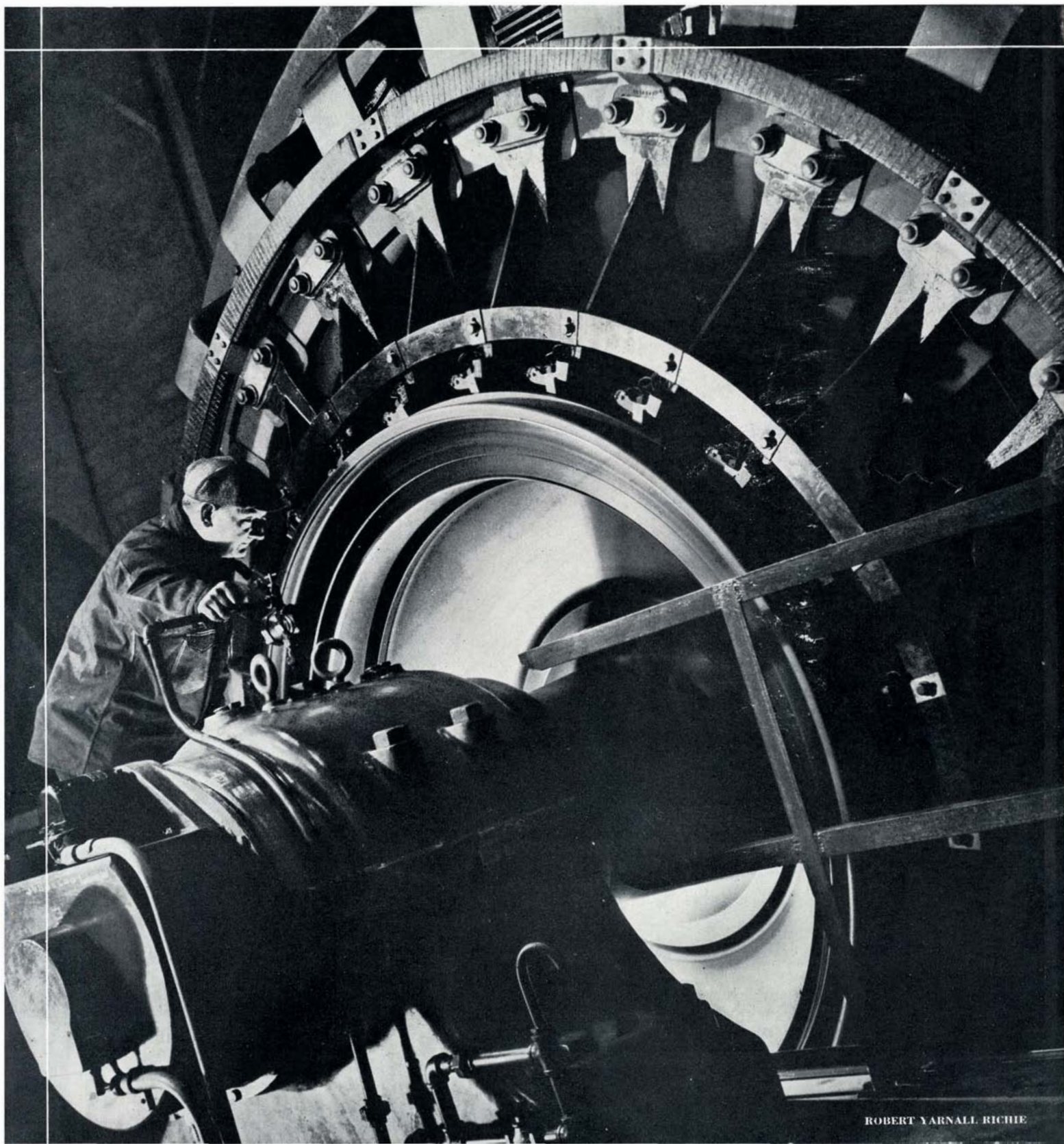


THE LIE DETECTOR: Is It Scientific?

SCIENTIFIC AMERICAN

June • 1937

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ROBERT YARNALL RICHIE



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DIVIDE this drop into 50,000 parts. Each part is a gamma— $1/28,329,000$ of an ounce. Yet in such tiny units research chemists find the secrets of long life and efficient operation of electric machinery—of refrigerators and electric clocks, of lamps as small as a grain of wheat, and great turbines that supply electric power to a whole city.

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purity. And so, in the Research Laboratory, in Schenectady, they check and examine, contributing of their skill and experience to the final perfection of the finished machine.

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NINETY-THIRD YEAR

• ORSON D. MUNN, Editor

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THIS month's cover shows one of the four shunt-wound variable-speed 5000-horsepower Allis-Chalmers direct-current motors driving individual four-high finishing roll stands of a semi-continuous 120-inch hot-strip steel plate rolling mill in the Carnegie-Illinois Steel Corporation's plant at Homestead, Pennsylvania. These are the highest powered individual roll stand drives in any of the new continuous mills operating in the United States. The speed of these large motors is under the supervision of a pulpit operator.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of June, 1887)

DOGS—"Careful experiments on the sense of smell in dogs have been made by George J. Romanes, who has communicated the results to the Linnaean Society of London. He finds that not only the feet, but the whole body of a man exhale a peculiar or individual odor, which a dog can recognize as that of his master amid a crowd of other persons; that the individual quality of this odor can be recognized at great distances in any direction; and that even powerful perfumes may not overcome this odor."

SEWERS—"Some system of constant artificial ventilation for sewers is, in the opinion of some of the most competent authorities, absolutely necessary, if we would be thoroughly rid of the deadly pest of sewer gas. Alanson Sibley . . . advocates for this purpose a furnace and chimney of strong draught, at the mouth of the main sewer, to create a constant suction of the gases away from the houses and into a consuming chamber in the furnace."

LIFE AND DEATH—"It has been computed that the death rate of the globe is 67 a minute, 97,790 a day, and 35,639,835 a year, and the birth rate 70 a minute, 100,800 a day, and 36,792,000 a year."

TYPEWRITER—"Among other advantages claimed for the Hammond typewriter are that it is compact in form and portable, weighing only 15 pounds; that the action is simple, and the machine easily worked by reasons of the accessibility of the keyboard and the disposition of the keys, and that the paper is not horizontal, but vertical, and is therefore easily read by the operator as he works."

MULTICYCLE—"This machine, manned by ten men, which may recently have been seen traversing numerous London thoroughfares, is Messrs. Singer & Co.'s latest adaptation of their 'Victoria' or 'Four-in-Hand' quadricycle, and is intended for the rapid transport of infantry from one point to another. When fully manned, it carries twelve men, who can take with them, if necessary, a light baggage cart or ammunition wagon. By thus mounting the riders in single file, instead of two or four abreast, the machine is both rendered more manageable and it also presents less surface to a strong head wind. The speed got out of this machine is surprising. Ten miles an hour is a low average rate, and sixteen have been easily accomplished."



SPEED AFLOAT—"Messrs. Thornycroft & Co., of Chiswick, in making preliminary trials of a torpedo boat built by them for the Spanish Navy, have obtained a speed which is worthy of special record. The boat is twin-screw, and the principal dimensions are: Length 147 ft. 6 in., beam 14 ft. 6 in., by 4 ft. 9 in. draught. On a trial at Lower Hope, on April 27, the remarkable mean speed of 26.11 knots was attained, being equal to a speed of 30.06 miles an hour, which is the highest speed yet attained by any vessel afloat."

ALUMINUM-SILVER—"Alloyed with a small percent of silver, aluminum loses much of its malleability, but with 5 percent of silver it can be worked well, and takes a more beautiful polish than the pure metal. With 3 percent of silver it is very suitable for philosophical instruments, being harder and whiter than the pure metal, and is not tarnished even by sulphureted hydrogen."

PLATINUM—"It has been demonstrated that platinum wire may be drawn so fine as to be invisible to the naked eye, although its presence upon a perfectly white card can be detected by the touch."

SUBMARINE—"The new Nordenfelt submarine torpedo boat . . . is the largest of its kind as yet launched, being 100 feet long, 12 feet beam, 160 tons displacement, and is engined to 250 horse power. She is able to descend to a depth of 50 feet, to remain submerged some nine hours, and proceed at a maximum speed of ten knots. Her coal capacity is sufficient to enable her to steam for 900 knots without taking in a fresh supply . . . The motive power is steam, and Mr. Nordenfelt can store up the heat necessary for its generation when the boat is submerged and combustion is no longer possible."



OARS—"Yates & Co., Birmingham, are making an oar in which the blade is made from the best sheet steel, highly tempered. It is put forward as being much stronger than the ordinary wooden one, and cannot be broken without undue violence. The handle fits into a socket running nearly the whole length of the blade, and forming a backbone of great strength."

SNAKES—"Statistics show that about twenty thousand people are annually destroyed in India by animals, and of these, nineteen out of twenty are said to be bitten by snakes."

EDISON—"Mr. Thomas A. Edison, the famous electrician, has a very handsome residence in Llewellyn Park, Orange, N. J., and he is about to erect outside of the park a three story brick building, 250 x 60 feet, for conducting his experiments and as a repository for his books, drawings, models, etc."

MONEY—"At the present time, deducting the money held by the Treasury and the banks, the amount of circulation really in the hands of the people can hardly fall, says the *Baltimore Sun*, much short of \$900,000,000, or about \$16.25 to every man, woman, and child in the country."

SPIRITUALISM—"After an extended and painstaking investigation, a commission appointed by the University of Pennsylvania, to see what there was in 'modern spiritualism,' have concluded their labors. They find that it is made up of equal parts of humbug and jugglery, calculated to deceive only the credulous or feeble-minded. In their summing up they . . . are . . . 'forced to the conclusion that spiritualism . . . presents the melancholy spectacle of gross fraud.'"

AND NOW FOR THE FUTURE

☞ **Radium: The whole story from discovery to the present day, by John A. Maloney**

☞ **Aircraft Engines: Latest developments in the field, by Reginald M. Cleveland**

☞ **Submarines: Their place in modern navies, by Walton L. Robinson**

☞ **Doctors: Scientific aids of the medical men, by Morris Fishbein, M.D.**

☞ **Quail: What California is doing to provide better hunting, by Andrew R. Boone**

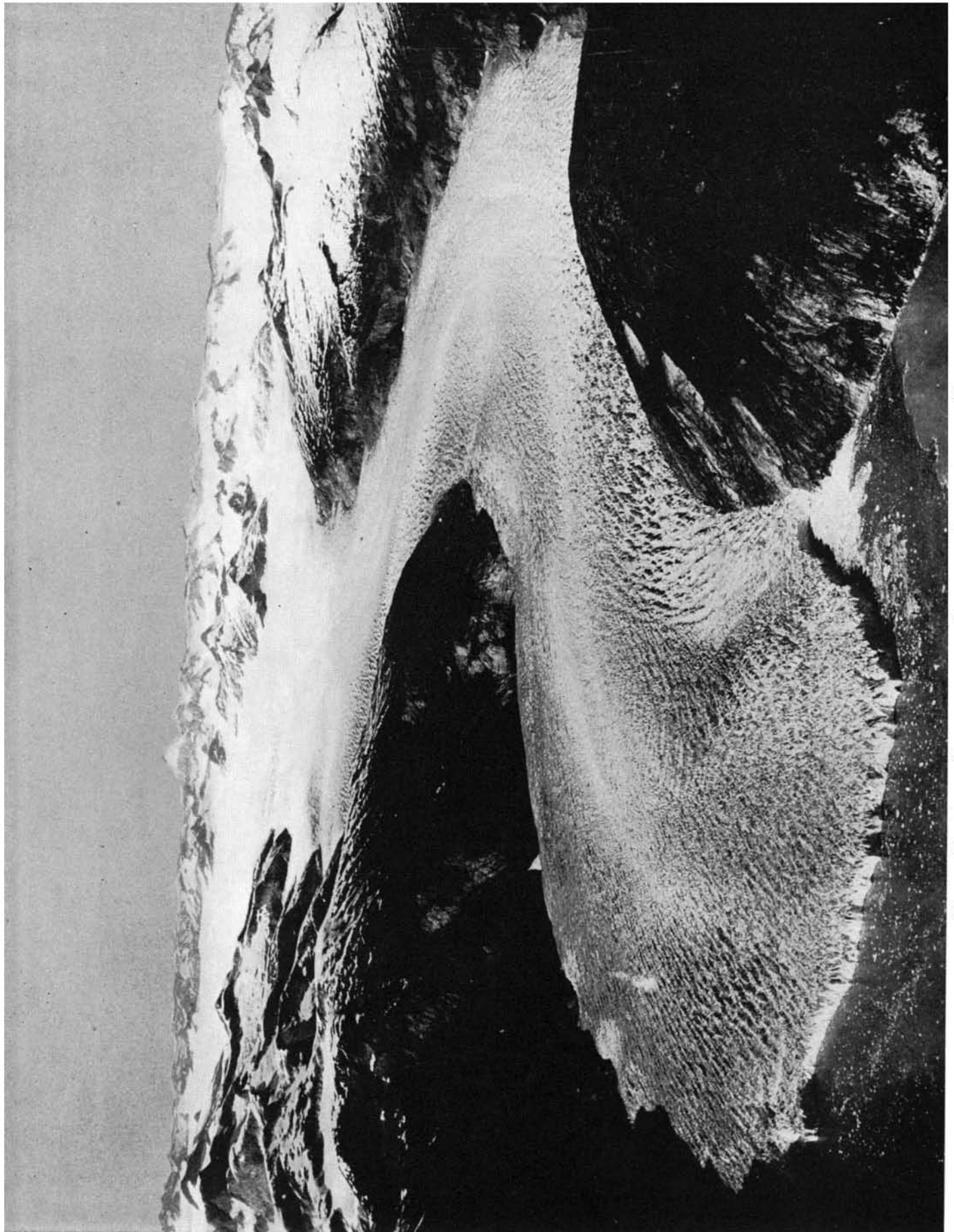


SYMBOL OF SERVICE

This country's good telephone service did not just happen. It has been made possible by the organization and development of the Bell System.

BELL TELEPHONE SYSTEM





TAKU GLACIER DISCHARGING INTO AN ARM OF THE PACIFIC

JUST south of Juneau in Alaska is Taku Glacier which starts 30 miles back in the mountains and discharges into Taku Inlet, an arm of the Pacific. Its dimensions are much greater than this plane's-eye view suggests—its length 30 miles, its width two to three miles. At its front large bergs calve off into the sea, their above-water portion being about 300 feet in height. Its daily movement is about ten feet or, roughly, an inch every 12 minutes

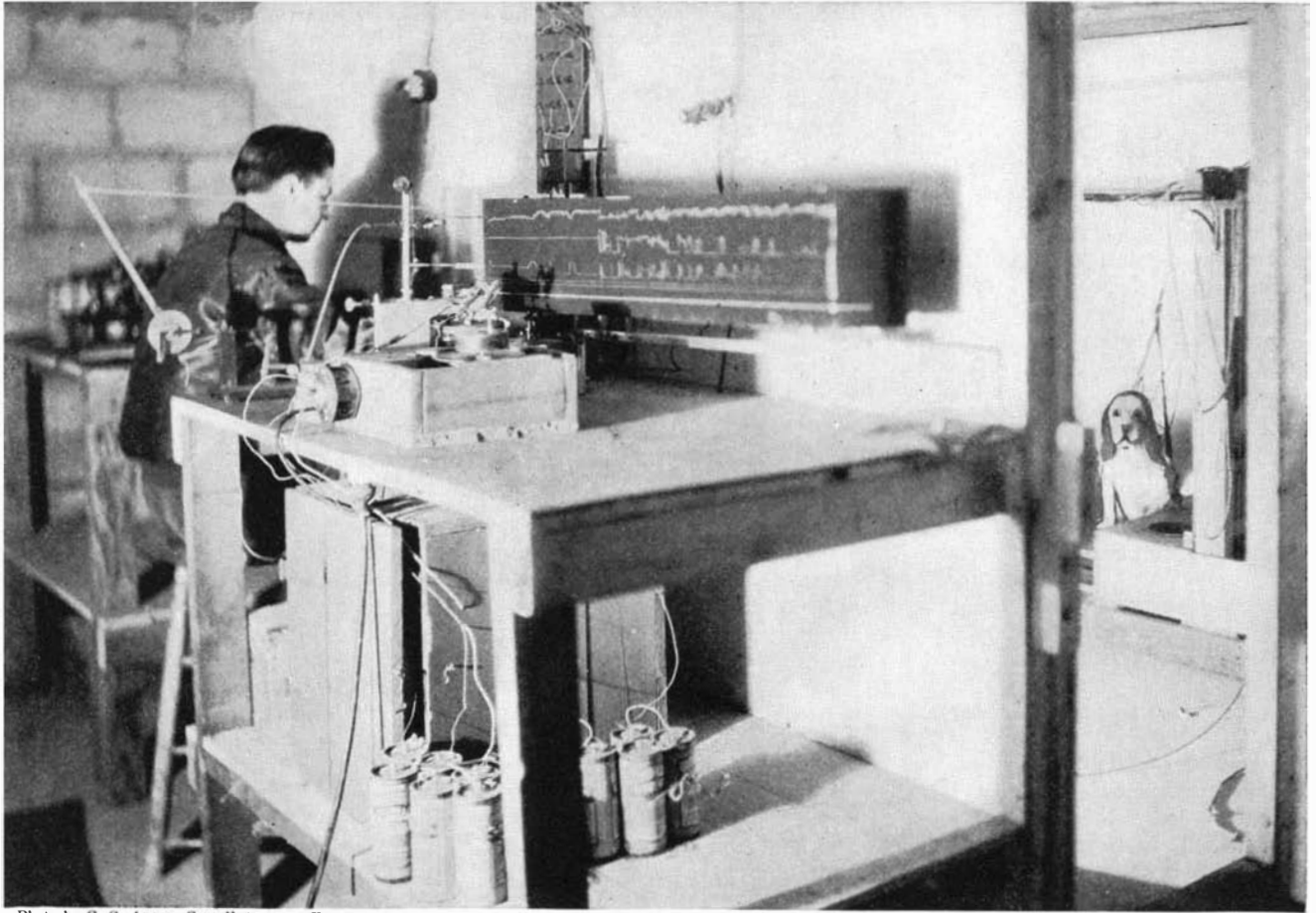


Photo by C. S. Appgar, Cornell Anatomy Farm

The experimental room and, through the door, the animal room of the Conditioned Reflex Laboratory at the Cornell Anatomy Farm. With the door closed the animal is free from disturbing sounds. Note experimental dog through door

ME AND MY DOG

Can Dogs Think? Lacking in Three Vast Advantages Humans Enjoy and Take for Granted, Dogs Cannot Be Regarded Scientifically as Thinking Animals

By **G. H. ESTABROOKS**
Professor of Psychology at Colgate University

CAN your dog think? "Certainly," you say. "Certainly not," says the psychologist. Then we have all the makings of a good row, for the dog is man's best friend, to be treated with respect and reverence, even by the man of science. Perhaps in this article we can shed a little light on the argument, always remembering that, as is the case with most arguments, the whole fuss may be over a confusion of terms. Learning and thinking are not the same.

Undoubtedly, your dog can learn. So can those tiny one-celled microscopic animals we call protozoa. Not much, to be sure, but a little and, as the organism becomes more complex, it learns more. A snail is really bright—compared with a protozoan; while a minnow could almost draw up your income tax return—relatively speaking. But let us concentrate on the dog, which is, of course, immensely superior to any of these others.

As a first point of interest, the dog is one of those animals with a backbone and a brain. We call him a vertebrate,

and man falls in the same group. These vertebrates are specialized in such a way that they cannot learn without the brain, probably differing here from other groups, such as those including the snail, the bee, or the starfish. We can illustrate this need of a brain very nicely by using the so-called "spinal dog." This is the animal in which the brain has been separated from the spine so that the brain is of no use at all in running the body. This spinal animal is still a pretty good dog. He can walk, eat, bark and bite, but he is "dumb" beyond anything you ever dreamed of. He just can't learn a thing. Suppose, for illustration, you place a red-hot electric grill in the room.

The light attracts his attention, so he walks up to the glowing metal and solemnly touches it with his nose. This results in a yelp and a headlong retreat. Ten seconds later the grill again catches his eye, so he approaches again, dabs it with his nose and admits he doesn't like it with another startling yelp. This would go on indefinitely until there was no nose left, but of course it is not permitted. The point is that without a brain he cannot learn even such a simple and painful lesson as the above.

Given his normal brain, on the other hand, your dog can readily perform wonders. This is no better illustrated than in the works of the great Russian physi-

ologist, Pavlov, father of the so-called "conditioned reflex." He made a most interesting series of experiments and discoveries. For example, if you feed a dog meat you get a flow of saliva. His mouth waters, and so does yours under a similar circumstance. Pavlov invented a very simple apparatus by which he could measure accurately the amount of saliva secreted during a meal. Then he proceeded to demonstrate the conditioned reflex.

For instance, he would shine a red light in the dog's eyes while the animal was eating. He would repeat this procedure several times and then, believe it or not, he had only to turn on the red light and the dog's mouth would "water" just as heartily as if he were having his usual meal. The light was the dinner bell, so to speak, and Pavlov found that practically any stimulus associated with food would give the same result. The sounding of a musical note or the ticking of a clock, patting the head or scratching the back, an ice pack on his left paw or a hot-water bottle on his right, all gave the same reaction, providing they were experienced by the dog while eating his meal. In other words, any of these unusual or "conditioned" stimuli would, in and of themselves, produce the flow of saliva if they were first associated with the "normal" stimulus, food.

Other investigators were quick to realize the possibilities of the conditioned reflex, which was soon advanced as explaining a great deal of learning, both animal and human. It was soon found that practically any response, be it of glands, organs, or voluntary muscles, could be conditioned. Take little Johnny, for example, and the reaction of crying. As a very young baby there are relatively few things that will make him cry, your neighbors to the contrary. But, as

one of my acquaintances said of Einstein, "He's bright. He catches on quick." One of the few normal or natural stimuli to crying is a loud noise, but a small child has no fear of, say, a cat. Now suppose little Johnny is playing with the cat when you sound a gong behind his head. He at once starts to cry. You repeat this experiment several times and, lo and behold, the sight of the cat alone is enough to start him crying. You have built in him a fear of cats which may last through his entire lifetime.

Very fortunately, it also works the other way around. If, for reasons unknown, you find that your child does not like cats, it is often possible to reverse this attitude by associating puss with something the child does like, such as eating. Care is necessary here, as a too sudden intrusion of your unpleasant factor might result in vomiting and conditioning the child against his *food* instead of toward the cat. This is exactly what does happen in a great many cases where we resort to punishment. We force the child to do our will, but that unpleasant emotion goes over to the activity in question—say, practicing on the piano. As a result, he will drop it at the very first opportunity, whereas if we associated the piano with something pleasant, the reverse would be the case.

MANY and weird are the results which conditioning will yield on your dog; also very instructive. For example, we can condition him so that he will wag his tail when you stick him with a pin, or bite you when you pat him. He will live on a diet of putrid fish and turn up his nose at good beefsteak. He will curl up and go to sleep in a mud puddle by preference, scorning the comfort of a warm, dry kennel near at hand. If the dog were a human and you ran

across these results, you would say he was crazy and clap him into an asylum. As a matter of fact, a great deal of so-called insanity among humans can be explained on this basis. The child gets a bad fright in a closed room. Result is claustrophobia, fear of closed places. Or he becomes very angry at a man with red hair. Later on, as an adult, he has a compulsion to assault every red-headed man he sees—dangerous business.

One medical investigator eclipsed even these crazy results. Playing around with diphtheria toxin, he discovered that a dose of this sent the animal's temperature up. So he gave it regular doses of toxin and every time he shot in the toxin he stimulated the animal's ear. Now he has only to tickle its left ear to get the rise in temperature! We should add that this last piece of research is under heavy fire at the moment, but there is no reason to believe that it wouldn't work. Also, the animal in question was a rabbit, not a dog.

The conditioned reflex explains a great deal of learning, but certain types do not seem to fall under the general laws of conditioning. At any rate they are better understood if treated separately. For example, the facts yielded by so-called "trial-and-error" learning are almost as spectacular as the preceding. We illustrate this best by the use of the problem box. This device is a cage in which the animal is confined. Somewhere within is a hook or a button; when the animal claws the hook or steps on the button it releases a spring, the door opens and the animal escapes. Now we take a hungry dog, cat, or monkey, put him inside the cage and place food outside but beyond his reach.

Naturally, the animal resents this and barks, yowls, or chatters at the top of his voice, all the while jumping around the cage in frantic impatience. Sooner or later he sets off the spring, purely by accident. He dashes out and gets the food. Next day he is hungry again, the experiment is repeated, and so on at regular intervals. But, like Einstein, the animal is bright—he catches on. After a dozen trials the whole picture is altered. The moment you close the door, the animal makes one leap, pounces on the button, releases the spring and is out almost before he is in, relatively speaking. He stumbled on the solution by accident—by trial and error, we say—and then proceeded to master the problem in very quick order.

This trial and error process explains a great deal of human and animal learning. We just go ahead and keep trying, so to speak. Then one of the trials yields success and we promptly mark that as the one to be used on all future occasions. This process is of enormous importance, not only in everyday life, but even in the development of insanity. Johnny doesn't wish to attend school.

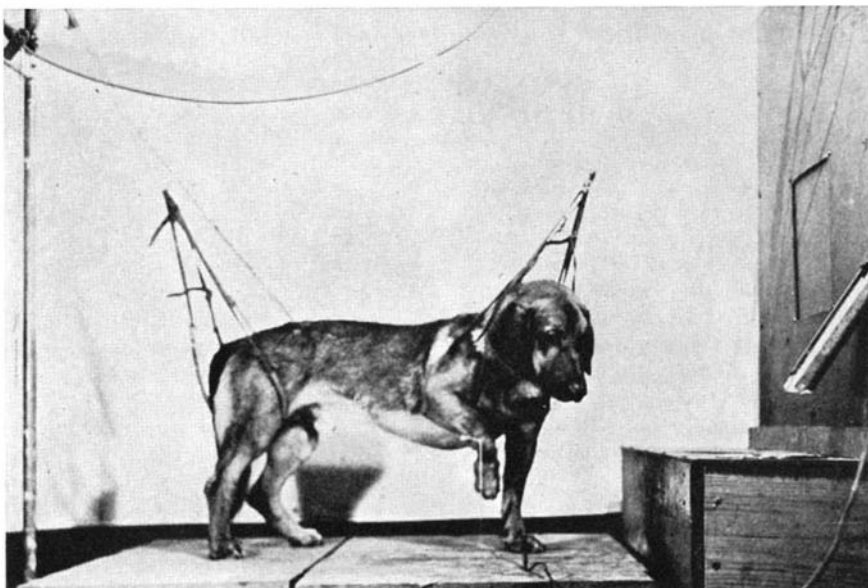


Photo by William T. James, Cornell Anatomy Farm

This dog is holding up his leg during the presentation of a signal accompanied by a liminal shock on the foreleg. With leg raised the shock is avoided

He hopefully announces a stomach ache. To his utter astonishment it works. Needless to say, he'd be a fool if he didn't use this marvelous new weapon every time he is faced with an unpleasant task, but as an adult, we may put him in an asylum. By then, he has learned to side-step reality so beautifully that he has waltzed right out of the picture.

The human being has tremendous advantages over your dog in this trial and error process—all the result of his much greater brain. Let us suppose that neither you nor your dog has ever seen a skunk and your dog discovers one raiding the hen roost. He rushes to die for God, for country; and ten seconds later he wishes he could die for anybody, even for Yale. An hour later, not having seen your dog, you discover Mrs. Skunk engaged in exactly the same process as before. So you seize a baseball bat and advance to the slaughter. Then you are retired, no hits and one error.

So you and your dog have in common a very unpleasant experience, with the added certainty that Mr. and Mrs. Skunk will return in the near future. Here is where you steal several marches on the canine. First, you have the use of language. You can either read about skunks in your library or you can call on one of your neighbors who has lived in the section and who knows skunks. He will solve your problem for you. The dog cannot use language and so is blocked here. Then, second, you can think over the experience after the skunk has gone. Actually, thinking is talking to yourself. A visitor to a state institution said to his guide: "Who is that chap in the corner snapping his fingers?" "Him? Oh that's just a deaf and dumb mute with the hiccups." Actually, when the deaf think, they use their fingers just as you often catch yourself using your lips. Thinking is simply a trial and error solution of your problem, with the tremendous advantage that you don't have to risk your body until you are certain of results. You sit back before your fire and visualize the whole situation. You appraise your own weakness, the skunk's strength and decide you will use missile weapons of your own next time: namely, a shotgun. Your dog can't think, in this sense of the word. He must have his enemy right in front of his eyes. Then, to be sure, he will remember the past experience, but he has prepared no solution to the situation.

Finally, you as a human have another curious quirk which no other animal possesses. Just when you get it, we cannot tell. We can't even say that it is really inborn. At any rate, you pick it up very early in life; namely, the tendency to imitate. Place even a monkey in one of our puzzle boxes with another monkey that knows the trick of getting out and it doesn't help a bit. Monk num-

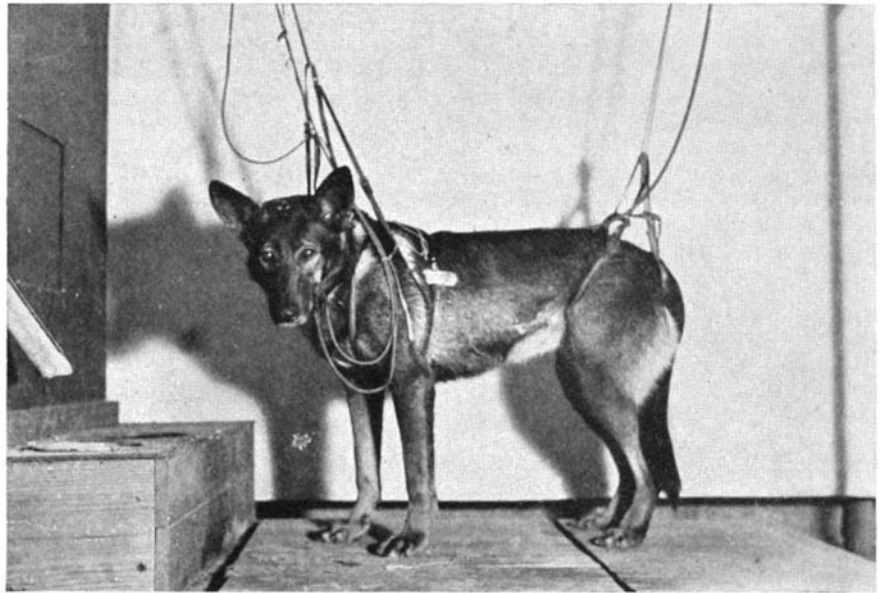


Photo by William T. James

This dog is standing in the animal room before the food table. Food is presented with a conditioning signal. Cup on cheek records conditioned saliva

ber two can demonstrate 100 times before his brother, but the first one has got to learn it all by himself, just as if the other weren't there. As one chap puts it, "Monkeys don't monkey." Your dog is just the same in this or any other situation. He will not imitate another dog.

The human is totally different. Directly Billy sees Johnny pulling the cat's tail, lighting matches, or turning on the gas, the world just isn't worth living in until he can do exactly the same thing. The adult human is even more of a "copy cat," although perhaps a little more discreet as to what he copies. When learning to sew on a button, drive an auto, or manufacture synthetic rubber, you watch your instructor carefully, then do your best to imitate him, correcting any minor mistakes by the trial and error process. The fact that your instructor may be a book in no way alters the argument. One authority in animal psychology says that an ape has the brains and the throat mechanism to learn speech if he would only imitate the human instructor. But friend Chimp isn't interested. (Perhaps he has observed the fate of many humans and decided that he'll save himself a lot of trouble if he just says nothing, in the first place.)

THESE three factors—language, ability to think in the absence of an object, and the tendency to imitate—give man an enormous advantage over your dog or any other animal in trial and error learning. On the other hand, the dog possesses certain advantages over the human which, on first sight, give the appearance of greater intelligence. These are largely matters of the sense organs. For example, a dog's hearing is remarkably acute and his sense of smell simply unbelievable. He will pick up the trail of a fox, circle around for a minute

and always start in the *right* direction. How can he possibly decide which way that fox was going? There is only one way. He back tracks 50 feet and picks up the difference of intensity in that scent, possibly ten hours old, over this short stretch of ground! Then he's away. You can't detect the slightest scent to begin with, let alone those tiny differences on which the dog must determine his activity. His sense of hearing is almost as keen, so bear in mind that much of your dog's performance may be just good ears and nose. This is not the same as intelligence.

The principle of the conditioned reflex, together with trial and error learning, explain a lot, but the picture is not complete. Only recently we have discovered a third broad principle, that of Gestalt learning, which, together with the first two, seems to cover this field of learning pretty thoroughly. Gestalt psychology is not so easy to grasp. It stresses the *whole* situation and raises a strenuous objection to the so-called "morcelment of the environment," so common with other schools of thought. In the actual field of learning it states that, given a certain intelligence, the whole picture or Gestalt will tend to complete itself. The problem, as it were, solves itself without any of this nonsense about conditioned reflexes or trial and error. But, as we mentioned before, you must have an animal of high intelligence if you wish to demonstrate Gestalt learning. Otherwise the first two principles are sufficient.

For example, let us suppose you place a chimpanzee in a room. From the ceiling you hang a banana, but put it well beyond his reach. There are also two wooden boxes in the room, and you take care that friend chimp is hungry. The latter point is not difficult, because he

runs a perpetual appetite, but the way he gets that banana is totally different from anything so far described. He doesn't raise a fuss but sits down, and, as it were, scratches his simian head. Then he places the first box under the banana, decides it isn't high enough, piles box number two on top, jumps on his pedestal and gets his reward. Or suppose we put him in a cage with a

again it was an idea, even if half-baked. You will note that in this Gestalt learning the entire situation is presented to the animal with all the factors necessary for solution *in plain sight*. Under these circumstances and in the presence of the high intelligence of the chimp, "the situation tends to complete itself." To be sure, the chimp didn't do so well, but his were "clever mistakes" and far

then on, the poor little chimp didn't have a chance.

Perhaps we can illustrate this human advantage even better from our own article: When you face your skunk situation, you at once resort to symbols or language for its solution. When you say "skunk" to your neighbor, you use a symbol which means something very definite to him. When he replies "shotgun," that symbol is significant. When he says, "Get my shotgun from the barn and meet me at the henhouse" he uses a whole string of symbols, not only for objects but for lines of activity, yet you have no difficulty in following him. As you have never before used his make of automatic shotgun, he demonstrates. In two minutes, through your peculiar human knack of imitating, you have learned all that is necessary about the gun. Then, as if all this did not give you sufficient advantage over your dog, you use "insight" when you face the actual situation. You size up everything as a whole and act accordingly.

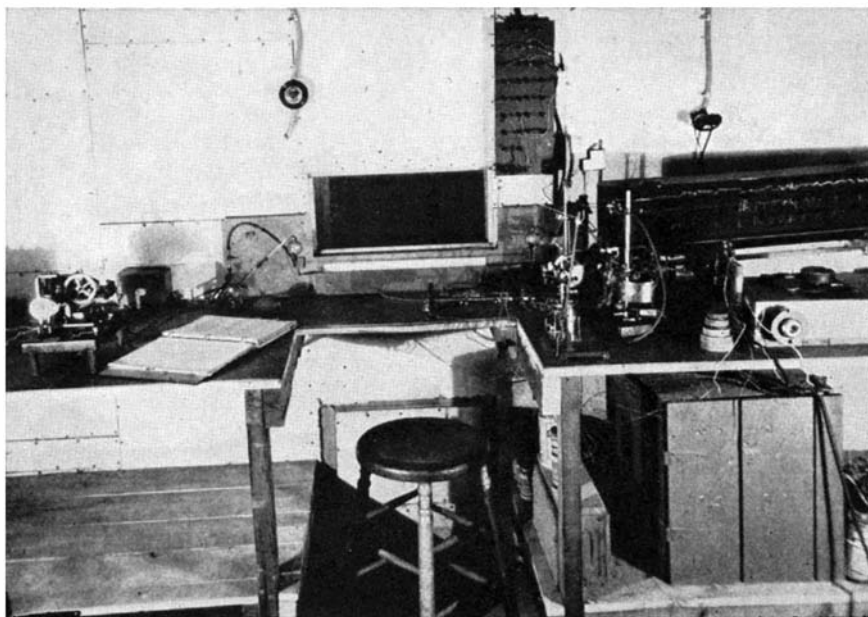


Photo by C. S. Apgar

Experimental room of Conditioned Reflex Laboratory, Cornell Anatomy Farm. Animal is observed through glass window in center and kymograph makes records

banana outside and well beyond his reach. In the cage with him are two sticks, one of which will fit into the other, thereby giving a much longer reach than either one by itself. He first tries to hook in the food with stick number one, finds it isn't long enough, lengthens it with the second and gets the object.

Just as instructive are the mistakes he may make, for there are degrees of intelligence in apedom. The performances just described were by a very bright chimp, but suppose we now get a "chump." An experimenter hung the banana close to the wall but high up. The chimp—in this case a chump—looked at it, brought up box number one and discovered it wasn't high enough. Then he got an idea. He solemnly lifted the box from the floor a couple of feet and placed it against the wall. Then he let go and raised a howl of woe when the box, instead of sticking there, came down on his toes. But it was an idea. Placed in the cage and confronted with the two-stick problem, he was equally brilliant. He reached with the first stick, but couldn't make it. Then he lay the first stick in front of the cage and poked it out with the second until he touched the banana. Contact established, he tried to hook in the food, and registered profound disgust when it didn't work. But

superior to any performance your dog could produce. He really showed "insight" into the problem, which fact has led to the further term "insight learning" as describing this performance. Apparently it is confined to man and the other primates, although there is certain evidence that other animals can develop along these lines. These three broad principles—conditioning, trial and error, and Gestalt learning—pretty well cover the field of learning. But we haven't answered our original question.

Can your dog think? The general answer would be "No." We would never deny his ability, or that of any other animal, to learn. He learns better than most. Here even the human, if forced to run a maze under the conditions we use with a dog, has little if any superiority. But we use the word "think" with a somewhat different connotation. We generally mean the use of language symbols in the solution of a new situation.

One scientist demonstrated this very nicely. He brought up a baby chimpanzee with his own little boy. They lived together as brother and sister. It is most interesting to note that, up to the age of 18 months, the baby chimp was superior to her human brother in practically all the intelligence tests used. Then the human, as was to be expected, took a mean advantage—he learned to talk. From

WITH animals we have to exercise the very greatest of care with reference to incidental cues. Perhaps this was never better illustrated than in the case of the Horses of Elberfeld or of Clever Hans. These horses astounded Europe by their ability to calculate, tapping out the right answer to intricate mathematical problems with their hoofs. Several very able scientists were completely deceived. Finally, it was discovered that the horses could give the correct answer only if their trainer were present and knew the answer in question. The animals watched him very closely and would always stop tapping on a very slight, possibly unconscious, sign on his part. In some cases the owner is perfectly honest.

Such has been the case in many animal experiments conducted in the laboratory. We would carefully train the dog to select a red light in the left corner of the room when we sounded one note on the piano, a green light to the right on another note. Then, after wasting a couple of months on the problem, we would suddenly discover that friend dog wasn't even listening to the notes; he was watching the experimenter, who would look toward the desired corner on the given signal, thus informing the dog where to go. The rule now is that, in good dog experiments, the human must be out of sight and sound.

IN conclusion, we can only say that the dog thinks on a very low plane, if at all. Perhaps he does use past experience to solve new situations, perhaps he may understand a few simple symbols, but his abilities here are so inferior to those of the human that we are almost entitled to say, for all practical purposes, that your dog is a non-thinking animal.

OUR POINT OF VIEW

Does It Condition?

PARASITES seem to be the rule rather than the exception in every line of endeavor. Let an honest development spring from the laboratories and immediately a group of imitators come forward with cheap, unreliable merchandise to foist on the unsuspecting public. The relatively new development of air conditioning is an excellent case in point. No sooner had the public been informed of the advantages which accrue from air conditioning than a crop of cheap "air conditioners" appeared on the market to be bought eagerly by thousands looking for the benefits of conditioned air without the expense.

Most of these so-called air conditioners consist of nothing more than a fan built into some sort of a fancy cabinet and selling for about three times the value of the materials used. Occasionally they contain a method of vaporizing water to increase the humidity of the room. In any event those selling at a ridiculously low price—ridiculous in the face of the necessary cost for true air conditioning units—have little or no more value from the standpoint of air conditioning than a fan.

In view of this situation it is encouraging to learn that the Federal Trade Commission has recently stepped into the picture and verbally spanked one manufacturer of an air "purifier" and circulating device. The Commission has ordered that this company discontinue the use of the words "air conditioning" from their advertising, as well as the statement that the device "... accomplishes cooling effects of 8 to 10 degrees lower temperature in summer."

If only this stipulation can be extended to curb the other parasites in the same line, one more of our thriving industries will be freed from a handicap which inhibits the growth that is rightfully its own.

Gas Hazards

WHEN 455 pupils of a public school are killed in seconds in an explosion of gas, it is but natural that, quickly, other schools are inspected to learn whether hazardous conditions exist elsewhere. After the New London, Texas, disaster, that is what actually happened. In a sense, such inspections were an admission that "perhaps we have been lax in our building construction or in safety precautions."

It seems that the Texas tragedy was only partly due to human error. In any

case it was unforeseen and unpredictable. Dr. David J. Price, explosion expert of the Bureau of Chemistry and Soils, gives it as his opinion that "the explosion was due to an accumulation of combustible gases in an open area underneath the first floor of the building by a flash from electrical equipment . . ." To prevent similar explosions, he urges the use of malodorants, gas detectors, special supervision and inspection, strict adherence to the code for electrical wiring, elimination of dead storage space where gas might accumulate, and adequate ventilation throughout schools and public buildings.

One further element entered into the Texas explosion. In an oil country where the very air reeks of oil, no one would detect, by smelling, a dangerous accumulation of gas. This fact serves to emphasize Dr. Price's first suggestion: the necessity for using malodorants in gas. Such chemical stench does not interfere with the burning of the gas nor do they smell except in the unburned gas. If such doctored gas leaks, its foul smell would immediately call the leak to the attention of persons in the vicinity long before a dangerous amount could collect. Addition of malodorants such as, for example, ethyl mercaptan, would cost, it is claimed, but 500 dollars for each billion cubic feet of gas used. Nine thousand dollars would, therefore, have imparted an odor to the 18,000,000,000 cubic feet of natural gas which was used in this country in 1929. Since natural gas is practically odorless and also more explosive than artificial gas, such use of malodorants is particularly important in some parts of the country. California, for example, has already decreed that all gas supplied to homes and factories be given such an evil smell. Other states have followed suit.

