The Poisons We Eat

By T. SWANN HARDING

SCIENTIFIC AMERICAN

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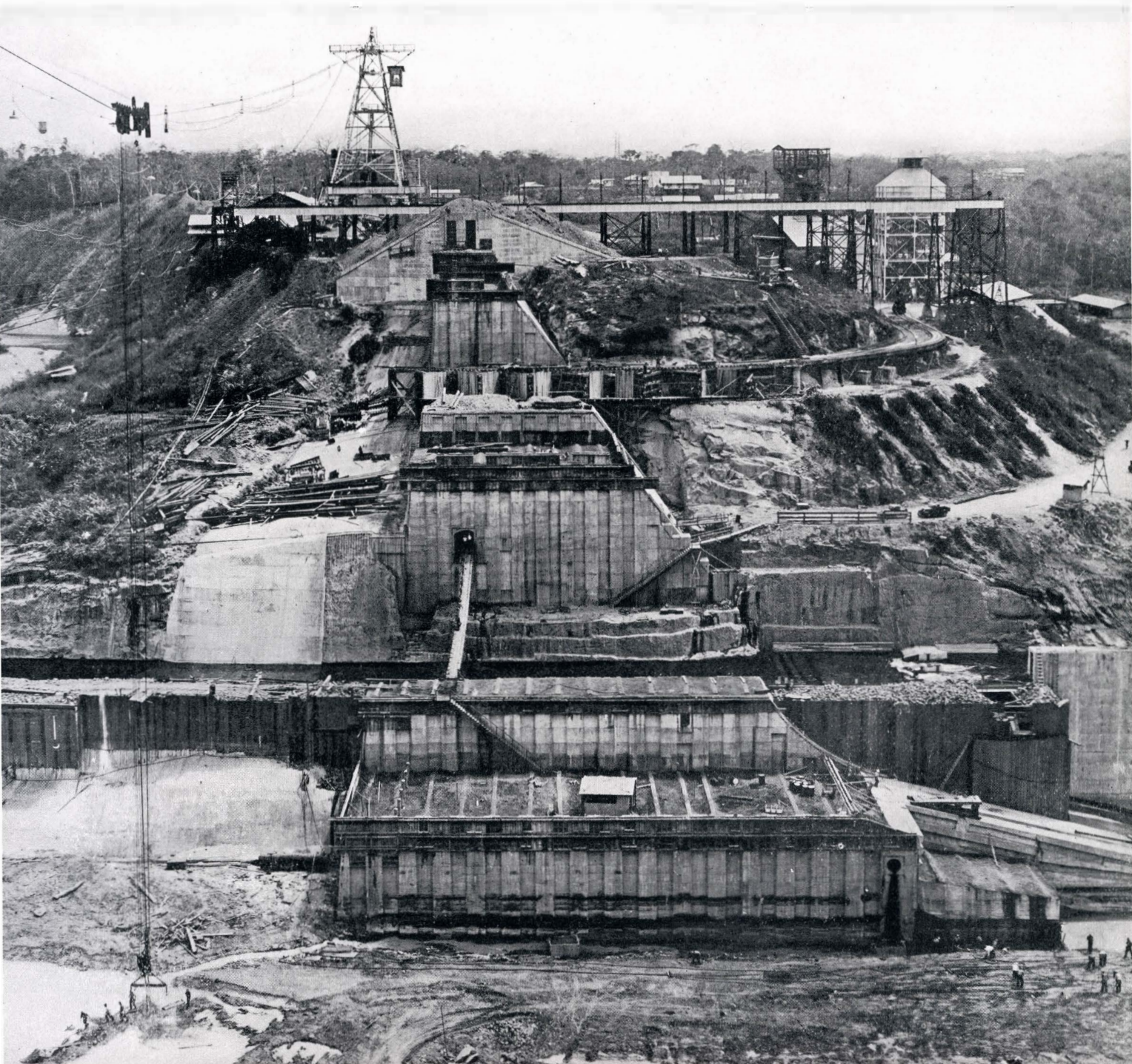

Madden Dam, Panama Canal Zone (See Page 206)

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SCIENTIFIC AMERICAN DIGEST

Of General Interest

Aviation

Chemistry in Industry

An index of articles appearing in back numbers of *Scientific American* is to be found in The Reader's Guide, Industrial Arts Index, Engineering Index, and Dramatic Index. These can be consulted in any large library.

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ACROSS THE EDITOR'S DESK

"THUS, perhaps, it is not race but *place* that counts most. Relief, climate, soils, plants and animals and minerals, all play their part in the working out of human history. We can hardly regard it as pure coincidence that the region bordering the North Sea and the western North Atlantic, which contains seven tenths of the world's coal and nine tenths of its iron, and includes the areas of most stimulating climate, also has dominated world history for the past 200 years." Thus Malcolm H. Bissell, Associate Professor, Department of Geology, University of Southern California, sums up his challenge to the doctrine of Nordic superiority. Professor Bissell's article, to be published next month, was prepared in answer to "The Nordic—Superior or Inferior," published in our August issue. It presents clearly and concisely the reasons why the Nordics have little or no claim to racial superiority. Read both articles. Compare them. The available evidence on both sides will thus be in your hands and you can settle the question in your own way to your own satisfaction.

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"And the trades took it to use in the manufacture of linoleum, paints, soaps, rubber substitute, glycerine, explosives, inks, celluloid, water-proofing, and any number of other things. . . . Milk, curds (not unlike cottage cheese), flour, macaroni, cakes, pies, candy, salad oil, cooking oil, and coffee are made from it. . . ." What is this which has so many uses in such widely separated fields? It is none other than the soybean, a native of the Orient, first introduced into this country over a century ago. But only within recent years have the possibilities of this humble legume been scientifically explored. The fascinating story of the development of new uses for the soybean is told in an article by Helen R. Crane, scheduled for our next issue.

●

"The chemist and the business man alert to utilize the very latest in the development of new products, are taking keen interest in liquid latex—the natural serum of the rubber plant. As a result, latex is being used in place of crude rubber for certain purposes, and in addition, it is being adopted by industries which never before employed rubber." This quotation is from an article by Philip H. Smith, which we expect to publish in our December number. Mr. Smith goes on to tell of the uses of latex in garments, paper, rugs, rope, leather, and many other equally important applications. He also gives a glimpse of the future uses of this product of Nature which will have a definite bearing on our daily lives. Here is an article which no well-informed person will want to miss.

"All is destruction. . . . Within a few months the microcosm will run down unless the operator introduces some of the smaller species of algae and thus adds some energy makers. . . . A daily inspection of this microscopic, dog-eat-dog universe will provide a practical experiment in microbiology of much interest and value." As this bit from our next article in the series on microscopy shows, the reader is being drawn into the practical observational end of the science, and to that part which probably holds the greatest interest to the majority. We will wager that if you have not already been bitten by the microscope "bug," you will find yourself seriously inviting the bite by reading the article that appears in this issue, and the second part of it which will be published next month.

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"Drilling an oil well to a depth of over 11,000 feet, pushing the slender hole down more than two miles, gives rise to three pertinent questions: Is it possible to reach a depth of three miles? What are the problems of such deep drilling? Will those who risk their fortunes find oil in these superheated subterranean rocks?" These questions form the basis of an article entitled "Black Gold—Three Miles Down," by Andrew R. Boone, to be published in December. From personal observations in the oil-fields and interviews with the men who make their living by wresting liquid wealth from the depths of the earth, Mr. Boone has written an article that answers these questions by taking the reader to the site of the drilling operations and showing him how this deep drilling is done.

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"The practical demonstration of the two-way, ultra-high-frequency radio equipment, placed in regular police service for the first time, suggests a new era of radio communication in which police departments cover large areas with 'talking' police cars," to quote from an article, scheduled for next month, by J. Henshaw Crider. With the new two-way communication system which Mr. Crider describes, police patrol cars not only receive orders from headquarters, as in the older and well known system, but the patrolmen now can immediately report back to headquarters, independently of widely separated telephone stations. Thus an added weapon against crime is placed by science in the hands of our law enforcement officers.

Editor and Publisher

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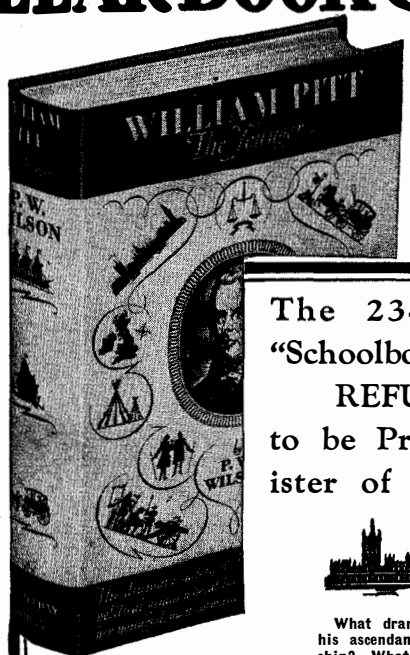

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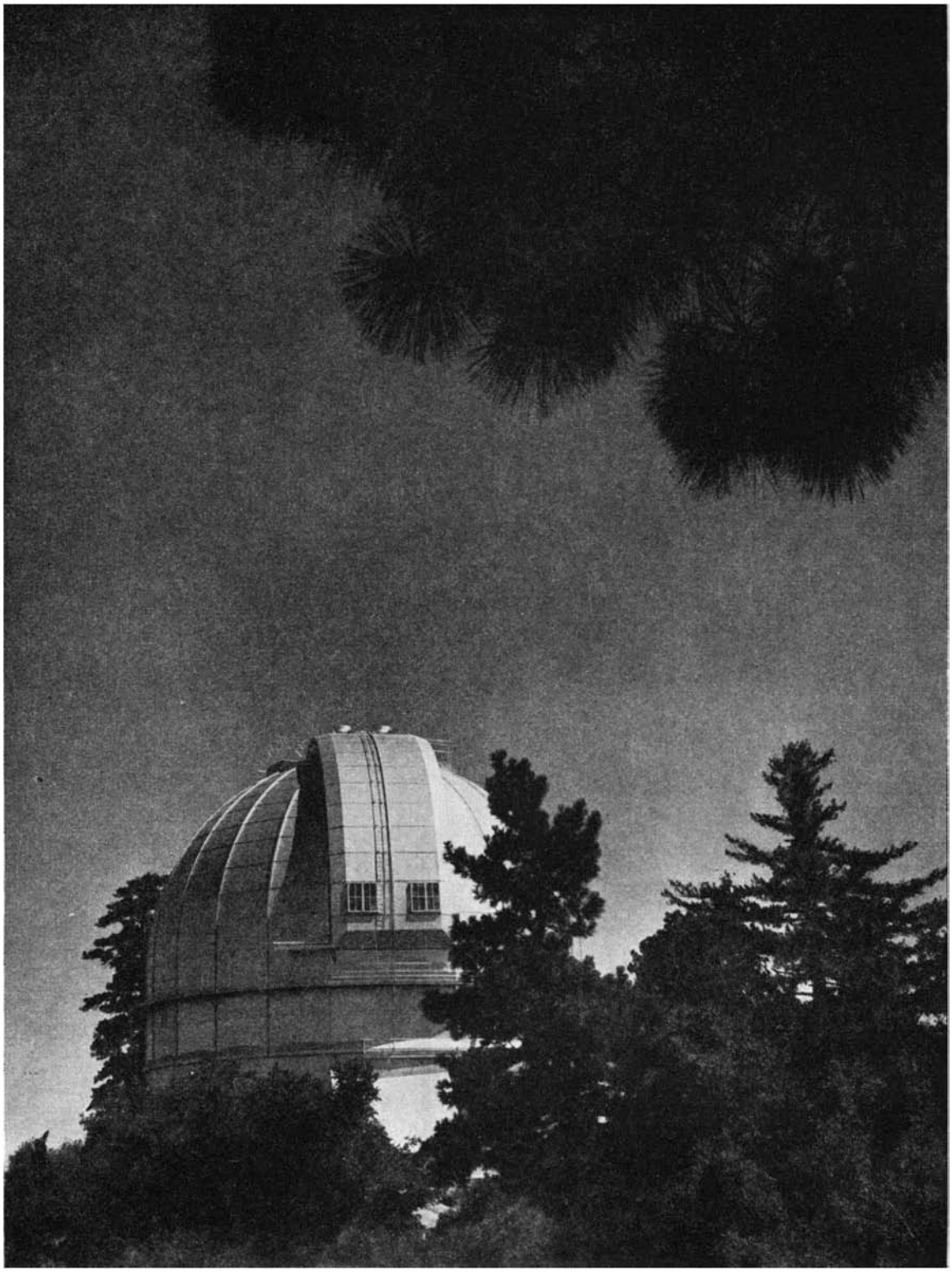
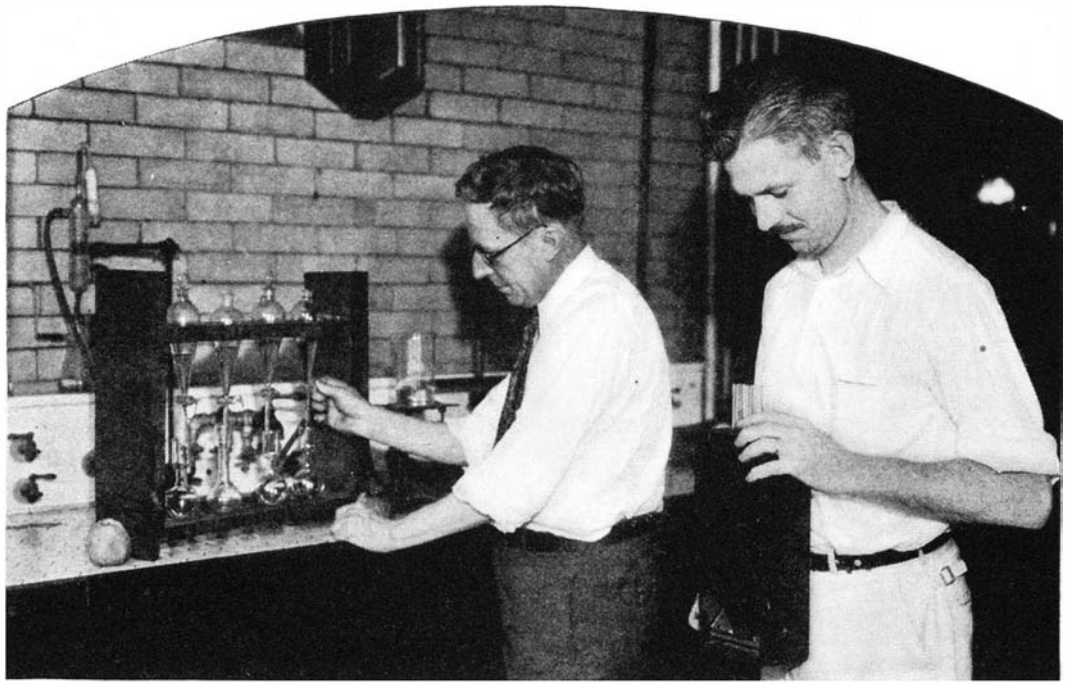


WHERE MAN AND NATURE BLEND

THE immense shining 448-ton aluminum-painted dome of the 100-inch telescope at the Mt. Wilson Observatory near Pasadena, California. The Mt. Wilson Observatory lies on a level summit 6000 feet above the sea and is surrounded by splendid spruces, pines and shrubberies. It is an environment in which men of science may make extended sojourns for work and live in an atmosphere conducive to thought. Original prints of this rarely artistic piece of photographic composition—suitable for framing—may be obtained from its maker, Mr. Malcolm K. Parkhurst of New York.



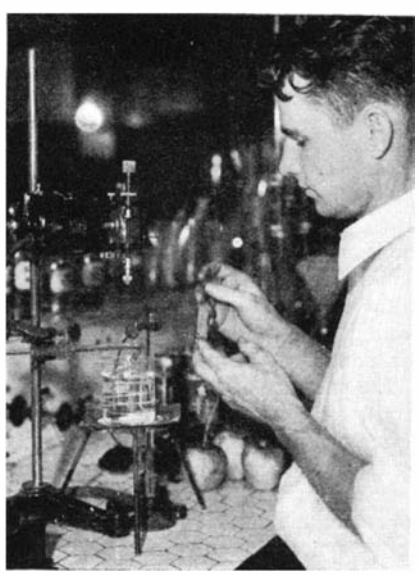
Apparatus used by U. S. Food and Drug Administration for rapidly determining lead

How Much Poison Can We Eat?

By T. SWANN HARDING

SOMETIMES it is difficult for the average man and his wife to choose and steer a sensible mid-channel course between those who unblushingly sell to the public foods containing poison in harmful amounts and another class, the overwrought emotional crusaders, who are always indignant because we are being offered "poison" foodstuffs. But the word poison is a relative term. One can eat certain amounts of poison without apparent harm. What is needed in thinking of the poison question is, then, mainly a sense of proportion—*How much* of this or that will be poison? Many excitable writers on the food question have apparently lacked that sense.

—*The Editor.*



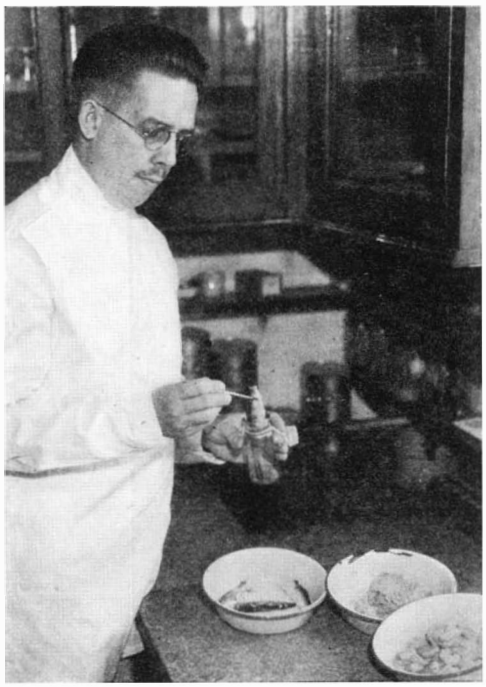
A near view of the electrolytic apparatus for lead determination

THE other day I was talking to a very distinguished physician about an astonishing (if true) and sensational book, of which many copies have been sold, which endeavored to show that we should all be poisoned if we bought most foods, especially those that were widely advertised. On the other hand, advertisers informed me that if I did not use their foods I should suffer in health and go to an early grave. I was therefore fortunate in being able to converse with a man who probably knows more about the digestive tract than any other specialist in the country. He said:

"These authors are just like all other fanatics, who are ready to tell you that there is arsenic in everything or that aluminum is bound to give you cancer. They are too fussy. After all, this is a complex civilization in which we live and we must not be so neurotic that we refuse to take any chances whatever. We risk our necks daily with automobiles, yet never demand their abolition because they kill thousands annually and maim others. Dangers hover all about us. We must simply learn to exercise sound judgment and be reasonable."

That and a little more of the doctor's sane conversation induced me to read up a little on arsenic and on aluminum. The authors of the book in question had loudly asserted that arsenic and its companion, lead, hovered in all fresh vegetables, and absolutely coated all fresh fruits, waiting to kill us. They asserted that the Government did nothing about this (though they also asserted that it had asked for and used special funds to study the problem) and that calloused officials looked on upon the poisoning of the entire nation, themselves included, with extreme complacency.

SPRAYING fruits and vegetables to prevent insects from devouring them does offer a problem, because the sprays must be poisonous, and they must adhere well and long, in order to do their work. Moreover, while calcium arsenate does rather good work as an insecticide, lead arsenate is still more effective and is widely used, and lead is a bad poison. As adhesives have been developed, which make the poison sprays stick to fruits and vegetables, matters have grown worse and it is more and more difficult for public officials to



The analysis of many sea foods reveals that they naturally contain some arsenic

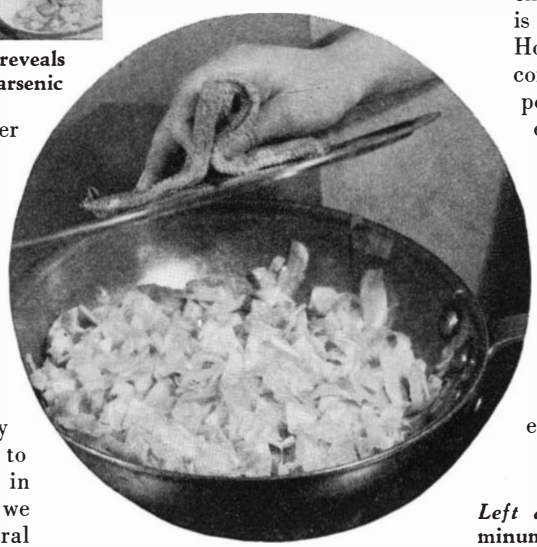
protect consumers. Meanwhile, ever new and possibly more poisonous insecticides are constantly being developed and Government scientists are hard put to it to keep up with them and accurately rate their dangers.

Arsenic spray residue work has long taken one third of the annual appropriation of the United States Food and Drug Administration. Since this administration has only about a million and a half dollars to police the entire interstate traffic in foods and drugs, that is about all we could expect of it in the way of Federal control. In spite of the known poisonous effects of lead arsenate it is a fact that many growers apply the poison very carelessly and contend that it is relatively harmless. Thus they get on their products possibly 200 times the safe limit, and do so near the harvesting season as well.

THESE spray residues are increasingly hard to wash off because the adhesives used to make them stick are increasingly effective. The Federal Government must also intercept fresh fruits and vegetables in transit, perform its analyses, establish valid court proof that the residue is there in poisonous amounts, and act before the product reaches the market. When you consider how slow and tedious the methods of chemical analysis are, that is no little problem in itself.

Moreover, since we cannot raise sufficient fresh fruits and vegetables for our own use unless we utilize insecticides which are poisonous, the only thing to do is police the industries concerned, get the growers' co-operation if possible, and establish a limit of tolerance for the poison which experts in toxicology will agree is safe. That has been done. Poison experts agree that the presence of 0.01 grain of arsenic trioxide per pound of fruit or food is safe, that it can not produce acute poisoning and will not cause cumulative, chronic poisoning, at least in the light of all evidence now available.

Plenty of growers are ready to assert that arsenic in much greater abundance is harmless, simply because no case has ever yet been found wherein it could be proved that death resulted positively from arsenic spray residue on fruit or vegetables. Thus cabbage has been seized and destroyed containing 0.250 to 1.473 grains of arsenic trioxide per pound; the same has happened to cauliflower containing 0.312 to 2.059 and to celery containing 0.43 to 0.209 grain per pound.



The presence of lead is an even worse menace. Until very recently the quantity of lead has been very hard to determine, the method being slow and tedious. It would have required troops of new Government chemists to do the work, and at a time when taxpayers angrily resent increased taxation. Just recently a method has been developed for the rapid and accurate determination of lead, and its use will enable the Government to give better consumer protection for the same money.

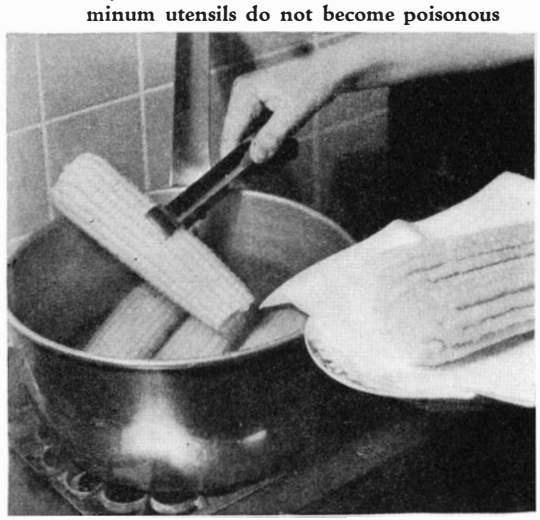
The food and drug law, however, merely covers "added poisonous ingredients" which it can be proved in court will potentially injure the health of those who eat the product concerned. The mere presence of a poisonous ingredient in a food does not of itself convict that food. Thus codfish naturally contains 0.0140 to 0.0380 grain of arsenic trioxide per pound, which is above the limit of tolerance, and doubtless cod-liver oil, so widely given to youngsters, contains a great deal.

The following figures will show the grains per pound of arsenic trioxide in the other common foods mentioned: Haddock, 0.0392; clams, 0.0104 to 0.0180; lobsters, 0.0160 to 0.126; shrimp, 0.0170 to 0.0770; sardines, 0.0105 to 0.0200; prawns, 0.125; crab meat, 0.0140 to 0.0770; oysters 0.0100 to 0.0165. Of 1169 samples of common foods of all classes, 11 percent contained arsenic trioxide in excess of 0.01 grain per pound.

NATURE put that arsenic in the foods. No poison expert could be expected to hold that "natural" arsenic is less poisonous than added arsenic. However, it would be very difficult to convict Nature in court of the charge of poisoning human beings by putting excessive quantities of arsenic in haddock or in prawns. The law covers no such natural additions of poison. Nor does it cover additions of poison in any case unless the poison is in the food in quantities that can be absolutely proved in court to be potentially deleterious to health.

Here are new jokers. For one thing many physicians and poison experts will disagree when you ask them exactly how much arsenic fresh apples may contain without danger to the consumers of those apples. They will all be sincere and may give very different testimony on the stand. For another thing, suppose that a person is deriving minute quantities of arsenic, or some other poison, from ten different foods. The grand total is a menace

Left and below: **Foods cooked in aluminum utensils do not become poisonous**



to this person's health, but the law offers no protection, because no one of the ten foods contains the poison in a quantity that could be proved in court to be potentially dangerous to health.

So we must take some chances and not scare ourselves to death all the time. It is very unfortunate that so many sensational writers are always ready to add to their incomes by misinforming and frightening the general public. The same thing occurs with regard to aluminum and the use of aluminum ware and the ever recurrent myth that this element causes cancer. Since medicine does not yet know the cause of cancer we cannot, of course, declare aluminum innocent. But neither have we any right to convict it.

ARSENIC is an old element. The alchemists knew all about it and played with it. Aluminum was not discovered until 1828 and it remained a laboratory curiosity for 60 years more. Therefore many people still regard it as some strange, unusual, and mysterious substance but recently created by scientific skill or magic. Yet it is the third most common element. Oxygen stands first and composes 50 percent of our world; silica is next as 28.5 percent; aluminum is third with 7.3 percent and iron, composing 4.18 percent of our world, stands fourth in order of abundance. Aluminum is widely distributed. It is actually the most plentiful of all metals, being twice as common as iron or calcium.

It is impossible to escape aluminum. We may as well face that fact and cease letting fanatics scare us to death with it. There are about 250 parts per million of aluminum in our brains and 100 parts per million in our kidneys. What are we going to do about it? It appears widely scattered in the plant world and we cannot get away from it.

