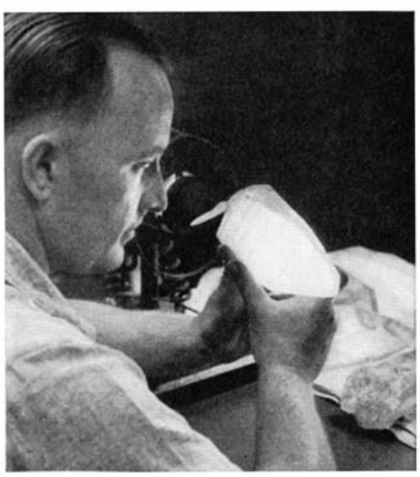
Radio Changes Its Tune

How Industry Produces Crystals that Hold Broadcasting Stations on their Frequencies

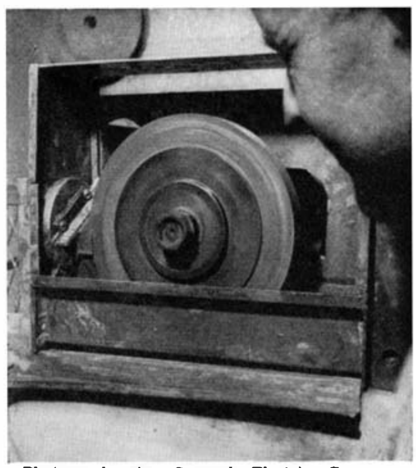
H. T. RUTLEDGE

WHEN, on March 29, 1941, your favorite radio stations suddenly appear at new points on the scale of your receiver, the latest re-allocation of wave bands by the Federal Communications Commission will have been completed. Designed further to relieve congestion on the air and to make for a better all-around public service, this change in wave bands brings to the fore a little-known phase of radio work.

It is one thing to complete a radio transmitter and start it in operation on a specified frequency; it is quite another to keep it on that frequency for long periods of time. And if a broadcast transmitter wanders only a relatively few cycles from its assigned frequency there is immediate trouble. If nothing more, the wandering would make it impossible to obtain uniform reception. Worse still, it would probably bring about interference with some other station.



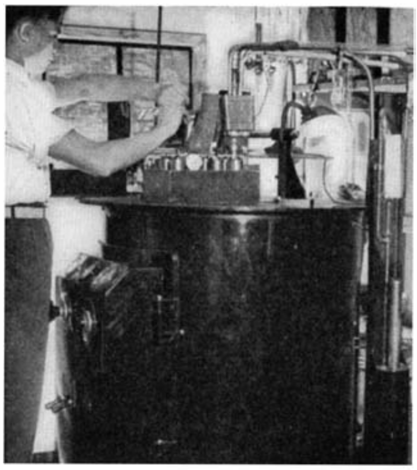
Examining raw Brazilian quartz under the light from an arc lamp



Photographs by General Electric Company

Blanks of crystal are cut with this gang-saw cutting machine

Years ago, however, a system was developed that makes it impossible for a transmitting station to wander off its wave band. Tiny crystals of quartz, ground with the precision of fine optical work, are placed in the transmitter circuit. Because of the electromechanical principle known as the Piezo-electric effect, these crystals generate small electric charges which can be used to control the frequency of another electrical circuit, holding it at a point that was determined when the crystal was ground and mounted. A number of materials



Crystal blanks, in adjustable fixtures, are oriented by X-ray reflection in this unit

exhibit the Piezo-electric effect, but crystalline quartz, because of its stability under operating conditions, is the most satisfactory. The frequency of the crystal-control circuit depends on the cut of the crystal, its dimensions, the temperature at which it operates, the design of its holder, and the constants of the rest of the circuit.

It is important that radio control crystals be ground to uniform thickness and with faces parallel to within a few millionths of an inch. This, of course, necessitates the use of optical measuring methods, as no mechanical means is sufficiently accurate. Further, for the day-and-night service required for broadcasting operation, the crystal must have long life; this is dependent on the quality of the raw quartz from which the crystals are cut. Defective crystals, if they operate at all, will soon become useless.

A crystal is ground to the correct angle, ready for finishing

Accompanying photographs show some of the important steps in the manufacture of control crystals for radio use. These crystals vary in thickness from ⅛ to 1/16 of an inch and are from ¾ to 1¼ inches square. When completely finished they are mounted in sealed containers ready for use. In operation, the temperature of the crystal usually is held to close limits by means of thermostatically controlled electrical circuits, since changes in temperature affect the frequency characteristics of the crystal.

First step in the production of crystals is the inspection of the raw quartz for imperfections. Light from an arc lamp is directed against the large rough crystals at an angle and reveals cracks, inclusions, and other defects that would affect the operation of a

Finished crystal, ready for its mounting in which it will control accurately the frequency of a radio broadcasting station

finished control crystal. The defective portions are marked, and the way in which the crystal is to be be cut up is determined so as to obtain the greatest number of blanks from each raw chunk. Since the arc light will not reveal all defects, this inspection is supplemented by polarized light, under which "twinning" of the quartz crystal is detected.

After the usable and the defective parts of the raw crystals are determined, the raw pieces are mounted and cut with revolving metal disks charged with Carborundum grains. In this step the defective parts are rejected and the remainder is cut into hexagonal pieces at approximately the correct angle. This angle is determined by the natural axes of the raw quartz and must be highly accurate in the finished crystal. The hexagonal pieces are now cut into bars and the bars again cut into thin slices or blanks. This work is all accomplished with metal disks and at all times the angle of cut is kept as near as possible to the predetermined value.

The blanks are now placed in adjustable fixtures and are oriented by means of X-rays. With the blanks properly held in the path of the X-rays, the technician can determine the exact angle at which the grinding operations must be conducted. Once this factor has been fixed, the crystals, sometimes in groups and sometimes singly, are subjected to a series of grindings that produce the necessary parallelism of the faces.

Grinding is followed by processes of machine and hand lapping, the final step being accomplished by highly skilled workers who are not guided by blue-prints or other set instructions but who work by cut-and-try methods acquired after years of experience. As these men work, they constantly test the crystal blanks with oscillator circuits to determine their rate of progress.

After final test for accuracy of frequency, the crystals are mounted, ready for use in the circuits of radio transmitters.

At present, regulations of the Federal Communications Commission require that a standard broadcasting station maintain its assigned frequency within limits of plus-or-minus 50 cycles; after January 1942, this standard of performance will be raised to plus-or-minus 20 cycles. The control crystal manufacturers, however, have established their own standards and even today are producing crystals that will operate continuously well within these limits.

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BRAKE LININGS

"Synthetic" — of Rubber and Small Wires

In an effort to overcome the disadvantages of a limited supply of asbestos, Germany is making automobile brake lining from a mixture of synthetic rubber bonded with tiny aluminum fibers. The rubber is a high - temperature - resistant Buna, and the aluminum reinforcement is in the form of tiny wires only 0.03mm in diameter.

The first experiments to make Germany independent of asbestos linings led to all-metal shoes, but the Buna-and-aluminum combination provides equal braking efficiency without the severe wear encountered by steel-on-steel.

This brake lining is also being used, it is claimed, with certain modifications, on railway equipment.—*Aluminum News-Letter.*

TUBE MAKER

Machine Automatically Shapes Tubes

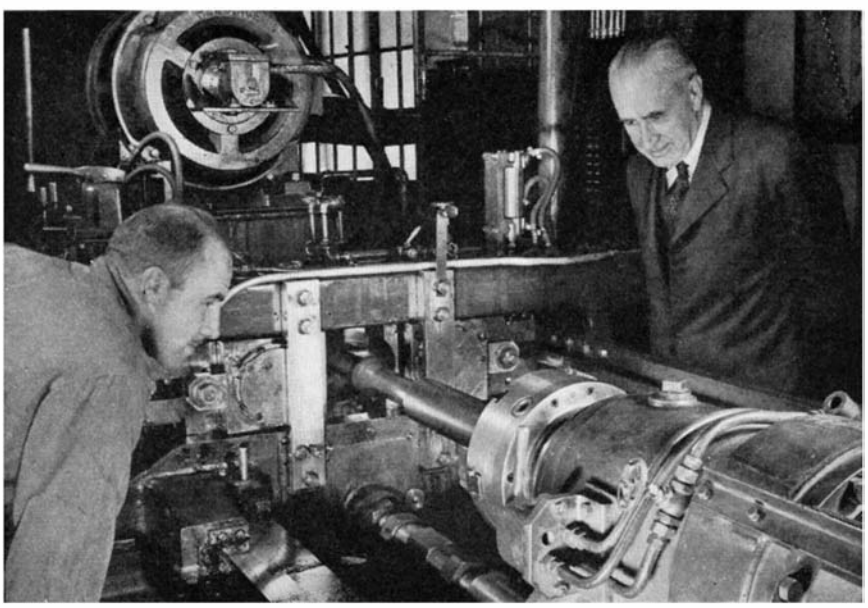
WITH the demand for aircraft parts skyrocketing in step with the national-defense program, the Steel & Tubes Division of Republic Steel Corporation is now making landing-gear struts, aileron torque-tubes, and other parts on a new machine which automatically shapes tubular products to practically any contour that could be machined from solid stock.

The machine, developed by Clarence L. Dewey and his son, Sydney L. Dewey, who have given full time to its development for the past six years, provides accurate control of wall thickness so that it is possible to turn out aircraft parts of maximum strength at minimum weight.

The 65-foot long machine, now in operation in Cleveland, is the one and only built thus far and is working two shifts exclusively on aircraft parts. However, the process will have an important bearing on the production of tubular furniture, lamps, automotive parts, tools, and numerous musical instruments.

The process has wide application in the shaping of light and heavy gage tubes of different metals at high speed. Welded or seamless tubing of any given diameter and thickness can be shaped for any required use, with the wall thickness under accurate control. This is made thicker, thinner, or held to the original thickness in the reduced section by working the tube with selected rolls under variable tension load.

Shaping is accomplished by the rolls in a moving carriage which travels horizontally along the tube, one end of which is anchored to a rotating chuck, while the other is driven by a power unit which is moved to accommodate elongations and to control the thickness. The shape is controlled by a cam parallel to the tube which moves the forming rolls to, or away from, the tube itself.


The Deweys and their automatic shaper for tubular products

RAYON

Production—and A New "Wool" Type

RAYON production in the United States during 1940 reached a record all-time high, estimates placing production at 460,000,000 pounds. This was 20 percent above 1939, which in turn was 3 percent over 1938.

Staple fiber, which differs from ordinary yarn in that the filaments are not continuous, jumped in production by 51 percent.

During the year, Du Pont developed a new rayon fiber with a high degree of permanent crimp. This new fiber, as yet known only by its laboratory name of "Fiber D," has characteristics formerly available only in wool, and it is therefore of particular interest to rug and carpet weavers. It is said also to show promising potentialities in upholstery materials, wall coverings, and plushes.

WATER-WHITE GLASS

New Plate Transmits 91 Percent of Light

GLASS technology has given us in recent years flame-proof, shock-proof, and safety glass, and glass sandwiches that aid greatly in the safety of automobile windows. Now the Pittsburgh Plate Glass Company has developed water-white plate glass which transmits far more light than any plate glass hitherto made. It is especially adaptable for multiple glazing, as in refrigerator cases, and may be used also for double glazing in connection with air conditioning and insulating installations.

The new glass is so clear, according to William J. Aull, Jr., that one can look through a 24-inch light of it, edgewise, and see an object almost as clearly and distinctly as though the glass were not there. Its total transmission of visible light is 91 percent, a figure that approaches the maximum possible. In addition, transmission of all colors in the visible spectrum is almost uniform, its transmission of the violet and blue rays being much higher than that of ordinary plate glass.

CHRONOSCOPE

Times Split Seconds Of Bullet's Flight

SPLIT seconds that are ages to a bullet or a camera shutter, are measured as easily as a wrist-watch measures the time of day by a new device called a chronoscope, developed by the Research Division of the Remington Arms Company.

The device, built into a portable cabinet, splits the second 1000 ways and will measure from one up to 200 of these milli-seconds with less than 1 percent error. Given an electrical impulse at beginning and end of an event, it can be clocked.

It has already proved valuable

for studying the effect of velocity and flight time of bullets on accuracy, range, trajectory, and hitting power, but its use is not confined to ballistics.

The maximum swing of an indicating needle across a scale tells the operator precisely how long it takes a fuse to blow out, a Photoflash bulb to light up, a telephone

Clocks bullet speeds

relay switch to snap, or a blasting cap to go off. Experimental gunsmiths using the instrument can make velocity measurements heretofore possible only in well equipped ballistic laboratories.

Projectile velocities can be measured accurately over distances as short as five or ten feet. "Remaining velocity" can be measured after the projectile has travelled some distance. The actual velocity at 100 or 500 yards, for instance, can be measured in a ten-foot span.

Remington technologists regard the instrument as a marked advance over the Boulenge chronograph, standard ballistic device, which has satisfactory accuracy on intervals of the order of 100 milli-seconds, but errs excessively on those of the order of 10 milliseconds.

GIANT TOOL

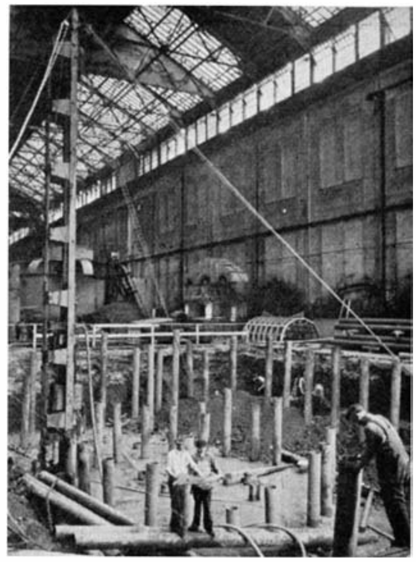
Cuts Fourteen Miles Of Steel an Hour

A 350-TON machine, capable of cutting 14 miles of steel shavings from a 500-ton piece of steel in a single hour, went to work recently at the East Pittsburgh Division of the Westinghouse Electric & Manufacturing Company to speed up production of large waterwheel generators and other power equipment required under the national-defense program.

One of the largest boring mills in the world, the machine supports its work pieces on an 88-ton turntable while two special steel, chisel-like tools do the cutting—like a phonograph needle moving across a record. Eleven freight cars were required to deliver its parts from the works of the machine tool manufacturer.

A pit large enough to hold four six-room houses had to be dug in the generator manufacturing aisle to make room for the machine's 24-ton foundation of steel and concrete. But despite its mass, this new steel Titan makes its cuts with an accuracy of four thousandths of an inch, performing on giant-sized machine parts the work of a fine watchmaker's lathe.

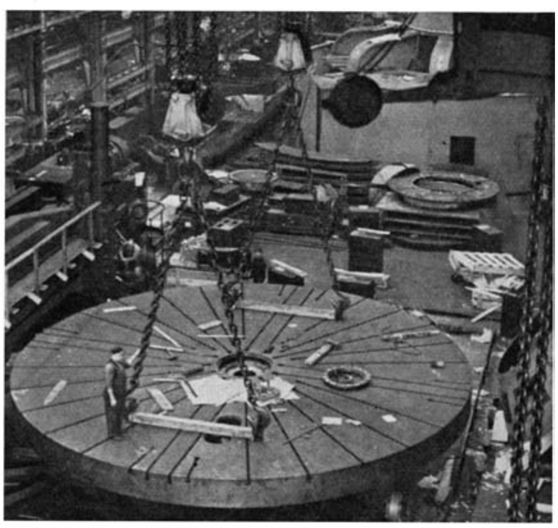
The tools of the boring mill can



Foundation of 125 steel piles, driven 29 feet into the earth, was necessary to support the 88-ton boring-mill turntable

cut a spiral path across the top of a steel disk as it turns on the table, or operate vertically on the sides of steel pieces. The boring mill's normal precision of four thousandths of an inch can be increased by controlling temperature conditions to prevent contraction and expansion. The machining of a steel piece often takes days, while the steel expands during daytime heat and contracts at night. When Westinghouse machined the "horseshoe" bearing for the 200-inch Mount Palomar Telescope, accuracy was improved by working on the piece for only a few hours during the night, during which the temperature changed very little.

Largest of the mill's 34 electric motors are the two 300-horsepower units which drive the table; smallest are the two one-half horsepower midgets which "float" the table by pumping lubricating oil into the grooves between the table and its circular track.



The 30-foot turntable of the boring mill described was cut in two parts for shipping on a special 200-ton freight car. Approximately 1300 cubic yards of dirt were removed for foundation pit

NYLON FOR RACQUETS

NYLON, which has found many uses in fields other than that of hosiery, now becomes racquet strings. This has been made possible by the development of a new "giant" strand, nearly one sixteenth of an inch in diameter. Since this material is practically unaffected by atmospheric changes, it will wear better than silk or gut strings. Since, further, it is a solid piece all the way through, it will not fray and therefore will require no waxing or shellac treatment.

INDUSTRIAL TRENDS

RUBBER'S ROLE

WHEN discussion turns toward the part of rubber in national defense, the question frequently arises of the availability of synthetic rubbers and how they can replace or supplement natural rubber. Present-day trends in the rubber industry, as a whole, can serve as a basis for estimating what will be done with synthetics in the near future.

In 1940, the consumption of crude rubber in the United States was approximately 615,000 long tons, a rise of some 4 percent over 1939. In 1939, there were consumed 1700 long tons of synthetic rubbers of all kinds, a figure which was stepped up to an estimated 3400 long tons in 1940. The present outlook indicates that about 650,000 long tons of rubber will be required to fill orders during 1941; of this total there is a probability that 9000 to 10,000 long tons will be taken care of by synthetics.

Manufacturers of synthetics are naturally secretive about future plans; enough information is available, however, to venture an estimate that by the end of 1941 they will be in a position to produce on a basis of 20,000 long tons annually. Much depends, of course, on a rumored RFC loan of $25,000,000 to $50,000,000 to be applied to synthetic-rubber manufacture.

While the figures—past, present, and estimated future—do not show synthetic rubbers as serious competitors of natural rubber, there are many places in the scheme of things, both in normal consumption and in national defense preparations, where certain characteristics of the synthetics make them not only competitors but highly desirable substitutes. Some of the oil-resistant and antioxidation qualities of synthetics, for example, fit them for use in places where natural rubbers cannot be used satisfactorily or are subject to constant and costly replacement.

Rubber consumption for military purposes involves far more than tires for vehicles; it is in these additional fields that synthetics hold the greatest promise. Flexible hose for many uses, gas mask parts, self-sealing airplane fuel tanks, airplane de-icers—the list is a far longer and more imposing one than could be itemized here. In this list, however, are implications of important outlets for the synthetics—implications that will, more and more, become realities as production of synthetics gets into stride.

IN THE BUILDING TRADES

Increasing prices for lumber and millwork, due to a variety of reasons, provide attractive opportunity for other building materials. Coming at a time when building construction all over the nation is on the upgrade, these higher prices for one of man's oldest building materials make it possible to turn to other sources which, under different circumstances, might be ruled out on grounds of immediate economy.

Brick, steel, cinder block, glass, plastics, all are usually higher in first cost than wood, although under most conditions they are more economical when permanency of the finished structure is considered.

Here is a case where increasing costs in one branch of an industry will undoubtedly react to the detriment of that branch; at the same time, products of science and technology are available to fill the gap that has been created. With the gap yawning for attention, there is every reason to believe that research men will soon close it, and, in the closing, will give added impetus to the use of a wide range of materials hitherto in the luxury class.

POWER INCREASES

As industries in general expand their operations, demands for electrical power climb; with increasing demands comes the need for power-plant expansion. Last peak year for expenditures for new steam-generating plants and equipment was 1924, during a period of vast industrial expansion; 1940 came close to equalling the 270 millions which were invested during that year. Estimates for 1941 indicate that a new all-time high will be set with at least three-quarters of a billion dollars spent for new and improved construction.

Emblematical of this expansion of steam-produced electrical power, and indicative of a definite trend, is the world's largest high-speed turbine generator, nearing completion in the East Pittsburgh works of Westinghouse. This generator will supply sufficient current to light a million 60-watt bulbs, its 35-ton rotor being whirled at a speed of 3600 revolutions per minute by a steam-driven turbine. Steam enters the turbine at a temperature of 900 degrees, Fahrenheit, and at a pressure of 1250 pounds. So high is the steam temperature that the moving parts of the turbine glow a dull red when in operation; this fact, alone, presented a pretty problem to the turbine designers.

This turbine generating unit will be installed in the Waterside station of the Consolidated Edison Company, in New York City. Thus do engineers and scientists provide the wherewithal for industry, supplying demands and, more often, creating new potentialities long before the demand is voiced.

BLACK-OUT FOR PEACE

Exigencies of war in Europe have taught many lessons, one of them being the protection afforded by black-outs. Developments in air-conditioning and electric lighting, reported regularly in the pages of this magazine, have not only made feasible the permanently blacked-out factory building, but have shown that the windowless building holds as many advantages for peace-time operation as in time of war.

Windowless factory design has already begun in the United States, indicating a trend toward building construction in which problems of ventilation and lighting are solved on a scientific basis. Air-conditioning equipment takes care of ventilation, providing working conditions that can be accurately controlled in temperature and humidity; fluorescent tube lighting, rapidly striding to the fore because of its color characteristics and economy, is taking over the lighting problem and solving it in a thoroughly effective manner. Contributing to the growth of this type of plant construction is the development of new materials that can be produced satisfactorily only under controlled temperature and humidity.

—*The Editors*

The Railroads Are Ready

American Railroads Are Now Equipped to Meet National Defense or War Emergencies

HOLCOMBE PARKES

ONE significant fact stands out in all the current rush of national defense preparation. The railroads—vital link in national defense—are functioning more smoothly than ever before. In the railroad industry there is no confusion and haste to make up for lost time. Why not? Simply because the railroads are already prepared to play their role in national defense.

Do not minimize the importance of mass rail transportation in time of war, or in time of preparation against war. Most war-time governments have found it necessary to commandeer the railroads. Our own government did so in the last world war. Although there is every indication that it will not have to do so again, our railroads are perhaps more essential today than ever before. With coast lines 3000 miles apart, it might be necessary to rush troops, equipment, and supplies across the continent in either direction, a task which could be expeditiously handled only by rail transportation.

The railroads have prepared themselves against the sort of transportation confusion which resulted from our entry into the war 24 years ago. Both the railroads and the government have profited by mistakes made then. The many improvements in the railroad set-up today over that of 1917 can be classed under three heads—better equipment, more efficient operating methods, and planned organization for emergencies.

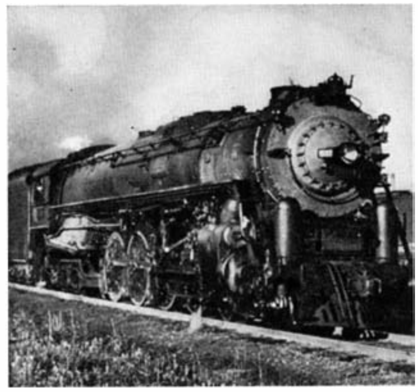
Freight locomotives today are far superior, on the average, than they were in 1917. The average tractive power of all locomotives in 1939 was 50,395 pounds, an increase of 52 percent over 1917. Locomotive design has undergone many changes to make for greater speed sustained over longer distances. Larger diameter of driving wheels, larger grate area, steam pressures of 250 or 300 pounds per square inch, and steam temperatures of 650 to 750 degrees, Fahrenheit, are some contributing factors in the evolution of the freight locomotive. Roller bearings and light-weight alloys are being used more and more. Large tenders capable of holding as much as 26 tons of coal and 22,000 gallons of water eliminate many service stops on long runs. Electric traction on the road and Diesel-electric traction in yard service have found important roles in fast and efficient freight handling.