To us this use of malodorants in all gas—whether for schools, factories, or homes—is so inexpensive a precaution as to make us wonder why it has not been made compulsory over the nation. When such a small amount of money may avert any number of tragedies, there is no excuse for past failure in this regard other than public ignorance and the apathy of those "in the know."

Telepathy Comes of Age

THE entity called science, with its scope limited to the more restricted sense of the term, is the sum of several constituent sister sciences such as mathematics, astronomy, physics, geology, botany, zoology, anthropology and psy-

chology. Some of these, such as mathematics and astronomy, physics and chemistry, are generally regarded as the more "exact" sciences, while others, such as anthropology and psychology, have not usually been so regarded.

If this has been true of the science of psychology, and if psychology was once looked at as something of a poor relative, then much the same kind of thing has in turn been equally true of one particular corner of psychology, the corner sometimes designated as "psychic science." Indeed, psychic science has long suffered the disowned status of Orphan Annie in the psychological and therefore the whole scientific world. If the reader will examine a textbook of psychology and look for the psychic science dealt with in it he will discover almost what the readers of Dr. Johnson's famous book found under the chapter on the snakes of Ireland—a blank. For this situation the psychic world has itself to blame; it too often wanted to play the game without rules or else to change the rules during the play. Scientists shied off. Many who didn't were burned.

Despite this unfortunate situation, a few scientific men did stick to Orphan Annie through thick and thin, determined not to quit merely because the conditions were most trying. One of these was the late Walter Franklin Prince whom some psychologists thought perhaps a bit too willing to believe, but psychics significantly regarded as hard and most unaccommodating. Another is Dr. J. B. Rhine of Duke University and, after some years of patient presentation of evidence in one small corner of psychic science—that pertaining to telepathy or extra-sensory perception—he is now winning a definite place in the sun for that science. Continuing researches previously described by Dr. Prince and by himself in this magazine, his work has now been checked up by psychologists in a number of leading universities and to their surprise they have found he was right—there actually is such a thing as telepathy and evidently even clairvoyance. The evidence looks like proof. With this excellent start a new journal has been inaugurated, the *Journal of Parapsychology*, and we take this opportunity to congratulate its editors, Dr. William McDougall and Dr. J. B. Rhine, on its excellence. This new journal will deal with psychic research—though for the present, only with those aspects of telepathy and clairvoyance which can be studied by actual experiment.



A doctor receives his goggles and smoke mask preparatory to penetrating a forest-fire line where he will render first aid to the fighters

MIDNIGHT on the fire line in the Malibu Mountains of southern California . . . 2000 weary, begrimed men battling ceaselessly . . . fire wardens endeavoring to halt the conflagration which already has burned over 30,000 acres . . . first-aid men backing up the fire fighters . . . doctors and nurses setting broken bones, sewing up cuts, swabbing inflamed eyes.

Two men stand beside portable short-wave radio sets, eyeing long lines of injured men. At the rim of Corral Canyon, almost within arm's reach of the blaze, Spence Turner, chief fire warden for Los Angeles County speaks into a microphone:

"W6LHB calling W6AEM. . . . W6LHB calling W6AEM."

Six miles distant, deep in Corral Canyon, safe at the base hospital from immediate path of the blaze, a second voice goes on the air.

"W6AEM . . . this is Nolan. How are things going?"

"Pretty hot."

"Any bad ones?"

"We've treated 312 moose, eleven rabbits, one wild horse, two antelope and 98 elephants at the advance stations."

As the fire warden, speaking through a portable, short-wave radio unit at the fire front, completed his report, Dr. Frank G. Nolan, head of the medical minute men who back up forest-fire fighters in California, turned to his code book.

"We've treated 312 burned eyes, 11 lacerations, one fracture, two back injuries and 98 body burns," was what Turner had told him. Injuries of various types are reported as animals to prevent misinformation "leaking" over the air.

All along the fire lines small field hospitals, staffed by trained, volunteer first-aid men, attended to minor injuries as the fire fighters beat back at the searing flames. Physicians and surgeons held

MINUTE MEN OF THE

By ANDREW R. BOONE



Brought in on an improvised stretcher, a fire fighter receives first aid. Note fire truck in background

their posts at a base hospital, a few miles removed. During the days when the Malibu fire raged, 2000 injured men were treated at six dressing stations and one hospital, most of them being sent back within an hour to take up their work.

Within 30 minutes after an alarm is received, these minute men of the forests are racing toward a forest fire, no matter where in California the outbreak may occur. Officially, they are known as the California Forestry Medical Corps. At all times 300 doctors stand ready to move in case of disaster, whether fire, flood, or earthquake. With them go first-aid and rescue units and trained radio men, each one with his own special job to do.

WHEN a blaze starts, even in an inaccessible mountain area, forest rangers move swiftly for medical aid. In the San Bernardino Mountains a ranger saw wisps of smoke, then flames, break into the sky the other day.

"Fire in Cajon Pass," a lookout reported by telephone to headquarters. "Spreading rapidly."

The forester consulted his maps. A brisk wind and sun-parched slopes would carry the fire quickly through the brush and trees. He ordered his aides to call out 900 men, then turned to the telephone and placed a call to the



A gas torch starts a backfire in order to head off a large conflagration

Alvarado hospital in Los Angeles, 60 miles distant.

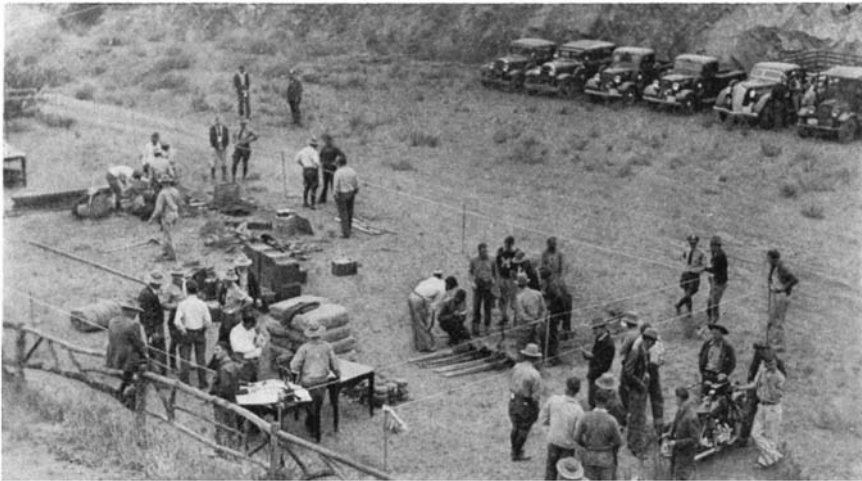
"We need five doctors and 10 first-aid men," he said.

Within five minutes the dispatcher at the hospital called five doctors, ordered an automobile from the sheriff's office, called the director of the first-aid unit, and 28 minutes later the last of the 15 men was speeding down the highway to the outbreak.

First-aid workers and doctors at the fire line often have to plunge through smoke to reach many victims, and must therefore be able to see at all times. To meet this condition, Dr. Nolan has invented a combination water goggle and

FIRE LINE

Volunteer Doctors and First-Aid Men . . . Use Short-Wave Radio Communication . . . Special Goggles and Smoke Masks . . . Keep Up Morale of Fire Fighters



A base hospital and supply depot located at a safe distance behind the line of a large forest fire



The Osborne fire finder in use to locate exactly the position of a fire. This information is then transmitted at once to the Forest Rangers

mask. Water is contained within the rubber mounting of the lenses and sweeps across the inner side when the wearer shakes his head, thus cleaning the fogged surface. The mask removes both smoke and acrid fumes from the air as it is breathed.

As soon as first-aid workers reach the scene of a forest fire, word is passed along that medical attention awaits anyone who needs it. By this means, the fire fighting crews are kept at peak efficiency so long as flames lick at trees of the forests.

Of course, only the larger fires make newspaper headlines and require the

presence of medical minute men near "the front." Good generalship requires that plans and strategy be worked out in advance of the enemy's invasion. Most forest fires are being put out this spring before they become large enough to make next summer's scare heads.

Foresters in the National Forests have for several years been conducting what they call "hazard" study. Fire reports have been analyzed to find out what happened, and how conflagrations could have been prevented. All types of forests were studied to learn what would happen if a fire started, and how quickly the fire must be reached to prevent it from spreading. This resulted in the so-called "hour control" plan of the forest service. Each section of the forest was laid off in zones, and the hours or minutes necessary to get at a fire in that particular forest zone were determined.

ANOTHER part of advance planning for the fire season is carried out each year by the District Rangers and Forest Supervisors. Each Forest Ranger makes a fire plan for his district every spring. Lists are prepared so that men and supplies may be quickly mobilized by telephone in emergency. Tools are organized, emergency rations kept on hand, transportation arranged for, fire fighting forces selected and trained.

When the humidity begins to drop and



Mopping up a burned-over area often results in burned feet that require immediate medical attention

woods get dry, the first line of defense is thrown out—guards, patrolmen, and lookouts—and located at strategic points to check the first invasion of the enemy. The detection system then begins to function. Lookouts on high mountain peaks constantly scan surrounding timber for the first puff of smoke. They use an instrument known as the Osborne fire finder. The fire finder, when sighted at a fire, gives a figure known as the "azimuth reading" which enables the ranger in the valley below to locate the fire on his map.

When a fire starts, usually it is spotted by one or more lookouts. The location, size, and other information about the fire is telephoned to the ranger. A smokechaser with tools, emergency rations, and a portable short-wave radio outfit is dispatched to the fire, immediately. He puts it out, if possible, and reports back by radio that the situation is in hand. If it is more than a one-man job, he radios back for reinforcements. These portable short-wave radios have been developed by the Forest Service during the past few years, and have been a valuable addition to the protection equipment. A smokechaser's set weighs 14 pounds complete, and receives and transmits.

In spite of careful planning and execution some fires get away. Combinations of wind, weather, and human carelessness may make it impossible for fire to be put out while small. Occasionally a big fire gets away which is costly in money, time, and destroyed resources. In most cases, however, forest fires are halted before their destructive flames spread far afield. But when a big blaze does get well underway, all the forces of fire-fighting science rush into the front lines to beat back the attack, while the medical minute men back them up in their untiring efforts to vanquish the red enemy.

DENMARK BRIDGES

By R. G. SKERRETT

DENMARK, with her Diesel-motored "Lightning Trains" and her splendid new bridges, is effectually reducing the handicap laid upon her by nature. The kingdom embraces more than a hundred islands, great and small, that have made the problem of rapid transit a difficult one; and Denmark is a thoroughly progressive country.

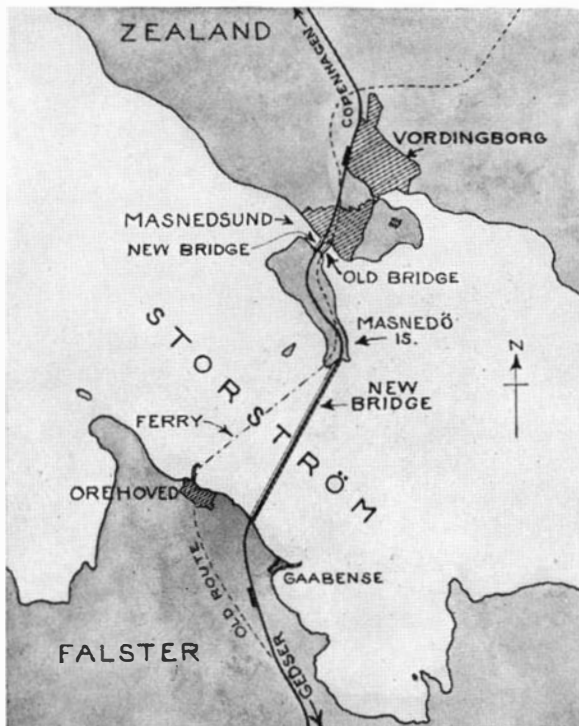
To cross her numerous domestic waterways as well as the water gaps that separate her from neighboring nations, Denmark has developed fleets of typically modern train ferries. The largest and finest of these link opposing shores at strategic points and especially along her rail trunk lines that are tributary to ports served by steamships and rail connections leading to the capitals of Europe. But the best of train ferries are slow compared with express trains, and every unbridged water gap entails delays and possible inconvenience, particularly when thick weather hampers the navigator. Accordingly, within the last few years, Denmark has embarked upon a program of bridge building, and the aim is to abandon the use of ferries wherever it is economically practicable to substitute steel spans. The latest and most noteworthy of these structures is the Storström Bridge, which was opened to traffic last December.

THE Storström Bridge is the longest bridge built to date in Europe, and it spans a body of water that lies along the important and much traveled route between Copenhagen and Berlin. The Storström, itself, is between the Island of Zealand, on which Copenhagen is situated, and the more southerly Island of Falster. The Storström, to be exact, flows between Falster and the small Island of Masnedö; and the latter is separated from Zealand by a narrow waterway known as Masnedsund. Masnedö, therefore, provides the northern approach to the Storström Bridge, this little island having been for years linked with Zealand by a low bridge that has served rail and other traffic. Before the Storström Bridge was available, a train bound from Copenhagen to Berlin, via Warne-

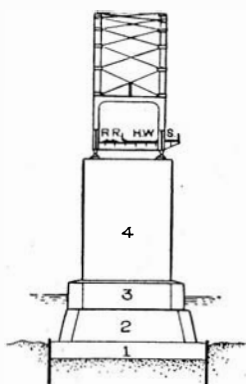
münde Germany, had to board a ferry at Masnedö and again shift to a steamer at Gedser, on the southern tip of the Island of Falster, making the two transfers within a distance of less than 30 miles. With the Storström Bridge in service, there is now only one such transfer, and that is at Gedser for the 2½-hour run across the Baltic to Warnemünde. The saving in time is substantial and, no doubt, deemed sufficient to warrant an outlay of approximately 6,120,000 dollars.

The Gedser-Warnemünde run was established in 1903, and the volume of traffic has since increased so greatly that the Danish government decided in 1932 to build the Storström Bridge in order to meet the needs of passenger and freight service. Over the same water route thousands of motorists enter and leave Denmark annually, the greater number doing so in the summer-time. The Storström Bridge has accommodations for both rail and motor-vehicle traffic, and is furthermore provided with a broad sidewalk for pedestrians and bicyclists. Denmark is over-run with domestic and visiting cyclists.

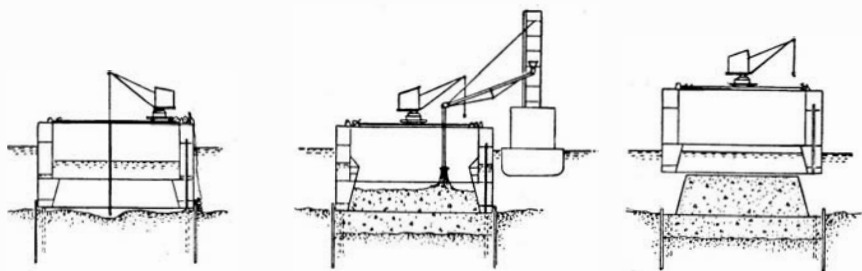
Work on the Storström Bridge was started in the spring of 1933, and its completion was contracted for by the close of this year. Through a combination of skilful engineering and the employment of novel and ingenious construction aids, the bridge was finished and turned over to the Danish State Railways 12 months sooner. From end to end, the crossing has a length of 10,532 feet, and its deck has a width of 49 feet, which affords space for a single railway track, a vehicular roadway more than 18 feet wide, and a sidewalk nearly nine feet wide. Of the three fixed spans over the channel, the middle one has an



Site of new bridge and the old ferry it supersedes



Section of the Storström Bridge showing railroad, highway, and sidewalk, and the four separate sections of one of the piers. Base slab is surrounded by a ring of piles



The floating caisson permitted open excavation of the pier bed. Then concrete for the base slab and first section of pier was poured, and caisson was floated away

THE STORSTROM

under clearance of 85 feet, which is ample for any of the 15,000 vessels that thread the waterway regularly.

The bridge is supported on 49 offshore piers that have their footings below the surface of the clayey water bed at a maximum depth, for the heaviest of the piers, of approximately 15 feet. Along the line of the bridge crossing, the Storström ranges in depth from an average of 26 feet to as much as 46 feet. The rise and fall of tide rarely is as much as three feet, and tidal currents have a velocity of 4.75 miles an hour. Fairly strong winds and large waves occur at times. The builder of the substructures had, however, to make provision against heavy floating ice; and that fact influenced the design and the method of placing the pier bases where the structures emerge from the water.

With 49 piers to be formed of concrete and to be erected from the water bed upward, the majority of them being identical in their dimensions, it was realized that much time and money could be saved if they could be poured in a few forms that could be used repeatedly as pier base after pier base was constructed along the line of the crossing. These pier bases reach from their footings in the bottom of the Storström up to an elevation of approximately 10 feet below the normal surface of that waterway.

For this repetitive work, the contractor devised a type of caisson, built of steel, that could be floated to each pier site in succession, sunk to the bed of the Storström and unwatered so that the workmen within it could excavate, in the free air, the area for the massive base slab of the pier foundation. With the excavating done, the concrete was poured within the caisson up to the prescribed elevation; and when the concrete had set sufficiently, the caisson was freed, again made buoyant, and allowed to float high enough to clear the top of the pier base. This was the procedure followed where the bottom clay was of a firm nature at the pier site. The caisson was made to sink by loading ballast tanks with water, and, when its work at a pier site was finished, it was given buoyancy by discharging the

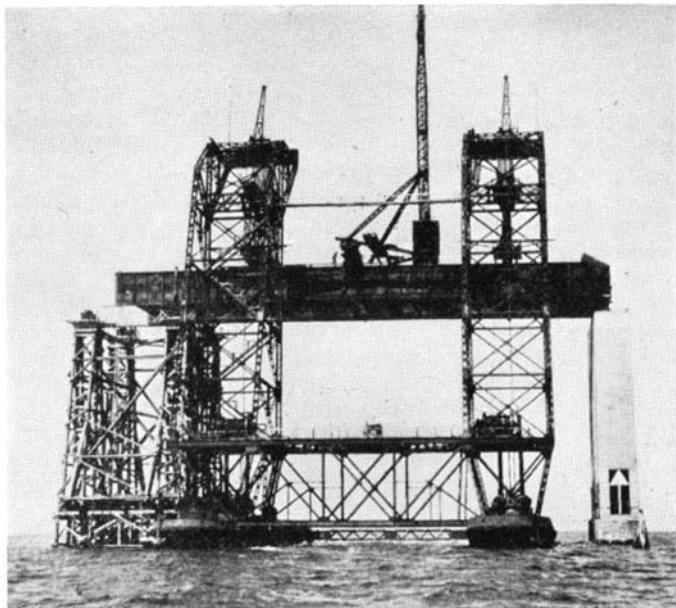
Longest Bridge in Europe . . . Speeds Trains Between Copenhagen and Berlin . . . Unique Floating Caisson Pier Forms . . . Completed Ahead of Time

water ballast by pumping out the tanks.

Where the clay was firm, a ring of piles was driven around a periphery somewhat smaller than that of the bottom of the caisson so that the caisson could rest on the tops of those evenly spaced and level supports, which projected slightly above the surface of the water bed. Next, steel sheet piles, hung like an apron around the outer surface

clay, the procedure at a pier site was somewhat different. A caisson was sunk and brought to rest after slightly penetrating the bottom material. Then a cofferdam, formed of steel sheet piles and suspended from within the caisson, was driven into the water bed closely subscribing to the interior walls of the caisson. The water bed so enveloped was next excavated for the basic slab—the

concrete slab being placed under water and made thick enough to seal the caisson. It could then be pumped out in order to pour the remainder of the subaqueous structure in the dry, the submergible caisson serving as in other cases as a form for the pier base. When that work was completed, the caisson, which was made buoyant by pumping out the water ballast, was shoved free with jacks and allowed to mount surfaceward and clear of the pier base. The caisson was then again available for service at another pier site.



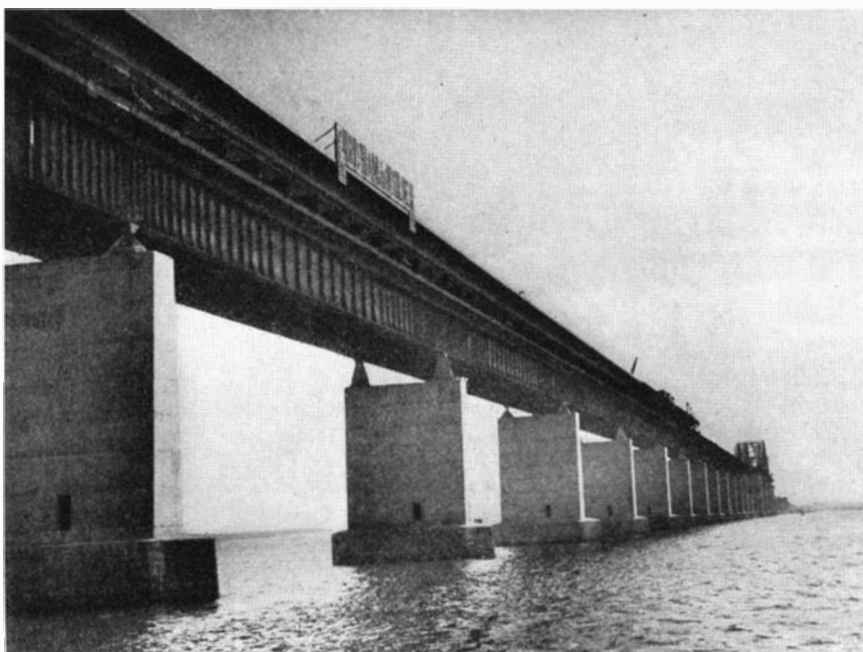
The 500-ton floating crane used to move a fully assembled large girder from land to its final position in the bridge

of the caisson, were driven deep into the clay, snugly around the bottom of the caisson and extending up above that level only a few feet. That enveloping wall was then made watertight at its top by forcing flexible fiber calking between the piling and the outer plating of the caisson. It was then possible to pump out the enclosed area so that the workers could do the necessary excavating preparatory to placing the base concrete in the dry. With that finished, and the concrete poured, the caisson was released and stripped from the concrete with the aid of powerful jacks—the caisson having been made buoyant and water having been admitted into the area enveloped by the caisson. The caisson was then available for service at another site.

Where the water bed was not of firm

tion extending from that level up to 10 feet above the water—the pier shaft rising from that level to the height required for the support of the steel spans. The savings effected by using mobile caissons would have been lost if separate forms had been built in which to pour the concrete for the intermediate base sections, that are half underwater and half above, and there would have been the hazard of ice or storm waves damaging or sweeping the forms away. Therefore, these special sections were constructed on shore and took the form of reinforced-concrete caissons that had sufficient buoyancy, after launching, to be floated to their prescribed sites and there loaded with enough water to cause them to sink on to the tops of the submerged pier bases.

These caissons, 20 feet in height, were



One of the two long approach sections of the new bridge across the Storström. The channel spans are to be seen in the middle distance, the island beyond

elliptical in plan, and their outer surfaces are faced with granite blocks embedded in the concrete of the caisson walls. They were really vessels with open-top compartments into which water ballast could be pumped to destroy their buoyancy. The contact surfaces of the underside of one of these caissons and that of the top of the submerged pier base were bonded by a heavy intervening coat of asphalt. After that union was made, the caisson was filled with concrete to transform it into a solid structure.

These caissons were poured on shore in forms that could be used repeatedly, and the caissons were launched and towed to their offshore positions whenever conditions were favorable. Each caisson was moved to its given position between two barges that held it nicely centered until set upon its proper pier base.

THE steel superstructure of the Storström Bridge consists of 47 approach spans and three longer and different spans immediately above the channelway. The approach spans are of the cantilever type, and those spans are alternately anchor arms or suspended spans, their lengths being either 190 feet or 204 feet. The three spans over the channel way are stiffened tied-arches. The two side spans are each 340 feet long and the center span has a length of 450 feet.

The basic steel structure throughout the bridge is composed of two parallel massive plate girders standing 12 feet high, separated either 24 feet or 40 feet, the latter being the case at the channel spans; the two lines of girders are tied together by an extensive system of intermediate bracing. On top of the girders

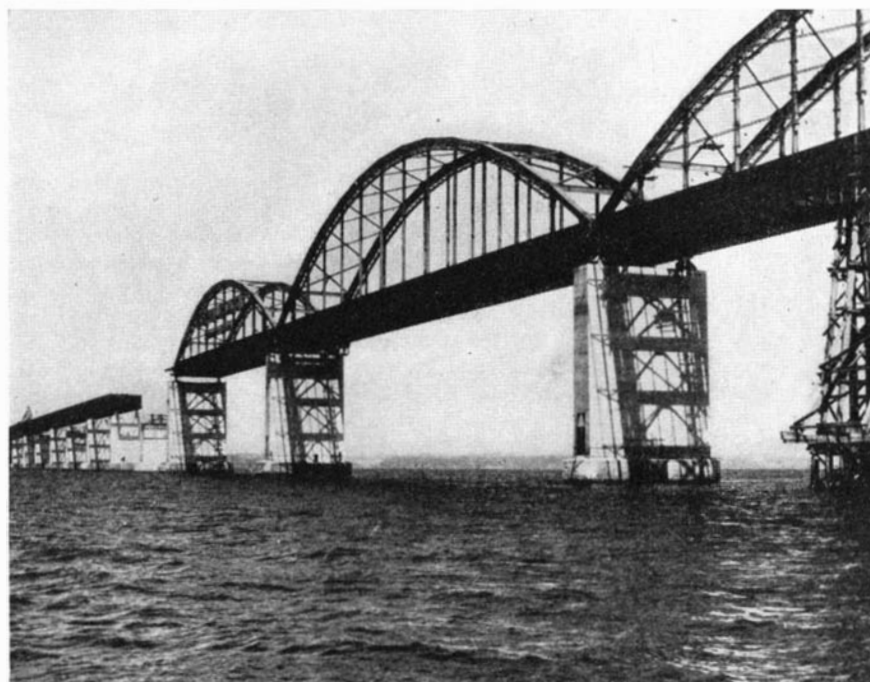
are laid the transverse beams that sustain the floors or beds for the railroad, the motor roadway, and the sidewalk. The reinforced-concrete highway and sidewalk are a single structure, while the reinforced-concrete floor for the railroad is an independent structure upon which is placed ballast that carries the cross ties and the rails. At each shore end, the suspended structure rests upon a massive concrete abutment; from those terminal points the bridge descends to the ground level by long approach ramps that have a gradient that reaches a maximum exceeding 6.5 per cent.

On the Island of Masnedö, the ramp

takes the form of a great "S" which links the Storström Bridge with a new swing bridge across the Masnedö Sund. The latter bridge is a part of the Storström Bridge undertaking, and is, therefore, contributive to time-saving. The Masnedö Bridge has a total length of approximately 606 feet and is made up of five spans. The more modest depth of the Masnedö Sund, its sheltered course, and other circumstances, made the work of building the supporting piers and the steel superstructure much less difficult than in the case of the bridge across the neighboring Storström. Nevertheless, both the steel workers and the concrete workers made rapid progress by reason of expert guidance and the employment of time-saving equipment.

THE substructures were built for both bridges by the well-known Danish firm of Christiani and Nielsen; all the steel material and the fabricated members of the bridges were furnished by Dorman, Long & Co., Limited, England, who also erected the superstructure. This latter concern devised apparatus by which entire assembled spans for the Storström Bridge could be moved bodily from a shore station and carried by a floating plant which could hoist those members to a suitable height and then lower them on to the sustaining piers. In short, numerous exceptional facilities were utilized by the contractors which set new standards in the design and construction of large bridges.

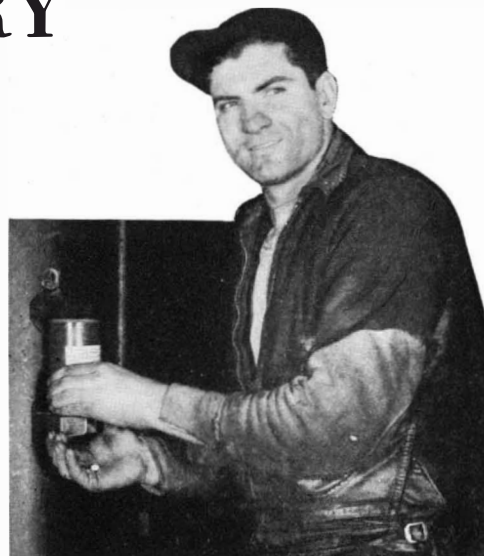
Submarines—their function in present and future naval tactics—are discussed by Walton L. Robinson in a July article.—The Editor.



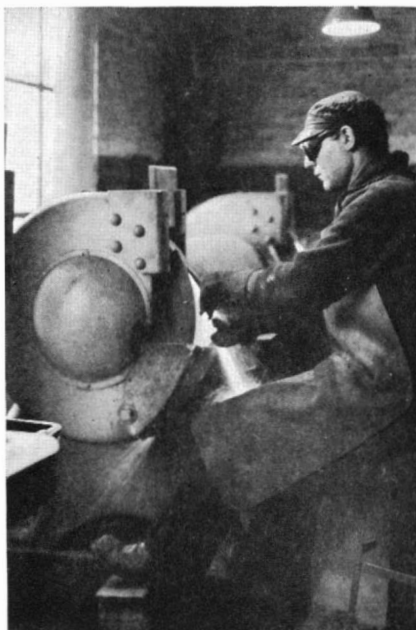
Spans of the long bridge at the point where it crosses the deep channel for the numerous and relatively large ships that regularly pass between the islands

SAFETY IN INDUSTRY

SAFE working conditions for employees are now considered to belong in the ABC's of operating efficiency by the country's more progressive industrial concerns. The pictures on this page show some of the many ways in which the Bethlehem Steel Company, one of the world's largest producers of steel, promotes safe working conditions among its workers. One of the important ways in which safety is promoted is by making working conditions as comfortable as possible, thus reducing the hazard that often has its origin in fatigue.



A pill when it's hot—but it's just salt and sugar, mostly salt. Since salt is one of the most effective antidotes to heat, steel workers exposed to intense heat keep comfortable by using pills which also contain dextrose, another heat combatant.



Heavy steel plate guards surround grinding wheels. Suction carries dust away. Use of goggles and leather aprons gives added protection.

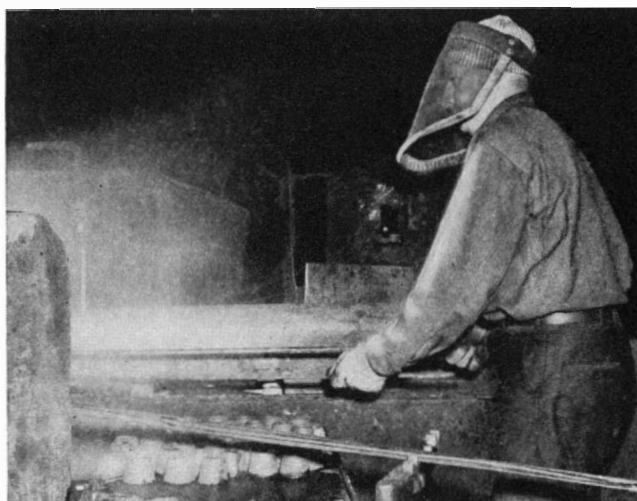


Goggles for modern blacksmiths are of the strongest, toughest safety glass.

Automatic vigilance. This press operator wears wristlets; cords attached jerk his hands back if he negligently leaves either of his hands in the path of the descending punch.



Doorways adjacent to tracks of the Bethlehem Steel Company are equipped with "cat-tails" to remind of possible approach of engines.



Operators of pipe welding furnaces are provided with "heat masks." The fine wire screen of these masks checks the heat by absorbing it, yet does not materially reduce vision.

YOUTH AND AGE IN THE

A Problem That is Not so Simple as it Seems . . . Ascertaining Which Astronomical Events Have Followed Others, and Which Have Preceded Them

By 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, President of the American Astronomical Society.

SEVERAL members of the staff of the Mount Wilson Observatory have found entertainment and profit in discussing a question which is not so simple as it looks—what objects of astronomical observation, outside our earth, are there about which we can say with security: "This is of more recent origin than that?" By the terms of the problem the answer, like the verdict of a jury, for conviction, must be given only in cases where there is no reasonable doubt about the conclusion. Deductions from theory are admissible only when the theory is supported by so great and so consistent a weight of evidence that it has passed from the stage of hypothesis into that of general acceptance. By mutual agreement, too, certain obvious cases are excluded as trivial—sun-spots, solar prominences, clouds on Mars, markings on Jupiter, where changes in rapidly varying phenomena are observed day by day. In the same class come changes in comets—although the conclusion that, of two condensations in the tail, shown on the same photograph, the one farther from the head is the older, might be presented as grounds for a verdict, since it depends on the general law that such objects always move away from the head.

The strict constructionists of our group, however, have secured a unanimous decision that all such answers, based on directly observed motion, shall also be excluded as obvious. This cuts out the expanding nebulae around Nova Persei and Nova Aquilae, which might already have been rejected as cases of directly observed change, and also the slower motion in the Crab Nebula in Taurus, which is expanding at a rate which indicates that it may have been produced by a great outburst, like that of a nova, about a thousand years ago.

In this case the advocate of exclusion might raise the question of reasonable

doubt, and inquire whether we can be *certain* of the conclusion just expressed. The opposing counsel may reply that the assumption that the observed motion of the nebular filaments has been uniform rests upon Newton's first law of motion, which we have every reason to believe to hold good unless some specific force is at work, and present evidence that no known forces of sensible magnitude will operate on diffuse material of this sort. If the exclusionist cannot specify any such force, his case is lost—for the assumption that some unknown force is at work must obviously be "off the record." The inclusionist may strengthen his position by remarking that outbursts leading to the ejection of nebular material have been observed to occur, so that this hypothesis is reasonable. But nevertheless he must lose his case on appeal, for it has been adopted as a constitutional principle that cases based on observed motion are to be rejected.

The great oval loop of nebulosity in Cygnus, which, by the same arguments, is approximately 100,000 years old, must meet the same verdict—though by this time protests may be made that the case has been thrown out on a technicality.

PASSING to the more interesting cases, which cannot be so simply disposed of, long and active discussions have brought out only a single irrefutable instance. Among the craters which strew the Moon's surface, there are a number of instances in which one crater cuts into the wall of another—interrupting it, while retaining its own symmetrical shape. This is circumstantial evidence, but of the most conclusive sort. We do not know how the lunar craters were produced—by volcanic eruptions, perhaps, or by impact of huge meteors, or by sinking of sections of the crust into a molten substratum—but, in any case, it is altogether reasonable that a

later formation should cut into, and partly obliterate, an older one, and altogether absurd that the later disturbance should stop acting as it reached the edge of the old crater, and leave it intact.

The very numerous cases in which small craters are found on the floor of large ones may be adduced as also in point—though our opponent might here argue that it was possible that the small interior craters had been produced so shortly after the big one that the material was "still soft" and were therefore substantially of the same age. The writer, faced with this dilemma, would be inclined to take refuge in the famous Scotch verdict "not proven."

These lunar formations, however, are quite unlike any other material with which astronomers have to deal. They are much more akin to the subject-matter of the geologists, who have established an extensive sequence of relative dates on earth, independent of any evidence from fossils, or of the powerful recent aid of studies of radioactivity. Moreover, from the astronomical standpoint, they are unique. Were the surfaces of Mars or Venus covered with craters of the same size, they would be observable under the best conditions—and we do not find them. Mercury, if it were nearer the earth and observable under better conditions, might perhaps show them—but this is mere guesswork.

Outside this, the best case for the prosecutor who seeks for youth in the heavens is found among the comets of our solar system. There are a great many of them—a very great many. Apart from the returns of periodic comets which have previously been observed, three or four new ones, on the average, are discovered every year. Most of these are moving in nearly parabolic orbits and on the average thousands of years must elapse between their successive returns. No matter how assiduous the search, it would therefore be many thousands of years before terrestrial astronomers could complete the census of comets. There must be at least 10,000 of them, and may well be 100,000—or more, if we allow for those which do not come close enough to the sun to be visible.

Now a comet is the poorest of all celestial life-insurance risks. It may perish in a variety of ways—ceasing to be a luminous object, though not, of course, being annihilated. In the first

HEAVENS

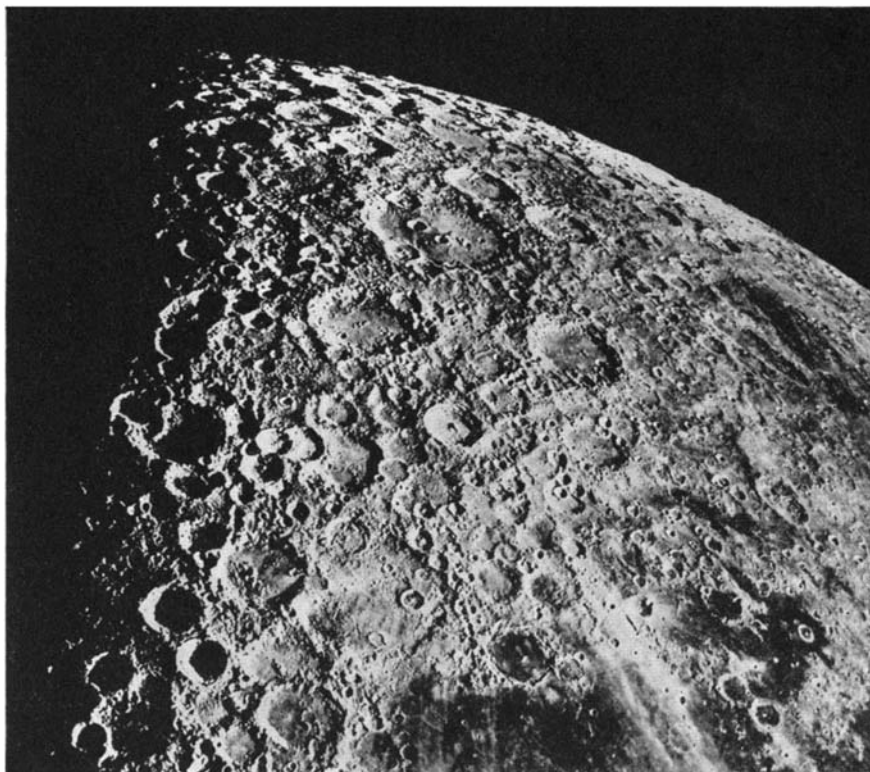
place, it is liable to changes in its orbit. The attraction of a planet, if it happens to pass near one, may speed it up, and send it away in a hyperbolic orbit, into the depths of interstellar space—never to return to the sun, and with an utterly insignificant chance of passing near any other star. The chance of so drastic a perturbation at any one return of a comet is small; but the change, if it occurs, is irreversible. (There is an off-chance, theoretically, that a comet ejected from some other star—if the stars have comets revolving around them—*might* pass through the solar system, but this chance is so exceedingly small that it can be neglected.)

Suppose that a comet, of period 10,000 years, stands one chance in a thousand of ejection at a given return. After 10,000,000 years a large number of such comets will evidently have suffered this fate—not all, because some of them will have had good luck. After 100,000,000 years very few of them will be left.

NOW the evidence from radioactivity shows that individual terrestrial rocks are at least 1,200,000,000 years old. The most searching cross-examination has failed to shake or discredit this evidence, and it may be accepted as establishing this, beyond reasonable doubt, as a minimum age for the earth—and *a fortiori* for the planetary system.

In so long an interval, the loss of comets by deflection into hyperbolic orbits would be very serious. Those comets which had the longest orbits, and returned to the sun most rarely, would be in greater danger per return, since their velocities would be close to the speed-limit for escape, and they would be subject to additional disturbance by the attraction of the stars.

Apart from these dynamical vicissitudes, a comet is in danger of wearing out. The luminous gas and dust, which form the envelopes of the head, and give out practically all the light which makes the comet conspicuous, stream away down the tail, and are dispersed into the very depths of space. The process is as hopelessly irreversible as anything known to science. Each new apparition draws anew upon the resources of the head, which must be limited. Halley's Comet, during the last 2000 years, has been seen to grow 26 long tails. If it has been returning to the sun in its present



Photograph by the Mount Wilson Observatory, 100-inch telescope

Just one inch below the top, and exactly in the center, is the large 150-mile lunar crater Clavius. This combines the two features mentioned by the author. Clavius is the largest depressed, mountain-ringed enclosure on the moon's face. Its walls average about 12,000 feet elevation above the interior portion. Other examples of similar kinds can be found if the photograph is studied closely

orbit for the last 1,000,000 years, it must have grown 13,000 successive tails—which is not to be dismissed as impossible. But in 1,200,000,000 years it would have had to grow 15,000,000 tails—which appears to be too much to expect of one comet.

It is highly probable, then, that Halley's Comet has not been moving in its present orbit for so long. It is entirely possible that until a relatively recent date its orbit did not approach the sun near enough to start the process of tail formation and that it has been diverted into its present path by planetary perturbations. At present, its orbit does not pass near those of any of the large planets; but this again would be expected as the result of the cumulative action of small perturbations. There are many other periodic comets—several with periods about the same as Halley's—but they are all inconspicuous.

It is tempting to suppose, therefore, that they have been in their present orbits longer, and are nearly worn out. But, though this is entirely possible, and, indeed, plausible, there is no sufficient proof to establish it beyond a reasonable doubt. For example, the other comets may have been smaller, or poorer in tail material, to begin with.

Under the strict limitations which we have accepted, it cannot therefore be asserted that Halley's Comet is younger than the others, though it well may be.

The question whether the existing system of comets, as a whole—the sun's

second family, as Chamberlin well called it—is as old as the first family, the planets, is the most doubtful that comes before our court. If we should assume that the processes of planetary perturbation and tail-formation have been going on as at present during all this vast interval, and should calculate back, step by step, we would find an ever-increasing swarm of bigger and bigger comets. Though numerical estimates are very difficult, even conservative assumptions lead to so great an initial number of comets as to be absurd.

Bobrovnikoff and others have argued, from similar premises, that the present family of comets must have been picked up by the sun much less than 1,000,000,000 years ago—perhaps when the solar system passed through some nebula. This suggestion is still speculative; but the general arguments that the cometary family is younger than the planetary are strong, and, if the question whether this is true without a reasonable doubt should be put before a group of astronomers, the decision would probably be by a close vote in which the individual convictions of the judges inevitably had weight.