Aluminum, as parts per million, occurs in the following common foods in the quantities indicated: Carrot tops, 41; figs, 18; lettuce, 30; beet tops, 24; pistachios, 46; raisins, 20; dried beef, 14; dates, 11; radishes, 26; and filberts, 47. But suppose the same identical food is cooked in glass and also in an aluminum utensil? Does that vastly increase the aluminum content of the food in question? The following tabulation shows that it sometimes does, but that even then the parts per million of aluminum in many of the foods cooked in aluminum does not exceed that in natural foods—

Food	Parts per million of aluminum when—Cooked in Glass	Cooked in Aluminum
Bacon	0.26	0.68
Potatoes	0.26	0.26
Stewed tomatoes	0.12	4.25
Beets	0.57	0.74
Creamed cabbage	0.34	91.00
Cranberry sauce & sugar	0.75	3.45
Rhubarb	0.95	13.45
Apricots	24.60	73.30
Apple sauce	0.28	1.40
Prunes	4.60	7.10

In spite of the fact that aluminum cannot be avoided, and of the further fact that, as my specialist friend told me, a compound of aluminum, the hydroxide or what chemists call alumina cream, has long been used in the treatment of stomach ulcers, many people claim that foods cooked in aluminum utensils produce unpleasant symptoms in them. These symptoms, they are careful to say, disappear "*at once*" when their food is no longer cooked in aluminum. That simply means that the aluminum could not have been at fault, for such symptoms, if genuine, could not disappear till the body had eliminated the aluminum it contained. This would not only take time, but it probably could not be accomplished entirely because our bodies always seem to contain some aluminum. Hence these symptoms are rather psychological than physiological and they are also the kind that could be caused by any number of possible other causes than aluminum in cooked foods. Indeed, these very people who claim to be benefited usually continue to eat foods containing natural aluminum, simply because they cannot avoid doing it.

Above: **Food and Drug inspector's station to catch shipments of apples for analysis for sprayed arsenic and lead.** ***Left:*** **A picture taken in Roswell, New Mexico, where they are even advertising "washed" fruit.** ***Below:*** **All trucks leaving Michigan with apples are stopped and test samples taken**

It is very strange how some of us become frightened at shadows. Thousands become almost too scared to eat anything, while the fussy fanatics who write sensational bogey books profit well in a monetary way and pose in self-adulation as saviors of mankind and champions of the downtrodden public. Accredited medical specialists make little headway in reassuring persons who have been scared by the fanatics, while their efforts to show up the fanatics result in their being attacked as malicious, paid henchmen of the "medical trust."

TELEPATHY ? MIND-READING

ANY more or less prolonged discussion of telepathy almost invariably leads to a comparison between telepathy and mind-reading. A few days ago the present writer and a reader of SCIENTIFIC AMERICAN were casually conversing across the luncheon table. "I wish you would explain something about telepathy," said the reader, "that has always bothered me when thinking about the subject. If, for the sake of academic argument, we allow that telepathy is possible, at least between certain persons under certain conditions, then does not the development of this power mean that eventually telepathists will be able to read the minds of others at will?"

From this question grew a discussion that would be too lengthy and involved to record here, rambling as it did through many fields that might be considered unrelated to the subject. The gist of it all was that, in the writer's opinion, the answer is "No." Of course, with the present knowledge, or rather lack of knowledge of telepathy, any argument such as this can only be based upon logic supported by personal beliefs.

At the present time there are many persons who are firmly convinced that telepathy does not need to be proved that it is as much an assured fact as communication by word of mouth. They base their belief on happenings in which they have been involved or of which they have been told by seemingly responsible persons. But in the majority of cases, if not in all of those in which the belief is founded on sincere grounds, telepathic communication has been evidenced only under unusual circumstances of danger, mutual rapport, intense emotion, or some similar departure from the usual routine of life.

Since these comments are in the nature of a philosophical survey of the mechanism of telepathy, rather than an attempt to explain that regarding which we know nothing definitely, we may be allowed to speculate somewhat. Therefore, let it be granted for the moment that telepathy can be accomplished under some such circumstances as mentioned above. Consider, for example, the case of the lad imprisoned in the well (October SCIENTIFIC AMERICAN, page 152) and his release by his mother as the result of an apparent telepathic communication. Here was the element of danger to a loved one, and the response. Could this by any stretch of the imagination be called "mind-reading"? Or could it be linked in any way with the familiar stage demonstrations in which the beautiful blind-folded blonde calls the numbers of bills, the value of coins, and the name of the maker of a watch, usually as a result of a clever system of signals used by her confederate in the audience?

IT would seem to the logical thinker that, even if the power of telepathic communication is inherent in everyone, it must be capable of control, just as much as is the power of speech and, in a more limited application, the sense of hearing. It therefore seems rather far-fetched to believe that the development of this telepathic power will make it possible to read the minds of others at any and all times and without their knowledge or volition. True enough, many of us have at one time or another observed that someone else speaks of some subject just at the moment when we are thinking of the same thing. But it is usually the case that the subject is one that was uppermost in the minds of both, or at least of more than passing interest to both of those persons concerned.

Still presuming that telepathic communication is possible, why should it be considered plausible that you could, when walking along the street, know definitely what the stranger walking near-by is thinking of? There is no connection between you—no "path" (used for want of a better term) along which the exchange of intelligence may travel. The medium of transfer is absent. Would it not seem logical that such a "path" is necessary? And that the "path" can be established only with a common bond of some sort between the parties concerned?

Without more definite knowledge of the mechanism of telepathy (still granting that telepathic communication is possible) it would seem futile to pursue the question farther. It does seem certain, however, that, if a sound foundation for the study of the fundamentals of telepathy is ever laid down, it will be found that a linkage, a "path" or "carrier wave" if you will, is an essential to such communication, and that the breaking down of the privacy of the individual mind by promiscuous "mind-reading" will not follow.

Can YOU Prepare a Telepathy Test?

UNDER the above heading (September issue, page 108) we published a request that our readers co-operate with us in preparing the third of our telepathy tests, the first two of which appeared in our issues for March and June, 1933. At the time of writing, we have received many communications from readers in which they have outlined their ideas of how they would conduct these tests. To date, however, none has been received that is suitable for use under the conditions that have to be met, or that is not a repetition of tests that have been made in the past.

We want a real test: Not one that is a make-shift variation of some parlor game in which accurate results cannot be recorded; not one in which the results are capable of various interpretations; not one that involves lengthy correspondence between the persons concerned, with the probability that interest will be lost through the time factor involved. Keep in mind that a test for telepathy—suitable for publication in a periodical—must not involve large groups of people; it must be adaptable to a wide variety of conditions; it must be simple to conduct and to record; it must not require complicated equipment.

If you want to help in this matter, refer to the article in September mentioned above, read the suggestions carefully, and then let us hear from you.

OUR POINT OF VIEW

Railroad Wrecks

UNWARRANTED criticisms of the railroads have been whispered here and there as a result of the three fatal railroad wrecks which occurred, all within a space of two weeks, late in the summer. On August 24, the crack *Crescent Limited* of the Pennsylvania and Southern roads crashed through a bridge over the Anacostia River near Cheverly, Maryland, resulting in the deaths of the engineer and fireman. On August 29, the *Golden State Limited*, en route from Los Angeles to Chicago, crashed through a flood-weakened bridge into a flooded arroyo near Tucumcari, New Mexico, and eight were killed and 40 hurt. On September 5, at Binghamton, New York, the rear car of the Erie's *Atlantic Express* was struck by a milk train with such force that it in turn smashed to splinters the next car ahead, a wooden one, and killed 14 and injured 30 people.

These three disasters, coming so close together, have set some people to wondering whether they are not attributable, at least in a general way, to poor maintenance and lack of sufficient numbers of trained employees. It has been bruited about that economic retrenchment must have lowered the efficiency of both the physical properties and the human employees of the roads concerned. Authoritative, unprejudiced opinion holds otherwise.

In the Maryland wreck, a central pier of the bridge had been weakened by flood waters in such a way that trained and highly efficient track walkers could not have seen the danger spot. Since no suspicion attached to this bridge beforehand, there should be no reason to accuse the train crew of negligence.

The wreck in New Mexico may also be placed in the category of "unavoidable" for, while in the arroyo beneath the bridge there was a torrent of flood water, that did not indicate a weakening of the bridge. The engineer, however, was proceeding cautiously when the crash occurred. He might, of course, have uncoupled from his train and tried out the bridge with the weight of the engine alone—but then, hindsight is *always* wisest.

At Binghamton, New York, the story is different. According to testimony in the investigation—which has not been completed at this writing—this was a case of human failure. The engineer had passed a "caution" signal, had acknowledged it properly, the fireman testified, but neglected to slow down sufficiently because, as he himself testified, "habit had made me bold." By this admission, he took all the blame. This does not, of course, entirely absolve the railroad, for it is certainly to be blamed for permitting the use of an antiquated wooden car. According to newspaper reports, this railroad has ordered the retirement of its remaining wooden cars in October.

Economy in maintenance can not, therefore, be held at fault in any of these accidents so far as may be determined at present. Furthermore the railroads are doing everything humanly possible with their limited income to maintain their properties at the highest efficiency. We may expect an even more intense effort to increase that efficiency as a direct result of the satisfactory increase in revenue which the railroads have enjoyed recently. It is to be hoped that that revenue increase will continue not only for the reason that it will indicate a revival of business but also because we do not want to hear of an accident for which the railroads may justifiably be blamed.

Talking Moonshine

LORD RUTHERFORD spoke sensibly when he told the members of the British Association for the Advancement of Science at their recent meeting that "anyone who says that, with the means at present at our disposal and with our present knowledge we can utilize atomic energy, is talking moonshine."

Perhaps this will at least partially cool the ardor of irresponsible writers who have, time out of mind, for the past decade or two told their impressionable readers that the time may come when the energy now locked up within the atoms contained in a mere thimbleful of matter will drive a liner across the Atlantic and back. Without definitely making such a prediction—that is to say, without making it in such a way that they could ever be pinned down and held responsible for it—these persons have nevertheless managed to create in the mind of the public the notion that boundless stores of untouched energy are just over the hill or, at most, over the second hill.

Among physicists the belief in the eventual recovery of atomic energy has swung back and forth several times within the past two decades. Recently it has been seen that the recovery of even a minute bit of this energy involves putting in far more energy than is taken out. This is not to say, however, that new discoveries may not alter the situation, but one slant which is often given the public—that the physicists are working toward the solution of this problem—is a misleading one. They are interested in the purely scientific problem of breaking up, transforming, and otherwise manipulating the atom. Any power discoveries which may come from these experiments will be in the nature of a by-product.

Strictly speaking, a truly cautious scientific attitude toward the question of the ultimate power-availability of atomic energy would require one to say "*we do not know* whether we shall ever attain it or not." But, in view of the over-sanguine imaginings of various writers, perhaps Lord Rutherford's recent dose of cold water was the right thing in the right place at the right time.

Profiteering Grave Robbers

ARCHEOLOGISTS, and particularly those of the Smithsonian Institution, are very much concerned over the evidence of vandalism, the ruthless looting of Indian graves and village sites, that is now accumulating. In the south and southwest especially, the so-called "pot hunters" have been increasingly active in recent months destroying many sites in which lie artifacts and human remains which would tell the story of America's rich past to the archeologist were they left *in situ* for his study.

These valuable relics of the past are being sold as souvenirs to tourists. Gasoline filling stations all over the southwest offer for sale human skulls to be used by their purchasers as ash trays, mantel ornaments, or for Hallowe'en parties. Many such antiquities are offered to museums, it is true, but having once been removed from their original locations, they do not as a rule have any meaning to the archeologist. Exact and highly technical data as to its location and perhaps its position in relation to other articles or ash and earth deposits are necessary before the story to be told by a skull or a pot can be read.

Once these treasures are removed, their story is lost to science. This is to be regretted, for there is much yet to be learned about America's pre-Columbian history. If tourists refuse to buy these relics; if local papers condemn the practice of removing them; and if public sentiment, awakened to the value of science, agitate against this robbing of graves, we believe much of the real background story of America may yet be solved by the archeologists.

THE DISTANCE FLIER TAKES

By REGINALD M. CLEVELAND

NEW records, new accomplishments in aviation, crowd so fast upon each other's heels that it is difficult to appraise the swift development of flight. Within less than a year, men of the air have stretched the cross-country non-stop record to 5341 miles. They have advanced the speed mark for air planes to 423 miles an hour; they have pushed up the altitude record to more than 43,000 feet; they have flown blithely over the Himalayas, making pictures as they went.

Frank Hawks has cut the non-stop record from Pacific to Atlantic to 13 hours 29 minutes. Roscoe Turner has chopped down the East to West mark across the continent to 11 hours 30 minutes. In July, Wiley Post, that sturdy, indomitable little flier from Oklahoma, who seems to need no more sleep than a basilisk, startled the world by flying a 15,400 mile ring around it by way of Germany, Russia, Alaska, and Canada in 7 days, 18 hours, 49½ minutes. And he did it solo, to boot.

BUT although this was a solo flight, Post was not alone, and neither were the other skilful airmen who have toppled record after record till one wonders what the end is to be. In their planes have been new and more perfectly developed instruments; more efficient and more smoothly functioning engines; mechanical and electrical aids to flight which have served as the sinews and the nerves to give fuller expression to the iron in the dauntless soul of man.

Just as the year 1933 was to see the greatest forward stride in the speed and the comfort of air transport in its commercial aspects through the refinement of plane design, the more advantageous placement of power plants, and the application of the principles of sound proofing, so the year to date has demonstrated the value of many auxiliaries in planes which have entered the lists of record performance. These auxiliary devices or developments have been confined to no one field. Engine, flying control, and avigation have all felt their beneficent influences.

Within a few hours after Post set down the wheels of the *Winnie Mae* at Floyd Bennett Field, he was voicing his belief in the practical possibility of flight at a speed of at least 500 miles an hour around the world, or a circuit, by the route which he followed, in an elapsed time of two days, allowing for stops and refueling at strategic points.

It must be remembered that such a statement comes from the least hysterical of sources. Despite his log of far and fast flight, Wiley Post—farm boy, mechanic, oil driller, parachute jumper, and test pilot—has his feet about as firmly planted on the ground as any pilot of our day. He based his prediction both on observation and on the improved performance of the *Winnie Mae* on her latest circumnavigation. Her normal top speed at normal altitudes would certainly not exceed 190 miles an hour. But Post had his Wasp engine supercharged, and he had a controllable pitch propeller. With these aids he found that his plane had a cruising speed of 200 miles an hour at 15,000 feet.

Courtesy Smith Engineering Corporation

Wiley Post and the *Winnie Mae* which is equipped with an adjustable pitch propeller and an automatic pilot

What he foresees, what he intends to try, is a further development both of supercharging and of propeller adjustment. This very hard headed, practical flier foresees no insurmountable barrier in the construction of sealed cabins such as Farman and Junkers have been working on in their planes for the stratosphere, so that pilot or passengers may have sufficient oxygen and be protected against the cold of 20 or more degrees below zero, or as Post prefers to put it, "up where the air is thin."

He is by no means alone in his praise of the adjustable pitch propeller. Such sound and excellent pilots as Hawks and Bernt Balchen have hailed it. It has put many miles an hour on the already fast Boeing 247 transports that have made the New York-Chicago run almost a commuting trip. Adjustable pitch means take off from smaller fields, take off with heavier loads, increased range, and, carried to further points of development, the ability to utilize full horsepower of the engine in those clear blue heights where the air is forever rarefied and clouds are only a billowy floor.

THE combination of controllable pitch and supercharging in their present state of development has meant much to pilots who ask performance. Colonel Lindbergh now has both on his Lockheed Sirius. Before he took off on his survey flight to Greenland, he found that his new Cyclone with its adjustable prop had given him a rate of climb of 2000 feet a minute. For high-altitude flight, still more efficient blowers will be needed to assure a horsepower output equal to that at sea level. And still more variation in pitch of propeller blades will also be needed to enable the whirling air screw to take the fullest possible bite in tenuous atmosphere, so that little of that horsepower will be lost. One cannot doubt from the strides already made that both developments will come.

Other things—other extremely useful things—however, have contributed to the success of the distance fliers in addition to supercharging and propeller control. Post said with characteristic frankness that he could not have made some of his huge hops—3900 miles from New York to Berlin, and close to 3000 from Khabarovsk to Alaska—without his automatic pilot. This device, developed by Elmer Sperry and the late Lawrence Sperry, with their engineers, nearly a decade ago, has been continually refined and perfected until it is now very compact and efficient.

Two gyroscopes, one for longitudinal

A CHANCE

But Highly Refined Devices Act To Reduce the Gambling Element

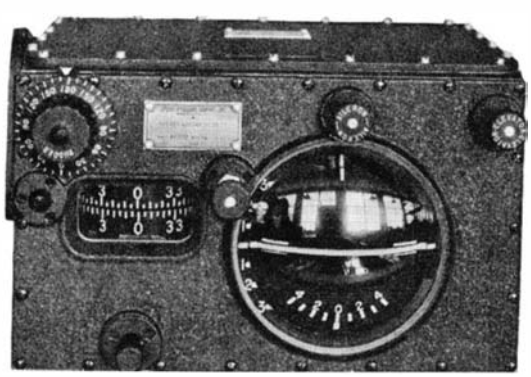
Lift and climb were built into the design of the Vickers biplanes that surged so gallantly above the crags of Everest, as they were in the sister ship which Captain Cyril Uwins flew to the altitude mark. Lines as clean as a hound's tooth and enormous horsepower marked the Macchi in which Flight Officer Agello sped above the waters of Lake Garda faster than man has ever moved before.

But things quite apart from wing and fuselage and engine power have also contributed to the great flights of recent months—things that hold out promise in rich measure for the future. When General Italo Balbo brought his eight triads of flying boats across the northern ocean with such spectacular success, each of the big Savoia-Marchettis had two American instruments on its board: a directional gyro and an artificial horizon.

The General also had with him aircraft radios, developed to a degree not heretofore appreciated. He was rather loath to talk about them, but when pressed, described them as the most powerful, the most compact, and therefore the most mysterious, sending and receiving sets in the world. He admitted that they had a range of 6000 miles, and that, although their details were still a military secret, he was able to communicate direct from Chicago or New York with Il Duce through the powerful land stations at Monticello and Ostia.

There was a radio device of paramount interest also in the *Winnie Mae*. This too was secret, and to a large degree remains so. It was mounted in the globe-circling ship by engineers of the United States Army Air Corps at Wright Field, Dayton, Ohio. Broadly speaking, it is a direction finder, a development of the Kruesi compass. To make use of it, the *Winnie Mae* had an aerial from rudder post to fuselage, although she carried no radio in the ordinary sense. Stations along the world route had been asked to broadcast to her in flight on specified frequencies, and this they did with the greatest success.

It is obvious that if a pilot can receive signals from two stations of known location while he is in flight, he can orient himself and fix his position. But the direction finder of the *Winnie Mae* did more than this. The signals from a single station actuated a pointer which told Post with great exactitude whether he was on course. He flew first on a signal from St. John's, Newfoundland. Then he said that soon after passing Cape Race, he picked up, clear and strong, the signals of the British station G2LO at Manchester. They guided him across the stormy sea, and in addition sent him weather reports clear into Berlin. Army stations in Alaska and commercial stations in Canada and at Chicago followed through as he roared along, and it may be said without too much stretching of the truth that he rode a radio wave around the world.



Right: **The Sperry automatic pilot installed on a Boeing transport of the United Air Lines.** ***Below:*** **The case of the automatic pilot is only 9 by 10 by 15 inches in size**

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EDITOR'S NOTE: *The two-part article, "The Truth About High Altitude Flight," March and April 1933* SCIENTIFIC AMERICAN, *explains many of the problems of sealed cabins and adjustable pitch propellers referred to by Mr. Cleveland in the above article.*

When he broke the Western nonstop record, Commander Hawks also let an automatic pilot fly the *Sky Chief*, hurtling toward the rising sun above the painted majesty of the Grand Canyon, the spire of Pike's Peak, and the lush carpet of the corn belt. His is a device of a different sort, a De Beeson, in which pendulums perform the function of the gyros in the Sperry instrument. This is not a technical discussion of these mechanisms, but whatever the merits of the individual types, it is plain that the automatic pilot has come to stay, and to play an important part in flight, whether it be a speed flight to far places, or the hardly less speedy flights of air transport, knitting together more closely on its appointed schedules cities, states, and nations.

Plane design itself, of course, has played an important rôle in the records that have fallen by the wayside in recent months. Streamlining and lift were carried very far in the Fairey long-distance plane in which Gayford and Nicholetts kept aloft from England to Wolfish Bay to hang up a record for Great Britain.

and one for lateral control, actuate a servo unit which, through oil pressure supplied by an engine-driven pump, actually moves the normal controls of the plane. But those controls are no longer dependent on the vagaries of human reactions. When a wing begins to dip, the corrective control begins immediately to operate. When the nose begins to go down, the stabilizer at once begins to be adjusted to bring it up again. This device (see also April, 1932, SCIENTIFIC AMERICAN) flew the *Winnie Mae* for a total of 90 hours before she ever started on this year's dash around the top of the world, and it flew her through thick and stormy Atlantic weather, and through the clouds high above the mountains of the Kamchatka peninsula and the Sea of Okhotsk while the pilot was able to relax and stretch his legs, and to watch altimeter and tachometer, fuel and engine temperature gages, relieved of the strain of continuous attention to controls.

STELLAR ATMOSPHERES

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 Association for the Advancement of Science

TWO months ago we told how the spectroscope has made it possible to secure almost complete analyses of the outer portions of the sun, and even of distant stars, despite the severe limitations imposed by the opacity of the earth's atmosphere to ultra-violet light.

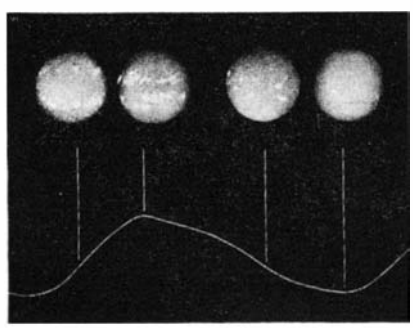
This opacity, by the way, though it greatly annoys the astronomer, probably saves our lives. Should the air suddenly become transparent to the short waves, every living thing exposed to direct sunlight would receive a very powerful dosage of radiation of the sort which is rapidly fatal to some organisms and dangerous even to the larger forms. Sunburn would become a real peril, and the consequences might be most disastrous. No one, however, need lose a single restful breath from worry over this danger, for there is good reason to believe that it is the action of these short waves on the upper air which forms the ozone there, out of the abundant oxygen. The earth automatically protects itself against the dangerous rays—or rather, life upon its surface has grown accustomed to such rays as actually reach it. Could life exist on a planet with an atmosphere transparent to the whole ultra-violet, evolution would doubtless proceed by the survival of forms which were able to endure these rays. Terrestrial life has never had to make such an adaptation, and has not made it.

BUT the student of stellar atmospheres, though he has perforce to be content with the loss of the most interesting part of the field of observation, has still a great deal to do. Sixty-two of the known chemical elements have been identified in the sun—three or four of them doubtfully. Some of the rest are so rare on earth that we do not know their spectra well enough for a test—others have all their strong lines in the forbidden ultra-violet region. There are only three whose strongest lines are accessible and fail to appear—bismuth, rhenium, and radium. The last two are excessively rare on earth, so that it is not surprising that we fail to find them in the sun; bismuth must really be rare in the solar atmosphere.

But no chemist would be content with a mere qualitative analysis—he supplements it by a quantitative analysis and finds out not merely what elements are present, but how much of each.

To attempt this in the sun we must have recourse to the intensity of the spectral lines. There is no question that it takes more atoms to produce a strong line than a weak one. How many more? There are various ways of answering this question.

The stronger lines are obviously wider



The illustrations above and on the opposite page have no direct connection with Professor Russell's article, but are inserted because of their general interest. The one above is reproduced from *Leaflet 50* of the Astronomical Society of the Pacific, prepared by Dr. Seth B. Nicholson of the Mount Wilson Observatory. It shows four spectroheliographs of the sun, taken at various phases of the 11.1-year sunspot cycle. The white spots on each represent calcium clouds overlying sunspots; thus these clouds give a measure of sunspot activity. Note how, at the beginning of the cycle, the spot-zones are about 30 degrees from the sun's equator. As years pass these move inward and, at the end of the cycle, most of them are less than 10 degrees from the equator. The curve indicates the number of spots. Just now we happen to be in the minimum phase, as is shown better on the opposite page

on good spectrum photographs than the weaker ones. It is possible, with modern technique, to measure the width of a line and find out how much light it cuts off from the spectrum. Under simple conditions the width should theoretically be proportional to the square root of the number of atoms (or sometimes molecules) which are at work producing the line. The relation has been accurately checked by observation of the lines due to oxygen in the earth's atmosphere, where, by observing the sun at different altitudes, we can change the amount of oxygen in the light-path in an accurately calculable ratio.

The sun's atmosphere is hot and the lower layers are hotter than the upper—which complicates the theory; but the test can still be applied to the stronger lines. For example, the yellow *D* lines of sodium indicate the presence of 26,000 million million atoms of the element above every square centimeter of the solar surface. This sounds tremendously large, and so it is; but things take another aspect when we realize that this number is no greater than would be found in a layer of red hot sodium vapor at atmospheric pressure about one thousandth of an inch in thickness.

THE fainter solar lines are too narrow to study in this way. But, fortunately, there are many groups of lines (of the same element) in which we can calculate how many more atoms are at work on a strong line than on a weak one, and thus the calibration can be extended even to the faintest lines. It is thus found that a line just comfortably visible on the photograph requires for its production only 1/4000th of the number of atoms which produce the sodium lines.

The swarms of faint solar lines therefore require but little material for their production. Even the great *H* and *K* lines of calcium—the strongest in the whole spectrum—demand only an inch-thick layer of vapor. These lines are observed during total eclipses to rise to an altitude of nearly 10,000 miles above the photosphere. For most of this depth the vapor must be of extraordinary tenuity. The lower atmosphere, or reversing layer, in which most of the line absorption is produced, may be no more than 100 miles deep but, even so, the pressure and density in it must be so small as to correspond to a good vacuum from the engineering standpoint—though not what the physicist calls a high vacuum.

What prevents us from seeing deeper into the sun? It was once supposed that the visible photospheric surface was a layer of clouds—condensed droplets of some highly refracting substance—but now we know that all such substances

would be wholly vaporized at the very high temperature of the sun's surface. The puzzle was first solved by the writer's colleague, Professor John Quincy Stewart, who showed that a gas containing free electrons and ions must necessarily scatter light like a thin fog or haze. The amount of this scattering can now be fairly well calculated. It is evidently the dominant factor in determining how deep we can see into the sun—better put, the depth from which light can get out to us without being blocked on the way.