Freight cars have likewise undergone a remodeling process. The average capacity is greater by eight tons than in 1917. Brakes, draft gears, trucks, and under-

The C. M. St. P. and P. and other roads carried many troops to maneuvers last summer

frames have taken their turns at improvement. Savings in weight as high as 6½ tons per car have been realized through special features of design, welding, and the use of high-tensile steel and aluminum alloys. Cars for special uses aid shippers in transporting their goods most efficiently.

Naturally, all the locomotives and cars in service are not of the latest design. Much slightly older



More power than in 1917

equipment is kept in service for use in handling peak traffic loads. The railroads cannot distribute their service evenly throughout the year, but must meet demands as they come. It would be poor judgment to invest in new locomotives and cars which would stand idle many months of the year.

MUCH of the ten billion dollars which have been invested in railroad plant improvements since 1920 has gone into better tracks, modern signals, and well-planned terminal facilities. Heavier and longer rails, improved processes of cooling rails in the steel mills to eliminate defects in the metal, and welding of rail joints either before or after the rails are laid have lowered maintenance costs and increased efficiency. Curves and grades have been reduced. Stronger bridges have been built. Passing tracks—sidings—have been lengthened.

Some of the greatest railroad developments since the time of the last war have taken place in signaling operations. Automatic block signal systems have been extended and improved to keep pace with the faster tempo of modern freight train operation. Locomotive cab signals, automatic train control, and interlocking systems aid in speeding operations and eliminate, to a great extent, the possibility of human error. Centralized traffic control is a signaling development which reduces the overall time of freight trains from one to two minutes a mile over the congested lines where installations have been made.

Modern freight yard and terminal layout and equipment is an essential item in the railroads' readiness to meet emergency traffic demands. Remotely controlled power switches and car retarders make it possible to break up and sort a 100-car train over the gravity hump of a modern classification yard in less than 20 minutes. Yards and equipment have been redesigned for speedier servicing of locomotives and cars en route.

Efficient operation brings benefits in two ways:

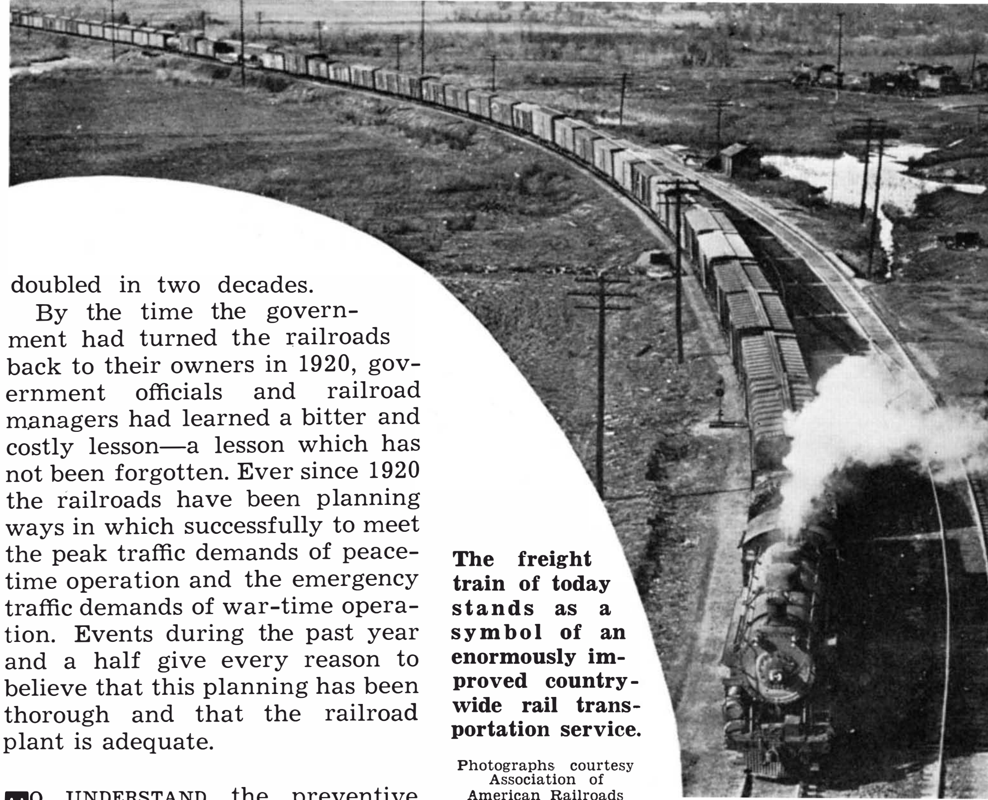
First, the time of freight in transit is shortened, with resulting savings to shippers. Between 1920 and 1939 the average speed of freight trains increased 64 percent. Whole days have been cut from freight schedules in recent years. Overnight merchandise service between points 400 and 500 miles apart is not unusual.

Second, equipment is used more intensively, with resulting savings in investment costs. In 1929, with 60,000 fewer freight cars and 5600 fewer locomotives than in 1918, the railroads handled 18 percent more carloads of freight. In fact, in nine different years after the World War they handled more traffic than in 1918, when the government had to take them over because of the transportation congestion then existing.

Outstanding achievements in operation have come through the coördinated movement of scheduled freight trains, more thorough classification of cars at major terminals to eliminate intermediate reclassification stops, and the elimination of unnecessary delays to freight trains.

The combined effect of better equipment and improved operating methods is reflected in the fact that the net ton-miles per freight train hour increased from 7303 in 1920 to 13,449 in 1939. In other words, the efficiency of railroad freight operation has just about doubled in two decades.

By the time the government had turned the railroads back to their owners in 1920, government officials and railroad managers had learned a bitter and costly lesson—a lesson which has not been forgotten. Ever since 1920 the railroads have been planning ways in which successfully to meet the peak traffic demands of peacetime operation and the emergency traffic demands of war-time operation. Events during the past year and a half give every reason to believe that this planning has been thorough and that the railroad plant is adequate.



The freight train of today stands as a symbol of an enormously improved country-wide rail transportation service.

Photographs courtesy Association of American Railroads

To understand the preventive measures which have now been taken by the railroads, it is helpful to recount briefly the transportation mistakes of 1917 and 1918. The railroad "breakdown" did not come as the result of the inability of the railroads to carry the goods. In 1916, the railroads of the United States handled the heaviest traffic in their history up to that time. In 1917, the year the United States entered the war, railroad freight traffic increased only 9 percent. But in that year, the use of government priorities played havoc with rail transportation. Hundreds of thousands of cars of government freight were rushed to the Atlantic seaboard area, only to be held there for weeks and sometimes months because no provision had been made for unloading on arrival. At one time more than 200,000 freight cars were out of transportation service—they were being used as warehouses, with accompanying congestion of yards and terminals. The railroads did the best they could with the equipment available for transportation service. But they had no control over the issuance of priorities, and the consequent misuse of freight cars. So at the end of December, 1917, the roads were taken over by the government. In 1918, freight traffic was only 3 percent more than in 1917. In 1919, it dropped back to the level of 1916.

Notwithstanding other difficulties encountered under war-time operation, the railroads probably could have handled the load had there been a systematic control of car movements. There is such a control in actual service today.

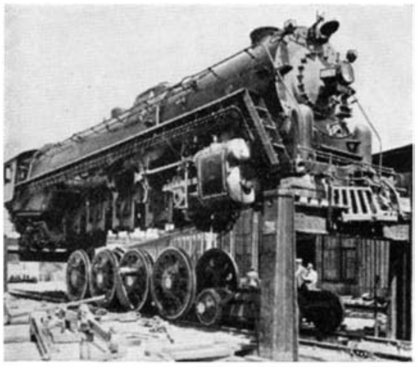
More efficient classification yards

Since 1922, shippers all over the country have organized themselves into 13 regional Shippers' Advisory Boards, coördinated in a national association. Through these boards, 25,000 shippers regularly forecast their freight car requirements in all sections, so that the Car Service Division of the Association of American Railroads can plan to have enough cars where they are needed when they are needed. The Car Service Division, with headquarters in Washington, has 13 district offices and car service agents at all important terminals whose duty is to keep cars moving in accordance with established rules.

The Car Service Division, for a number of years, has had in operation an embargo and permit system, under which embargoes are placed against consignees who cannot unload cars promptly on arrival. These embargoes are held in force until the consignees are able to unload goods, when permits for shipments are issued by car service agents. Plans have been established under the control of the Army and Navy Munitions Board to prevent the loading of government freight until it is known that it can be unloaded promptly at destination. Where necessary, the government, through the Association of American Railroads, can arrange for the issuance of embargoes on government freight. Thus, the necessary preparations have been made to prevent the transportation confusion of 1917 and 1918.

In the last war, many freight

cars sent to eastern seaports stood under load because vessels were not available for the trans-shipment of goods. In the summer of 1939, the Port Traffic Section of the Car Service Division was established in New York. Through daily reports and the use of embargoes, this office is equipped to prevent congestion at all Atlantic and Gulf Coast ports. During the past year, export freight through the port of



Improvements have been made in train and track maintenance

New York has been as high as 85 percent of the peak traffic of the last war, yet has been handled with facilities to spare.

The Military Transportation Section is still another branch of the Car Service Division, established to coördinate railroad operations throughout the country for defense purposes. An illustration of how this section functions was given last August, when in the space of a few days the railroads carried 150,000 troops and their equipment to army maneuver areas. Car service field agents and railroad traffic officers informed the Military Transport Section of troop train movements by telegrams which were sometimes received at the rate of one a minute. This information was relayed to the Quartermaster General's Office where movements of 300 trains, day and night, were shown on a large wall map. By keeping in such accurate touch with train movements, the troops could have been quickly diverted had the necessity arisen. In one three-day period, nearly one-sixth as many troops were moved as *in the peak month of the World War.* This movement was consummated without delay or congestion, during the summer period of heavy tourist traffic.

The railroads have left no stone unturned in their efforts to assure the United States of a smoothly running transportation machine, whatever emergency may come. Even though statistics show that all the additional traffic which is likely to result from the national defense program is but a small fraction of the regular commercial traffic, railroad men are taking no chances. Class I railroads, in the first nine months of 1940, placed in service 52,685 new freight cars and 265 new locomotives, while orders for 16,892 freight cars and 215 locomotives were outstanding on the first of October.

No higher compliment could be paid the railroad industry than that expressed by Louis Johnson, as Assistant Secretary of War, in an address on April 26, 1940. He said:

"We, in the War Department, have full confidence in the innate capacity, in the co-operative spirit, in the ability, and the patriotism of our railroads to cope successfully with the transportation problems that any grave military emergency would involve. Our faith is well founded."

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THE "JEEP"

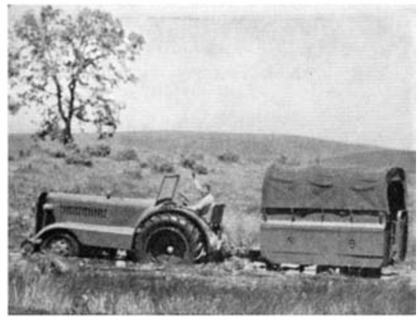
Versatile Tractor

For Army Use

ONE of the strangest and at the same time one of the most versatile military vehicles yet tested is a tractor made by Minneapolis-Moline Power Implement Company. This tractor pulled six-inch howitzers over almost impossible terrain, through mud and water 40 inches deep, and crashed through trees four and five inches in diameter, reports *Ethyl News*. Furthermore, it virtually climbed the trunks of trees 28 inches in circumference to heights of 70 inches, at which point its weight was sufficient to break the tree.

This tractor was designated merely as a military high-speed

The "Jeep" can climb trees



Amphibious, it fords streams

prime mover, but the Army boys were quick to christen it the "Jeep." It is powered with a standard 6-cylinder engine, develops 75 horsepower, and will tow heavy equipment at 40 miles an hour on the level. It operates on 70 octane gasoline and is a four-wheel drive vehicle with two front and four rear tires, the front ones being 8.25

Rolls over rough terrain

by 20 and the rear 11.25 by 36—all low-pressure pneumatic.

The "Jeep" is provided with both air and electric brakes for controlling the towed load. The drawbar at the rear is equipped with an air lift which makes it possible to back into a load and lift or lower that load from the operator's seat.

TWO NAVIES

Comparison of U. S.

and Japanese Navies

MANY years ago, Admiral Mahan, whose books on naval subjects are studied by the navies of the world, said that if we should ever fight Japan we would need four times the naval tonnage of that nation in order to be victorious. Many things have happened to modify this situation—if, indeed, Admiral Mahan did not exaggerate it in the first place. It is still serious enough, however, for any war with Japan would have to be fought on Japan's home waters. Because of the dis-

Navy	Category	Built	Building	Total
U. S.	Battleships	15	17	32
Japan	"	10	8*	18*
U. S.	Aircraft Carriers	6	12	18
Japan	" "	7	3	10
U. S.	Cruisers	37	48	85
Japan	"	44	6	50
U. S.	Destroyers	155	170	325
Japan	"	135	11	146
U. S.	Submarines	103	82	185
Japan	"	69	13	82

*Estimated.

tances our ships would have to travel and because of our present lack of sufficient bases in the Pacific, the accompanying comparison of two navies is signficant.

Five 35,000-ton Japanese battleships, each carrying nine guns of at least 16-inch size, are scheduled to go into commission in 1941. Two more, of the *Owari* class, will be commissioned in 1942. These two are believed to be the first of the super-ship type of 40,000 tons each.

The U. S. Navy, in 1941, will commission the *North Carolina* and the *Washington*. In 1942, four more—the *Alabama, Indiana, Massachusetts,* and *South Dakota*—will go into service. All six of these are of about 35,000 tons. The first of our 45,000-tonners—the *Iowa, New Jersey, Missouri,* and *Wisconsin*—will not be ready until 1943.

SUB-MACHINE GUN

Lighter Weight, Lower Cost, Mass Production

PRODUCTION is now under way at Harrington & Richardson Arms Co. on a new sub-machine gun, invented by Eugene G. Reising, capable of all the fire power and effectiveness of the existing accepted military type but weighing 50 percent less and costing approximately 60 percent less.

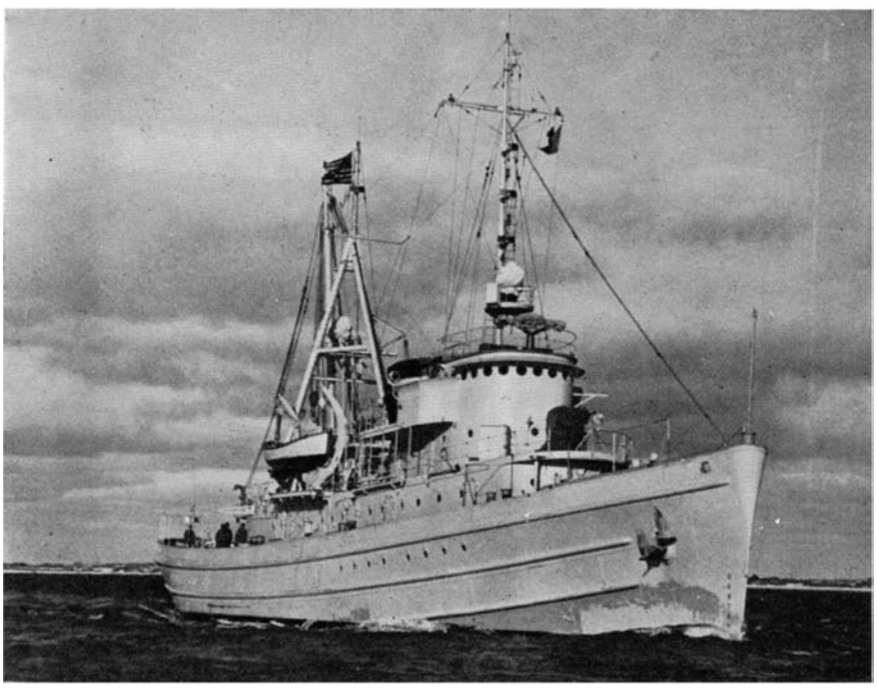
Until recently, heavier sub-machine guns have been adequate to command an area at short and moderate ranges, but military authorities now hold that more intensive distribution of this lighter type of weapon among the troops is tactically desirable. The Reising sub-machine gun, developed to meet this need, incorporates such additional advantages as use of a patented, delayed-recoil mechanism, minimizing recoil and permitting fully automatic firing from any position.


Assembling Reising gun

The Reising gun can fire approximately 500 shots per minute at an effective range up to 300 yards, and weighs only 6½ pounds.


Weighs little, fast in action

Mass-production methods, previously considered impossible for an arm of this kind, will produce 1000 a day by April 1, if present expectations are realized.


The U. S. S. *Navajo,* which will have two sister ships

NAVY TUGS

Three Largest, Diesel-Electric, Ocean-Going

NOT long ago the United States Navy commissioned its first seagoing tug in 20 years. This tug, the U. S. S. *Navajo,* is to be followed by two sister ships, the *Seminole* and the *Cherokee.* These three tugs are the largest Diesel-electric tugs in the world, being 205 feet overall. Main and auxiliary generators as well as propulsion motors and control were furnished by General Electric. The tugs each have four main Diesel engines totalling 3800 horsepower. A 600-kilowatt generator is direct-connected to each of the Diesels.

Wah—Late of Thebes, Egypt

When Used on a 4000-year-old Mummy the X-rays Unexpectedly Reveal a Human Story

H. E. WINLOCK
Director Emeritus, Metropolitan Museum of Art, New York

The digging in Egypt was about over, in March, 1920, when our men unexpectedly struck the buried entrance of a little tomb. Rough steps going down had been successfully hidden with shale chips, and the little tomb door was still blocked with a stout brick wall, but once that had been removed we found ourselves in a narrow, rock-cut room which no one had seen for nearly 40 centuries. At the back there was a coffin bearing the name of a certain Wah, and in it, under a pile of laundered bed linen, lay a mummy with wrappings still as fresh as the day it had been buried.

The meal of beer and bread and meat beside the coffin was so simple, and so were the few objects in the coffin, that there seemed little likelihood of there being anything of value inside Wah's bandages. Furthermore, we had found his title written in ink on some of the bed sheets and knew that he was simply an "estate manager," and since this was not the sort of person who might be expected to be buried with jewels, so far as our experience went, it was decided not to unwrap him but to show his mummy in the Museum, just as it was found.

Reprinted from *Bulletin of the Metropolitan Museum of Art*

For years the mummy of Wah had been on exhibition in the Metropolitan Museum of Art, New York, when it was used in some experiments with an X-ray apparatus. The first photograph gave us a sudden surprise. From Wah's neck, down over his chest, and about his wrists crossed in front, there was a whole series of objects clear enough in the X-ray to be easily identified. We could recognize strings of beads around his neck, a broad bead collar over his breast, bracelets and anklets on his arms and legs, and some extraordinarily large scarabs near his wrists.

The outermost piece of linen on Wah's mummy was a shawl, wrapped kilt-like about him, with its fringed edge around his waist tucked in in front. It had often been to the laundry; it is pink now but had doubtless once been a henna red; and down the front are two very washed-out lines of hieroglyphs, written in black, which read: "Linen of the temple protecting Nytankh-Sekhmet, the justified."

After we had taken off the kilt we unwound a dozen bandages spiraling up and down the mummy, each about as wide as one's hand and several nearly 12 meters long. Then came sheets wrapped around, or big pieces of linen folded as pads and laid on to fill the mummy out until it was practically a cylinder. Later we came to a layer of bandages streaked with the very thin dregs of a pot of resin, probably smeared on with incantations for Wah's continued existence, for its purpose must have been magic—it could have had no preservative effect. A score more of sheets and pads were then unwrapped, and Wah, from having been a very stout party, was becoming more and more slender, and the face which had been peeking out of thick folds of linen now appeared as part of a stucco mask extending down to his waist.

The pinched little face was

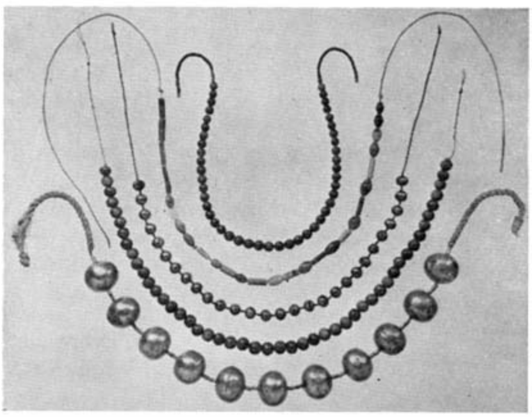
Wah gradually emerges as enough wrappings to cover a building lot are removed from his small body

gilded, and on it were painted a thin moustache and, around the jowls, scant whiskers. A highly conventionalized wig, striped light blue and dark green, covered the head, and a crudely painted broad collar with red, blue, and green rows of beads was shown suspended on the brown chest. It was a barbarous-looking affair, but, after all, Thebes was still a rather countrified, Upper Egyptian town when Wah died, and this mask was clearly bought from one of the more old-fashioned of the local artisans.

One of the two silver scarabs. Its length is 38.5 millimeters

When we had taken off the mask and ten more sheets and pads, we came to another layer of resin, thick and black this time, poured all over the front of the body except the head and face. When we had removed it, the bandages it had penetrated, and another dozen sheets and pads, we came to the first of Wah's jewelry.

There were four bead necklaces, each with its cords tied behind the nape of his neck. There was a string of 11 big, hollow, silver spheroid beads separated by little cylinders, and another string of 28 smaller ones of gold. A third string was of 48 blue faience ball beads, and a fourth of 28 cylindrical and oval beads of carnelian, amethyst, moss agate, milky quartz, black and white porphyry, and green glazed steatite. The dents in the hollow metal beads and the fraying of the cords of the silver and of the faience necklaces show that at least three of these strings had actually been worn by Wah or by some of his family, just as we see them today.



The jewelry from Wah's mummy, as exhibited at the Metropolitan Museum

Half a dozen more bandages and pads and then we came to more jewelry. Another string of 45 deep blue faience ball beads had simply been bundled together and laid on the mummy's chest, and over his crossed arms there had been placed four large scarabs. One was of plain blue faience, about an inch long, without any inscription or other device. The other three are among the surprises of our Egyptian work.

Two are of massive silver and the third of lapis lazuli. The larger silver scarab is an inch and a half long. Each was made up of separate pieces, molded and chased and then soldered together—a head and back plate, legs, and a flat base, with a gold tube for a cord fastened lengthwise through the middle. The lapis lazuli scarab is nearly an inch and a half long and perfectly plain, but on the bases of the two silver ones there are graceful, meandering scrolls interspersed with hieroglyphs which made easily recognizable seal devices. Both silver scarabs were oxidized, and when we began to clean the larger one we found heiroglyphs skilfully inlaid on its back in pale gold, those on the one wing reading, "The Prince Meket-Re," and on the other, "The Estate Manager Wah"—the names of the owner of the scarab and the grandee for whom he worked. The scratches and dents on the polished surfaces of this silver seal scarab and its smaller mate, and the wear in their gold string-holes, showed that they had seen real use. But it was surprising to find that just before they had been put on the mummy the faces of both the silver scarabs and of the lapis lazuli one had been purposely and methodically hammered and pecked as though to blind them. Then, after the blinding, each scarab was strung on a stout linen cord with one barrel-shaped and one cylindrical bead, which obviously made them into amulets to protect Wah against some of the many perils of the life to come.