Among the stars, it seems impossible to find a decisive case. If we knew more than we do now about the sources of stellar energy, we might have something to say; but, at the moment, there appears to be no sufficient evidence for a verdict.—*Mt. Wilson Observatory, April 1, 1937.*

SCIENTIFIC DETECTION

By THOMAS HAYES JAYCOX

"Lie Detector" Operator,
Police Department, Wichita, Kansas

BACK in biblical days, when Moses chiseled the Ten Commandments on tablets of stone, a field of endeavor was opened that was to reach near perfection some 3400 years later—the detection of lies. That 9th Commandment—"Neither shalt thou bear false witness against thy neighbour"—was probably the most frequently broken then; it is the most broken now. Consequently, truth-loving people devised means of ascertaining whether or not the spoken word was fact or falsehood. They learned that attempted deception is usually accompanied by certain visible physiological changes such as pulsations in the throat, blushing, eye squinting, apparent dryness of the mouth and lips, and many other manifestations. The ancient Chinese required their suspects to chew rice while being questioned, and then spit it out for examination. If the rice were dry the suspect was presumed to be guilty because his tension of guilt was supposed to cause a cessation of the salivary gland secretion. In India the movement of a suspect's big toe was supposed to indicate deception.

Not always, however, have investigators depended entirely upon the physiological reactions. History, in the detection-of-deception field, records some amusing, yet effective psychological tests. Probably the most outstanding of these among the ancients is attributed to a crafty Hindu prince who used the superstitiousness of his subjects to catch the guilty. Whenever a crime was committed within his jurisdiction the Prince sent his investigators into the field to round up all the suspects. They were gathered into one large chamber in his palace and instructed to stand against the wall with their hands behind them. They were told that in an adjoining chamber was a sacred ass who would bray loudly when his tail was pulled by a lying person. They were further instructed to proceed, one at a time, into the chamber and grasp the tail of the guilt-detecting ass, and then return to their original positions.

EACH superstitious native took his turn, went alone into the chamber with the supposed supernatural donkey, gave the tail a pull and then returned, hands behind him, to his original position along the wall. When each of the group had been into the chamber and the donkey had not brayed, the Hindu prince ordered all suspects to extend their hands in front of them for inspection. A quick inspection showed that

only one suspect had emerged from the donkey's chamber with clean hands—the guilty one. The Prince had dusted the donkey's tail generously with black powder before the test, and those who grasped it soiled their hands!

Such tests worked very well with a superstitious people, but in our modern complex society they would be worthless.

Back in the 16th Century, Benvenuto Cellini, Italian artist, metal worker, and sculptor, recorded in his autobiography the following, concerning his musician father who had destined his son for the musical world and attempted to thwart his inclination for design and metal work: "I was ill about two months during which time my father had me most kindly treated and cured, always repeating that it seemed to him a thousand years till I got well again, in order that he might hear me play a little. But when he talked to me of music with his fingers on my pulse, seeing he had some acquaintance with medicine and Latin learning, he felt it

change so much if he approached that topic, that he was often dismayed and left my side in tears."

Since that time many years have been spent in research, and hundreds of experimental examinations—conducted by such men as William Moulton Marston, Vittorio Benucci, Harold Burt, John Larson, and Leonarde Keeler—have definitely established the fact that con-



Figure 1: The author and Keeler Polygraph

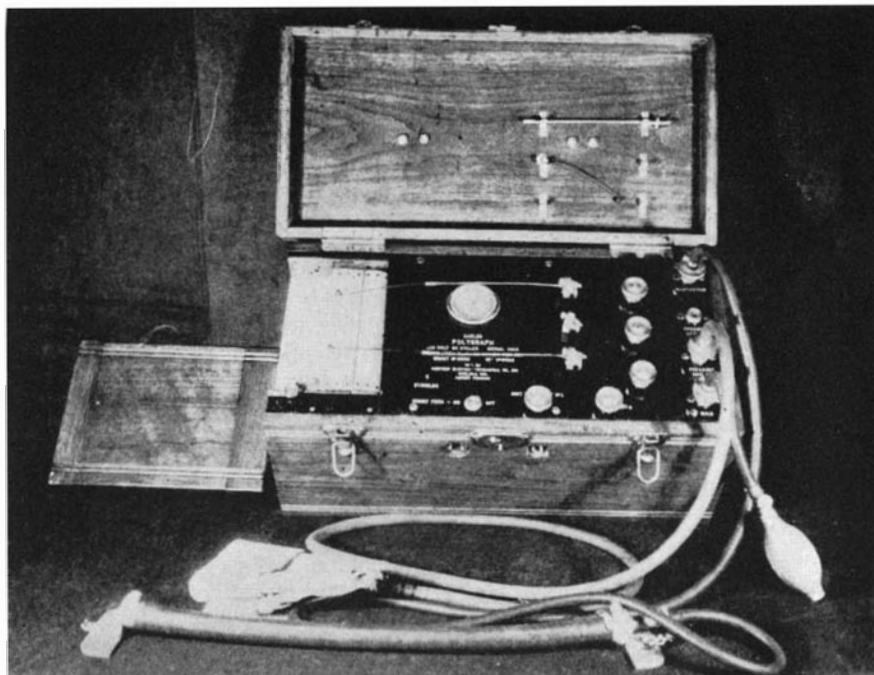


Figure 2: The Keeler Polygraph. In the foreground are the pneumograph (large tube; see Figure 1) and blood-pressure cuff (the irregular white object)

OF LIES

Where Stands the "Lie Detector Machine" Today?... Sensational Claims and Sound Science . . . Replaces Third Degree . . . The Superstitious Porter Shied Off

scious lying causes certain emotional disturbances which can be recorded.

In 1913 Marston began research in the Psychological Laboratory at Harvard University, regarding the detection of deception. After innumerable experimental tests he became assured that it was impossible for a normal person to

lie without effort. Expended effort, he found, either mental, nervous or otherwise, caused an increase in the strength of the heart beat and necessarily an increase in the systolic blood pressure (the pressure in the arteries at the time the heart contracts and forces the blood through the body).

The following year at Graz, Austria, Benucci devised a test based on the principle that the respiration rate was affected by the effort of conscious lying, and that these changes could be accurately gaged. Some three years later, in the same laboratory where Marston had worked, Burt further developed Benucci's method.

Then, in 1921, Dr. Larson, working with the famed criminologist August Vollmer at Berkeley, California, combined an Erlanger Sphygmomanometer (apparatus used by physicians to determine blood pressure) with a pneumograph (a one-foot length

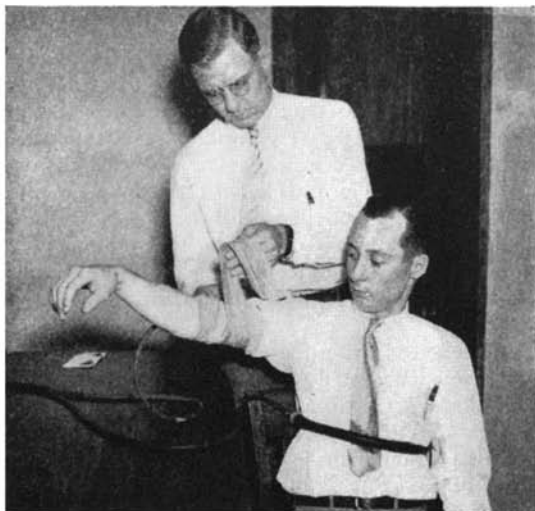


Figure 3: Attaching the blood-pressure cuff

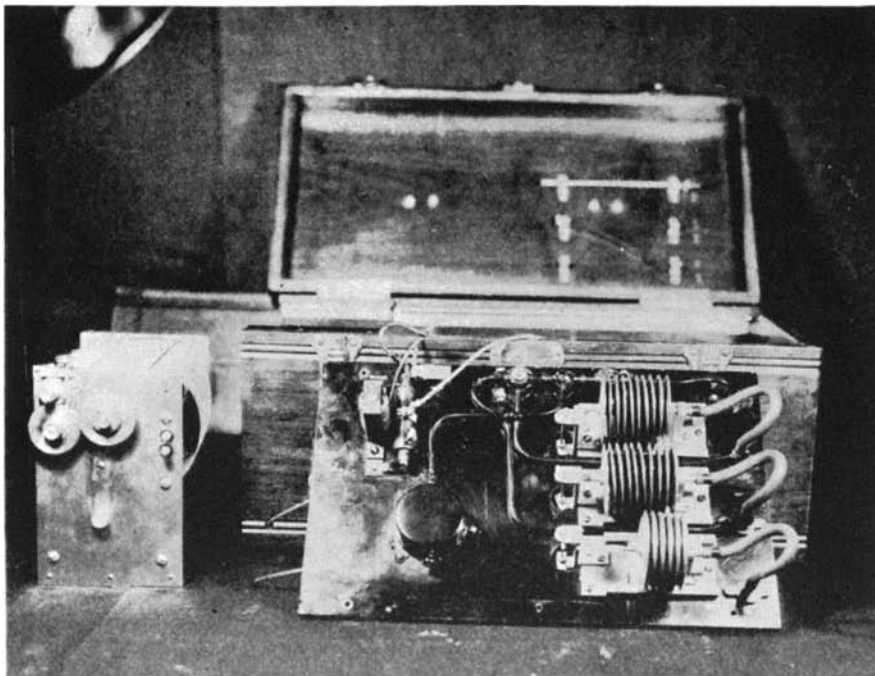


Figure 4: Left: The kymograph mechanism unrolling paper. Right: Inner mechanism of the Polygraph, showing the three metal bellows mentioned in the text

of $\frac{3}{4}$ inch diameter spring encased by light rubber tubing for recording respiration) and conducted a series of tests on suspects and prison convicts. Although Dr. Larson did not treat his material statistically, he reported a high degree of accuracy in his findings.

In 1925 a young student at Stanford University, Leonarde Keeler, began the assembly of an instrument which he called the "Keeler Polygraph." During his years in the psychology department at Stanford and later (1930) when he became Assistant Professor of Law, Scientific Crime Detection Laboratory, Northwestern University, Professor Keeler, now a well known criminologist, perfected his instrument for recording continuously the blood-pressure, respiration, and psycho-galvanic reflexes of a subject under examination.

Having studied and experimented with the emotional factors accompanying deception, Professor Keeler arranged his instrument to record the various voluntary and involuntary bodily changes in a lying subject simultaneously. Thus the name "Polygraph" ("many-graph") came into being. Several graphs made simultaneously with well selected relevant and irrelevant questions as the stimulus, cause certain reactions which can be correlated and truthful answers and falsehoods separated.

ALTHOUGH Professor Keeler does not claim that his instrument (Figure 1) is a "lie detector," it is commonly known by that name. Because of sensational claims made by some writers of the news and others whose facts were not well founded, a lay public has been led to believe that a light flashes or a bell rings each time an examined subject strays from the truth. The facts regarding Keeler's Polygraph are quite the reverse. The instrument is used much as the physician uses his stethoscope, his clinical thermometer, and his blood count apparatus—as a means of diagnosis. Certain symptoms, combined with a case history and other indicating factors, assure the physician that his patient has an infected appendix, arthritis, or other disease. Certain delusions and other accompanying factors assure the psychiatrist that his patient is psychopathic, and in a like manner certain reactions in Polygraph tests, combined with other accompanying factors, assure the Polygraph expert that his subject is not telling the truth. The instrument itself is simply the tool with which the deception is detected.

The Keeler Polygraph (Figure 2) consists of three units housed in an 18 by 9 by 7 inch case. One unit is for continuously recording the changes in blood-pressure and pulse; another gives a duplicate blood-pressure record, and a third is for recording the changes in respiration. Ordinarily the duplicate

blood-pressure unit need not be used.

In order to record the bodily reactions a pneumograph (rubber tube containing a metal coil spring) is adjusted about the chest and a blood-pressure cuff is snugly wrapped about the upper right arm (Figures 1, 3). Both the pneumograph and blood-pressure cuff are attached to the instrument by means of four foot lengths of rubber tubing. The rubber tubes connect with metal tambour stacks or bellows (Figure 4) located immediately beneath the instrument panel inside the case. The tambour stacks in turn are attached to pivots which protrude through the panel and to which are attached long arms. At the end of each arm is a small ink cup which tapers at the bottom and forms itself into a pen. The cups are kept filled with ink, and feed the pens which ride upon a slowly moving graph paper. The graph paper is unreel by a kymograph mechanism (Figure 4) at the rate of six inches per minute.

When all adjustments have been made, the blood-pressure cuff is inflated (note bulb, Figure 2) to a point midway between diastolic (minimum) and systolic (maximum) blood pressure. The midway point is called "mean" pressure and can be determined by the position of a dicrotic notch which appears in the blood-pressure-pulse record. As the heart forces the blood through the artery beneath the inflated blood-pressure cuff, the volume of compressed air inside the cuff is changed with each beat and transfers that change to the pen arm by way of the metal tambour stack and pivot. The pen arm moves with an up-and-down motion, causing the pen to record on the slowly moving graph paper each heart beat and change in blood pressure.

SINCE the second element of the apparatus, the pneumograph, is adjusted snugly about the chest, inhaled air expands the chest and elongates the tube. When the air is expelled from the lungs the tube contracts to its original length. These elongations and contractions of the pneumograph change the amount of air within the tube, causing these changes to be transferred to the pen arm by way of another tambour stack. The flow of ink from the pen records each breath taken, as well as any changes in the respiration, at the same time the other unit is recording the blood-pressure and pulse.

The graph paper is divided by three principal horizontal lines, each from left to right, as shown in Figure 5, and into many spaces by lines in the other direction. The upper horizontal line is the region for recording the respiration. The center (not always used) is for recording the duplicate blood pressure, and the bottom for recording the blood-pressure pulse wave. The vertical lines represent a period of time—one second

each for the lighter lines and five seconds each for the heavy lines. Since the kymograph mechanism unreels the graph paper at the rate of six inches per minute, one of the lighter lines passes beneath the pens each second the instrument is in operation. Thus the operator is given an exact account of the time required for his stimulus question to take effect, the length of time required for a return to normal, and an easy check on the number of heart beats per minute.

A subject taking the Polygraph test is seated facing away from the instrument so that his interest is concentrated on the questions being propounded and not upon the fluctuating pens recording his reactions. About every 30 seconds he is asked a question and is required to answer with a simple "yes" or "no." The operator first establishes a normal by asking irrelevant questions: "Have you had breakfast this morning?" "Is this the month of February?" and so on.

After the normal has been established, the questions are arranged so that they hint at intimate details of the crime under investigation. Necessarily, if the subject is not acquainted with those details, and if the test is properly controlled, his reaction to the hints will be no greater than to irrelevant questions. If his record indicates that he had knowledge of the details—if he reacts to hints—questions concerning the actual crime may then be propounded. Significance is attached only to the deviations from the established normal at points where the stimulus questions are relevant to the crime under investigation.

The progressive police of the nation were quick to recognize the value of Keeler's Polygraph. The need for such a device was acute. The old so-called

"third degree" methods of obtaining the truth had been proved inefficient so far as actual results were concerned and were frowned upon not only by an indignant public but by the police themselves. A quick and easy means of getting true facts simplified the work of the police and added another scientific weapon with which they could combat crime. Fortunately, however, Professor Keeler limited the distribution of his instrument to the medical profession, certain educational institutions, and recognized law enforcement agencies who could produce men capable of becoming skilled operators. An instrument of this nature in the hands of an unskilled or unscrupulous person would be a very dangerous thing. The operators therefore are required to take certain training, to become proficient, and to demonstrate their ability, before an instrument can be purchased by the group he represents.

EARLY in 1933 the Wichita Police Department, having met the requirements laid down by Professor Keeler, purchased a Polygraph. In the beginning the new "lie detector" was a target for many derisive jests, but the ensuing three years changed the minds of the skeptical, and a full-time operator is now kept busy examining that never ending line of subjects whose stories and alibis have sounded false to investigating officers.

During the year 1936, a total of 1262 suspected persons were sent to the Polygraph Room where, as operator, I conducted truth tests. Of the total, 339 were found to be lying, and of that number 151 made full confessions of their guilt. On the other hand, 919 were found to be telling the truth and were immediately

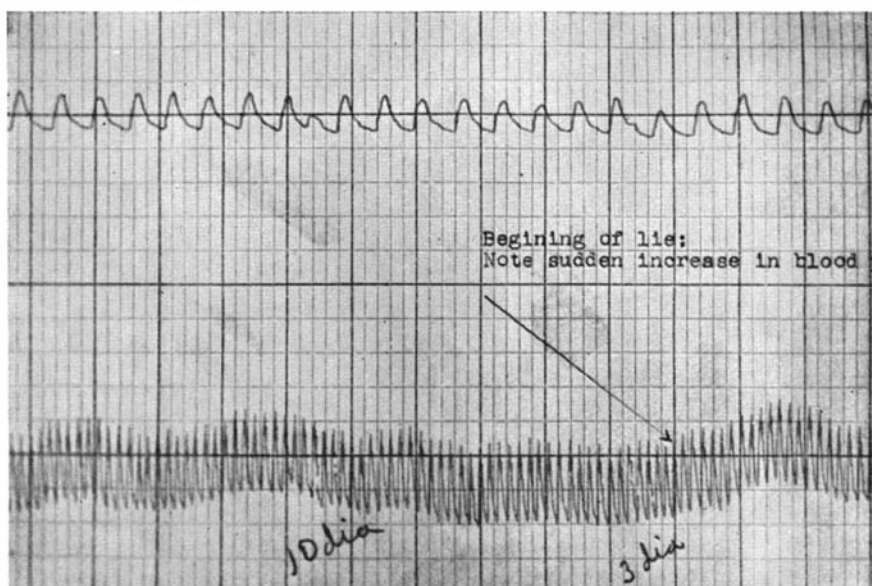


Figure 5: A typical graph. This graph depicts the sudden rise in blood pressure at the point of attempted deception. The subject was handed ten well-shuffled playing cards, with instructions to choose a card and then lie about his choice. Respiration at top, blood pressure below. Notice where he said "No" to the three of diamonds. He later admitted that the three of diamonds had been his choice. Such tests are often used to obtain controls—that is, find the normal

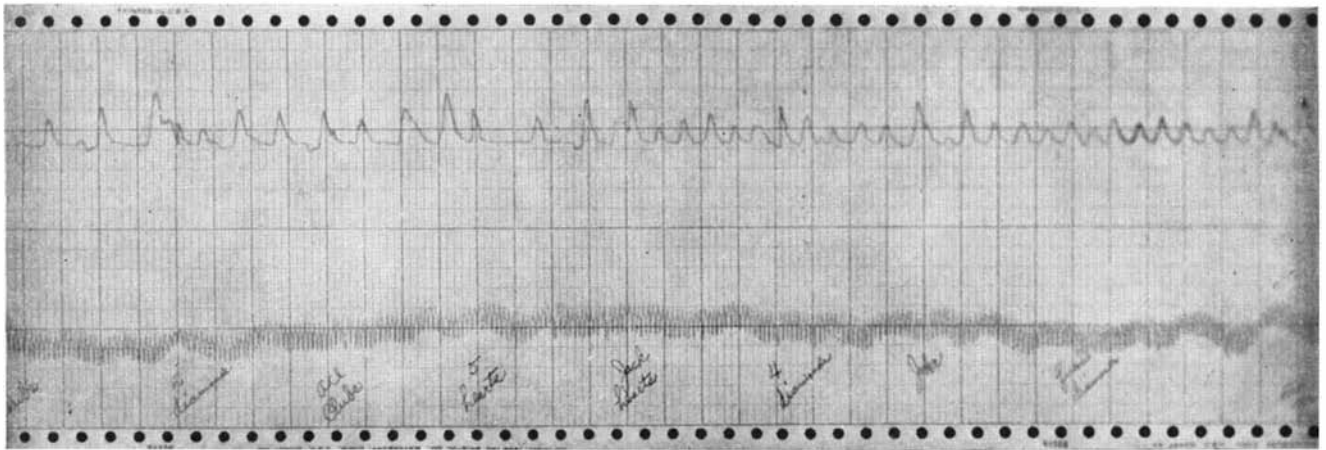


Figure 6: Another graph, this one indicating very clearly the relief following deception. The subject had selected a playing card and lied about his choice while the Polygraph recorded his respiration and blood pressure. Note abnormal breathing (top) up to point near center where he answered "No" to the Jack of Hearts. From then on to the end he showed almost normal breathing. (Breathing is at top, heart at bottom.) The Jack of Hearts, however, was the chosen card

released from custody. The "lie detector" not only detects the guilty, but serves to establish the innocence of those falsely accused.

To my office come people from all walks of life: honest people, thieves, suspected murderers, shoplifters, fleeing criminals, vagrants, and a host of others. All are suspected of one crime or another and it is my duty to weed out the guilty and secure immediate release for the innocent. Let's look back on some actual cases and see what happened.

Late in December, 1935, the vice-president of a bank came to Police Headquarters for assistance. His story was an odd one, but nevertheless true. He advised that a certain transfer of money had been made to his bank the day before and that one sack containing a sizable sum had disappeared. The teller who had received the sack remembered that during the rush hour the sack had fallen off the counter to the floor. Busily engaged at the time, the teller decided to leave the sack where it had fallen until after the rush. The teller, being human, did a very human thing—forgot all about the sack until late that night. He rushed back to the bank and to his cage, but the money was gone. During the previous afternoon numerous bank employees had been in and out of the teller's cage and, since the sack was out of reach of the public, the vice-president concluded that some member of the bank's personnel had stolen the money, sack and all.

The bank's personnel consisted of some 50 people. The process of elimination finally narrowed the field to seven who had had an opportunity to commit the theft—those who had frequented the teller's cage during the afternoon. But who was to be accused? The seven were trusted employees. How was the guilty person to be singled out? The police suggested a Polygraph examination for the entire group.

This suggestion met with the approval

of both the vice-president and the suspected men and the Polygraph was set up in a room at the bank and the examinations begun. The afternoon slipped into evening but the tests continued. One after another the suspects ran clear records. Late that evening the negro porter was brought in for his turn on the instrument. He had cleaned the cage shortly after the bank had closed the previous evening, and was among the seven to be examined. The negro was superstitiously inclined and obviously badly frightened. The whites of his large round eyes were an extreme contrast to his face, and he shied at the box-like instrument sitting on the table. After much explanation and assurance that the instrument would not injure him, the porter was finally induced to sit in the chair and allow the pneumograph to be adjusted about his chest and the blood-pressure cuff attached to his arm. Questions concerning the stolen money bag brought violent increases in blood-pressure and a suppression of respiration—an unmistakable indication of deception.

WE soon learned that the man's fright was not all superstition. Much like the Hindu who emerged from the room with clean hands, his fear of the consequences of exposure led him to expose himself. In trying to suppress his emotions he had only succeeded in increasing them. After the examination was completed he was accused outright and the records were explained to him. Later that evening he confessed the theft and led detectives to an abandoned house where he dug several hundred dollars of the stolen money out of the unused chimney.

Another case: Near the Colorado border, the general store in a small town had been entered late one night. The burglar had stolen all the cash from its hiding place and then set fire to the building to cover his crime. Nearby farmers, seeing the blaze, rushed to the

scene and extinguished it, but the culprit had fled. The sheriff conducted an immediate investigation and some days later arrested a young man who had previously been employed in the store as a clerk. The young man vigorously denied any knowledge of the crime and withstood a ten day grilling by officials, and all but convinced them that he was telling the truth. To be sure of their findings, however, the officers asked that he take a Polygraph examination. He consented and was brought to Wichita. One hour after he arrived at headquarters the results of his tests were laid before him and explained in detail. The Polygraph records indicated that the young man was lying; that he was the burglar; and that he had attempted to burn the building to cover his crime. He finally admitted that the instrument had recorded the truth and signed a confession giving full particulars of the crime. The Polygraph had accomplished in that hour what a ten-day grilling had failed to accomplish before.

An outstanding case was the investigation of a one-way-ride gang murder. A dead man was found at the wheel of a truck in Kansas and was identified as a rum-runner. He had been shot. The Highway Patrolmen took into custody a man who "might know" who killed the truck driver but he refused to talk, except to insist that he knew nothing concerning the killing. To prove his statements he agreed to a "lie detector" examination. Given the "name" test—a group of names of men who "might" have committed the crime—he gave little or no apparent response, except to one name at which his blood pressure and respiration became abnormal. He confessed.

Hundreds of instances like these may be found on file wherever the Keeler Polygraph is in operation. The final reports on some of the cases read like leaves torn from some strange fiction story—but they're true.

WRITTEN WITH THE

Dura . . . Archeology's Most Hectic Day's Work . . . Found the Contracts, Mortgages, Accounts, Receipts, Letters, and Wills of the Ancient Citizens

IT was on March 30, 1920, during the Iraq war. Captain Murphy had camped his company of East Indian troops on the cliff above the mud village of Salihiyeh, commanding the Euphrates crossing, where the grim walls of an ancient fort offered a little protection against Arab sharpshooters. Strolling among the ruins, he stepped into a tower room from which some trick of desert winds had emptied centuries of sand. The walls were alive with astonishing bright priests and worshippers—frescoes.

He hastened to notify his superiors, who notified Miss Gertrude Bell, who notified the late James Harvey Breasted, then surveying Babylonia for the new program of the Oriental Institute, Chicago. Breasted rushed to Salihiyeh, arriving on May 3 to find Murphy ordered to evacuate this advanced position. In one working day Breasted made color notes of the frescoes while his assistants feverishly photographed: it was archeology's biggest single day's work, and then they rushed on upstream to safety.

The book that resulted, Breasted's *Oriental Forerunners of Byzantine Painting*, created a polite archeological furore. The frescoes contained the name of the town, Dura, solving one more problem in Mesopotamian topography, but raising a thousand new fields of speculation in Syrian and Parthian art.

IN the meantime the Académie des Inscriptions et Belles-lettres had sent Franz Cumont to dig there and soon the historians had something more appetizing than any fresco to sink their teeth into, for Cumont was turning up the stuff of which the history textbooks of 1960 will be written: vast temple complexes, a long series of Greek inscriptions—yes, Greek—and parchments. Dura began to be a historical landmark.

About 300 B.C. Seleucus I's leading general, Nikanor, built a guard post where the caravan trail along the Euphrates forks for Palmyra, and called it *Europos*, after Seleucus' birthplace in far-off Macedonia; the Bedawi promptly named it *dūr*, 'wall'.

At first there was no proper settlement—just a barracks for the Greeks on guard. But the situation offered

tempting commercial possibilities, and a few Syrian traders settled there. Perhaps they brought their daughters—at any rate, the Greeks raised families and founded a little half-breed dynasty. The fort grew into a model walled city, and trade prospered in its shelter.

With the collapse of the Seleucids about 130 B.C., Dura became the ranking fort of Parthia's western frontier. Far different from what the Roman armies they repeatedly whipped would have us believe, the Parthians now appear as enlightened and considerate rulers of the vast provincial empire they flung together. Certainly the change made little impression on the inhabitants of Dura; no Parthian carpet-bagger could have been induced to settle there at any price, and her municipal laws and organization were not disturbed.

The inscriptions dug up by Cumont, and later by ourselves, reveal some aspects of the local government. The Senate, consisting of the heads of leading clans and prominent traders, met in a small *bouleuterion* in the temple of Artemis (Figure 1). Presumably all matters of municipal justice, discipline, and comfort came under their control.

In each of three temples was a hall flanked by rows of steps, which became reserved seats for the ceremonies when Dura's aristocratic ladies carved on them the date and their names, their fathers' and grandfathers', and their husbands', sometimes also their husbands' fathers' names. From these hundred genealogies-in-brief we can reconstruct the family trees of half a dozen of Dura's most prominent clans, one in particular through two centuries of the city's history; to that family, descended from a Greek soldier and a native girl, belonged every *strategus* ("mayor" or "governor"—the title originally meant "general") of Dura during the Parthian period.

That dignity was therefore hereditary like that of an Arab sheikh today; when one even calls himself *genearches*, Greek for "sheikh," it is hard to distinguish between their functions. Like the Ptolemies in Egypt they married within the family to keep the race pure, a custom they did not learn from the European side of the house.

THE parchments alone guaranteed Dura archeological immortality. On parchment in Syria as on papyrus ("paper") in Egypt were kept the archives of antiquity, contracts and mortgages, accounts and receipts, letters and wills. At Dura alone of Syrian cities, however, were they buried so rapidly they had no time to rot; until the discoveries there, Egypt had a practical monopoly of such



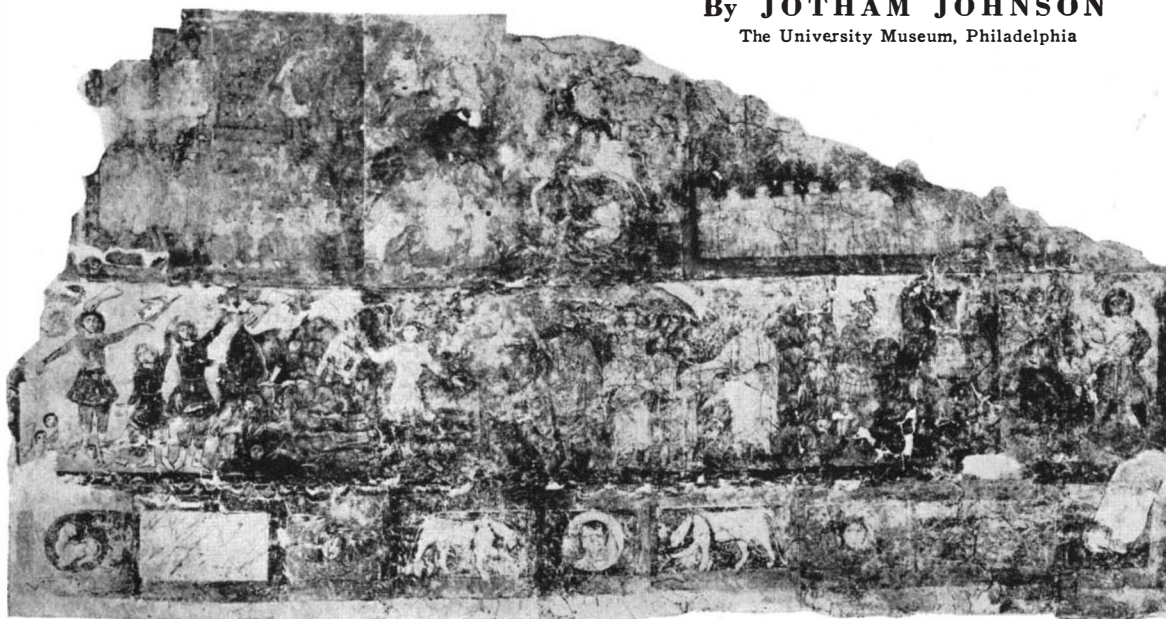
Photo Serge Dairaines, courtesy Gallery of Fine Arts, Yale University

Figure 1: A Beduin foreman poses in the senate-chamber of ancient Dura

ARCHEOLOGIST'S SPADE

By JOTHAM JOHNSON

The University Museum, Philadelphia



Courtesy Gallery of Fine Arts, Yale University

Figure 2: Earth once packed against the walls covered up and thus saved the synagogue frescoes

information on private commerce and society, and it was very much of a question how much Egypt could teach us by inference about Syria and other Hellenistic kingdoms.

Therefore when Cumont turned up two bills of sale, fragments of the official ledger in which were abstracted all registered deeds and contracts, a loan, a summary of the law of inheritance in intestacy, and a painted shield showing the travels of its owner, all in Greek, plus two lists of soldiers in Latin and a letter in Aramaic, it was *news*.

We now know, for example, that the code used at Dura (and the rest of Syria?) was independent of the Egyptian, resting rather on an older Babylonian code. In a city held by Parthia for three centuries we are surprised to find no trace of Parthian meddling with the local laws; but this only indicates that they saw no need to interfere where the local people were competent to take care of themselves.

At this time Dura's culture was most heavily in debt to Palmyra, the luxurious caravan capital half way to the Mediterranean coast. Agents and camel boys brought with them their own religious customs, and that tower, whose frescoes astonished Captain Murphy, proved in fact to be a temple dedicated to Palmyrene gods by a prominent Dura family.

Where such documents had been found it was not safe to predict what would not turn up. When Cumont's two fat volumes came out it was easy for

Professor Rostovtzeff of Yale University to persuade his administration to take up where Cumont had left off, and only this spring was Yale's tenth and last consecutive season at Dura-Europos concluded.

The first director of the excavations under Yale was French—M. Maurice Pillet who had dug at Susa in Elam and Karnak in Egypt. As assistants in 1928-9 he had Dr. Clark Hopkins and myself. We too found parchments. In one, Phraates the Eunuch lends Barlaas 400 drachmas in good silver, Barlaas contracting to work for Phraates in lieu of interest. And inscriptions: an altar (Figure 3) was set up to Almighty Zeus by the cautious populace after an earthquake which occurred about 10 A.M. on October 27, 160 A.D. And, scratched on the plaster walls, graffiti—scraps and jottings too personal and ephemeral to waste parchment on, potentially as interesting as the parchments themselves.

ONE graffito I noticed on the wall of a private house which had been dug clandestinely by soldiers stationed there to prevent clandestine digging. It proved to be a horoscope, showing graphically the positions of the seven planets (sun and moon included) among the constellations of the zodiac. From this Dr. Dirk Brouwer of Yale's astronomy department was able to work out its Julian date, July 3-5 or 10-12, 176 A.D. With this to go on I could decipher a few more letters scratched above the horoscope; they gave the date by the Seleucid cal-

endar, Panemos 9 of the year 488, equivalent to July 4, 176 A.D., a shiny feather for Dr. Brouwer's cap. This taught us that the lunar calendar survived late at Dura; second that the Neo-Babylonian calendar, a 19-year cycle of intercalary lunar years in effect since 383 B.C., had been taken over by the Parthians and was still swinging on its way unchanged; and third that the populace were believers in astrology.

Dura's first papyrus also turned up in my lucky sector, in the bottom of a tower of the city's main gate, but we did not then know that Clark Hopkins, succeeding Pillet as director, was to sink his shovels into the record-office of the Roman prefect and find still preserved there sheaves of army records on papyrus, one of the great archeological finds of this or any age.

Dura had been occupied by Trajan about 115 A.D., but Hadrian soon ceded it back to Parthia. In 165 A.D. Lucius Verus annexed it for good. True to Roman practice, Roman law was imposed but local religious customs were not interfered with. In the sprawling temples that characterize Dura's architecture continued to flourish the pagan worship of strange Oriental gods and goddesses, Nanaia, Hadad and Atargatis, Azzanathkona, Mithras, Aphlad, Bel, Yarhibol, and Aglibol. Altars and small reliefs dedicated in bad Greek to Zeus, Artemis, and Apollo, Nemesis or Herakles seem even more out of place when accompanied by Aramaic translations in



Figure 3: "An earthquake occurring throughout the land, in the year 472, on the ninth day of the month Dios, about the fourth hour of the day, the city set up this altar to Zeus Megistos", this reads

the picturesque Palmyrene alphabet. Tyche, however (Gad of the Semites, Fortuna of the Romans), was perfectly at home wherever Rome's oriental army reached.

To Rome's policy of tolerance we owe the addition of Christian and Jewish congregations to Dura's confused religious panorama. Less beautiful as art than the frescoes of the Temple of the Palmyrene Gods, less important for science, but sentimentally far more significant to the rank and file of us today, Dura's most memorable archeological moment was Clark Hopkins' discovery in 1931 of the oldest frescoed Christian chapel yet known. Its scenes, painted soon after 200 A.D., and published in 1935, are already famous: Adam and Eve, the Good Shepherd, the Paralytic Who Took up his Bed and Walked, Christ Walking on the Water, the Marys Approaching the Tomb, David and Goliath, and the Samaritan Woman.

BBETTER art, and of wide interest outside of Germany, are the only Jewish synagogue frescoes (Figure 2) so far unearthed, discovered by Hopkins in 1932 and now finally published. They were painted between a rebuilding of the synagogue in 245 A.D. and the siege of Dura in 256 A.D., and if they clash with the basic archeological axiom that the Jews had no church art, our only refuge is the assumption that at that date Jewish religious sentiment had not crystallized into aversion to pictorial art. And indeed the editors find support for this in the existence of medieval illuminated Jewish manuscripts and in modern discoveries of Jewish catacomb decoration in Rome and of Old Testament scenes in synagogue mosaics from Palestine. If other synagogues of the time had comparable frescoes, we are no longer at a loss to explain that Christian art of which Dura herself provides the most conspicuous primitive example.

In other ways, too, Dura was transformed under Roman guidance. Polyglot troops from all over the map added to the color and noise of Dura's riotous streets. Right in the passageway of the busy Palmyra Gate they installed their shrine to Tyche. They took over a large area in the north end of town for administrative offices and in 216 A.D. built a tiny amphitheater, with space only for a thousand spectators. They insisted on Roman standards of hygiene and comfort, and built four Roman baths. The water was lugged painfully up on donkeyback from the river valley below; heaven knows where the fuel came from in that treeless land.

I don't know that Dura has any great message. It is not a 20-stratum "laboratory mound" of the Painted Pottery Peoples, stretching 7000 years back into prehistory, like Tepe Gawra and Tepe Hissar [described in *Scientific American*, respectively, October 1935 and May 1937.—*Ed.*]. It is rather a melting-pot of Greek, Babylonian, Syrian, Persian, Palmyrene, desert Arab, and Roman cultures, just as to at least one of its diggers it is a confusion of single memories, not all archeological: the six-foot skeleton in one of the towers, the rope by which he was hanged still around his neck; the tomb of a medieval Arab chief (Figure 4) which we dared not touch for fear of a riot among our workmen; deciphering inscriptions at the Palmyra Gate at night, when a flashlight cast shadows sharp enough to make them legible; the viper that struck at me (he missed); the endless wrangling over the date of the walls, not even now resolved, and our perpetual wonder that the Parthians left so few traces of three centuries' occupation; my first sandstorm; the workmen crossing the river on inflated skins at dawn, just as on the Assyrian reliefs.

But Dura might also crash the pages

of world history for the story of her siege by the Sasanians in 256 A.D. The city was defended on the east by the Euphrates cliff, on north and south by wall-crowned ravines. Only on the west, facing the open desert, was Dura's wall vulnerable.

AS Dr. Hopkins has reconstructed the siege, the Sasanians tunneled under one of these west towers, shoring it up as they went, planning when all was ready to burn the timbers, bring the tower crumbling down and rush in through the breach. The defenders feverishly countermined.

Where they met, the Sasanians had the advantage of a sharp fight but, not daring to pursue, they fired the defenders' mine, walled it up and withdrew, leaving the wounded to die screaming in the blazing gallery. Then they calmly completed their own mine and fired it. The supports gave way and the tower settled, but did not collapse and still was adequate to repel the enemy.

While the worried householders hid their jewels and money for Yale to find, the Sasanians drew off to reconsider. Smarting from the defenders' yells of derision, they toiled under a shower of lances, arrows, and slingstones to build a ramp against the wall. Simultaneously a new mine demolished the corner tower and a wide tunnel nearby let loose a flood of Persians within the city.

By these means the walls were rushed and Dura was sacked. No one returned to recover his hidden treasures, no one but a lone hermit ventured back to share the ruin with wolves and jackals, and desert storms soon mercifully covered it with sand.

And of all this no ancient writer says a word. The whole story was written with the archeologist's spade.



Figure 4: In the vestibule of the Parthian palace, looking over the interminable desert, we discovered the tomb of an Arab sheikh and left it inviolate

HOMALODOTHERIUM FOR SHORT

By ALBERT G. INGALLS

THE awkward appearing extinct mammal shown below once lived in Patagonia, in the Miocene Epoch of the Tertiary Period or "Age of Mammals," an epoch which lasted from about 19,000,000 years ago until 7,000,000 years ago. The word Homalodotherium, with accents on the "ma" and "the," is the briefer of two forms of the same animal's name, the other being one syllable worse—Homalodontotherium; but since the main accent was found to fall on the "dont," the sensible advice it gave has been applied to this form of the word and the longer name is seldom used.

The skeleton (left) and reconstruction (right) are on exhibition in the Field Museum of Natural History in Chicago. The skeleton was discovered by Elmer Riggs, Associate Curator of Paleontology, in a block of sandstone which had fallen from a cliff on the eastern shore of Patagonia and was rapidly being worn away by waves on the beach. This is the only mounted skeleton in the world. The reconstruction was made by Phil C. Orr. To fill in the soft or body parts, in making reconstructions, paleontologists have far more than guesswork to go by. Bones show where muscles were attached, and the proportions and relations of the bones tell many things derivable from common principles of mechanics. Study of living animals of all kinds provides certain laws and verifies them, and in many cases these have been checked by actual finds. A paleontologist cannot reconstruct a whole animal from a toe bone, but one need not study paleontology long in order to note the surprising amount of safe deduction that can be made from a little evidence if one is

aware of the principles. Sherlock Holmes did no better with tobacco ashes, pencil parings, and other trifles.

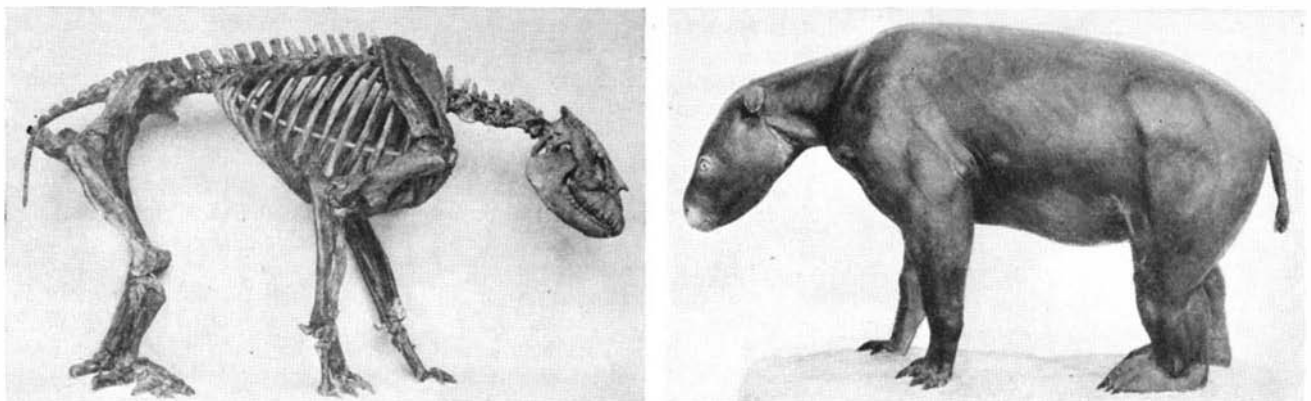
What an odd "critter" Homalodotherium was! As big as an ox, but with stupid look and tiny ears on a too small appearing head, massive hind legs and long flat feet, heavily muscled forelegs and rather sloping, clumsy body like that of a middle aged man who had lived too well. His teeth were excellently adapted to cutting and grinding vegetation and not at all designed for meat eating, yet he was equipped with powerful claws. This combination tells its own story: an animal that lived largely on grass and tubers, possibly roots, and carried with him his own powerful tools for digging them up.