There is, of course, no sharply bounded fog surface—only a steadily increasing haziness. But Milne showed some years ago that it is nevertheless possible to adopt an average depth—roughly that from which half the light escapes unobstructed—and obtain reliable results. Above this level very little material is required to account for all the lines in the solar spectrum. Taken altogether, they demand only atoms enough to produce a layer of gas (under standard conditions) a foot or two thick. It would be hasty, however, to conclude that there was no more stuff than this in the sun's atmosphere.

FOR the metals, most of whose atoms produce lines in the observable part of the spectrum, we should have a pretty trustworthy census, after allowance has been made for the fact that many atoms are ionized—and this, too, can be closely estimated.

The case is quite different for the light elements. Here the observable lines are absorbed only by highly excited atoms. For every such atom there must be many thousands of others which produce lines in the inaccessible ultra-violet.

Making the best allowance we can for this, it appears that carbon, nitrogen and sulfur are comparable in abundance in the sun with the most prevalent metals, such as iron or magnesium; and oxygen even more abundant. Hydrogen, whose lines are very strong, despite a high degree of excitation in the atoms which produce them, must be the most abundant of all.

Here we get into trouble, for there are other influences besides an increasing abundance of atoms which may widen a hydrogen line—in particular, the presence of an electric field. In the ionized gas of the solar atmosphere many hydrogen atoms will be near to electrons or positively charged ions, and such atoms will give wide fuzzy lines. From instant to instant different atoms are thus affected, but the average effect remains. This effect is smallest—though important—for the red line, and increases steadily toward the violet. In the near ultra-violet it is so great that the lines become wide, shallow, hazy, and so ill-defined that it is impossible to measure their positions. Were they on a uniform background they would still be easy to see, but this part of the spectrum is cut to pieces with heavy lines of other elements, so that they are difficult to detect.

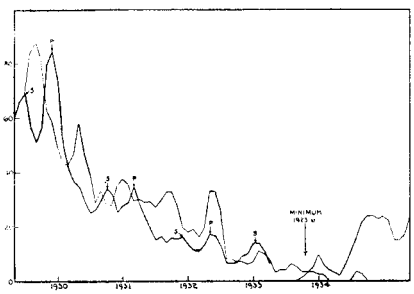
For hydrogen the line widths fail us, and we must seek some other way of determining its abundance. It may seem strange that this can be done with the aid of lines of iron. As one passes from cool stars like Arcturus to hotter ones, such as the sun, Procyon, and Sirius, the arc lines of iron, like those of other metals, gradually fade out; because, of course, the atoms in increasing proportion become ionized. The enhanced lines, due to the ionized atoms, at first grow stronger. We should expect them to continue to do so until the arc lines were practically gone—that is, till all the atoms were ionized—and to fade out gradually at still higher temperatures, when the ionized atoms lose a second electron apiece. This takes considerably more energy than is required to ionize hydrogen, so that we may expect the enhanced iron lines to strengthen and stay strong without much change until the hydrogen lines have pretty well faded. But, in fact, these lines reach a maximum at about the temperature of Procyon (Class F5) and weaken in the hotter stars, such as Sirius, long before the hydrogen begins to fade. This can be explained only if there is a great excess of hydrogen in the atmosphere.

At relatively low temperatures, such as that of the sun, the hydrogen atoms will be practically all neutral. The electrons and ions coming from the metals will produce opacity enough to limit the observable atmosphere to a moderate depth. At higher temperatures, when the hydrogen begins to be ionized, it (owing to its great abundance) will liberate a much larger number of electrons. The atmosphere will grow much more hazy, and the depth to which we can see will diminish. This will cause the spectral lines to grow weaker—even those which, like the enhanced iron lines, would otherwise be somewhat strengthened. The greater the amount of hydrogen the lower will be the temperature at which this effect shows itself. In this way the writer has recently shown that in an average stellar atmosphere there must be about 1000 times as many atoms of hydrogen as of all the metals together.

THE outer parts of the stars therefore appear to be composed of almost pure hydrogen. The nitrogen, carbon, and oxygen, though abundant in comparison with the metals, make up at most but a few percent of the whole, even by weight, and much less by volume. This is probably not true of the deep interior, for there are certain influences which tend to draw the light hydrogen atoms to the surface. But of the composition of the surface there can be no question.

Of the many interesting connections of this, we have time to mention but one. Everyone knows that the major planets, and especially Saturn, have low mean densities, while planets like the earth are several times denser. Yet they were probably both made in some way out of material taken from the sun. Moulton suggested more than 30 years ago that the difference arose from the fact that the major planets have sufficient force of attraction to retain light gases such as hydrogen, while the earth and the smaller bodies do not. This suggestion is strengthened by the evidence that an unassorted sample of the sun's surface material would contain even more hydrogen than would be required to make a planet of low density.

—Clark's Island, Plymouth, Mass., Sept. 4, 1933.



Strictly speaking, the smooth curve on the opposite page is diagrammatic. As Dr. Nicholson and Miss Elizabeth E. Sternberg pointed out in the August number of the *Publications of the Astronomical Society of the Pacific,* "solar activity usually progresses unevenly in short-period fluctuations which can be traced through each cycle. During the present cycle these fluctuations have had a period of about 15 months, with secondary maxima between the primary maxima." (Indicated by S and P on the heavy line; the light line is for the previous cycle, superposed on the present one). "Minimum sunspot activity for the present cycle has not yet been reached," these astronomers continue, "nor have any spots for the new cycle yet appeared. The time of the last minimum has been determined as 1923.6." The expected time of minimum of the present cycle is October or November, 1933, though the period of low activity on the sun may be prolonged into 1934. The frequent citation of the 11.1-year sun-spot periodicity may have misled some into a belief that the periods are uniform in length. The 11.1-year figure is, however, only an average. Actually the intervals between the successive maxima have fluctuated between 7.3 and 17.1 years, and the fluctuations are not regular

Panorama of Madden Dam in the Canal Zone, as it appeared last spring. Excavation is in progress in the river bed while the Chagre section of the dam. Cableway is shown ending on tower on track near mixing plant. To right is screening plant, and at extreme right o

More Water for the Panama Canal

By E. S. RANDOLPH
Construction Engineer

THE engineers who planned the Panama Canal anticipated the need of a larger reserve water supply before full development of its capacity could be attained. This reserve could best be obtained by the construction of a dam on the Chagres River, the largest tributary to the Gatun Lake, at a point about nine miles from the Canal.

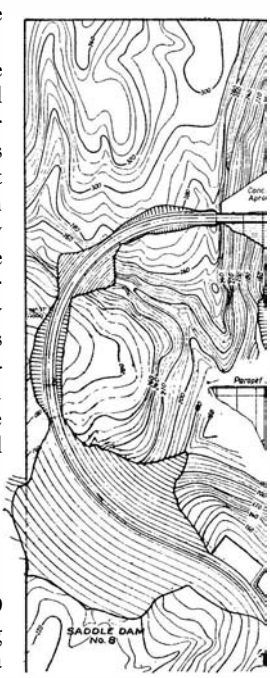
The water used for locking a ship completely through the Canal—first up a distance of 85 feet into Lake Gatun by filling the three chambers of the locks and then down into the sea by successively lowering the water in the three lock chambers on the other terminal—has averaged 6,500,000 cubic feet.

The use of water, exclusive of that for power, for a single day during the dry season—with 16 ships transiting—was a total of 194 million cubic feet divided into 104 for lockages, 85 for evaporation, and 5 for municipal uses and leakage (all values expressed in millions of cubic feet). The effect of these drafts on Gatun Lake was to lower the level, and in a prolonged dry season the lowered level caused added difficulties to navigation in the narrow channels of Gaillard Cut.

When the final plans for the dam on the Chagres River were being considered in 1930, the rate of increase of water use was estimated to be 1300 million cubic feet per year for lockages alone or 2400 million cubic feet per year for all uses except power. The available storage in Gatun Lake of 32,000 million cubic feet had previously been nearly exhausted during a prolonged dry season due to the operation of a hydro-electric plant at Gatun which discharged into the sea. While this demand on the reserve water supply was lessened by the installation of a Diesel-electric plant for use only in the dry season, it was seen that in a comparatively short space of time, based on the rate of growth of traffic, the Canal would probably be unable to continue to operate throughout a prolonged dry season.

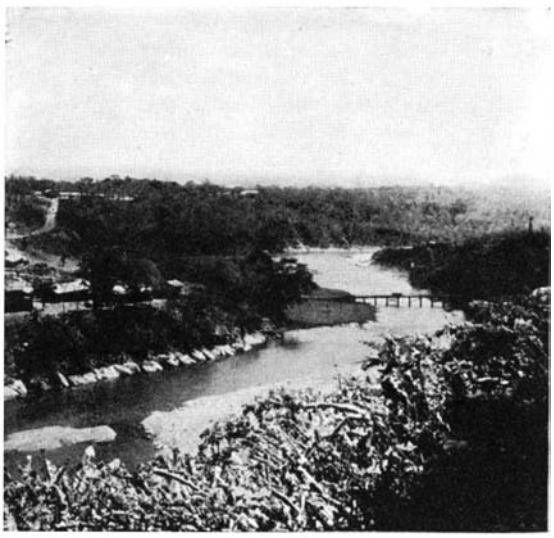
THERE are two distinct seasons during the year in the Canal Zone, the "dry season" which lasts between the average dates of January second and May fifth, and the "wet season" during the remainder of the year; these dates have varied as much as a month each way from the average. During the dry season the Atlantic trade winds sweep the Isthmus and there is very little rainfall. The Chagres River, which has an average flow of 2520 cubic feet per second, has been known to flow only 235 c.f.s. (cubic feet per second), and in the greatest flood its flow was estimated to be 176,000 c.f.s. The greatest flood of future times which is probable has been estimated to be 280,000 c.f.s., which corresponds to a rate of run-off of 650 second-feet per square mile over the entire reservoir watershed of 427 square miles.

The Madden Reservoir will have an area of 17 square miles at its operating level of 240 feet above sea level and 21.4 square miles at the maximum flood level of 263 feet. It is not for water supply alone but serves also as a power and flood control reservoir. An ample supply of water for generating electric current sufficient for all the needs of the Canal Zone for many years will be provided and the water which will pass through the turbines will flow down to Gatun Lake and be available for locking ships, because the operating level of Madden Lake is 155 feet higher than Gatun Lake. A regulating reservoir will also be provided for the moderation of the intensity of floods which occasionally pass down the Chagres River with sufficient force to cause navigation in the Canal to be suspended. With the increase in traffic which will normally occur, such delays become more serious.



The function of the dam in case of floods will be to impound the water as the flood wave enters the lake and to feed it more gradually through the controlled spillway with the result that the lake level rises as water is impounded and slowly lowers to normal level as the flood waters are allowed to flow away at a harmless rate. An increase in depth of 23 feet will be permissible for impounding flood waters which will provide a volume of 12 billion cubic feet.

During the year 1919 the topographic mapping of the reservoir site to a



River flows through the incompleted power plant picture is a tower at the gravel reclaiming point

scale of 1:5000 was commenced. In 1924 the areas required for the reservoir and construction camp were acquired from the Republic of Panama under the terms of the treaty between the United States and the Republic of Panama and placed under the political jurisdiction of the United States in the same manner as the original Canal Zone.

Engineering studies of the project commenced in 1928 and included water supply, transportation, power, general design, materials for construction, and construction program. These studies by the Panama Canal engineering staff resulted in the accumulation of a mass of tabulated data which became the basis of the final designs of the dam. In 1929 geological investigations revealed the presence of cavernous limestone in the ridges on each side of the dam; this discovery was followed by a wide-spread program of drilling and testing and further consultations with geologists and engineers. Specimens of stone from the foundations were tested by the local government laboratory, also by the Bureau of Standards and the University of Illinois laboratories. Besides the limestone which occurs at a depth of 80 feet below the base of the dam, there is the foundation stone itself which is a gray calcareous sandstone having a compressive strength of 1600 pounds per square inch in a testing machine.

Core drilling was commenced using black carbon diamonds for the cutting medium but it was found that a tungsten carbide cutting tool was sufficiently hard to cut the relatively soft Madden Dam stone at a large saving in cost. A total of 23,000 linear feet of cores were cut through solid rock.

Beneath the ridge on the right bank of the Chagres River above the dam and partly below reservoir water level, a cavern 1500 feet long, 100 feet wide, and 40 feet high at its maximum section was discovered. Other smaller caverns were known to exist but a careful search did not reveal any of them passing through the impounding ridge of the reservoir. The condition led to a program of clay grouting along this ridge where there was a probability of rapid leakage. It is expected that there will be a total of 30,000 cubic yards of a thick clay-water solution pumped into holes drilled through this seamy formation.

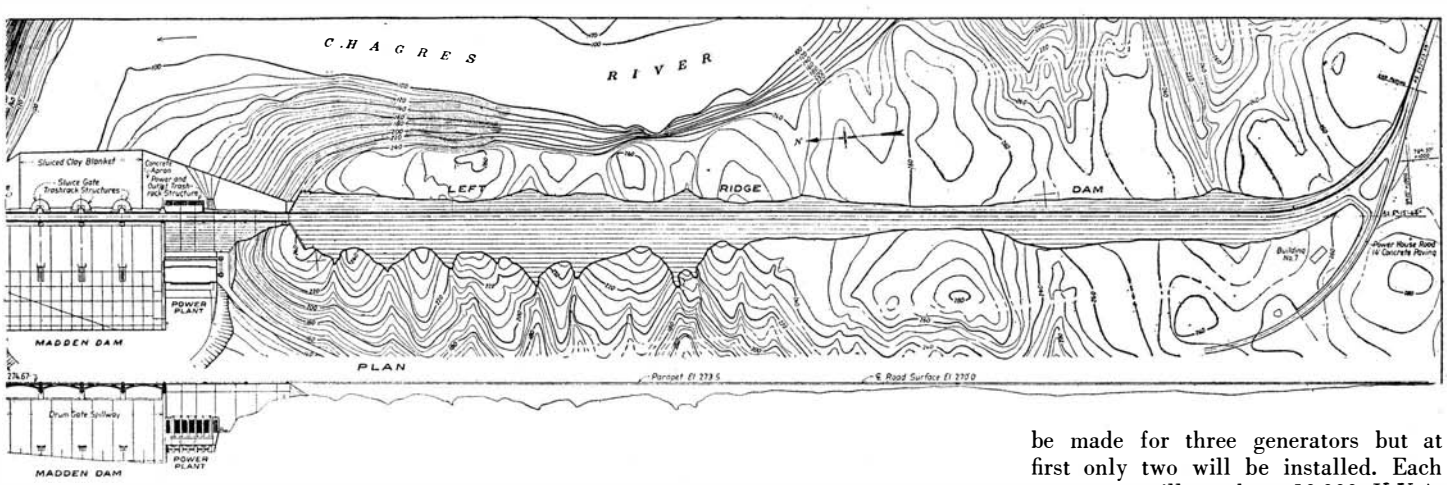
THE silt content of the Chagres River was measured and found to be of little importance.

The rate of absorption of water at various depths by the core drill holes on the damsite was measured with a device which plugged the hole at different depths and introduced the water beneath the plug. This information is used as a guide for the locations and depths of the holes for injecting a thin solution of cement and water known as cement grouting.

The final studies, plans, and specifications were prepared during 1930 in the Denver office of the United States Bureau of Reclamation with R. F. Walter as Chief Engineer and J. L. Savage as Chief Designing Engineer. Representatives from the Panama Canal engineering staff collaborated with the reclamation engineers who were retained by the Governor of the Panama Canal as consultants on this project. After studies and comparative cost estimates had been made for various suitable types of dams, it was decided to make the principal structure across the Chagres River of the massive concrete gravity type, having a spillway apron of concrete 150 feet long, and an upstream concrete apron and clay blanket 10 feet thick and 150 feet long. The purpose of the former is to prevent erosion of rock below the toe of the dam, and of the latter to protect the rock from weathering and to diminish the rate of seepage of water beneath the dam. Such protective measures are beyond those ordinarily used for similar structures and are made necessary by the soft nature of the stone foundations. The dam will be 950 feet long and the maximum height above foundations will be 228 feet.

CONTAINED in the central portion of the main dam are four spillway gates each 100 feet wide and 18 feet high. They are of the overfall, or weir, type known as the "drum" gate. They are floated to form a closure and submerged to open the aperture.

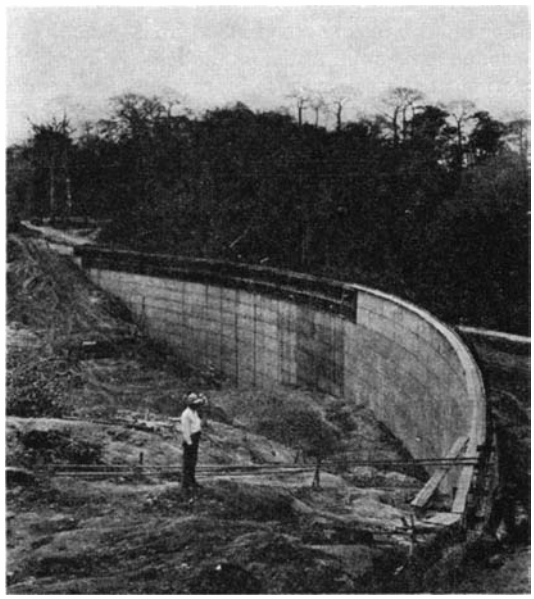
On the left bank is the hydro-electric power plant built against the downstream toe of the dam. Provision will be made for three generators but at first only two will be installed. Each generator will produce 10,000 K.V.A. of energy and will be driven by a 11,200 horsepower water turbine. This electrical plant will furnish the current for operating the Canal Zone for many years. A transmission line 12½ miles long joins the new plant to the existing



Plan and elevation, with contours, of Madden Dam. This clearly shows details of the dam itself, the elevations above sea level, and the long ridge dam and saddle dams necessary to obtain the proper amount of storage for the purpose

electrical system. At present this line furnishes power for constructing the dam.

Due to the irregular topography of the country there are several points where water would escape from the reservoir through the low points in the hills and such points are being plugged with earth and rock fill dams. On the left bank of the main dam is a ridge below the maximum reservoir level and it is elevated by means of a concrete-faced earth and rock-fill dam having a roadway over its top.



Concrete cut-off wall of one of the larger earth dams. Completed, this will be 58 feet high

Bids for construction of the dam were opened September 1, 1931, and award was made to the joint firm of W. E. Callahan Construction Company of St. Louis, and Peterson, Shirley, and Gunther of Omaha. The low bid was 4,048,657 dollars for building the dam with materials furnished by the Government estimated to cost 3,000,000 dollars additional. The Government also furnishes engineering and inspection during the construction, and the labor of installing the power plant machinery which is scheduled to be completed during July, 1935. Work is paid for each month, based on quantity completed at the unit prices agreed to in the contract. There were 95 items of work in the original contract including 518,000 cubic yards of concrete of all classes; 3,800,000 pounds of reinforcing steel; about 9,600,000 pounds of gates, valves, conduits, and structural steel; 680,000 cubic yards of excavation; and 640,000 cubic yards of earth and rock fills in embankments.

THE general contractors for the dam employ about 950 men of all classes; other contractors about 150 men; and the Government about 225 for force account work and administration, engineering, and inspection connected with the project.

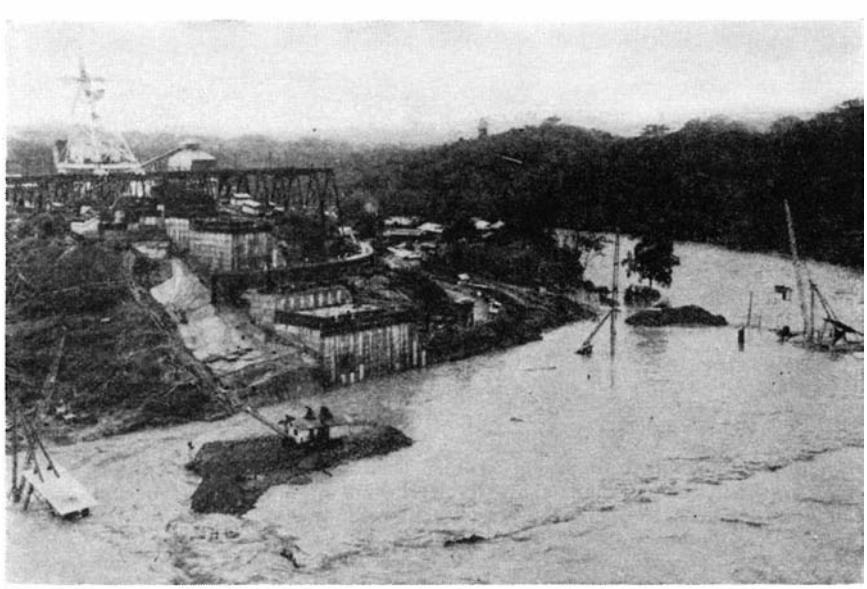
The river is spanned at the site of the dam by a three-inch diameter steel cable mounted on the tops of 100-foot movable steel towers 1325 feet apart at the cable anchorages. Both towers can travel at a speed of 66 feet per minute up and downstream, for a total distance of 410 feet, on wheels which roll on two rails spaced 60 feet apart. A "carriage" mounted on 12 wheels is towed along the three-inch track cable at a speed of 1200 feet per minute and to this "carriage" is suspended the hook which can pick up any load to a limit of 25 tons. The hook may be raised and lowered at a speed of 300 feet per minute. Thus the cableway may lift a bucket containing eight cubic yards of concrete or rock, or may lift a 25-ton piece of steel from a wagon on the riverbank and place it at any point within an area 410 feet wide and 1200 feet long. This cableway is a modern mechanical device and is operated electrically with all movements controlled by one operator who is housed high in one of the movable towers. This operator is in constant telephone communication with signalmen at the points of picking up and depositing the load. Often those points are not within sight of the operator.

The concrete will be made of cement, imported from the United States, and water, sand, gravel, and cobbles reclaimed from the river bed. Igneous gravel is present in great abundance. It has been washed down from the igneous rock formations about 15 miles upstream from the dam. The most favorable gravel deposit is one mile down river. The contour of the land and prevalence of floods led to the adoption of an aerial tramway for the transportation of some 550,000 cubic yards of gravel to be washed, separated into five sizes, and finally re-proportioned scientifically to form concrete yielding the maximum strength with the minimum of cement.

THE aerial tramway is composed of a track cable making a continuous circuit from the gravel loading terminal to the washing and screening plant, a series of towers to support the track cable, a series of buckets suspended from wheels which roll along the track cable, and a traction cable which tows the buckets around the circuit. Buckets have capacities of 32 cubic feet each, are spaced 256 feet apart and are towed at a rate of 500 feet per minute. The buckets are released from the towing cable for loading which is done by passing them under a gate leading from a hopper and are again fastened to the towing cable at evenly spaced intervals. On arriving at the washing and screening plant they are automatically dumped, without stopping, into a hopper.

The construction plant was built by the general contractors and is their property. The Government furnishes only those materials which are to form a part of the permanent structure. The contractors are represented on the premises by Paul Grafe as Managing Director and R. M. Conner as General Superintendent.

The project is under the direction of Colonel Julian L. Schley, Governor of the Panama Canal, assisted by Colonel Clarence S. Ridley, Engineer of Maintenance, and by Major Joseph C. Mehaffey, Assistant Engineer of Maintenance. E. S. Randolph is Construction Engineer.



Looking southwest across the left abutment of Madden Dam during a flood of some months ago. Note the heavy machinery covered by this 112,000 c.f.s. flood

A Sculptor Turns Anthropologist

A Woman Artist Circles the Globe to Fix Native Types in Imperishable Materials

An Australian spear thrower

THE human family numbers 1,800,000,000 or more people, widely scattered as to races and breeds. Museums are filled with cases containing skulls and casts and models which are of interest to students, but have a tendency to repel the casual visitor. Recognizing that to be the case the Field Museum of Natural History in Chicago adopted the plan of giving the native races of mankind a plastic representation from actual studies in their native lands, made by a practical but highly competent sculptor, and now the studies, made all over the world by Miss Malvina Hoffman, are forever preserved in enduring bronze.

Indian Tamil climbing tree

Miss Hoffman spent four years in seeking types in Africa and in the Far East. She had to penetrate the forbidding interior of many remote jungle lands to find living models who could represent some of the most primitive and little known tribes, and there she created works of the highest merit. Of them Sir Arthur Keith says: "In these sculptures the anthropologist finds triumphant expressions of race. Intuition has transformed the artist into an anthropologist; the mirror of her imagination caught from her sitters and held only the essential traits of race. . . . She is a great sculptor who lavishes her art in the service of anthropology." The same great authority also says that a knowledge of physical and racial anthropology is not confined to those who work in museums and universities and he holds that the busts, figures, and groups modeled by Miss Hoffman are priceless registers of anthropological fact and in the full sense of the term are scientific documents as well as works of art.

Yellow Race—merchant of Tibet

The Chauncey Keep Memorial Hall where these sculptures are displayed was recently opened to the public and the exhibit produced a profound sensation. It may be questioned whether any vestiges of the life and culture of primitive man will remain by the time the next century arrives, but in any event many of the vanishing races will continue to live in the statues and busts in these halls.

North Chinese jinricksha coolie

On this page are illustrated a few of the examples displayed. Miss Hoffman was a pupil of Rodin who probably never thought of his pupil, the modeler of the dancing Pavlova, as penetrating the wilds of the primitive places of the earth. She had much difficulty in overcoming the reluctance of distrusting and dangerous savages towards posing. Eighty-five types are now represented but the whole collection will require another year to complete.

Pygmies from the Belgian Congo

THE AMATEUR AND HIS MICROSCOPE—V

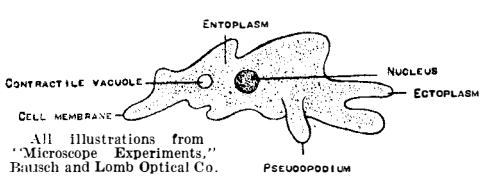
EXPLORING UNKNOWN WATERS

By JULIAN D. CORRINGTON, Ph. D.
Ward's Natural Science Establishment, Inc., Rochester, New York

PREVIOUS installments in this series on amateur microscopy have dealt with the microscope as a precision instrument and with explanations concerning its construction and operation. It is now time that we put this marvelous tool to work and see at first hand some of the things which have enabled the microscopist to rewrite entirely the story of the universe.

Among the many strange realms which possession of a microscope opens up for exploration, none is more fascinating to novice and old timer alike than the microcosmic panorama to be met with in making cultures from any roadside pool or ditch. There are myriads of plants and animals composed of but a single cell, and other hosts of many-celled organisms which, though complex in structure, are yet microscopic in size. Microbiology concerns itself with a study of these forms, and of bacteria and parasitic species as well, but it will prove more satisfactory if attention is at present concentrated upon the free-living species, deferring work on most of the bacteria and all of the parasites to later chapters.