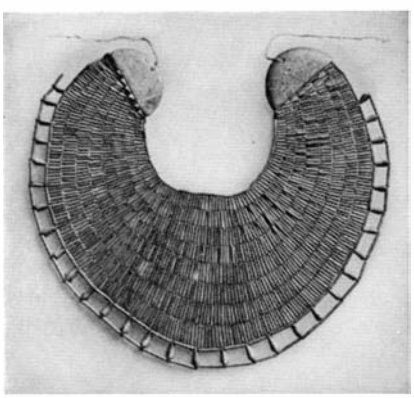
NEXT we unwrapped half a dozen large bandages and twice as many pads and sheets, each one more stained with resin than the last. Clearly the linen we were now taking off had been put over a third resin layer while it was still soft, and when we got down to it we found stuck fast in it a broad collar of greenish blue beads on Wah's chest and matching bracelets on his wrists and ankles. All were stiff with the resin which saturated them, and tight bandaging had crumpled up the collar, but soaking in alcohol made them all pliable once more, and their stringing needed very little reinforcement before they were ready for exhibition.

What we found so far had seen actual use in Wah's lifetime. Here we had objects made expressly for the tomb and in the style of centuries long gone by even in Wah's day, and perhaps this explains why they had been put on the body in a perfunctory and careless way. The cords of the broad collar had only been twisted together behind the nape of the neck, and not tied, and there had been a good deal of confusion over the bracelets. There were eight of these last. Two were tied on each ankle, and then, by some mistake which no one noticed, a third was put on the right ankle. Thus, when the undertakers began putting bracelets on the wrists, they had only three left, and the last of these they simply dropped on the body in the soft resin and went on with their bandaging.

We still had quantities of bandages and sheets to take off, but there was only one more object to remove. We had thought from the X-ray that an oval seal was on a finger of the left hand, but what we actually found there was an oval *seweret* bead of red carnelian such as was usually put on the throat of a mummy. Why this one was laid in Wah's palm is still another puzzle.

While we were unwrapping the mummy we had it up on two carpenter's saw horses; the Egyptians who wrapped it probably had it up on blocks of wood while they squatted beside it on a wide wooden platform. Alongside they had great heaps of old linen bed sheets, which they tore as they needed into pieces about eight feet long or into strips of bandage of whatever width they required at the moment.

NEAR by was the resin pot, and sometimes the resin got splashed on the heap of linen and sometimes it was wiped from sticky fingers on the pile of sheets, but the emblamers were very careful not to get any on the bandages that were going to show or any pitchy fingerprints of the part of the mask that was not going to be covered up. When, however, they thought they would not be found out they showed indifference. One of them had killed a mouse while they were smearing on the last layer of resin, and the dead mouse and the linen resin swabs were dropped on the mummy's knees and hidden



The blue-green collar, found rather mussed up — perhaps Wah wasn't a popular overseer

under the next bandages. What we had taken for another mouse was much less distinct in the X-ray. It turned out to be a little house lizard, of a kind still common in Egypt, which probably ran under the mummy, got stuck in the innermost layer of soft resin, and was wrapped in the bandages. A cricket had been entrapped in the same pitch layer beside the broad bead collar, and it got wrapped in, too.

In all we unwound 375 square meters of linen from the mummy, and, if we add the sheets we found in the coffin and two pieces which had covered it in the funeral procession, the total from the tomb of Wah comes to about 9090 square feet, or nearly a quarter acre. This was old household linen, shawls and bed coverings saved against the day of need, or procured from friends and relatives, or perhaps even bought of strangers for the occasion. Linen was costly and was an important form of wealth.

In the corners of at least 60 of these sheets there had been written in ink a hieroglyphic sign or two which told its quality, and often, in the opposite corner, the owner's name. For some reason there seems to have been an objection to letting linen go to the tomb so marked, and therefore most of the little labels had been torn out. This was done during the actual wrapping of the mummy, but so carelessly that three of the torn-out corners got rolled on the mummy with the bandages, and one third of the marks were entirely overlooked and not torn out at all. Half a dozen gave the names of various people for whom they had originally been woven, and in the mark on the longest sheet of all we could just make out "Year 31," now very faded from much washing. That seems to fix the date of its weaving some 30 years before Wah died.

Eleven sheets bore the name of Wah himself. One was marked with his name only. Two were marked with his name and the date "Year 2," unquestionably of King Sankh-ka-Re, the last legitimate ruler of the Eleventh Dynasty. Then come three sheets of "Year 5," three of "Year 6," and two others without any year, all marked "The Estate Manager Wah." It looks as though it had been between the second and fifth years of Sankh-ka-Re that Wah got the job of manager of Meket-Re's estates, and as there are no higher dates than the sixth year, he probably died in the second half of the king's 12-year reign, or about 2010 B.C.

It only remained to find out what we could from the body of Wah himself, and in this we had the co-operation of Dr. Harry L. Shapiro of the American Museum of Natural History. Wah turned out to be a youngish man about 30 years old, who had undergone a primitive mummification. His brain was probably left in place, and the embalmers seem to have left his viscera intact above the diaphragm. Below that level they appear to have removed them, apparently through an incision in his lower abdomen. The more or less prolonged soaking had made Wah's flesh so soft that too tight a bandaging made a very narrow bundle of his body.

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AMERICAN PREHISTORY

Summary of Major Factors in Early Peopling of the Continent

THE New World apparently was peopled by two major migration waves out of Asia. There have been human beings in North America for approximately 15,000 years.

These are among the conclusions stated by Smithsonian Institution ethnologists in a recent major stock-taking of North American prehistory.

It is now fairly conclusive, reports Dr. T. D. Stewart, one of the ethnologists, that two different basic stocks were represented in the aboriginal population. One was characterized by long, high heads, and broad noses. This type of skull predominates in those sites which, it can be demonstrated, were settled first. Later sites yield skulls of a broad-headed people.

A few years ago it was generally believed that man was a relatively recent arrival in North America. Finds of human artifacts in geologic strata which can tentatively be dated and in association with the bones of extinct animals have forced a revision of this doctrine.

The remains are so few and scattered that the historical picture remains very confused. A broad outline is that, late in the Pleistocene geologic period, there was an ice-free corridor from the Arctic through Canada east of the Rockies by which bands of hunters were able to penetrate far to the southward. Those probably were the so-called Folsom and Yuma men whose spear points are widely found.

Later, it now appears, this corridor was closed by some fluctuation in the ice sheet and — perhaps after a long interval — other groups began coming southward west of the Rockies.

Magnetism Comes of Age

Today Science Knows that the Ultimate Key to Magnetism is the Spinning Electron

JEAN HARRINGTON

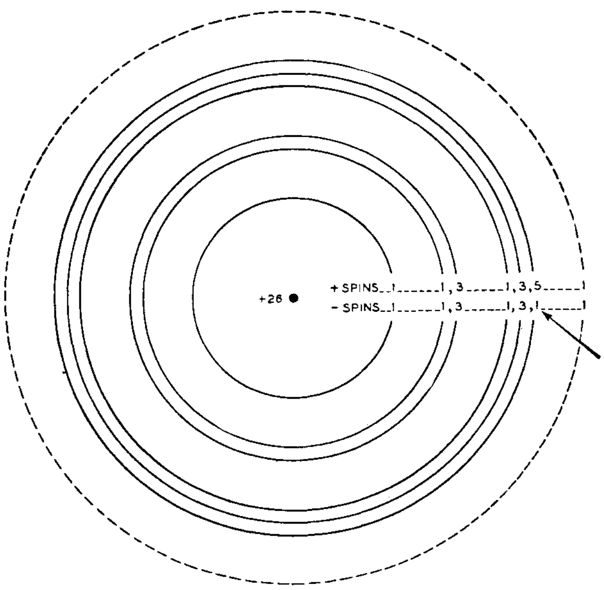
MEN have known about magnetism since before the dawn of history, but magnetism as a science has been in its adolescence until lately. The past few years, however, have seen such strides that, today, though we still don't know all the answers, we think we know enough to say that at last this science is coming of age.

There are various kinds and degrees of magnetism common to all substances, but the kind that people generally mean when they say "magnetism" is ferromagnetism. It means, literally, "magnetism similar to iron's." It means, in practice, the power of certain materials to exert strong external forces, to build up intense magnetic fields, to magnetize other susceptible bodies, or to move them. Only a few materials have this peculiar power, but their significance in your life and mine couldn't be exaggerated. Our telephone receivers, our radio loud speakers and, more fundamental, all our electrical systems that light our lamps, run our motors, or manufacture the goods we buy, are based on the use of ferromagnetic substances.

It is tremendously important for man to know a lot about these materials—how they get that way, how they vary with heat and cold, how they behave under strains and tension, how their qualities change when other materials are mixed with them. Knowing all these things, man can make more efficient machines—create, perhaps, more wonders.

Of the known ferromagnetic materials, iron, cobalt and nickel are the Big Three, and their characteristics are carried over into many of their compounds and alloys. A fourth element, one of the rare earths, gadolinium, has recently been added to the list, but it probably will prove to be of little commercial importance. Most ferromagnetic materials contain one or more of the Big Three elements, but a marriage of non-magnetic elements sometimes gives birth to a ferromagnetic alloy, proving that the Big Three aren't essential.

What, then, does iron possess that copper, for example, or lead, does not? Why ferromagnetism?



Illustrations courtesy Bell Telephone Laboratories

Electron shells in an iron atom. Arrow indicates incomplete sub-shell that causes ferromagnetism

It all goes back to the atom, so let's take a look at the atom, and particularly at the electrons that are its outer part.

If you were of a size to ride on an electron, you might feel quite at home, so alike is the geography of an atom to our own solar system. Electron "planets" whirl in orbits around a nucleus "Sun", and also spin on their own axes, just as the Earth turns about its own.

Whenever electricity is in motion (and it always is—nothing ever rests in this universe of ours), it creates a magnetic field about itself. Electrons are infinitesimal bits of negative electricity. Therefore, *q.e.d.*, every moving, spinning electron in an atom creates its own magnetic fields—one for its orbital motion, one for its spin. We can leave the orbital effect out of the present discussion, because experiment shows that it has little or nothing to do with ferromagnetism. The effect of the spin alone is enough to make each electron behave in many respects as if it were a tiny bar magnet with a north and south pole.

The spinning electron is the ultimate magnetic particle, the key to magnetism. Yet these elementary electron magnets are far too feeble to have any influence outside their own small sphere. Moreover, the atoms of all elements, ferromagnetic or not, contain these seeds of magnetism. How, then, does it happen that the tiny seeds grow to such lusty proportions in a few cases, yet are choked out in the large majority of elements?

Well, the study of ferromagnetism, as we shall see, is a study of co-operation—co-operation between electrons within atoms, between atoms in a group, and finally, between all the groups in a mass of material.

The first step is to find what magnetic effect the spinning electrons have on the atom as a whole. Often the spins add up to nothing at all. This is possible because the electron spinning clockwise cancels out the magnetic effect of a nearby electron whirling counterclockwise. Take, for example, the helium atom with its two electrons spinning in opposite (plus and minus) directions. Their two magnetic fields blot each other out; the net magnetic effect is zero, so helium is magnetically neutral.

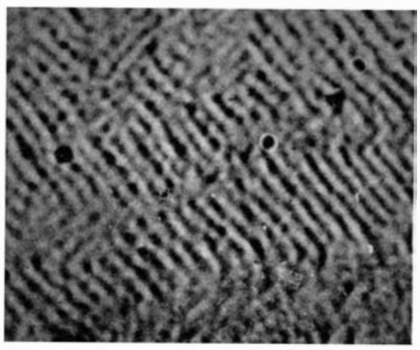
But in ferromagnetic materials we could hardly expect to find magnetically neutral atoms. On the contrary, instead of neatly counterbalanced plus and minus spins, we anticipate a marked excess of one kind over the other. And that is just the case.

THE iron atom has 26 electrons in its outer structure, all following separate orbits around the nucleus. These orbits fall into certain groups, or shells and sub-shells, as shown in the first figure. The number of electrons with each direction of spin is marked on the drawing for each of the several groups.

On comparing the numbers it is apparent that one of the subgroups—the outer part of the third shell—is all out of kilter: six electrons, and five of them with plus spins. All the other groups are balanced, the spins cancelling out. But here, in effect, are four rebel electrons to give the iron atom a strong permanent magnetic effect. In cobalt, there are three extra "plus" electrons, in nickel, two.

In the case of alloys, where one metal is dissolved in another, electrons from one element drop into outer shells of the second element; and, if the new arrangement leaves unbalanced spins in the majority of atoms, the alloy has at least a possibility of being ferromagnetic. For, as long as it has excess plus or minus spins, the atom as a whole behaves like a small magnet, and this is the first requisite of ferromagnetism.

Unfortunately, lots of other atoms besides the ferromagnetic ones have permanent magnetic effects—hydrogen, for example, with its lone electron. Yet hydrogen not only isn't ferromagnetic; it is magnetically neutral in the molecular state. This is because the pair of atoms in an H_2 molecule have opposite spins. So there must be some additional requisite for ferromagnetism besides atoms that act like magnets.



Typical powder pattern, X 1000

Now a single little atom is no good to anybody as a magnet, but when trillions of atoms all get lined up in the same direction, pulling with instead of against each other, they can lift many times their own weight, or produce the powerful magnetic fields that make our dynamos and motors run. The question is, how to get them lined up.

An important thing to remember about magnets is that they have a tendency to rotate when they are placed in the field of some other magnet. When they are free to pivot, they rotate just enough to line themselves up in the direction of the outside field. The compass works on this principle. This tendency toward rotation is termed "magnetic moment," and atoms with unbalanced electron spins are said to have permanent magnetic moments.

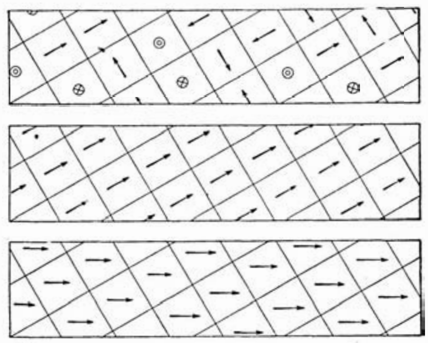
The earth, itself a gigantic though rather weak magnet, provides a universal outside field, and one might suppose that all magnetic atoms would rotate in it and line themselves up north and south, like tiny compasses. Fortunately, perhaps, this doesn't happen, or coins might fly out of our pockets and we'd run into difficulties with the steel springs of our watches and clocks. It takes a greater force than the earth's field to marshal atoms in magnetic array; in fact, it takes a stronger field than any man has been able to produce. This is because atoms are such jitterbugs. Even at ordinary temperatures and in solid materials they are vibrating and rotating like mad. Strong external fields alone are not enough to calm them down and straighten them out.

But in the ferromagnetic clan, and in it alone, there exists another force—an internal force that makes groups of neighboring atoms lie parallel to each other. This force is an abstruse thing, called an "exchange interaction." It is quite distinct from ordinary electrical or magnetic forces, and depends on such things as the radii of electron shells and the distance apart of atom centers. The exchange interaction is universal, but it can be either positive or negative. When it is negative, as for hydrogen, it tends to bring atoms of opposite spin together, resulting in nonmagnetic materials. For the ferromagnetics it is positive, lining up atoms of parallel spin into submicroscopic groups or "domains" of intense magnetization.

We can't see the domains but we know they are there. Everyone is familiar with the feathery patterns that iron filings make when they are spread on a piece of paper and held over a bar magnet. The tiny domain magnets produce the same kind of patterns when powdered iron is spread on the surface of an unmagnetized ferromagnetic crystal . . . only you have to use the microscope to see them. A typical powder pattern is shown in the photograph.

The domains, small as they are, contain billions of atoms which pool their individual magnetic moments. The result is a domain magnet, billions of times stronger than the atom magnets . . . strong enough to respond to outside fields. This is the essential difference between ferromagnetic substances and the rest of the world.

In an unmagnetized iron crystal, the domains lie all helter-skelter, pointing toward any one of the six crystal sides, as in the top part of the illustration below, where the



Domains in a single iron crystal

diagonal lines indicate the crystal axes; the circles, crosses, and arrows the domains. The arrows also indicate magnetic fields. It is a tug of war, with neither side gaining an inch on the other. But when the crystal is put in a strong enough magnetic field, the atoms within the domains begin to rotate. First they swing around until they are all parallel, as in the middle part of the figure. Then they gradually rotate till they all lie along the direction of the outside field, as in the bottom part. This final step brings the magnet to full strength or saturation. Sometimes the earth's field is strong enough to aline the domains, and that is why we have naturally occurring magnets.

The crystal can be demagnetized by reversing the direction of the outside field, or by heating the material so hot that nothing, not even the strong internal exchange forces, can make the atoms and the domains stay in line. The temperature where this happens is called the Curie point, after Pierre Curie, who did outstanding research in magnetism before he and his famous wife discovered radium.

This has been only a sketchy account of the why of magnetism. We have seen how two fundamental conditions must be satisfied—first, that the atoms have a permanent magnetic moment, and second, that an internal force exists to hold the spins of groups of atoms parallel. There are many other factors, however, which influence magnetic properties—problems of chemical composition, methods of preparing materials, and so on—too complex to go into.

Our civilization requires many great tasks of ferromagnetism, and that is why our engineers and metallurgists, our physicists and chemists need a sound knowledge of the principles that govern it.

• • •

SOUND

By a New Method The Speed of Sound Has Been Redetermined

A NEW method for measuring the velocity of sound over short distances has been devised in which 60 pulses per second cause a sinusoidal curve to appear upon an oscilloscopic screen. As the receiving microphone is moved away from the sound oscillator, or producer, the crest of the sine wave moves across the oscilloscope. The actual velocity of the sound is easily calculated after the distance moved by the microphone has been measured.

The method has been described by R. C. Colwell, A. W. Friend, and L. H. Gibson of West Virginia University. The average of 1200 measurements made by this new method gives a velocity of sound of 331.364 meters per second at zero degrees, centigrade, or 32 degrees, Fahrenheit, and the researchers state that this is accurate within 0.043 meters per second.

NATURE LEADS

Best Light Detector Is Not Man's Invention

A CHANGE in only eight or nine molecules of the "sight chemical," visual purple, in the retina of the human eye is sufficient to produce the sensation of sight, Prof. Selig Hecht, of Columbia University, recently told the American Association for the Advancement of Science. Associated with Professor Hecht in his experiments were Simon Shlaer, also of Columbia, and Dr. Maurice H. Pirenne of the Belgian-American Educational Foundation.

In the research, an observer would stay in a dark room for half an hour, until his eyes had become dark-adapted and reached a maximum of sensitivity to light. Then a flash of light, exactly a hundredth of a second in duration and of carefully measured radiant-energy content, was shot at his eyes. The amount of light actually reaching the retina, when the minimum sight-causing illumination was reached, was calculated at eight or nine quanta, each quantum being able to cause the necessary chemical change in one molecule of visual purple in the retina.

Professor Hecht commented: "Judging by the structure of the retina, the structure of light, and the chemistry of visual purple, it is hard to conceive of a biological system which could be more sensitive than this. Certainly there are no physical systems which even approach it."—*Science Service.*

PROGRESS

Electron Microscope Is Now Ready for Industrial Use

THE electron microscope which substitutes for light a stream of electrons speeding through magnetic coils that bend their paths as a lens bends light, has already emerged from a stage described in Scientific American last July, in which it was essentially an instrument for the physicist and electrical expert alone, and has been simplified so that now it is only

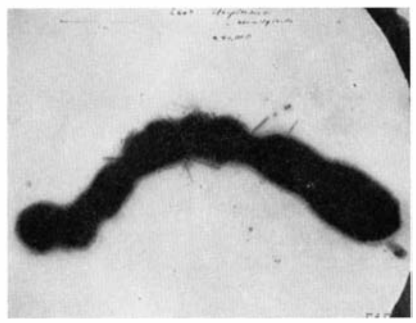
Electron micrograph of human tubercle bacilli showing detail that had never been seen with visible-light microscopes

half as bulky (and incidentally half as expensive) and is adapted to use in general chemical and medical laboratories. No longer need it be operated by a physicist; any competent laboratory worker can use it.

The new form was developed by James Hillier, physicist at the RCA Research Laboratories, under the direction of Dr. V. K. Zworykin, and is expected to find practical uses in virtually every field of industrial research. (See also page 133, this issue.)

With microscopes using light, magnifications of about 1500 were practicable, and at one time it was customary to *prove* that no human being would ever see the detail of any object magnified much more. The proof consisted of the simple fact that the very wave length of visible light did not afford more magnification, and that was that. The electron microscope magnifies up to 25,000 times, additional magnification being possible by photographic enlargement.

Bacteriologists, physicists and industrial laboratory research workers have journeyed to the Camden RCA research laboratories to study their specimens under the new instrument. So much more than has ever been revealed before has



Streptococcus beta haemolyticus under electron microscope. This reproduction, and one at left, were reduced from original photographs that showed magnifications of about 45,000

been made visible, that the scientists have been plunged into intensive research in new and wider fields.

"Objects which have been studied under optical microscopes for years take on new form when magnified 100,000 times," Mr. Hillier says. "Portions of the organisms or particles never before noticed have to be identified, as must other objects being seen for the first time. It is as though a man blind from birth should suddenly regain his sight, only to realize that there were many new aspects to objects with which he had been familiar, but had never seen."

The extreme simplicity of the new instrument makes it ready for operation when plugged into an ordinary light socket. An adaptation of a radio transmitter circuit provides the high voltages required.

A New Tool for Science

A Noteworthy New Atlas Shows Astronomers What the Solar Spectrum is Really Like

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

As THE writer of these lines ran through his morning mail a few weeks ago, an exciting postcard appeared. On its face, it was merely a routine announcement that packages "containing charts" and presumably subject to duty were at the Custom House in New York—and also that they had been sent from the Netherlands by Minnaert.

Here was real news. Every worker on the solar spectrum has known that an atlas of the solar spectrum was in preparation at the Utrecht Observatory by Professor Minnaert—the leading authority on the precise measurement of line-intensities—and that the work had been practically completed before the invasion of Holland. But few had dared to hope that the results could be transmitted across the barrier raised by the War and reach us in perfect condition.

Profound satisfaction in realizing that scientific communications are not completely cut off was followed by enthusiasm when the packages arrived and were opened, and the new Atlas, with its wealth of information, was inspected.

Photographic maps of the solar spectrum have been in the library of every observatory since the classic work of Rowland more than 40 years ago, and anyone who desires one for himself may get it for a few dollars by applying to the Mount Wilson Observatory for the photographs of the sun-spot spectrum, which they have on sale.

A SMALL portion of one of these photographs (in the orange region) is shown in Figure 1—the spectrum of the spot running lengthwise down the middle, with that of the undisturbed disk of the Sun above and below. The differences between the two would furnish material for two or three articles as long as this. We can only notice here that some lines are greatly strengthened in the spots, others much weakened, and a few of the strongest "winged" on each side, while the zig-zag appearance (brought out by polarizing apparatus in front of the spectrograph) reveals the presence of a magnetic field in the spot.

The undisturbed spectrum of the disk appears in comparison to be a simple affair. The stronger lines are wider and blacker than the rest, some of the fainter ones look a little fuzzy; and there are close doubles—as at 6147 and 6163. But the general impression is of sharp-edged lines ruled across a uniformly bright background.

Such photographs are admirably adapted for recording the exact positions of the spectral lines—their wavelengths—but they provide only a crude indication of their intensities. A rough-and-ready scale can easily enough be obtained by assigning numbers 1, 2, 3, and so on, to lines of increasing strength—as Rowland did. By comparing different plates, the effects of different exposure-times may be allowed for, and a scale of "intensities" reached which is fairly uniform over a range of the spectrum, and describes the appearance of the line on a properly exposed plate. But when different kinds of plates have to be used for different colors, there is likely to be a break in this scale; and, in any case, it affords us no way of knowing how much stronger a line of intensity 5, for example, is than one of intensity 1.