THIS ungainly beast is chiefly of interest, however, because he is a relic of a "lost world"—mid-Tertiary South America. Most readers are familiar with the fact that the animals of Australia, to take another example, are peculiar if not bizarre. This is because Australia has long been an island, and evolution has gone its own way there, diverging from that of the continental land mass. Similarly, Africa contains an odd mammalian fauna and for the same reason: while this was evolving it was an island continent. For about 40,000,000 years South America was similarly shut off from the main current of mammalian evolution because the land that now forms the Isthmus of Panama gradually sank beneath the ocean late in the Eocene Epoch of the Tertiary Period, and stayed sunken for about 40,000,000 years. (Its unkind emergence cost your Uncle Sam \$525,812,661.) During those millions of years evolution in the island continent of

South America took its divergent course, hence the bizarre mammals found in fossil form there: not alone the one shown below but tree sloths and immense ground sloths, ant-eaters and their cousins the armadillos, as well as the heavily armored glyptodonts, as big as a hoghead, with large spiked bony clubs on their tails.

Now the story cuts back like a motion picture or novel, to see what was going on in North America while these bizarre beasts were evolving in South America. There we find the evolution of the mastodons, the three-toed horse, the camel (strictly "made in the U.S.A." and exported, millions of years ago, to the Old World; later it became extinct here where it was made, and today camels are imported for circuses; the horse was a parallel case), titanotheres, rhinoceroses in Nebraska and elsewhere, and literally thousands of other mammals—the whole forming an assemblage of mammals much more varied and numerous than in our times.

When the land again arose between the two continents and afforded a bridge, reciprocity was adopted and about 5,000,000 years ago the fauna of either continent spread to the other. That accounts for the presence in North America of some of the odd South American improvisations—for example, the common small armadillo. A large part of all these mammals became extinct. We still live, however, in the Age of Mammals, but we, ourselves, are rank outsiders in both of the Americas. During most of the evolution described above our own ancestors were Old World apes. Some say, of course, that they were not apes, because man and the apes evolved from a common stem. However, should you meet that "common stem" you probably would find but one term that really fitted him.



The world's only mounted skeleton of one of the rarest and strangest of South American fossils, with a reconstruction

FENCES, BRIDGES, ZIPPERS

OUR civilization is built upon wire, wire makers claim. Rather, wire holds our civilization together, because to dispense with it would throw us back to the horse-and-buggy days if not further and that would virtually mean collapse.

You cannot live and still escape using wire in one or more of its various forms. You encounter it first as a safety-pin and from then on it serves in countless guises until the final coffin nail. If wire's importance is unappreciated it is because its products often depart so radically in appearance from the basic form. Tinsel, for instance, which cascades from Christmas trees, doesn't resemble wire, but it is a wire product. So is the "zipper" fastener.

The manufacture of wire and wire products is an industry which comes close to the half billion dollar class. When things were not humming in 1935, over 2,000,000 tons of plain iron and steel wire were produced. Copper wire followed with a tonnage of more than 200,000; brass and bronze wire with 37,000 tons; while other non-ferrous wires aggregated some 10,000 tons. Among the many products of wire, such small items as nails, brads, and spikes accounted for a tonnage of over 478,000, while coat hangers absorbed 7600 tons. Just to keep flies out of the house required that mills produce 23,000 tons of screening. And these figures are for a year of little activity!

THE manner in which small wire necessities roll forth by the ton to satisfy the consuming public is really astonishing, but there are more concentrated uses which consume wire products in a way to defy imagination. A suspension bridge is one of them. When a bridge calls for a single span 4200 feet long, the amount of wire required for suspension is tremendous, and that's what we find in the newest of bridges: the Golden Gate Bridge in California. Here are just a few of the wire items required; a complete list would swamp this article:

The two main cables contain 79,792 miles of wire, weighing 21,392 tons. There are nearly 40 miles of wire-rope suspenders, five miles of wire hand-rail strand, two miles of strand to support electric cable, and two miles of cable for

Wire . . . In Industry, Everyday Life . . . For Man-Sized Jobs, For Tinsel . . . Important New Electro-Galvanizing Process . . . "Tailor-Made" Wires

By **PHILIP H. SMITH**

outline lighting. All this material stays in the bridge, but to erect the bridge takes about 45 miles of wire rope, 50 miles of wire strand, and 237 miles of electric light, power, and signal wire.

These enormous tonnages and mile-ages are difficult to grasp and they serve only to indicate that anything connected

tolerances, and greater uniformity of product. Better machines, vastly improved dies, and higher technical skill have led straight to superiority of product, cheaper because produced more rapidly and, in certain instances, more suitable because made of metals which could not previously be drawn commercially. The import of these gains will become evident if the art of wire drawing is refreshed in the memory so that comparison can be made.

Wire starts in the form of a rod about $\frac{1}{4}$ of an inch in diameter. This rod is pulled through a die to reduce its size, and, after a series of such passes, each making a further reduction, the resulting wire is wound up on a reel. When copper is drawn through the die it is reduced by about 26 percent of its cross-sectional area each time it passes through. In the case of steel, the reduction runs from 20 to 30 percent depending on what type of rod is used. The dies are made of very hard steel or diamonds, the former for large size wire and the latter for fine sizes.



Golden Gate Bridge, where 79,792 miles of wire (in two single cables) support a span 4200 feet long

with this industry is gargantuan. Our particular concern, however, is with the question of what the industry is doing today in the forward march, rather than to prove that it is essential, gigantic, and still growing.

Despite the highly specialized state of the wire industry, there are still vestiges of the rule-of-thumb method of operation. In recent years, rapid progress has been made to establish more scientific control and to this end metallurgists and men with technical training have made contributions. Outstanding in the forward march has been an increase in drawing speeds, the attainment of closer

IN the light of present-day knowledge, there were many things unsatisfactory in the operations of not so many years ago. The steel dies wore off-size so that uniformity in size of product could not be obtained in long lengths. To get a uniform product, the machine had to be stopped, a new die installed, and the process begun again. Also much wire had to be rejected. After the first pass, the wire had to be carried to another machine and then others until the proper reduction had been obtained. This made for much handling and loss of time.

Today's high-speed machine performs multiple operations. The wire passes from one die to the next in a series so that complete size reduction takes place on one machine. As fast as one bundle of rods has been reduced, another bun-

die is welded to the end to give an almost continuous feed. Speed of drawing has been doubled, tripled, and increased even more, depending on the metal being drawn.

If any single thing has made possible this increase in speed, continuous operation, and uniformity in product, it is the improvement in dies. The die is really the heart of the drawing machine. Any failure of the die means damaged or off-size wire and stoppage of the machine. Speed presupposes that the die will "take it" and remain true to size so that the product will meet with specifications at the end of the drawing as well as at the beginning. The advent of cemented carbide dies a few years ago was the great step forward because these dies permit high-speed drawing of large diameter wire; they made possible the drawing of wire literally by the mile, with the sure knowledge that the miles will be all the same and no part need be rejected. When cemented carbides were first introduced it was thought that they would replace diamonds, but the latter still hold their own in dies for fine wire.

CEMENTED carbides necessitated the redesigning of drawing machinery to eliminate vibration, before maximum advantages could be enjoyed. Wire must pass through the drawing machinery at proper tension and the operation must be synchronized with the greatest care. It is obvious that speeds step up with each phase of the reduction—rod speed and finished wire speed are far apart. Not only must these various speeds be controlled but provision must be made for any slippage along the line. Uniformity of elongation is a prerequisite of good wire.

In addition to higher speeds of production and uniformity of product, there is another advantage in modern equipment. It is possible for one man to attend to several machines so that his productivity has been multiplied as many as four times. Then, too, multiple operations save floor space and the amount of handling required.

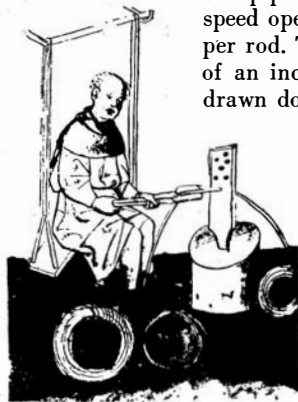
There is, of course, a limit to the length of time wire can be worked in the drawing process, because drawing is really a cold-working operation which hardens as well as increases the tensile strength of metal. Annealing must be resorted to at intervals, depending upon the physical and chemical properties of the metal being drawn. Both pressure and heat are encountered when the metal passes through the die to be deformed and elongated; therefore a lubricant must

be employed. Ordinary soap is the lubricant base and the wire must be carefully prepared before the drawing begins. Steel rods are rusted and then dipped in lime. Copper is dipped in sheep's tallow. Stainless steel, which cannot be corroded so that the lubricant will cling, is coated with a lead alloy to provide a suitable lead lubricating sheath.

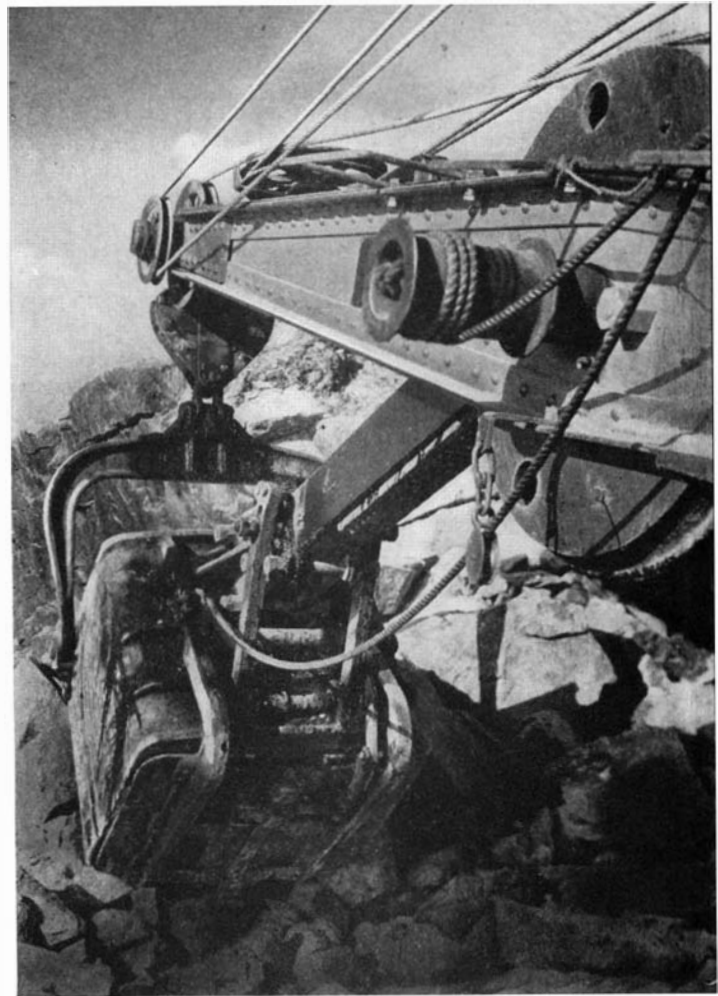
The improvement in drawing machinery and dies has functioned to advance the industry in two ways. It has made possible the cheapening of products to bring them within a wider range of consumers, and it has made the drawing of tough, alloyed materials commercially feasible. Metallic cloth will exemplify the cheapening of a once expensive product. The raw material for this is copper, or aluminum, whichever is the cheapest at the time of manufacture. The copper is drawn to .012 or .013 of an inch in diameter, coated with silver and then drawn again to .002 of an inch and burnished. A similar process, without the coating, is used for aluminum. The finished wire reels up at a speed of a mile a minute. Starting with about 2½ pounds of aluminum, there will be some 30 miles of .004 inch wire 30 minutes later.

Tinsel, likewise, could not be a cheap product if it were not for high-speed operation. Tinsel starts as copper rod. This is drawn down to .012 of an inch, coated with silver, then drawn down to .002 of an inch and burnished. The shiny wire is then rolled flat. Here again, aluminum replaces copper when the cost of the latter rises to a point to make it uneconomical.

The foregoing examples afford some idea of what high-speed drawing means and what an accomplishment it is to be able to take rod and turn it into miles of true-to-gage wire. Wire mills are loath to reveal their best operating speeds for competitive reasons, but their secrets are usually general knowledge. Take .004 inch copper wire as an example. Drawing speeds are customarily between 2500 and 4000 feet a minute; however, some concerns have been able to reach speeds of 10,000 feet per minute and that's close to two miles a minute.



Wire Drawer and Equipment
Germany, A. D. 1421



A man-sized job for wire in the form of husky ropes, controlling a steam shovel for high-speed, dependable operation

Emphasis upon speeds should not cloud the fact that there is another factor of equal importance. High speeds are attained with extraordinarily close tolerances. Without accuracy the speeds would be a liability, resulting in heavy rejections and economic loss. Today an item such as steel screen-cloth wire .010 of an inch in diameter can be drawn with a tolerance of .0003, with a 96.6 percent decrease in rejections over the old-style steel die, and 130 times more poundage can be drawn before changing dies.

CEMENTED carbide dies, being many times harder than the best steel dies, have made it feasible to draw phosphor bronze, other bronze alloys, and stainless steel. Now that they can be had in long lengths at reasonable cost, they are available for such products as screens and meshes where it is desired to use a non-corrosive material. We now find stainless steel wires being tried out for Fourdriniers on paper-making machinery and in the form of rope for ship rigging where resistance to the action of salt water is desired.

Copper is commonly thought of as the one metal suitable for electrical conductors, but there are other metals being used in wires for this purpose. In Mexico and Canada, aluminum is being used for telephone wires. While the conductivity is not as good as copper, aluminum requires fewer poles for support and it

is figured that savings in cost of installation offset the poorer conductivity.

Efforts to obtain wire combining high conductivity with strength have resulted in two products not widely known outside the trade and the technical world. One of these is a combination copper and steel wire; the other a beryllium-copper alloy. The former is not brand new, but has recently attained a commercial success that warrants its mention here. The latter is just coming to the fore.

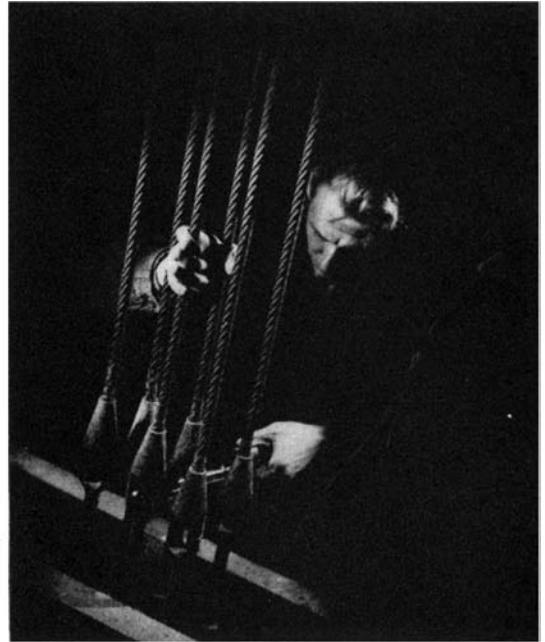
EARLY attempts to combine copper and steel failed because electrogalvanic action took place wherever a poor bond permitted the entrance of moisture. To avoid this hazard the newer process calls for welding the copper to the steel. A beginning is made by placing a cleaned and fluxed billet of steel in a mold, leaving a uniform space between steel and mold. This is placed in a furnace and heated to a high degree, then molten copper is poured into the mold around the steel. The resultant ingot, nine inches in diameter, is hot rolled to form a rod $\frac{3}{8}$ of an inch in diameter, and it is then ready for drawing.

An interesting fact about this process is that the proportion of copper to steel remains the same through the rolling and drawing operations and is, therefore, under strict control. The wire so formed has the strength of steel in its core and the corrosion-resistant properties of copper for its sheath. It can be

used wherever the combination of qualities makes it desirable, and that carries it into a great number of fields. It goes even into barbed wire and fencing where conductivity serves no purpose but where long life is desired.

In striving to obtain greater strength with the high electrical conductivity of copper, research has brought forward beryllium-copper, which is copper containing 2 to 2.5 percent beryllium. Having the best conductivity of any copper alloy, this new product enters into the production of many things. It has been found to be excellent for precision springs and for certain applications it has replaced phosphor bronze.

The development of more and more special wires is only one of several indications that the industry has advanced far beyond the age when wire was a simple product, to enter into a new era in which products must meet rigorous specifications for each and every purpose to which they are put. With the slow passing of traditional ways, the metallurgist has assumed a more important place and demands to know chemical composition, crystal structure, physical properties, and the surface condition or finish. Wire-making control begins with

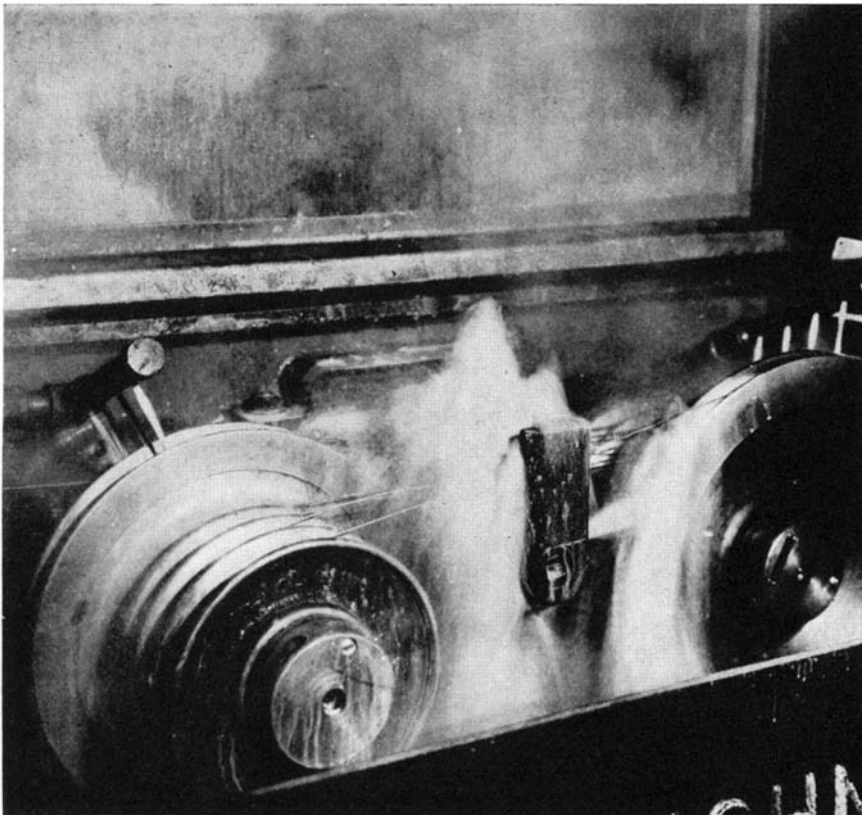


Safe operation of building elevators demands unfailing service from groupings of wire ropes

the billet and is not relaxed until the desired product is brought forth.

Credit for giving the impetus toward more scientific control of manufacture can be given to the automobile industry. It was, perhaps, the first to set severe specifications and to demand that they be met. Automobiles make large use of wire. Valve springs are most exacting in their requirements because they must have proper vibration frequency and withstand severe heat. Every tire consumes about four pounds of bead wire and this, too, is an exacting wire to make. Then there is spoke wire, used in great quantities a few years ago when wire wheels were in vogue. Bolts, machine screws, and rivets begin as wire, and if we accept the wire mills' definition of wire, we must include all cold-drawn shapes.

THE effect of this demand to produce uniform, quality products has to some extent increased specialization where it was already far advanced. There are mills devoted to the manufacture of screen wire and screens; others which make nothing but carding wire for carding brushes. Then there are many highly specialized processes for drawing such wires as tungsten alloys for lamp filaments and molybdenum for thermionic tubes. In recent years there has been an enormous growth in demand for welding wire coincident with the enormous development of welding technique. The 1935 Census of Manufactures tells us that nearly 14,000 tons of this wire was produced, and that does not include electrodes. Almost the only product escaping the newer specialization is nails. There are mills devoted to nail manufacture but for the most part nails are a by-product, being made from re-



Drawing copper wire from rods at the rate of 2500 feet per minute on a continuous machine. One of several wire-reducing dies performing in a cooling bath

jected wire—the scrap of the wire mill. Such use of rejected wire to make an important by-product reduces the overhead charges appreciably, with resulting benefits to the consumer of the primary product.

Even as modern wire manufacture begins with scientific control of the properties of the billet, so it is that research carries through to the very end and the end is the surface finish. This applies particularly to galvanizing, a most important surface treatment, because galvanized wire is consumed by millions of tons annually.

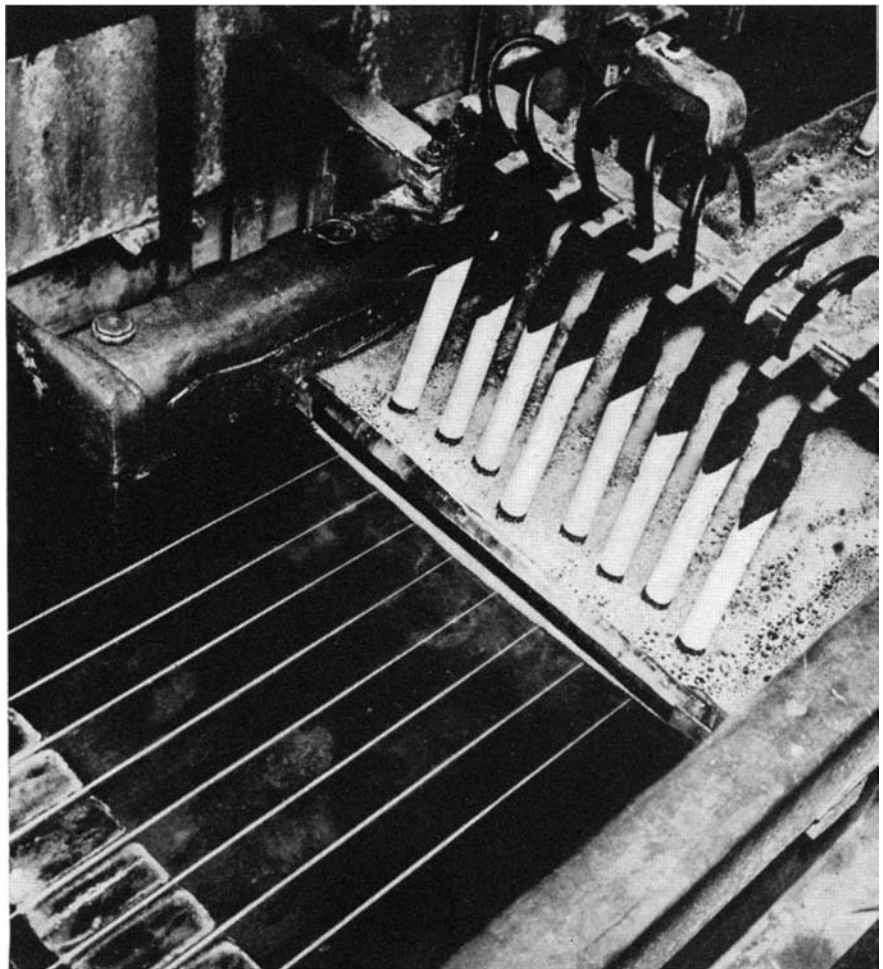
If one were to cast about to discover where the greatest wire mill research activity was centered, it might well be in this field of galvanizing. A few years ago the electro-deposition process of coating wire with zinc became a practical commercial reality and immediately precipitated a host of studies seeking to improve all galvanizing processes. So much work has been done and so many processes have been developed that to describe them all is impossible. Here we can only touch upon the main points and make comparisons between the old and the new.

THE aim of research has been to improve the bond between the zinc and the base metal, and to obtain a more uniform and heavier coating. A defect of the old hot-dipped wire was the tendency of the zinc to separate from the base upon twisting or bending. Such an effect might be produced in weaving the wire into fence. Another weakness was its uneven and impure coating which resulted in ultimate destruction of the wire when exposed to the elements and especially to sulfur gases which are present everywhere. A fence, for example, was no more durable than its weakest point. When attempt was made to increase protection by applying heavier coatings, it could be done only by sacrifice of durability.

There are two paramount requirements for good galvanizing. It is essen-



Flat wire, for which there are many uses, must flex without injury



Electro-galvanizing eight wires simultaneously by passing them through an electrolytic solution. Electrical connections, above, are immersed in the solution

tial that the uncoated wire be in a perfectly clean state to promote the bond, and it is necessary to use zinc of the highest purity. One of the refined hot-dip processes calls for passing the uncoated wire through a bath of molten salts which contain carburizing material to act upon the surface of the wire. The electro-galvanizing process we are about to describe tackles it another way. The wire is cleaned electrolytically by passage through a bath of molten caustic soda.

The electrolytic process is very complex and the product of long research. The raw material is a roasted zinc concentrate, containing about 55 percent of zinc and more than two dozen other elements, present as impurities. The concentrate is fed into tanks of sulfuric acid to make zinc sulfate which is then subjected to several purifying processes and passed to the plating cell, ready for coating the wire.

THE plating cell may handle eight or twelve wires, depending upon its size. A current of 15,000 amperes is used and the density ranges from 400 to 700 amperes per square foot of surface to be plated. The voltage is about four. It is in this cell that the final purifying process takes place, because

as the wire passes through the zinc-bearing solution, supported on glass rods, the zinc alone is carried to the wire by the electrolytic action.

Actually, this newest galvanizing process permits the closest control because the weight of the coating is determined by the speed of the wire moving through the solution, while uniformity of coat is controlled by running at a constant speed. Since very heavy coatings can be applied and still retain ductility and toughness, the product can be used where before only light coated wire was practical, and for purposes hitherto barred.

If one were to examine this process in full detail, study the complex chemistry of it, and see what rigid laboratory control must be exercised to make it work, one would begin to appreciate what scientific research means to the advancement of this industry. Research now permeates the industry to create a new era and there is still much to be done. Just as the steel industry has moved toward the manufacture of special steels for special purposes, so the wire industry perfects its processes to produce "tailor-made" wires.

Photographs courtesy: American Steel and Wire Co., Bethlehem Steel Co., John A. Roebling's Sons Co., and The Vaughn Machinery Co.

LEGS

By S. F. AARON

All drawings by the author

THERE are no characteristics of animal life, however essential to the struggle for existence, that show such a variety of forms as the means of bodily progression. The varied development of locomotory appendages displays the most complete evidence of natural selection. Wings, fins, movable scales, and pliable segments have generally distinct developmental relationships to legs in the vertebrates, but in those creatures without backbones and having external or exo-skeletons (the arthropods, which include the insects), wings are but separate extremities of the thorax.

In the vertebrate animals, wings are nothing more than modified legs, as evidenced by their bony structure. In all animals they are levers of the first and third classes, with the power and fulcrum often very close together in comparison with the resistance. This is most noticeable in the grasshoppers, where more than usual power is required. In the invertebrates, legs are more numerous, in order to give firmer hold on all surfaces, and there is a wider range of uses besides those of locomotion.

The various uses of legs are often surprising to those who have given the subject little attention. Locomotion has probably been a primary cause of development, following which in succession have been modifications made in order to allow for special means of protection. Therefore there has come about, in addition to that of running, the power to leap, climb, strike offensively and defensively, to seize and to trap victims.

IT goes without saying that, as a means of escaping from enemies or in the pursuit of prey, the attainment of leg power has been of first importance, resulting in the perpetuation of many creatures, but not in all cases absolutely necessary. With the higher animals it has reached its present limit of speed probably in the prong-horn antelope, some Old World gazelles, at least one member of the Canidae such as the fox, that notable member of the Felidae, the cheetah, the larger hares, and the ostrich. The jerboas of the Old World, the kangaroo rats of western America, the kangaroos and wallabies and, exceeding all in proportion, the jumping mice, are the champions in leaping. In muscular strength probably the wolverine, the badger, and other members of the weasel

family excel among the mammals, but are hardly more muscular than turtles and tortoises. The squirrels give the monkeys a close race for supremacy in climbing. In these frequent contests, the prizes for which are a full stomach or a continued existence, it may be noted that, however swift the predatory ani-

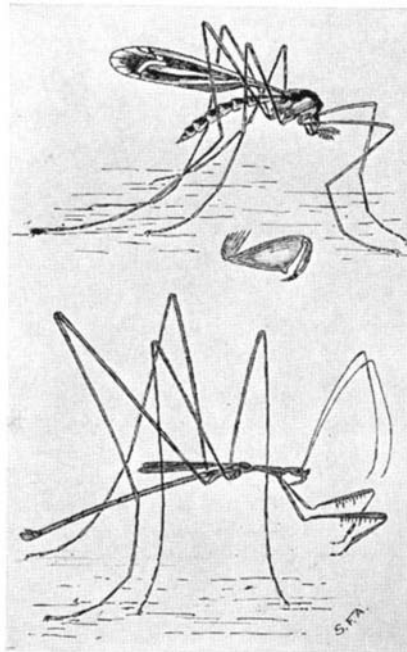


Figure 1. Top: A giant crane-fly, safe above capture by ants. **Center:** Foreleg of ambush bug, able to hold a victim four times larger. **Bottom:** Stilt bug, most slender of living creatures; grasping forelegs

mals have become for the purpose of overtaking their prey, the potential victims have always managed to exceed the killers by a small margin. This is nothing less than self-evident in the nature of development, for a predatory animal may find other means of catching its prey and therefore continue to exist, while speed, at most, may be the only means of escape and perpetuation may depend wholly upon the ability of the hunted creature to get away. Leaping and climbing also carry the same conditions for sustenance and protection; in this also the creatures preyed upon are superior to their enemies.

As a slight digression it may also be here remarked that the same thing holds in speed of wings: many of the birds preyed upon, such as the plovers, snipe,

and sandpipers, the fly-catchers and warblers, many sea birds and the swallows and swifts, by long odds can exceed the hawks and falcons, the speed of the latter having long been exaggerated. Only the swoop of the gyrfalcon and duck hawk, with the frequent strategy of approaching flocks unaware, enable them to overtake swifter victims.

In muscular strength that of the invertebrates so greatly exceeds all the backboneed creatures as to make the comparisons almost ridiculous, but proportionate weight must be considered.

The development of claws for perching, climbing, and seizing victims has been extreme in the evolution of legs, not strangely keeping pace in the case of predacious creatures with the canine teeth—for example, in the cats—and with grasping jaws, as in the tiger beetles. Oddly, it has not proved analogous with, or as showing community of origin with, prehensile tails. For perching, claws have reached their highest development in the woodpeckers and parrots; for grasping, in the hawks, owls, parrots, and monkeys. In climbing, independent of grasping, the squirrels, woodpeckers, nuthatches, creepers, certain warblers, and lizards seem to excel among the vertebrates. With the insects, owing largely to the lesser relative weights, special developments greatly excel, as in almost all species, especially those Diptera closely related to the common house-fly, a few beetles, and the true bees, which have a greatly altered, fan-shaped claw called the pulvillus, enabling the possessor to walk on smooth surfaces and upside down.

THE development of leg muscles must of necessity match the power expended, and nearly always by comparison it indicates relative strength and special needs. The rapacious birds have unusually developed femora for grasping and driving their claws into vital organs, the deadly effect of which cannot be matched by any mammal or other bird. Cats use their canine teeth for killing, as do all carnivorous mammals with or without claws, and thus the birds of prey have a distinct advantage in not endangering their eyes when killing a victim that is capable of giving serious wounds.

Special development for offensive action and in seizing victims, while consisting principally of claws, has resulted in odd peculiarities among the invertebrates; the prey is grasped between the tibia and tarsi, one or both of which are armed with spines for the surer holding of the captive. Examples of this are the praying mantis, certain assassin bugs and that odd form, the Mantispa.

Leg spurs above the feet in certain male birds are both offensive and defensive and, as is well-known, occur among gallinaceous species and some-

times, in modified form, among the females.

Defensive leg development among the insects and their allies generally consists of extreme length, by which the possessors are lifted above the attack of many foes. Examples are the crane-flies (Figure 1), mosquitoes, gnats, the long-horned grasshoppers and walking-sticks, the mantis, the Emesa or stilt-bug, many syrphus and bee-flies, the Meloe and the Spanish-fly among beetles, many non-stinging, parasitic wasps, as well as the ants in general, though some of the latter among the smaller forms have relatively short legs. The solitary true wasps of "the stinging sorority" may be said to use their long legs both defensively and aggressively, as do also many species of ants and notably the ground spiders that spin no web snares, but seek their prey in the true hunter manner, escaping also from such predatory insects as assassin-bugs and Carabid beetles by both retreat and height.

When an ant or an assassin-bug encounters a crane-fly, it finds only several towering, thread-like extremities that mean little in the way of meat or blood juices and the sought-for prey is alarmed and takes its leave. The peculiar stilt-bug above mentioned (Figure 1) has proportionately the longest pedal extensions known, and this is the more remarkable because the body of the insect is also exceedingly long and slender. This perfect defense permits the creature to invade spider webs and to evade the rightful occupant. The stilt-bug feeds on the insects caught in the web before the spider finds them. The

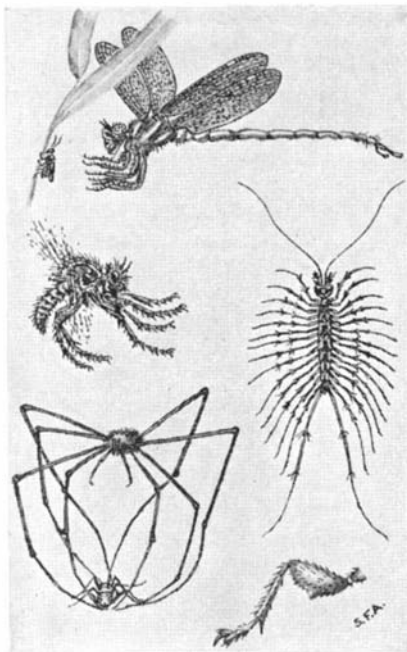


Figure 2: The dragon-fly's insect-catching legs. Robber fly pouncing on a victim. Caging legs of a centipede. Daddy-long-legs snaring its surrounded prey. Leg of boll weevil

bug is doubly endowed for seizing these struggling victims by having its delicate, spiny, pincer forelegs developed as in the mantis.

Among the quadrupeds—and unlike spiders, insects, and millipedes—length of leg commonly means speed and nothing else; there is an exception where another purpose is employed—that in which the giraffe reaches the mid-height foliage of trees, correlating his neck in the act. Among the birds the many exceptions are the waders.

In seizing their prey, predatory vertebrates are especially endowed by extremely powerful adductor muscles aided by the coracoid bone as a brace to afford gripping by the claws.

Used as traps, by the arthropods alone, legs are both specially endowed or are but occasionally so employed. Predatory daddy-long-legs surrounds its prey with its eight long limbs like a cage, drawing them together so that a victim, not very small, finds escape cut off, as from an inverted basket (Figure 2). Scorpions also practice this act and the hunting spiders either do it purposely, or their legs naturally surround the prey upon which they leap. The peculiar attachments of the legs of the dragon-flies (Figure 2) are notable; the thoracic segments holding the three pairs are so proportioned as to bring each succeeding pair below the anterior ones. Thus, all are forward-reaching to about the same length, forming a basket of six claws to encompass small gnats, moths, beetles, and so on, taken on the wing or when perched.

RETURNING to the subject of speed, it is among adult insects and those of medium length of leg that we find the remarkably rapid runners, while those with very long legs are generally slower in all their movements than those with exceedingly short legs. Length of legs, then, is obviously for other purposes than speed, as has already been shown. While ants are swifter than the fastest racing car, in proportion, those of the spiders that travel about move much faster, even when spinning a thread behind them, than ants or ground beetles. The latter, such as the carnivorous Carabids, rival the ants. Roaches also are sprinters of the first rank.

The leg muscles of leaping insects are naturally enlarged, as may be observed among the grasshoppers (Figure 3), flea-beetles, and fleas. There is not the marked difference between the members of the kangaroos and the many mammals that do not leap that there is between the grasshoppers and insects that do not leap. But running seems to be more a matter of muscle and control than of relative size; thus the ants and ground spiders (Figure 3) move far faster than the flies, true bugs, and most beetles, and yet show little or no external difference in leg development. Femoral de-

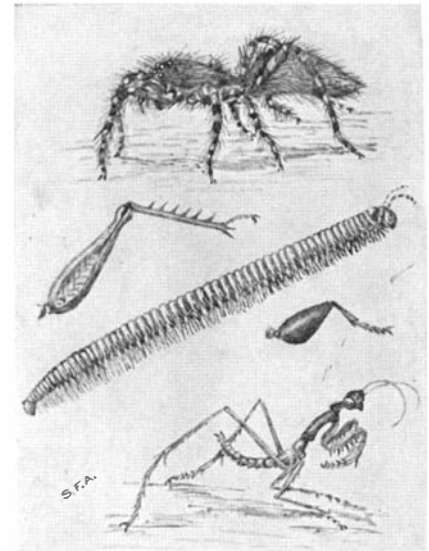


Figure 3: Ground or wolf spider, proportionately swiftest of all running creatures—about 3/4 inch long. Hind leg of grasshopper. A diplopod (thousand legger); though its 58 segments bear 96 pairs of legs it moves like a turtle. Hind leg of flea-beetle, enlarged; its leap is over 200 times its length. Young of praying mantis. Note forelegs

velopment accompanies lifting strength.

Most remarkable concerning leg development is the voluntary release of muscular attachment as a means of escape, common alike with spiders, grasshoppers, a few species of other orders, and not a few lowly vertebrates, such as lizards and salamanders. This is also a characteristic of the caudal appendages of these latter creatures and some snakes. When seized by an enemy, the muscular attachments, often capable of great power, instantly become detached and the enemy is left with but a leg to satisfy its appetite, while the rightful owner escapes, very shortly to grow another leg. This operation has been timed with lizards and it was shown that, within a few weeks, the creature that was bereft of a right hind leg grew and perfectly ossified 26 bones, also as many distinct muscles and muscular attachments. There is less complication in the spider and grasshopper legs, though sufficient to make the rebuilding in even a shorter time astonishing.

Other useful characteristics of insect legs are the spines on the tibia and tarsal joints of insects and their allies, best developed in the leaping Orthoptera: both the long and short-horned grasshoppers. Though their very evident use is apparent, they have not been fully appreciated by many students. These spines are merely aids to the resistance of the leg against any fixed object; they also give the insect a firmer footing, especially when leaping, the spines often catching in grass and stems when the slender tarsal claws, set for perching, will allow slipping.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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D. H. KILLEFFER
Chemical Engineer

MUSICAL REFRIGERATORS

IT has been said that 60 percent of a housewife's time is spent in the kitchen. Now by having a Crosley Shelvador refrigerator with a radio built in its top, the housewife may listen to the radio programs she wants, while she works. Most radios are placed in the living room which is two or three rooms away from the kitchen, and the



Refrigerator-radio combination

housewife either has to miss the program when she is in the kitchen or turn up the radio in the living room so loud that it will ordinarily drive everyone out of the house.

The radio is installed in the front of the refrigerator top, and its dial fits in the space where the escutcheon is ordinarily placed. The dial frame and knobs are all chromium to match the hardware on the refrigerator, yet the radio is in no way connected with the operation of the refrigerator.

LONGEST TOTAL ECLIPSE OF SUN IN 1200 YEARS

THE two ends of the path along which the shadow of total darkness will move in the eclipse on June 9th and 8th are shown in the accompanying chart by the small arrows; the path itself, by the light, broken lines and the elliptical and round spots.

The large arrow shows Enderbury and Canton Islands of the Phoenix group, on one of which the party of American scientists to be sent by the National Geographic Society and the United States Navy will set up their instruments. These islands are the only spots of land directly in the path of the total eclipse at a time of day when the sun will be high enough above the horizon for good observation—roughly between 22 and 23 degrees. At these islands the total eclipse will last about four minutes. Near noon, the total darkness will last for more than seven minutes—almost the longest of possible eclipses, and the longest that has occurred since 699 A.D. But no observers will be able to take advantage of this extraordinarily long period, for the shadow will be 1500 miles from the nearest land.

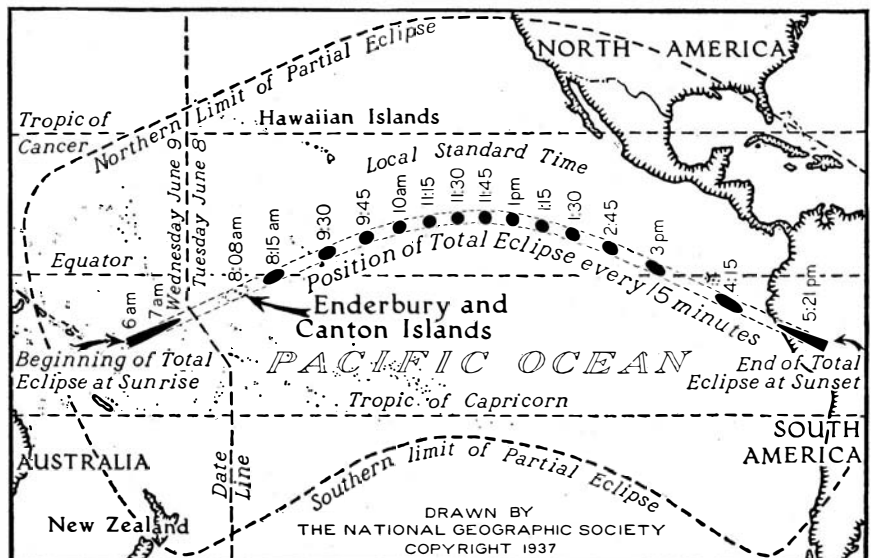
The black spots on the map represent the actual shape and size (to scale) of the shadow, during the eclipse, every 15 minutes, at the standard times indicated above them. The times shown on the map seem to vary from the 15-minute intervals because

the shadow sweeps through nine of the standard time zones, each differing by one hour, into which the earth's surface has been divided for ease in time-keeping. The shadow will cross the International Date Line as shown, early in the morning. As a result of this crossing the eclipse will have the rather uncommon experience of ending the day before it begins.

The unusual duration of the eclipse—more than seven minutes at its greatest—is due to the fact that it occurs near July 1, when the sun is at its greatest distance from the earth; that it occurs at a time of the month when the moon is closest to the earth; and that the shadow falls near the equator.