A feature of value in connection with



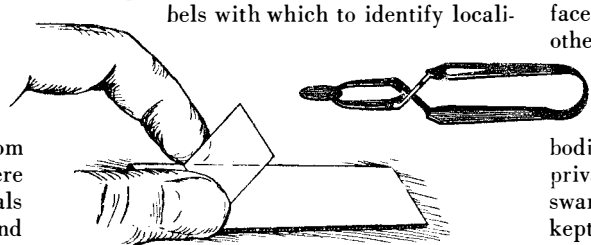
All illustrations from "Microscope Experiments," Bausch and Lomb Optical Co.

Body of a protozoan, showing parts

the studies proposed in this article is the simplicity with which they may be made. Presupposing the ownership of a microscope to begin with, little else in the way of materials is necessary. A few blank slides and cover glasses, cleaning cloths or lens paper, a small tube of vaseline, two or three pipettes of the variety commonly known as medicine droppers, and several large containers, are all of the items that could be considered as indispensable.

The best form of container is not expensive—the gallon sized glass battery jar, cylindrical in shape. If these are not available, use two-quart fruit jars or small fish globes. The most serviceable cleaning cloth is a soft piece of old household cotton goods, free from lint, or an old linen handkerchief.

Outfitting for field collecting may be as simple or as elaborate as you wish. Recommended for all-purpose use is a knapsack or army gas mask bag, both of which are retailed at Army and Navy stores or sporting goods establishments. A half dozen bottles, wide-mouthed and cork-stoppered, two and four ounce capacity, with some blank gummed labels with which to identify localities from which collections are made, will be desirable, though any type of clean, small bottle will do.



Left: **How to drop the cover glass on the culture.** ***Right:*** **The glass may also be handled with forceps**

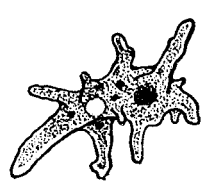
Finally there are the chemicals. Tincture of iodine and powdered rouge are to be found in practically every home, and complete a list of materials easily assembled and inexpensive.

The study materials are likewise readily secured and will depend upon individual preferences. The majority of those who read these instructions will wish to go afield and collect their own cultures, but for those unable or disinclined to do so, other sources are available. Bottles containing living protozoa—the unicellular animals—either as mixed species or in pure culture form may be purchased from dealers in biological supplies. Standing containers of stagnant water or fermenting liquids are likely to be present somewhere about the premises of most homes, and will yield at least a few interesting observations. For both the field-trippers and the stay-at-homes there is the highly enjoyable culturing of the assemblage of living organisms known as the microcosm, with its kaleidoscopic array of bustling life and its fatalistic history.

Protozoans have a habit of turning up in strange places. An old pickle barrel in a grocery store was skimmed by an amateur microscopist, curious to see what the scum contained and, to his amazement, was found to be teeming with life. The water that collects along with dead leaves in park, cemetery, and gate-post urns will usually provide excellent preparations, especially of rotifers. Try scraping a bit of film from greenhouse plant leaves, in cases where considerable moisture prevails. Mount the scrapings from the inner glass surfaces of aquaria, humidifying vessels, or other containers of water in which some slight scum clings to the sides. Ornamental pools, fountains, bird baths, fish ponds and similar bodies of water in cities, parks, and private grounds, will all be found swarming with microscopic life if not kept too well cleaned out, and especially if aquatic vegetation is present.

NO elaborate trip is then necessary, and it is certainly not a task to gather cultures for study. Yet the real enthusiast will wish to obtain the rich variety of life that flourishes best in the natural country environment of pond and stream. The roadside ditch, the backwater eddy or quiet pool in a stream-course, and the small pond, will all prove happy hunting grounds for the microbiologist. Choose stagnant water or quiet water sites in which green scums—species of aquatic plants termed algae—abound, and in which there is some variety of other plant life, notably lily pads.

To collect, immerse a stoppered bottle in the shallower parts at such places and, when it is on the bottom, remove



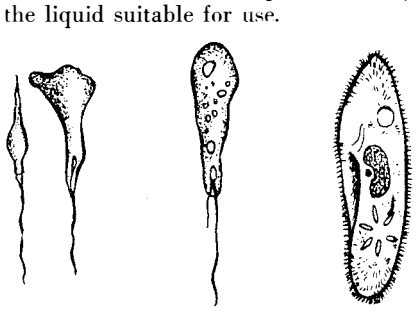
Amoeba proteus, commonest species

the cork and at the same time push in some of the mud, dead leaves and other bottom material with the fingers. The inrush of water will carry in quite a bit of solid matter. A good proportion for the filled bottle is about one fifth solid ingredients, including soil, bark, leaves, and so on, three fifths water, and the remaining fifth air. Replace the stopper

before removing the bottle from the bottom, bring it to the surface, pour off a bit of the water and remove any excess of leaves. Then stopper again and label, indicating the name or nature of the collecting site.

Scrape the undersides of lily pads, or cut up bits of these and place them in another bottle, together with some of the adjacent water. Try several of the species of higher algae, many of which are familiar to the owner of an aquarium, and which may be purchased, for that matter, in pet stores. Sphagnum bogs will yield an entirely different assortment of protozoans than that obtained in the lily-pad frog pond. Spring-fed pools give still another assemblage, and sewer-polluted water yet another.

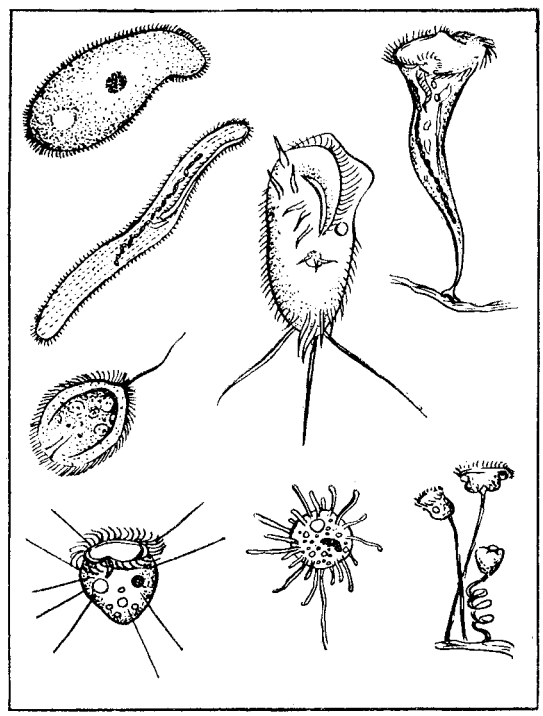
ON arrival home from collecting, something must be done about the billions of animals with which you are freighted. Fortunately they require neither food nor water at your hands; they will themselves attend to all physiological needs save one, and that is the universal and ever-present demand for oxygen. Therefore remove the corks in your bottles, after they have been arranged on your work table, and cover each container with a piece of gauze or cheesecloth, large enough to be secured around the bottleneck with a rubber band. These micro-aquaria will now stand for a long while if you occasionally renew the water lost through evaporation. Add water brought from the same source as the material itself, if convenient. Otherwise, draw off a vessel of tap water and allow it to stand uncovered for two days in some situation relatively free from dust, after which the excess oxygen dissolved in such water will have escaped, rendering the liquid suitable for use.



Left pair: **Paranema.** ***Center:*** **Astasia.** ***Right:*** **The slipper-shaped Paramecium is an agile performer**

And now we're ready to make a microscopic inspection of what we have in these bottles. Thoroughly clean a slide and cover glass, using clean water and drying them with the soft cleaning cloths. In stubborn cases, dip the glassware in alcohol or household ammonia and wipe it dry. Cleaning cover glasses without too great a mortality in the ranks of these very thin slips may require some practice; cover the thumb and forefinger of the left hand with the cleaning cloth, grasp the cover glass through this cloth and work it gently back and forth, or turn it around and move it in and out of this grasp by holding it with the right thumb and forefinger by its edges. The main trick is to keep the pressure on the two sides of the glass opposite and equalized at all times. Always handle every clean piece of glassware by the edges, thereafter. No matter how clean your hands may be, they will leave a fingerprint impression in oil if you touch the flat surface of clean and polished glass.

Pipettes must also be very clean before using them with the culture bottles. Have a separate one for each bottle, or clean well before transferring from one culture to another. In this way you will avoid contamination of the different containers. Remove the rubber bulb and vigorously squeeze it several times in a glass of water, thus flushing it out. Hold the glass barrel under a running tap of water and run it through with a pipe cleaner, then replace the bulb. It is an excellent idea to label pipettes to match each bottle of culture, so that they will not become mixed. Threads of the same color may be tied around both bottle and pipette, using different colors for different sets.



A typical collection of microscopic forms of life. How poorly any reproduction of these little creatures does them justice will become evident only when they are seen under the microscope, their detail being clearly visible and their antics an endless source of interest

PLACE a clean slide before you on the work table, and have ready a clean pipette and cover glass. Squeeze the bulb of the dropper and insert the glass barrel so that the tip is applied to the upper surface of the sediment on the bottom of the selected bottle of culture. Release the pressure on the bulb slowly, obtaining a mixture of sediment and water. Place two drops of this solution on the center of the slide and lay aside the pipette. Pick up the cover glass by its edges or by means of a cover-glass forceps, bring it over the fluid on the slide, and tilt it so that one edge of the cover touches the slide at one side of the liquid. Then merely let go, allowing the cover to fall into place by its own weight. The water immediately spreads out into a thin film under the cover and, if the right amount has been used, none will run out from beneath the cover.

Now let's go big game hunting! Mount the slide under the spring clips on the stage of the microscope, attend to the duties of adjusting light and focus with the low-power ocular and low-power objective in line. A moderate illumination is best; the objects to be seen are largely colorless and transparent and too bright a light will render them invisible.

What wonders may now appear before your eyes it is impossible to tell. Your culture may be a poor one, showing little or nothing. But the chances are a thousand to one, if you have collected in a suitable place and have secured the drops for mounting in the manner above directed, that you will see many varied and interesting creatures. There are stationary organisms, both plant and animal, slow and uncertain wanderers; and finally the agile and swift-moving forms that are all the more interesting for their many activities – though they give a bit of trouble in the matter of detailed study under high power. Actual species encountered will vary with the district in which you live, and with the type of situation where the collection was made. Yet many of the commoner types, such as Amoeba, Euglena, Paramecium, and Stylonychia are well-nigh universal and you will soon get to know a dozen or more kinds without difficulty.

Space does not permit anything like a complete description of the hundreds of forms to be met with in such mounts. Many pages of manuals have been devoted to brief characterizations and illustrations of the better-known varieties, and new species are constantly being found.

●

Next month further practical pointers will be given.

SOLAR TIDES

By H. A. MARMER
Assistant Chief, Division of Tides and Currents
United States Coast and Geodetic Survey

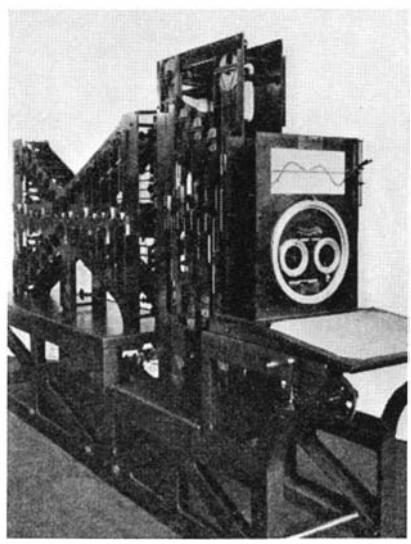
THAT the tide is in some way intimately related to the apparent movements of sun and moon, and that the latter body plays the leading rôle, has been known for ages. But how sun and moon give rise to the tide, and why the moon plays the leading rôle, remained a mystery till the latter half of the 17th Century. It was only with the formulation of the law of gravitation that the tide received a rational explanation, for Newton proved that the tide is a necessary consequence of gravitation.

On the basis of gravitation, the mathematician can readily show that the tide-producing power of a heavenly body must vary directly as its mass and inversely as the cube of its distance from the earth. This explains why the moon is the principal tide-producing body, so far as our earth is concerned. Although the sun has a mass 26,000,000 times that of the moon, its distance from the earth is 389 times that of the moon. Hence the tide-producing power of the moon is to that of the sun as $(389)^3$ is to 26,000,000, or about 2¼ times as large.

AS developed in textbooks on physical geography or astronomy, the subject of tides is simplified by assuming the earth to be entirely covered by the waters of the sea. On this assumption the general features of the tide can be derived easily. Thus it can be shown that the tide, like the moon, must come later each day by about 50 minutes, and that the rise and fall of the tide must vary with the waxing and waning of the moon. As it is put colloquially, "the tide follows the moon."

This simplification of the tide appeared to be validated by the tides on the shores of the Atlantic Ocean. These tides are of a relatively simple character, agreeing surprisingly well with the features deduced on the assumption of the mathematician's ideal world entirely covered by water. Since these tides were the ones which the early investigators had at hand for study, it was but natural that their simple character should be taken as typical. This procedure, however, very much oversimplified the subject.

The tide-producing forces, being of astronomic origin, are distributed regularly over the surface of the earth, varying only with latitude. But the response of the waters of the sea to these tide-producing forces is so very profoundly modified by the hydrographic features of a particular ocean basin, that the tides at different places vary strikingly, but with no regard to latitude. Seattle, Washington, and Prospect Harbor, Maine, do not differ much in latitude. How different the tides are at the two places is shown in Figure 1, which reproduces the tide curves at these places for the first two days of September, 1929, as derived from automatic tide gages at these two localities.



The mechanical tide predictor of the Coast and Geodetic Survey

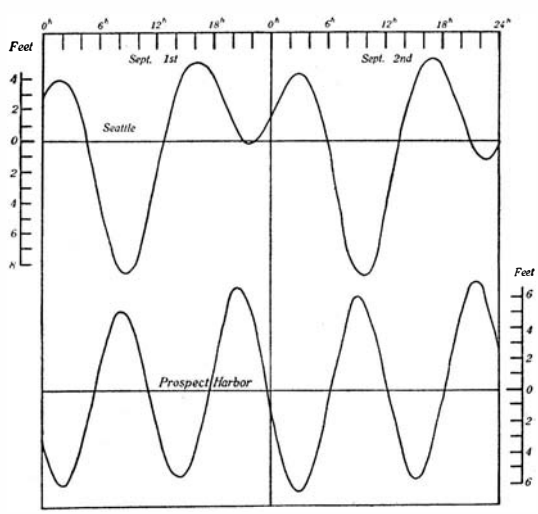


Figure 1: **Tides at different places are seldom alike, because of the effects of local features**

In the diagrams of Figure 1, the horizontal lines represent the undisturbed sea level. At Prospect Harbor the high waters rise approximately as much above sea level as the low waters fall below it. Furthermore, the two high waters of a day, as well as the two low waters, are much the same in all respects. In fact, the Prospect Harbor tide is a typical Atlantic Ocean tide.

ON comparing the tide at Seattle for these same two days, striking differences are seen. In the first place the high and low waters are not symmetrical with respect to sea level. In the second place, while the two high waters of a day are much the same, the two low waters differ by many feet. For the two days shown in the figure, the morning low waters at Seattle were about eight feet lower than the afternoon low waters. Indeed, the afternoon low waters barely fell below sea level.

Now it must be noted that the differences in the tides at the two places shown in Figure 1 are in no way due to the disturbing effects of wind and weather. Heavy winds and wide variations in barometric pressure do bring about very considerable differences in the regularity of rise and fall of the tide, but the first two days of September, 1929, were chosen precisely because of freedom from such disturbing effects. The features shown in the figure are characteristic of the tide at these two places.

The variety of tides actually found to occur is at first glance bewildering. Altogether aside from differences in time and in range, which may be regarded as merely differences in degree rather than in kind, and aside, too, from local peculiarities due to local geographic features, the tides at different places differ strikingly. In Figure 2 are shown the tide curves for the same two days of September, 1929, at Pensacola, Florida; Honolulu, Hawaii; and San Diego, California. At Pensacola there is but one high and one low water each day. At Honolulu there are two high and two low waters in a day; but while the two low waters of each day are much the same, the two high waters differ considerably. At San

Diego both the high and the low waters of each day differ.

Still different varieties of tide may be found at other places. Thus at Galveston, Texas, the tide shows two high and two low waters for several days at a stretch and then only one high and one low water for a number

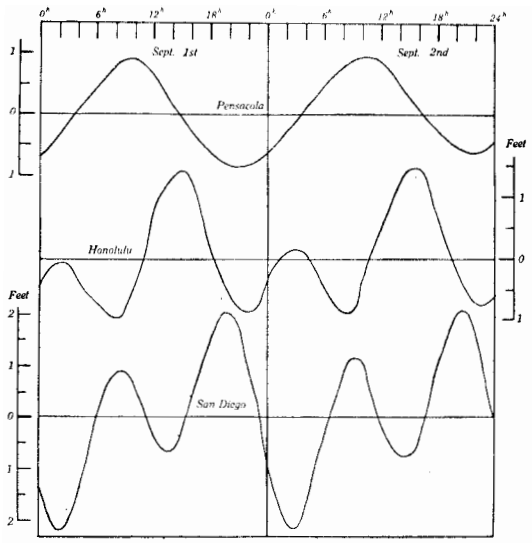


Figure 2: **How strikingly local tides may vary is shown clearly by these three tide curves**

of days following. But, without going into further detail regarding this matter, it may be said that all of these varieties of tides may be related to the movements of the moon. As a general statement, the dictum that the tide follows the moon is true.

There are, however, a few places where the tide does not appear to follow the moon. Tahiti is the classic example of this type of tide. Herman Melville in his "Omoo" thus describes the tide here. "The Newtonian theory concerning the tides does not hold good at Tahiti; where, throughout the year, the waters uniformly commence ebbing at noon and midnight and flow about sunset and daybreak." Authors of the more popular style of travel books have been less restrained than Melville and either state or imply that at Tahiti the tide ebbs and flows with unfailing regularity, never changing in time from one year's end to the other. In a popular book of a few years ago, the author quotes a mariner as saying that from the verandah of his club at Tahiti he could tell the time of day within a quarter of an hour by looking seaward and seeing where the water stood!

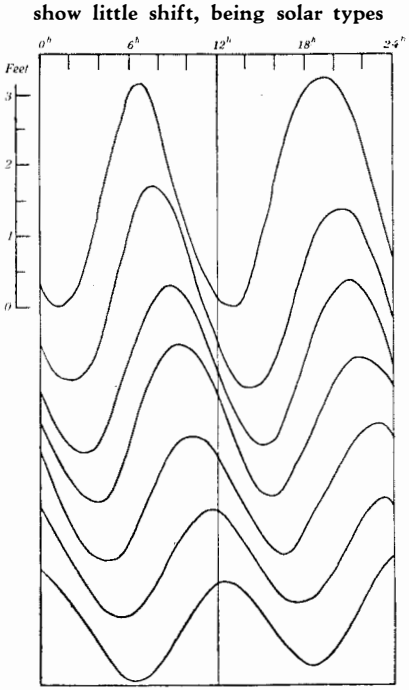
RECENT tidal research has shown that such statements are exaggerated. While the times of tide at Tahiti vary somewhat from day to day, it may be said that, in general, high water comes a little after noon and midnight, and low water a little after six o'clock both morning and evening. In other words, the daily retardation in the time of tide of about 50 minutes, which is the imprint of the moon's sovereignty, is absent at Tahiti, the tide here being a solar tide rather than a lunar tide.

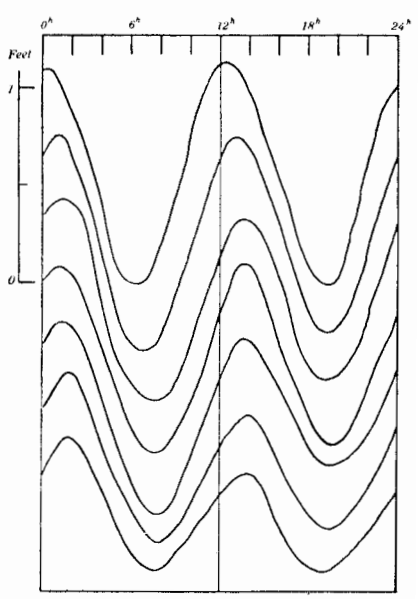
This peculiar behavior of the tide at Tahiti stands out clearly if the tide curves for each day are arranged in serried ranks, like an army on the march, and compared with a like series at some other place. In Figure 3 the tide curves at Apia, Samoa, for each day of the week of September 14-20, 1924, are plotted under each other, and in Figure 4 is shown a similar plotting for Tahiti for the same week. Apia was chosen for comparison because, like Tahiti, it is situated in the South Pacific in very nearly the same latitude.

Glancing down the tide curves for Apia it is seen that any high or low water comes progressively later each day, this being indicated by a progressive shift of the curves to the right. In the six days between the 14th and 20th of September, it is seen that the high and low waters have become later by a little more than 4½ hours, or at the rate of nearly 50 minutes per day. At Tahiti, however, the curves show practically no shift to the right, the high waters coming a little after midnight and noon and the low waters a little after six o'clock, morning and afternoon.

At Tahiti the range of the tide is small, being on the average only 0.8 foot. A much better developed solar tide has recently been brought to light

Figure 3 (below): **Typical lunar tide with daily shift in maximum.** *Figure 4 (right):* **These curves show little shift, being solar types**





by British Admiralty surveys in Torres Strait. At Tuesday Island, a small island lying about 15 miles northwesterly from the northern point of the Australian mainland, the tide is decidedly solar, but has a range of more than three feet on the average. The tide curves for the week beginning September 9, 1925, at Tuesday Island, are shown in Figure 5. Like the tide curves for Tahiti, the tide curves for Tuesday Island show practically no shift to the right in the times of the high and low waters from day to day.

BY mathematical analysis the tide at any place may be resolved into a number of simple constituent tides, and in this way the magnitudes of the solar and lunar constituents may be compared. These constituents have periods of different lengths, the most important being those with a length of about half a day, and therefore known as semi-daily constituents. At Apia the lunar semi-daily constituent has an amplitude, or semi-range, of 1.26 feet while that of the solar is 0.29 foot. Hence the tide observed here exhibits the features of the lunar tide. At Tahiti the amplitudes of the lunar and solar semi-daily constituents of the tide are, respectively, 0.29 foot and 0.26 foot. Being so nearly equal, the tide here does not exhibit the dominant features of the lunar tide, but in part also the features of solar tides. At Tuesday Island the amplitudes of the lunar and solar constituents are both 1.6 feet, and so here, too, the features of the lunar tide cannot dominate, the tide actually observed partaking of the characteristics of solar tides.

The prediction of tides for tide tables, solar tides, and quasi-solar tides presents problems of a much more difficult character than do the simple lunar tides found on the shores of the Atlantic Ocean. In fact the methods used in the

earlier tide tables would entail such an enormous amount of computation as to be altogether prohibitive. In harmonic analysis, however, is found a successful method for predicting all kinds of tides. And by the use of a mechanical tide predictor, as for example that used by the Coast and Geodetic Survey, the tides at Tuesday Island, for example, are predicted with no more difficulty than simple lunar tides.

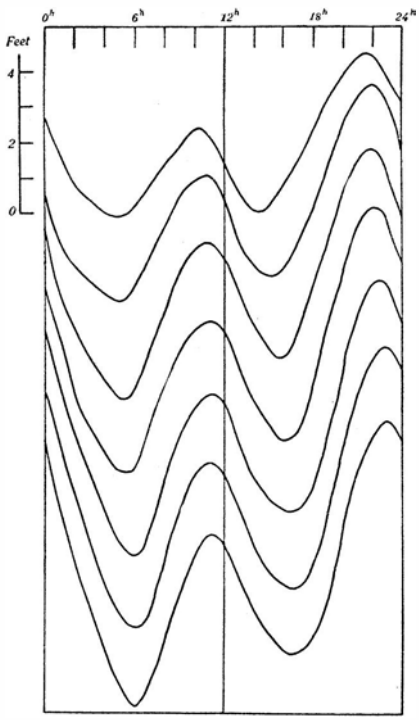


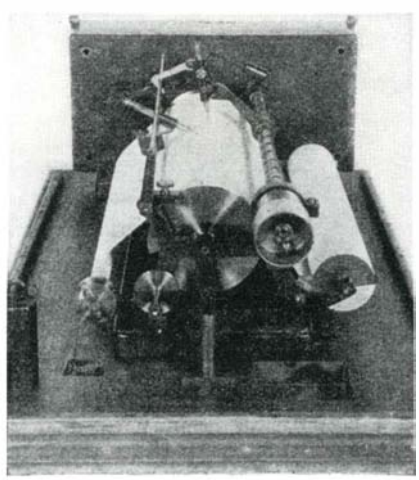
Figure 5: **Another strongly solar type of tide—at Tuesday Island**

But what explains the existence of solar tides? Why is the response of the sea to the same set of tide-producing forces so strikingly different at places near each other? Clearly the answer is to be sought in the physical features of the ocean basins. And on the basis of this, two different theories have been proposed.

The older, known as the progressive-wave theory, regards the tides of the open ocean as progressive waves. Such waves, consisting of crest and trough, travel across an oceanic area at a rate depending on the depth. The birthplace of the tide, according to this theory, is to be found in the broad and deep waters of the Southern Ocean, the belt of water which completely encircles the earth in high southern latitudes. There, it is argued, the tidal forces of sun and moon have uninterrupted sway and raise two primary tide waves, 180 degrees apart in longitude, which traverse this belt of water from east to west, constrained by the moon—the principal tide-producing body—to keep in step with its own motion. As these primary tide waves sweep the southern points of Australia, Africa and South America, they generate secondary tide waves which progress up the Indian, Atlantic, and Pacific Oceans, respectively.

The progressive-wave theory of the tide makes careful distinction between the primary tide waves traveling from east to west in the Southern Ocean and the secondary waves which progress across the other oceans and seas. The secondary tide waves travel as "free" waves, their velocity depending on the depth of the water. But the primary tide waves in the Southern Ocean keep step with the moon; they travel not as free waves but as "forced" waves, compelled by the moon to keep in time with its own movement.

The differences in the time, range, and other features that are found to characterize the tides at different places, the progressive-wave theory explains as arising from differences in the depth and width of channel, differences in the configuration of the shore line and interference of tide waves coming from different directions. Solar tides are therefore explained as occurring at places where two tide waves meet under the condition that they have approximately equal lunar ranges but are about six hours apart in time. Under such conditions the lunar high water of one wave neutralizes the lunar low water of the other, and allows the solar tide to become prominent.



Automatic tide gage which makes a continuous record of tidal changes

THIS is a plausible explanation. With regard to various other features of the tide this theory appeared to give satisfactory explanations. But with increasing knowledge of the tide in the various seas it became clear that this theory is altogether too simple to fit the facts. Too much is left to be explained by changes in cross-section of channels, configuration of coast line and interference of tide waves progressing from different directions.