An accurate study of the intensities of the lines must begin afresh. The very plates should be different. For wavelength measurement, contrasty plates are used, and developed so as to emphasize the dark centers of the lines and reduce as much as possible the impression produced by the gradually shaded wings on each side. For the present purpose, plates of low contrast must be employed, and developed so as to bring out the wings. The plates are measured with a microphotometer. The image of an illuminated slit is focused on the

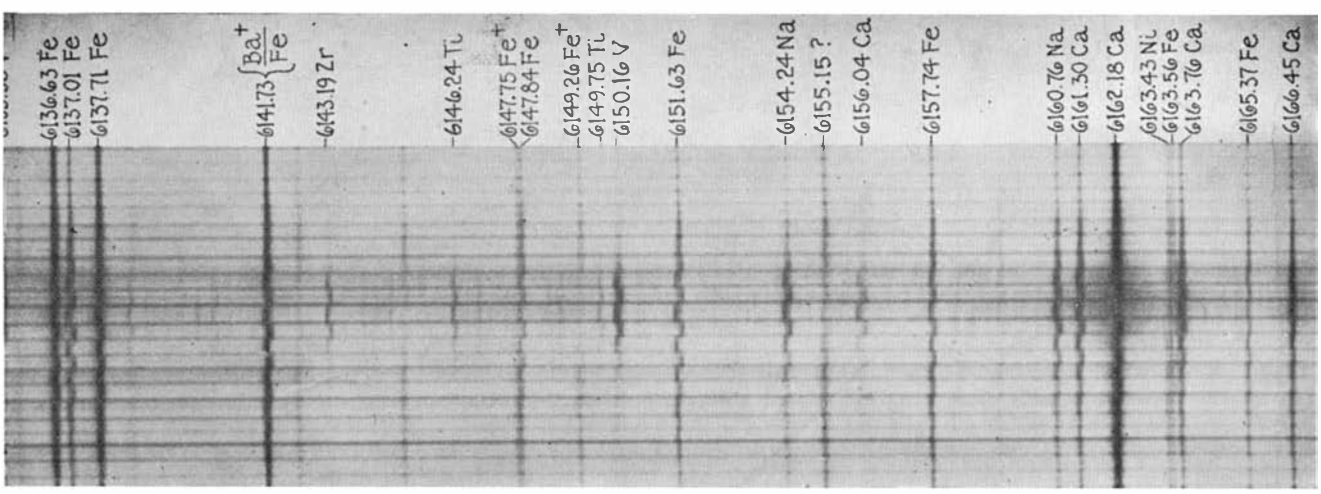


Figure 1: **A typical section from the photographic spectrum map from Mount Wilson Observatory**

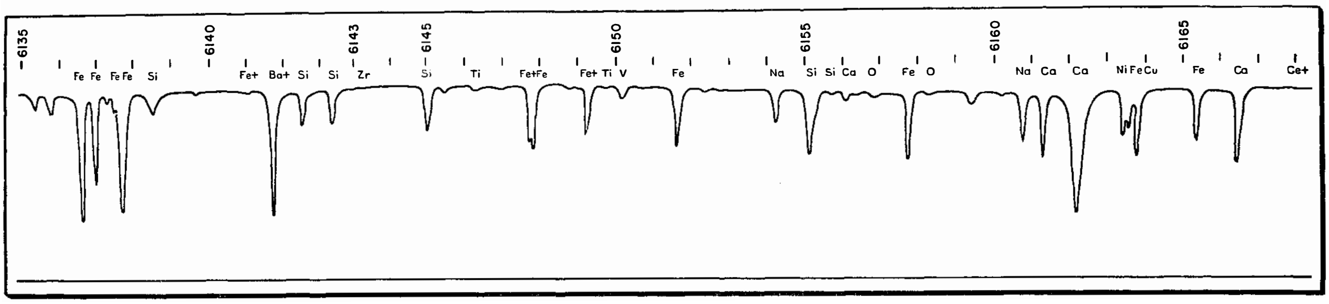


Figure 2: **A small part of the 300-foot curve of the new charts, corresponding with Figure 1**

plate, forming a very narrow bright line, parallel to the direction of the spectral lines. Since the negative is not wholly opaque, even in its densest parts, some at least of this beam passes through, to be caught by a delicate thermocouple, which sends a current to a recording galvanometer. The plate, mounted in its carriage, is slowly moved across the beam by a micrometer screw. Every time a solar line—which is dark in the spectrum, but bright on the negative—passes across the narrow beam, an increased amount of light goes through to be recorded. The record of the changing galvanometer deflections is automatically made on a strip of bromide paper, connected with the micrometer screw by gearing, so that it moves (in this instrument) just seven times as fast as the plate. The developed roll of paper will then exhibit a curve, rising highest where the film is most opaque, and with a dip upon it corresponding to the passage of each spectral line across the recording beam. The blacker the line in the spectrum of the Sun, the more nearly transparent will be the bright line on the negative, and the deeper the dip in the curve—while it will also evidently reproduce faithfully differences in the widths of the lines.

The new Atlas gives a curve of this sort. A small part of it, representing the same spectral region as Figure 1, is shown in Figure 2.

With the aid of very ingenious devices, the original photographic record was transformed in such a way that the continuous background of the spectrum, free from lines, is represented by a horizontal line, and that the depth of the curve below this at any point is proportional to the amount of light removed from the spectrum at this point. The published curve is therefore a graph showing, in extreme detail, the absorption in every part of each spectral line.

The new Atlas is a work of impressive size. The principal part, based on spectrograms taken at Mount Wilson by Dr. Mulders, extends from λ3612 in the ultraviolet to λ8771 in the infra-red. The scale is two centimeters per angstrom, so that the set of charts, if laid end to end, would be more than 100 meters long. A supplement, from spectrograms made at Utrecht, shows the ultra-violet from λ3332 to λ3637.

The work of taking and standardizing the plates must have been heavy, that of preparing the tracings no less so, and the transformation of the results to an accurate intensity scale the most troublesome task of all. The charts themselves are a masterpiece of scientific printing—the profile-curve, in black, being superposed upon a background, ruled in centimeter and millimeter squares in blue, so that the exact coördinates of any point may easily be read off. One especially pretty thing is visible only with a magnifying glass. The individual millimeter rulings are composed of fine dots, accurately spaced five to the millimeter, so that the place where the curve crosses any one of them can be read by inspection to a tenth of a millimeter or even to a twentieth.

All in all, the Atlas is a monumental work reflecting high distinction both upon the scientific workers who prepared it and the technicians who realized it in practice.

It is deeply satisfactory to know that this splendid piece of work has escaped the perils of war. Only a few copies are yet in this country, but it is expected that more will come soon.

The cost of publication must have been very heavy. It was defrayed mainly by the co-operation of a long list of institutions, mainly in Holland, so that it is being sent free to the principal observatories. It forms a noteworthy addition to the working capital of astrophysics—something that will retain its full usefulness for many years.

Let us now see how this Atlas differs from the older photographic ones. Comparing Figure 1 and Figure 2, we see that the ordinary photographs, taken for wavelength measurement, actually obscure certain important facts. Look, for example, at the three lines between 6163 and 6164. On the direct photograph these appear fully distinct, with even the two closest separated by an interval about as bright as the continuous spectrum on each side. The curve shows that these two lines, in reality, almost run together. (A still more striking example may be found at 6147.8, but the half-tone process does not resolve these lines, which are clearly separated on the original photograph.) We have to deal here with a noteworthy optical illusion. Our eyes are remarkably sensitive to contrast, and a small abrupt change in brightness impresses them far more than a smooth gradual change of greater amount. In the red end of the spectrum, the lines are fairly far apart, and this effect finds little place. In the violet, where the lines are much more numerous, we get the situation illustrated in Figure 3 (also traced from the new Atlas). The lines crowd upon one another so that it is only here and there that the unobstructed background gets clear through. In some cases, as in the violet side of the line at 4068.0, smaller lines reveal themselves, not by minima in the curve, but by "hesitations" in the steep descent. Yet, on the direct photographs, these two little wiggles in the curve appear as definite, clearly separated, dark lines, very similar to the two next to these toward the violet, which correspond to conspicuous minima in the curve.

From the direct photographs, too, one would hardly suspect that even the strong lines are so far from being black. In the orange, the strongest lines (such as 6136.6, 6141.7, 6162.2) show a residual intensity at their centers of fully 30 percent of that outside the line.

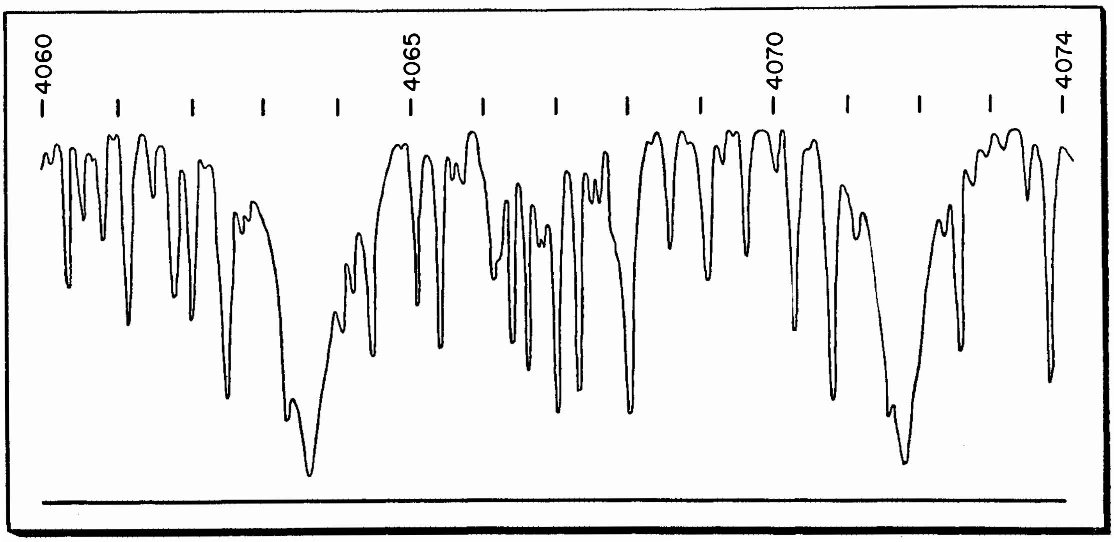


Figure 3: **Traced from the new atlas. A section taken from the violet part of the spectrum where the lines are crowded**

In the violet, the heavy lines at 4063.6 and 4071.8 are much deeper, with residual intensities of 7 and 9 percent; but these lines are very much stronger, as shown by their great width. Their wings extend far on each side and ten or a dozen neighboring lines are included within their extent.

The fainter lines, in both spectral regions, are represented only by very shallow dips in the curve. This arises partly from instrumental reasons. Powerful as is the great 75-foot spectrograph at Mount Wilson, it could not give a perfectly sharp image of an absolutely sharp spectral line (supposing that such a thing existed). The light waves themselves, going through lenses of finite aperture, form diffraction images of definite width. Most of the width of the observed images arises from this unescapable cause; imperfections in the instrument add but a little.

The width of this "instrumental profile" was measured by photographing a bright-line spectrum containing many sharp lines such as is given by a suitable neon tube (the exposures sometimes running up to as much as five days!), and it was found that an image (in the red) which ought to be perfectly sharp would actually be 0.15 angstrom wide between the parts where the brightness fell to 10 percent of the maximum. Comparing this with the scale of angstroms marked at the top of Figure 2, we see that the strongest lines are considerably wider than this; so that the instrumental shifting of light from one point of the image to another does not disturb the profile to any important extent.

The faint lines are usually (though not always) narrower, and instrumental effects must have a large influence in making the observed curve shallower by filling up the middle with light that by rights ought to go on one side or the other. Though this process makes the observed profile shallower, it also makes it wider. The instrumental imperfections cannot create light, or destroy it—they can only shift it from one point in the spectrum to a near-by one. While stronger light from the sides is diverted into the middle of the line, the weaker light of the line-center is diverted to the sides.

The net result is that, though the shape of the line-profile may be much changed, its *area*—representing the whole amount of light cut out of the spectrum—is not altered. This area is usually expressed as the "equivalent width" of a perfectly black, sharp-edged line, which cuts out the small amount of energy. For the faintest lines which appear as shallow dips in the curve, the equivalent width is about 0.002 A; for the strongest lines in Figure 2, about 0.2, and for those in Figure 3 rather more than 1 A. For the great H and K lines it is fully 10 A.

With this Atlas, and a planimeter, the intensities of many hundreds of solar lines could be measured far more accurately than they are at present known. One might say thousands of lines, were it not that the lines in the violet, and still more in the ultra-violet, interfere so much that it is practically impossible to draw separate profiles for the constituents of an overlapping group.

Much work on equivalent widths has already been done—some of the best of it by Minnaert himself—and in the preface to the new Atlas, he modestly says that it is "provisional"—meaning that the equivalent widths obtained from it will not be as precise as could be obtained by a careful study of selected individual lines. They are very good, just the same.

To derive from the equivalent widths the numbers of atoms which are at work producing the lines is a major problem, not yet completely solved. The range in equivalent width among solar lines is more than a thousand to one. In the numbers of atoms at work on them the range is much more like a million to one. For the very faint lines, which appear as tiny dips in the curve, the equivalent width is proportional to the effective number of atoms involved. For the strong winged lines, this equivalent width varies as the square root of the number of atoms. For lines of moderate intensity, like the majority of those shown on the graphs, the change of width with number of atoms is much slower. Accurate calculation of the "curve of growth" which exhibits these relations demands a detailed study of the effects produced in successive layers of the Sun's atmosphere, differing in temperature and pressure, and of the possible "interlocking" of lines produced by transitions of atoms of a given element from some particular state, or set of states, to others. There are many fascinating and difficult problems here for theoretical workers. They will rejoice in the new Atlas, even more than the rest of us, for there they will find the material they need to test, and to improve, their theories.—*Princeton University Observatory, January 3, 1941.*

BROWSING with the Editor

THROUGH THE SCIENCE LITERATURE OF THE WORLD

IRON AND STEEL—Of the 1,760,000,000 tons of iron and steel which have gone into consumption in the United States since 1854, close to one-third has been repurchased over the years by steel mills and foundries as scrap to be reprocessed into new iron and steel. Of the remaining total, some 1,210,000,000 tons is believed to be still in service in the form of buildings, bridges, automobiles, pipes, bathtubs, and a host of other articles.—*Steel Facts,* December, 1940.

FISH PLANTING—Into the streams and lakes of 34 states and Alaska, the fish planting program of the Forest Service during 1939 placed 288,000,000 fish.—Notes, United States Department of Agriculture.

RAYON—The acetate rayon industry is not quite 20 years old. The last 10 years have witnessed an amazing expansion, first in the field of continuous-filament yarns and more recently in the field of staple fibers. The consumption has increased at a faster yearly rate than that of other types of rayon until today acetate rayon accounts for 30 percent of the total domestic rayon consumption.—*Industrial and Engineering Chemistry,* December, 1940.

TANK PRODUCTION—One hundred eighty six pounds of blue-prints are necessary to detail all the intricate parts of a 20-ton military tank before production can get started.—*Automobile Facts,* November, 1940.

SUPERIOR ASTRONOMY—A 20-inch telescope will now do some types of work superior to that done by the 100-inch telescope of Mt. Wilson Observatory when it was first installed 20 years ago. The improved results are due wholly to the advances made in photographic materials with which the skies are photographed through this telescope.—James G. Baker, Harvard Observatory.

RAIL MILES—There is more railway mileage in the United States than in South America, Asia, Africa, and Australia combined.—Notes, Association of American Railroads.

WILDCATS—About 2500 wildcat oil wells were drilled in 1939. Fewer than one in thirty of these found new oil fields, showing the enormous difficulty and expense in trying to locate petroleum. When the advice of geologists is used in this exploration, about ten times as many of the exploratory projects find oil.—*Oil and Gas Journal.* November 2, 1940.

HORSES AND BUGGIES—In 1939 fewer than 1000 horse-drawn carriages were built, while 4,362,000 automobiles were made. Dr. Vergil D. Reed, assistant director of the Bureau of the Census, compares these figures with those of 1914 when the country's production of carriages, sulkies, and buggies totalled 550,401 and automobile production totalled 543,881.—*Science Service,* November 29, 1940.

CELLULOSE SHEET—Back in 1924 Cellophane cost so much that one small user in Philadelphia locked up his stock in a vault for safe keeping over night. Increased production, increased efficiency in manufacture, and widening markets have lowered the price of the plain transparent film from $2.65 a pound to 33 cents.—*The Du Pont Magazine,* November, 1940.

RESEARCH PAYS—It is being urged by the National Association of Manufacturers that American industrial organizations as a whole should spend at least 2 percent of their gross incomes for research. Thus would be created a billion-dollar fund to provide new jobs, new industries, new goods. The total expenditure for all basic production research in the United States in 1940 was considerably less than one quarter of this sum—probably in the neighborhood of $225,000,000.—*News Edition,* American Chemical Society, January 10, 1941.

RATIO OF 15,000 to 1—Prior to settlement by the white man there were 75,000,000 "buffaloes" (bison) in the United States area. Today there are about 5000. No longer, however, is there any danger that the bison will become extinct.—*American Forests,* January 1941, page 12.

LOCUSTS—Once the female locust has laid her eggs, her life mission is done. She flies away and soon dies. In a square yard as many as 50 to 75 separate deposits of eggs are often found, which means that from 5000 to 7500 locusts will emerge from a space 36 inches square. The only effective way of destroying the eggs is by ploughing the ground, for once exposed to the air, the eggs never hatch.—American Wildlife Institute.

RESEARCH REDUCES COSTS—Magnesium, which is vital to our national-defense needs because of its use in the manufacture of airplanes, now costs 30 cents a pound as a result of research. In 1915, magnesium cost five dollars a pound.—*Kodak Magazine,* December, 1940.

STORAGE BATTERY—Few of the products of Thomas A. Edison's genius represent the results of harder work or more prolonged research than does the nickel-iron-alkaline battery which bears his name. Today, this storage battery has a wide variety of uses in industry, including the supply of power to trucks and mine locomotives, and current to airway beacons in remote locations. It is also used for the operation of doors, brakes, signals, traction motors, and emergency lights in subways.—*Inco Magazine,* Volume 17, No. 3.

RHEOLOGY—The word 'rheology' was coined in the United States in 1929 to denote the science of the deformation and flow of matter . . . We study these "phenomena" every time we spread butter over bread with a knife . . . paint a garden shed . . . If it be of any advantage to man to improve bread, butter, cheese, jam, chocolate, inks, paints, varnishes, textiles, building materials, and a host of other everyday commodities . . . then the study of rheology needs no further justification.—*Nature,* London, November 2, 1940.

WILDLIFE CONSERVES FOOD—In the face of nature's prodigality, the creatures of the wild might well be forgiven if they satisfied their pangs of hunger, regardless of wastage. As a whole, however, it has been determined through extensive study that nearly all creatures—whether winged, walking, or creeping—show an instinctive appreciation of nature's bounty. They draw upon it to no greater extent than is necessary for their well-being. —*The Illustrated London News,* December, 1940.

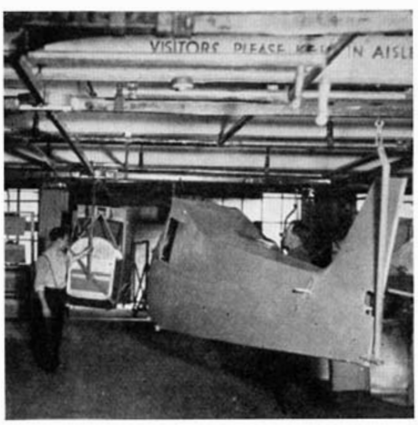
Conveyor System for Planes

Assembly Line Principle Successfully Applied in Airplane Manufacturing Plant

ALEXANDER KLEMIN
Aviation Editor, Scientific American.
In charge, Daniel Guggenheim School of Aeronautics, New York University.

It is fashionable to say that, to step up aircraft production, the example of the automobile plants should be utilized fully in building planes and engines. There is every reason to seek maximum help from automobile makers and to farm out everything possible to this industry—engines, bomber parts, or bomber sub-assemblies. In the past, whenever automobile people have tried to revolutionize airplane manufacturing methods, they have met with indifferent success, but now, with necessity driving, the real advances in aircraft production may well come from the aviation manufacturers themselves.

Every day witnesses some new method of speeding up aircraft production. Due to the C. A. A. training program and general increase in private flying, Piper Aircraft Corporation has been flooded with orders and has introduced the conveyor system in



Monorail conveyor system

building its fuselages. Beginning with the priming process, prior to rust-proofing, the fuselage is suspended on a monorail, and cockpit assembly, brake and control assembly, covering doping, sanding and rubbing are all completed while as many as 50 suspended bodies move slowly but steadily forward,

Wing-spraying "Ferris" wheel

hanging from the rail. A somewhat similar system is employed in the wing doping shop. The units are placed on a huge "Ferris" wheel and as they pass on the lower level, workmen spray dope—a nitro-cellulose paint—on the fabric to tighten and strengthen it.

• • •

RESEARCH

Projects Indicate Progress

The Annual Report of the Bureau of Aeronautics of the Navy Department must of necessity be brief and guarded. Normally, the United States is that country which disseminates technical information the most freely. Now that the necessity of national defense and aid to Britain are realized, secrecy must be the watchword of our services, and quite rightly so. Nevertheless, just the titles of some of the research projects carried out under the Bureau's sponsorship are of interest.

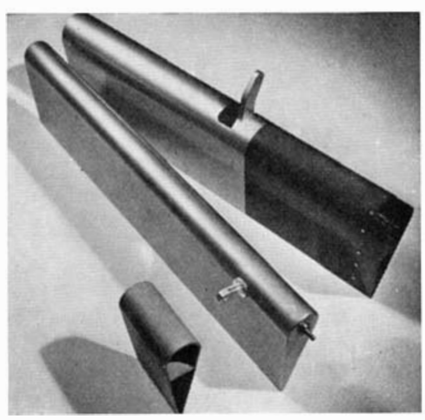
Thus we read of "Properties of Flat Plates under Normal Pressure." The research relates to the strength of a hull, or float bottom, at the instant of alighting on the water. Mathematical calculations are very difficult, and the experimental work now undertaken should make life easier for the designer and stress calculator of the seaplane. As we have had occasion to mention in these columns, plastic construction is assuming importance and the Navy is procuring wings in plastic from a number of firms and will undertake comparative tests.

Flutter of wings is a dangerous phenomenon, and when the test pilot is asked to investigate wing flutter in the air and even to try to induce it, he is undertaking a definite risk. Hence "Dynamic Testing in Flight by Radio Control," the title of this research project, tells the story. Another important undertaking has been in the development of a "Thin Film Rust Preventive Compound." This has been adopted by the Naval Air Service and reports show that it is possible to maintain equipment so protected with an expenditure of less than half the time required when other protective methods are employed. Synthetic silk for parachutes has appeared and proved stronger than real silk; and these constitute but a fraction of the research work completed.—*A. K.*

PLASTIC TABS

Production Possibilities in Small Control Surfaces

Tabs are small control surfaces, placed at the rear of the main control surfaces—ailerons, rudder, or elevator. When the tabs are irreversibly fixed at a certain angle to the main control surface, they cause the latter to hold a certain angular position, up or down as the



Plastic tabs relieve fatigue

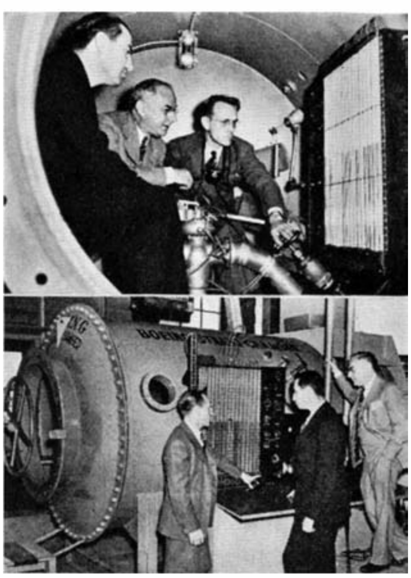
case may be, and the airplane is automatically trimmed or put in balance. Tabs are now almost universally employed on large airplanes and relieve the pilots of much of the fatigue of long flights. Hitherto these tabs, just like the main surfaces of the airplane, have been built of aluminum alloy, which necessitates cutting of sheet, folding, riveting, and so on. Now a plastic tab has been developed by the Glenn L. Martin Company. The plastic tab is remarkably smooth and neat in appearance and is lighter and less apt to buckle or wrinkle than the metal tab. Again, it has real production possibilities. The outer skin and the inner longitudinal reinforcement are fabricated in one piece by a single application of heat and pressure.—*A. K.*

STRATOSPHERE

High-Altitude Flying Conditions

Produced in Three-Ton Tank

CERTAINLY, the emphasis in aviation today, after many years in which we sought only development, is on quantity production of aircraft, but that does not at all mean that experimentation should cease. On the contrary, experimentation should be pushed more energetically than ever, particularly in special research divisions of our aircraft factories. At least one organization, the Boeing Aircraft Company, subscribes to this principle through the establishment of a stratosphere laboratory in which it is possible to test controls, pressure seals, structural members, and so on, of the supercharged airplane when flown at high altitudes.