SYNTHETIC DECANE FUEL

IN the search for fuels to be used in aviation engines of high compression ratios, recent investigations have led to the study of synthetic compounds containing 10 carbon atoms. It has been found that compounds of hydrogen and carbon which contain branched instead of straight chains of atoms are the most efficient constituents of high compression fuels. The iso-octane used as a standard in rating octane numbers of fuels is such a branched chain compound and is known chemically as 2, 2, 4, trimethyl pentane. Recent investigation has shown that the decane containing 10 carbon



Path and time of the total eclipse of the sun, June 9 and 8

atoms, derived from dimethyl ethyl carbinol, is even better fuel than iso-octane when used in engines of very high compression ratios. This compound, which is called isodecane, is presumably tetramethyl hexane. In tests it shows no knocking at compression ratios of 11 to 1, and by the addition of tetraethyl lead its anti-knock characteristic can be extended as high as 13 to 1. (The average compression ratios in present automobile engines is about 6 to 1.) The efficiency increase through the use of such very high compressions is substantial.—*D. H. K.*

AGING ROCKS

RAW cuts through rock in the construction of a highway near Carlsbad, New Mexico, looked too glaringly new, so National Park Service officials applied copperas to give a yellow tinge to the fresh cut rock, and spread road oil over that.

NO ILLUSIONS IN COLOR MATCHING

TO manufacturers of white porcelain products, there are as many degrees of whiteness as there are shades of blue. Many factors difficult to control in the manufacture of porcelain enter into the whiteness of the product, making unavoidable variations in color. Unless all the panels used on a refrigerator or range are carefully matched the difference in color is noticeable to the purchaser.

Many methods for inspection have been employed but the "tunnel of light" recently installed by Westinghouse at Mansfield, Ohio, is the most effective yet used. This room has no corners, employs combination incandescent-mercury lighting with an effective intensity of 114 foot-candles, and is shadowless so that even curved surfaces may be compared effectively against standard colors. This color-matching booth has been termed one of the most efficient lighting systems for color matching in the world.

Previous to the installation of the "tunnel of light," rejects were at least 300 percent higher. During the peak months of 1936, color rejects found on the assembly floor were less than 1 percent.

The room is designed to eliminate shadows and provide a high intensity of diffused, even lighting. If a pencil were placed anywhere in the room, there would be no visible shadow cast from it. None of the inspectors wear anything other than white



Whiteness of white is checked accurately in this color-matching room

uniforms. Every precaution against optical illusions is provided in this modern inspection booth.

The lighting is supplied by 28 300-watt incandescent lamps and 11 400-watt mercury-vapor lamps, making a total of 12,800 watts with an average light intensity of 114 foot-candles. The lamps are so alternated, spaced, and shielded as to give the maximum efficiency. As shown in the illustration, all pieces pass through the booth on conveyors and are compared with three commercial standards. The inspectors are all required to report to an eye specialist for eye tests periodically.

On flat ware, the pieces are checked on the color-matcher which is shown on the table. All panels with large radii, however, are checked with the color standards. The man at the end of the table on the right-hand side checks the enamel for thickness on an electro-magnetic gage. On range parts any enamel that is over .018 of an inch thick is scrapped inasmuch as enamel over this thickness would chip readily not only in the assembly but in transportation and after it had been installed.

"MECHANICAL" STOCK EXCHANGE

A PICTURE of peace, calm, and orderliness is presented by the main trading room of the Stockholm Bourse, or Stock Exchange, where all transactions are carried out mechanically. The brokers sit comfortably in their chairs; desks equipped with push buttons are before them. If they want to make a selling offer, they press a button of one color, and all their fellow members

instantly see the price they ask. If they wish to purchase at a price noted, or offer a different price, another button announces their intention.

All goes quickly and as if by clock work. There is none of the frenzied shouting of other exchanges, where the strongest lungs have the advantage in times of keen bidding. Each bid is registered in its proper order, even if the difference in time of pressing the respective buttons may be but one hundredth of a second.

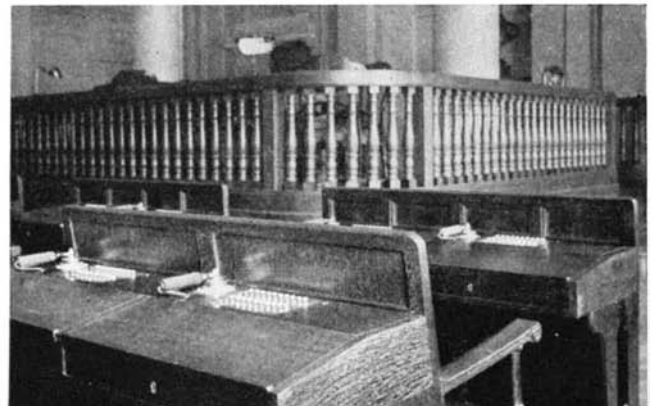
The installation was designed by the Swedish L. M. Ericsson Telephone Company, which has delivered similar models to stock exchanges in other cities. Thanks to this smooth working machinery, stocks valued at about 2,000,000 kronor change hands each day, the average yearly turnover being 600,000,000 kronor.—*Holger Lundbergh.*

IMPORTANCE OF HUSH-HUSH PLAGUE

THE seriousness of syphilis from a dollars-and-cents standpoint has been proved in Fulton County, Georgia. A study of syphilitic and non-syphilitic persons on the relief rolls of that county has been made with federal funds, and Dr. J. G. McDaniel of Atlanta reports the results in the *Journal of the American Medical Association*.

About 34 percent of the Negroes and 7 percent of the white persons on the county relief rolls are syphilitic. Of that number 17 percent between 20 and 40 years are not able to do competitive work. Sixteen percent of those past 50 years are not able to work at all.

The Fulton County study showed a sud-



Mechanical bidding in a stock exchange. Left: The board on which bids appear. Right: The members' push buttons



Night view of a parachute tower in Chicago, where over 70,000 persons made safe drops in a single season

den drop in the number of the syphilitic between the ages of 39 and 60 and over. This rapid decrease means one of three things, according to Dr. McDaniel—the people died, have been treated, or are not able to report for examination.

No orderly train of symptoms could be found resulting from syphilis in the Fulton County study.

“There is no disease that I know of, found among such large numbers, that responds so beautifully to treatment as does syphilis, nor can I think of one that has a longer latent period before serious symptoms manifest themselves, thereby affording a golden opportunity for diagnosis and cure or at least an arrest of the ‘disease,’” Dr. McDaniel states.—*Science Service.*

TRAINING FOR PARACHUTE JUMPS

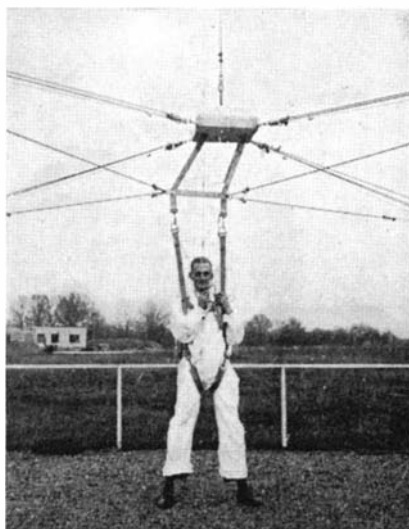
THE Commanding Officer of the Lakehurst Naval Air Station gave an excellent rating to parachute jumping towers for training men in this difficult activity. Accordingly, we have secured a first-hand account of this novel device and its uses from the President of “Safe Parachute Jumps Company.”

In military or naval aviation the parachute is regarded as an absolutely indispensable safety device, yet training in parachute jumping is haphazard, and the average pilot is apt to know but little regarding the ‘chute. The parachute is something to be strapped on with a harness, the rip cord something to be pulled after making a jump. That is perhaps the sum total of his knowledge. How to land correctly with a ‘chute and how to avoid injury in so doing are mysteries to the novice. Instruction is apt to be confined to the reading of printed instructions and the mind of the jumper is likely to become confused when the critical moment arrives. When more intensive parachute training is attempted, by a pull-off or free jump from a plane or a “blimp,” there are hazards and expense.

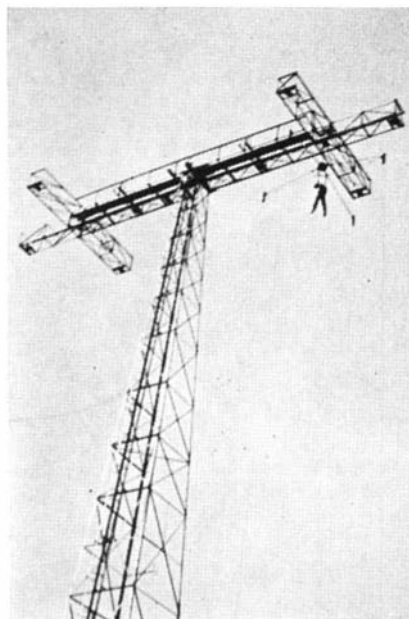
With these thoughts in mind, James H.

Strong spent more than two years in developing a system of training which would be free from these objections, and finally developed the parachute tower and specially devised guides.

The parachute tower, as illustrated in our photographs, is 250 feet in height. From cross arms at the top of the tower vertical guide cables extend to the ground. A large size parachute is secured around its skirt to a spreading ring, so that the ‘chute is kept permanently open. The ring, in turn, is secured to fittings that move up and down the guide wires. In the peak of the parachute a special fitting engages the ‘chute with a



Harness and hoisting rig



Ready for a drop

hoisting hook, centrally located with reference to the guide wires. Below the parachute the regular harness is replaced by a very comfortable swing. With this simple yet entirely effective apparatus, the training proceeds in four phases.

First Phase: The student sits in the swing with his feet well off the ground. He is strapped securely into place, and hoisted with his parachute to the top of the tower. Then the parachute is either detached manually by the student from the hoisting hook or is automatically released. As the fabric is

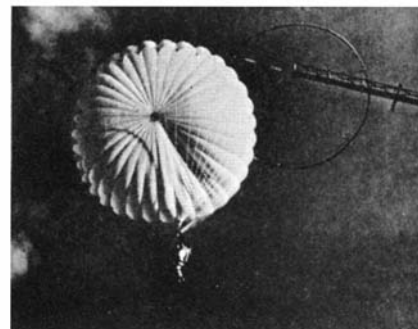
spread out by the ring, the ‘chute fills with air immediately, and supports the student comfortably on the descent. Just before the ground is reached, arresting and shock-absorbing gear comes into play, and stops the downward movement of the swing in gentle fashion. The occupant’s feet never come into contact with the ground. The student soon realizes that because the parachute is permanently open and because of the absorbing gear, he is at no time in any danger whatsoever. The first ride or ‘drop is a sensation. After a few drops the novelty wears off. The student begins to study the rate of descent and to estimate exactly when he would strike the ground if he were wearing a harness. Soon he is ready for the second phase.

Second Phase: Now the swing is replaced by a regular harness, and the student learns to relax and to cushion or “shock-absorb” his landing with legs and feet. Several drops in this fashion teach him the lesson thoroughly.

Third Phase: Here a tower is employed, provided with a rotating boom, which is “trimmed” down wind. The hoisting cable passes over a sheave at the outer end of the boom, so that the ‘chute is at a maximum distance from the tower. The peak of the ‘chute is still engaged by a hoisting ring, and the skirt still secured to a spreading ring. But in this phase of training, when the ‘chute is released, it trips itself clear of the spreading ring, drops through the ring in a “filled” condition and drifts down wind, clear away from the tower. With his previous experience, the future member of the Caterpillar Club is able to take full advantage of this third phase, which gives him precisely the experience of a jump from an airplane but with far greater safety. The instructor stands at the bottom of the tower and notes errors. The student rapidly learns how to land correctly and safely.

Fourth Phase: Now the student drops with a closed pack, instead of the open ‘chute, and can pull the rip cord within a fall of 75 feet. When the rip cord is pulled, air fills the ‘chute, and the shock load is taken on the canopy but, because of a special harness, not by the jumper. The descent thereafter is perfectly normal. If the jumper does not pull his rip cord within a fall of 75 feet, automatic safety features come into play. After several jumps of this nature, the student learns how to time the rip cord so as to open the ‘chute when it is clear of all obstructions. He is now thoroughly ready to jump from a plane or a “blimp.”

There is not the slightest doubt that this training removes physical danger, but, what is more, it robs parachute jumping of its attendant fears. It is not surprising that the



An open ‘chute after it has been tripped clear of the spreading ring

navy men at Lakehurst are all being given this form of training, nor is there any reason why civilian pilots should not take advantage of the same training system.—A. K.

RADIO SIGNPOSTS FOR THE AIRPORT

A NEW radio range system, providing positive radio identification of airport location, has been developed by United Airlines and placed in service in several cities on its transcontinental airway.

The radio localizer, which is shown diagrammatically in one of our illustrations, uses a novel triangular “umbrella” type antenna. The localizer beam intercepts the regular radio beam some thirty miles from the airport and provides identifying code signals. The pilot follows the local beam till he is directly over the landing field. It is claimed that the triangular shape of the antenna eliminates any distortion of the path of the beam by weather conditions. At the same time, the new beam does not interfere with voice transmission.—A. K.



Artist's drawing of a new radio range system for aircraft

THE CASE FOR THE BESPECTACLED PILOT

THE pilot with spectacles finds it hard to get a job. Yet Francis Chichester, writing in the *Aeroplane* (London) makes a strong plea for their usefulness. In a closed cabin machine the difference between a pilot with perfect eyesight and one whose eyesight is made perfect by wearing glasses is evidently nil. In open cockpit flying, Mr. Chichester thinks that the flier accustomed to wearing spectacles actually has advantages over the pilot who needs no glasses, because (1), he is accustomed to wearing spectacles and will therefore handle goggles more efficiently; (2), in bad weather water is just as distorting on goggles as on spectacles, but where goggles fog spectacles rarely do so, and a pilot can look out of a cockpit at 150 miles per hour if his eyes are protected with spectacles; and (3), shortsighted pilots see better in the dark.

We do not necessarily agree with all of Mr. Chichester's arguments, but there is evidently hope for the shortsighted man who wishes to make flying his career.—A. K.

TRANSPARENT MATERIALS IN AIRPLANE CONSTRUCTION

GLASS technology has made great strides of recent years. Once upon a time we used to think of glass as just glass,

and took no particular interest in its physical qualities. Now we know that there are available sheet glass, plate glass, laminated safety glass and tempered glass, and also a number of plastic materials which are a most excellent substitute for glass itself.

Glass is six times as strong in compression as in tension. That is why the portholes of our ocean liners are curved on the outside. They are then much stronger than would be flat windows or windows curved inwardly. When we build the supercharged cabins of the future, with a higher pressure inside the cabin than outside the cabin, the question of glass strength will have to be carefully considered. With tempered glass, the thickness of a 15-inch diameter circular port will be about $\frac{3}{8}$ of an inch. Ordinary glass would have to be $\frac{3}{4}$ of an inch thick, with a corresponding increase in weight. Soundproofing has to be considered with reference to windows; it is of little use to soundproof the walls of a cabin if the glass windows let noise through, and windows should be of laminated glass with a stiff plastic sheet at the core. Glass can also be curved in many ways, an essential

requirement for the airplane cabin windshield.

The plastic substitutes for glass are strong competitors of the glass itself. A material such as “Plexiglas” has great toughness, strength, and a permanent colorless transparency. A photograph supplied by Röhm & Hass, the manufacturers of this material, shows how this material may be appropriately curved. The photograph of the Bellanca racer shows a beautifully curved windshield and complete cockpit enclosure for the pilot.

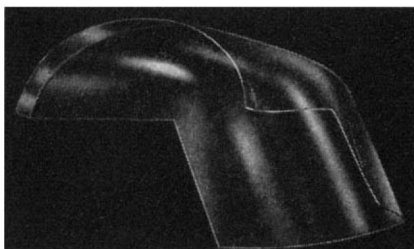
We never cease to marvel at the way in which all branches of technology are drawn into the service of aviation. Of course, aviation renders a reciprocal service to technology by postulating new and severe requirements in materials and manufacturing methods.—A. K.

AVIATION IN THE PUBLIC SCHOOLS

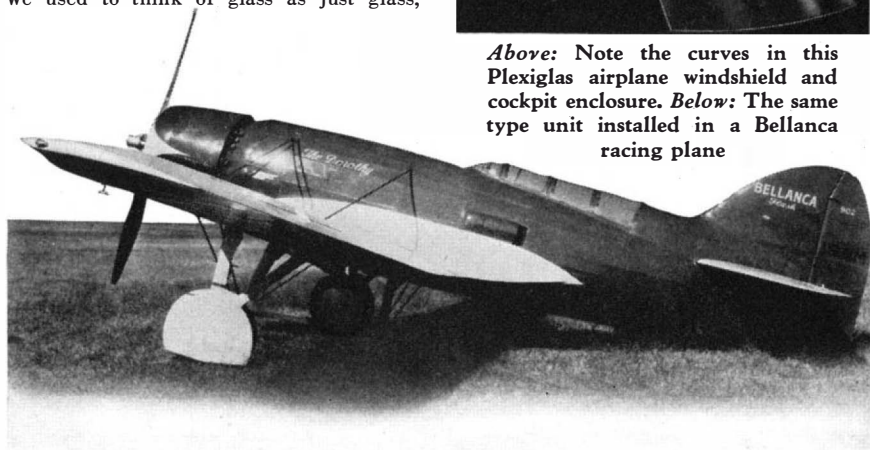
BECAUSE of the immense public interest in aviation, a great many of our public schools are teaching this subject in some manner or other, but we are not quite sure that this fashion in education is fully justified. Why not, for example, teach railroad engineering or naval architecture in the public schools? These subjects are not so novel or romantic as aviation, perhaps, but they are just as important in the life of the nation and just as capable of serving as a medium of instruction in applied science.

One very good reason why aviation should not be too highly stressed in the public schools is because the tendency is to imbue every bright boy with the idea that aviation may be his career, whether as a pilot or as an engineer. Thereby the pressure of young men seeking employment becomes too great even for this rapidly growing industry.

On the other hand, aviation is a fine medium of instruction in applied science, physics, mathematics, and in handicraft. Nothing brings out the wonderful possibilities of aviation in this regard more than the pamphlet entitled “Aviation in the Public Schools,” by Robert W. Hambrook of the United States Department of the Interior. A small three foot diameter tunnel can be readily built on principles identical with those of the large scientific tunnels—in fact we know of several schools where teachers



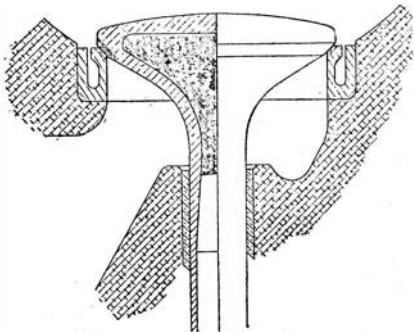
Above: Note the curves in this Plexiglas airplane windshield and cockpit enclosure. Below: The same type unit installed in a Bellanca racing plane



and boys have co-operated successfully in building such tunnels. In such a small tunnel all the basic aerodynamic experiments can be performed, not with great accuracy but in perfect qualitative fashion. If a school has a class in woodworking, it is much more fun to build flying models than dull pieces of carpentry such as a book case. In some schools the boys have built and flown their own gliders. In the vocational high schools, fine instruction is given, fitting young men for work as airplane engine mechanics. Obsolete equipment such as planes and engines can be obtained by recognized schools on "indefinite loan" from the Army and Navy Air Services. So, with the above reservations still in mind, we cannot but admire the splendid and varied work in aviation that our public schools are undertaking.—A. K.

FLEXIBLE VALVE SEATS FOR AIRCRAFT ENGINES

THE valve seats in modern aircraft engines are made of the finest materials and are shrunk-fitted into the aluminum head with the greatest care and skill, but



The new flexible valve seat

the exhaust valve seat operates, of necessity, under very high and uneven temperatures. Such conditions produce valve-seat distortion, and the consequent valve leakage is one of the major causes of exhaust-valve burning in aircraft engines of high specific output.

Messrs. Heron and Beall, in a paper presented before the Society of Automotive Engineers, suggest a remedy, after four years' intensive research, in the form of a flexible valve-seat insert. As can be seen from the drawing the ring-shaped valve seat is made of such a form that the lip carrying the seating material proper (austenitic nickel-chromium valve steel) can yield radially outward under the valve pressure. In the conventional valve seating there can be no such yielding. This yielding should eliminate the bad effects of distortion, and the device should prove very useful.—A. K.

ROCK OF GIBRALTAR ON WHEELS

ONE look at the new "rolling fort" of the Milwaukee Police Department should be enough to deter anyone with ideas about starting a riot, for this armored car is intended to be driven into a mob and used as a base of operations by the 25 policemen carried in it.

Built by Erlinder-Platt Body Corporation, the car is fully armored with aluminum and glass; convenient gun-ports are provided on all four sides, and novel wheel "pants" can

TRANSPORTATION SECTION

be let down to the ground to protect the tires from gunfire. The lower edges of the body are rounded to prevent a crowd from overturning the 6800-pound car.

The outside skin is thin steel, under which are felt, hardwood, and finally a ¼-inch thickness of aluminum alloy. The glass is 1¼ inches thick and proof against bullets from side-arms and machine guns. A heavy steel shutter protects the radiator from bullets and damage, and the engine is housed entirely within the bus to prevent tampering by a mob.

SHIPS MUST HAVE SMOOTH SKINS

SMOOTH outer surfaces for steamers is not a matter of beautifying, but a technical and economic requirement. It is only in recent times that we have acquired more accurate knowledge of the decisive influences of friction-resistance and a rough outer surface on the speed and commercial value of any vessel. All this was clearly set forth in a lecture recently given by Prof. Dr. G. Kemp, Director of the Hamburg Shipbuilding Research Station.

In connection with experiments made at the Göttinger Institute of Aeronautics, observations were made by testing the effects of various degrees of roughness on surfaces covered with sand of different degrees of coarseness. Certain general rules could be laid down, from which Professor Kemp was able to make tests at the Research Station and also on board several vessels, with respect to the resistance created by roughnesses on the ship's outer surfaces, including bent plates, uneven seams, and projecting belts and rivets. The astonishing result of the tests was that such roughness on the surface increased the resistance no less than 35 percent, even when the vessel was brand new, over that which would be experienced by a ship whose sides were absolutely smooth.

Therefore, a ship which has just been

launched, makes about 1½ knots less if her outer hull is not smooth. In practice, this roughness also adds to the tendency for mussels, seaweed, and rust-spots to accumulate and increase, gradually damaging the ship's paint. The amount of sailing time lost in this way was also accurately estimated by Prof. Kemp, so that as a result of his scientific researches and experiments, the importance of having the outer surfaces of ships absolutely clean and smooth can readily be seen.

RAILROAD BUYING

PURCHASING of fuel, material, and supplies by Class 1 railroads in the United States during 1936 totaled 803,421,000 dollars. This represents an increase of 35.5 percent above the purchases for 1935 and the total was greater than any year since 1930.

TIRES AND ROAD SURFACES

THE tire engineer's life is just one problem after another. As soon as he builds a satisfactory tire, which is no easy task in itself, something else pops up to challenge him. Now comes a certain type of corrugated road construction to provide new worries.

This particular type of road is made by roughening the surface to give a better skid resistance for automobile tires. In many cases the roughening is done by running a cleated wheel over the road. The wheel leaves a pattern of rough marks at regular intervals. Now, this is well and good from the standpoint of safety, but these regular corrugations in the road surface cause vibration and noise as the car goes over them.

This situation has aroused considerable interest among tire engineers of United States Rubber Products, Inc. Having given



A veritable rolling fort is this latest police riot car

“We’re
living again
—thanks
to music!”



TIME AND AGAIN *Hammond owners have written us letters like this one:*

“I am not a professional organist. I played the piano a little before we got our Hammond, but the simple melodies in my repertoire sound so full, so satisfying on the organ.

“We wouldn’t be without our Hammond for anything—it’s our relaxation—our hobby—we’re living again—thanks to music!”

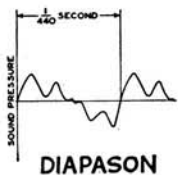
You too can experience the joys found in this new world of music—organ music. Right in your own home you can have a Hammond Organ occupying less space and costing no more than a good piano. If you like music and can play the piano even just a little, the ownership of a Hammond can lift you and your family out of the depths of an ordinary existence and launch you into a new world.

The leading music dealer in your community is probably a Hammond Organ specialist. Besides

selling Hammond Organs, he sells a line of high grade pianos and other musical instruments. He is an authority on musical merchandise and the proper use of it. Spend a half hour with him and let him tell you how a Hammond Organ in your home can bring you joy and contentment.

The Hammond Organ, 2943 N. Western Ave., Chicago

Science creates the ideal musical instrument



Helmholtz’ Law of Tone Quality contains the simple principle on which the Hammond Organ is based:

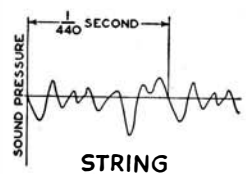
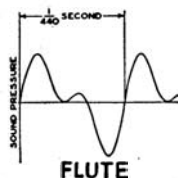
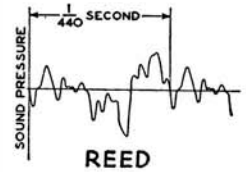
The characteristic auditory quality of a musical tone—flute, violin or any other—depends solely upon the number of harmonics in the tone, and the strengths of these harmonics relative to the fundamental note.

A number of widely different musical tones are described graphically here. Each of these tones is the same *pitch*, since each repeats its wave pattern 440 times per second. But the number and strength of the harmonics, or overtones and subtones, mixed in each are very different—which is why the tones *sound* so

different.

In the Hammond Organ, which creates all its lovely tones by *electrical impulses* instead of by air pressure, Helmholtz’ basic principle of tone construction is applied practically. Through simple controls, the organist can mix his fundamentals and harmonics as an artist blends colors. He can duplicate the musical tone of almost any known instrument—or he can create an almost infinite number of *new* tone colors, never before heard by the human ear!

Thus in the Hammond Organ science has created the Ideal musical Instrument—one that contains, potentially, the entire cosmos of audible music.



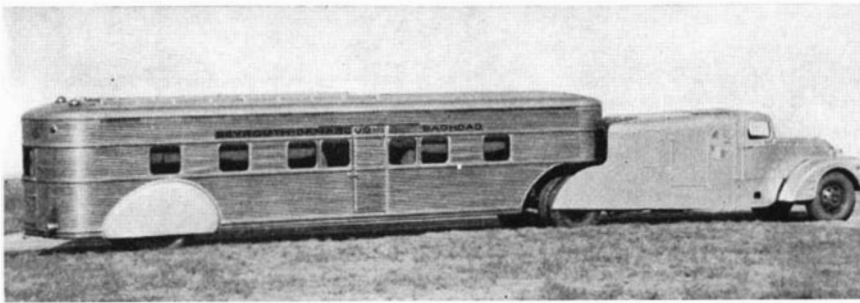
THE HAMMOND ORGAN

THE HAMMOND IS THE LARGEST-SELLING ORGAN IN THE WORLD

\$1250

and up f.o.b. Chicago—slightly higher for large installations.

In Canada—address Northern Electric Co., Ltd. Montreal



The desert has no terrors for the new type desert trailer shown above. Constructed by the Edward G. Budd Company for the Nairn Transport Company, Ltd., this trailer, which will be used for travel in the Syrian desert, utilizes the same principles of construction incorporated in modern light-weight trains. It is of light-weight, stainless steel construction, has a capacity of 14 passengers, and is powered by a 150-horsepower Diesel tractor. Weight is 28,000 pounds, speed on the desert 65 miles an hour. The illustration below shows the comfortable dressing room and the lavatory, photographed through the rear door of the trailer

quietness to that company's tires, they believe they also have a solution for the road problem. Furthermore, they believe that the solution is similar to the one they used in reducing tire noise. They found, in their research on tires, that much of the tire noise came from the regular impact of the tread blocks against the pavement. They reduced this noise by arranging the spacing of the tread blocks to break up the regularity of the impacts.

Therefore, they offer the theory that irregular spacings of the corrugations in road surfaces may solve the new obstacle to the quiet operation of motor cars. They point out that by a slight staggering of the road marks in a systematic manner it will be possible to break up the impulses transmitted to the car and greatly reduce the noise which now exists. And they predict that when both the road surface and tire treads have these irregular spacings, the whine or "pitched" noise which comes from regular impacts will be entirely eliminated.

UNDER THE MEUSE

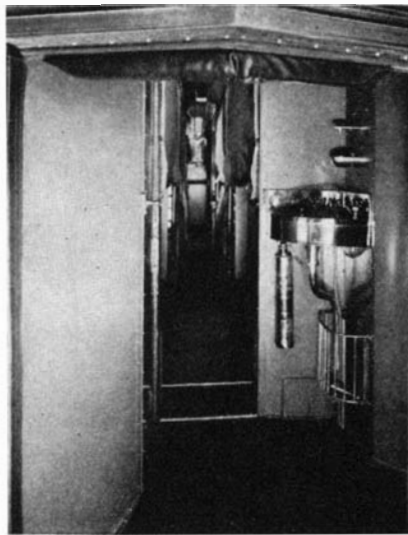
HOLLAND is to build a vehicular tunnel under the river Meuse with lanes for automobile traffic, bicyclists, and pedestrians. Its cost will be 7,500,000 dollars.

NEW HIGH-PRESSURE LOCOMOTIVE TYPE BOILER

WHAT is thought to be the first high-pressure boiler ever made with welded barrel and dome, under U-68 (Class I) rules of the A.S.M.E. Code for fusion welded vessels, was recently completed by Farrar and Trefts, Inc., of Buffalo.

The new boiler is of locomotive type and is for use in oil fields. The barrel, shown in the accompanying illustration, is 16 feet 6 inches long, 62½ inches outside diameter, and made of steel plate 1.15 inches thick, electrically welded by the shielded arc process with equipment supplied by The Lincoln Electric Company.

Welded construction of the barrel eliminated a large amount of caulking of seams which was necessary with the former method of construction employing riveting. The manufacturer reports that the seams remain



permanently tight in the field, thus assuring freedom from maintenance. The two longitudinal welds of the barrel were hammer tested at 575 pounds and leak tested at 700 pounds hydrostatic pressure, revealing high quality leak-proof seams.

HIGHWAY FOUNDATION AND SURFACE FAILURES

HIGHWAYS safer and more durable through improved design and construction—particularly in better soil founda-

tions—are pictured for the future by Thomas H. MacDonald, Chief of the Bureau of Public Roads. Improvements can be attained by more use of present knowledge, he says, as research continues to arm the engineer with more information about highway materials.

Like any durable structure, the highway must be built upon a firm base. In the past, attention has been focused upon adequate drainage and hard, all-weather surfaces. The soil foundation upon which the surface is placed merits, and in the future will receive, more attention.

A test road, built by the Bureau of Public Roads and the South Carolina State Highway Department, after seven years confirms previous evidence that poor foundations, more than type of surface, are a prime cause of surface failure. The test road, 20 miles in length, was surfaced with bituminous-treated local materials. Construction methods varied on different sections of the road.

Where the foundation failed it was found that only by replacing unsatisfactory materials with stable materials or by providing better drainage could failed areas be permanently improved. Mere substitution of a new surface for the old one was but a temporary cure.

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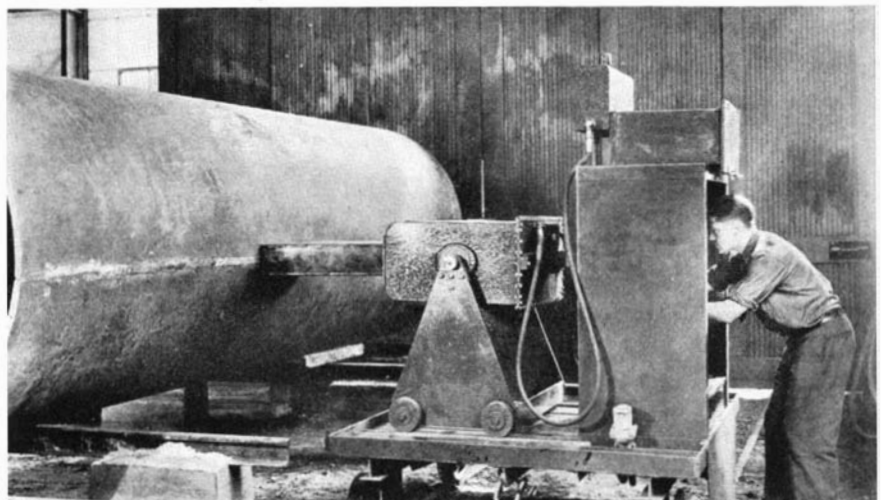
"LIE DETECTOR" USEFUL ONLY IN EXPERT HANDS

THE "truth about the 'lie detector'" has been disclosed by Prof. Christian A. Ruckmick of the University of Iowa, who conducted in his laboratory experiments to determine usefulness of this electric instrument often used for crime detection and for obtaining confessions from suspects.

Clever witnesses can fool the machine, Professor Ruckmick has found. But clever operators of the machine can also detect these efforts at evasion, reports *Science Service*.

In the hands of an expert who understands thoroughly the workings of the human mind and who is able, in interpreting the records of the lie detector, to make allowances for wide natural differences between the excitability of different individuals, this technique should prove valuable for crime detection, Professor Ruckmick concluded.

But this instrument is not as reliable for



Examining a welded seam of the barrel of the boiler described at left

HERE'S ALL IT TAKES *to get full engine power as you stop wasteful "knock"*

Just two easy steps bring you all the economy and performance offered by modern high compression cars . . .

1. (Below) Practically all modern high compression cars have an adjustable spark for the octane (anti-knock) quality of the fuel used. "Knock" can be eliminated by retarding the spark, but the result is loss of power, sluggishness, danger of overheating and waste of gas and oil. To take full advantage of your high compression engine, have your car dealer adjust the spark for *maximum* performance. It takes only a minute or two, and then . . .



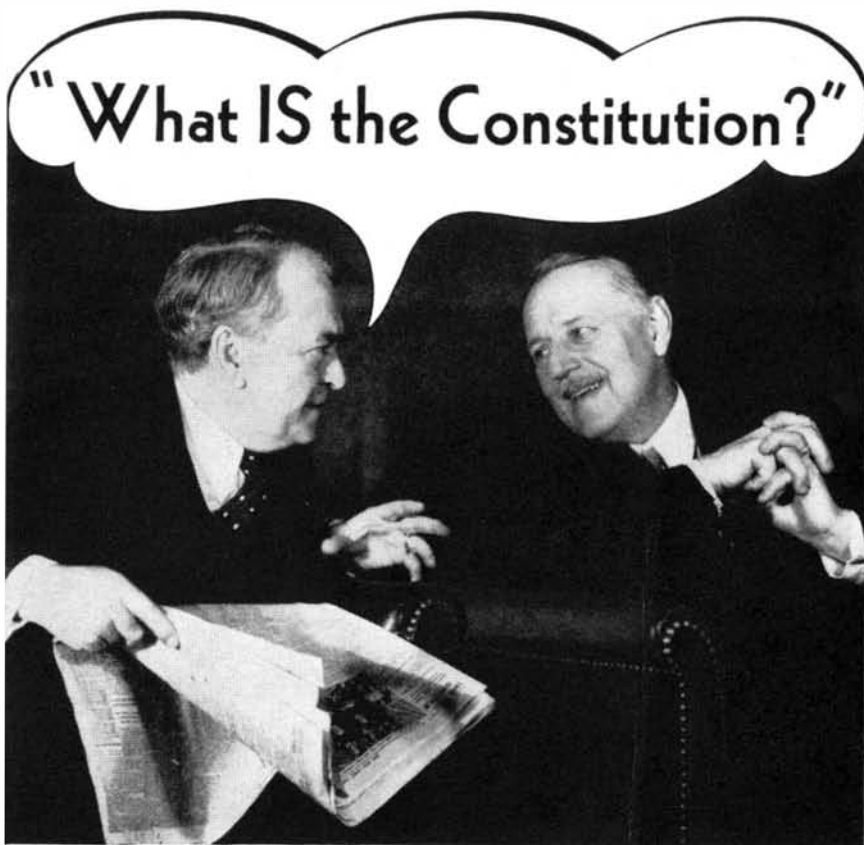
2. (Above) Use Ethyl! Your high compression engine, with its spark properly adjusted for maximum performance and with Ethyl in the tank, will give you the fast acceleration and the generous reserve of power it was meant to give. Ethyl is at least six octane numbers higher in anti-knock value than any regular-grade gasoline—and what a difference that extra anti-knock value makes in the engines of modern high compression cars!

Here's the EXTRA value you get at the ETHYL pump:

1. You get more anti-knock fluid (containing lead tetraethyl) at pumps marked "Ethyl" than you get in the best regular-grade gasoline.
2. You get the all-round quality (including quick starting) that is *double-tested* by the oil company and by the Ethyl Gasoline Corporation.
3. You get 100% performance from your high compression engine.
4. You save on oil as well as gas by preventing overheating.



NEXT TIME GET ETHYL . . . A BETTER RUN FOR YOUR MONEY



Today, the Constitution of the United States is news, vital news. To change—or not to change—that is the question. It is on the lips not only of legislators, lawyers and jurists but of citizens everywhere. But before we can intelligently decide whether the Constitution needs changing and how to change it, we should know what it is, its basic purpose, how its founders intended it to operate. To meet this need, The Christian Science Monitor will publish a series of articles—

1787—Making the Constitution—1937

May 20 to September 18

Tully Nettleton, the writer of this series, travels back 150 years to cover the events of the Constitutional Convention as if they were happening today. You read about George Washington, James Madison, Benjamin Franklin, Gouverneur Morris and other early leaders—how they discussed, and analyzed, and reasoned, and finally worked out the Constitution that bound the thirteen states into a nation.

The articles will appear as day by day accounts, on approximately the same day of the month that the events described took place 150 years ago. The series will be the equivalent of virtually a full length book by a writer who has made long and diligent research into available records. It comes to Monitor subscribers at no added cost. Four months subscription at the regular rates brings you all the articles. Subscribe for the entire period or a month at a time. For convenience, you may use the coupon below.

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purposes of identification as either facial photography or fingerprinting, he warned, and therefore becomes a dangerous weapon in the hands of any but the most competent persons.

"The situation is in the same category as are many other techniques including mental testing," Professor Ruckmick said. "Only those who can see beyond the actual scores and interpret these scores in the frame of the individual mental life are competent to pass judgment."

A NEW USE FOR HEAVY WATER

IN speculating about the future, Professor James Kendall of the University of Edinburgh, Scotland, suggested in a recent interview that old age may be made much more comfortable in the future by slowing down a person's chemical reactions by generous use of heavy water. As a speculative possibility this has a sound scientific basis whether it will ever be realized or not. By substituting hydrogen having an atomic weight of 2 for the customary kind, whose atomic weight is only 1, in the fluids of the body, it should be possible to reduce materially the rate of chemical reactions which characterize life. In other words, as a person approaches the period of inactivity of old age his metabolism can be made slower to meet his requirements and thus avoid too rapid body functioning.—D. H. K.

WARN CHILDREN AGAINST PLAYING WITH "DRY ICE"

DON'T let children get hold of dry ice, warn Drs. Max L. Som and A. Harry Neffson of New York City. One of the popular neighborhood diversions is to beg or buy some carbon dioxide snow and to put a small piece of it in the mouth. Then the child will blow off "steam."

These two physicians report the case of a seven-year-old boy who swallowed a piece of dry ice, in the *Journal of the American Medical Association*. The boy is all right today, but it took a great deal of medical treatment and surgery before the damage was repaired.—*Science Service*.

PLANT PREFERENCES IN WAVELENGTHS

GROWTH of plants, upon which all life ultimately depends, requires the absorption and assimilation of carbon dioxide from the air under the influence of light. This is the basic physio-chemical reaction of all life. The assimilation of carbon dioxide takes place throughout the entire range of visible light from the deep red to the violet, but like the eye, a plant is more sensitive to some colors than others.

By use of the Christiansen filter, an instrument which makes possible plant illumination with color bands between very narrow limits of wavelengths, Mr. W. H. Hoover of the Smithsonian Institution has studied the effects on photo-synthesis of the constituent wavelengths of the entire visible spectrum. He finds that there are two points where the effect of illumination is greatest. One is in the deep red, centering around the spectrum line of hydrogen at a wavelength of about 6550 Angstrom units, and the other in the blue centering around the wavelength

of 4400 Angstrom units. An Angstrom unit is a ten-millionth of a millimeter and is the unit most convenient to use in measuring the wavelength of light.

Green light, Mr. Hoover found, is rather poor in its efficiency as an agent of photosynthesis. This was to have been expected, since the carbon-dioxide assimilation requires the absorption of the light by the molecules of the green coloring matter of the leaves, chlorophyll. A large percentage of the green light is reflected by the green leaves, which is why they appear green to the eye. Little of it is absorbed.

Mr. Hoover found that the photo-synthesis effect begins at the very limit of the visible red, just as it verges into the invisible infrared. On the other end of the spectrum however, a slight effect is found just over the limits of the ultra-violet, which is invisible to the human eye.

As a result of the experiments, the 655 and the 4400 Angstrom-unit lines of light appear to be the dominating factors in the basic phenomenon of life.

POWER

STEAM power plants in the United States burn about the same amount of coal now that they burned in 1920 but they generate twice as much electricity with it. The use of high-temperature steam with a resulting higher operating temperature for the turbine is partially responsible. A modern turbine shell runs, almost literally, red hot.

**NO MORE SHEEP'S WAILS*
AS OFF COME TAILS**

SHEEPMEN in the Uvalde section of Texas are using rubber bands instead of surgery to bob lambs' tails, according to information received by The B. F. Goodrich Company.

The newest method of tail bobbing involves only the tight application of a rubber band in the right location to stop circulation.