The more recent theory of the tide is known as the stationary-wave theory, since it conceives the response of the ocean waters to the tide-producing forces to consist of stationary waves rather than of progressive waves. A simple stationary wave in a tank of water is illustrated schematically in Figure 6. Such a wave may be started by raising and immediately lowering one end of the tank. This wave movement is not like the progressive wave which travels across a body of water with crest and trough. Instead, it oscillates or swashes about an axis in the middle of the tank, one point of this axis being indicated by the point *C*. It may be noted, too, that a stationary wave arises from the complete reflection of a progressive wave.

In regard to stationary-wave movement it is to be noted that along the axis of oscillation no vertical rise and fall takes place. Each body of water has a natural period of oscillation which depends on its length and depth. For a rectangular basin the formula is $p = \frac{2l}{\sqrt{gh}}$ in which p is the period of oscillation, l the length of the body in the direction of oscillation, g the acceleration of gravity, and h the depth of the water. Furthermore, in responding to forces that tend to disturb its equilibrium, a body of water will respond best, or resonate, to that force the period of which most nearly approximates its natural period of oscillation.

ACCORDING to the stationary-wave theory, the dominant tides of the world arise from stationary-wave oscillations which are set up and maintained in various portions of the oceans by the periodic tide-producing forces of sun and moon. And since the periods of the forces differ, different portions of the oceanic basins will respond in different ways to the same set of tide-producing forces. In other words the axis of oscillation of an oceanic basin responding to the solar forces will not coincide with the axis of oscillation of the lunar forces.

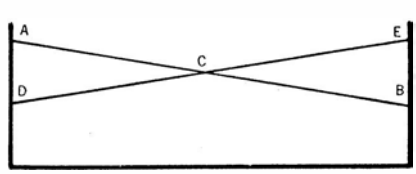


Figure 6: **A simple stationary wave like that often seen in bath tubs**

On this latter theory, therefore, solar tides are explained as occurring in regions which lie near an axis of a lunar oscillating system. The rise and fall of the lunar tide is at such places therefore small. This gives the solar tide the opportunity to become the dominant constituent of the tide, and hence the tide in such places follows the sun rather than the moon.

A Rapid-Fire Weapon to Fight

TUBERCULOSIS

Typing identifying data on the lead cards, which are later X rayed with the subject

AMONG the more prevalent diseases of mankind, pulmonary tuberculosis—the White Plague—is one of the most deadly. Now doctors think they have a weapon which, if it is extensively used, will enable them to plan and carry on a much more effective campaign against tuberculosis.

The new weapon is a machine capable of taking X rays of the lungs at the rate of four a minute. The pictures are made on inexpensive paper film instead of the more costly celluloid film heretofore used. A hundred pictures, or radiographs, the full size of the chest of the subject, are made on a single roll of a recently developed high-speed X-ray paper 150 feet long. The high speed and precision with which the new machine turns out its product makes it possible to examine large numbers of subjects in a very short time—up to 800 a day.

The machine consists of a box-like receptacle which is adjustable vertically to the height of the subject, who stands with the chest tight against its front side. A canvas compression band is drawn across the back of the subject just below the shoulders. The X-ray tube is automatically centered on the vertical center line of the box and also at the height of the center of the compression band. A scale automatically registers the thickness of the chest and indicates to the operator just what voltage to use to secure a good picture.

The distance from the X-ray tube to the box is maintained constant at 40 inches. The current passed through the tube at each exposure or discharge is also kept constant at 100 or 150 milliamperes. The time of exposure is usually 1/10 of a second, but is sometimes increased to 3/20 of a second for subjects with very thick chests.

The subjects to be X rayed are lined up near the machine and one by one they step into position and are "shot" at the rate of 150 or more an hour. At this speed an entire class of school children can be taken during one "period" in the day's schedule, or in about 20 minutes. The unit is portable and may be set up in the school building, ready for use in a short time.

A feature of the new method, which makes it possible to maintain high speed, is the system of marking each radiograph at the time it is taken. Each subject is provided with a lead card on which is typed, by means of a special typewriter operated by an electric motor, all the identifying data required by the physician or health officer in charge, such as date, name, address, grade, sex, weight, height, and so on. This complete record prevents errors, as each subject has his or her own card, which is placed in a clip on the front of the box and is X rayed with the subject.

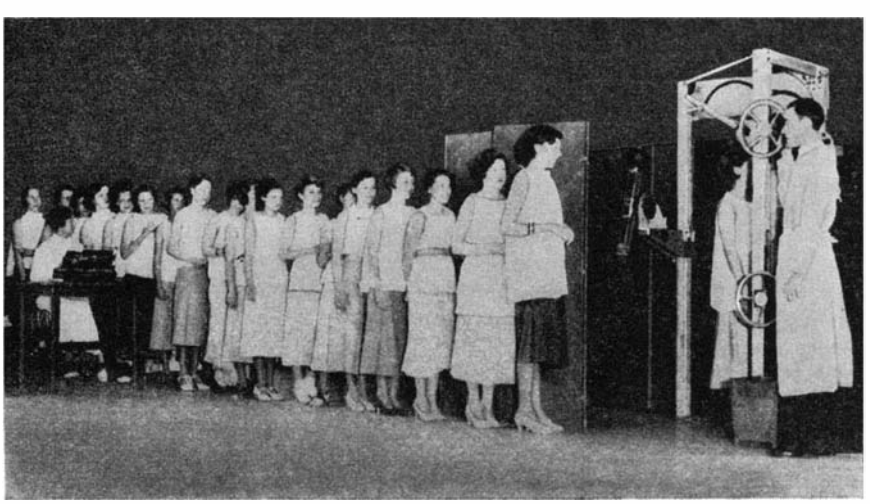
A QUESTION naturally arises: How can rapid X raying help eradicate tuberculosis? The mere taking of an X ray does not improve the patient's condition. What has this high speed to do with fighting tuberculosis?

The effectiveness of this new weapon comes about in two ways. It is due not only to the speed, quality, and low cost of the new method itself, but also to one of the peculiarities or characteristics of the disease against which it is aimed. At some time during their lives a large majority of persons contract tuberculosis. More often than not the subject is unaware of its presence. Usually the infected spot in the lungs heals itself and the patient never knows of it. Often, however, it spreads and a serious case develops. In its early stages a cure is comparatively easy and sure, but after the disease has progressed to the point where it makes itself manifest, it has reached a stage where its cure is much more difficult.

The problem, therefore, is to discover the presence of tuberculosis before it has reached the dangerous stage. This is where the X ray steps into the picture. As a rule every significant tubercle, spot, or lesion in the lungs may be detected by the X ray long before it has progressed to a stage where its presence is recognizable by other means. An X-ray examination, therefore, gives a forewarning of trouble. If the examination is made in time, and if the warning is heeded, the trouble in most cases can be averted. It is this characteristic of the disease which enhances the value and effectiveness of the X ray as a weapon against it.

Eminent specialists and authorities have said that if periodical X-ray examinations could be made of all children during the adolescent period, and the cases found be properly cared for, this would go a long way toward wiping out tuberculosis.

In many localities plans are under way by local medical authorities and Boards of Health, looking to the wholesale X raying of school children and adults as a means of "screening out" those cases which should be watched and treated by the family physician.



Every 15 seconds a pupil steps up to the machine and an X-ray photograph of the lungs is taken. Thus whole classes may quickly be "run through the mill"

THERE IS NO SAND IN SANDPAPER

And a New Process of Making This Important Product Regiments Its Grains, Point Outward, Electrostatically

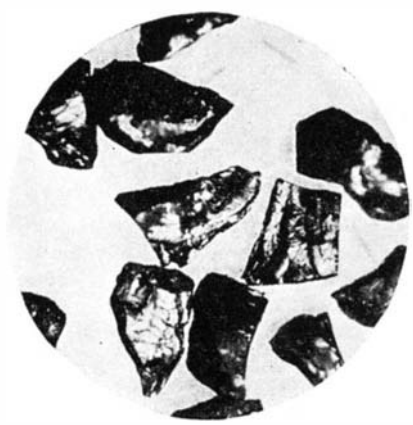
EVERYONE is familiar with sandpaper, in one form or another. Including industrial workers, service men, and home users, it is estimated that some 60,000,000 people in the United States use sandpaper, either continuously or from time to time. Coated abrasives are used in the manufacture and repair of practically everything we touch or use, whether made of metal, wood, rubber, glass, leather, plastics or compositions; whether painted, varnished, lacquered or simply smoothed or polished. Cradles are finished with sandpaper, so are caskets, and all through life every tool, instrument or implement we handle, every vehicle we ride in, every house or building we enter, all have known the magic touch of sandpaper.

But how much does the average person really know about this useful, universally used product? He may be surprised to learn, for example, that there is no sand in sandpaper. The fine abrasive particles on sandpaper are specially crushed flint or garnet or are products of the modern electric furnace —aluminum oxide or silicon carbide. Sand is not efficient for the purpose, because most sand is waterworn and the particles are therefore more or less rounded and have no sharp cutting edge.

THERE is no end of interesting and amazing facts concerning sandpaper and its manufacture. Since coated abrasives were first commercially produced they have been constantly improved by research and invention. Sandpaper is today more than 125 times as efficient as the crude product first manufactured near Philadelphia 83 years ago. During this development many difficult problems have been solved, but none more baffling than that upon which for the past two years, the best minds in the industry have been concentrated, and which has just now been brilliantly solved.

With few exceptions, the abrasive particles used in the manufacture of sandpaper are not true crystals, nor are they alike. The particles, though carefully graded, vary in size and shape and have many edges and points, some of which are much sharper than others. Best results are obtained from grits approximately twice as long as they are wide, and with several conchoidal, sharp fracture edges.

Engineers and research workers in the industry determined that, in order to improve still further the efficiency of sandpaper, it was necessary to devise a way to make each individual little particle adhere to the paper or cloth backing so that its very sharpest edge or point would face out towards the work



Photomicrographs showing *above:* Excellent shape for sandpaper grains for strength and sharpness; and *below:* Wood shavings, not dust, are cut by sandpaper

when the sandpaper was finished. How should they go about solving such a problem as this: to make as many as 35,000,000 tiny abrasive particles regiment themselves like so many soldiers, each with its sharpest cutting edge up, all evenly spaced, and all within one square inch?

Previous to the time that this problem challenged the skill and ingenuity of coated abrasive engineers, decades had been spent in improving glues, backings, forms, coatings, and grain shapes. The manufacturing industries had been insatiable in their demand for coated abrasives of greater efficiency.

Sandpaper backing was originally ordinary paper. With the development of strong manila fiber papers, these were adopted as more satisfactory backing materials. Later, for special uses, backings of cloth or a combination of cloth and paper gave better service and endured greater stress. The strength of glues and adhesives was also vastly improved.

THE primary form of sandpaper has generally been the roll, made in widths up to 36 inches. From this were cut sheets, disks, covers for drums, and molded forms to meet special requirements in various industries. The nature of the grits, or abrasive particles, was exhaustively studied, and countless experiments made to improve their efficiency. Quartz, though tough, did not provide sufficient strength for severe work in the metal trades. Experiments were made with other materials; garnet, the same mineral used for jewelry, was found to be highly satisfactory, especially for wood working, and is used to produce the familiar "red" sandpaper of today. A revolutionary development came with perfection of the electric furnace; it was found that aluminum oxide and silicon carbide could be fused at high temperature to make two new, synthetic minerals which, when crushed, provided grains of amazing hardness with extremely efficient cutting edges. At the present time garnet, aluminum oxide, and silicon carbide are the minerals almost exclusively used for sandpaper coatings.

Success seemed to be too much to hope for, when attention was first directed towards the problem of arranging the abrasive particles on their long axes, all evenly spaced, with sharpest cutting edges up so that every grit would work with maximum efficiency. It is re-

markable that this has been achieved; also noteworthy that the baffling problem was solved by application of a basic principle discovered 2500 years ago.

The new "electro-coating" process which has revolutionized manufacture of sandpaper and which miraculously orients the abrasive particles, makes use of the action of the electrostatic field, first observed by Thales as long ago as 600 B.C., when he noticed that amber rubbed with silk attracted bits of straw, pith, and so on. Our word "electricity" comes from the Greek word "elektra" meaning "amber."

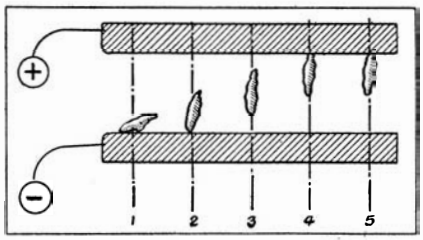
In the process of manufacturing electro-coated abrasives, two groups of equipment are essential: the electrical equipment to generate the high potential uni-directional current required, and the electro-coating machine proper in which the abrasive particles are individually oriented and deposited onto suitable adhesively coated backing.

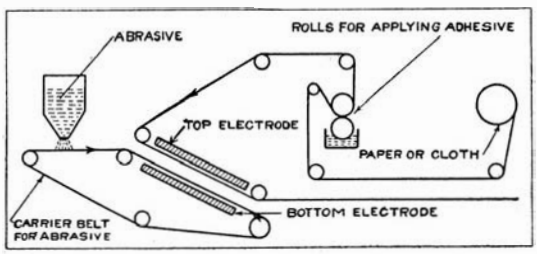
THE electrical apparatus includes a variable high voltage transformer for stepping up the low voltage supply, usually 220 or 440 volts, to the required high voltage ranging from 20,000 to 75,000 volts alternating current. This current is then rectified by means of vacuum tube equipment and transmitted to the electro-coating machine as a unidirectional current.

The electro-coating machine consists essentially of two electrodes, shaped like flat, oblong plates, and facing each other at less than an inch apart, usually two centimeters or approximately ¾ of an inch. The lower electrode is connected to the negative terminal of the power supply. An endless belt passes over the surface of the lower electrode. The upper electrode is grounded. Just beneath it, freshly glued paper passes. The accompanying drawings will help to visualize the entire electro-coating machine.

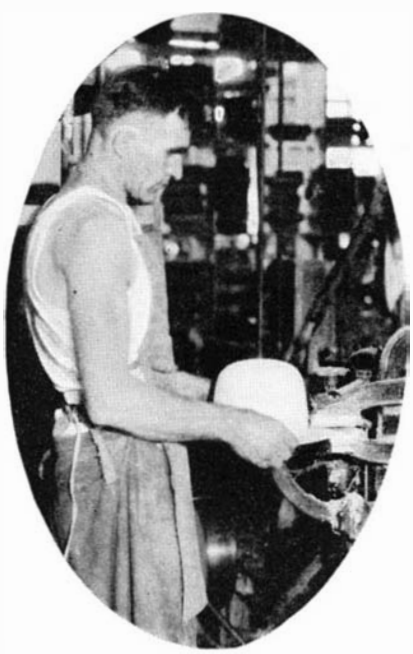
Abrasive granules are fed from a hopper onto the moving conveyor belt which carries them into the intense electrostatic field. As they enter this field and pass across the lower electrode, each individual grain acquires an electrical charge by induction. At the same time, due to the elongated character of the grain, the electrical charge becomes segregated at the two ends. In other words, the particle is polarized, the positive charge concentrating at one end and the negative charge at the other end.

In accordance with the familiar law of physics that opposite charges attract and similar charges repel, the negatively charged end of each particle is attracted by the upper or positive electrode and repelled by the lower or negative electrode; simultaneously, of course, the positively charged end of each particle is attracted by the lower electrode and repelled by the upper electrode. This attraction-repulsion results in each grain orienting itself to the field of force; in other words, it stands up on its long axis.





Above: **Five positions of sandpaper grains as they pass between the electrodes.** ***Below:*** **Schematic diagram of the electro-coating machine**



Coated abrasives used in finishing a felt hat. ***At left:*** **Small and large rotating implements use sandpaper**

The particles now discharge into the belt that part of their charge in the end nearest the belt, or, in other words, the positive charge which is nearest the negatively charged belt. The particles lose this part of their charge either by direct contact or by corona leakage, and are thus left negatively charged; also, the particles accumulate stray electrons by ionization and thus become negatively charged.

Two simultaneous phenomena now take place. The particles, being all negatively charged, mutually repel each other and move apart to a new symmetric formation at the same minute distance from each other. At the same time, the particles are all violently repelled by the lower or negative electrode and attracted by the upper or positive electrode. Without breaking their formation or changing their position, they are strongly repelled upward and imbed themselves in the freshly glued paper which is passing beneath the top electrode. The paper then emerges from the electro-coating machine and enters a drying-room.

AS explained before, this process makes three major improvements in coated abrasives. It spaces the particles evenly apart at 1/100th to 1/6000th of an inch as the case may be, depending on the grain size, whether it is for fine or coarse sandpaper. Coarse sandpaper has from 12,000 to 25,000 grains per square inch and the finest coated abrasives as many as 35 million per square inch.

The practical advantages of these improvements in industrial and general applications are several. Electro-coated abrasives provide better surfacing because the action of the coating is uniform. They give faster sanding because the largest number of best sharp cutting edges and tips stand point up. They have a longer effective life because the particles are more securely imbedded, and because of less wear per unit sanded. They can be subjected to greater stress in harder service as a result of the stronger adhesion of the coating. They save time in the surfacing of any unit or material. They enable manufacturers to increase production and lower costs, and disks do not need to be replaced as frequently as before, thus minimizing the costly delays of stoppage in mass and line production.

THE PROBLEM OF THE DIVINING ROD

By COUNT CARL VON KLINCKOWSTROEM[1]

IS there anything in the divining rod? Opinions differ widely and strenuously. Most men of science remain skeptical about it, but a cautious, conservative, truly scientific attitude would doubtless require the answer, "We do not yet know." Divining rod fakers there have been; need this prejudice the real question? After eliminating the nonsense, enough remains to leave it an intriguing one.

How, then, can science investigate it? Perhaps in final analysis it can't, at least until the underlying principle (if there is one) can be discovered. Actual demonstrations, apparently so simple, do not on the whole provide really satisfactory proofs, and give no final answer, except to those who have the will to believe or the will not to believe. There are too many uncertainties in this method. True investigators are seeking the underlying principle.—*The Editor.*

HE who watches a "dowser"—that is, the user of the divining rod—at work, as he strides over the ground holding his rod stretched out before him until it suddenly points toward the ground, will naturally be very skeptical of the declaration that under the designated spot will be found a "vein of water," for that seems like superstition or pure imagination. In fact, the divining rod had a part in ancient superstitions and was in a class with other methods of divination. Just as in many another inherited superstition there is at least a grain of truth, so it became evident that in the divining rod, when used for discovering various minerals, there was a phenomenon calling for rational investigation, and such an investigation recently has become a highly interesting problem of scientific research.

THE miners of the 17th and 18th Centuries took the divining rod seriously and used it in their search for mineral deposits. The age of enlightenment in the second half of the 18th Century banned it from use in mining operations, but the dowsers who sought springs continued quietly to pursue their craft. Scholars again and again took up the problem of the divining rod without being able to find a theoretical explanation which could satisfy them. The actual successes of those who sought water could easily be explained by attributing to them hydrological experience. This was the case with the Abbé Paramelle in the middle of the 19th Century, the most noted finder of springs in his time, who worked exclusively as an experienced hydrologist; that is, he drew his conclusions from the conformations of the earth and from geological indications. Also, there were just as many failures as successes.

Dowsing is an old art. Here is an illustration from "The Mining Custom Book," by Ch. Weigal, 1721

It is, then, quite understandable that until recently science has brushed aside the problem of the divining rod.

During the last few years, however, the situation has changed. The phenomenon of the divining rod has been recognized as a complex problem, which cannot be explained from the standpoint of any one science. We must differentiate between three main factors which combine to bring about its action. If we assume that the dowser really reacts to a force given out by water flowing underground, or by various minerals or underground structural peculiarities, then it is the task of the physicist as well as the geophysicist to discover the nature of this hypothetical force and its manner of working at a distance. Geophysics can deal with a whole range of actions which seem competent to explain the structure of parts of the earth, yet which are unclassified geologically, and with the help of which one can check the claims of dowsers. On the other hand, experiments of physicists like R. Ambronn of Göttingen, and von Haschek and Herzfeld of Vienna, have offered much data to substantiate the hypothesis that the dowser is really affected by physical changes in the conformation of the earth's surface—changes which can actually be recorded with instruments and which are brought about by underground factors such as changes in the relationship of the strata.

TO determine how the effect of such a force is produced upon the nervous system of the dowser is the task of the physiologist. Willy Hellpach has strikingly compared the particular gift of the dowser to the so-called power of "feeling weather," although the actual character of this susceptibility to a particular force has not by this means been made any clearer. The most noticeable phenomenon, the visible movement of the rod in the hands of the person who carries it, becomes relatively unimportant in this connection. One may conceive of the divining rod as the symbol of the nervous excitement of the dowser, as Albert Heim does, and the physiological explanation of the typical reaction—that is, the effect of the force on the tense muscular and nervous system—has been satisfactorily given by Dr. H. Haenel, a Dresden physician. He regards it as a case of involuntary and unconscious changes in the muscles of the hand and arm, which react on the rod and cause it to point downward at a given moment.

The question is complicated by the fact that the dowser is not a mechanical recording apparatus but a person, and with all the possibilities of error and self-deception entailed thereby. Thus psychology enters our problem. There is no doubt that the pointing of the divining rod in the hands of the dowser may also occur as the result of purely psychological impulses — expectation, guessing, wishing, thinking; that is, as the result of his own action—and this explanation cannot be dismissed from consideration. Many experiments have also brought out the fact that a dowser is very susceptible to suggestion from the person who is conducting the ex-

[1]Translated by Eleanor Bianca Hoffman

periment or who is accompanying him.

These psychological possibilities of error, as well as the dowser's purely subjective reaction to outside influences, constitute a serious obstacle to the practical use of the divining rod in the search for minerals, without simultaneous control through other processes or by experienced geologists.

In contrast to incontestable excellent results there are serious failures which call for a final explanation of this complex phenomenon through the concerted efforts of scientists from diverse fields —physiologists, psychologists, physicists, geologists. The German Society for the Solution of the Problem of the Divining Rod (Deutsche Verband zur Klärung der Wunschelbrutenfrage), which has existed since 1911 and which serves purely scientific ends, considers its most urgent task to be practical tests and experimental investigation, through co-operation with the State Mining and Water Works Departments; also the collection of as complete statistics as possible on the activities of dowsers. This is done in order to reach a decision regarding their ability and also to be able to guard against the flagrant imposture which is practiced in this unregulated field.

THAT there are possible successes which do not depend upon chance or upon the unconscious assistance of experienced companions must be shown by outstanding achievements on the part of able dowsers. Such outstanding achievements are, of course, rare. But they lead us to the conviction that it is at least worth while to pursue the scientific investigation of dowsing, since the real explanation of the causes of the force involved has not yet been reached. Until we know to what particular force the dowser actually reacts—whether to radiation, or to changes in electro-magnetic fields—failures cannot be avoided. The replacement of the dowser by recording apparatus will not be possible until then.

The complete reports of the results which will be briefly recounted in the following comments were published in the *Handbook of the Divining Rod*, published in 1931 by von Klinckowstroem and Maltzahn (in German).

The first example deals with a search for water which was successfully carried out by a dowser at the site of a dam across the valley at Brüx in Czechoslovakia. During the construction of this dam it developed that, with increasing water level, leaks appeared in one side of the structure. In April, 1914, the impounded water reached a level of 122 feet and a leak of 33 gallons per second was in evidence. It was thought that the strata on the left were leaky because of clefts and decay in the rock, and the engineers tried to stop the damage by blocking up the crevices. A thousand sacks of Portland cement were used in vain. The leakage did not cease.

Thereupon the construction manager, Professor Robert Weyrauch, entrusted the work of stopping the flow to Eduard Doll, the head of a firm engaged in the construction of water works and in excavation, who had become noted as a dowser in a similar emergency during the building of a dam across the Gotha valley. In contradiction to the opinion of engineers that the water seeped in through the material on the left, Doll

Common method of holding the rod

immediately was able to determine, by the use of the divining rod, that the crevices sought were under the foundations themselves. By walking along the top of the structure he located the various clefts, drilled down to them and filled them with about 2500 sacks of Portland cement. The result was that the leakage was only 10 gallons per second upon the completion of the work. That the scientific knowledge also possessed by the dowser, in a section strange to him, could not have helped him in this instance, as one would perhaps be inclined to assume at first, has been affirmed by an associate, Construction Engineer Dr. Marquardt.

Another case, which also concerns a search for water, is the investigation by the divining rod, in conjunction with geological knowledge, of the location for the Mang Falls canal, 100 to 125 feet deep and three miles long, between the Mang Falls and Lake Seeham, in Upper Bavaria. The geologist Dr. Kurt Oswald, who is also a dowser, was to examine the proposed site by walking on the surface of the ground and pointing out with the divining rod zones of possible danger. These could not be determined in any other fashion, because the country is a region of moraines. Oswald picked out several clearly defined lines along which water was traveling with more or less force, as he indicated, which would cause trouble during the building of the canal by breaking through. The statements of the dowser were later proved to be true with amazing exactitude. There were breaks in three places when zones which he had indicated as dangerous were cut into, and the wet earth from the moraine poured into the canal in one place along a distance of 130 feet. This problem could have been solved only by a dowser who was expert in geology as well, because an ordinary dowser could have pointed out, at best, only a few veins of water, and this information would have been of no practical use under the circumstances.

One could still have attributed this success not to the dowser but to the geologist Oswald, were it not that Dr. Oswald was carefully tested by the geologist Dr. Kranz, under strict conditions of such character that geological knowledge could be of no use, as Dr. Kranz especially emphasized in his report. These experiments, which dealt with disturbances in the earth's structure, cannot be accurately judged without going exhaustively into the geological facts. The remark will have to suffice that Dr. Kranz, who has tested many dowsers, considers Dr. Oswald the only one whose powers with the divining rod he can take seriously and whose achievements he rates as good. "He manifestly has the power," Dr. Kranz says, "to sense or to feel to a certain extent differences in the rock formations, disturbances of the earth, and so on."

ANOTHER dowser, close to the Society for the Solution of the Problem of the Divining Rod, offered to be tested by the School of Mining and the Mining Commission in Freiberg, Saxony, and was once sent to a district which was known to have deposits of lead ore and barite, and again in the high mountains of Saxony to a district where there was cobalt and bismuth. His statements, on the whole, proved to be true. The indications of the divining rod in general agreed perfectly, with a few insignificant exceptions, with the actual appearance of the underground structures as determined by mining experts. By the action of the divining rod in the hands of a dowser who was totally unfamiliar with the region, it was proved that veins could be found, and whether or not they contained ore. These experiments were all carried out with no one accompanying the dowser who knew of the deposits, so that there could be no possibility of an explanation on the grounds of telepathy.

In various countries interest in the phenomenon of the divining rod is increasing. In France and in Italy associations have been formed and dedicated to the study of this problem. A short time ago the "Italian Divining Rod Society" was founded, with the approval of fascism, and it counts among its members the most noted scientists and representatives of the government.