High-altitude flying conditions are simulated in Strato-Chamber

The laboratory is in the form of a three-ton steel tank, 12 feet long by 5½ feet in diameter, with pressure-tight doors at each end and divided into two compartments, which are interconnected. One of these compartments represents the cabin of an airplane; the other compartment, the outside atmosphere. Several engineer-observers can be housed in the "cabin" at the same time, and have at their command controls and instruments which duplicate a set outside the tank. Contact with the outside is maintained by means of observation windows and a telephone system.

A motor-driven vacuum pump is used to reduce the air pressure within the high-altitude section of the Strato-Chamber to simulate actual high-altitude flight conditions. Dry ice reduces the temperature of this air to the 30 degrees below zero, Fahrenheit, which may obtain in substratosphere flying. The air is then piped into the cabin and is warmed and supercharged to a condition comfortable to passengers.

With such equipment the engineers can at little expense and in a few hours obtain information that would cost $1000 per hour to acquire in actual flight. If it is desired to undertake physiological experiments on the effect of rarified cold air on the human body, the low pressure from the high-altitude chamber is circulated directly into the other compartment without supercharging. In this case, of course, oxygen equipment may be put into service.—*A. K.*

FIGHTER

Radial Engine Powers

Navy's New Ship

THERE is good reason to believe that a chemically cooled in-line engine such as the Rolls-Royce Merlin or the Allison V-twelve gives greater overall aerodynamic efficiency than the radial air-cooled engine, however carefully cowled. But the difference is not very great. And while the 2000-horsepower liquid-cooled engine is still in the development or prediction stage, the immensely powerful radial engines, close to 2000 horsepower, are already available.

The Army Air Corps is emphasizing liquid-cooled engines for its fast pursuits. The Navy Bureau of Aeronautics seems to be a trifle more conservative and to lean to the powerful radials because they are already here. It is not for us to say who is the wiser, but certainly the Navy has reason to be proud of its Vought-Sikorsky Single Seater Shipboard Fighter. The new fighter has passed its tests in magnificent shape, has shown remarkable performance—equal or superior to that of any similar type in the world—and its top speed has been reported as over 400 miles per hour.

1850 horsepower, air cooled

The XF4U-I is a single-place, single-engine, all-metal monoplane embodying all of the most advanced developments of this type of craft. The fuselage is of monocoque construction employing spot welding (which may be an indication of the use of stainless steel) and the finish is therefore exceptionally smooth. The tail surfaces are also of monocoque construction. In front view they present the appearance of an inverted gull wing. This provides low points on either side of the airplane where the landing gear is attached and not only reduces the weight of the landing gear but facilitates towage. The landing gear retracts into the wing, the final closure being made by doors so that when the gear is fully retracted this portion of the wing presents a perfectly smooth surface. The engine is an 18 cylinder Pratt & Whitney double-row, radial, rated at 1850 horsepower or more at an altitude of more than 20,000 feet. The gross weight of the airplane is approximately 9000 pounds, it has an approximate wing span of 40 feet and an approximate overall length of 30 feet. Altogether it is a ship that manufacturers and Navy may both be proud of.—*A. K.*

[Recent advices indicate that Army officials are seriously considering the adoption of a radial type of airplane engine.—*The Editor.*]

Fungi

As the Enemy of Domesticated Plants These Lower Plants Cost us $3000 a Minute

CHARLES M. HACKETT

NOT long ago an itinerant handyman, something of an amateur tree surgeon, sawed a dead limb from a tree. There was nothing unusual in the operation, nor did he note anything peculiar about the rotted wood of the branch. There was no reason why he should have flamed the tool before performing a similar amputation on another tree a hundred miles away. Yet in the following spring when he retraveled his accustomed route, he observed that both trees were dead.

The victims were of the species known variously as sycamore, button-wood, or plane. If the handyman had looked further, he would have seen that these lovely, scaly-barked shade trees were dying by the thousands in the eastern states. They have been afflicted with a blight such as that which has almost obliterated the chestnut tree and decimated the storied elms of New England.

Just what, or who, started this blight, no one can say. It is certain that it has been spread from one tree to another by such incidents as that described here. Sycamores are favorite trees for city street planting, and in many instances entire rows have been stricken, while those across the street remain unaffected. This bears witness, experts say, that the blight may be communicated by pruning tools and saws. The villain of the sycamore tragedy, like that of the chestnut and elm debacles, is a minute parasitic bacterial growth or plant described technically as a fungus. The fungi are not green like the higher plants. They are difficult to find, and are almost incredibly hardy and resourceful.

They thrive both in the light and dark, depending on either living or dead animals or plant matter for food. They reproduce rapidly by means of millions of spores or seeds, broadcast by the wind—or spread by animals or man.

In some forms, fungi are beneficial in character. They assist the process of making cheese, beer, and even bread. In their malevolent role, they form the spearhead of a botanical blitzkreig which causes an estimated $1,000,000,000 damage yearly in plant disease alone, with untold further losses levied on lumber and stored materials. Diseases caused by fungi also attack farm animals and sometimes humans.

Millions of dollars are being spent in defense measures. The United States Government's Bureau of Plant Industry has been working diligently for years, seeking answers to many of these problems. State agricultural experiment stations have also done much.

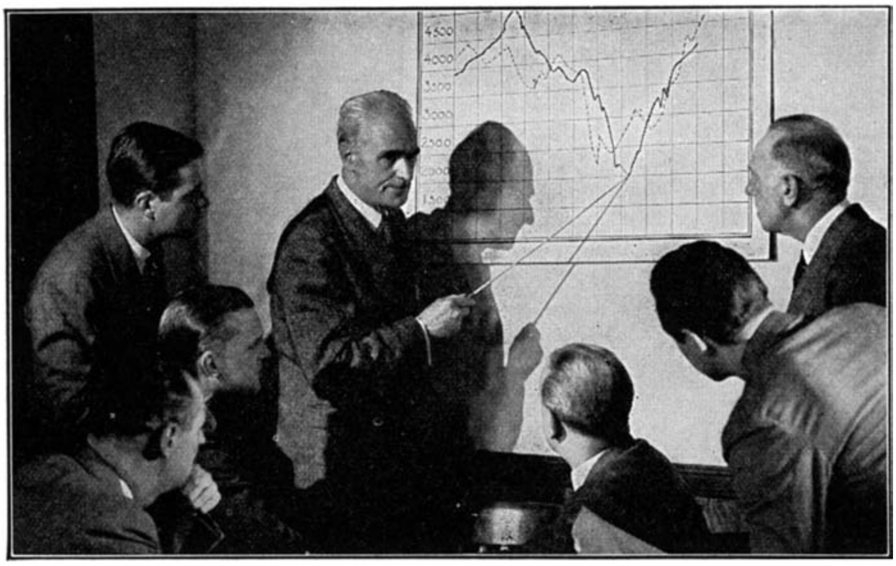
Mold spores from bread. ***Insert:*** **A Du Pont chemist studying the growth of such molds**

More recently, industrial organizations have tackled the fungus menace with all the resources of modern science, and some notable successes have been recorded. The Du Pont Company, for example, maintains a well-equipped pest control laboratory at Wilmington, Delaware, part of which is devoted to research on fungi. This same company also operates laboratories and testing plots for studying seed-borne fungus diseases, and has developed seed-treating chemicals which substantially reduce losses. Another Du Pont activity in the field is research in mold, which has produced "inhibitors" to prevent such growths in bread and other materials. Still another deals with the development of "mildew-proofing" preparations.

THE world has been kept well informed of the havoc wrought by insects, since winged or crawling pests are not likely to be overlooked, for they invade our homes and flower gardens, and their descent upon us is vigorous, but the almost-as-deadly fungus works silently and out of sight. Nevertheless, we are faced at every hand with evidences of destruction. There is not a full-grown native chestnut tree left standing on the New England hills which, 40 years ago, were covered with these stately trees. Something introduced the chestnut blight and valuable timber stands were wiped out. The devastation was due to a fungus that became parasitic on this particular tree, then ungratefully murdered its host.

The "Dutch" elm disease is thus far classed as irremediable. Thousands on thousands of these classic American trees, long identified with village square and college campus, have been victims. The fungus of the disease is carried into the wood by a beetle, hiding so completely that treatment by fungicides is considered very difficult if not impossible. Injections, however, are now being attempted, with some promise of success. Spread of the ailment is being checked by inspection, quarantine, and ruthless destruction of all infected trees.

The important white pine industry is being threatened



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by a "rust" fungus which alternately attacks gooseberry or black current bushes, then the tree. An active program of cleaning out the berry bushes near pine forests promises solution of this problem by breaking the cycle of the pest's habit.

Most serious salient of the fungus attack is in the field of plant disease.

"A plant," observes Farmer Brown, "hasn't a friend in the world. If the rabbits don't get it, the bugs will. If it's not the bugs, it's the blight. If it's not the blight, it's the wilts."

He might add, there are the rusts, the smuts, the scabs, and the rots, and after them the blotches, the smudges, mildews, galls, and curls. Most of them are the work of the foraging fungi, although some are caused by bacteria and by the viruses. The United States Government figures the toll of these plant diseases at about $3000 a minute.

The Irish cop on the corner may never have heard of fungi, yet they are probably responsible for his being a citizen of New York or of Boston rather than of County Clare or Killarney. It was a fungus disease, potato blight, which brought on the Irish famine of 1845, sending hundreds of thousands of Irish immigrants to the United States. The same fungus is still around, and occasionally gets at the potato crops in this country. Now, however, we have learned to keep it under control with sprays and dusts. In the soil-borne diseases of potatoes, calomel and mercuric oxide have shown promise when mixed with fertilizer. Organic and inorganic mercury compounds are playing a large part in new developments, one important new use being the acid mercury and mercuric oxide dips for potatoes.

NO PLANT is immune to these microscopic marauders. Leaves, flowers, and fruit develop spots, blemishes, and wilts, and may shed off and die. Cankers and galls form on stems, trunks, and roots. Growers have done a great deal with the breeding of disease-resistant species. This is difficult, however, for, as has been indicated, the fungus is a most adaptable campaigner, able to assume a new form through mutation and hybridization. Some of these new forms or strains will attack previously resistant plants and nullify expensive research accomplishments that seemed final.

Rusts of wheat and other grains cause enormous crop losses. One of the worst offenders is "black stem rust," the fungus of which spends a part of its life on the common barberry plant. Large sums are now being spent in the eradication of barberries and the breeding of rust-resistant varieties of wheat. Copper carbonate is an effective dust treatment for controlling "bunt" of wheat, and represents the beginning of a dust method on a large scale.

Dr. W. H. Tisdale, who heads the Du Pont pest control research program, counts fungi among the major problems of America's agricultural economics. A plant pathologist by profession, Dr. Tisdale is one of the nation's outstanding authorities on fungicides. He was formerly associated with the United States Bureau of Plant Industry. Dr. Tisdale is hopeful that the defense forces will prove adequate. "Possibly," he says, "the most significant step in the development of fungicides and insecticides is the focusing of the attention of the research chemist, and the institutions supporting chemical research, on the needs for better pest control.

Spraying fruit with fungicides to control plant disease fungus

"It has not been many years since the plant pathologist and the entomologist selected chemicals as best they could, from the available lists. Now, with the co-operation of the various plant scientists concerned, the statistician, the physicist, and the chemist, we are in a far better position to advance."

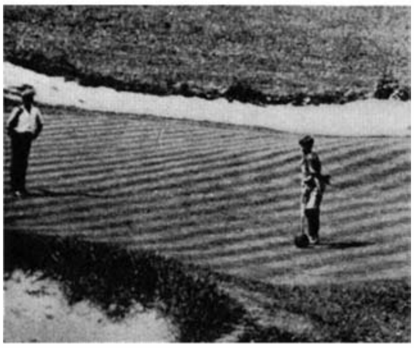
Dr. Tisdale points out that the battlefront of fungus warfare is long indeed. Some fungi are carried on the seeds of plants. Others live in the soil, attacking seedlings and the roots of growing plants. Cotton, beans, melons, peas, and flax are subject to wilts and root-rots caused by soil-borne fungi. The flax industry in this country gradually migrated westward until it could go no farther, driven by wilt-infested soil. The fungus root-rot that causes huge losses of cotton and other crops has not yet been brought under control. The costly "blue mold" of tobacco is being checked by fumigation with benzene and paradichlorobenzene.

SEED-CARRIED diseases are being combatted effectively by treatment. Seeds are treated with chemicals developed for the purpose. Large increases in yields have been reported. The "stinking smut" of wheat, for example, which fills and covers the grain with black sooty spores, is held in check by seed-treating chemicals, notably the organic mercury compounds. Many other seed-borne diseases are routed by proper seed disinfectants. The use of ethyl mercury chloride for the treatment of cotton-seed has advanced the control of seed-borne and, to some extent, soil-borne diseases of cotton. It is effective also in curbing seed ailments of flax.

Fungi do not confine their activity to living plants, Dr. Tisdale points out. Raw plant products after harvest are subjected to heavy losses during transit and storage. Foods prepared from plant products are set upon by molds and mildews. "Losses in these products are large," he declares, "despite modern methods of control, including sanitation, refrigeration, heat, and the use of chemicals, ray treatments, and high-frequency currents."

Fiber, hemp, and lumber are subject to stains, molds, and decay. Awnings, ropes and other cellulose fabrics, wallboard, and wood products are attacked. The familiar "blue stain" of freshly sawn lumber brings woe to lumbermen. Chemists have now introduced preparations based on ethyl mercury phosphate to control this discoloration, which is actually the spores of the fungi themselves as they invade the wood.

Oil soluble coppers, such as the naphthenate and oleate, are finding limited use in the treatment of wood and other cellulose materials, especially fish nets. Phenyl mercury oleate is being used on ropes to prevent decay. The treatment of fabrics, especially cellulosic fabrics, and related materials that are handled extensively or those that contact the human body, is becoming important due to fungus molds. For such needs, water insoluble materials of non-poisonous nature are desired. Salicylanilide has



"Brown patch" on golf courses is one of the fungus diseases

been found suited for such purposes. Special adhesives have been developed that hold the disinfectant in place when the fabric is laundered or exposed to weathering.

The damage to the wooden parts of buildings and other wood products done by fungi is adjudged much greater than that attributable to termites. What the householder calls "rot" is really the remains of a fungus banquet. The spores feed upon the cellulose of the wood. Treated lumber is now curbing a huge national loss from this cause; it also helps to reduce the estimated $80,000,000 annual termite bill.

Although fungus infection among man and animals is less serious than that stemming from their close relatives, the bacteria, some important discoveries are laid to this destructive vegetation. If you've ever suffered from the well-known and highly uncomfortable athlete's foot you've had a taste of it. Ringworm is another sample. Many allergic conditions have been traced to the identical fungi which bring plant diseases.

Even under water, certain fungus families multiply exceedingly and leave havoc in their wake. A fatal fungus invasion is now being combatted among sponges, the thread-like filaments of the fungi having committed appalling submarine mayhem among these useful growths. At one time, the salmon fishing industry was imperiled by a serious fungus epidemic, the fish sustaining heavy casualties.

All fungi cannot be classified as pests. One of the simpler forms of beneficent fungi is yeast, and bread-making would be impossible without it. The distinctive flavor of Roquefort or Camembert cheese arises from fungi employed in the ripening process.

One of the most valuable functions of the fungi, according to Dr. Tisdale, is to serve as scavengers of field and forest, destroying or reducing to elemental form the waste or dead plant products. Fallen leaves, limbs, and trunks of fallen trees and the plant by-products of the farm, when decomposed, return chemical constituents to the soil, again to provide food for growing plants. Carbon dioxide is released to the air during the process of decay, serving its normal and useful purpose in the process of life. Without the fungus action, these waste plant products would accumulate indefinitely, hoarding the valuable plant food elements. We profit by this decay, yet we find it necessary to use millions of pounds of disinfectants on wood products to prevent decay caused by the same fungi.

The gains already chalked up in the battle against these tiny armies are conspicuous. Chemists have found "inhibitors" for checking mold in bread and other products. Sprays and dusts on growing plants provide a defense without which agriculture might well prove inadequate to our demands. Seed treating is an accomplished fact, with scientific studies authenticating its efficiency. Mildew-proofing is now a commercial success.

No one should underestimate the strength or resources of the enemy, and America's scientists do not view their task sanguinely. Nevertheless, as Dr. Tisdale points out, co-operative efforts, enlisting all the skill and knowledge at our disposal, promise results. It's a safe bet that science will win out in the end.

• • •

COTTON SEEDS

De-Linting Process is Money Saver

DOWN in Missouri some men with an idea are doing things to cottonseed.

These seeds normally have a fine fuzz, or lint, completely enveloping them. They therefore cling together so that when planted they can seldom be dropped singly but only in clusters of two or more. Later, farm laborers must "chop" cotton—go through the fields after the young plants are up and methodically chop out excess stalks, leaving single ones standing alone. Not only is there a waste of cottonseed but this job of "chopping" is slow and expensive.

These men with the brilliant idea started working in 1923 on a chemical process for de-linting cottonseed and now they have machinery which does the job in rather simple fashion. The fuzzy seeds are fed into a hopper at the lower end of a trough. A worm gear carries them over to another hopper where they are drenched in a stream of sulfuric acid. The acid dissolves off all the lint, leaving slick, black seeds. These seeds are separated by washing the gummy mixture with cold water until all acid is removed.

Besides removing the lint, this treatment permits separation of poor seeds by a process of flotation; bad ones are "floaters."

With planting machinery, these de-linted seeds can be evenly spaced in the row and planted singly, thus eliminating the waste mentioned above plus most of the chopping operations.

ALCOHOL

Sweden Uses More For Motors

Sweden is taking steps to expand the output of alcohol employed as motor fuel, according to the American Commercial Attaché, Stockholm. Construction work on a new plant for the manufacture of alcohol from wood using a saccharification process will be started immediately by Korsnas Saw Mills, Inc. Bengtsfors Sulphite Aktb. will construct a new sulfite alcohol plant.—*News Edition,* American Chemical Society.

PAPER COATING

A new composition that can be applied to paper in a continuous film makes the paper substantially proof against moisture, odors, and vapors.

The basis of the coating is said to be a granular white material, made by completely reacting chlorine and pure, pale crepe rubber.

For paper coatings, the material is usually mixed with a plasticizer such as dibutyl phthalate, it is reported. Dibutyl phthalate is used because it helps to develop excellent moisture- and vapor-proofness in the finished coating.

BOAT SPEED

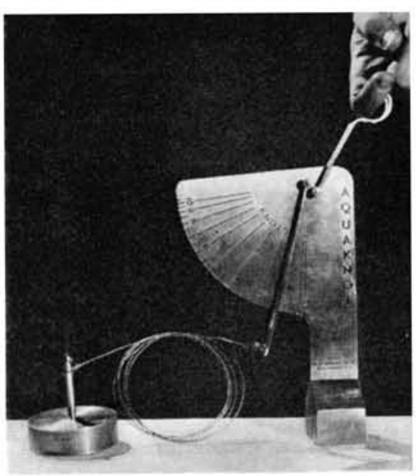
Fishline Method For Clocking It

ANYONE who has cast a lead or fished with a sinker knows that the faster the speed of the water in relation to the shore or boat, the greater will be the angle of deflection of the line from the vertical. This is the simple principle which has been used to produce a new type of "log" or speedometer for a sail or motor boat.

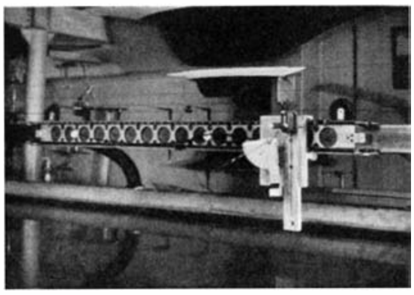
This device consists simply of a sinker of special design on a line which is attached to the arm of a scale. As it is held over the side and the speed of the boat increases, the arm on the scale moves toward the horizontal. The scale is etched with numbers up to ten knots, accurately calibrated and tested in the towing tank at Stevens Institute.

Most other modern devices for determining the speed of boats are actuated by the passage of water over a fixed vane in the boat's hull. Unlike these, the new unit, known as the Aquaknot, is portable. To read the speed it is held over the side by hand. In this way its accuracy is not affected by the turbulence which prevails close to the underbody of a moving vessel or by the accumulation of marine growth on the ship's bottom.

Because of its portability, a single Aquaknot may be used to test the speed of any number of different boats. The effect which different sails and their trim have on the speed of a boat can be checked. This is an important item in today's



Lead, line and gage of Aquaknot



Aquaknot tests speed in tank

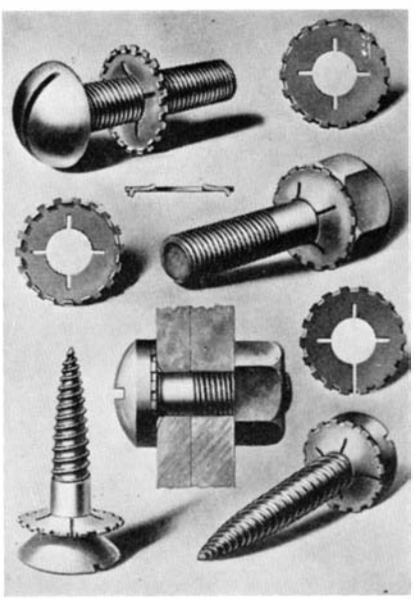
racing which features science and seamanship equally. Accurate knowledge of a boat's speed, besides being a check on performance, is also essential to accurate navigation.

Due to simplicity and sturdy construction, there is little possibility of failure. To resist corrosion and provide the necessary strength, the entire Aquaknot, with the exception of the sinker, is made of Monel by William H. Van Gaasbeck. It was invented by David Moffat Myers.

LOCK WASHER

Positive Locking With Toothed Rim

AN EFFECTIVE, pre-fixed, lock washer, which is designed to be permanently assembled with screws, bolts, or other threaded fasteners, has been developed by Mechanical Laboratories, Inc. These washers are designed for a squeeze fit and are assembled on standard threaded



Uses for pre-fixed lock washer

fasteners when they leave the factory.