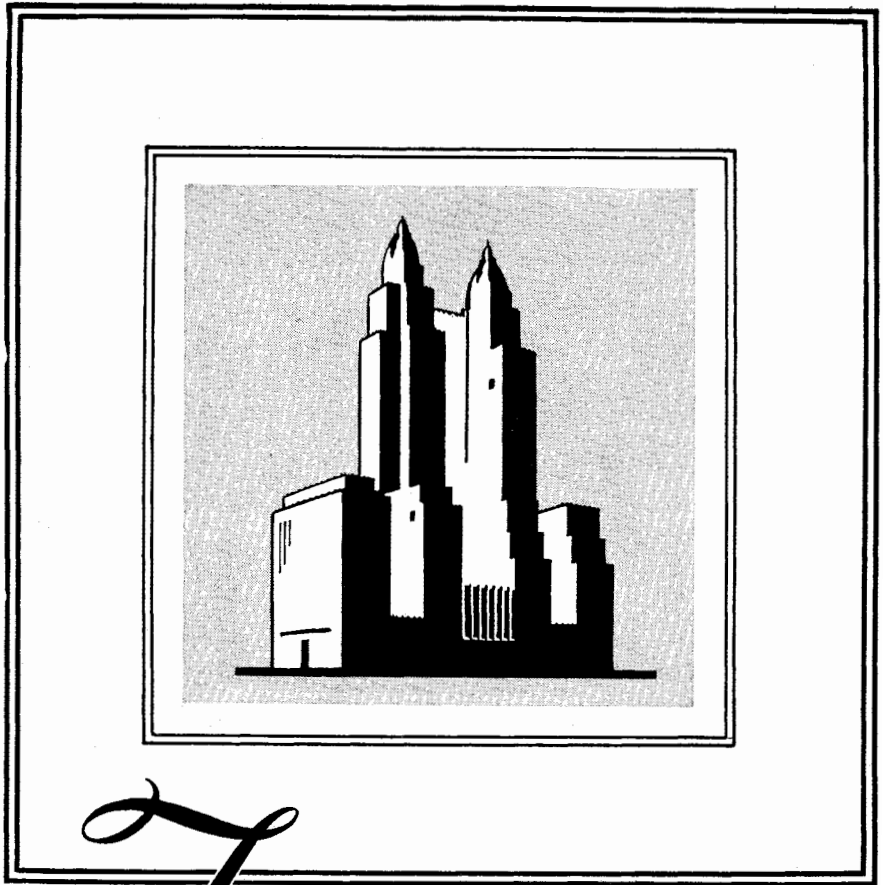
After a time the tail drops off, saving expense, time, and trouble for ranchmen, and some pain and possible infection for the lambs.

*A sheep or lamb bleats, as we know, but the word doesn't rhyme.

**FLAVORS OF MEAT AND
MEAT PRODUCTS**

MEATS are among the foods most desired by savage and civilized man alike. Meats possess not only proteins and minerals of high nutritive value but also flavor, that highly desirable adjunct in food. This problem of flavor is now being studied systematically.

The Bureau of Animal Industry has been engaged for several years in studies leading toward the production of superior animals the meat of which will possess the characteristics desired by critical consumers. Until recently the flavor of cooked meats resulting from these controlled experiments has been determined solely by trained judges who evaluate, by taste and smell, the results for intensity and desirability of flavor. A
(Please turn to page 406)



*T***HE WORLD IS FULL OF HOTELS:**

- little, Old-World inns cherishing the tradition of generations of personal hospitality . . . and magnificently appointed hostelries, efficient to the last needle-and-thread in every guest-room pincushion.
- quiet, gracious hotels, where hospitality in the grand manner is revered as a fine art . . . and glamorous centers of metropolitan gaiety, aglow with the cheer of music and laughter.
- intimate gathering-places whose charm is the treasured secret of a few . . . and world-renowned caravanserais where ambassadors rub elbows with captains of industry . . .

But there is only one hotel in the world which typifies them all in one . . .

THERE IS ONLY ONE "WALDORF"

Wm. B. Boomer
PRESIDENT

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH STREETS · NEW YORK



THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

IF you make your own eyepieces, or plan to learn this branch of the telescope making hobby now that R. E. Clark has explained the work in such minute detail in the new book "Amateur Telescope Making—Advanced," the four small photographs in Figure 1 may interest you. The photographs and the eyepieces were both made by D. Everett Taylor of Willimantic, Connecticut,

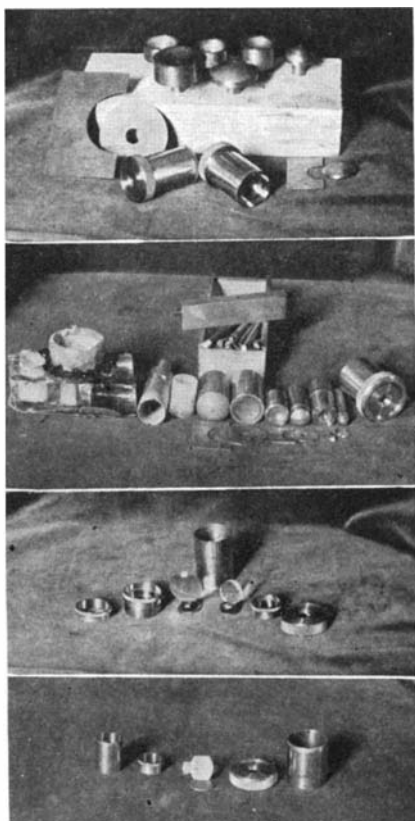


Figure 1: Eyepieces

cut, author of the chapter on refractor mountings in that book, and they exhibit the neatness that is characteristic of his work.

Top photo (*Eeny*): "Templets and tools used in making the lenses for the two eyepieces shown," Taylor states. "Templets were machined to .001", curves on tools are equally accurate. The field lens is of Chance Bros. crown and the smaller lens is a cemented doublet of barium crown and flint. First class performance from both eyepieces."

Meeny: "From left to right: A block of glass from which two cylinders have been ground; the trepan that did the grinding; a cylinder of glass $\frac{3}{4}$ " in diam. x $1\frac{1}{2}$ " long, ground out in one hour without forcing; six brass tools for grinding curves, and the finished Hastings type D eyepiece. In the foreground are the precise templets with which to check curves. The background shows a group of drill-rod tools with holder, used for fine thread cutting and work on small parts."

Miny: "A $1\frac{1}{2}$ " eyepiece completely disassembled. The 'skirt' or tube is steel (less

likely to scratch from brass adapter tube). The four cell parts are of tobin bronze. Smaller lens is a cemented doublet of barium crown and flint."

Mo: "A $\frac{3}{4}$ ", type D Hastings eyepiece completely disassembled. The first two parts are the cell which holds the lens. Next is the complete lens, showing the tiny cap lens which is cemented to the small end of the cylinder. Then comes the front or eye end made of tobin bronze, and at right the skirt of steel. All parts are precisely centered."

Figure 2, also by Taylor, shows his drill-press setup for grinding cylinders from a block of glass. "Note the dam of wax which forms a well to hold the abrasive mixture," he writes. "This arrangement keeps the trepan from overheating, reduces the necessary grinding time to one third, is economical on abrasive and makes a cleanly performance, as can be seen from the photograph. This was taken immediately after releasing the cylinder, and with no cleaning up except to wash the cylinder. The latter shows in the foreground, washed free of the grinding goo. Tools for grinding the curves of a Hastings D type lens are shown lined up, in order to include them in the photograph."

IN one chapter of "A.T.M.A." Dall of England describes the construction of a camera obscura, consisting of a movable flat projecting above the roof of a house and feeding downward into an objective lens which throws its image vertically down on a viewing table in an attic. Figure 3 is a terrestrial photograph made through this instrument. "I was trying," Dall writes, "to take an infra-red photo of a little church which stands up in the sky-line 17 miles from here, in Buckinghamshire. I have got best results so far with visible light and a red filter instead, because of the too lengthy exposure with infra-red, also because of enhanced diffraction effect of the longer wave. Infra-red long-distance photography tends to defeat itself, as far as detail is concerned, because of the reduced resolving power of the long wavelength. A 2" telescope will give as good an image at 5000 A.U. (average of spectrum) as a 4" telescope at 10,000 A.U. (infra-red), although the infra-red does penetrate atmospheric haze. (Objective diameter $4\frac{1}{4}$ ", plus eyepiece, plus enlargement. Red screen and Ilford Panchro plate. Exposure 2 minutes (This house won't 'stay put' for a long exposure. A temperature difference of a degree or so will cock the house over enough to give a band image of a line at this high magnification.) at 8 P.M., last July. Beclouded sun immediately above and slightly to right. *E.F.I.* of final result about 1400", or 115'. The curve drawn on the photo shows the size of the setting sun or moon at the same scale. The little drainage trough just visible [It shows on the original but not on the half-tone, hence we added an arrow.—*Ed.*] sticking out of the distant tower would be about 6 inches across. It is a coincidence that my viewpoint shows two churches, one

distant 17 miles, the other $5\frac{1}{2}$ miles, within 1 minute of arc of one another."

Foreground objects in Dall's photograph, under-exposed as he explains, are rather dim and the half-tone reproduction renders them still more so. On the original the details of the foreground, consisting of tree-tops, are visible, and the picture has considerably more life than in the half-tone.

Any readers of "A.T.M.A." who may be planning camera obscuras will gladly be hooked together by ye scribe if they care to send in their names—a sort of "Camera Obscura Club" would thus be formed. It is also expected that the publication of Haviland's detailed instructions for making objective lenses by something more like professional methods than any instructions previously available, will result in a trend in that direction, as "A.T.M.A." has already reached more than 1200 persons, assuming but one reader to a copy—quite an assumption, for some copies are known to be read by a dozen amateurs.

THOSE of us who observe in the East, or even in parts of the West, will envy Clyde W. Tombaugh ("A.T.M.A.", page 639) of the Lowell Observatory in Arizona, where seeing is really seeing. He writes:

"I have been having some fine views of Venus, Mars, and so on, through my 12". On the 5th of March, during the early twilight of the evening, the seeing was ripping good—No. 8 on a scale of 10 (10 giving a perfect diffraction pattern for a 5" object glass) and I finally put on a power of 742. The image of Venus was huge, perfectly sharp, clear cut, and there was scarcely a quiver.

"On the morning of March 11, I had some No. 6-7 seeing with my 12", power 300, and saw the minute northern polar cap (now at



Figure 2: Cookie cutting

minimum size) of Mars well; it was only about 1/2 by 1/4 second of arc, down at the N. limb of the planet. I saw the oasis Isminii Luci, cloud areas, Dawes Forked Bay, Syrtis major, portions of the Protonilus and Deuteronilus "canals", and glimpsed the Hiddekel and Gehon "canals"! The colors of the markings came out beautifully in the morning twilight. At that time, the angle subtended by the disk of Mars was only



Figure 3: Camera obscura photo

9.8 seconds of arc (equal to that of a 3" ball placed a mile away). Isn't that enough to thrill anybody? At moments of very good seeing, the whole disk of the planet came out very hard and sharp (then is when one sees the canals).

"The time to really see things on planets is during the twilight, both morning and evening, when there is a lull. We find that our seeing in regard to steadiness is generally 2 to 3 points lower during the middle part of the night. Soon after the sun gets up in the morning the seeing begins to dance again. Most people think they should wait until it is good and dark before looking."

THERE is evidently much interest in the Richest-field Telescope described in the final chapter of "A.T.M.A." The only misprints yet found in this book which could really cause trouble are in that chapter. On page 635, bottom paragraph running over to next page, please change the capital letters *M* in five places to *m*. On page 637 line 2, make log delta sub *m* read simply log delta, and in line 3, make delta *m/a* read delta over *a* squared. Of less importance, on page 140, line 2, change "opposite" to "preceding." On page 155, third line, change plano-convex to plano-concave. Page 215, Figure 1 was accidentally turned on end. Page 334, shift footnote star in line 5 to page 335, line 34, after "14". Page 348, line 11, change "remaining" to "ramming." Page 583, line 18, insert after "image," "as full as the eye can accept." Please report any other errors found.

AMATEURS who collect practical data on telescopics (how do you like that word?) may wish to obtain a pamphlet entitled Abrasive Grain Sizes. Write Supt. of Documents, Washington, D. C., and ask for R118-36.

AUTOMATIC guiding again: In August, 1934, James T. Barketlew, of Los An-



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geles, described his attempts to solve this intriguing problem and last January Wilbur Silvertooth of Long Beach, California, described the efforts he too has made. Further efforts toward solution of the same problem are now outlined in the March number (Vol. 8, p. 78) of the *Review of Scientific Instruments* (Lancaster, Pa.) by A. E. Whitford

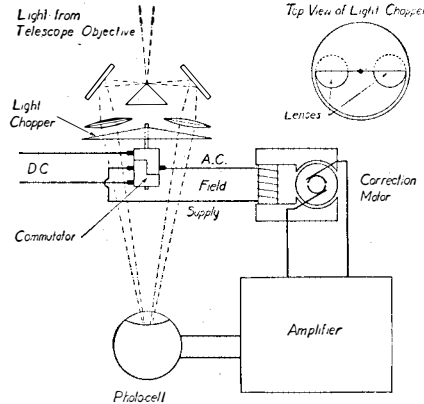


Figure 4: Automatic guider

and G. E. Kron, of Washburn Observatory, University of Wisconsin, Madison, Wis. The following is from their article:

“The principal difficulty in designing an automatic guider for a telescope is the extremely small amount of light available to actuate the mechanism. Most photo-electric control devices operate on 10^{-2} to 10^{-3} lumens, but an automatic telescope guider must work on 10^{-9} to 10^{-10} lumens to be successful.

“The plan of operation of the automatic guider in its present form is shown schematically in Figure 4. The control is exercised in one coordinate only. The similarity with the original design of the Hardy color analyzer is evident. A 90° roof-prism aluminized on its upper surfaces is set in the focal plane of the telescope and divides the light of the star into two parts. These two beams are reflected by mirrors, pass through converging lenses and are reunited on the sensitive surface of a photo-electric cell. A light-chopper nearly in the plane of the lenses occults the two beams alternately. If the star image is not centered exactly on the knife-edge, unequal amounts of light will pass through the two lenses and there will be an alternating intensity on the photo-cell. The alternating voltage thus generated is amplified many times and applied to the armature of the correction motor. The field of the motor is supplied with current of the same frequency from a commutator on the same shaft with the light-chopper. The correction motor drives the telescope or a sliding plate-holder in the focal plane in such a direction as to correct the error. When the star image is centered exactly on the knife-edge the two beams are equal, there is no flicker and the motor stops. When the star image moves from one side of the knife-edge to the other there is a change of 180° in the phase of the armature current with respect to the field current and the motor reverses its direction of rotation.

“The advantages of this system of control are: (1) Because there is only one photo-cell and because a.c. amplification is used, the balance condition is dependent on geometrical considerations only, and is independent of drifts in steady-state currents in vacuum tubes and changes in cell sensitivity. (2) The control is exercised entirely by electron tubes without any mechanical re-

lays. (3) As long as the error is less than half the diameter of the star image (and an error larger than this is certainly beyond the limit of tolerance) the correcting impulse is proportional to the need for it. As the balance point is approached, the motor current gradually goes to zero. This permits rapid correction of an error without the oscillation about the mean position common with simple on-and-off methods of control.

“This arrangement was tried out on the 10” photographic telescope of the Mount Wilson Observatory, and later at the Cassegrain focus of the 60” reflector.” The results are shown in three star photographs not here reproduced but the authors describe them as follows: “In all three cases the guider corrected a cumulative error in right ascension and produced round star images of about the same diameter as 1-second exposures of bright stars.

“In the preliminary tests of the guider’s usefulness made thus far it has been considered sufficient to confine the control to one coordinate. In order to have control in both coordinates, the outfit would have to be duplicated. Two knife-edge prisms set at right angles could be used, with separate guiding stars for each, or the light of a single star could be divided by a half silvered mirror. Perhaps the best system would be to use a four-sided reflecting prism.”

The four-sided prism method was the one proposed by the amateur, Barkelew. Just how far this latest bit of work, following the work previously described by amateurs, has gone in the direction of a final solution, cannot yet be said, but the results appear to be promising.

IN April, 1936, we showed how W. B. Hiner, 123 Cleaves Ave., San Jose, Calif., attached a simple “Barlow” lens fixedly to the end of an eyepiece. Figure 5 shows a later arrangement of his which has variable magnification. As the largest lens is moved toward the diagonal the eyepiece must be moved away from it, as provided by his mechanism. Such a lens is, of course, not achromatic and with higher powers it gives pronounced color on the planets, but this is less noticeable on the moon, he states.

Answering several inquiries about achromatic Barlows, J. R. Haviland, author of the chapter on objective lens design in “A.T.M.A.,” says: “Use same formula as for achromatic O. G. Start with focus, say, minus 8- or 10”, take account of signs in formula, and results will give foci of two components.

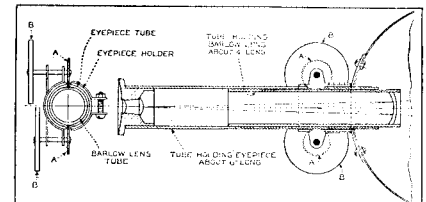


Figure 5: Hiner’s arrangement

Go on from there same as for positive lens. When used as a Barlow flint is first, that is, away from the eye and toward the sky.”

FIGURE 6 shows what James W. Lillico, 10 Bayley Ave., Yonkers, N. Y., thinks a perfectly good bathtub is for. “Living in an apartment and having a wife,” he writes, “I could not see the possibility of having a barrel full of stones parked in the kitch-

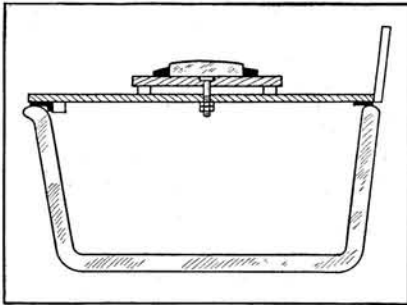


Figure 6: TN housekeeping

en." Years ago, when R. W. Porter took up mirror making, that is what he did and Mrs. Porter says he tracked a heavy, red ring of rouge around a pedestal on her kitchen floor. Once his rouge was accidentally mistaken for paprika and shaken on baked potatoes.

AND now comes a note from Russell W. Porter, whom we have frequently begged to send us, for this department, any homely little scraps of information or practical sidelights on the progress of the 200" at Pasadena until it is finished. "In order to show members of our fraternity the care exercised in safeguarding the 200" mirror from scratches, I am sending you a sketch (Figure 7) taken at the wicket door where all who enter the large room are required to remove their shoes and to don rubber sneakers. Before this rule was laid down, sweepings from the optical shop floor showed innumerable pieces of steel chips that had found their way into the 'holy of holies,' clinging to the soles of shoes of workmen—or visitors—who thus unconsciously imperiled the surface of the big disk.

"As the 200" telescope is the No. 1 exhibit here on the campus now, the visitor's gallery is well patronized by tourists from all over the states."

The sign on the doors reads: "No Admittance. Please do not open these doors until the outside doors are closed."

WHAT TN can read Czech? Each month the Czechoslovak Astronomical Society sends us a neat little journal named *Rise Hvezd*, but we can't read it. One page is evidently devoted to amateur telescopes, some of which may call for translation and presentation here, but it's all Czech to us.

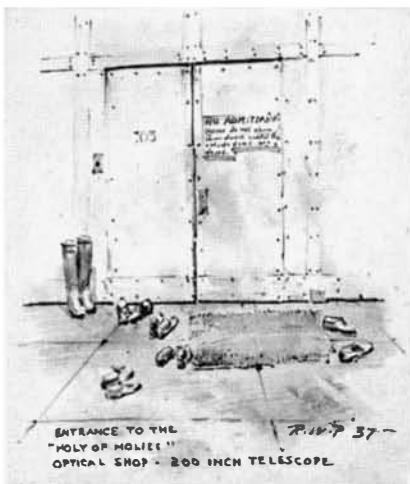


Figure 7: Hon. muddy footshoes of Yankee tourists parked near door of sacred Japanese clean temple

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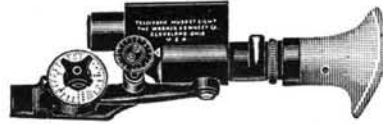
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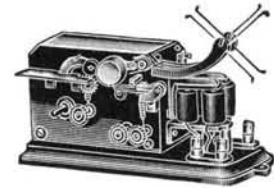
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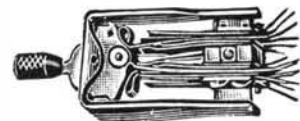
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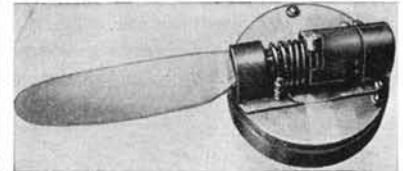
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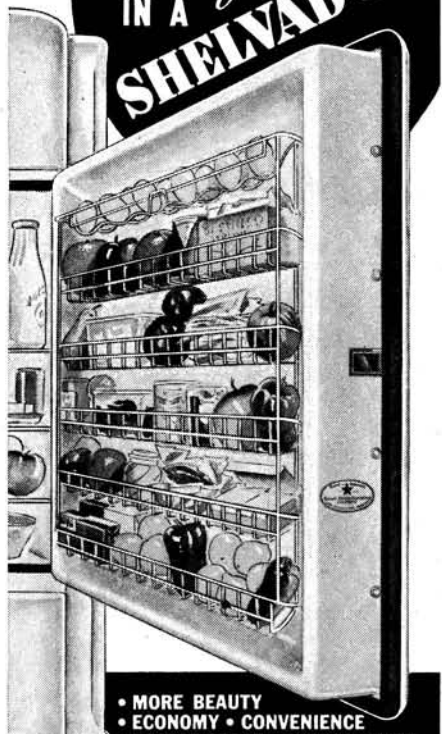
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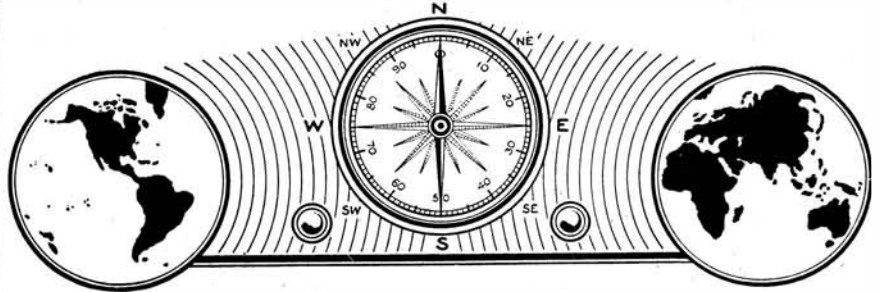
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RADIO recently added another episode to its long history of rendering aid in time of distress, during a freak storm in Tyler, Texas, which crippled transportation, paralyzed all communication systems, froze the power plant, and covered the city with an icy blanket.

Into Tyler, the day before, had rolled one of the RCA-Victor Company's radio show-coach trailers, equipped with its own powerful 3-kilowatt electric power plant.

At the request of the Police Department, the trailer was used to supply current for



Interior of the radio show-coach trailer that helped defeat a storm

operating amateur radio station W5EME which was immediately placed into service for clearing emergency traffic for the telephone and telegraph companies, and to obtain news from the "outside."

Tyler's newspaper, the *Morning Telegraph*, was almost ready to suspend publication, but was able to get out a condensed edition which it called a "Short-Wave Radio Paper." With all normal outside communications cut off, the paper arranged for a stenographer to copy Associated Press dispatches in shorthand at station W5EME as transmitted by radio from Dallas. All the outside news subsequently printed in the paper was prefaced "By Radio From Associated Press."

The power company was by this time able to supply sufficient power for operating the newspaper plant so that the news could be set in type, cuts made from photographs, and the presses allowed to roll.

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THE fact that a short-wave broadcasting station may be transmitting on a frequency of, say, 9.51 megacycles, does not necessarily mean that it will be found at

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Therefore, when looking for a station of known frequency, tune over a space equivalent to at least 100 kilocycles—50 kilocycles on either side of the station frequency.

This procedure is usually not necessary when tuning in the standard broadcast band. Most receivers are well calibrated in this region and stations will appear "on the nose."

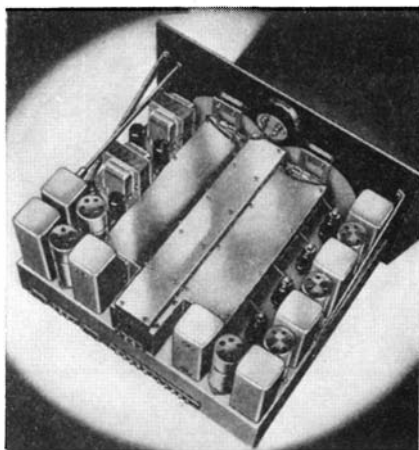
**CHAIN SMOKE-
BROADCASTING**

A REPORT from Western Australia gives an illustration of how, in isolated communities, primitive methods of sending signals may be linked up with short-wave broadcasting. A sheep-station hand was reported missing from an outstation in the Roebourne tableland. The police at Port Hedland were informed. Before setting out on what might have been a long and fruitless search, the police broadcast messages to all who had short-wave receivers in a given area, asking them to put up smoke signals if they were able to receive the message. A second message was then transmitted, asking those who had responded to put up another smoke signal if they knew that the missing man had been found. After an interval a second smoke signal gave the police the information they required.

**NEW HAMMARLUND
"SUPER-PRO"**

THE new Hammarlund Super-Pro receiver employs 16 tubes, eight of which are the metal type and eight the glass type. It is available in three basic models; one with a range from 540 kilocycles to 20 megacycles or 555 to 15 meters, a second which tunes from 1250 kilocycles to 40 megacycles or 240 to 7.5 meters, and a third which omits the band from 2.5 to 5.0 megacycles but includes a range extending from 1000 to 2000 meters which takes in weather broadcasts, time signals, and foreign long-wave broadcasting.

In all other respects the three models are



Chassis view of the new Super-Pro receiver described in these columns

identical, and are equipped with electrical band-spread in the short-wave bands, a continuous band-width control which permits high-fidelity reception from local broadcast stations, calibrated sensitivity, audio and beat oscillator panel controls, and a tuning meter.

Means are provided for the reception of c.w. code signals, and a toggle switch on the front panel permits the operator to switch from loudspeaker to headphones which are permanently connected. The powerful audio amplifier and loudspeaker may be used in conjunction with a turntable and pick-up for phonograph reproduction by merely connecting the pick-up leads to a small terminal strip located at the rear of the receiver.

The Super-Pro has a high degree of stability, sensitivity, and tonal fidelity. The dial calibrations are held within a tolerance of plus or minus 0.5 percent, which assists immeasurably in rapidly locating stations of known frequency.

NEW DAVENTRY FREQUENCY

A NEW frequency—GST on 21.55 megacycles or 13.92 meters—has been allocated for use by the BBC for its Empire transmitters at Daventry. Although it is not proposed to operate on that frequency immediately, it may be used from time to time during the summer months.

The identification-word of the call GST will be "Transmitter." As listeners to Daventry are aware, the letters "GS" are common to all sixteen calls associated with the BBC's Empire Service, the final letters of the calls being the differentiating factor. To avoid confusion in the announcements of the calls, an identification-word has been allotted to each final letter. The identifications in present use are:

- | | |
|--------------------|----------------|
| A for Aerial | H for Home |
| B for Broadcasting | I for Ireland |
| C for Corporation | J for Justice |
| D for Daventry | K for King |
| E for Empire | L for Liberty |
| F for Fortune | O for Ocean |
| G for Greeting | P for Progress |

NAVAL RADIO TIME SIGNALS

TIME signals are transmitted daily on a number of frequencies and at various hours from the Naval Radio Stations NAA,

at Arlington, Virginia, and NSS, at Annapolis, Maryland. During the time broadcasts these stations operate in synchronism.

The signals commence five minutes before the hour and end exactly on the hour. Most of the transmissions are broadcast simultaneously on two or more frequencies, as indicated in the following schedule:

Time (E.S.T.*)	Frequencies in Kilocycles
0055-0100	113, 9425
0155-0200	113, 9425
0255-0300	113, 9425
0355-0400	113, 9425
0455-0500	113
0555-0600	113
0655-0700	113
0755-0800	113, 9425
0955-1000	64, 113, 4390, 9250, 12630
1155-1200	113, 9425
1255-1300	113
1355-1400	113, 9425
1455-1500	113
1555-1600	113, 9425
1655-1700	113
1755-1800	113, 9425
1855-1900	113, 9425
1955-2000	113
2155-2200	64, 113, 4390, 9250
2355-2400	113, 9425

A frequency of 64 kilocycles is equivalent to a wavelength of approximately 5000 meters, and a frequency of 113 kilocycles is approximately 2500 meters. These are not covered by the average all-wave receiver and therefore cannot be intercepted unless a special receiver covering these frequencies is employed. However, at least one high frequency which is within the range of the average all-wave set is used at most hours.

*The times given are based on the 24-hour day system used by the Navy. Thus, 0100 EST may be read as 1 AM, EST, and 1200 as noon. —Ed.

NEW SHORT-WAVE BROADCASTERS

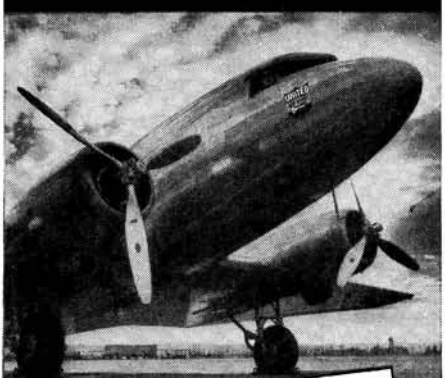
WITH the arrival of the warm months, when reception in the short-wave bands is often less subject to atmospheric disturbances than it is in the standard broadcast band, a number of new stations have added their voices to the many others in the already over-crowded high-frequency spectrum.

But when there is no station interference to mar reception, listeners will find the programs from the foreign broadcasters distinctly refreshing. To those whose hobby it is to collect verification cards, the new stations will be welcome additions to those already logged.

The latest stations, with their frequencies, calls, and locations, are given in the following list:

K.C.	Call	Location
18090	FYE-1	Paris, France
17775	PHI	Huizen, Holland
15160	OLR5C	Prague, Czech.
11900	OLR4D	Prague, Czech.
11895	HP5I	Aquadulce, Panama
11820	XEBR	Hermosillo, Mex.
11040	CSW	Lisbon, Portugal
10670	HBP	Panama City, Pan.
9550	OLR3A	Prague, Czech.
9504	OLR3B	Prague, Czech.
9340	OAX4I	Lima, Peru
9120	CP-6	La Paz, Bolivia
6210	YV1RI	Coro, Venezuela
6130	LKJ1	Jeloy, Norway
6117	XEUZ	Mexico City, Mex.

UNITED'S MAINLINERS



FINEST COAST-TO-COAST
California — New York
in 15½ hours
PLUS NEW LOWER RATES

★The Mainliners, exclusive with United, inaugurate a new era in air transportation—the finest coast-to-coast service ever offered—deluxe 3-stop 15½ hour flights daily between California and New York.

The Mainliners, built by Douglas, with their plus comfort features, are the ultimate in luxury, service, speed . . . 14 overstuffed swivel lounge chairs in a 21-passenger cabin! 190 m.p.h. cruising speed using only 62% of available power! 100 million miles of experience . . . and personalized attention to passengers that is famous!

Be sure your ticket reads *United* when you take your next flight.

Tops in luxury—the Mainliner!



New Lower Fares

May 1, Coast-to-Coast \$149.95, Chicago-New York \$44.95. Extra fare on 14-passenger Mainliners: New York-Chicago \$2; Coast-to-Coast \$5. No extra fare on 21-passenger Mainliners and 10-passenger Boeings.

UNITED AIR LINES

ANNOUNCING THE KINE- EXAKTA

*The Only Compact 35-MM
Reflex Camera on the market*



Under the heading "A Scoop," the April issue of Scientific American announced this new Kine-Exakta as "a reflex camera using 35-mm regular and Kodachrome film, which can be focused at either eye or waist level with provision for easy interchangeability of lenses of various speeds and focal lengths."

It is all of that—and more . . . for its features make it the most completely satisfactory "seeing" camera yet produced. Only in the Kine-Exakta, among miniature cameras, do you find a negative size of 24 x 36 mm (1" x 1½") combined with safe and certain focusing and image composition on a ground-glass screen. With the result that the range of work is practically limitless—short or long focus, measuring in miles or inches, for normal or photo-micrography.

This is but a bare outline of the virtues of the Exakta—camera enthusiasts will be quick to inspect this brilliant camera itself, and study examples of its performance now on view at Willoughbys.

• Equipped with Exaktar
Anastigmat F3.5 \$130⁰⁰
Lens.....

**TRADE IN
YOUR OLD
CAMERA**

See it demonstrated in our store or send check or money order to Dept. K.E.S.A., and we will ship it prepaid on 10 days' trial. Money back if not satisfied.

Willoughbys

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World's Largest Exclusive Camera
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"At the Sign of the Camera"



CAMERA ANGLES

Conducted by JACOB DESCHIN

MOOD AND ASPECT

FROM the time you arise in the morning until dusk and the night, you will notice, if you are observant (which you are, if you have the make-up of the serious amateur), that there is a constant change in the appearance and the atmosphere surrounding familiar scenes and objects. Scientifically the changes are due to variations in lighting, but actually the differences are due also to matters of an emotional nature. In the morning you feel refreshed and eager, full of plans for the day; in the afternoon

dozen pictures giving a story in sequence of the varying effects created by the "painter's brush" of the sun, will provide you with a group of photographs which, if well done, should give you much real satisfaction and pleasure.

We referred some months ago to the plan of photographing a scene as it appears at different times of the year. We would like now to recommend the making of a series of pictures of a single scene as it appears during a typical day in early spring, in summer, in the fall, and in winter. Only distinct changes, of course, should be recorded, and the scene chosen should be attractive enough and lend itself sufficiently to the idea to make such a series worth the effort that will have to be put into it. Choose a scene you know well and have observed often and admiringly. You could easily fill a special album of modest dimensions with a season-to-season, mood-to-mood record of such a subject.

The taking of the picture, that is, the making of the exposure, is just the beginning, and if you go ahead and simply make ordinary prints or enlargements on the same paper for all the scenes, you will be missing the whole point. Some of the scenes will be more suitably printed on glossy paper, others on semi-matt or matt. You may wish to treat some to a toning bath, while others, like a snow scene, you will find more attractive if done in pure black and white. If you take to the album idea, you will find it preferable to make the prints or enlargements all of the same size; 4 by 5 or 5 by 7 inches should be ample. It is doubtful if such a series, even if only three or four are made, would look well in a frame on the wall, but there doubt-

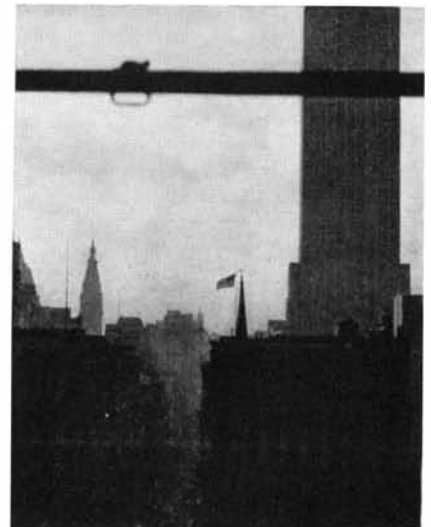


"Dawn"

there is a considerable letdown; by dusk you are ready to call it a day and long for the easy chair, the pipe, and the book.

We have tried to express something of the sort in the three pictures illustrating this piece. "Dawn" shows the lyrical touch of the rising sun on the side of the building and the gradual illumination of the sky; "Afternoon," as seen through an office window, suggests the work-a-day world, with its view of the buildings in which many like yourself are bound to their duties; "Dusk" interprets the sombre aspect of the day's end, with its silhouetted skyline and masses of slowly moving clouds.

Whether you live in town or country, city or hamlet, this continual process of transformation is made apparent to you in many ways. Doubtless you have made pictures on various occasions when certain familiar scenes presented their most attractive aspect. However, to photograph a single scene at different times of the day, accumulating at the end as many as half a



"Afternoon"



"Dusk"

less will be at least one or two that you will want to hang separately. One idea would be to hang a favorite picture of the scene during the season in which it was taken, the spring scene in the spring, the snow scene in the winter, and so on.

It sounds like an awful lot of trouble, we know, but if the opportunities are available and you feel so inclined, we are sure you will find it worth your while.

LUMINOUS PAINT

IF you have been having trouble seeing things in the dark, especially when developing panchromatic film under the weak light of a green safelight, perhaps the use of Ray-O-Lite will help. This is a luminous radium paint for painting watch dials, second hands, light meters, and other dark-room apparatus. It is available in six colors, and is said to be easy to apply, absolutely harmless, and lasting. It comes ready for use in ¼-ounce and 1-ounce bottles.

PHOTOGRAPHY FIRST

ACCORDING to the annual poll of the graduating class of the Columbia University Engineering School by the *Engineer*, school annual, the average senior of the class is an amateur photographer, any other hobbies or outside interests he may possess taking second place.

MERCURY VAPOR PHOTOGRAPHIC LAMP

MERCURY vapor, long the ally of photographers, is again being utilized in a new photographic lamp now under development in the Mazda Lamp Laboratories, according to an announcement by the Lamp Division of the Westinghouse Electric & Manufacturing Company.

This new light source, which will later be known commercially as the Flood-Flash lamp, is similar in appearance to some of the high intensity mercury vapor lamps now on the market in that it consists of a

bulb within a bulb. It has an overall length of approximately six inches and a diameter of approximately 1½ inches. Under continuous operating conditions, the lamp consumes about 100 watts, producing 3000 lumens. However, by operating it in conjunction with special equipment, high momentary current discharges may be passed through it, resulting in a flash at peak brilliancy of about 500,000 lumens with an average brilliancy of 300,000 lumens.

The flash may be so controlled as to be timed with the opening of a camera shutter, thus making possible the utilization of a light of high intensity and great actinic value at the instant the photograph is taken.

At the present time, the Flood-Flash lamp is not available commercially since further development on it is necessary. When perfected, this lamp may be used for general lighting of a studio while posing the subject and focusing the camera and then may be flashed for the actual photograph. The same lamp may be flashed as often as necessary.

PLAUBEL MAKINA II S

EVER alert to new trends in photographic practice and the needs of the times, the Plaubel Makina, for many years the choice of the pictorialist and journalistic photographer seeking in a single outfit an instrument readily adaptable to any need that may come up, now offers new advantages. In its altered aspect, the Makina is now the Makina II S, in which is introduced as its principal feature a new type of lens mounting. It is neither a screw-in mount nor a bayonet mount, but something altogether original—a half-screw arrangement which combines the advantages of both methods. The quick interchangeability of lens units that is now so greatly desired by workers who often have to use lenses of different focal lengths on a single occasion when speed of adjustment is a prime factor, is thus accomplished in the Makina II S without the sacrifice of any of the advantages embodied in the other model. Indeed, there are now two Makina models, differing from each other in this single respect. To the man who has no need for speedy interchangeability of lenses and finds all his needs cared for in the standard outfit, which accommodates the 4-inch Anticomar F:2.9 objective, the regular Makina may seem preferable since the design of the mount on the Makina II S has made it necessary to extend the lens one inch beyond the plane of the lens board. It is, then, simply a matter of choice dictated by



The complete Makina II S outfit

A NEW KIND OF RANGE-FINDER! Measures Down to 14 Inches! BALDAMETER

The Double-Micrometer Range-Finder



Doubles the Scope of Your Camera
Doubles the Scope of Your Work

A double-action range-finder for all distances, the BALDAMETER, with its micrometric operation for very close distances in addition to the normal ranges, enables the photographer to utilize supplementary lenses on his camera without ground glass focusing or tape measures.

PRICE, including soft leather purse and shoe mounting.....\$10.00

DISTANZER RANGE-FINDER



For Distances from Infinity to 2½ feet

By the simple addition of a BALDA DISTANZER to your camera it becomes as focusure as super-expensive outfits with built-in range-finders. Included with the DISTANZER is a "shoe" which permits attachment for eveready use on the camera, or instant removal for carrying in the pocket.

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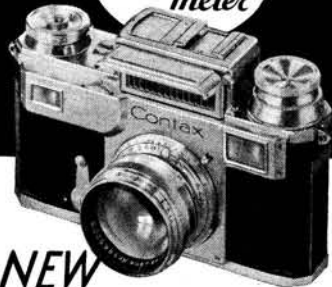
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Built-in exposure meter



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All guess-work is eliminated in this most advanced of miniature cameras.

Built-in photoelectric exposure meter indicates exact settings of speed and diaphragm for any light conditions. Long base range-finder, coupled with lens, automatically ensures exact focus.

Fast Zeiss Lenses permit virtually unlimited scope—pictures under poor light and adverse conditions . . . even at night. Eleven speeds up to 1/1250 sec., 36 pictures on a load. Choice of 14 interchangeable lenses.

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The cameras are unusually light weight models, with double extension bellows, rising and falling front, opening automatically by pressing the spring knob down. The lens and shutter are the best obtainable and ordinarily sell for more than the price we are asking for complete outfit. The price includes three plate holders and film pack adapter.

Sold on our usual 10 days trial basis

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the requirements of one's method of working as well as one's desires and needs.

Another new feature incorporated in the Makina II S (the S standing for Speed Change in lens units) is the design of the mount of the seven filters, ample to serve every task one may undertake. These seven



Makina II S lenses have the advantage of a “half screw” arrangement

filters fit any one of the three lenses which constitute the complete Makina II S outfit—the 4-inch Anticomar F:2.9, the 7¼-inch Tele-Makinar F:4.8, and the 2⅞-inch Wide Angle Orthar F:6.8—by screwing over the first two lens mounts and inside the wide angle lens. The filter outfit, which consists of three yellow, a red, a blue, a green, and an ultra-violet filter, thus assumes a universal aspect.

As always, the new Makina is also universal as to the type of sensitive material that it can accommodate, being the only camera on the market with a back that will take instantly a roll-film holder, plate and cut film holders, or a film-pack adapter. All of these units are also a part of the complete outfit.

SPIRAL FILM WALLET

AN inexpensive negative file consisting of a spiral-bound book of ruled pages and transparent envelopes is announced by Willoughby's, under the name Spiral Film Wallet. Costing less than the price of a movie ticket, the file takes strips of negatives up to the size of the 120 roll film. The great convenience of being able to view negatives without the necessity of removing them from their envelopes is obvious and because the binding is of the popular spiral design, each data sheet and envelope lies flat.

CANDID CAMERA NIGHTS

SPECIAL nights set aside in theaters, radio stations, and other places of entertainment when candid camera shooters are invited to come and take all the pictures they want have become very popular. Just what happens on these occasions may be discerned from the *Chicago Tribune* description by Frank Marshall Moore of one such event, regularly held in the College Inn of the Hotel Sherman in Chicago.

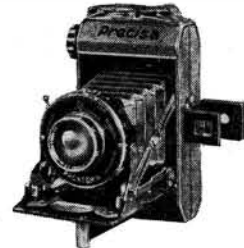
“Picture, if you can,” he writes, “more than three-score snapshooters, perched on table-tops and pianos, others in kneeling position, and still others prone on their backs, taking a bead on the fleeting Gertrude Hoffman Girls—from every conceivable angle. Heads and shoulders pop up suddenly from nowhere, and as quickly recede. More daring hawks swoop down in

Popular Priced CAMERAS

BEIER cameras are compact, light, of streamlined, solid construction, and elegantly finished. All exposed metal parts have a brilliant nickel finish.