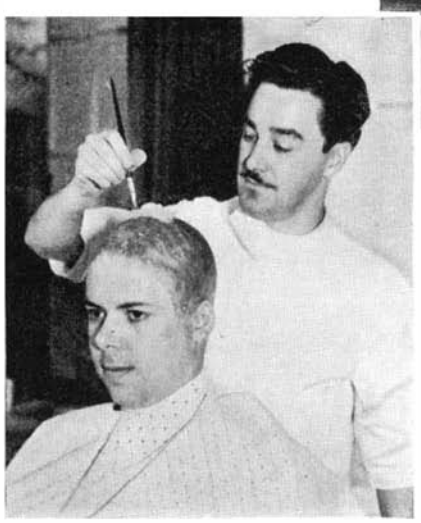
MYSTERIES OF M

Making An Actor Look L
Requiring Skill, T

From youth to age by movie make-up. Gail Patrick as she is, and made up to play the character of a much older woman

Two clay models which show how age effects may be produced—by lining and patting the plastic make-up

After a wig is completed and waved as desired, it is baked in an oven for four hours at 110 degrees to "set" the wave



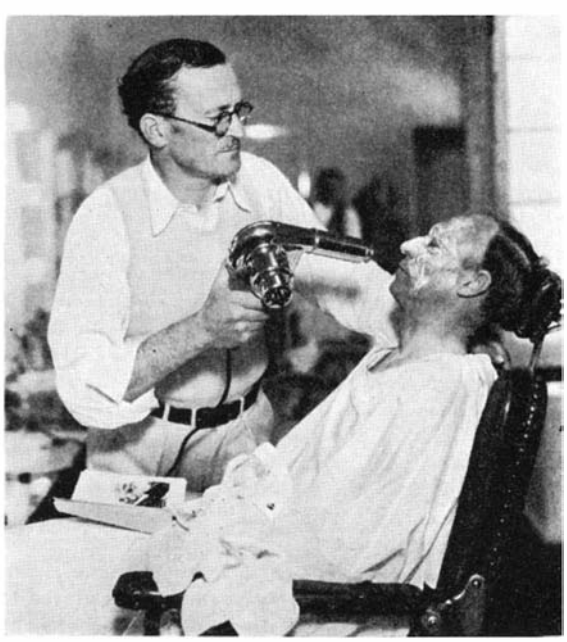
Left: Bald heads to order. The actor's hair is covered with flesh-colored gauze, held in place by spirit gum. The gauze is coated with grease paint dulled with powder to prevent shine

Above: G. B. S.? No Atkinson, character a the movie part of the *Left:* Wax applied t to build up the nos obliterate the eyebr blower. *Right:* The w the eyebrows are buil glued in place a bit a hair is in place, it is takes three hours to

DURING the past two years, developments in photographic research laboratories have compelled the make-up artists of the movies to change their entire technique. New panchromatic film, sensitive to all colors and much "faster" than the former orthochromatic film, has opened a field of realism in the movies that was never before possible. The new film records detail that formerly was entirely lost, and it permits the use of character make-ups that so closely resemble the one impersonated that it is usually impossible to tell the difference.

Behind such make-ups as that of Frank Atkinson as G. B. Shaw or of Gail Patrick as an elderly woman. illustrated on these pages, are often weeks of study and preparation before the actor is ready for the first screen test. And then, every time a sequence is to be "shot," the tedious process of applying the make-up must be gone through. Not only that, but each time the make-up is applied, it must be exactly the same as it was the last time, otherwise the present-day critical movie audience would at once detect the difference and the effort would be wasted.

The making of wigs alone is one phase of make-up

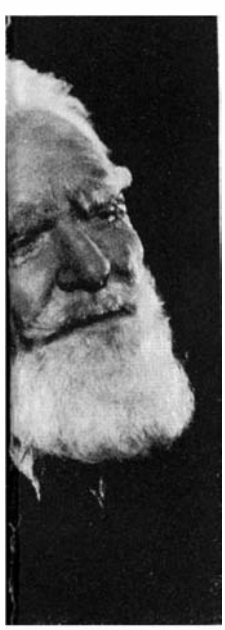


Photographs courtesy

MOVIE MAKE-UP

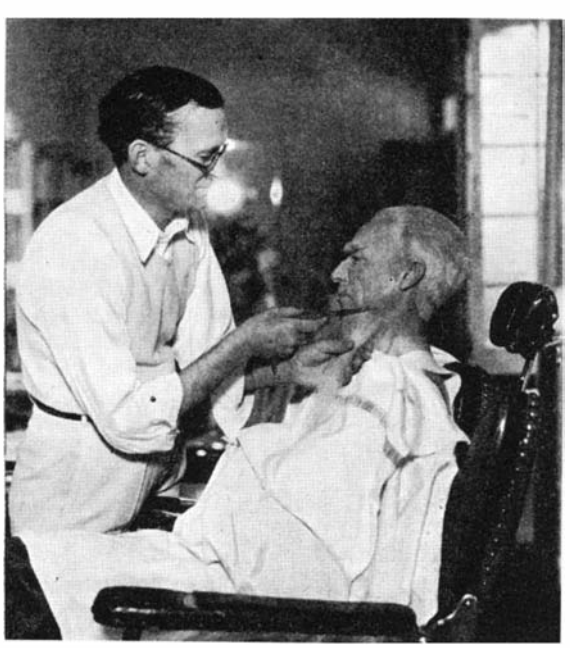
ke Someone Else is an Art
ime, and Patience

Applying final touches to the "old man" make-up of Richard Dix. The artist carefully blends colors and introduces lines

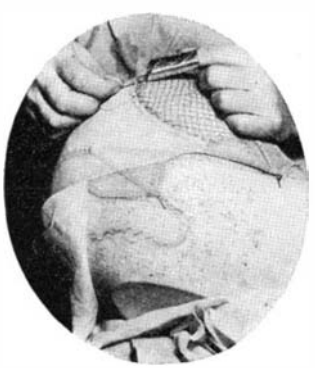


t at all. This is Frank ctor, made up to take "famous" Irish "wit." Mr. Atkinson's face and cheeks, and to ws, is dried with a g is fastened in place, up, and the beard is t a time. After all the trimmed to shape. It omplete this make-up

x Films and Max Factor



Immediately before a character appears in front of the motion picture camera, a make-up artist applies a last-minute dusting of powder to dull sheen



Above: **Sewing ribbons, gauze, and net on a block preparatory to making a wig**

Left: **Tiny clumps of hair are tied in place as the wig is built to specifications**

The skilfully made wig appears to grow naturally from the head of the actress

that requires the utmost attention to detail. Notice, in the illustration directly above, how the hair seems actually to grow from the head. But it is a wig! In the process of making a wig, the actor's head is first carefully measured and a plaster form made on which the wig is to be built up. This form is covered with foundation cloths, ribbons, and nets, and edged with hair lace made of white human hair. Into the meshes of the net and lace are laboriously fastened the hairs that will present the completed appearance. From one to three hairs at a time are worked into place with tiny hooks in the hands of skilled workers, and it usually takes a week to complete a wig in which only three ounces of hair is used. When the wig is finished it is fitted to the head and the edges coated with spirit gum. So cunningly is the work done that the edge of the wig is absolutely invisible.

When an actor's face is to be transformed completely, it is first coated with spirit gum to seal the pores and prevent perspiration from forming pockets under the make-up. Then pliable wax is applied in order to build up cheeks, narrow the eyes, hide the brows, and so on. A coating of brown liquid make-up hides the wax, and a layer of liquid rubber holds everything in place.

Farm Problems and the Machine

By HARRY G. DAVIS
Director of Research, National Association of Farm Equipment Manufacturers

WHEN all other efforts to bring about the end of the depression had failed, political leaders and economists turned their attention to the agricultural situation. Under the leadership of President Roosevelt, Congress passed the agricultural adjustment act, designed to raise the farm price level, and the land bank and farm credit bills, to ease the debt burden. Secretary Wallace called to his assistance a few men who for years had been pleading for a national policy which would elevate agriculture to the plane of other industries.

The strange part of all this is that we have been pathetically slow in recognizing the fact that agricultural prosperity is basic to prosperity in every other line of business, no matter how remote it may be from the farm. Unless the farmer is earning an annual income of more than 10 billion dollars, the rest of us must be satisfied with a national income of less than 80 billion dollars.

IN April, 1932, *Business Conditions Weekly*, published by the Alexander Hamilton Institute, printed a graph showing the relation of farm income to the value of factory output between 1919 and 1931. The lines were closely parallel over the entire period, ranging from a high of approximately 130 in 1919-20, with the average of 1923-25 as 100, to a low of 60 in 1931. Nobody would presume to say that farm income, in any degree whatsoever, is governed by the value of factory output and the obvious fact is that it takes the dollars of new wealth produced by the farmer to flow into the marts of trade to create the demand for the output of factories.

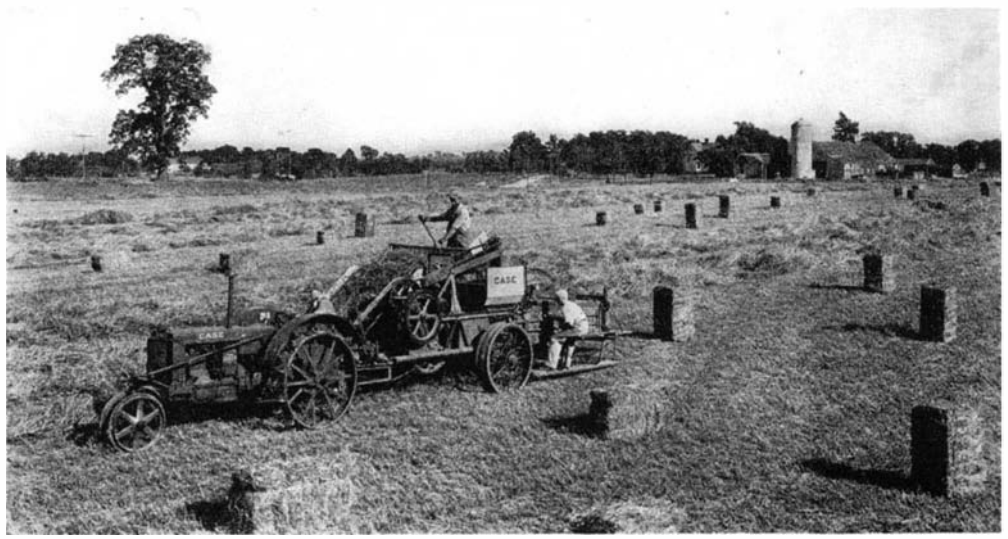
The national program for agriculture is simple and, apparently, practical. It is based upon the assumption that the natural law of supply and demand governs the price level and, if the supply is curtailed or the demand increased, the price level will be high. To bring this about, two things are being done. Farmers are being encouraged to curtail their production to reduce the supply and industry is urged to raise wages and expand employment to increase demand. These, with the federal financing of agriculture, through the newly established Farm Credit Administration, are expected to bring about the desired results by solving farmers' problems.

While national leaders apparently have been thinking straight in this program, they seem to have overlooked another fact which has a most important bearing on the entire program. This fact is that it is the margin between cost of production and selling price that contributes to national welfare, and not the price itself. Any level of farm prices established by national agencies high enough to cover the cost of inefficient production methods, simply imposes a burden upon the general public through higher living costs, and virtually subsidizes waste.

Production costs on the farm have been steadily declining since the advent of the machine age in agriculture and vary among individual farmers today in about an exact ratio to which they have mechanized their operations. The farmer who clings to the methods of two or three decades ago finds his costs abnormally high, while the one who has availed himself of the labor-saving equipment now obtainable is producing at a cost which will leave him a profit, even at the July, 1933, price level.

The U. S. Department of Agriculture recently issued Miscellaneous Publication No. 157, entitled: "Power and Machinery in Agriculture," which gives some interesting information upon the effect of mechanization in agriculture. According to this authority, the growing and harvesting of an acre of wheat in 1830 required 57.7 hours of man labor; in 1896, 8.8 hours; and in 1930, using the most modern machinery, only 3.3 hours. An acre of corn in 1830 required 33.6 hours to grow and harvest; in 1894, 15.1 hours; and in 1930, only 6.9 hours. In the cotton fields of the south, the efficiency of the producer has not been as greatly increased. In 1841, it required 148.6 hours of man labor per acre; in 1895, 102.4 hours, and in 1930, 71.8 hours.

Now that we have a national policy of elevating agriculture to the plane of other industries, the future for the farmer with modern equipment is most bright. What he has done in modernizing his operations can be done by every farmer, large or small, because one of the late developments in the farm equipment manufacturing industry is the bringing out of machines in smaller sizes, adapted to the needs of smaller farmers who, heretofore, were unable to use some of the most efficient machines because of their large size and consequent high cost.



The tractor affords an excellent example of this trend. Originally it was an enormous machine, designed for pulling four, five, and even more plows. Then the manufacturers began bringing out smaller sizes. The two-plow tractor became a most popular model. Its cost was within the reach of the 160-acre farmer and it could be used most profitably by him.

But, there are about 2,000,000 farms that are too small to afford enough hours of use to make the two-plow tractor an economical power unit. These smaller farms need mechanical power really more than do the larger ones because their owners must utilize every

available acre for crop production and cannot afford to devote acreage to growing feed for work animals.

Early in 1933, one manufacturer announced a still smaller tractor—a one-plow job. This unit sells at a price within the reach of the operator of an 80- or 120-acre farm. It is built in the general-purpose type which makes it available for cultivating row crops, operating a large variety of machines, running silo fillers, feed grinders, small threshers, and such machines with its power belt.

ANOTHER example of "building down" machines can be found in the case of the combined harvester-thresher. This machine was originally brought out for large wheat growers. It cut a swath of 20 feet or more, and threshed the grain in one operation. While it was most efficient on large farms, it was too big and costly for the smaller farmers. New models, smaller in size and lower in price, appeared, and the combine began to spread into the diversified farming areas.

Just recently, the daily newspapers have printed stories about a demonstration of a "baby" combine on an Indiana farm. This machine weighs only 2400 pounds, sells for less than 500 dollars and with it, if we believe the press stories, a farmer can cut and thresh 20 or more acres of standing grain a day. It is designed, its manufacturers say, for use on corn belt farms where the acreage of small grain is comparatively small but where low costs are just as imperative as on the larger acreages of the wheat belt.

Hay is one of the big crops on the American farm and its total value is usually a little more than that of the wheat crop. In 1931 it was worth nearly twice as much. An acre of hay requires from 15 to 20 hours of man labor, even with the use of such equipment as side rakes, hay loaders, and the like.

Recently, there came on the market a machine, known as the pick-up baler which eliminates the labor of stacking. This machine, pulled by a tractor, follows the windrow, picks up the hay, bales it and drops the finished bale on the ground, later to be stored in barns, or under roofs, or hauled and shipped to market.

Not only in the use of crop producing and harvesting machinery can the farmer reduce his production costs, but he can use machines for processing crops and materially increase his net income. Livestock and dairy production, after all, is nothing more than a method by which the farmer markets the products of his acreage. The more pork, or beef, or milk, or butter, or eggs, or poultry—or whatever it is that he sells—he can get from a given acreage, the greater will be his returns.

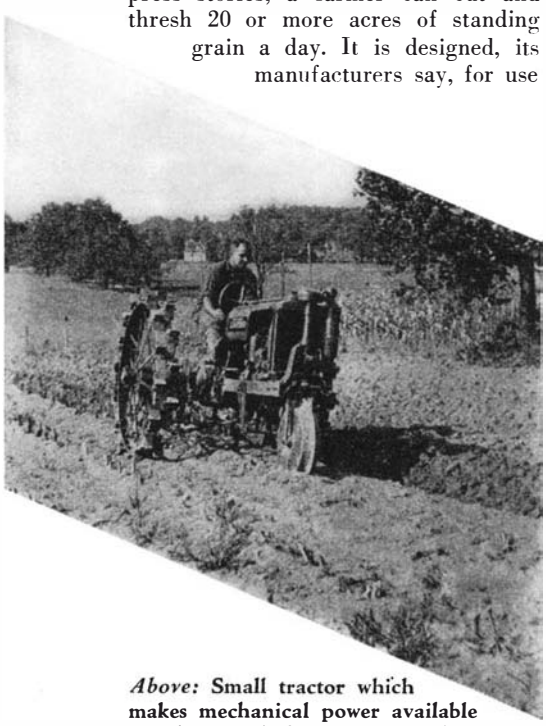
Animal husbandry men at the various agricultural experiment stations have demonstrated that the feeding efficiency of many crops can be materially increased by mixing them with other crops so that a balanced ration will result. This has brought on the market a number of feed grinders designed to process different kinds of crops, frequently mixing minerals and concentrates so that the resultant product will be a balanced ration which will increase the production of the animal to which it is fed. Here again, the machine makes a worthwhile contribution to that margin, or net income, which is needed to support other industries.

So it goes in every department of farm operation. The machine is displacing labor, reducing cost of production and adding to the efficiency of the farm worker. That it is making a worthwhile contribution to national welfare, as well as to that of the individual farmer who uses it, is evidenced by the fact that the income per farm worker is closely governed by the value of equipment he uses. In New York, for example, where the value of equipment per worker is 795 dollars, the income is 1559 dollars while in Mississippi the equipment value is 144 dollars and the income per worker 498 dollars.

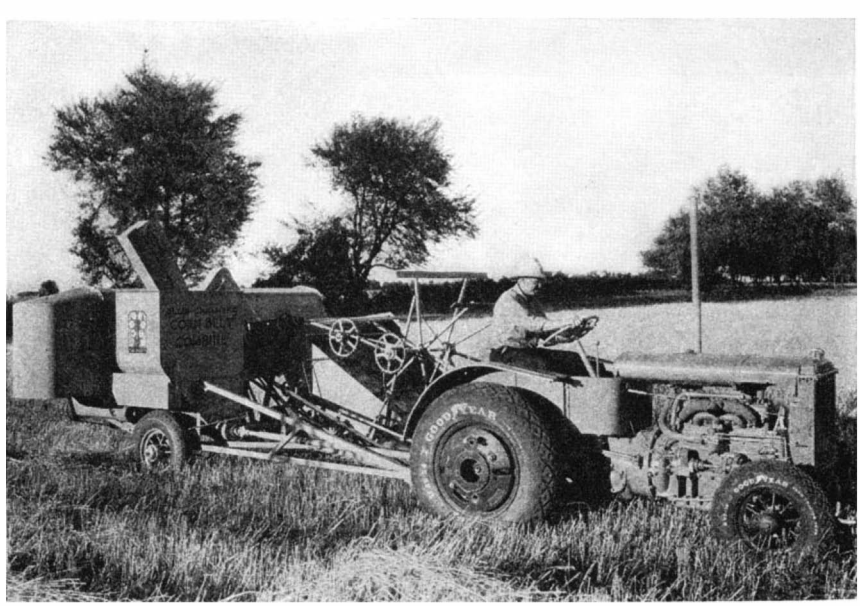
THE farmer, who through failure or inability to utilize labor-saving equipment, is compelled to put too much work into each unit of his production, naturally gets a lower rate of pay for his services than does the one who increases his efficiency through the use of machinery. This is true regardless of what prices may be.

Studies made by the University of Ohio and published in Bulletin M-26, reveal that a farmer who uses two-horse equipment in growing corn and picks it by hand, puts 27.63 hours of man labor into growing and harvesting an acre of corn yielding 55 bushels, while the one who uses a tractor and tractor-drawn equipment for all operations except planting, and uses a two-row picker, puts in only 7.48 hours. The one gets two bushels for each hour of his labor while the other gets 7½ bushels.

Thus, it will be realized, the success of the national policy for agriculture will depend in the long run upon farm efficiency as much as upon the matter of curtailed production and higher prices.

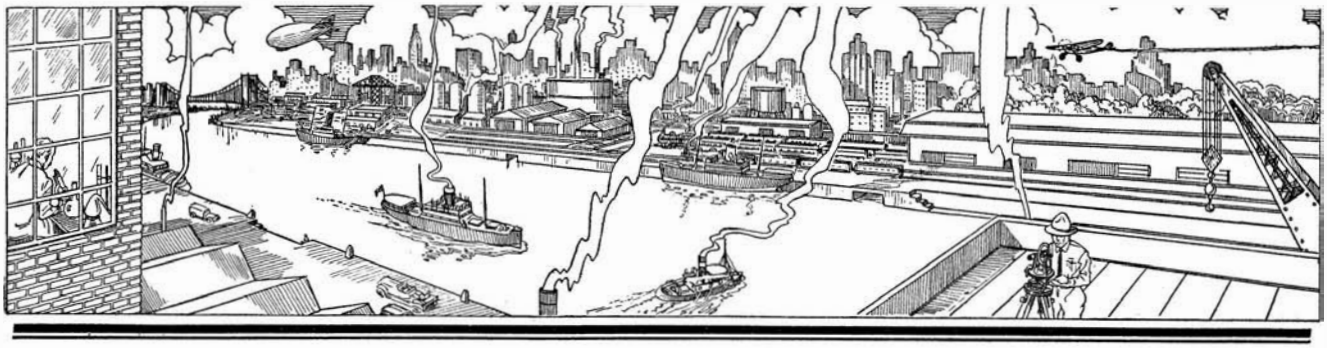


Above: **Small tractor which makes mechanical power available on the small farm at very little cost**



Upper Left: **The pick-up baler which eliminates the labor of stacking hay by baling it in the field ready for storing**

Right: **"Baby Combine" designed for use on farms where acreage of small grains is comparatively small, pulled by tractor**



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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The Brocken Ghost "Laid" by Cameraman

THE camera of Dr. A. Brack, photographer of Zurich, Switzerland, has definitely solved the "Brocken Ghost" mystery. This strange phenomenon derives its name from the Brocken, a peak in the Hartz Mountains, where its appearance used to terrify the superstitious peasants of that region. Dr. Brack reports on his discovery as follows:

"Last summer I had for the second time an opportunity of observing the Brocken

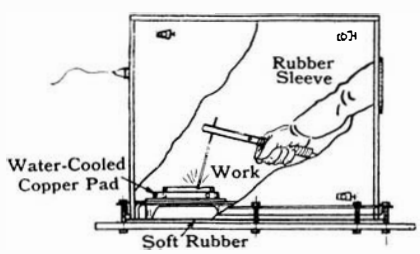
The Brocken ghost—a shadow on a cloud—as revealed by the camera

Ghost. The first time I saw it on the Sexmoor in the St. Gall Oberland; the second time I beheld it on the Säntis. It was at 6:30 A.M. on June 28th when a friend of mine and I reached the so-called Hühnerberggrat on this latter peak. A thick morning fog on the northwest side of the mountain ridge obscured a view of the territory we had climbed, and we deposited our knapsacks in the warm sunshine. Suddenly we noticed in the empty space our shadow, huge and distorted, surrounded by a brilliant, rainbow-hued halo—the Brocken specter. The apparition was so striking that for a few moments we were simply dumbfounded, and we could now readily understand why this phenomenon has succeeded in frightening many a sturdy mountaineer.

"The apparition lasted only a few moments, for the fog rose and fell continuously, but it came back several times. Thanks to the speed of my Leica camera, I was able to take a few pictures and the one presented herewith is the best of them. After a while the fog withdrew and we beheld the shadow of our mountain ridge far away, surrounded by the halo of the Brocken Ghost. This specter is in reality the shadow of the observer which the sunshine throws onto a background of clouds."

Gas Absorption During Welding

BECAUSE the amount of gas absorption during welding has a vital effect upon the finished weld, the Research Laboratories of the Westinghouse Electric and Manufacturing Company constructed a special welding hood in which the atmosphere may be controlled for the study of gas absorption.

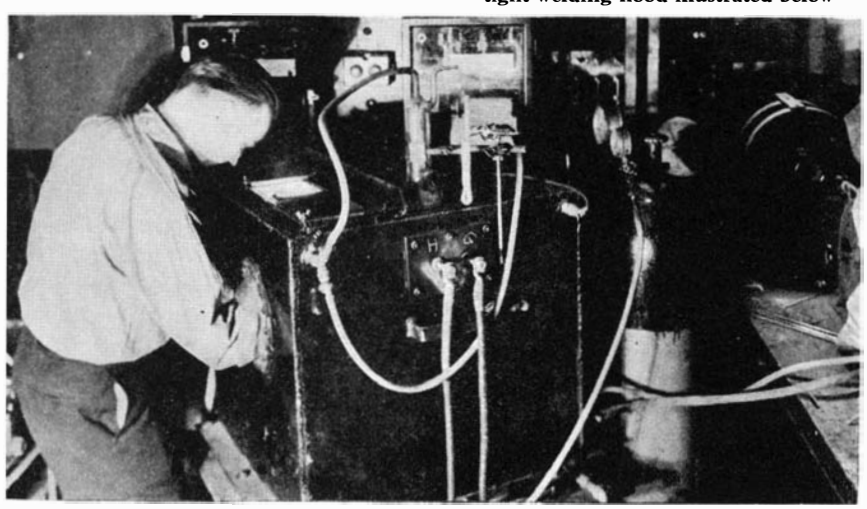


At welding temperatures the solubility of metals for gases is generally increased. After the metal cools, some of the previously dissolved gases are given off and cause blow holes. Other gases are not liberated but remain in solid solution. These gases affect the properties of the weld material considerably.

With high-grade coated electrodes the oxygen content near the arc is very low but the nitrogen content is over 90 percent. However, the nitrogen absorption of the deposited metal is smaller with higher nitrogen contents in the atmosphere. With the use of the welding hood this strange phenomenon of lower nitrogen absorption in an atmosphere of 98 percent nitrogen as compared with the nitrogen absorption in air was confirmed. This result is of enormous importance to the welding industry because it discloses some of the mechanism of absorption by weld metal. It shows that molecular nitrogen is hardly dissociated at iron-arc temperatures. It must therefore be assumed that nitrogen is absorbed by the weld metal in the form of an active nitrogen-oxygen compound.

Single gases or mixtures of gases can be admitted to the hood. If the pressure inside the hood is increased too much as

Below: **The laboratory equipment used in the study of gas absorption during welding.** ***Left:*** **Drawing showing the interior of the gas-tight welding hood illustrated below**



a result of the heat developed by the arc, the flow of gas can be regulated. The hood is connected to a vacuum pump which will retain a definite positive pressure within. —*A. E. B.*

Ammonia Protects Idle Steam Boilers

RUSTING of idle steam boilers may be overcome by the use of gaseous ammonia, is the statement of the Merseburg ammonia works of the large German dye manufacturing company, I. G. Farbenindustrie.

Boilers that are to be shut down are blown dry with air as completely as possible and then filled with ammonia gas from a pressure container. The ammonia reacts with the remaining water and moisture in the boiler to form rust-proof surfaces. These compounds can be removed from the surfaces by flushing the boiler with water.—*Science Service.*

More Uses for Copper

MANY new applications for sheet copper may result from a process recently developed, for electrodepositing copper in thin wide sheets. Such sheets are now commercially available as light as one ounce per square foot, as wide as 30 inches, and in rolls of indefinite length and uniform thickness.