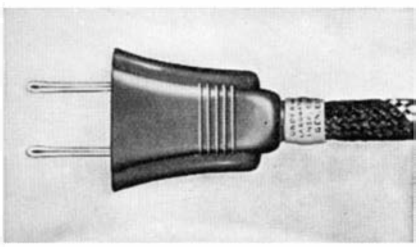
This new washer is a disk with a central hole, like that of the ordinary washer. From this hole, however, slots are cut part way out to the edge radially to provide for the squeeze fit. The rim of the washer is cut with numerous radial slits to provide short tongues. Alternate tongues are turned upward to contact the head of the screw or bolt to provide a toothed grip that prevents the head from turning.

ATTACHMENT PLUG

Holds Tight: Has Anchor Prong

An "anchor" has been built into attachment plugs to promote closer relations between convenience outlets and cords. A new "Anchor Loop" contact prong, with all the virtues the name implies, has been announced by the General Electric construction materials division. It is designed to increase holding power in both old and new convenience outlets without distortion of outlet contacts.

The new prongs can be supplied on several types and sizes of molded-on, all-rubber attachment plugs. The prongs are designed to eliminate excessive stress on outlet contacts, and tests indicate that outlets retain their original ability to hold standard solid prongs after long use of plug caps with new "Anchor Loop" contacts.



Self-anchoring electric plug

DEFICIENCY DISEASE

Chemical Test For Diagnosing Pellagra

A chemical test for diagnosing pellagra, more specific than any that doctors have had before, may result from a discovery announced by Dr. Victor A. Najjar and Dr. L. Emmett Holt, Jr., of the department of pediatrics, Johns Hopkins University.

Diagnosis of pellagra now is made from the skin rash, inflamed tongue, and other symptoms. A more exact method of diagnosis, such as a chemical test, would be extremely helpful because the symptoms of pellagra are sometimes confused with similar symptoms brought on by lack of other vitamin chemicals than the pellagra-preventive, nicotinic acid. With the aid of the chemical test, doctors could tell whether or not the patient needed treatment with nicotinic acid.

A chemical, as yet unidentified, appears with a bluish fluorescence in alkali-treated excretions of normal persons who have plenty of pellagra-preventing nicotinic acid in their bodies, the Johns Hopkins doctors discovered.

In pellagra patients, this substance does not appear, but another, also unknown, chemical which gives a whitish-blue fluorescence without alkali treatment appears instead.

Disappearance of the bluish fluorescent substance, called F_2, is apparently the earliest change in the kidney excretions in pellagra patients. As the disease progresses, the other substance, called F_1, appears. Treatment of the patient with nicotinic acid, which cures the pellagra, banishes F_1 and allows F_2 to appear again. Both of these substances can be measured quantitatively by the fluophotometer, although the doctors do not yet know what they are.—*Science Service.*

HEAT FROM COLD

First Unit Built

For Homes

THE system of heating a house in winter with the same unit that air-conditions and cools it in the summer—which was mentioned in our February issue—has now been adapted for home use. Our February article told how units of this nature extract heat from the cold atmosphere outside an office building and throw off the heat units indoors.

The new air conditioner for the home is the first window type cooler to be developed which also provides heat by reverse-cycle refrigeration. It is designed to fit into an ordinary sized window, has a capacity of 6000 cooling units an hour and a heating capacity of 7500 heating units an hour and up. It comes equipped with an electrical cord which can be plugged into an electrical socket.

NOT FOOD

Nylon Is, However,

A Protein

DESPITE bombs and vast destruction in London, the editors of magazines published in that city still seem to have time to do a bit of original—and humorous—thinking along scientific lines. So far as we know, no one in this country has pointed out the fact that nylon is a synthetic protein and that it, therefore, approaches closely to a food made of coal, air, and water. The editors of *Plastics* (London) after discussing the economics of the newer factory-made fibers, have this to say about nylon:

"Which reminds us. Carothers and his remarkable team of coworkers in Du Pont's have produced the first synthetic protein. True, it is not in texture very much like the proteins we encounter in life, except the skins and horn-like proteins, although it does resemble them all chemically. How much

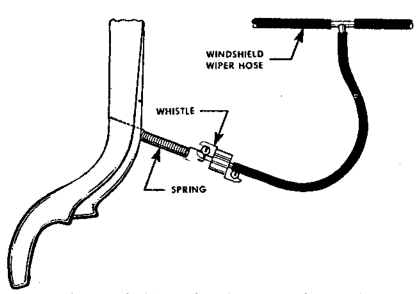
Window unit provides warm or cool conditioned air more would we thank Dr. Carothers if he had devoted those years to producing a protein that would be more digestible than his nylon, which is so tough and not readily attacked by the gastric juices. Think of having a dozen chemical factories here turning out tens of thousands of tons of juicy nylon, already treated with dozens of vitamins and doses of the appropriate salts, extruded into just the right size for making sandwiches. And, of course, these factories would turn out not only beef flavour, but ham, lamb, and egg flavours, too! Think of the shipping we would save and how we could laugh at Hitler. This would be totalitarianism with a vengeance."

BRAKE WHISTLE

Notifies the Driver That Brakes Are Set

It is very disconcerting to attempt to start a car rolling when the hand brake is on—while the resultant stalling of the engine sometimes causes dangerous traffic snarls. An interesting accessory for the new Pontiac cars prevents this trouble.

The device consists of a whistle which is connected to the windshield wiper hose and to the hand brake in such a way that when the hand brake is set, the whistle is held open. As soon as the engine is started the whistle blows, thus telling the driver to be sure to release his emergency brake before he starts the car.



It whistles if brake is set

TUNG OIL

Greater Production In the U. S.

More than a million dollars in new wealth will come to the tung growers and millers of the South as a result of the record 1940 crop recently harvested, the U. S. Bureau of Foreign and Domestic Commerce has reported.

In the six southern states now producing tung trees — Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas—the 1940 crop will yield approximately 5,000,000 pounds of oil, despite limits imposed by the damaging cold wave of last spring.

United States imports of tung oil from China in 1939, the established world source of supply for this important commodity, totaled 79,000,000 pounds. Consumption of the oil in this country last year is estimated to be in the neighborhood of 100,000,000 pounds, necessitating the use of reserve stocks. The price of the oil from China has for the past year been approximately 25 cents a pound. Imports of tung oil from China have amounted to as much as 175,000,000 pounds and values have been as high as $20,000,000 a year. The United States, under normal conditions, takes approximately 75 percent of Chinese exports of this commodity. — *News Edition, American Chemical Society.*

"GHOSTLY" BOAT

Hull Made of Clear Plastic

So far we have not been able to learn just why seventeen-year-old Richard W. Boerstler wanted to ride in a "ghostly" boat with all its ribs showing, but he does have such a boat on the Charles River. The covering, according to *Aluminum News-Letter,* is a transparent plastic material which gives the effect of a glass boat. With its aluminum and wood framework and transparent covering, the Boerstler boat weighs only 43 pounds, and is powered by an outboard motor giving a speed of 24 knots.

STIMULANT

Vitamized Hormone Compound for Plant Growth

A new root-growth stimulant, Transplantone, that might well be termed a vitamized hormone powder, has been announced by The American Chemical Paint Company.

Transplantone is a water-soluble powder containing two plant hormones, including napthylacetamide, and three vitamins, including Vitamin B-1 and C. The plant hormones initiate or form roots on established plants, while the vitamins help to maintain their continued growth. Transplantone, though in no way to be considered as a fertilizer, is compatible with soluble fertilizer and as such can advantageously be used in starter solutions.

Inevitably, damage occurs to the root systems of plants during transplanting operations, be they tiny tomato seedlings or massive mature trees; and, as a result, the root growth is arrested or definitely retarded. During that period, also, transpiration may be so excessive that the plants wilt or, in severe cases, die. All these deterrents to good growth may be obviated by watering the plants with a solution of Transplantone a day or so before transplanting, or by soaking the roots in the solution for an hour in the case of easy-to-handle plants. A third method involves only the soaking of the soil with the solution after the plant has been set in its new location. The last technique is the method recommended for stimulating growth on all established plants: pot plants, flowers or vegetables, fruit trees, or ornamental shade and evergreen trees.

CIGARETTE CRUMBS

None Drops From Processed Cigarettes

NO LOOSE shreds of tobacco will find their way into your mouth, if the end of your cigarette is impregnated with a solution of ethyl cellulose in anhydrous ethyl alcohol, it is claimed by an inventor. The solution, it is said, stiffens and waterproofs the paper at the mouth end of the cigarette, and binds the tobacco shreds together so that they do not become loose.

The inventor also claims that the composition is non-toxic and has absolutely no effect on the taste or odor of the smoke. Best news of all is the claim that absent-mindedly lighting the wrong end produces no ill effects.

UNIQUE GRADING JOB

Highway Bank Graded In Steps

AN UNUSUAL job of grading the bank of a highway has been done by The Eblen Construction Company out in Iowa. The cut through which this highway runs is 80 feet deep, and in winter it would normally be piled with drifts of snow. Hence, to prevent such drifts, the construction company cut the bank as a series of steep, smooth-sided terraces, using a Caterpillar motor grader.

Similar jobs have been done in the past, but this one offered a particularly bad problem. At the start of the job, the hill was so

Terraces act as snow fences

steep that a detour had to be made in order to get on top with a bull-dozer. Then, after starting the first bench, the motor grader was pulled up the hill by a cable and settled into working position. As the first bench was pushed off with the bull-dozer, the motor grader came along doing the finishing work, and it was gradually stepped down from the first bench to the next one until it reached the bottom of the cut, as shown in the photograph.

TURF DISEASE

Worries Golfers and Greens-Keepers

GOLFERS, and particularly the greenskeepers of their courses, have something new to worry about: a fungus disease that kills out large patches of the grasses most suitable for putting greens. It was reported on recently by Dr. C. C. Wernham and Dr. R. S. Kirby of Pennsylvania State College.

The two botanists have isolated cultures of the responsible fungus and grown it under laboratory conditions. They find that it thrives most lustily at the high temperatures of midsummer, becoming much less virulent when kept in a cooler place. This checks with the golfers' complaints that their greens are in worse condition in hot weather than in cool.

Field experiments indicate that the disease can be controlled by small applications of dusting sulfur or zinc oxide.—*Science Service.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Backgrounds For Your Movie Titles

MANY amateur movie fans look upon titles as a nuisance, with the result that either they avoid making them at all or, when they do, try to get the job over as quickly and easily as possible. But a great many more workers feel that if their screenings are to be worth anything at all, titles will help tremendously in making the show complete and professional-looking, as well as adding to the entertainment values of the picture.

Of course, the chore can be accomplished simply by typing on a card and filming the title with one of the many efficient little devices now on the market. However, we feel that titles, too, are part of the film and should be set off in some pictorial way, so that the title is not merely a label, but attractive in itself. Even the cleverest title, when agreeably presented, will prove at least twice as effective if pains are taken to play it up in some way.

One of the methods we would suggest is the use of still shots as backgrounds for the titles. These can be made either at the same time the filming of a particular subject is done, or taken from one's files. The latter method will often be satisfactory, if the scene is general enough to make it suitable in particular instances. However, the best plan is to make a few still shots at the same time you do your movie shooting. The title backgrounds will then be a very definite part of the picture and tie in perfectly with the film.

Cloud pictures offer the greatest opportunity for title backgrounds and, since the dyed-in-the-wool photographer is a sucker for good cloud effects at any time, there must be plenty of these in your files to start a little experimenting in this connection right now. Cloud pictures have the virtue of being general enough in theme to fit into many types of films and, for this reason, plus the utilitarian one that they allow plenty of space for the title, are very useful.

Figure 1 is a sure bet for a movie title, particularly because of the general darkness of the print, which makes it an ideal background for white lettering. Of course, the title should be kept above the horizon line and the legend well spaced to allow for generous borders around the other three sides. This particular print makes an excellent title background for a film of beach scenes. Depending on the subject-matter, it can be used either as the opening or the closing title of the film. If the

Figure 1 (below)
Figure 2 (above)

Figure 3 (above)
Figure 4 (below)

story covers that day at the beach last summer, it seems just made for that inevitable "The End" title.

Figure 2 is an idea for waterfront films. Here the lettering can be done so that it reaches higher towards the top than usual. This because there is so much going on in the lower third of the print. A film covering the ever-attractive subject of seagulls flying about the masts of sailboats could use such a title background at almost any suitable place in the film —beginning, end, or somewhere in the middle. In contrast with Figure 1, it suggests movement and atmosphere, and this fits in perfectly with movie technique.

Closer to home and a swell title background for a piece possibly "Wash Day Comes on Monday," is Figure 3. Clouds again, but the clothes-line, roof, and chimneys pack a good story. The obvious place here for the title is the inverted pyramid bounded at the sides by the roof line and the clothes swinging against the sky, with possibly a word or two, preceded by a dash, in the small cloud space below the clothes-line.

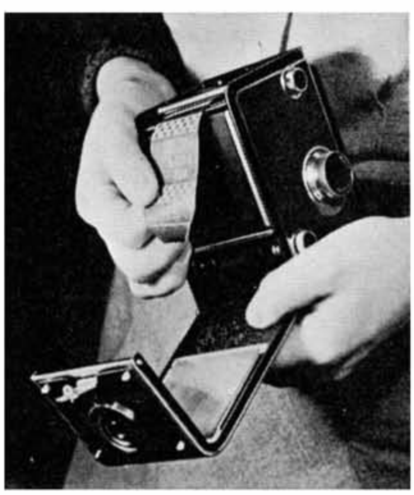
Cloud pictures are not the only stills, however, that can be used for title purposes. A story of a street incident in town could well employ such a title background print as Figure 4. The lettering space is again obvious and would, incidentally, balance the content of the print. The dark space seems ideal for a title.

These are merely suggestions that will start a train of thought, the stations at which that train stops determining the types of title backgrounds you will try out for your own movie films.

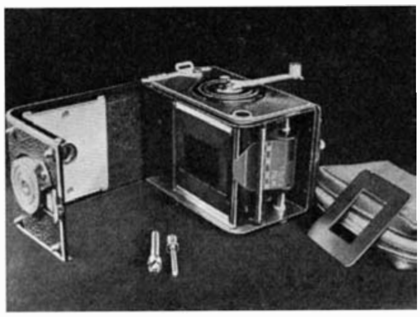
Rollei Adapter

A NEW, inexpensive, and extremely simple adapter which will permit using Bantam size film with Rollei cameras, has just been announced by Burleigh Brooks, Inc. With this new device, Rollei owners can use the economical Bantam-size Kodachrome roll film, as well as Bantam size black and white film.

The use of this Rollei adapter is extremely simple. A metal masking frame of Bantam size is quickly inserted in the camera back, and a similar mask placed over the ground glass. Two spool adapters, one furnished equipped with a Bantam size spool, are quickly inserted in the spool holders. The complete change from the 2¼ by 2¼ size to Bantam



Bantam size film being loaded in Rollei camera with adapter size, or vice versa, is merely a matter of seconds. An exposure window, placed in the proper location in the back of the camera, is equipped with green safety material to permit the use of all types of film. This film window is absolutely essential in order to insure proper negative spacing. This new Rollei adapter can be installed by your photographic dealer, and the price is extremely reasonable.



Rolleiflex with simple parts needed for Bantam film use

Single-Frame Movie Work

SOME of the many possibilities available to the movie camera sporting a single-frame movie device, by which a single frame may be exposed at a time, as in regular still photography, and then projected in the usual way, are cited by Bell & Howell in connection with the Filmo 141.

"A map can be animated with a line which extends as by magic to trace your travel route," they suggest. "Letters in a jumbled mass, or even grains of sand, can arrange themselves, on your screen, into a neatly composed title. Dolls and toys can be made to move on a miniature stage as though alive. Clouds can be caused to billow past trees or mountain tops with accelerated, clearly visible motion. Explanatory diagrams may be animated. And, if you can draw a little, you can produce animated cartoon films, like Mickey Mouse . . . even in color!"

Snow as Color Subject

WHY shoot snow in color since it is all white? Actually, snow is an excellent subject for color photography because, although to the casual glance it may appear to be paper white, it contains delicate color hues that can be picked up and revealed in a well-exposed color transparency. This is due to the fact that snow is a fine reflector of the colors of the objects around it. These include trees, houses, people's clothing, and so on, plus, of course, the blue of the sky.

Lighting For Scientific Movies

HENRY M. LESTER, noted for his motion picture work in scientific and surgical fields, employs an arrangement whereby two miniature spotlights, one on each side of the stand supporting his camera, provide the illumination. These lights are mounted on adjustable supports, obviously a great necessity in his type of work. Mr. Lester uses the F-R Hi-Spot, alternatively employing one Hi-Spot in conjunction with a GE R2 reflector flood lamp, the latter combination when photographing an eye operation. His movie camera is the Cine Kodak Special. Mr. Lester finds the combination of spot and flood highly useful, but adds that "it does not lend itself to high-low circuit arrangement, which circuit, however, is fully applicable to two Hi-Spots operating at the same time."

Foreground Shadows

WHEN the foreground is empty and therefore without interest, a shadow will help to fill up the expanse, as in the accompanying illustration. It fills the space by providing a pattern, which, being dark, does not call too much attention to itself and therefore permits the eye to center attention on the main subject. Such a large area as that shown in "Provincetown Pattern" does, however, usually require some shadow detail in the pattern to show through. Smaller areas can do with jet-black shadows, if necessary.

"Provincetown Pattern"

Acid-Proofing Sinks

FOR that darkroom sink or table, here is a formula that has worked well in at least one laboratory:

Solution No. 1
125 grams copper sulfate
125 grams potassium chlorate
1000 grams water

Solution No. 2
150 grams fresh anilin oil
180 grams concentrated hydrochloric acid
1000 grams water

After cleaning the surfaces free from dirt and paint or varnish, if any, apply two coats of No. 1, using a paint brush and applying hot. Follow the usual procedure of allowing each coat to dry before applying the next and then apply two coats of No. 2 in the same way. When completely dry, wash with hot soapsuds and finish with raw linseed oil, rubbing the oil well down to obtain a polish. As the table or sink is used the polish will wear off somewhat, but an application of linseed oil will freshen it up again.

Amidol Developer Hint

Referring to our little piece in the March 1940, issue, on amidol development, Alfred L. Fitch, of North Easton, Massachusetts, says that the information agrees with his experience in over 20 years use of it, but that he found objectionable the necessity for weighing the formula each time it is used.

"For a number of years," he writes, "I used a three-solution pyro developer for plates and kept solutions of pyro, carbonate, and sulfite which were mixed at time of use. The sulfite was 60 degrees by hydrometer, of which I took 1 oz., a level mustard-spoonful (10 gr.) of amidol, and 4 ozs. of water, to which was added 10 to 20 drops of 10 percent bromide of potassium solution. This I found more convenient than weighing each time. Multiples of these quantities were used according to the size and number of prints to be made."

Body Heat as Intensifier

Although not to be recommended as a general practice, some darkroom workers have found that rubbing the palm of the hand against a highlight that seems tardy in showing up detail, will help to speed up development in the local spot and thereby print out the wanted highlight detail. The reason for this, of course, is the basic one that the higher the temperature of the developer the quicker the development; the palm of the hand soaked in developer and warming the latter by friction provides the increase in temperature.

Stunting With a Kaleidoscope

The kaleidoscope is a tube with a peep-hole at one end and a sort of pill-box containing an assortment of colored pieces of glass at the other. Two mirrors or pieces of glass blackened on the back are set at an angle to each other inside the tube. The

Kaleidoscope portrait

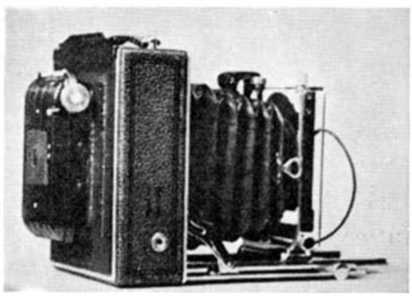
device is pointed towards a light and,—as the front element is revolved, various symmetrical designs are formed. The kaleidoscope may be used in photography to obtain multiple effects, as in the accompanying illustration. Both back and front elements are removed and one end attached in front of the lens. The tube is turned to obtain various arrangements. Exposure, to hold the extra images, is approximately four times normal.

Bantam Back for Film Pack Cameras

REDUCING backs for view cameras or the popular ground-glass focusing type of film-pack cameras are not new. The introduction of Kodak's new direct positive panchromatic safety film in 8-exposure Bantam size rolls, however, has revived interest in a special back to handle this film.

Such a back can be easily constructed from two plate-holders of a film-pack camera, but the ground-glass focusing panel supplied with the camera cannot be used.

The center portion of one plate-holder is cut out and matched to the exact size of the opening in the plastic



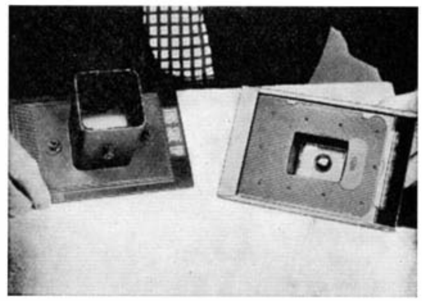
Home-made Bantam film back for pack camera is simple to make

case of a Bantam *f*/6.3 Kodak. The all-in-one piece, lens-shutter-bellows assembly, attached at the factory to the camera by four screws, is not used, but the screw holes are used to attach the plastic case to the plate-holder of your camera, as shown.

To make the assembly light-tight, press in some Plastic Wood between the Bantam case and the plate holder after the screws have been tightened. The dark slide of the plate holder operates as usual and will only be removed from the loaded Bantam case during an exposure and then replaced.

The second plate-holder, with a small center section removed, is made into a focusing screen by mounting a small piece of ground glass on a cut-out block of wood, the same distance from the front surface of the plate-holder as is the film plane of the Bantam equipped holder. The screen is encased in a small metal can or other form of focusing hood as shown in one of the pictures.

To register the images, place a piece of ground glass on the film runway of the Bantam holder and focus a test object sharply by racking the lens in the usual manner; then carefully lock this point. Remove the Bantam holder, replace it with the second holder containing the cut-out block of wood and ground glass, and



Focusing and film-holding backs

adjust this ground-glass back and forth until the previously focused image comes up needle-sharp. Make this adjustment permanent on the focusing holder and the job is finished.

The obvious and varied uses to which the device can be put need no discussion here. The Bantam camera case complete, but *minus* the lens-shutter-bellows assembly, can be obtained on order from Kodak through your dealer.—*Herbert E. Hayden.*

Police Restrictions

WITH war abroad and fifth column talk in this country, life for the amateur photographer is no longer the carefree business it has been. In New York City, after a number of incidents in which persons were stopped when attempting to take snapshots from bridges and similar places, the police department was queried on the subject. Police Commissioner Lewis J. Valentine, although assuring amateurs that they will receive every consideration and not be interfered with by the local police, advised amateur photographers to use discretion "in the taking of photographs at or in government reservations, such as the New York Navy Yard and army posts, transatlantic steamers, important public utilities and so on."

Composing on the Easel

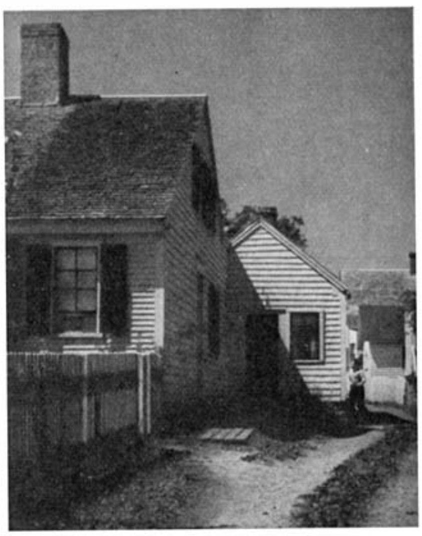
COMPOSITION of subject-matter should be done directly in the ground-glass or finder, they tell us, but this is not always possible. Sometimes, too, projection of the negative on the easel gives us other ideas on how to treat the particular subject. Compositions are made of lines, masses, and light contrasts. The exact result cannot always be studied properly while observing the subject on the easel. Here is an aid that may spell the difference between a good and a bad composition or at least between a good composition and a better one. Place a sheet of ordinary white paper or cardboard on the easel and mask it as usual. With a pencil, draw out-lines of the principal lines, masses, and darks and lights, shading heavily for the shadows (the light tones on the easel), and lightly for the highlights (the dark tones on the easel). Then study the result by white light. This will give you a pretty good idea of how the subject is composed.