They are equipped with high speed lenses of famed manufacturers, yet moderately priced. They carry a new, quiet working Prontor shutter, with speeds ranging from one second up, a built-in self-timer, and an optical view finder.

They are precision cameras, swinging into action at the touch of a button in a split second and operate with smoothness and accuracy. They can conveniently be carried in a coat pocket.

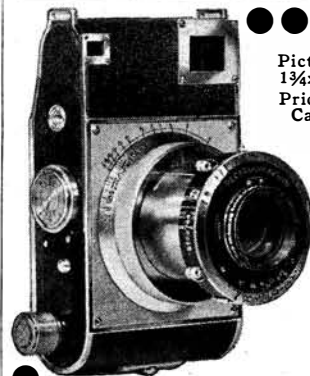


- PRECISA (above) with Trinar 2.9 in Prontor II, 16 negatives 1½ x 2¼" \$36.50
- RIFAX I with Trinar 3.8 in Prontor II, 8 negatives 2¼ x 3¼" or 16 neg. 1½ x 2¼" \$36.50
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- VORAN A with Radionar 4.5 in Prontor II, 8 negatives 2¼ x 3¼" or 16 neg. 1½ x 2¼" \$28.50

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Case \$7.50

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THE CANDID CAMERA with a coupled Telescope Range Finder

YOU will find that the Beira is easier to focus and that there is nothing more exact than this new and unique method whereby critically sharp negatives are obtained. A highly corrected little prismatic telescope mounted on the top of the camera shows a section of the field clearly and luminously enlarged to 6 diameters. This telescope is coupled with the camera lens—so that your focus is needle-sharp up to a distance of 3 ft. . . . and automatic as well. Has many other unique features as well.

Uses standard 35mm. film cartridges
With f/2.7 lens in Rapid Compur Shutter with speeds up to 1/500 second

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INSURE PERFECT PICTURES WITH your CAMERA

① Just before you shoot, point a WESTON Exposure Meter at the scene or subject to be photographed. The meter instantly measures the reflected light, and gives you the correct camera settings. Then . . .

② Set your camera as indicated on the WESTON Meter, and take your picture. You'll have correctly exposed negatives . . . whether you're shooting indoors or out . . . and no matter what kind of camera or film is used. On sale at all photo dealers. Literature on request.



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Send literature on WESTON Exposure Meter.

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Address _____
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the very midst of the entertainers, shoot and retreat. Some shoot other shooters shooting. The band blares on. The drums beat out a steady machine-gun barrage. Some take cover, exhausted from their mad race about the battle field. Others fall back to recuperate from an attack of laughter that leaves them limp and quaking. It's gay, it's fast, it's sheer idiocy. But it's fun."

Mr. Moore is reminded of Tennyson's "Charge of the Light Brigade."

NEW CONTAX LENS

THE recent addition of a new lens to the already long and varied list of objectives available for the Contax now brings the total up to 14, offering a lens choice ranging from a focal length of 28 mm up to 500 mm and of angles of view from 75 to 4.5 degrees. The new lens—the Zeiss Biogon F:2.8 35-mm wide-angle lens—has the three features which many serious amateurs have long sought, namely, a wide angle having a great depth of field yet possessing speed. The lens covers an angle of view of 64 degrees, as compared with the 55-degree angle of the 40-mm Biotar F:2 and the 75-degree angle of the 28-mm Tessar F:8 extreme wide-angle lens. The standard 50-mm lens, as is well known, covers an angle of 45 degrees.

UTILITY CUTTER

A METAL frame conveniently fitted to a comfortable hand grip and instantly adjustable for holding cutter blades in various positions is on the market as the Brooks Utility Cutter. The heavy-weight blades furnished for the cutter slide into the handle when not being used, thus preventing possible accident from having a sharp instrument lying about. The cutter is designed specially for cutting cardboard of various weights, being equally useful for cutting heavy wallboard and light veneer wood. The handle is polished aluminum with a wing locknut.

SPOTLIGHT SILHOUETTE

THIS month we introduce what we dare to call a new type of silhouette, though for all we know it may already be familiar to



With a spotlight

Bass Bargaingram

VOL. 26 179 WEST MADISON STREET, CHICAGO, ILL. NO. 5

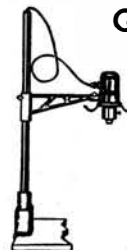
Bass Says:

Longer days, more sunlight . . . all spell greater photographic opportunities . . . The perennial addict had better dust off his equipment, clean up the ol' darkroom and sit himself down to write for ye new BASS BARGAINGRAMME listing thousands of attractive values in every department. Yes sir: once you get a photographic infection . . . it stays in the blood for good.

Charles Bass
President

Never Before Such Features!

GRANT Enlarger and Projector



For 35 mm. and 1/2 V.P. Also parts of up to 4x5 negatives. Cool. Horizontal or vertical. Also as a projector. Fast F:3.5 lens. Complete, including lens

\$49.50

24 Shots in 6 sec.
WITH THE **NEW ROBOT**

The most versatile of all candid cameras. Single or consecutive shots. The newspaperman's camera. Tessar F:2.8 lens. Write for literature.

Write For News About This Remarkable Miniature!

Balda Baldaxette



Uses regular No. 120 or B-2 Roll-film. With Meyer Trioplan F:2.9 lens. With coupled range finder, automatic film transport, helical lens mount. Self erecting.

Model 1—Sixteen 1 3/4 x 2 1/4 pictures
With Compur Shutter, list \$90.00, Bass price **\$62.50**
With Rapid Compur Shutter, list \$97.00.
Bass price **\$67.50**

Go Candid with WELTA — WELTI



Xenar F:2 lens, Compur Rapid Shutter—36 shots —list \$79.50. At Bass . . .

\$62.50

Same with Steinheil Cassar F:2.9 lens, Rapid Compur Shutter

\$45.00

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Two rolls \$4.00

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Model A-75, 500 Watt..... 36.50
Model A-72, 300 Watt..... 29.50

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Cameras, Lenses, Equipment
at Bargain Prices**

Trade in your used equipment

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some of our readers. Possibly it is more useful in commercial photography, particularly in making pictures for a hair-dressing establishment, but we can see where it might be appropriate in the amateur world where it is desired to get special effects in portraiture. The lighting used in the accompanying illustration is, of course, obvious. A single spotlight was so directed from above that it lighted up the hair of the sitter as well as the tip of her nose and a patch on her temple, while the rest of the subject's face is outlined in silhouette against the circle of light on the background. There are several variations of this method which may be tried by those interested, the only requirement being that a single light, preferably a spotlight, be used for illumination.

**CHAMPLIN No. 15
FORMULA**

COINCIDENT with the publication of Harry Champlin's new book "Champlin on Fine Grain" is the announcement of the author's new formula for developing fine-grain film—Champlin No. 15. It is obtainable ready mixed in 24-ounce bottles, but for those who would like to know what's in it, the ingredients are as follows:

- Water 20 ounces
- Rubinol or Pyro 32 grains
- Sodium Sulfite 1½ ounces
- Acid Benzoic 12 grains
- Acid Salicylic 4 grains
- Acid Boric 25 grains
- Acid Digallic (Tannic) 9 grains
- Glycin ¼ ounce
- Paraphenylenediamine ¼ ounce
- Alcohol Iso Propyl 97 percent . . . 1 ounce
- Nickel and Ammonium Sulfate . . . 10 grains

The chemicals should be dissolved in the order indicated, the paraphenylenediamine being dissolved separately in a small quantity of water heated to about 180 degrees, Fahrenheit, and then added to the developer, Mr. Champlin states. "After the solution has been cooled to 70 degrees, Fahrenheit," he continues, "dissolve the nickel and ammonium sulfate in a small quantity of water (1 ounce) and add very slowly to the developer."

**OLYMPIC GUN FOR
LONG SHOTS**

SOMETIME ago we announced in this department a new telephoto lens for the Contax camera, combining speed and real distance-snatching. It was the Sonnar F:2.8 of 180-mm. (7-inch) focal length. We mention it again not only because we wanted an excuse to publish this striking picture, but also to call attention to the unique "tripod" now being furnished for it. The outfit is called the "Olympic Gun" because it was widely used by press and sports

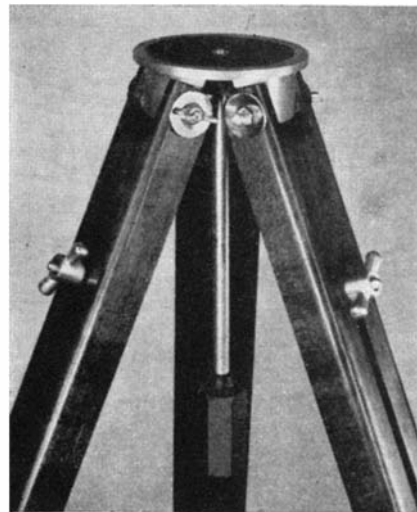


For long shots

photographers in covering the Olympic games in Berlin. This is what we call literally shooting pictures!

**TWO-SECTION WOOD
TRIPOD**

FLEXIBILITY, light weight, attractive appearance, and moderate price are combined in a new tripod called the Bee Bee Wood Tripod. Despite its light weight, this tripod is rigid, rugged, and durable, and is made of a hard, close-grained wood.



Top of a new tripod

It has two sections for convenience in carrying and is equipped with substantial locking devices on top and bottom, being also provided with a conveniently located and easily manipulated handle for locking the camera onto the tripod head.

The Bee Bee Wood Tripod is sufficiently strong to bear the weight of fairly heavy view cameras. When closed its height is 2 feet, 7 inches, and when fully extended, 4 feet, 7 inches. The diameter of the head is 3¼ inches, the screw handle is 8¼ inches long, and the tripod's weight, 3 pounds, 14 ounces.

COMPANION REFLEX

REFLECTING the increasing popularity of the twin-lens type of miniature reflex camera, a new relatively low-priced outfit called the Companion, of Czechoslovakian manufacture, has just been imported for distribution in the United States. Both lenses are the same, the Meyer Trioplan F:2.9, and the film size is 6 by 6 cm (2½ inches square). This is considered a rather fast lens speed for this type of camera. The shutter is of the Compur type with speeds up to 1/250th second and roll film is used. Automatic film transport, pressure plate back for holding the film perfectly flat, depth of focus scale, and attractive chromium appearance, constitute some of the features of the Companion.

"POPULAR PHOTOGRAPHY"

THE first issue of the new photographic magazine being published by Ziff-Davis Publishing Company, of Chicago, which was announced in this department some months back, was published in April under the name, "Popular Photography." Starting with a first printing of 150,000

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copies and a cover in full color, the magazine contained articles of varied photographic interest, both in the fields of still and motion picture photography. It is replete with helpful articles, many illustrations, and enthusiastic announcements for the future. We wish for it all the good luck in the world.

PERSPECTIVE

THE camera being a one-eyed creature, we resort to every device available to give a three-dimensional, stereoscopic appearance to the subject photographed, in order that the resulting print may be a fair representation of the original. In stereo-



"Progress"

photography this is accomplished by two pictures, the two combined, as viewed through a stereo viewer, permitting the same binocular vision as that enjoyed in viewing the subject itself. Two devices by which we attempt to gain perspective—that is, depth—are illustrated in "Progress." One is by means of light and shade, the other by showing a part of a window through which the scene was photographed.

PHOTOGRAPHING THE LEAF

A METHOD of photographing leaves without using a camera was recently passed on to this department by Weatherman Bernard B. Whittier, of Fort Wayne, Ind. He explains the procedure as follows: "Equipment needed: A printing frame (4 by 5 or larger); a light bulb of 60-watt or stronger; developer and hypo; and the leaves. Use only regular photo paper.

"Process: Put the leaf in the printing frame just as the film ordinarily would be placed; either side of leaf is good, best results being had by which-ever side will keep leaf most smoothly against the paper. Lock it in, backed up by photo paper, and expose quite close to the light; time will vary according to density of the leaf; say perhaps 40 seconds to two or three minutes, with a 60-watt light. Then develop and fix.

"Results: Experiments and experience will alone guide the operator to best results. The leaf comes out white against a black background, with the stems and veins in fine black lines. Even the cell structure may be brought out if the leaf is not too opaque."



MR. HERBERT MATTER, the famous and widely traveled Swiss photographer, whose work has created quite a sensation in this country and abroad, writes:

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THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 393)

more precise measure is needed since the human judge has been shown to vary in his judgment under different conditions within the same day—for that matter within the same hour.

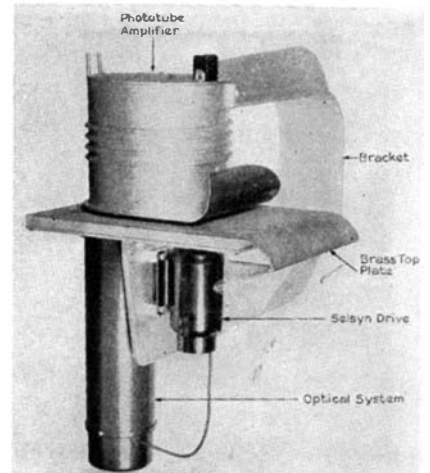
Many factors probably influence meat flavor—physical, chemical, and psychological. The texture, the degree of tenderness, and the juiciness of a piece of meat have much to do with a human judge's reaction. His own experience, his physical and mental condition also have influence. It is believed the chemical nature of the extractives responsible for flavor hides some of the secret.

The chemistry of meat flavor is extremely difficult to measure since the compounds responsible for flavors seem to be present in minute amounts. It has been established with considerable certainty that flavor carriers are water soluble. They are products of enzyme action or of oxidation due chiefly to heat and are much more in evidence in cooked meat than in raw meat. The chemical make-up of these compounds and their behavior under subjection to enzyme action and oxidation remain to be learned.

Blindfolded judges have found that the better known meats—beef, veal, pork, and lamb—cannot consistently be differentiated, and that pork and beef have the most intense flavor. Aging and ripening of meats have always been considered as developing new, and to some, more appealing flavors. The southern ham is a good example of this practice. The new flavors are apparently due to disintegration products of protein and fat brought about chiefly by enzymes.

TO REMOVE SKEW FROM COTTON CLOTH

WITH the increasing demand for better quality cotton fabrics, the textile industry is faced with the problem of producing uniformly straight cloth at higher speeds. As an important aid in meeting this demand, General Electric has developed a new photo-electric control for operating a cloth-straightening device which removes skew (deviation from straightness) from cotton cloth during the tentering or stretch-

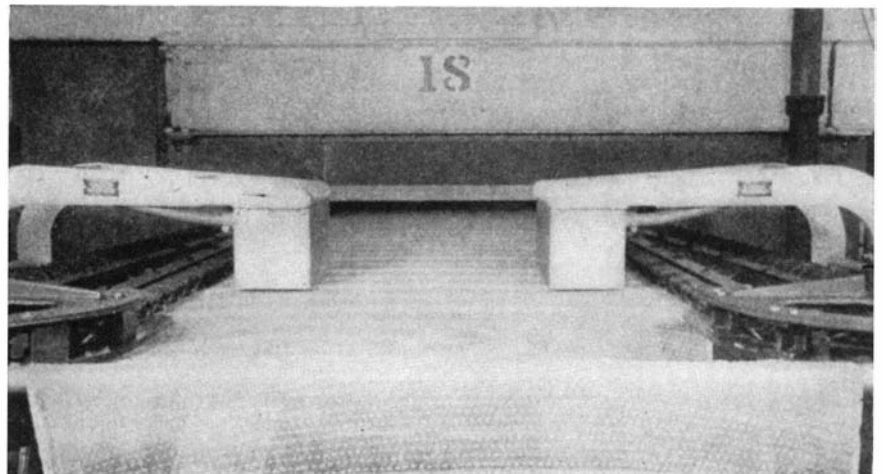


The weft-straightening control, using a photo-cell and light source

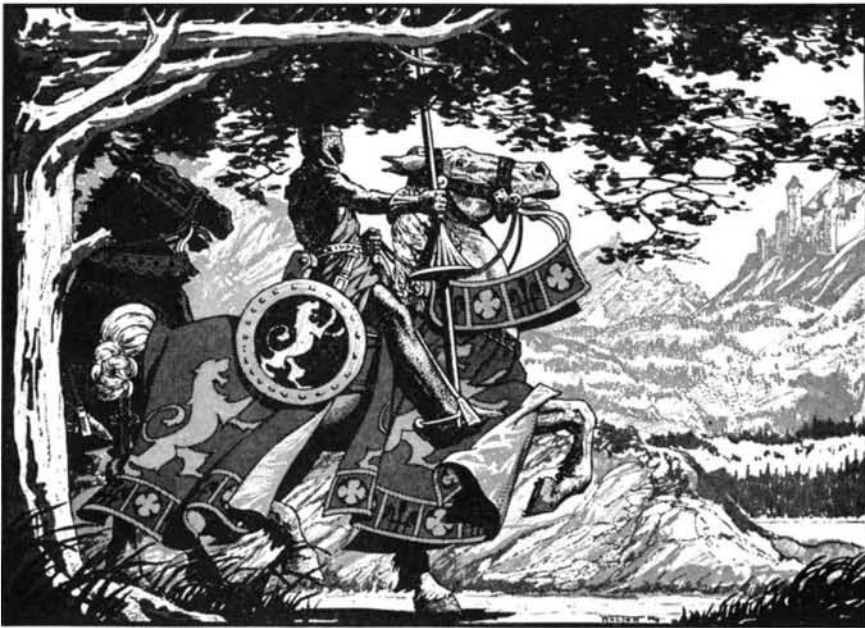
ing process. Where patterns are to be printed on a cotton fabric, it is additionally important that the weft, or crosswise threads, be square with the warp, or lengthwise threads, because figures or patterns printed on a distorted weave will themselves be distorted when the printing process is complete. The new control, which assures straighter cloth at higher speeds, also reduces operator fatigue.

The operation of the new control centers around two photo-cells which are mounted over the cloth, one on each side of the tentering machine. Light sources are located beneath the cloth and directly under the photo-cells. As the cloth progresses through the tenter, the cells receive an equal number of light flashes between threads if the cloth is straight. If the cloth becomes skewed, however, one tube receives more frequent light flashes than the other. In consequence, the frequencies on the tubes will be unequal and, by means of amplifiers and a frequency responsive circuit, this inequality of frequencies will operate relays which, through a magnetic switch, control the operation of a straightening motor. This motor, in turn, advances or retards one edge of the cloth with respect to the other, thereby removing the skew.

The control is sensitive over a wide range of operation. Cloth speeds may vary from 20 to 140 yards per minute, and the weft-thread count may vary from 20 per inch in open woven curtain material to 100 per inch in closely woven shirting. Several installations of the new control are already in suc-



The long arms carry the weft-straightening control units



An example of work done with the drawing-toning paper described below

cessful operation, functioning as an important part of complete weft-straightening equipment built by the Winsor & Jerauld Manufacturing Company.

WASHING DISHES CLEAN

THE addition of sodium metaphosphate to the water used in dish washing machines not only softens the water but materially improves the cleanliness of the dishes. A recent study of the problem of dish washing at the Mellon Institute of Industrial Research has developed the fact that bacteria are frequently trapped in the insoluble soap which deposits as a film on dishes washed in hard water with ordinary soap. The usual water softening agents (trisodium phosphate, sodium carbonate, and so on) form precipitates with the calcium and magnesium in the water, and these similarly trap bacteria. Although its bacteriocidal action is not great, sodium metaphosphate makes dishes cleaner and freer of bacteria by preventing the formation of films or precipitates with the salts present in the water.—D. H. K.

DRAW AND TONE

A NEW drawing paper, which provides halftone effects so that commercial artists and layout men in the graphic arts may improve greatly upon line cuts and yet get their engravings at line-cut cost, has recently been placed on the market. This new paper, called "Doubletone," is sensitized with chemicals that are not visible until they have been "developed" by other chemicals laid on with brush or pen.

In using Doubletone, sketches are made the same as on any other drawing paper. Then the dark tones are brought out with a dark tone developer. After these are developed, light tones are brought out by the application of a light tone developer. In both cases, the developers are blotted as fast as they are applied instead of being permitted to dry. The result is that the artist can practically create a highlight halftone in the original drawing. In fact, four shades can be produced—white, black, and two tones of gray.

This new paper is particularly useful at points where Ben Day effects are desired, yet the cost is considerably less. An accompanying illustration gives an idea of the effects that can be obtained.

LABOR!

JAPAN has just drafted a bill to make an 84-hour week universal in Japanese industry as a means of improving national health, according to the *Associated Press*. It is noted further that a 15-hour day has been usual during the present boom in the munitions industry.

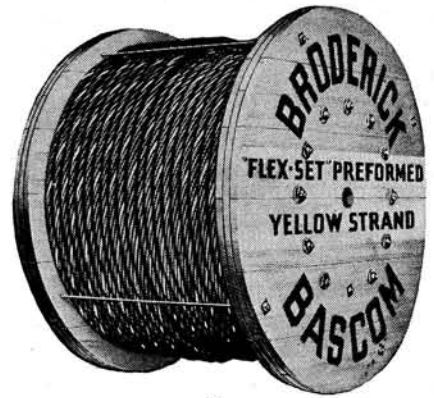
CHEAPER LITHIUM

BY utilizing a new process to recover lithium from its ores, this valuable element is expected to be made more useful and cheaper. The most plentiful ore of lithium is spodumene, a complex lithium aluminum silicate which occurs in South Dakota, North Carolina, and Maine. Usually it is associated with other minerals and the new process developed by the United States Bureau of Mines makes its separation in relatively pure form quite simple.

The process consists of heating the mineral in a lime kiln which converts spodumene to a chalky white mass that crumbles easily to a powder without similarly affecting other minerals mixed with it. By sifting the resulting powder away from the larger particles of other minerals, a dust of the lithium mineral of 80 to 90 percent purity is obtained. In this form it is easily adapted to chemical treatment. The process is so simple that it can be carried out in small homemade kilns and is expected to make lithium compounds much cheaper and thus broaden their usefulness.—D. H. K.

STAPLE FIBER, NEWEST IN RAYON

FOR years rayon was produced and used exclusively in the form of a bundle of continuous filaments twisted together to



THE Heritage of Longevity

What is it that makes one man outlive another—that makes one business outlive another—that makes a machine, a shoe, a wire rope, outlast another?

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This firm, which has enjoyed 61 years of continuous business success, certainly possesses that quality which makes for long life. And it is but natural that this "heritage of longevity" should have been imparted to its products. Yellow Strand, the wire rope with one strand of yellow, has always displayed conspicuously long life under the most severe operating conditions.

Now this same Yellow Strand is given the many advantages of "pre-forming," a method of manufacture during which the wires and strands are permanently set to the helical form they occupy in the finished rope. This gives an already long-lived rope still longer life by endowing it with properties not possessed by any rope of standard construction.

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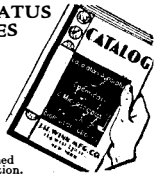
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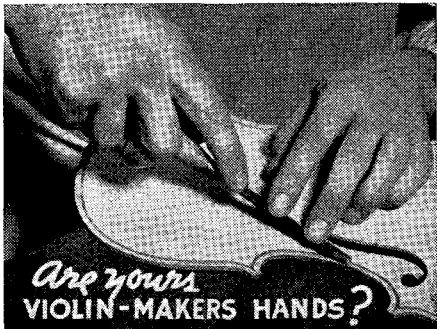
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produce rayon threads. Recently, increasing quantities of rayon have been appearing in fabrics in the form of staple; that is, short discontinuous filaments twisted together in a manner similar to cotton or wool threads. Initiated by countries that wished to be independent of King Cotton and Queen Wool—for example, Italy and Germany—the development has spread rapidly to all the larger rayon producing countries. Staple rayon constituted only 1.5 percent of the world's total rayon production for 1930. It rose to nearly 21 percent in 1936, in spite of a 233 percent increase in the total rayon produced during the same period.

Developed originally as a substitute fiber, it is rapidly carving a textile niche of its own. It was discovered that alone or mixed with cotton or wool it produces a soft, fluffy fabric of subdued luster having good strength, handling, and draping qualities. In blends it may be cross dyed with interesting results. Entering a market in which novelty, style, and surprise dominate, rayon staple is proving to be a fascinating and effective tool in the hands of fabric designers and stylists.

As a man-made fiber, its future is limited only by the boundaries of imagination. It can be produced in any size filament or length staple or degree of luster. For rayon staple to improve in quality and strength and to be modified to meet varying requirements would simply be carrying forward the tradition of rayon itself.

The market price of rayon staple is approximately one half that of continuous rayon. In place of the usual thread of 40 or 100 filaments collected in a separate package and processed separately, the staple thread begins with 1300 to 2000 filaments. Then over 100 of these are gathered into one "tow," which can be either machine-cut to the desired staple and then processed in bulk form, or else processed in "tow" form and then machine-cut to staple length. Enormous productions are possible at low machine and labor cost.

Rayon staple is quoted at about twice the figure for raw cotton. However, some reduction in production cost is still probable. A more complete recovery of chemicals and a more efficient equipment for producing "spinning dope" should not be far away. However, with the 1936 rayon staple consumption in the United States only 0.7 percent that of cotton, there is no great rivalry between the two. Rayon has always assisted the sale of cotton in most markets and the case of rayon staple will doubtless be no exception.

APE THAT ATE LIKE MAN PUZZLES SCIENCE

WHERE, oh where, on man's family tree to hang an ape-brained creature with strangely human teeth. This problem ape that ate like a man was recently thrust into the scientific limelight at the International Symposium on Early Man in Philadelphia.

From South Africa, where it has rested in a cave for thousands of years, the extraordinary skull of this ape has emerged into a world that has living apes and men, but not missing links like this.

Dr. Robert Broom, of the Transvaal Museum in Pretoria, reported his recent finding of the skull, and displayed a cast so that his fellow pre-historians might inspect the long, narrow chimpanzee type of skull with mea-

ger brain capacity, and the almost human mouth.

Dr. Broom tentatively gives this ape the distinction of revealing a new species. It bears the name Australopithecus Transvaalensis Broom. It lived, he has reason to believe, about the middle of the Old Stone Age or even the latter part. And that is one of the most puzzling suggestions about it. For by that time in pre-history, men were no novelty on earth. Various species of man had evolved and some had already become extinct. If this South African ape was on the way to human evolution, it must have started extremely late. And it never arrived. Dr. Broom told of unearthing the skull while he was searching South African caves in hope of solving another ape puzzle. Twelve years ago, Prof. Raymond Dart had announced the startling discovery of this other ape, called the Taungs ape, which he considered the long-looked-for missing link, and a near common ancestor of ape and man. "As the Taungs skull belonged to a child ape, four or five years old," said Dr. Broom, "this was not entirely convincing to the scientific world, and it seemed necessary if possible to get an adult specimen."

Comparing the Taungs skull with the one now revealed, Dr. Broom said:

"The skull is manifestly closely allied to the Taungs ape, but I am placing it in a new species because the associated mammals are all different, and I think later."—Copyright 1937 by Science Service.

POCKET CHANGE

DURING the first five months of the fiscal year 1936-37, the Treasury Department put into circulation 27,939,000 dollars' worth of halves, quarters, dimes, nickels, and pennies—more than the total for the five fiscal years beginning 1930. The biggest increase was in nickels of which few were produced in depression years and only 1000 dollars' worth in 1932.

SYNTHETIC RESIN BEARINGS

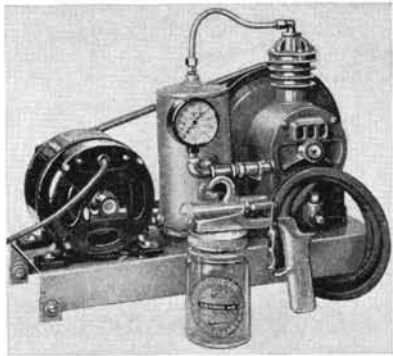
TRAVELERS recently returned from Germany report the wide use of synthetic resins to form bearings of even heavy machinery. The point in this practice is to reduce the necessity for importing into Germany metals customarily used in rabbit and bronze bearings. Synthetic resin bearings can be lubricated with water instead of oil and are said to be giving satisfactory service under a wide variety of conditions of loads and speeds.—D. H. K.

SCIENCE PROMOTES PEACE NOT WAR

SCIENCE, instead of promoting war, actually holds the key to the ultimate solution of the problem of peace, Dr. C. C. Furnas, Yale professor of chemical engineering and author of "The Next Hundred Years," recently told the American Institute in New York, notes Science Service.

"It takes a long-time view to believe this," he explained, "but it is true even if slow." Some feel that science is merely an in-

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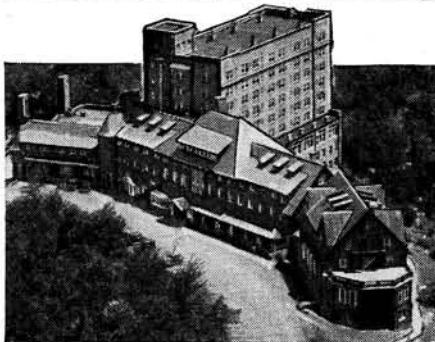
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strument of suicide because of its contribution to the deadliness of war, he said. The mob-stirring abilities of super-nationalistic maniacs do not seem to him to be dependent in any way upon the effectiveness of science. They can act more quickly than they used to but they will be eliminated more quickly too.

“Modern war with its destructive potentialities is no more destructive of life than the old fashioned kind—with its attendant pestilence,” Dr. Furnas continued. “The Thirty Years War with the crudest of weapons succeeded in laying waste northern Europe and directly causing the death of between eight and twelve million persons, more through starvation and pestilence than combat. A race bent on suicide will turn the trick if it has to resort entirely to stone axes.

“Modern equipment increases the speed of the reaction but doesn’t change the final result. Science further holds this important ace—it has the ability to reduce economic pressure because productivity per man, per acre, per hour, per anything is rapidly increasing; hence in the long run there will be a gradual diminution of economic pressure in certain groups. Since Germany can and is making nitrate fertilizers from the air, artificial rubber from limestone and coke, motor fuels from coal, there is less high-pressure demand for these commodities than there would otherwise be. The demands of peoples are gradually being limited to a few basic commodities such as coal, iron, lumber, cotton, and potash. It simplifies the picture of international relations and demands, hence raises hopes of peaceful solutions.

“Economic pressure is one, if not almost the sole fundamental cause of war. It is only through the application of science that we can hope to have a universal standard of living high enough to ease this pressure which is the virus of the greatest mental disease of the world.”

Dr. Furnas said that science and technology are taking us toward a longer and better life and doing it relatively swiftly. If the world can for a short while keep the super-patriots from cutting the jugular vein of civilization, he believes we shall find applied science leading us into the wide rolling sea of the good life.

“Only the most rabid optimist could say that life is yet ‘good’ for the average man,” he said, “but give us time and it will be. The critics of science are impatient. The scientists are just beginning to get steam up. With the help of the crowd, or perhaps in spite of it, they will soon begin going places.”

FISH RESEARCH PROJECT

THE first co-operative research project in the management of fish in the United States has recently been initiated at the University of Michigan by the American Wildlife Institute of Washington, D. C., according to a recent communication from this Institute. This project is under the supervision of Dr. Carl L. Hubbs, Curator of Fishes of the Museum of Zoology, University of Michigan, and a member of the Technical Committee of the American Wildlife Institute.

Karl F. Lagler, graduate of the University of Rochester, is in charge of the work which will undertake a study of the enemies of fish and their control to permit a greater

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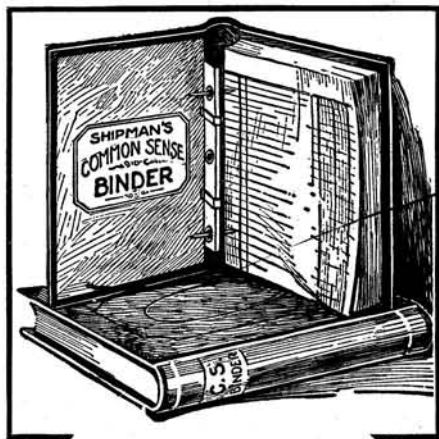
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production of game fish for anglers. This study will devote most of its time to the enemies of trout.

Predation of one wild species on another is a subject of great controversy. The present project is designed to find out positively, in a thoroughly scientific manner, unbiased by prejudice or predilection, just what enemies are serious factors in the lives of trout and what is their effect, for good or bad. Further, where the influence of certain trout enemies is found to be bad, it will attempt to ascertain deterrent measures without resorting to killing.

The striped bass is the subject of another study being undertaken under the American Wildlife Institute's program at Yale University, under the direction of Daniel Merriam. This bass is of great importance as both a commercial and a game fish on the Atlantic coast and on the Pacific where it was introduced from the eastern seaboard many years ago. Uncontrolled take has reduced this fish alarmingly and the present study is being undertaken to determine means of restoring and maintaining this valuable species, in more nearly adequate numbers.

HOUSEHOLD HIKER

THE average housewife walks some five miles daily in the pursuit of her household duties, says *Food Industries*, adding: "Probably at least two miles is in pursuit of a can opener."

**MACHINE ENGRAVES 300
LEGIBLE CHARACTERS IN
.005" CIRCLE**

EVERY few years we read in the daily press about the remarkable feat of some engraver who has inscribed by hand the Lord's Prayer on the head of a pin. Now a machine comes along which far eclipses this achievement, and demonstrates beyond question the superiority of the machine over hand craftsmanship, by engraving the prayer on a pin point.

The feat was accomplished at the plant of the George Gorton Machine Company at Racine, Wisconsin, at the suggestion of the National Machine Tool Builders' As-

sociation, using a standard Gorton duplicating machine. The machine engraved all 300 characters within a circle .005 of an inch in diameter, about twice the diameter of a human hair, or equivalent to the point of a rather dull pin. A pantograph arrangement was used, by which the prayer, which had previously been printed within a circle about two inches in diameter, was duplicated in these microscopic proportions.

These machines are used industrially for reproducing dies, molds, and the like.

**MINERAL STICKS ITS
"FINGER IN THE DIKE"**

A SCIENTIFIC mineral counterpart of the legendary Dutch boy who stuck his finger in the dike and saved the Netherlands from disaster, was described at a meeting in New York of the American Institute of Mining and Metallurgical Engineers. Engineers are already using the mineral to seal dams and the walls of reservoirs, declares *Science Service*, and the possibilities of use in levees along the Mississippi and Ohio Rivers cannot be disregarded.

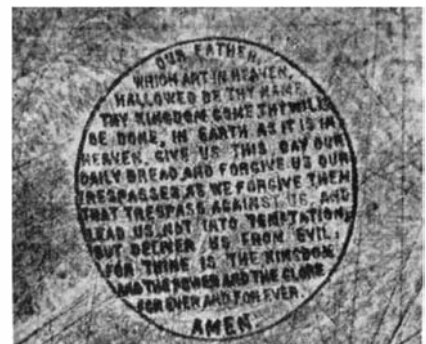
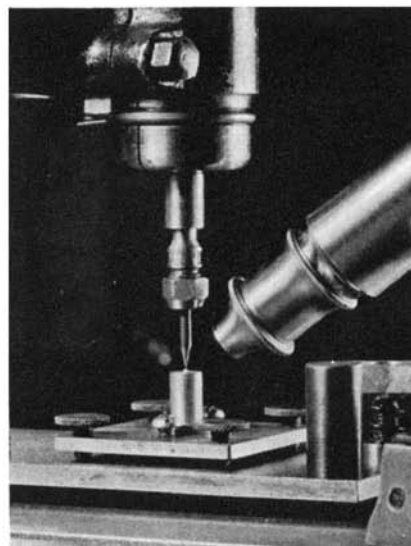
The sealing mineral is known as bentonite, a form of clay, which has the curious property of absorbing from three to seven times its volume of water and expanding to more than six times its original volume.

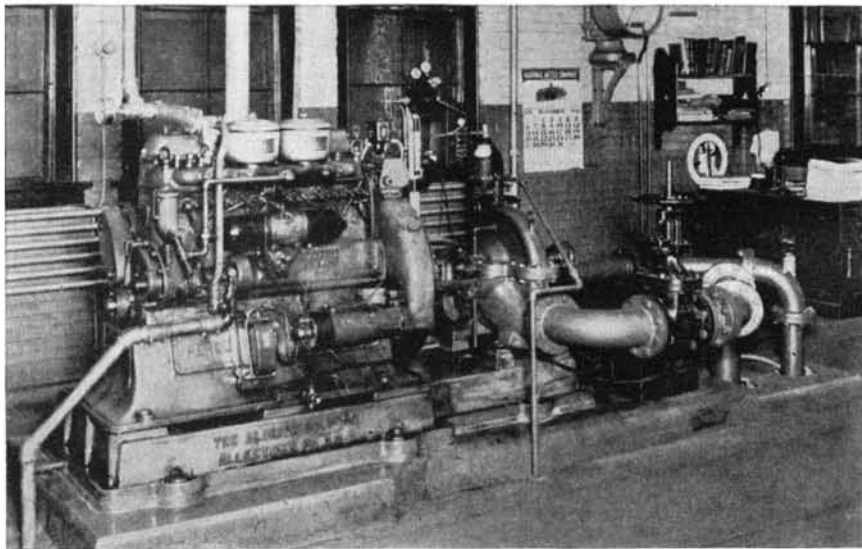
Oliver Bowles, U. S. Bureau of Mines, and chairman of the Institute's Industrial Minerals Division, told how a soupy mud is made of bentonite and forced, under pressure, into sand or gravel beds.

The slurry, as the engineers call it, coats



Above: The machine with which extremely fine engraving is done. Below: Enlargement of engraving in a .005 inch circle. At left: Close-up view of the engraving point and the microscope through which the progress of the work is followed





Interior of the fully automatic Diesel water-pumping station

the grains of sand or gravel, fills the voids between them and makes the whole mass water-tight even under high pressure. When drying occurs, the bentonite shrinks and clings tightly to the sand or gravel. But as soon as leakage occurs the bentonite takes up the water, swells again and reseals the entire mass.

the automatic controls have released the engineer for other duties and consequently effected a considerable savings in operating costs.

The plant not only maintains automatically the desired pressure differential in the pumping system, but supplies as a by-product all the heat required to maintain the pumping station temperature at 70 degrees.

KILLERS

CROWNED hawk-eagles, large birds of the South African forest, are big, heavy, ferocious; their very appearance inspires terror. A favorite prey is monkeys; simian skulls frequently litter the ground beneath their nests. They kill with a sudden blow of their large feet.

FIRST AUTOMATIC DIESEL PUMPING STATION

ON December 7, 1936, the Municipal Pumping Station at North Easton, Massachusetts, completed its first full year of operation with power supplied entirely by Diesel engines. This station was the first in the country to have a fully automatic, Diesel-driven centrifugal water pumping unit.

The unit consists of a 600 g.p.m. Aldrich centrifugal pump directly connected to a six-cylinder Hercules Diesel engine, operating at 1400 r.p.m.

The results of the first year's operation proved the complete satisfaction of Diesel power for pumping station installations. According to George B. Bailey of The Thermal Engineering Company, which made the installation, the Diesel engine has required a minimum of maintenance expenditure while operating over a period of more than 1800 hours, and starting and stopping six to eight times daily. With a fuel cost of 5½ cents per gallon, the Diesel unit operates at a cost equivalent to electric power at less than one-half cent per kilowatt hour.

The automatic feature of the plant is a decided step forward in Diesel engine water pumping. Prior to the development of the special automatic control equipment the continual presence of an attending engineer was necessary. At the North Easton plant

HUMIDITY CHANGES KNOCK VALUES

VARIATIONS in the humidity of the air fed to carbureters of test engines apparently cause wide differences in the anti-knock rating of the fuel tested. The improved performance of automobile engines at night and in foggy weather when humidity is high has been noticed by most automobile drivers. Recent investigations have shown, however, that humidity affects the performance of different fuels quite differently, so that unless tests are made with a constant humidity in the air they may show a variation of several units in the octane number of the fuel.—D. H. K.

INGENIOUS RUBBER THREAD PROCESS

A NEW process for making elastic rubber thread from latex has been developed and put into commercial use. Heretofore, such thread has been made by forcing latex through an orifice and coagulating the filaments in a chemical bath, whereas the new process employs neither orifice nor bath, but forms the thread by picking up the latex in grooves on a heated cylinder.

The grooves are carried on continuous ridges, so placed that, as the cylinder rotates, the grooves contact the latex in a constant level tank disposed below the cylinder. The grooves are filled by the surface tension of the latex and capillary attraction, and the filament so formed is dried by the heat of the cylinder. After a 270-degree rotation of the cylinder, the thread is stripped off, passed through a dusting bath and wound on a spool. The product of this process is known under the registered trademark "Filatex."

Claims made for this process are that it simplifies the machinery of manufacture,

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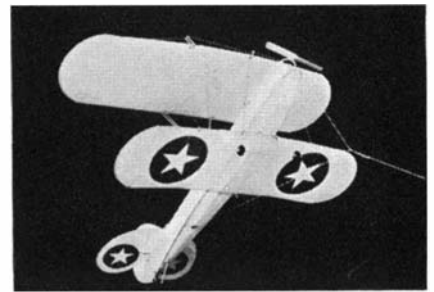
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that it does away with coagulating baths and requires less manipulation of the latex, thus leaving its natural strength unimpaired.

Since the commercialization of this process, still another method has appeared. It is Italian in origin and calls for flowing the latex into grooves etched in the surface of a heated cylinder from a super-imposed tank, then stripping by means of a roller, and finally passing the thread through a hot water bath and drying chamber before winding.



A kite—not an airplane

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QUEER LIVELIHOODS

THE Census Bureau's manual of occupations lists about 25,000 ways of earning a living, but it overlooks mattress walkers, says the *Associated Press*.

Dr. Vergil Reed, acting director of the bureau, vouched, however, for this exclusive group.

He said that there are at least 100 professional mattress walkers in the country, earning their way walking the kinks out of mattresses. They stamp extra hard on hard spots, he said, and put the new mattress into a flat, even state.

Even Dr. Reed didn't know the duties attendant on some of the obscure occupations the manual lists.

Some which pique the imagination are "bogeyman," who works in glass factories; "secret hand," who adds a note of chill mystery to the rubber industry; the "fat man," connected with the printing business, and "tooth knocker out," who helps in meat packing houses.

Stickers-up, said the expert, pile pottery over the fire; spooners clean out holes for dynamite in coal mines; speeders run a species of textile spinning frame; neckers do about what one might expect, to sweaters in knitting mills; knifers-up have a place in shoe factories.

Knockers-down, off, and out, and crackers-off and open, earn livings in glass factories.

AIRPLANE KITE

MUCH of the original research that led to the development of the airplane was done with the aid of kites. Airplane development since then has gone far; the child has outgrown the parent, and kites have not kept pace. It is interesting to note, therefore, that a kite has now been developed which not only simulates the airplane in appearance but also performs many of the stunts that an airplane can do in the air.