In the new process, copper is deposited from solution upon a revolving large-diameter lead-faced drum by an electric current many times higher than is normally used for copper plating. As the lead drum slowly revolves, the copper sheet which has been deposited upon it to a thickness of one ounce per square foot passes continuously from the plating bath through a cleansing operation. If a heavier weight is desired the one-ounce sheet is passed over a series of rolls up and down through a long tank in which are suspended copper electrodes, until sheets of any desired weight up to 16 ounces are secured.

The new copper sheeting possesses especially interesting possibilities when bonded to other materials, such as textiles, felt, paper, fiber and composition boards, and to other metals. Specially embossed and bonded to fabric by a flexible binder, 1½-ounce sheet is being used experimentally by automotive engineers as a topping material for closed cars. A similar composite sheet, with a somewhat heavier copper facing, is manufactured for use as roll roofing.

New? Old? Both. A modern version of the tandem of the Nineties, symbolic of the back-to-the-simpler-life trend which has given so much satisfaction to those who have deplored our speed-mad age. This particular tandem is modernized in every respect—balloon tires, chromium plate, ball-bearing throughout. The tires are double tube type

The copper sheet alone is being introduced for sheathing and for use in built-up felt-asphalt-gravel roofing. Test roofs indicate that the copper affords almost perfect protection to the underlying asphalt, a fact which probably will permit elimination of one or more plies of felt.

Thin sheet copper is also finding application as a paper substitute. Used on a recording meter in place of ordinary recorder paper, the dimensions of which changed with the humidity of the air, copper sheeting corrected for a petroleum company an error equivalent to 5000 dollars worth of oil a month. Sheet copper has been used for novelty greeting-cards, and has been found to be useful, when composited to fiber-board, as covers for books subject to severe usage in public libraries. The surface of the copper may be chemically treated to permit its taking ink satisfactorily, and the copper sheets may be attractively embossed.

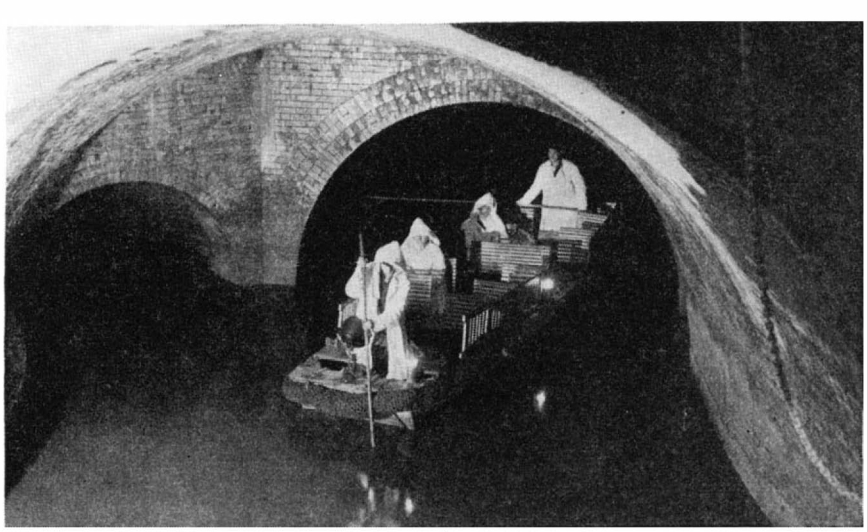
Electrodeposited copper has a somewhat lower tensile strength across the sheet than has rolled copper, a somewhat less dense structure, and a greater tendency toward the development of patina, the green film formed on the surface of copper during weathering. However, the manufacturers have found no reason to believe that electrodeposited copper is less weather-resistant than other copper. The thin sheets of copper dissipate heat so readily as to make allowance for expansion and contraction unnecessary.—*Industrial Bulletin of Arthur D. Little, Inc.*

Science Service Photo

B-r-r-r. Winter's coming. But up on top of Mt. Washington, the winter snows and winds mean nothing to the weather observers who are here shown ready to send up a balloon with candle attached which will be watched through the transit

Cheaper Towels Are Better

A LARGE hotel was in the market for towels, and the size of its purchase made possible a considerable saving between an all-linen towel and one made partly of linen, relates *Chemistry and You.* The all-linen towel looked better than the other at a lower price, but before deciding, the two towels were submitted to the Arthur M. Maas Chemical Laboratories in Los Angeles. Tests by chemists demonstrated that the part-linen towel was more absorptive than the linen, which was an advantage that offset appearance as far as guests were concerned. Also, the cheaper towel was stronger, and would give longer service.—*A. E. B.*



A series of unique canals extend for long distances under the streets of Hamburg, Germany, for sewerage and other purposes. These waterways also serve as transportation arteries for the workmen of the underground system, who travel in boats

New Gas for Ship Fumigation

CARBOXIDE gas, a mixture of nine parts of carbon dioxide and one part of ethylene oxide (See also "Fumigating Books," February 1933 issue), has been found an effective fumigant to rid ships of cockroaches and other insect vermin, with-

out the serious danger to human life that has always attended the use of hydrocyanic acid, now the standard gas for this purpose. The experiments establishing the value of the Carboxide mixture have been conducted by the bureau of medicine and surgery of the United States Navy.

The carbon dioxide in the mixture removes the fire hazard that would go with unmixed ethylene oxide, and at the same time practically doubles its toxicity for insects. Carboxide has been found effective in comparatively small dosages, making it economically practicable for conveniently short periods of exposure.—*Science Service.*

Traveling Power Hammer

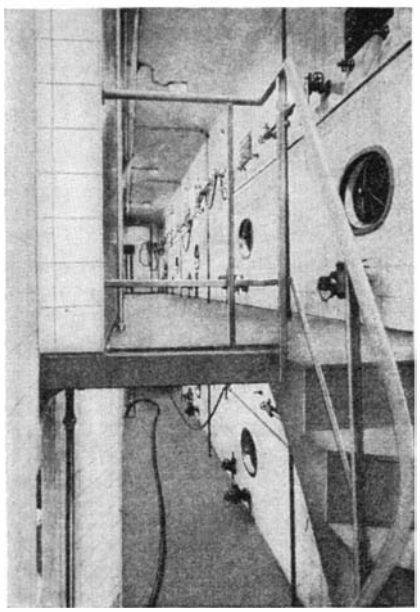
THE typical power shovel or excavator has for many years consisted of a crawler mounted revolving machine, equipped with conventional dipper sticks and dipper, and convertible into a crane (with clamshell, dragline, magnet, or other utility), also into a skimmer and a pullscoop or "trench hoe." The two latter utilities were originated and introduced by the Keystone Driller Company about 1914, and have since then been adopted by many other shovel manufacturers offering a so-called convertible machine. To these utilities Keystone now adds yet another; namely, a 3000-pound hammer, mainly intended for general demolition purposes.

The power hammer is a development which may prove to add substantially to the scope and utility of a power shovel. Its applications promise to be almost as numerous and varied as that of the hand hammer, the most universal and indispensable of all tools. Among the most obvious of these applications are the following: Breaking reinforced concrete pavements; breaking ice or frozen earth crust; demolishing small structures, fences, walls, and parapets; breaking castings in scrap yards, foundries, and steel plants; breaking shale and sandstone bodies which are too hard to dig with the shovel and would otherwise have to be blasted; breaking oversize rocks and other obstructions encountered in excavation, or to be used on layer compacted fills; tamping; driving short piles and fence posts; and so on.

The hammer weighs 3000 pounds and is capable of delivering 20 blows per minute; the drop is from five to ten feet. The hammer head is rigidly attached to a tubular handle about eight feet long, which is hinged to the boom end. The joint is free and flexible; blows may be struck in rapid succession without undue strain on the joint which is caught by the hoisting line before the tool strikes the ground, with the stick or handle in approximate alignment with the boom.

Concrete Stock Houses for Beer

BREWERIES require starting tanks, fermenting tanks, and aging tanks. In the old-time brewery these tanks were of wood and had to be renewed from time to time. Then metal tanks, enameled or glass lined, came into use, giving a far superior and more sanitary container. In Europe many of the breweries have constructed stock houses of concrete and this system has been introduced in the United States by a leading firm of concrete constructors—The Turner Construction Company, allying itself with the Rostock Company of Vienna under the title Turner-Rostock Corporation.



Typical aisle in a modern brewery where concrete stock tanks are used

In this new system, the tanks are constructed with the building itself and require no supporting floors or special foundations; they make practically all space available for storage. The fermenting tanks are usually built at the top of the building. Then follow the storage tanks. Each fermenter and storage tank is provided with copper pipes through which cooling fluid is circulated. Each tank is individually cooled, which permits individual regulation of the tank temperature by operating valves on the tank walls within easy reach from the work corridor. The inside lining of the tanks is a special coating invented by Herr Rostock. It produces a smooth, black, glossy, uniform surface which is both acid and alkali proof. Accidental damage to the interior surface is easily repaired.

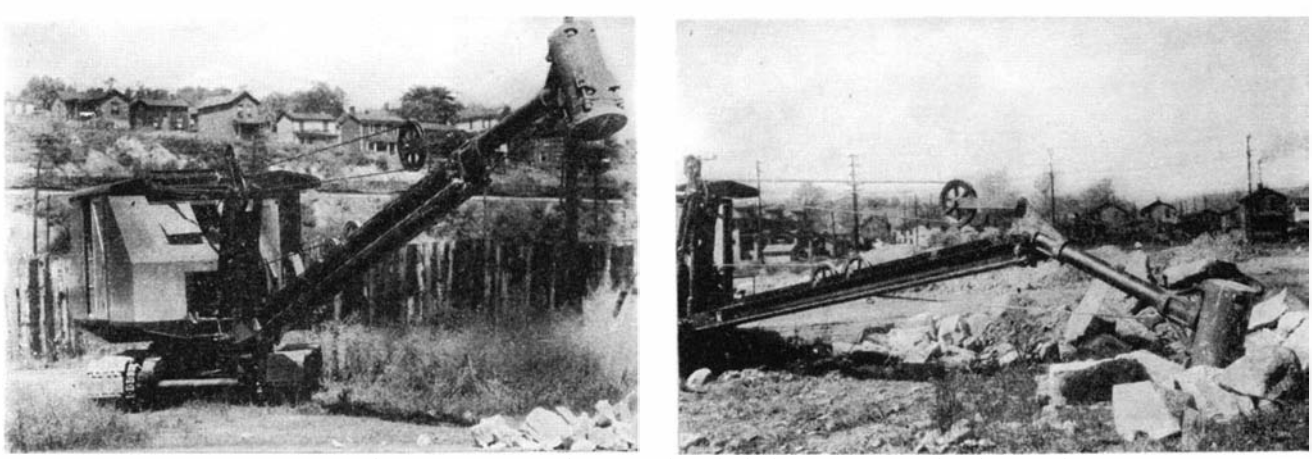
Pigeons versus Airplanes

WE recently read a curious letter from the Detroit City Airport. Many people living in the neighborhood of this airport are pigeon fanciers. The birds frequent the airport in great numbers, but they do not come for grain or seeds, nor do they make the airport a nesting place. Apparently they come there for certain salts or mineral substances. In the process the pigeons are frequently killed by the airplanes. This is not dangerous to the fliers, but rouses the anger of the pigeon fanciers. The birds cannot be frightened by guns, and poison gas cannot be used because of possible danger to humans. Another dilemma for the airport designer!—*A. K.*

Faults in Landings

DURING the execution of a landing it is necessary for a pilot to judge quickly and with accuracy his elevation, distance from the desired landing spot, and speed. A common fault is trying to glide in too slowly; when gliding too slowly the lateral or aileron control may become inadequate and the airplane have a tendency to fall off on one wing just before touching the ground. But it is equally bad to glide in too fast. In such a case it requires a longer run for the airplane to lose excess flying speed, and the dangers of a long run in a small field are obvious.

Another frequent fault is that of not heading directly into the wind; then when the airplane touches the ground it may be drifting sidewise, with possible damage to the wheels. If the pilot misjudges his height above the ground he may bring the plane to a stall or landing attitude several feet above the ground. It will then drop the remaining distance with an unpleasant bump. The perfect way to make a landing is to glide at a reasonable angle of incidence, not too fast nor too slow, to level off a very short while before making the



Two views of the traveling power hammer, described above, in use for breaking rocks

landing and to make the initial contact with the front wheels and the tail wheel all touching at the same instant. In such a case the plane will be just sustaining its own weight and the impact of landing will be imperceptible. Passengers of our scheduled airlines scarcely know when the transport has alighted. The same may not be true in the case of a passenger flying with a friend who is an amateur pilot. We are not depreciating the skill of the amateur pilot; some of them are just as well-trained as the best of the professionals, but insistence on more finished flying by every man who takes a plane up can never be amiss.—*A. K.*

Plane Wing Can Support Five Elephants

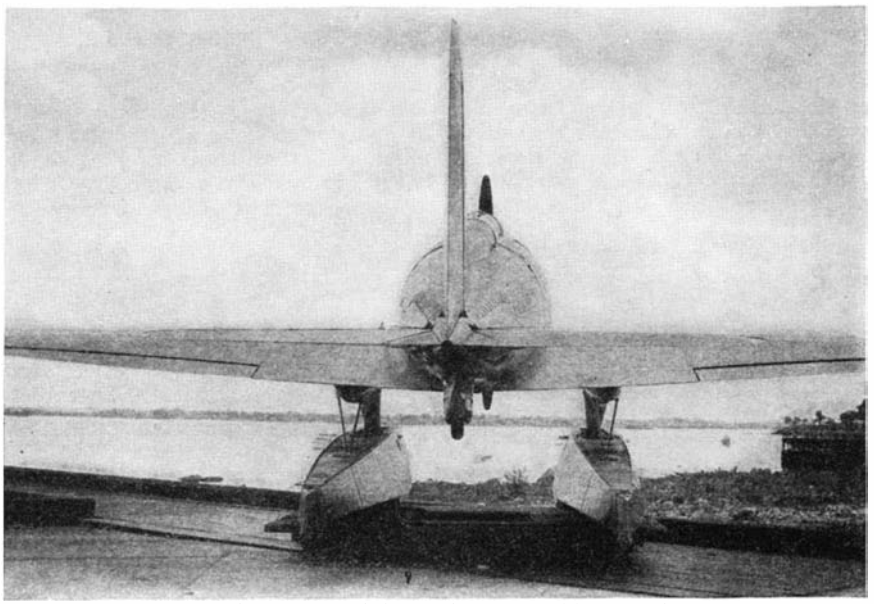
TUSKO, mightiest elephant in captivity, tips the scales at seven tons. And the wing of the nation's latest commercial air transport plane, believe it or not, is designed to withstand a load equivalent to more than five Tuskos!

Thirty-six and a half tons is the weight which the all-metal wing of the new United Air Lines passenger-cargo plane is constructed to stand up under. As further evidence of the plane's sturdy construction, the steel chord of one of its inboard wing spars has a tensile strength of 140,000 pounds per square inch!

A Novel Amphibian

MAJOR SEVERSKY, a Russian military aviator who still carries a "game" leg as the result of war experiences, has achieved a real reputation as a designer of bomb sights and other aeronautical devices. Now he has added to his laurels by designing and testing a novel and interesting amphibian.

The first point of interest lies in the all-metal construction, particularly that of the wing, which is so designed as to have considerable buoyancy—a valuable feature in the case of a forced landing by an amphibian. The wing is constructed entirely of sheet metal, perfectly smooth on the outside so as to offer no hindrance to the air. The upper smooth skin is reinforced on the inside with corrugated sheet. The bottom skin is stiffened by the use of a channel section running the whole span of the wing. All the conventional wing spars and ribs of airplane construction are thus avoided.

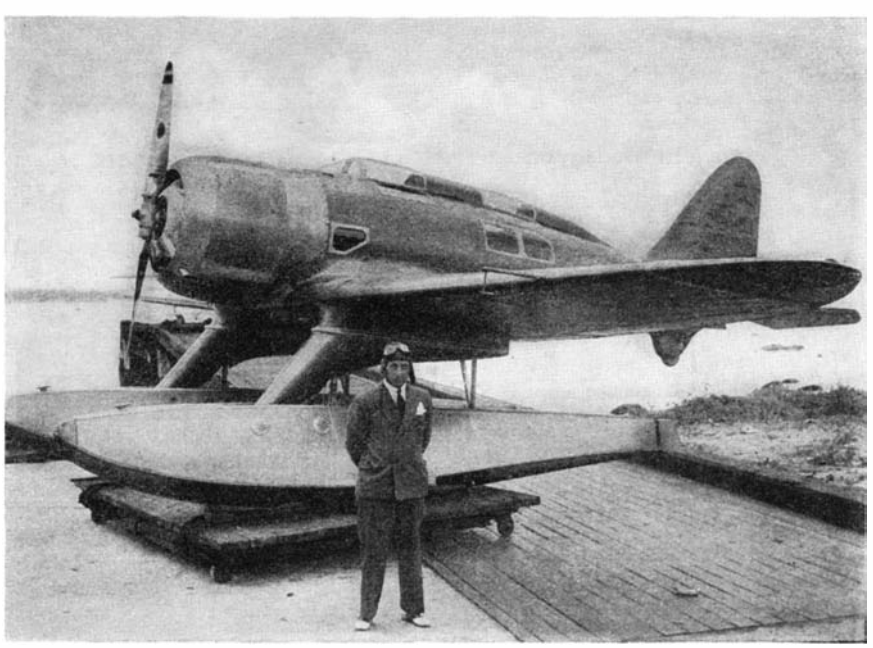


Rear view of the new amphibian, showing rudders on the pontoons

There is also an important military advantage in this type of construction. Since there are no "main" members in the shell, it may be riddled with bullets in combat and yet maintain the major part of its strength. This would not be the case with a wing involving two or even three spars, where the failure of one spar might entail the almost immediate collapse of the entire wing.

The amphibian gear is of equal interest. The two floats are strongly braced to the wing by the rugged sheet metal struts, which fair into a sheet metal projection on the lower side of the wing. At the ends of the floats are mounted water rudders, without which maneuvering on the water is difficult. At the extreme end of the fuselage is mounted a tail wheel which almost disappears into its fairing. In the floats there is a recess for the wheels which are supported by the usual type of shock absorbing struts. (The top of these struts is seen just behind the main float brace.) These wheels can be withdrawn into the floats at will. Moreover, by removing the floats, the amphibian can be immediately converted into a simple land plane with naturally greater performance than in its amphibian form.

The design should certainly appeal to the sportsman pilot, particularly as the top speed as an amphibian with a 700 horsepower Wright Cyclone engine and a gross weight of 3600 pounds, is estimated at 240 miles per hour.—*A. K.*



Major Seversky standing beside his new plane. Note cock-pit covers

A Tunnel for Spin Study

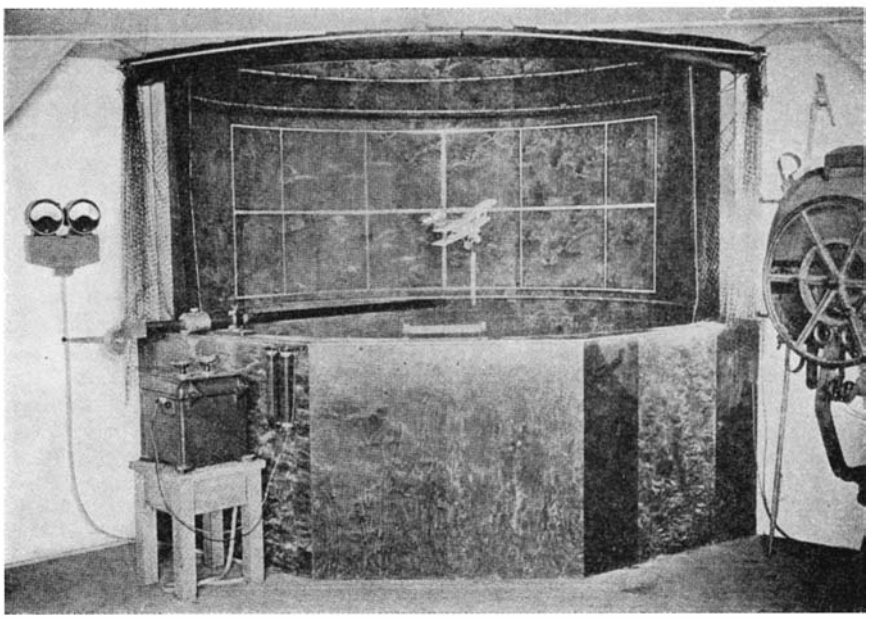
THE spin is still a frequent cause of airplane accidents. The large transport planes operated by skilled pilots are fortunately immune to this type of accident, but in military and navy work, spinning is an accepted maneuver which pilots must of necessity undertake. The flat spin is particularly unpleasant. In this so-called flat spin the airplane has its axis almost horizontal and rotates steadily about a vertical axis passing through its own body, while descending fairly slowly to earth.

One of our photographs shows a model mounted in a flat spin attitude in the new spin tunnel, the first of its kind in the world, developed by the British Royal Aircraft establishment at Farnborough, England. Previous spinning experiments have been made with carefully constructed models set in the spin in some high building where the air was reasonably still. The models, launched into space, were protected from a crash by an automatically opening parachute. These launching experiments, while yielding useful and interesting results, were difficult of observation and of very short duration.

These difficulties are overcome by the new tunnel. Models are launched in a spin in the vertical tunnel and their descent is neutralized by an upward flow of air induced by a powerful propeller fan. Free spinning can thus continue as long as desired and the spinning characteristics

can be examined at leisure and at close range.

The tunnel, which is designed to accommodate models of two feet span, is 12 feet in diameter and 30 feet high. The models are observed from an opening in the side of the tunnel. They are launched from an arm which is swung from the opening in the center of the tunnel, as seen in our photograph. When the wind is turned on, the model, which is mounted freely on a pivot in the approximate spin attitude, begins to rotate. The speed of the fan is then gradually increased until the model becomes airborne and rises from the pivot and continues to spin freely. The spinning motions are recorded by a high-speed moving picture camera against the carefully graduated background.



The open part of the vertical wind tunnel for studying the effects of spins

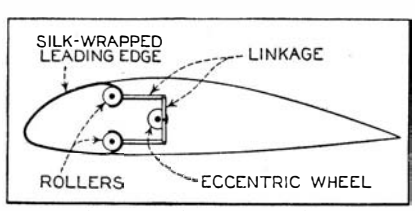
What is more important, however, than the study of the spin is the study of the recovery from this maneuver, when the rudder is moved against the spin. To study recovery the control surfaces of the model are moved some 20 seconds after the instant of launching by a delayed action mechanism in the fuselage. The model can then be seen to spin slower and less steadily, until it finally dives down into the net at the bottom of the tunnel. The rapidity of recovery and the character of the recovery are also recorded by the moving picture camera. This experiment provides a very fine check on the efficiency of the rudder in the spinning attitude.

We understand that every new airplane built for the British Government is now first subjected to the spin test in this tunnel.—*A. K.*

An Oiled Curtain to Break Ice

THERE have been described in these columns "over-shoes" for airplane wings to prevent dangerous ice formations. These "over-shoes" consist of a rubber cover for the leading edge which, under air pressure, changes its shape and breaks the ice. Now Thorne Hiscock of United Airlines has brought forth another method of getting rid of ice, which, equally effective, has perhaps even greater simplicity. Our artist has used his imagination to depict this new method which has not yet been fully described. Essentially, the device consists of an oiled silk curtain which sheathes the leading edge of the wing, sliding back and forth around it on rollers, and countersunk in the all-metal wing so that the latter preserves its smooth contours. The rollers are actuated by an eccentric drive from the airplane engine and are set in motion by the pilot. The oiled curtain bends around the leading edge; the ice will not bend and therefore breaks off.

This ingenious device was conceived by accident, when Mr. Hiscock saw the ice snap off a flag whipping in the wind. Chance observation is so often the origin of an invention—provided the observer is alert and intelligent.—*A. K.*



Sketch of mechanism of the oiled curtain that breaks ice on wings

Science in the Navy

THE administration is taking steps to give Uncle Sam a Navy second to none. Over 300,000,000 dollars of the federal public works funds will be spent on some 37 new ships, on reconditioning existing ships, and for airplanes of the new Navy.

Coincidentally with this dual purpose project, a reaction to disarmament failure and to domestic unemployment, serious limitations are being made in the scientific research of the Federal Government. About 10,000,000 dollars are being pared off Congressional appropriations in the name of economy. For instance, the National Bureau of Standards has lost a third of its highly trained personnel.

What have scientists in laboratories to do with the Navy? The scientists are the real men behind the guns, the engines, the armor plate, and the "mechanical brains." Destroy the search for new methods of building and operating the Navy and it is obsolete and licked before it puts to sea or fires a shot.

It is not too much to say that if the complete creative aid of American science is not utilized by the Navy in its rejuvenation, millions upon millions of dollars will be wasted in lulling naval officers and the public into a sense of false security.

In fact, when United States Navy authorities and designers want information on technical points they have turned freely to the scientific bureaus of the government. It should be part of the new Navy program to see that these bureaus are not crippled and thus made ineffective in answering these science calls.

Imagine an American Navy or a possible enemy navy that can: Foretell its weather conditions a week in advance; send a radio scout plane, with robot pilot, that will reconnoiter an opposing fleet and television the prospective battle scene for the advancing fleet; make harder steel for better armor plate; make its guns shoot a little farther and a little harder; cruise a few hundred miles farther on the same amount of oil.

If the American Navy does not enlist science to bring to it such superior advantages, it must remember that foreign navies are doing so. The American public must be ready to take the consequences.—*Science Service.*

Progress in Air Transport

ONLY 19 years ago P. G. Johnson graduated from the University of Washington and entered the employ of the Boeing Airplane Company as a junior draftsman. His progress first as an engineer and then as an executive was so rapid that he is now President of Boeing, of United Airlines, and of the great United Aircraft and Transport Corporation, perhaps the strongest and best integrated of all American aviation companies. Aviation has been rather slow in producing real executives; but Mr. Johnson certainly is one, and his career will be watched as synonymous with the progress of this industry. A short summary of his views as expressed at the In-

P. G. Johnson, whose views on transport aviation are given here

ternational Engineering Congress held in Chicago under the auspices of the Society of Automotive Engineers is therefore of more than passing interest.

Operators are concentrating on speed and more speed. Increased speed not only pleases the public, but actually spells economy because all airplane costs go down as less time is spent in the air for a given journey. Biplanes are losing ground and monoplanes are definitely in the ascendant. Since the public, quite rightly, will not trust itself to one engine, multi-engine planes—generally with two motors—are the rule for passenger traffic. Planes are of medium size. It was thought a few years back that "superplanes" of 30 and 40 passenger capacity would be built. On the contrary, the present trend is to smaller planes, of some 10 or 12 passenger capacity. These medium-size planes provide for more flexible schedules, and it is better to run "extra sections" by dispatching more planes when needed than to have a few large planes not adequately filled. Our railroads might well learn a lesson here from the more progressive aviation operators. In the last five years the rate per mile received by operators for carrying mail has been more than halved. But the airmail net-work has been more than doubled and with the help of passenger traffic the airlines are flourishing.