Copying Texture Subjects

THE routine copying technique is to illuminate the original with one light on each side directed at an angle of 45 degrees to the plane of the easel on which the original is mounted. However, there are instances, as in the case of textiles, where it is desirable to show the texture of the surface as well. This is accomplished in a simple manner. Instead of having both lamps equidistant from the easel, place one of the lamps at the usual 45-degree angle, but move the second one in a distance equal to two thirds of the other. This technique will give a good copy and at the same time show up the surface of the original.

Human Interest

TO MANY workers a landscape is incomplete unless it contains some suggestion of a figure. No matter how small the figure, it brings the landscape or some such study as "Country Home" to life for them. The boy running towards the house fills the bill in the present case, even though he is somewhat indistinct due to movement.



"Country Home"

Shooting Friends

TOM WEBB, New York illustrator, is a photographer by avocation, and for the past three years has taken a particular delight in shooting his famous friends when they come to call on him. His portraits have been placed in such high esteem that he has had two one-man shows in two years. Frank Crowninshield, editor, says of the portraits that they "mirror a man's inner life rather than the transitory and superficial aspects of his physical exterior."

Kyohei Inukai, by Tom Webb

"Cameras like Tom Webb's," he adds, "can be bought anywhere. Concerning his films, too, his darkroom, his developer, his technical methods, there is no mystery at all. The enigma, all of it, springs from Tom Webb himself; his sensitiveness as a man, his ability to apprehend and evoke; to imbue his sitters with an added and, perhaps, unsuspected aura."

Mr. Crowninshield himself is among Mr. Webb's "victims," as are also Kyohei Inukai, the portrait painter, Mr. Webb's study of whom is reproduced here; Bruce Barton; Pierre Van Paassen; Dean Cornwell; Owen Davis; James Montgomery Flagg; John Golden; Rube Goldberg; Clarence Buddington Kelland; Grantland Rice; and many others.

Utilizing Rubber-Cement Waste

THE penny-saved-is-a-penny-earned philosophy is put to practical use by the students of an art school, who save the excess cement along the sides of a paste-up and roll it up into a ball which is used as an eraser. They find it wonderfully efficient in erasing spots and dirt, particularly in wiping up the leavings of a removed strip of scotch tape. The trick will work as well for photographers.

Why Pure Water for Solutions?

THE frequently occurring question concerning the use of pure water in mixing developer solutions is discussed authoritatively by LeRoy Roselieve, an xpert in these matters and designer of the fine grain developer X-33, in a recent issue of *The Foto Review*, a publication o. Fink-Roselieve Co., Inc.

"The fact is too often forgotten," he writes, "that water demands most serious attention when mixing and diluting developers, fixing solutions and other photographic formulas. Few are aware that even municipally supplied water may cause an endless amount of trouble from a photo-chemical standpoint, due to the fact that it may contain a large amount of harmful impurities. These impurities occur in the form of various calcium, aluminum, copper, and iron salts, in addition to minute vegetable and marine matter, which react with the chemicals used in solutions and are very harmful in their chemical reaction during processing.

"Iron salts appear particularly in considerably large quantities since the water has to pass through a multitude of metal pipes made of various alloys of questionable condition. During its journey through these pipes the water will collect and carry a lot of iron deposit and other impurities. The presence of any considerable quantity of iron salts in a developer will seriously affect the photographic emulsion and the chemical action of the solution itself. Developers mixed in water of doubtful purity break down rapidly and produce an abundance of stains, black spots, and other blemishes on the surface of photographic emulsions.

"Therefore, we cannot stress too greatly the importance of using only purified and preferably filtered water for mixing solutions if no distilled water is readily available. This precaution will eliminate the possibility of contaminating solutions with impurities which act as oxidizing agents in a developer, thus decreasing the life and usefulness of solutions. The slight expense involved in using distilled water or equipping water faucets with filters will more than pay for itself by insuring a longer life to developers and fixing solutions besides producing better results in negatives and prints."

Why Home-Made Safelights Fail

Although the amateur worker with a yen for making his own gadgets may do so with many odds and ends of small equipment, safelights are not one of the things he should attempt. The ordinary means is to use a red bulb or screen the lamp with a piece of green cellophane. But this is inadequate and far from safe when handling sensitized materials. In this case, at least, it is better to purchase the commercial product, for the reason that, it being difficult to obtain a single simple dye that is pure in color, the commercial slide is made up of a number of different colors. The red bulb, on the other hand, while it may look red, may also be transmitting some blue, and this blue will fog the emulsion.

Daylight Shots Indoors

Sunlight through curtains, a bowl of peaches on the kitchen table by the window and patterns of light nicely arranged, make up the ingredients of "Still Life." A snapshot exposure with a reflex camera held in the hand while standing on a kitchen ladder to get a down-tilt, caught this picture at 1/25th of a second, $f/5.6$, on fast pan film. Opportunities such as this are frequent in the home. Sometimes the arrangement is just as you want it; sometimes the table is cluttered up too much; a picture is possible only if one object, such as the fruit bowl here, is isolated from the rest. If sufficient depth is not possible with a snapshot, move farther away and enlarge only the wanted portion, or, of course, use a tripod.

Simplicity is the keynote of still-life camera studies, many of which can be shot indoors by daylight, as was this example

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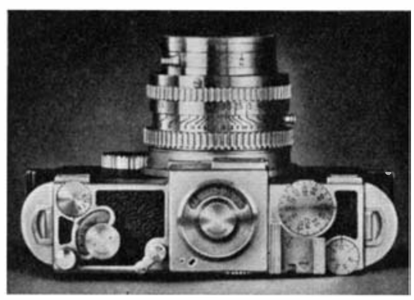
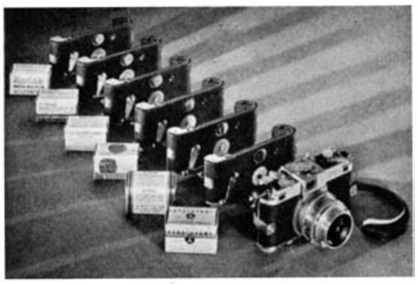
WHAT'S NEW
In Photographic Equipment

Kodak Ektra ($235 to $325): Eastman's new high-grade 35mm miniature camera, featuring interchangeable backs, comprises three units: camera body, interchangeable lens, interchangeable magazine back. Body and back, when placed together, combine into single trim unit, with rounded ends fitting user's hands. Each back has manually set exposure-count dial, mechanism for moving film, visual indicator to check on film movement, metal slide which automatically covers film opening as back



Operating controls of new Kodak Ektra are grouped on top

is unlocked from camera body. Sliding lock keeps back fully light-tight when unloaded from camera body. Back cover also has small metal indicator dial to identify film in magazine. Film winding by small lever takes



Interchangeable magazine backs are one feature of new Ektra

two quick flicks of thumb. Interchangeable lenses include Ektar f/3.5, 35mm focal length; Ektar f/1.9, 50mm focal length; Ektar f/3.5, 50mm focal length; Ektar f/3.5, 90mm focal length; Ektar f/3.8, 135mm focal length; Ektar f/4.5, 153mm focal length. All lenses, surface-treated to improve clarity and brilliance, couple automatically with Ektra range finder. Focusing by range finder to five feet on two telephoto lenses; to 3½ feet on others, with closer focusing by scale. Diaphragm scale, distance scale, direct-reading depth-of-field scale engraved in large numerals on lens; special indicator for infra-red film. Lenses screw in; positive lock holds them in position. Large, milled ring for rapid preliminary focusing, with smaller milled focusing wheel for final adjustments. Shutter of pre-selected type, width of slit established as shutter dial is set. Shutter speeds above 1/25 second (up to 1000) selected by lift-and-set dial; slower speeds (1 second to 1/10) by auxiliary dial. Brown cowhide combination case ($15) available to take camera with lens, extra magazine back, two extra film cartons, several filters. Ektra may be purchased with any desired lens, including telephoto.

Kingdon Film Washer ($1): For washing film in Bakelite or metal reels. Handles up to dozen 4 by 5-inch cut films or three rolls 35mm film. Eight outlets in base for expelling hypo-laden water. Washer incorporates own elevated base. Rust-proof spun-aluminum construction.

Crawford Flexichrome Process ($6 complete outfit): For making inexpensive color prints from black and white negatives, by contact or enlargement on special Flexichrome Matt Base Positive Relief Film. Process produces black dyed gelatine relief image on white backed celluloid base, colors being applied to surface with brush. Outfit includes set of 12 Flexichrome colors (in one-ounce bottles); Flexichrome Modeling Agent or Black Dye Bath (powder) to make 64 ounces, or 2000cc working solution; Flexichrome Liquid Paper Backing (6½-ounce jar); Flexilene Quick Drying Cover Varnish (four-ounce bottle); chromic acid; ammonium bichromate; soft flat backing brush; camel's hair paint brush; Flexichrome lintless paper-napkin blotters (200); instruction booklet. Flexichrome film available separately in sizes 5 by 7 to 20 by 24 inches, prices varying $1.05 for half-dozen 5 by 7 to $30 for dozen 20 by 24.

Boes Model A 35mm Film Winder ($4.50): For daylight loading of bulk film into all standard magazines and cassettes. Capacity to 100-foot rolls of Eastman film or 50-foot rolls of other popular brands. Bulk film storage chamber normally closed when spool leaders are threaded. Film gate opened when door is closed. Film emulsion does not touch winder at any point. Special inter-lock feature prevents opening door unless film gate is closed. Frames counted automatically.

Kodak Print Lacquer (60 cents for 8-ounce can): Designed to protect surface of prints from marks, dust, abrasion, and atmospheric discoloration. May also be applied on album covers, leather surfaces of cameras and cases, other equipment made of natural or artificial leather, and metal parts (to prevent oxidation and discoloration).

Seeclear Fotofolio ($5 for deluxe genuine leather; $3.50 for imitation leather): For filing contact prints. Equipped with transparent acetate pockets for inserting prints. Each pocket attached by cloth hinges. Each pocket holds two prints back to back with negatives between. Pockets flip back for display.

Six-20 Flash Brownie ($4.25): Features built-in shutter synchronization for Photoflash. Takes pictures 2¼ by 3¼ inches. Accessory flash-holder $1.50 extra; may be purchased separately. Similar to Six-20 Brownie Special, but two threaded electrical connectors provided on front of case to take flash unit and carry synchronizer current. Flash holder made of black molded material, with four-inch polished metal reflector. Socket of spring type. After firing, bulb is released by finger pressure on two small projecting clips, and shake of camera.

Enlarg-O-Meter ($4.95, including Reco Gray-Scaler): Exposure meter for enlarging timing, featuring micro-star providing sharp division between matching surfaces, making readings possible as low as 1/50 foot-candle over area 1/16-inch diameter; automatic switch turns unit off when not in use; simple cam shutter instead of rheostat; two-color dial for easier settings; Bakelite case. Reco Gray-Scaler supplied with meter makes calibrated gray scale with relative exposure number printed right on strip.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Marlin—1941

When you receive your copy of the Marlin Firearms Company's new 1941 catalog, you'll have an encyclopedia of the entire Marlin line of 35 splendid guns. You'll find 10 rifles in the .22 caliber class, eight in the .30-30 group (which includes your option of a .32 Special Model), 15 over/under shotgun models, and two smart numbers in the .22 smoothbores with which to break miniature clay targets. Model 101-DL bolt action, single shot, .22 caliber, is going to delight the nation's junior target shooters, for it is self-cocking, has peep-sight, ramp front sight and hood, swivels, and a 24-inch round barrel —all for slightly over seven dollars. This should help produce a good crop of younger generation gunners, a healthy sign in this country these days.

Another new Marlin for folks who like to smash little clay targets with .22-caliber scatter shot is Model 80-CSB, a smooth-bore, 8-shot, clip type, bolt-action repeater whose 24-inch round barrel is recess-choked to aid in scattering the tiny pellets. Other .22-caliber Marlins are two single-shot bolt actions; two 25-shot bolt action, tubular magazine, 24-inch, round barrel guns, one equipped with peep-sight, ramp front sight with hood, and swivels. Then, there's Model A-1C, an automatic .22 rifle, six-shot clip type, for long-rifle cartridges only; and its brother, with peep-sight, hooded ramp front sight, and swivels. And, of course, the old reliable Marlin 39-A (May and November 1940), one of the country's finest small-caliber rifles since its inception in 1891.

In the heavier caliber group—.30-30 or .32 Special—you'll find eight excellent guns, of which Model 36A-DL, with 24-inch barrel, 2/3 magazine, six shots, checkered grip and forearm, detachable swivels, leather sling strap, and pistol-grip cap is the newest member. In .30-30 or .32 Special, this is Marlin's latest contribution to the deer-hunter's happiness, and, although not available until late June, it will sell for less money than other guns in the same field.

Marlin's series of Model 90 over/under shotguns needs no introduction to American shooters. This year they'll be featured with checkered grip and forearm, whether of double or single (non-selective) trigger style. They may be had in 26-, 28-, or 30-inch barrels in the 12 gage; in 26- or 28-inch barrels in the 16 and 20 gage; in the .410 bore, with 26-inch barrels, all with the double trigger. The same selection is offered in the single-trigger gun except that the .410 is not made in this style. The single trigger is *absolutely* positive in action and *will not* fire both barrels. Due to war-time conditions, it has been necessary to suspend manufacture of the famous Skeetking.

Another Marlin 1941 feature is the new style buttstock, best described in the words of the catalog: "Marlin introduces a new and one-piece military type buttstock, handsome with fluted comb and semi-beavertail forearm, for its popular .22-caliber rifles. Fashioned for easy holding, balance, and 'feel,' the new buttstocks have the fine proportions usually associated with custom-made firearms."

One of Marlin's newest guns

All details of these and other guns are completely listed and illustrated in the new Marlin catalog. If you'd like one, just let us know, but please —*please*—remember to send us six cents in stamps to cover mailing and other costs.

Want a Tackle Tax?

The so-called Pittman-Robertson Act provides for annual Congressional appropriations to many states from the 11-percent federal excise tax on sales of sporting arms and ammunition. Any state which receives approval of its rehabilitation projects for its wildlife participates in the annual grant of these accumulated funds, provided the state (1) appropriates 25 percent of the cost of such projects and (2) goes on record legislatively not to divert hunting license funds and fees from conservation channels. During the last two years this method has provided close to $6,500,000 for wildlife restoration projects, other than fish, in the states that have participated.

Now comes another piece of legislation, known as the Buck Bill, modeled on the Pittman-Robertson Act, and reportedly designed to accomplish the same thing for fish that the P.-R. Act has done for wildlife. However, the situation does not appear to be comparable. Questionnaires were sent to several state conservation departments asking whether they needed or would be interested in federal funds for rehabilitation of fish.

Three of the states that are among the hardest fished in the country—Indiana, Michigan, and Wisconsin—advised that additional funds were not needed. Anglers in California are reported to be definitely opposed. In our opinion, this is a poor time to consider another tax on the sportsmen. We're going to pay increased taxes to support the national-defense program, and certainly, until the states themselves are more unanimous in their desire for federal help, we see no reason to over-burden the already burdened sportsman with an extra 10-percent tax.

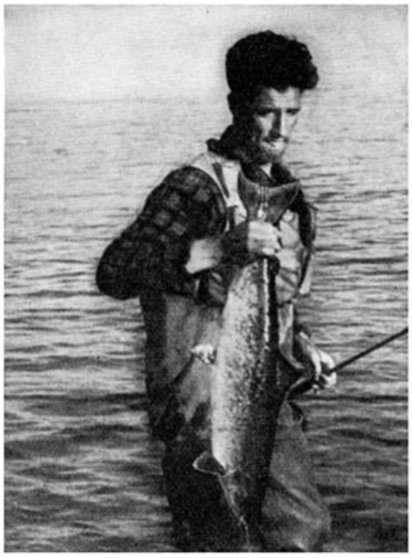
Angling Heresy

When a man occupies himself for two to three months every year for five years in diligent, assiduous angling for Newfoundland Atlantic salmon, and when he then says, "No spring will ever be complete without a day of salmon fishing," he has proved fallacious the old adage, "Familiarity breeds contempt." To the contrary, Lee Wulff, angler of many waters, author, artist, and motion-picture photographer of rod and line sequences that cotton your mouth, tingle your spine, and make you want to go and do likewise, maintains the salmon is deserving of more respect than any other game fish.

The salmon fisherman, says Wulff, faces the dual task of acquiring a technique different from that he has used in other forms of angling, and of mastering sufficient ichthyological lore of *Salmo salar* to enable him to fish intelligently and with even a moderate amount of success. These tenets are particularly true in view of the gradual but decided change in salmon tackle. The long, two-handed rods are disappearing from the Humber, the La Poile, the Gander, the Codroy, and other famous Newfoundland streams. In their places are found five- to six-ounce rods from 8½ to 9½ feet long.

An advocate of lighter rods and terminal tackle, Wulff suits his equipment to stream size and conditions, often using a two- to three-ounce rod to accomplish what he considers the peak of salmon fishing sport—to hook, play, and land a big fish, unaided, on light tackle. Terming his own method of playing a fish "rank heresy," he explains that after the fish strikes and starts the run, he lowers the rod to an almost horizontal position, thus permitting the line to flow freely through the guides with a minimum of friction. The instant the run stops or slows up, the rod is flipped back to vertical to provide the necessary line tension to hold the fish, and slack line is then reeled in. The process is repeated until the salmon has become sufficiently tired to land.

As to leaders, length and thickness depend on water and weather conditions, but Lee warns us to "use light leaders to catch more fish," and suggests leader lengths from six to 25 feet, "each having its proper place under the varying conditions of the fishing." He says, "the length of the leader is equally as important as its thickness in fooling the wary fish." His leaders taper from .022 down to .012 or .011 for normal angling, but he has successfully used tippets as fine as .008.



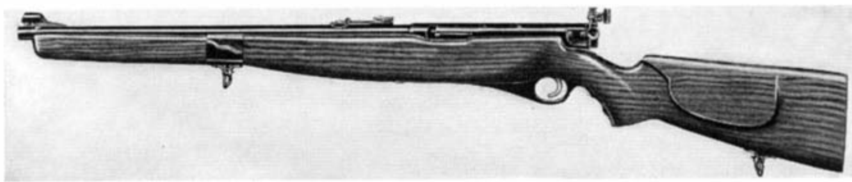
Wulff and 15-pound salmon

Heretical or not, Lee Wulff's fishing methods and his study of the salmon bring him results with a maximum of sport. To acquire his extensive knowledge of where salmon lie in streams, what they prefer in lures, and why; how best to hook, play, and land them, he catches—and returns—an average of 500 fish per season. If the fish are properly played, brought in quickly before they are too tired, and if a gaff or other injurious instrument is not used in landing, 99 percent of fish so landed will live.

Admittedly, an angler who so exhaustively studies his avocation is in a position to discuss the sport with authority. This Lee Wulff has done in his latest book on salmon, "Leaping Silver," which is profusely illustrated with his own drawings and photographs. Of exceeding interest to clubs and organizations that desire to provide entertainment for members, are Wulff's "Newfoundland Series" of motion pictures in full, natural color. These graphically depict not only salmon and trout fishing in Newfoundland, but also deep sea angling off the coast, as well as hunting trips for ptarmigan, caribou, and moose. Lee's latest folders are available to clubs and other groups.

"Those Mossbergs"

When, last May, we told you about the new .22-caliber rifles by O. F. Mossberg & Sons, Inc.—Models 42M, 46M, and 51M—we received so many inquiries we couldn't go fishing. We suspect that situation will recur—except we'll have to give up ice fishing, not stream angling—when we tell you of certain refinements that will be found on all Mossberg guns in 1941, and particularly on Model 51M, which is the 15-shot automatic that handles .22 regular or high-speed long-rifle cartridges, either lubricated or dry, and which proved so universally popular last year.



Mossberg's model 51M

Every 1941 Mossberg gun will have a blued finish that will be second to none. The Mannlicher, Mauser, or Military type—whichever name you prefer—exemplified by these three models was so acceptable to shooters that no change is contemplated in general design and styling. Each member of this "M-Family," you'll recall (May 1940), is equipped with hooded ramp front sight with four permanently attached inserts: No. 2 rear sight with screw adjustment for windage and elevation; No. 4 micro-click peep-sight which swings out of the way, permitting use of open or 'scope sights. All have detachable swivels, non-breakable molded trigger guard with finger grooves, and in the cases of Models 42M and 46M, there's a Mauser-type bolt-action that hugs the stock and doesn't interfere with 'scope mountings.

In Model 51M—the automatic—the shooting world will be treated to two more Mossberg innovations. The safety, which was formerly a red and green "traffic light" type on top of the small-of-the stock, and just behind and below the rear end of the barrel, has been changed and improved. It is now in the form of a lug-bolt, positively operating from the receiver port, and by means of which the action of the gun may be backed up and held open at the port for cleaning purposes without removing the bolt containing firing pin and the balance of the firing mechanism. If, however, it is desirable to extract the bolt and firing section of the receiver, this can be easily and simply done by sliding the whole apparatus from the rear of the barrel without use of any tools. All parts are so constructed that it is impossible to reassemble them *incorrectly*. They're made to fit and fit perfectly; one way, and one way only—a boon to many shooters.

The four inserts of the hooded ramp front sight are composed of a wide, flat-top post; a narrow, flat-top post; a bead; an aperture. They are permanently attached to the gun in a notch in the ramp, can't be lost or bent out of shape when not in use, and, depending on the type of shooting and the gunner's preference, are quickly swung up into place or folded down into the notch, out of sight and harm.

The three "M" guns are drilled and tapped for all Mossberg side-mounting telescope sights. The 1941 catalog is now on the press and will be ready by the time you read this. In it, you'll find all we've said, and more, amplified by pictures and descriptions. We'll be glad to send you a copy, if you'd care to have one.

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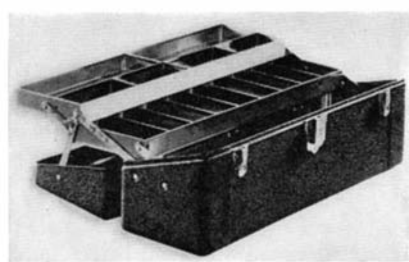
POT-SHOTS

At Things New

Outing Manufacturing Company, makers of tackle boxes galore, show real appreciation of value of non-corrosive metal to ocean-going anglers by offering the world's only Monel metal tackle box in generous proportions—21-inch length, 6½-inch width, and 7-inch height. It boasts two automatic cantilever type trays with six compartments in the upper, nine in the lower, ample room in the bottom for reel, large plugs and complete supply of tackle. Coated with clear lacquer inside, in black, ripple-finish baked enamel outside, Outing's newest comodious tackle box is waterproof, weatherproof, offers a life-time of service.



Monel metal tackle box

Our Book Corner

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MUST WE GROW OLD?