Those who have seen the Trevor Wonderplane in the air say that at a moderate height it is mistaken by observers for an airplane which, strangely enough, seems to remain practically stationary. By simple manipulation of the restraining cord, it will perform loops, barrel rolls, nose-dives, and side-slips.

Two models of this plane, one 56½ inches across the wings, and the other 46 inches, come in knock-down form ready to be as-

sembled by the amateur. The plane-kite can be flown in fields that are too small for ordinary model flights, since it does not require a large space for take-off.

VITAMIN D IN MENHADEN OIL

COD-LIVER and other oils of high vitamin content have become expensive as constituents of poultry feeds. In the search for cheaper oils to be given chickens it has been found that the oil pressed from menhaden, a fish caught in large quantities on our Atlantic seaboard, has a high vitamin-D potency. Menhaden oil, which is used in the manufacture of certain paints and varnishes, is considerably cheaper than cod-liver and sardine oils for poultry feeding purposes. Strangely enough, young fish of low oil content yield a better grade of oil than fat, full-grown fish.

IF GORY FINGERNAILS ANNOY YOU

BECAUSE daylight is white light, man has a prejudice against colors such as sodium's yellow. Yet they are sometimes useful. One illuminating engineer installed a sodium lamp in his office. His secretary at first emphatically disliked the effacement of colors other than yellow. But she became accustomed to it. The engineer said that red on the secretary's fingernails did not look half so bad as it did under ordinary light.—*Science Service*.

PAPER FROM STRAW

SO successful has been the manufacture of pulp and paper from wheat straw, using chlorine as the pulping agent (Pomilio process), that the plant now in operation in south Italy is to be enlarged to supply 150 tons per day of pulp. This is more than ¼ of the total paper consumption of that country and is part of the plan being pursued to make Italy independent of imports.—*D. H. K.*

WOODMAN SPARE THAT TREE—WITH RUBBER

ONE of the most interesting examples of the skill and ingenuity employed in the art of tree surgery is the project now in progress at "Monticello," famous Virginia home of Thomas Jefferson, which is maintained by the Thomas Jefferson Memorial Foundation as a national shrine. Surrounding the house are a group of beautiful trees which, it is said, this great statesman planted with his own hands. Now over a century old, many of them are rapidly deteriorating due to rot. To combat this condition, a new

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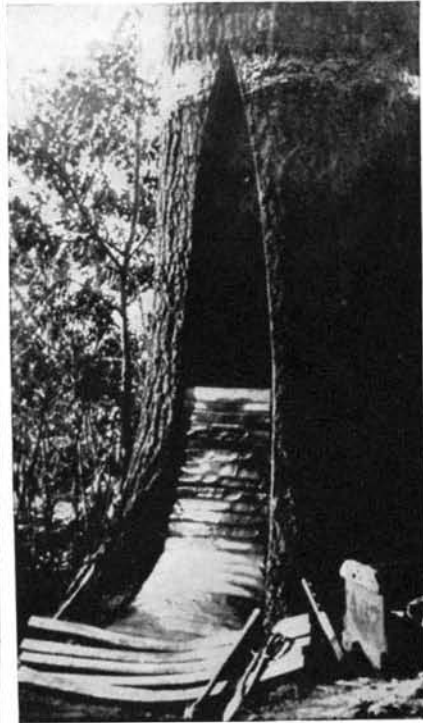
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form of tree surgery is used which employs rubber for sealing the cavities after they have been thoroughly scraped of all decayed wood.

Not satisfied with the materials generally accepted for this service, George Van Yahres, well-known eastern tree surgeon, began a search several years ago for one which would be more adaptable to nature's requirements. He reasoned, and logically so, that the ideal material should be one which most nearly simulated wood. Why not use a



Major tree repair, using rubber

product derived directly from trees? His first experiments were with cork. Although possessing most of the desired qualities, it was soon found that this material had to be specially waterproofed and treated to withstand the elements, insects, and birds. The added expense made the use of this material impractical in many cases. Mr. Van Yahres then started experiments with another product which comes from trees—rubber. A few test installations convinced him he was on the right track. He then submitted his problem to development engineers of The B. F. Goodrich Company, who supplied him a rubber specially compounded to withstand continuous flexing, long exposure to sunlight, and extreme temperature changes.

This special rubber is made up in strips about 1 1/2 inches wide by 1/4 inches thick. After the decay has been removed from the tree, the cavity is walled up with these rubber strips in much the same manner as bricks are laid. The strips are cut so that their length is slightly greater than the width of the cavity. This is done so that the ends of the strip will compress against the sides of the cavity to give an absolutely tight seal. One strip is laid upon another, each being cut so that it will exactly fit the contour of the cavity. As the wall of rubber is built up, the remainder of the space back of it is filled with a cementitious mixture designed to absorb all moisture and not shrink. The inside surface of the strips contains a series of small double dovetails which are embedded in the cement to prevent any possi-

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This is an hypothetical algebraic oblong root:
 $\sqrt{u^2 - 5u + 6} = \sqrt{(u-3)(u-2)} = (u-3)$ or $(u-2)$

That hypothetical formula merely illustrates the analogy of the idea "oblong root" to the idea "square root"; the formula does not define a determinate algebraic operation.

Squares and square roots are equivalent to algebraic rotations in the plane of complex numbers.

The plane of complex numbers floats in the space of bifoliate numbers.

Oblong powers and oblong roots, which are indeterminate operations in complex numbers, become determinate operations in bifoliate numbers and are equivalent to polyarithmic (nonalgebraic) rotations in the space of bifoliate numbers.

This is a polyarithmic oblong power:
 $(u-3\&2) \hat{=} (u-3\&2)(u-2\&3) = u^2 - 5u + 6$

This is a polyarithmic oblong root:
 $\sqrt{u^2 - 5u + 6} = \sqrt{(u-3\&2)} \hat{=} \sqrt{(u-2\&3)} \hat{=} (u-3\&2)$ or $(u-2\&3)$

This simple application of polyarithmic roots to the formal solution of quadratic algebraic equations may be extended to equations of higher degrees which are incapable of solution by means of the usual algebraic roots. This thesis is developed by Robert A. Philip in three monographs:

- MULTIFOLIATE NUMBERS.....Price one dollar
- MULTIFOLIATE SUBSTITUTIONS.....Price one dollar
- MULTIFOLIATE RADICALS.....Price one dollar

THE MONOGRAPHIC PRESS

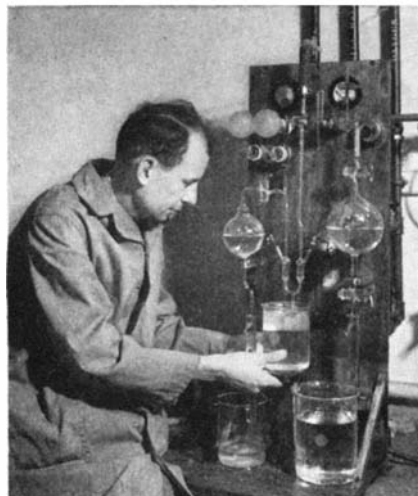
106 Washington St. Fairhaven, Mass.

bility of their pulling away from the filling.

The use of rubber is said to offer many advantages. It provides a simple but permanent seal against air, moisture, and insects. The great flexibility of the material enables it to sway and twist with the tree without cracking, and permits natural growth of the bark over the filled area. Appearance is improved, also, as the color of the rubber is in harmony with that of the tree.

WAGES

THE American steel industry pays wages that are from 120 percent to 650 percent above the average in foreign steel mills.



New electrolytic apparatus with which heavy hydrogen is produced

COMPREHENDING THE SIGNIFICANCE OF SCIENCE

RECOGNITION is growing that the history of science is one of the essential cultural disciplines. Courses in the subject are given at our important engineering schools and at several of the older universities which have long been strongholds of classicism. Scholarly books have begun to appear, and more popular books which unroll the drama of man's eternal quest for the truth and his persistent effort to turn to his perpetual advantage the new things which he has learned. These books are fascinating reading for any but sluggish minds: they appeal alike to the student of philosophy and to the lover of detective stories. Research is a high adventure.—*Industrial Bulletin* of Arthur D. Little, Inc.

ter to use in getting a supply of neutrons for the study of nuclear physics.

Outstanding features of the method are its simplicity and economy of operation. It requires only a small amount of heavy water, from three to five cubic centimeters, resulting in small waste, and a minimum of attention after operation begins. As seen in the accompanying illustration, the apparatus occupies a small space in the laboratory.

FACS

ALTHOUGH nine billion fewer cigarettes were manufactured in 1933 than in 1929, production jumped in 1934 to a point totalling six billion more than were manufactured in 1929. Growth since then has been continued and steady.

MOST POWERFUL MOTOR SIREN

A MOTOR siren which can be heard distinctly at a distance of eight kilometers (five miles approximately), and which is almost unbearable for people within a radius of 50 meters (164 feet), has been invented by Harald Ekman, a Stockholm engineer. Mr. Ekman has several other inventions to his credit, among them an automatic fire alarm system and a fire protection system using thermo-contacts, which are now manufactured by the L. M. Ericsson Telephone Company.

The new siren has proved to be 14 times stronger than any other previously constructed, and is estimated to be able to awaken a person sleeping within half a kilometer's radius. Experts consider that the Ekman siren solves the problem of giving effective alarm in case of air raids.

Tests have been carried out both in Sweden and in other countries. Competing against the noise of London traffic at a time when there was a wind of 10 meters (approximately 33 feet) a second, the sound of the siren was found to be audible at a distance of approximately five miles.—*Holger Lundbergh.*

HEAVY HYDROGEN BY SIMPLIFIED METHOD

USING electrolysis in an apparatus constructed entirely of glass parts, research physicists of the Westinghouse Lamp Company have devised a simplified method of extracting heavy hydrogen from heavy wa-

FUEL GAS FROM PULP WASTE

FUEL gas equivalent in heating value to approximately 400 pounds of coal can be obtained by the anaerobic (without air) fermentation of the waste liquor produced in the manufacture of each ton of paper pulp in a sulfite mill. This fuel gas can be obtained as a valuable by-product in the treatment of sulfite waste liquor to prevent pollution of streams. After fermentation, the liquor contains only lignin and can be dumped into streams without causing dangerous pollution.—*D. H. K.*

CERAMIC LABORATORY TABLE TOP MATERIAL

EXPERIENCE has shown that the materials commonly used in making laboratory table tops do not inherently fulfill in the highest degree the exacting requirements of such service. Wood, for example, is not fireproof; repeated applications of protective finishes are required in order that it may withstand chemical action. Asbestos, in any of its forms, is fireproof but it must have special fabrication to provide adequate strength and acid-resistance. Soapstone, one of the most generally used materials, does not long retain its smoothness and pleasing appearance because it is relatively soft and will crack or spall when subjected to local-

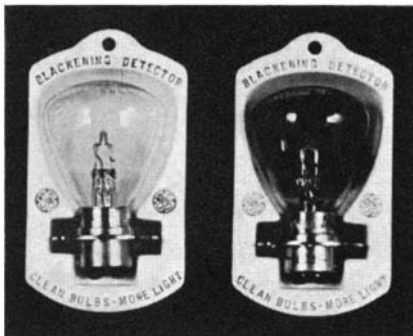
ized heating. Vitrified tile is used in many laboratories but, because it is produced in small sections, tops made from it have many dirt-collecting joints; it is difficult with tile to attain even a relatively smooth surface.

These considerations led to the thought that it might be possible to find a material that would have none of these disadvantages. Experimental work at Mellon Institute extending over a period of years resulted in the production of a porous, non-warping ceramic body that is impregnated with bituminous substances and then heated under special conditions to form coke in the pores. Unusually high resistance to thermal shock is imparted to the material because artificial cordierite, a mineral that has a very low thermal expansion, is used in making up the ceramic body.

Thus there was produced a material that can be polished to velvety smoothness, possessing sufficient hardness to resist scratching and abrasion, ample structural and impact strength, denseness that prevents absorption of liquids, resistance to solvent action and chemical attack, and the ability to withstand perfectly the effect of rapid heating and cooling. In other words, "Kemite," as it has been called, has none of the disadvantages of the commonly-used table top materials.

AUTO BULB "BLACKENING DETECTOR"

THE silent and oft-unheeded blackening warning that headlight bulbs serve before burning out, and which if unheeded leaves the motorist with a one-eyed car, may now be readily interpreted by means



Good

Bad

of an implement developed by the Incandescent Lamp Department of General Electric Company at Nela Park, Cleveland, Ohio.

The bulb-blackening detector is a small receptacle of molded plastic material into which the bulb to be tested is fitted and slowly rotated. The white background of the receptacle shows up any blackened portions of the bulb in bold contrast. Severe blackening is a certain indication that the bulb is rapidly approaching burn-out.

CONTROLLING SUNBURN

NUMEROUS products now being marketed prevent dangerous sunburn from summer or winter exposure, but at the same time also prevent healthful tanning of the skin. These treatments take the form of chemical compounds, usually complex salicylates, included in a lotion or cream applied to the skin. A recent advance in this field has been the development of a syn-

thetic compound to be used in this way which has a selective filtering action on the ultra-violet rays of sunlight. A layer as thin as 1/300 of an inch of preparations containing 3 percent of the new synthetic prevents injurious sunburn and at the same time allows enough ultra-violet to pass to create a healthy tan and to produce vitamin D in the skin. By combining the new compound with methyl or benzyl salicylate, the quality as well as the quantity of the healthful and harmful ultra-violet rays reaching the skin can be accurately controlled. It is reported that a healthful tan can be easily secured without danger of serious burns and without losing the value to be had from vitamin D formed in the skin. Many compounds heretofore used for this purpose are too effective in preventing burns and keep the skin white without allowing it to tan naturally.—D. H. K.

THE PROPHETS WOULD SCARCELY KNOW PALESTINE

AN account of electricity supply in Palestine since it was initiated in 1923, given recently in *Electrical Industries*, is of special interest in connection with the political rioting which began last April. The pioneer of this supply was Mr. P. Rutenberg, who enlisted the support of the late Lord Melchett and the Baron E. de Rothschild.

It was decided to have a national power supply from water-power, but as the rainfall for Palestine lasts only four months in the year, it was necessary to store the winter rainfall in reservoirs, the construction of which would take several years. It was advisable therefore to use temporary Diesel-engine power stations at Haifa and Jaffa to begin the supply, while the Dagania Dam across the River Jordan and the large one on the Tarmuck River were being constructed. In addition to these dams, Lake Tiberias, which forms a natural reservoir with a surface of 170,000,000 square meters, was utilized. The water-power is converted into electrical power which, by high-potential electricity, is distributed to Haifa and thence to the north and south of Palestine. In addition, a steam turbine power house was constructed in 1935 and a large power house is being built in southern Palestine.

When these plans are completed, the Holy Land will be as highly electrified as any territorial area in the British Empire. During the last three years, the consumption of electricity has quadrupled.

There can be little doubt that industrialization is rapidly changing the character of Palestine and that electric power is the main factor in producing this change. Electric lighting, electric power-driven machinery, and wireless sets are to be found in small towns, villages, and even in remote farming settlements. This is partly due to the fact that the immigrants, who come from Germany, America, Czechoslovakia, Austria, and the British Dominions, have been accustomed to the use of electric light in factory and home.

It looks as though schemes for flooding the Dead Sea from the Mediterranean and so getting electric power possibly for sale to Egypt will soon be considered. One very beneficial effect would be that the constant evaporation from the greatly increased surface of water would humidify the atmosphere and so contribute to the fertility of the region.—*Nature* (London).

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ocular adjustable	Body: Featherweight aluminum alloy with water-
Weight: 14 oz.	proof morocco grain covering
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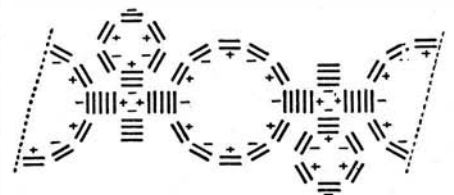
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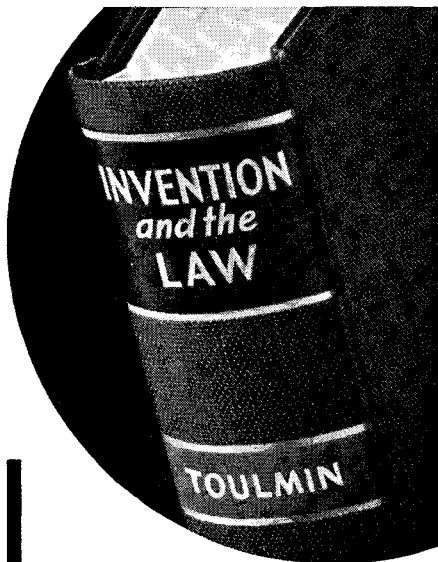
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Diborane molecule, B₂H₆. (Each line represents one vortex-ring, viewed edgewise.) Diborane has actually been prepared in the laboratory and is in perfect agreement with the vortex theory. Under the nuclear theory it could not exist because the nucleated boron atom has only three valence-electrons whereas diborane requires at least four. There is no catch or trick to this. The very existence of diborane flatly disproves the entire nuclear theory of atomic structure, and not even its endorsement by high authorities can save it. Copyright 1937 by Carl F. Krafft.

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CURRENT BULLETIN BRIEFS

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TECHNOLOGY AND THE AMERICAN CONSUMER is a brief discussion of the relation of machinery to consumer purchasing power as reflected in wages of factory workers and prices of manufactured goods. It is illustrated with simplified charts which drive home pertinent facts, and contains a definite series of conclusions regarding the effect of technological development as it pertains to the average man. *Machinery and Allied Products Institute, 221 North La Salle Street, Chicago, Illinois.—Gratis.*

BROWN FLOW METERS is a comprehensive catalog with numerous illustrations in color giving details regarding indicating, recording and integrating meters, both electrical and mechanical. The catalog will be of value to any plant executive who has occasion to make use of such instruments. *Write for Bulletin 637A, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MANUAL OF LATHE OPERATION AND MACHINISTS TABLES is a spiral-bound book with a sturdy, flexible composition cover, which will be invaluable to anyone who operates any type of lathe either in the home workshop or in industry. Index tabs make it easy to find any particular section of the book without having to wade through a mass of other material. The book is replete with photographs and drawings that explain the text, and presents tables of materials and other pertinent data that make it complete in every respect. *Atlas Press Company, 1822 North Pitcher Street, Kalamazoo, Michigan.—One Dollar.*

BUILDING A CAREER IN ARC WELDING describes a course in this subject that will give the student a thorough background in an industry which is constantly widening its scope. *Write for Bulletin 637B, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

AUTO DRIVING HAZARDS AND A PLAN TO OVERCOME THEM, by Dr. M. E. Streen, gives the author's proposed plan for reducing the reaction time of a motor-car driver, faced with an emergency, to what may be termed an irreducible minimum. This is accomplished by a mechanism which makes it unnecessary to shift the foot from the accelerator to the brake-pedal, and which also eliminates the danger of the "extensor thrust" reflex, which frequently makes the driver push down hard on the accelerator in an emergency just when he should be applying his brakes. *Dr. M. E. Streen, 908 Bergen Street, Newark, New Jersey.—25 cents.*

SOME CONSEQUENCES OF GRAPHITIC CORROSION OF CAST IRON, by W. A. Wesley, H. R. Copson, and F. L. Laque, is a reprint of an article which originally appeared in *Metals and Alloys*. It shows that the rapidity with which such corrosion sometimes occurs may be due to local galvanic effects, and shows how nickel alloy cast irons have favorable characteristics which will give better performance in many corrosive en-

vironments. *Write for Bulletin 637C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ELEVATOR WIRE ROPE presents interesting data on elevators and elevator rope and also provides a handy means of keeping records of elevator service. *Write for Bulletin 637D, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

100 YEARS IN FLUID CURRENT MOTORS is a small booklet that presents an historical survey of the development of the screw propeller, the magnus rotor, the Panama Canal, and the phenomenon of lift by autorotation. *Charles Cottingham, 918 Grant Place, N. W., Washington, D. C.—75 cents.*

HOW AND WHEN TO CONTROL INSECTS AND DISEASES ON VEGETABLES has been prepared to assist the grower in solving his insect and fungus disease control problems. The information is general in treatment since it is intended to cover the most troublesome pests found in growing areas throughout the country. *Write for Bulletin 637E, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ALIGNING PHILCO RECEIVERS, by John F. Rider, is a 136-page bound book covering specifically all the models of receivers made by this one manufacturer. It includes drawings of chassis layouts of each receiver and pertinent data on their adjustment. *John F. Rider, Publisher, 1440 Broadway, New York City.—One dollar postpaid.*

PLEASURE AND PROFIT WITH THE HANDEE is essentially an instruction book for the home workshop owner in the use of those little portable hand-size grinders that are becoming increasingly popular. The book tells how to construct various fixtures that will make the use of the grinder more flexible, and also gives many hints on doing work other than ordinary grinding. It also tells how to work with various materials, including plastics and metals, and devotes a couple of pages to the use of these little machines in working on automobiles. *Write for Bulletin 637F, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

LIGNUM-VITAE FACT FLASHES is a small folded publication which appears at regular intervals and which gives detailed data regarding this hardest of hard woods. Lignum-Vitae has many uses in various industries because of its hardness, weight, density, and close grain, as well as its self-lubricating and acid-resisting properties. *Lignum-Vitae Products Corporation, 96-100 Boyd Avenue, Jersey City, New Jersey.—Gratis.*

MODERN CORNELL DOORS—UPWARD ACTING describes and illustrates metal and wood doors and grilles suitable for closing all types of openings in shops, factories, and garages. *Cornell Iron Works, Inc., 36-20 13th Street, Long Island City, New York.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trademark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By **ORSON D. MUNN, Litt.B., LL.B., Sc.D.**

New York Bar
Editor, Scientific American

BELLIGERENT TROLLEY CAR

ATROLLEY car is generally regarded as an instrumentality of peace and quite remote from machine guns and similar implements of warfare. Nevertheless, in a recent decision of the Court of Customs and Patent Appeals, a patent for an ammunition counter on a machine gun was rejected on the basis of a prior patent for a motorman's recorder for a trolley car. The ammunition counter which was sought to be patented was designed to be used with a machine gun for indicating the number of rounds of ammunition fired by the machine gun. The Court of Customs and Patent Appeals found that a prior patent disclosed a similar counting mechanism for counting the rotations of one of the wheels of the trolley car to indicate the distance travelled.

The applicant for the patent on the ammunition counter for machine guns contended that trolley cars were so remote from machine guns that there was no relationship between the two and that he was accordingly entitled to a patent on his counter. The Court disagreed with the applicant, however, and held that he was not entitled to a patent. In reply to the applicant's argument as to the differences between machine guns and trolley cars, the Court stated:

"It does not seem to us that the broad difference between the arts of street car operation and machine gun firing are decisive of the issue here. The actual art is numbering or counting, with a display of the result at a desired location, and we regard such art as being the same in both * * * *"

FUTILE UTILITY

CAN a patent be obtained on a new use for an old machine? Inventors frequently ask this question and the answer is that, generally speaking, a new use for an old machine cannot be patented. If the new use amounts to a new process, the process can be patented. However, the old machine cannot be repatented merely because a new use for it has been discovered; nor can the normal function or mode of operation of the machine be patented. This principle of law frequently works hardships on inventors because at times the discovery of a new use for an old machine does require that spark of genius frequently associated with invention.

In a recent suit for patent infringement before one of the United States Circuit Courts of Appeals, the Court gave consideration to this question. The patent in suit

was for a surface condenser which the inventor described as operating in a particular way to produce a desired result. The Court found that a prior British patent disclosed a surface condenser of similar construction but which was intended to be operated in a different manner to produce a different result. The Court concluded that the patentee had merely discovered a new use for an old condenser and that the new use was not patentable. In this connection the Court stated: "It may require the spark of genius to discover a new use for an old machine, but the law does not make that patentable when, as here, it does not amount to a new process, since it is not any 'new and useful art, machine, manufacture, or composition of matter' or any improvement of them."

PUNCH BOARD SALES

AFEDERAL Circuit Court of Appeals recently sustained an order of the Federal Trade Commission directed against a candy manufacturer which, among other things, ordered the candy manufacturer to cease and desist from supplying punch boards or similar devices to dealers purchasing the manufacturer's candy.

The Court found that the manufacturer sold candy assortments consisting of a large number of uniform small candy bars of the size and kind usually retailing for five cents each and of a small number of larger candy bars. The purchaser of the assortment was supplied with a push card or punch board made of stiff pasteboard with covered holes in each of which was concealed a number. Certain of the numbers designated the larger size candy bars. For five cents a customer was entitled to uncover any number on the punch board and if he uncovered one of the lucky numbers he received a large bar. Otherwise he received the standard bar of the size generally retailing for five cents. The Court sustained the contention of the Federal Trade Commission that this was an unfair method of doing business and affirmed the order to cease and desist the supplying of punch boards to dealers and jobbers purchasing candy.

A prior decision of the United States Supreme Court had held that the use of the element of chance in selling merchandise was an unfair method of competition. The candy manufacturer contended that there was no element of chance in that the customer always received at least five cents' worth of good candy and therefore there was no possibility of loss to the customer. The Court disagreed with this contention, stating that the removal of all possibility of loss only made the incentive to play more

effective. In conclusion the Court stated:

"A method of sale which employs the element of chance as an essential feature is against public interest because it is in the nature of a gambling game" . . . and that "such a method is unfair competition because it places competitors in the position where they must unwillingly adopt such method or run the risk of losing business if they refrain from so doing."

ARTISTIC INVENTION

IS a design the product of invention or of artistic genius? Unquestionably a design is popularly considered to be an artistic creation. Nevertheless, as a matter of law, a design must be the product of invention to be proper subject matter for a design patent.

In a recent case decided by a Federal District Court, the Court held a design patent invalid as lacking in invention. The patent related to a design for an automobile radiator cover in which the cover was cut so as to fit over the lower portion of an automobile radiator. A slit provided with a "zipper" fastener extended from the top of the cover to a point below the center thereof and a pair of garnishing strips were secured from the upper corners of the cover to the center of the bottom thereof so as to form a V. The Court found that the radiator cover did not embody a patentable design, and in reaching this conclusion stated:

"Some exercise of the inventive faculty is as essential to the validity of a design patent as to the validity of a mechanical patent. * * * * In order to involve an exercise of the inventive faculty, a design must be shown to be beyond the range of the ordinary routine designer. * * * * To add to such a cover an ornamental V cannot be said to constitute invention."

BEWARE

THERE are operating throughout the country a number of corporations employing in their title the words "patent," "trademark," "design patent" or "copyright," combined with the words "specialist" or "bureau" in such a way as to give rise to the presumption that they are of an official or semi-official nature. In most instances the personnel of these organizations are not attorneys nor are they bound in any way by the ethics or standards of the legal profession. It has been the practice of such organizations to solicit the business world, offering to secure trade-mark registrations, design patents, and in some instances, but more rarely, patents.

A recent instance has come to our attention where one of these so-called "bureaus" advised a manufacturer that it could secure for him a monopoly on a certain dress design which had been used as a staple design by the trade generally for a period of years. Relying on this assurance the manufacturer invested heavily in seasonable materials. The Patent Office search did not disclose the design and a design patent was issued.

The natural result was that when the manufacturer attempted to secure an injunction restraining other manufacturers from making a dress embodying the particular design in question, his injunction was refused, and he found himself in the embarrassing position of having contracted for great quantities of material which he will be unable to dispose of.

Books SELECTED BY THE EDITORS

MATHEMATICS FOR THE MILLION

By *Lancelot Hogben, F.R.S.*

A NOTED scientist, not primarily a mathematician, wrote this book in a hospital during a long illness and for fun. His aim was to help millions who have "forgotten their mathematics" or who run when mathematics leers at them, yet secretly wish they could cope with the bogey. Many able critics think he has succeeded. Figuratively, instead of doing his best to keep the poor sufferer mystified—as many writers of mathematics textbooks do—he takes the scared-cat by the hand and leads him beside still waters. The main chapters are: Translating Number Language; Euclid Without Tears; Arithmetic; What We can Do with Trigonometry; Algebra; Logarithms; Calculus (which it really explains in plain language). This reviewer, one of the scared-cats, often suspects that many writers of books that make mathematics "easy" are cheerful liars, and that "painless" mathematics is of a piece with "painless" dentistry. But the present book comes closer to having a heart than any other he has seen. Still better, it hasn't the usual earmarks of those old school books but is a pleasant book to look at and handle—nice printing. 650 pages.—\$3.95 postpaid.—*A. G. I.*

SALT WATER FISHING

By *Van Campen Heilner*

SHEER joy of writing about a subject that has been virtually the author's whole reason for existence shows through every page of this 452-page volume. Covering all forms of angling in salt water from flounder fishing to the pursuit of monsters of the deep, the text is an easily readable combination of anecdotes and practical information. Almost 150 pages are devoted entirely to action photographs. Sprinkled through the book are 12 beautiful full color reproductions of paintings of fishing scenes. This volume is certainly a "must" for every fisherman's library.—\$5.20 postpaid.—*A. P. P.*

THE REALM OF THE NEBULAE

By *Edwin Hubble, Mount Wilson Observatory*

THE realm of the nebulae is the known universe beyond our own nebula, the galaxy; and this book shows, step by step through the stages of rea-

soning, how the astronomer attempts to work out its arrangement. It is not simple and is only semi-popular, nor on the other hand is it abstruse. In short, it is just such a book as an amateur astronomer who had already read seriously one or two textbooks of astronomy would regard as a nice piece of study, giving a semi-professional insight into professional astronomers' methods without getting in beyond the average man's depth, and coming out at the end on very familiar terms with the orderly wheels of the universe.—\$3.15 postpaid.—*A. G. I.*

IN QUEST OF GORILLAS

By *William K. Gregory, Curator of Comparative Anatomy and Ichthyology, and Henry C. Raven, Associate Curator Comparative Anatomy, American Museum of Natural History*

THE two authors describe an expedition across central Africa in search of a perfect specimen of a full grown gorilla for scientific study. The account contains numerous side-lights on natural history and geology of Africa, but is mainly a narrative of a grand trip, and a lively, most readable account at that. It has been chosen as a Scientific Book Club selection as well as a Book-of-the-Month Club recommendation.—\$3.70 postpaid.—*A. G. I.*

HANDBOOK OF ENGINEERING FUNDAMENTALS

By *a Staff of Specialists Under the Editorship of Ovid W. Eshbach*

TRAINED engineers will find this a "must" book for their libraries. It is not elementary but will give such men the essential facts plus the mathematics on practically any engineering subject.—\$5.20 postpaid.—*F. D. M.*

CHAMPLIN ON FINE GRAIN

By *Harry Champlin*

MR. CHAMPLIN reveals himself in this book as that rare combination of a scientist who is also able to write in the language of the man in the street. The author, whose formulas for fine-grain development of miniature films have created a sensation among amateur photographers, has worked conscientiously and productively over a long period of time on a problem that has

troubled a great many people. That he has now, with his head crammed with scientific facts unfamiliar to the average amateur photographer, been able to sit down and clarify the whole fine-grain problem so that anyone can understand it, makes the publication of his book news of first rate importance. His book describes various formulas in current use and explains how he compounded his own formulas, what ingredients they consist of, and why he used each particular chemical included. He explores the entire subject from A to Z and, incidentally, offers a complete handbook, remarkably compact, on the proper methods of making fine-grain negatives and printing enlargements from them. Besides containing an analysis of the various formulas which have been published by him from time to time, this book reveals for the first time anywhere his newest formula, Champlin No. 15.—\$1.90 postpaid.—*J. D.*

THE ROMANCE OF THE CALENDAR

By *P. W. Wilson*

A VERY readable account of the origins and development of the calendar, with full discussion of the question of calendar reform.—\$3.15 postpaid.—*A. G. I.*

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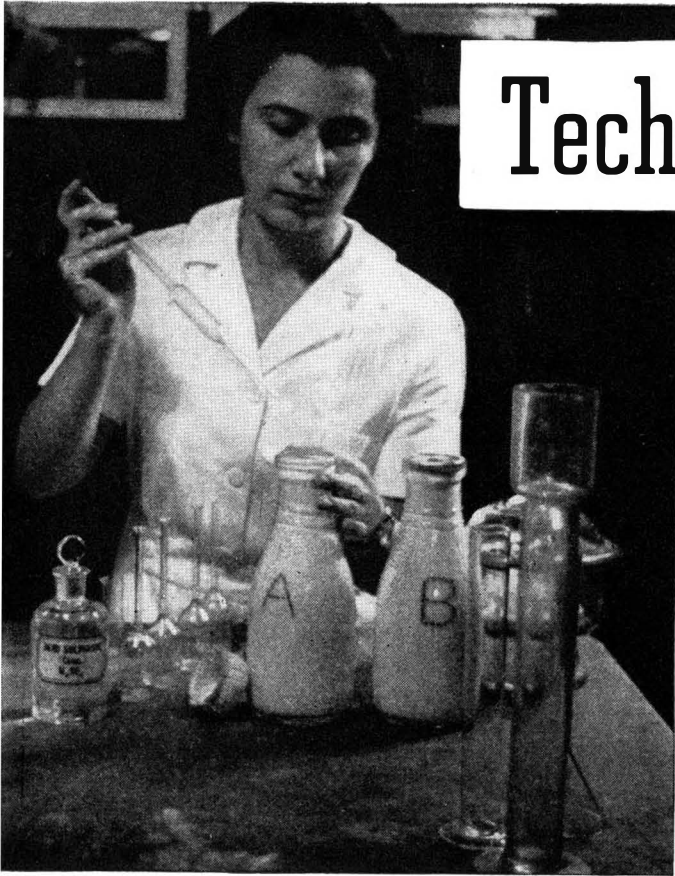
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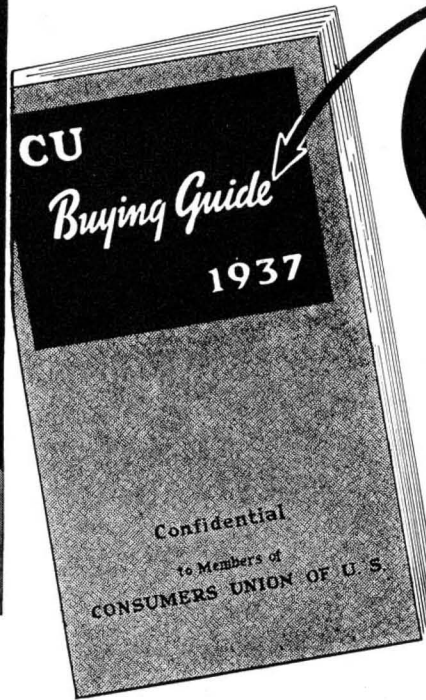
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(Digest of a medical report of an actual case of agranulocytosis, a disease caused by aminopyrine.)

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and VEGETABLES
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SHIRTS
LIQUORS and
WINES
MOTOR OIL
GASOLINES

MECHANICAL
REFRIGERATORS
MEN'S, WOMEN'S
and CHILDREN'S
SHOES
CEREALS
COLD & HEAD-
ACHE REMEDIES
COSMETICS
DRUGS
ELECTRIC SHAV-
ERS
FLOUR
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CHILDREN'S
CLOTHING
SOAPS
SHAVING SOAPS
and CREAMS
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Have you ever heard of agranulocytosis? Or aminopyrine? Probably not. The first is a disease, discovered only a few years ago and responsible for more than 1,500 deaths in the United States alone during a three year period. The second is a drug—the direct cause of agranulocytosis. It is contained in many widely-advertised headache and pain remedies. Despite warnings against its use by the medical profession and the United States government this deadly drug, under a variety of brand names, is sold freely in great quantities.

There may be aminopyrine in your medicine chest—without your knowing it. If you want to be sure that you're not unwittingly using this drug read the article on "Aminopyrine" in the April issue of *Consumers Union Reports*. Prepared by competent medical specialists, it tells what agranulocytosis is and lists by brand name a number of proprietary and patent medicines which contain aminopyrine.

What Consumers Union Is

A strictly non-profit, membership organization, Consumers Union was set up by consumers and is supported and controlled by them. It is sponsored by more than seventy widely-known scientists, educators government officials, journalists and other public-spirited people.

Each month in the 24- to 32-page *Reports* the members of Consumers Union receive *unbiased*, usable information on many types of products to guide them in their daily buying—with ratings, based solely on quality and price, in terms of brand names. In many cases information is given on the labor conditions under which products are manufactured.

The coupon on the opposite page is your invitation to become a member of this rapidly growing organization. The membership fee is \$3 a year (\$1 for an abridged edition covering only the less expensive types of products). It brings you: (1) Twelve issues of *Consumers Union Reports*; (2) the 240-page YEARLY BUYING GUIDE described above; (3) a vote in the control of the organization. You can start your membership with the current issue or with any previous issue as listed in the coupon. Start now to get the most for your money. Mail the coupon today!

CONSUMERS UNION

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Consumers Union Reports Rates Brands By Name as "Best Buys," "Also Acceptable," and "Not Acceptable."

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In Current Issues



Which of ten brands of widely-advertised washing machines operated the most satisfactorily in a test made for Consumers Union? Will any of the advertised moth preventives really protect your clothes?

What are the causes of constipation and what are the best methods of curing it?

What cold cream was described by the American Medical Association's Bureau of Investigation as "... a particularly blatant example of cosmetic quackery?"

What two automobiles were considered the "Best Buys" by Consumers Union's automotive experts after examinations of twenty-four 1937 models in the \$1000-\$3000 price range?

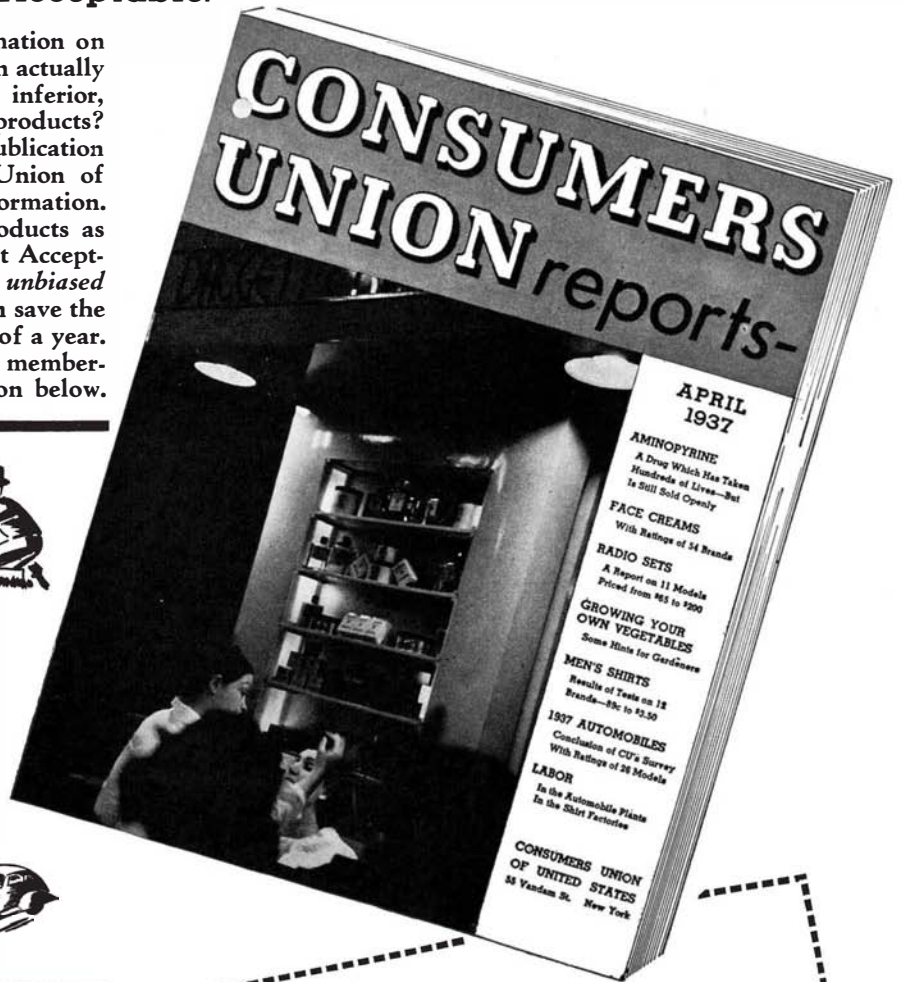
Which vegetables grow best in (1) clayey soil, (2) sandy soil? Which will endure the most shade? Produce the most food per sq. ft.?



These and dozens of similar questions are answered in reports in the April and May issues of *Consumers Union Reports* on washing machines, moth preventives, cold creams, automobiles, radios, men's shirts and other products.



Rating of widely-advertised brands are given *by name*. These issues also contain articles written by specialists in their fields on aminopyrine (a dangerous drug which has caused hundreds of deaths) and on gardening, constipation, fruit and vegetable prices and other subjects of interest to consumers.



In Early Issues

REPORTS, with ratings as "Best Buys," "Also Acceptable," and "Not Acceptable," of the following products will appear in forthcoming issues of *Consumers Union Reports*:

- Cameras and Photographic Supplies
- Cigarettes and Tobacco
- 1937 Refrigerators
- Razor Blades
- Golf Balls
- Trailers
- Electric Clocks

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- NOV.—Winter Oils, Radios, Toasters, Wines, Children's Shoes.
- DEC.—Fountain Pens, Electric Irons, Vacuum Cleaners, Blankets, Nose Drops.
- JAN.-FEB., 1937—Shaving Creams, Men's Suits, Cold Remedies, Children's Undergarments.
- MAR.—Autos, Face Powders, Sheets, Flour, Canned Foods.
- APR.—Radio Sets, Gardening, Autos, Shirts, Cold Creams, Aminopyrine.
- MAY.—Washing Machines, Constipation, Moth Preventives, Canned Peaches and Tomatoes, Spring Fruits and Vegetables, Insecticides.

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SA-6



The deepest chasms across the paths of product development have often been bridged by utterly new materials . . . conceived and compounded by Westinghouse engineers.

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cost only a few dollars a *pound*.

So it was that Konal helped to bring radio enjoyment within the reach of millions of families. And so it also was with Kovar, the new alloy that makes possible the modern all-metal radio tube — and with Micarta, and Hipersil, and Hipernik, and many other strange new materials, born of equal need, and fostered by Westinghouse research.

The need for such ventures into

plastics and metallurgy may sometimes delay an electrical development — but it has seldom caused a sound idea to be abandoned. Today, as for more than fifty years, Westinghouse scientists are starting new quests for the treasure that lies in research — often with the result that new electrical products create new industries, and distribute more wealth among the people of America.



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