By Barclay Newman

UNIVERSAL is the realization that we all must grow old—unless in the meantime science finds ways to head off this slowly creeping process. This makes the subject of the present book equally universal in appeal. And scientists *are* at work on research connected with numerous angles of this all-important problem. What they are doing is explained in this work in seven lengthy, topical chapters. One discusses geriatrics, our newest medical specialty which deals with the diseases of old age, now that an increasing proportion of the population reaches advanced years. Another asks whether death need invariably be the result of some precipitation cause, as at present; that is, without such cause would we live on and on indefinitely? A third deals with food factors which limit life, and a fourth with our hormones, chemical messengers of the blood, which may number our days. Cancer and the problem of aging is a fifth, and a sixth is high blood pressure. The author, primarily a scientific man (biologist), writes for the reader who wants scientific substance to his reading, not just fluff; and, while this still is a popular work, it is a solid one based on recorded research in biological literature. (269 pages, 5½ by 8 inches, unillustrated.)—$2.60 postpaid.—*A. G. I.*

MEN AND VOLTS

The Story of General Electric
By John Winthrop Hammond

IT IS curious that a history of one of the outstanding industrial and research organizations of the present day should end with the year 1922. Since the material for the present book was finally brought into shape, 18 years have elapsed, during which there has indeed been remarkable progress in the electric industry. On the other hand, the progress from the beginning of the industry in the United States up to the year 1922 encompassed the romantic period of rapid and unparalleled development. In these pages is told the story of the struggles with early dynamos, the sales resistance that had to be overcome before electrical power and distribution could be started even on a small scale, the early days of the electric light, the battle between the arc and the incandescent, and all the other ramifications of the early struggles of electricity. While the text is essentially devoted to those organizations which eventually were merged into the now famous General Electric Company, it deals also to some extent with contemporary work in allied industries. A brief epilogue and an appendix to the original author's text serves quickly to bring the reader up to date. (436 pages, 6 by 9 inches, a large number of illustrations.)—$2.60 postpaid.—*A. P. P.*

LEAPING SILVER

By Lee Wulff

AN Alaskan by birth, an ichthyologist and an expert angler by dint of exhaustive research in many waters, the author has followed his two other successful books, "Lee Wulff's Handbook of Fresh Water Fishing" and "Let's Go Fishing," with this splendid dissertation on salmon angling in Newfoundland. For the experienced salmon fisherman, as well as for the would-be *Salmo salar* nimrod, this book is packed with informative helpful data "On the Life of the Salmon," "On Where Salmon Lie," "On Salmon Tackle," "On Hooking the Salmon," "On Playing the Salmon," all simply and informally told. For the sportsman who collects beautiful books, there is a Limited Edition of 540 autographed copies in half leather, in slip case, with full color frontispiece. (150 pages, 6 by 8 inches, 72 action photographs, 26 sketches.)—Regular edition, $3.60 postpaid; Limited edition, $15.10 postpaid.—*A. D. R., IV.*

MULTIPLE HUMAN BIRTHS

By Horatio Hackett Newman, Professor of Zoology

UNTIL this book was written there was no book on this subject for the general public. Professor Newman, an outstanding American scientist, has made the study of twins and the science back of them a specialty for 25 years. This most readable book deals with the mutual intimacy and interdependence of twins; odd notions entertained about them; one-

The Editors Recommend

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egg and two-egg twins; why twins are at a disadvantage in life; Siamese twins; causes of twinning; triplets, quadruplets, quintuplets (with a long, detailed and accurate section on the Dionne quints, free from unscientific bunkum); what twins show about human heredity; twin psychology; twins and the old hereditary-environment argument; life stories of one-egg twins; life stories of twins reared apart (these are filled with human interest—remarkable accounts of separated twins' mutual rediscoveries); how environmental differences affected separated, one-egg twins. A splendid piece of scientific but equally readable popularization. (214 pages, 5½ by 8¼ inches, 24 illustrations.)—$2.60 postpaid.—*A. G. I.*

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By Perry Burgess

MOVING, in fact, heart-rending, is this living account of a man, an American, who discovered he had leprosy, went to a leprosarium and there lived out his utterly hopeless, mentally tormented, isolated life. The account, not technical or medical, but popular, is extremely well written, moves swiftly and without dull spots, and poignantly conveys to the reader a full, sad comprehension of how it feels to be and live the best one can as a leper. (308 pages, 5½ by 8 inches, 14 illustrations.)—$2.85 postpaid.—*F. B. I.*

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An Introduction to Frequency Modulation

By John F. Rider

ALTHOUGH this compact book is designed for the radio service-man, it will give the intelligent layman an excellent insight into the operation of frequency-modulation transmitters and receivers. In final analysis it deals with those things which it is necessary to know in order properly to service FM receivers. (136 pages, 5 by 8 inches, a large number of drawings.)—$1.10 postpaid—*A. P. P.*

U. S. CAMERA ANNUAL 1941

Edited by T. J. Maloney

Prints selected by Edward Steichen

PUBLISHED for the first time as a boxed set of two volumes, this Annual, now in its fifth year, offers in the first volume a pictorialization of the American scene, and in the second a portrayal of the best photography of the year as selected by Edward Steichen, dean of American photographers. Particularly delightful is the piece, "Horton, Kansas, a Midland Chronicle," by J. W. McManigal, widely famed for his farm pictures. Helpful because of the detailed instructions and clarity of style is Eliot Elisofon's compact article-manual on "Flash Photography," supplemented by many illustrations.

—OUR BOOK CORNER—

Carl Mydans writes of his experiences in covering the Finnish war, and Pare Lorentz evaluates the work of Dorothea Lange. A biographical article by Hartley Howe on William Henry Jackson, 97-year-old photographer of the old West, is a valuable contribution. The photographs, both in color and black and white, cover a wide range of effort by professional and amateur and, in general, are indicative of an increasing sense of values among American photographers. (Two volumes, 248, 256 pages, 9 by 12 inches, many photographs)—$5.35 postpaid.—*J. D.*

A BOY GROWS UP

By Harry C. McKown and Marion LeBron

IF YOUR adolescent boy never causes you any headaches, this book probably won't help you or him, but if he is a normal adolescent and therefore occasionally seems to need steering, it may provide some useful ideas for directing his energies and giving him some sound outlets and attitudes. Typical chapters: Fitting into the Family Picture and into Organizations; Studying Your Own Progress; Skills and Hobbies; Jobs. (299 pages, 5¼ by 8 inches, illustrated.)—$2.10 postpaid.—*A. G. I.*

HOW TO KEEP MENTALLY FIT

By Lowell Thomas

MR. THOMAS explains that the brain is simply a muscle which, like the biceps, needs constant exercise. Elaborating upon this theme, he shows how quick-witted men in the public eye maintain their sparkle and command situations because they never permit brain laziness. Then he gives a large number of what are commonly called brain-teasers, a number of general quizzes, games with words, and information tests. This reviewer can vouch for the amount of mental exercise required on the brain teasers alone. (248 pages, 5¼ by 7¾ inches, illustrated.)—$2.10 postpaid.—*F. D. M.*

SCIENCE IN PROGRESS

Edited by George A. Baitsell

TEN Sigma Xi lectures given at Yale: Stadler on the experimental alteration of heredity; Went on the regulation of plant growth; Fulton on experimental studies of the functions of the frontal lobes in monkeys, chimpanzees, man; Johnson on the mysterious craters of the Carolina coast; Lane on how the earth shows its age; Robertson on the expanding universe; Anderson on cosmic rays; MacInnes on motions of ions and protons in electric fields; Beans on the ultracentrifuge; Hunsaker on recent advances in aeronautics. All are a notch or two stiffer than ordinary popular writing. (317 pages, 6 by 9¼ inches, 129 illustrations.)—$4.10 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

It's just a commonplace that the fellow who can always have whatever he wants by writing a check for it doesn't get as much fun out of what he owns as the other fellow who has to exercise his resourcefulness as well as his muscles in order to possess the same thing. The rich man will be the first to agree with this.

Rev. C. J. Renner, Trenton, Ohio (population 636), has managed without much actual cash expenditure to accumulate two good telescopes plus a serviceable observatory, and the letter he writes sounds as if he had had a great deal of fun in doing it. The two telescopes (Figure 1), one an 8" reflector, the other an 11", are built largely from spare parts—an iron wagon tire for a base, cast-iron drain pipe for a pedestal, steering knuckle for a polar axis, half of a rear axle housing for another. Such parts come ready made and in good proportion for adaptation to the needs of a telescope mounting.

The larger telescope has a tube skeletonized to obviate stray air currents that sometimes circulate within conventional tubes to the detriment of good seeing. Simply, ovals are cut out of it. This telescope has a flat instead of a prism for diagonal mirror and Rev. Renner says he found making it a most interesting job though

Figure 1: **Renner's pair**

it took a long time. He was permitted to machine the mounting at the Miami University shops, where he was helped through the woods by Prof. Wm. Albaugh, himself interested in telescope making. Leo J. Scanlon, of Pittsburgh, lent patterns for the castings.

"One great thrill," Rev. Renner writes, "was to build the little observatory. [Not yet finished when Figure 2 was taken.—*Ed.*]. Its total cost was less than $15, because it is made mostly of parts from the junk yards. I used water pump pulleys from Model A Fords for rollers under the revolving dome and the sheet metal was second hand, though the shutters are of new metal." He adds casually that, while doing all this, he also has been making household furniture and helping build a parish house. Maybe country parsons have more fun than city ones.

Tragedy? Not altogether. Suppose you had put in the spare time of two months grinding and polishing the concave mirror for a reflecting telescope, and then accidentally dropped

Figure 2: **The observatory**

it on a concrete floor, knocking the long slice off its edge that shows in Figure 3. That's what happened to Eugene R. Jolly, 3523 Fourth Ave., Los Angeles, California. Yet no great harm was done to the actual optical performance. Jolly made a new mirror, which incidentally required only 10½ hours because the experience already gained enabled him to go straight ahead with the second job without running up blind alleys. Only then did he discover that the remains of the first mirror performed as well as the second one. There is no theoretical reason why a mirror or lens must be round. The base of Jolly's telescope mounting (Figure 4) is cast integral with the two uprights forming the polar axes. The two setting circles are 16" lids obtained from the American Can Co. and laid off to appropriate angles.

The electric drive is equipped with a variable speed motor, Model V-10R, made by the Bodine Electric Co., Chicago, and the gears are from the Boston Gear Works. A three-way remote control switch permits the operator, while at the eyepiece, to run the drive at speed, or at approximately sidereal rate, or to stop it. Jolly states that experience in building this drive proves that there is no substitute for a good motor with plenty of power, which will save headaches later on.

He also comments on the fortunate fact that among amateur telescope makers there are as many ideas for telescope design as there are amateurs. He found telescope making fun, also that it taught lessons in patience and perseverance. He winds up: "I know of no greater thrill than the first night performance, when all the trials and tribulations of building were repaid a thousand fold by the first glimpse of the moons of Jupiter, the rings of Saturn and the Great Nebula in Orion."

How many who have made telescope mirrors can say that the work greatly increased their tenacity as applied to other things? In this sense it rates as a real character builder.

Suppose the glass tool is broken? One amateur says his tool broke squarely in two during coarse grinding and he glued it together, later used it as the base for his polishing lap, and got a fine figure on his mirror without trouble from this source. Another tells how he practically destroyed the tool by accident; it broke into about eight pieces. Yet, when cemented to the plate with pitch, it worked all right. Before doing the cementing he took pains to bevel the sharp edges, otherwise chips would have broken off and caused bad scratches.

Of course, if the tool should break after all grinding was done, and during polishing, a lap could be made on any other rigid substance which will not warp (as would happen if wood were used, for example). Russell Porter, when a beginner, broke one and remade the lap on an old stove lid, and this dodge worked satisfactorily.

Ramification of amateur telescoptics is spectroscope making and spectroscopy, either for astronomical or laboratory use. Unfortunately, this ground never has been organized more than sketchily for amateur purposes—that is, there is no convenient amateur's manual of spectroscope making and spectroscopy. The exist-

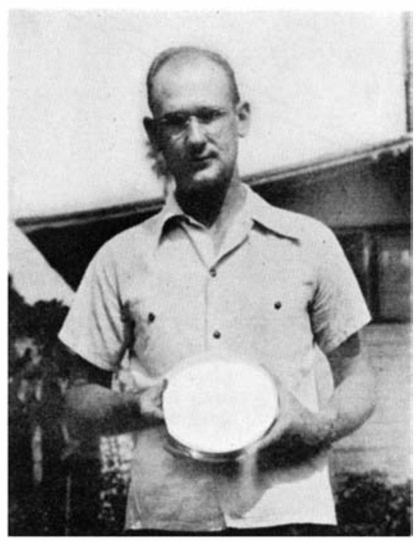

Figure 3: **The broken mirror**

ing literature is scattered, fragmentary and mostly takes for granted that the reader already is a physicist and knows much about the subject. For years about one request for such a manual has reached the editors each month. A little preliminary skirmishing revealed the probabilty that amateur spectroscopy, except possibly in a limited way, is largely a contradiction in terms, because spectroscopy so

Figure 4: **Jolly's drive**

quickly leads into the advanced physics that underlies it. In fact, on this account some assert that it simply cannot be made elementary or easy.

Now, in order to pay its own way in the world, any book must be assured of a sale of several thousand copies, not merely the one or two hundred copies such as the limited number of advanced amateurs undoubtedly would absorb. Is the desired book on amateur spectroscopy then not possible?

The solar spectroscope is relatively simple; there is an abundance of light from our nearest star. For a few other bright stars you also can rather *play* with a small spectroscope attached to a 4" or 6" telescope, but, in order to do much with the other stars, you need a considerably larger light gatherer. To the amateur this leaves only laboratory work in spectroscopy, using artificial light sources. On this the articles on the spectroscope and spectroscopy, in Glazebrooks "Dictionary of Applied Physics," are helpful but not elementary. W. E. Forsythe's "Measurement of Radiant Energy" contains 33 pages on the adjustment of spectroscopes but, being aimed at the physicist, takes for granted a general familiarity with spectroscopes and spectroscopy. S. Judd Lewis's "Spectroscopy in Science and Industry" is an excellent little book. The *Journal of Applied Physics*, Nov., 1939, contains a bibliography on spectrochemical analysis, and the American Society for Testing Materials, Philadelphia, also has published such a bibliography. Yet none of these is really elementary, Lewis's book, named above, being the most so. The "Proceedings of the Optical Convention of 1926, Part II," shows the construction, but not actual instructions for the construction, of a rather elaborate goniometric spectroscope.

In short, the amateur who exploits spectroscope making will have to be resourceful in filling in the big gaps between existing pieces of literature, themselves hard of access.

There still are, however, quite a few amateurs who already know something of the general background of spectroscopy and spectroscopes and who might make their own instruments. For example, Austin F. Trumbull, Airline Liaison, Aeronautical Radio, Inc., National Press Bldg., Washington, D. C., has built the instrument shown in Figure 5. "I never fail to read the section of Scientific American on telescoptics," he writes, "although my interest in optics does not center primarily around the telescope. I built this spectroscope for less than $50, around two old surveying instruments, one for the collimator and one for the telescope, which I bought for $10 each. One came from the Union Pacific and one from the City of Cheyenne and, from my inquiries, I gather that there are hundreds of these old 'transits' throughout the country. A base plate, the two transits, a good prism and a bilateral slit, and you can start to assemble. The only real problem is the slit, which is difficult to make. [See "ATM," pages 247-8.—*Ed.*] This particular assembly is not suitable for celestial work."

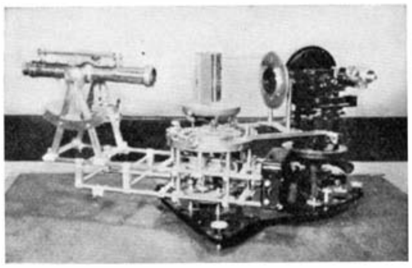

Figure 5: **Trumbull's neat job**

Asked to describe the instrument in detail, Trumbull begged off for one year because of absorbing preoccupation with a certain task of that length. Who among the readers can jimmy this subject open for the *average* amateur?

SITTING down instead of standing up is the really luxurious way to make mirrors. On the night in June, 1925, when your scribe first visited Stellafane to gather the material to write a story which started this hobby off among our readers, he showed Russell Porter a sketch of a sitting down grinding rig, the mirror to be rotated by the feet. Porter said this wouldn't be sportsmanslike; you must do it the hardest way (sacred New England tradition, no doubt). Not yet having made any mirror, and feeling humble, your scribe subsided and did it standing up.

Now comes Robert E. Smith, D.D.S., Medico-Dental Building, Sacramento, California, with the creation shown in Figure 6. He says: "Being a dentist, I am on my feet much of the time and, after a long trek around the barrel at night, grinding a mirror, my doggies sure do howl. Hence," he continues, "the machine that allows me to sit.

"The turntable lifts off, and the removable galvanized pan catches all overflow. The motor and worm gear on the concrete-filled tub base were taken from the slow motion of my first telescope. Fins were put on the motor shaft to slow it down. There are two gear reductions, 10 and 20 r.p.m., and a flexible shaft goes to the worm gear shown. The latter carries a pulley, and the belt gives the spindle, inside the pedestal, one revolution per 100 seconds, which may perhaps not be orthodox, but it worked splendidly [is OK, and no exact speed is orthodox.—*Ed.*].

"The spindle runs on ball bearings top and bottom. The turntable is removable (slot and key), facilitating quick, complete clean-up after each size of abrasive used, simply by removing and cleansing the annular pan."

Note the Doctor's stool, with its patent adjustment and soft cushion, plus a spiral spring near the bottom.

Figure 6: **Smith's solid comfort**

What sybaritic luxury! Being lazy, your scribe always wanted one of these but is also too lazy to build it, so what?

HINDLE grinding machines of the alligator type, described in the fourth edition of "Amateur Telescope Making," have made good; there are numbers of them in use. The one in Figure 7 was made by Alfred Bryant, 516 Eggleston Ave., Kalamazoo, Mich., who confesses he built it at first mainly to watch its wheels go round, since he felt that "making a mirror by hand puts the personality of the worker into the mirror." Later he "'fell for" this machine for mirror making.

He secured his speed reduction from an old washing machine, as he also did the alligator drive—it had been a wringer post drive. The take-off that drove the revolving cylinder of the washing machine, when reduced to half speed, worked out well for the

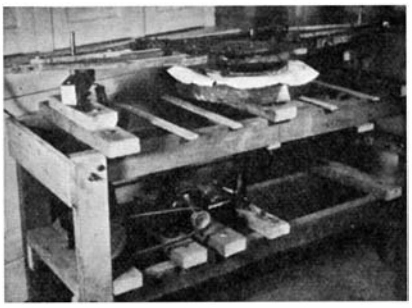

Figure 7: **Bryant's machine**

side-throw motion. Result was 28 r.p.m. on the drive part, 6 r.p.m. on the side throw and 1½ r.p.m. on the turntable. There is, of course, no cast-iron law about these speeds; many write to inquire for the "rule." The rule is, simply, use common sense. Don't give it so much speed that it performs like a speeded-up motion picture doing a crazy act but, instead, as calmly deliberate as a good hand worker moves.

Bryant had made eight mirrors by hand, so he started the machine on a 12½" Pyrex disk. He found he still had a few new things to learn, but says the machine seemed uncanny with its variations of stroke. Grinding in all stages went like a top, and so did polishing. The machine even brought the mirror, an $f/6.6$, to a paraboloid "by first intention," as Ellison says. "Really," Bryant writes, "it is a wonderful machine and does things impossible to do by hand. The way the mirror rotates in the opposite direction to the table, due to the loose rubber bumpers, is a corker, and it merely floats on top, just as Hindle states."

Bryant's log for the $f/6.6$ 12½" Pyrex mirror runs as follows:

Carbo No.	Wets	Hours	Strokes
80		6	9000
150	28	4	6750
220	22	3 2/3	6160
400	22	2	3360
500	16	1 1/3	2240
600	16	1 2/3	2680
Emery	10	1	1680
Totals		19 2/3	31840
Polishing		38	63840
Grand total		57 2/3	95680

THOSE who saved the Walkden discussion on matching RFT eyepieces and objectives, in the November number, are requested to place a vinculum over both the 2.5 and the a^3, in the second column of page 300, near the middle: Square root of the two.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

OPTICS AND WHEELS is a 32-page, thoroughly illustrated booklet that shows how scientific knowledge of optics and light have been applied to solve the problems of night automobile driving. It tells the whole story from kerosene to modern "sealed beam" headlights. *General Motors Corporation, Detroit, Michigan.—Gratis.*

THE OBSERVER'S HANDBOOK FOR 1941 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, variables, four star maps, an ephemeris of the Sun, and miscellaneous astronomical data to the extent of 80 very useful, practical pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

WHAT IT TAKES is a 32-page, completely illustrated booklet designed to present in simple terms the fundamental factors of time, planning, and specialization that are necessary for the creation of today's unparalleled values through mass production. Text and illustrations pertain specifically to the automobile industry, an outstanding example of mass-production possibilities. *Automobile Manufacturers Association, New Center Building, Detroit, Michigan.—Gratis.*

ENGINEERING STANDARDS AND TECHNICAL INFORMATION is a 16-page, illustrated booklet that gives specific data regarding "Aero-Thread" screws, studs, bolts, and nuts. "Aero-Thread" is a screw-thread system in which a spring wire insert is employed between the tapped hole and the mating screw. *Aircraft Screw Products Company, Inc., 25-12 Forty-first Avenue, Long Island City, New York.—Gratis.*

THE STORY OF MODERN INDUSTRIAL WEIGHING is a large illustrated folder that shows a wide range of weighing equipment specifically designed for certain industrial uses. A series of photographs shows these devices in use; a comprehensive group of illustrations shows specific forms of equipment, accompanied by compact data. *The Exact Weight Scale Company, Columbus, Ohio.—Gratis.*

PHOTRIX UNIVERSAL PHOTOMETER is a new 8-page folder that deals particularly with the use of the photometer for measuring the density of negatives and with the evaluation of these density measurements for determining exposure time in contact printing and enlarging as well as for balancing three-color separation negatives. Other chapters deal with the use of the photometer in testing the efficiency of various types and makes of enlargers, for studying the effect of the lens opening upon the light distribution, and so on. *Intercontinental Marketing Corporation, 8 West 40th Street, New York, New York.—Gratis.*

IT'S A NEW BUSINESS CUSTOM is a completely illustrated booklet that tells the story of tough manufacturing problems solved with the use of Durez plastics. Reports such as this can be highly inspirational to industry in general. *Durez Plastics & Chemicals, Inc., North Tonawanda, New York.—Gratis.*

KOPPERS CHEMICALS FROM COAL is a 28-page pocket-size booklet devoted to a description of some of the materials which are obtained from coal. Physical and chemical properties are listed for each and some suggested uses are included. *Koppers Company, Koppers Building, Pittsburgh, Pennsylvania.—Gratis.*

THE MICO ENGRAVER is an 8-page catalog which describes and illustrates a versatile pantograph machine adaptable to many lettering tasks associated with experimental work as well as with the routine production of panels, name-plates, and small parts. *Mico Instrument Company, 10 Arrow Street, Cambridge, Massachusetts.—Gratis.*

MICROMAX TEMPERATURE INSTRUMENTS FOR ELECTRIC POWER EQUIPMENT is a 32-page, illustrated catalog for those concerned with the operation of generators, frequency changers, large motors, transformers, and cable systems. Micromax recorders prevent loss in industrial plants by providing automatic and continual temperature checks on a wide variety of jobs. *Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

PORTABLE ELECTRIC TOOLS is a new 60-page catalog which fully illustrates a complete line of 132 portable electric tools. These range from a variety of power hand drills through hammers, saws, power shears, sanders, and so on, to industrial vacuum cleaners and a complete line of accessories. *Black and Decker, Towson, Maryland.—Gratis.*

BAKELITE MOLDING PLASTICS is a 32-page, illustrated booklet which contains descriptions of molding processes and explains the differences between thermosetting and thermoplastic materials. The physical, mechanical, and electrical properties of phenolics, ureas, polystyrenes, and acetates are enumerated. Request booklet on your business letterhead. *Bakelite Corporation, 30 East 42nd Street, New York City.—Gratis.*

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