Mr. Johnson is of the definite opinion that in addition to the present substantial support from business executives, the general traveling public will patronize airlines in increasing numbers.—*A. K.*

Magnetic Testing of Steel Propellers

THE wooden airplane propeller is rapidly disappearing. It is being replaced by the solid blade of duralumin and by the hollow steel blade propeller as manufactured by the Pittsburgh Screw and Bolt Corporation. Both types have their advantages and disadvantages, and it is not the purpose of this note to discuss their relative merits. The hollow steel propeller exponents have, however, stolen a march on the duralumin users by a very ingenious magnetic method of testing for hidden flaws or defects in the hollow blade.

The new system of testing is known commonly as the "Magnaflux" method. It is based on the fact that finely divided iron will cling to the edges of cracks in a magnetized body.

As shown in the photograph, the propeller blade is mounted between the poles of a large magnet. The magnet consists of a core and poles of solid rolled machinery steel, magnetized by the action of six coils. The distance apart of the poles can be adjusted to suit the particular blade under test. The iron powder, "Magnaflux," is carefully sprinkled on the surface of the blade. Any concentration or piling up of the iron powder indicates cracks or other defects, however minute.

Thanks to co-operation between the Army, the Department of Commerce, and the propeller company a successful technique of flaw detection has been built up.

Right and left: **Using the new reflex camera in the conventional manner and at eye level**

Incidentally, the Magnaflux method was carefully checked by sawing apart any propeller showing defects under magnetic examination. It is now possible to detect flaws on either side of the blade, or even in its interior.

This method is another illustration of how every branch of applied science is brought into use in the all-embracing field of aeronautical work. It is described fully in a paper by Hamilton Foley presented under the auspices of the Society of Automotive Engineers.—*A. K.*

New Small Reflex Camera

A CAMERA that will surely catch the eye of the photographic enthusiast and that holds promise of giving excellent results even after long and hard usage is the little Exakta recently put on the market by the Ihagee firm of Dresden, and now available in this country. The camera is of the true reflex type with shutter speeds from 1/25 to 1/1000 of a second. Although unorthodox in shape, being in the form of a shallow triangle, the overall dimensions are only 6 by 3 by 2¾ inches.

The shutter release is near the front of the camera and on the left side. It is operated by pressing toward the operator, rather than downward. The lens is in a helical mount that is turned for focusing to as close as a three-foot range. There is no bellows.

The finder has a magnifier for fine focusing, which may be folded out of the way when not needed. It is also provided with a mirror so that the camera, if desired, may be held at eye level when using the reflex principle.

Another important feature that will prevent many double exposures on the same film is that a single knob resets the reflex mirror and the shutter in one operation, and at the same time winds up the film for the next exposure. Until this is done, no image can be seen on the mirror.

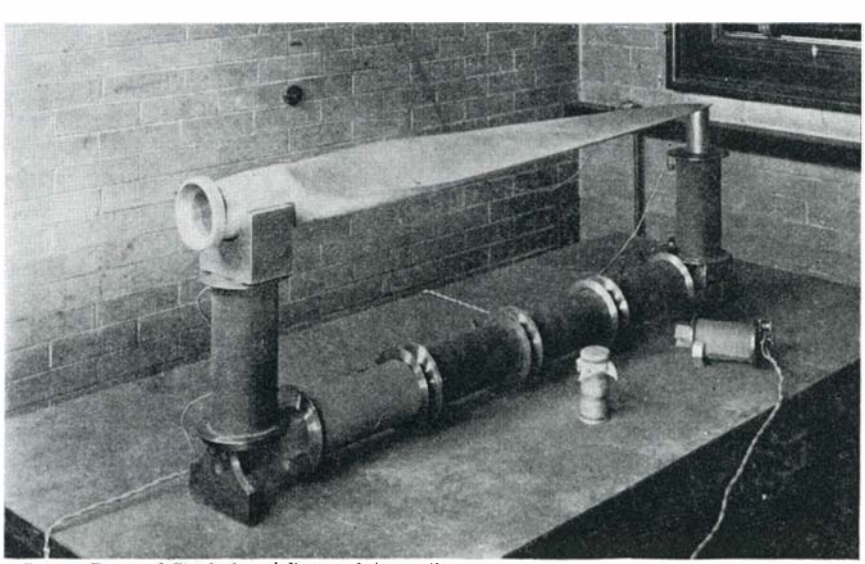
Synthetic Castor Oil

SYNTHETIC castor oil has made its appearance—probably at the psychological moment, for the natural product is scarce and expensive. "Castoreum Synthetic" is reported to have the following advantages over the natural material: obtainable in unlimited quantities; no pronounced coloration; low and stable in price; substitute for the natural product in many instances, and moreover can be employed in creams, soaps, and face powders; on account of its chemical composition this product greatly retards rancidity in soaps.—*A. E. B.*

English Criticisms of American Automobiles

THE question that bothers most prospective car purchasers is how they can tell the differences between and the advantages of the many almost identical automobiles in the medium-price class. American manufacturers have lost sight of some of the important foreign automotive engineering developments and are proceeding along a narrow path of specialized improvement in detail, in the opinion of the British engineer, L. H. Pomeroy, Managing Director of the Daimler Company that produces the Austin cars in England.

The English criticisms of the American car range from too rapid depreciation caused by big horsepower to the opinion



Courtesy Bureau of Standards and Bureau of Aeronautics

Propeller set-up for testing by the Magnaflux method

that the windows are too high. Although they grant that "one man's meat is another man's poison," some of their suggestions are worth considering.

The premier contention is that the size of the engine has been developed out of all proportion to the requirements of rational performance. High speeds and high acceleration have been overemphasized and the comfort, spaciousness, and luxury of the body have not kept pace with the stupendous power performance. Perhaps this has been due to the ease with which publicity departments can impress the public with spectacular figures.

English engineers feel that American designers have not taken advantage of the possibilities of considering the gear box as part of the engine. They feel that the motorist will secure as much enjoyment at less cost from driving with a lower powered car even if it is necessary to shift the gears more often.

The use of light alloys of aluminum and other metals that has become so common in European cars has been almost entirely neglected in this country. A light weight car means that the engine power can be cut down and the economy of operation increased. The saving of as much as 50 percent in some of the heavy steel parts, such as axles, will entail an additional expense but past experience has shown that the consumer has always been willing to pay for a genuine improvement.

Engineering developments in Europe that are not attracting the attention that they should in this country are methods of gear shifting, automatic variable-speed transmission, fluid flywheels, and supercharging.

British manufacturers are wondering if the American car is to hitch its wagon to the star of top-gear performance forever in spite of engineering developments which make this wasteful and unnecessary.—*Science Service.*

Salvage Gold from Rubber Erasers

BY saving up the sponge rubber used to wipe the excess gold leaf from newly lettered book covers and turning it over to the University Department of Engineering Research for treatment, the book bindery of the University of Michigan now finds itself richer by 150 dollars in the useful metal.

Gold leaf has long been the chosen substance for the cover titles of good books because of its appearance, legibility, and wearing qualities. The Library bindery applies it to new covers over an egg albumin adhesive, pressing in the gold with hot iron letters. The excess adhesive and leaf is then rubbed off with a plastic rubber eraser. The research engineers took this rubber and reduced it to an ash, which they then smelted, with the result that in the bottom of their crucible appeared a sizeable nugget of gold to be refined and turned in on the anti-hoarding campaign.

A Plow for Reforestation

A FORESTRY plow especially made for reforestation work is now available. The plow has been developed by Professor S. O. Heiberg, of the New York State College of Forestry, Syracuse University, in co-operation with engineers of the John Deere Plow Works and the Syracuse Chilled Plow Company.

Note freedom from weeds in strip cultivated with new plow described

Following in the footsteps of its cousin, agriculture, forestry is taking into its service the machine. During the last three years trees have been planted in many places by machines instead of the grub hoe, and now the forestry plow appears.

It is a tractor-drawn implement which removes the sod to a depth of about two inches from an 18-inch-wide strip and then cultivates this strip by means of spring teeth and subsoiler so the soil is in excellent shape for planting. Different combinations and adjustments make the plow equally suitable for heavy and light soils. The depth of cultivation of the cleared strip can be adjusted from very superficial scratching of the surface down to a depth of 12 inches.

The machine can be handled by the tractor driver alone as the levers are adjustable for different tractors.

Experiments conducted by the New York State College of Forestry show that with a six-foot spacing between the center of the strips, the plow can prepare one to two acres per hour. With all expenses included, the preparation of one acre thus costs from 75 cents to $1.50, or ½ to ¼ the time for hand-made holes, and the strip is much better prepared than it would be economically possible to do by hand. Planting in such a strip is extremely easy and the young trees have a better chance for survival and development than if they were just planted in holes.

Tellurium Makes Better Lead

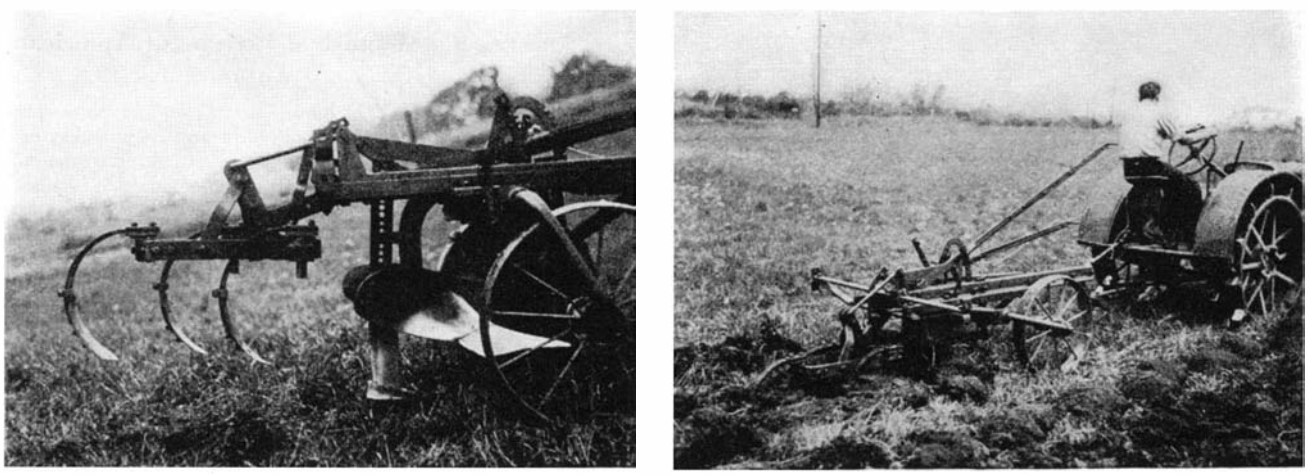
LEAD has lost some of its market in recent years because it is soft and "creeps"; other materials have been substituted for water pipes and roofing. But now, English investigators have found that lead is better behaved when alloyed with as little as 0.06 percent tellurium, a sulfur-group element, which has so far had no commercial use. The *Industrial Bulletin of Arthur D. Little, Inc.* predicts that this alloyed lead will recapture old markets and find new ones.—*A. E. B.*

Less Risk Now from Vaccination

SMALLPOX vaccine virus from chicken eggs instead of from calf lymph is the achievement of Col. W. D. H. Stevenson and Dr. G. G. Butler of the Government Lymph Establishment, England, as reported in *The Lancet*, a widely read British medical journal.

The new method opens the possibility of large-scale production of a bacteria-free virus for vaccination, it is claimed. From 28 eggs the investigators obtained enough material to vaccinate 7000 persons.

Commenting editorially on this new method, *The Lancet* points out that the new vaccine is sterile; that the method is not as arduous or expensive as the produc-



Two views of the reforestation plow. At left are shown sod cutter, sub-soiler, and cultivator teeth. Plow in use at right

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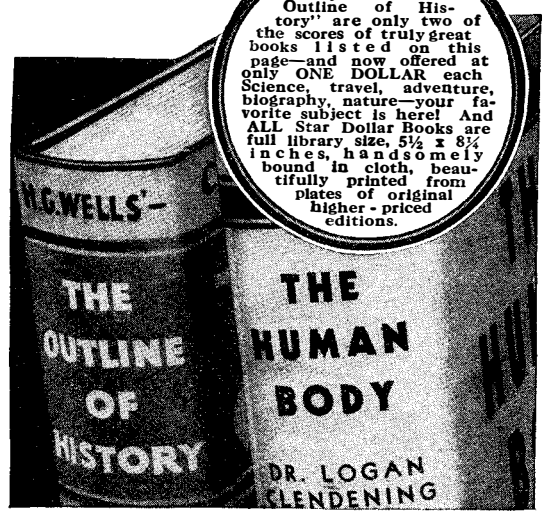

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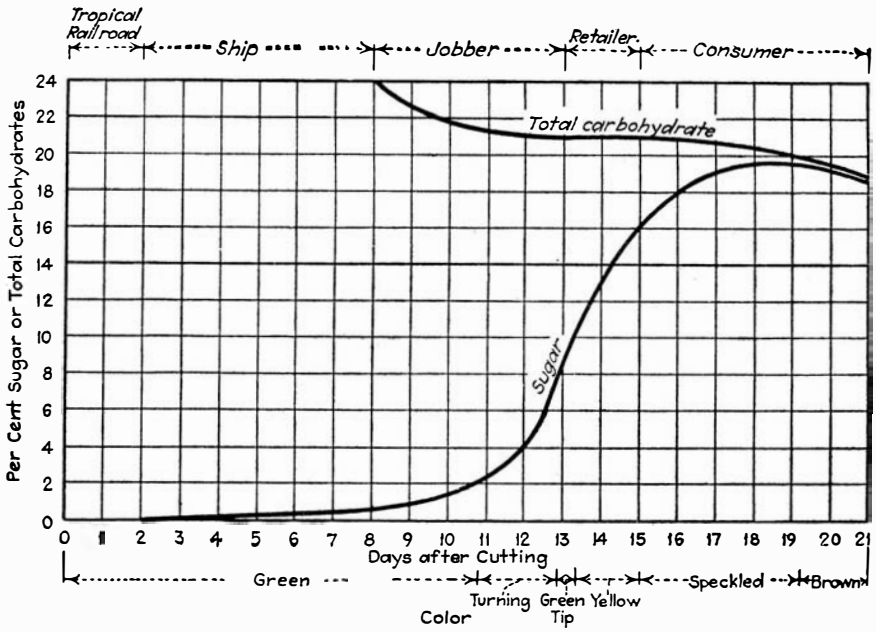


This chart, reproduced by courtesy of *Food Industries*, shows how the ripening of bananas develops after the fruit is cut, and is a guide to scientific planning

tion of calf lymph, and that the yield is excellent. The method seems to represent a definite advance and to be free from the objections to which calf lymph is open.

Other investigators have tried to produce a similar vaccine virus. The method reported by Col. Stevenson and Dr. Butler is a modification of the technique developed by A. M. Woodruff and Prof. E. W. Goodpasture of Vanderbilt University, Nashville, Tennessee.

The English investigators started the cultivation of their virus with purely dermal strains derived from rabbits that had been injected intra-dermally with glycerinated vaccine lymph derived from the calf.—*Science Service.*

How Ripening of Bananas is Controlled

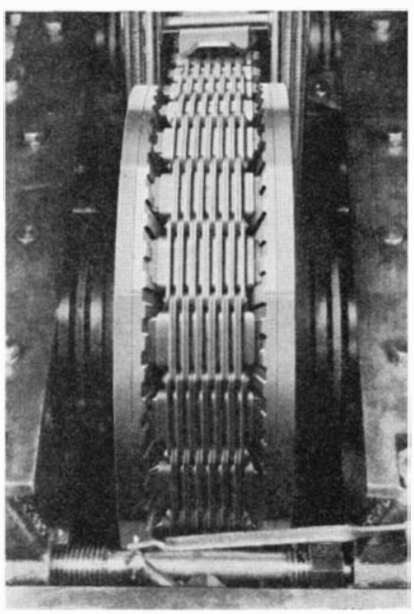
As everyone knows, a banana is at its best when it has reached just the proper stage of ripeness, indicated by the beginning of brown speckling of the yellow skin. The scientific planning required to bring bananas to the ultimate consumer in this condition is revealed by C. F. Greeves-Carpenter in the September issue of *Food Industries* and by the chart reproduced by the courtesy of that interesting periodical.

Natural enzymes in a few days' time convert the starch content of the green banana almost completely into sugar. This ripening is evidenced by a change of color in the skin from green (unripe) to yellow, then to yellow flecked with brown (ripe). The fruit ripens from center out as the enzymes convert the starch first into sucrose or crystalline sugar, and then into invert sugar. The fully ripened fruit contains approximately half its sugar content in the form of sucrose and half as invert sugar.

Ripening is controlled by temperature and humidity. The most desirable temperature has been found to be from 62 to 68 degrees, Fahrenheit. When rapid ripening is necessary to meet marketing needs, the temperature is increased as much as 3 degrees, Fahrenheit, per hour within that temperature range without its having any injurious effect on the fruit. When the fruit begins to color, the temperature is reduced to 66 degrees, Fahrenheit, and held at that point. During the warming period heavy condensation of moisture on the fruit takes place, which seems to have a beneficial effect. When it is necessary to hold the ripening fruit in an almost static state to prevent over-ripening, a temperature around 56 degrees, Fahrenheit, has been found most satisfactory.—*A. E. B.*

Ingenious Design in Variable Speed Transmission

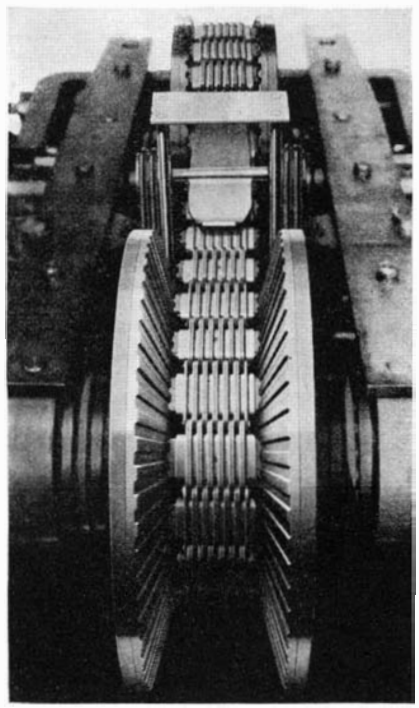
In the P. I. V. (positive infinitely variable) transmission developed by the Link-Belt Company, there is provided, as the name implies, an infinite variation in speed change ratios up to six to one. It is built in five sizes, from one to ten horsepower.



Basically, this speed change unit consists of two pairs of wheels of the opposed conical disk type, between which a unique chain transmits power. The effective diameters of each pair of wheels can be altered under load to change the speed ratio, without steps and without dependence upon friction. On changing speed, the self-pitching chain rises in one set of wheels and descends in the other, so that while the input shaft connected to a motor or other source of power turns at constant speed, the output shaft is brought to the desired speed.

Variable-speed devices employing adjustable conical disks and belts with side friction contacts have been used for some time. The wholly original feature of the P. I. V. gear is its use of a positive chain drive to transmit the power. Radial teeth are cut in the conical faces of the driving disks, and the self-adjustable teeth projecting beyond the sides of the chain are arranged to engage positively the radial teeth of the disks.

The chain used in the P. I. V. gear is made up of a series of steel leaves or links with joints consisting of hardened steel pins turning in segmental bushings. There are no teeth on the inner surface of this chain. Instead, what may be called teeth are made up of packs of hardened steel laminations or slats which extend through slots in the links at right angles to them, and project about ⅛ of an inch at each side of the chain. The individual containers which hold the packs of slats are secured in the openings of the links, but, within each such container, the slats are free to slide from side to side individually with relation to each other and adjust themselves to engagement with the radial teeth of the disks, over substantially the full range of diameters. The angle of the slat ends, 30 degrees, is the same as that of the conical faces of the wheels.



***Above and left:* Two views of the variable speed transmission, showing how ratio changes are effected**

The teeth of the disks widen from the center outward toward the circumference, but are of uniform depth. They are so staggered relatively on each pair of wheels that the slats move back and forth into the

(*Please turn to page* 237)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

SO far as is known, the telescope mounting and observatory shown in the drawing at the bottom of the page is an original. It is the design of John H. King of Amityville, Long Island, who also furnished the drawing.

"This mounting," Mr. King writes, "combines some of the features of other fixed eyepiece mountings, with one new feature —it allows the observer to be sheltered, yet does not thereby cut off any of the sky. While other fixed eyepiece mountings accomplish the same thing, they make use of large auxiliary reflecting surfaces."

In Mr. King's design an extra lens system transposes the primary image at such a distance from the tube that it is possible to interpose the observatory shelter, the magnification being either unity or a small factor. "This lens system," Mr. King continues, "involves more than a problem in simple erection, because of the long distances between images and therefore the use of lenses of large aperture (about 1½ inches) and the necessity of preserving the image quality for high-power observation. Two methods suggest themselves: the autocollimation scheme with unity magnification using two similar lenses (see small sketch) which are corrected for focusing parallel light, separated by twice their principal focus, and a special lens designed to meet the sine condition for two finite focal points, which would magnify the image by a factor of two or three. Of these methods the first is easily within the means of amateurs, as two good field glass lenses, with their infinity surfaces facing one another, will do the trick."

"Despite some loss of light," Mr. King adds, "I think that this mounting would be more useful for general observation than a conventional exposed telescope. The physical comfort of the observer contributes a lot toward the efficiency of a visual telescope."

Commenting on Mr. King's design, Russell W. Porter says it "is all right, provided the user is willing to pay for the comfort gained by the loss of light through reflection and absorption." A roughly comparable though smaller loss is of course caused by auxiliary reflecting surfaces used in connection with similar telescopes. For example, see "Amateur Telescope Making," pages 50 and 51, sketches I to IX. Who will build a telescope of the King type?

By the way, it seems odd that the Hindle enclosed observatory, A.T.M. page 362, 363, 365, has not yet been copied by someone.

SOME months ago we inquired about the reported inaccuracy of synchronized current supply. Gerald E. McCord reports on the letterhead of his "Skylight" Observatory, Oak Park, Illinois:

"I have a four-dollar clock from which I get my time for figuring stellar calculations. I had noticed that it did not always keep what I thought was right time, so, since I saw the note in the SCIENTIFIC AMERICAN, I have been checking up on it. "My time comes by radio from the clock in the Elgin Watch Co. observatory and is clicked off from the Naval Observatory, with a five-second pause before the hour. I had never found the clock more than 5 seconds off in my calculations before."

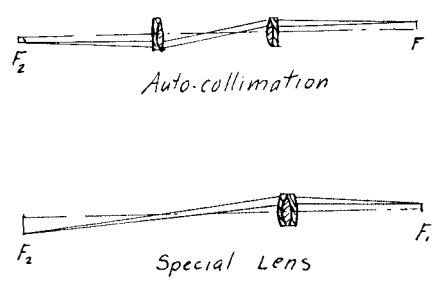
Mr. McCord sends a graph (which cannot be reproduced, being on green-lined cross-section paper) which shows twice-daily discrepancies of: 1 second fast, 1, 5, 1, 4, 1, 2, 2, 1, 2 seconds slow, 5 and 5 seconds fast, correct, 1, 1, 1 slow, correct, 1, 1, 2 slow, correct.

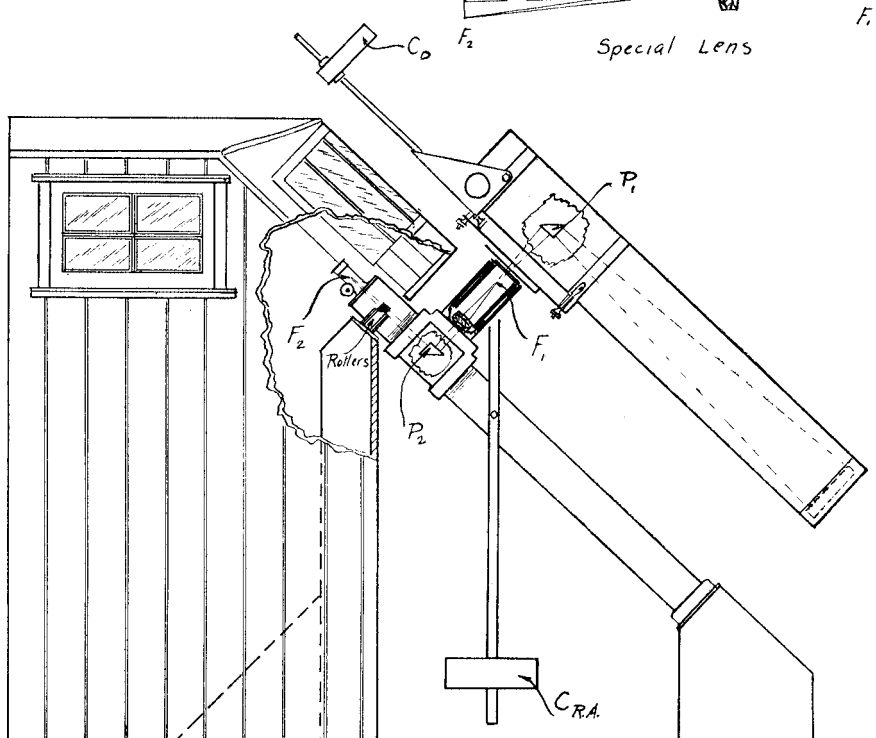
Mrs. B. L. Souther, 239 Beverly Road, Mt. Lebanon, Pittsburgh, Pa., also writes concerning the same subject, which she has investigated. "The time signals used were the 9 P.M. signals from the Elgin Watch Co. observatory, through station WJJD, Chicago. According to the announcer, these are accurate to .01 second. The other standard time signal was the 10 P.M. signal of our Naval Observatory sent out on 690 kc. by station NAA. The clock is a Westinghouse New Haven electric alarm, with subsynchronous motor, running at 200 r.p.m. The second marks on the dial are about ¼-inch apart, so that the data are correct to approximately ½-second." Mrs. Souther found the current ran slow on a series of days, as follows: 2, 1½, 1, 1, 3, 0, 1½, 0, 3, 2, 3, 2, 1, 2, 3, 1, 3½ seconds, and she continues: "The above data show that there may be errors as great as 3 seconds an hour, and that, especially at the weekends, the synchronization is inaccurate. The greatest error observed was 5 seconds at a weekend. This apparently indicates an effort to correct it at the first of the week. I have been told by my brother, an electrical engineer, that the local system is hand-regulated."

IN the September number, page 132, third column, near the bottom, the figure 2,584,902—the reduction ratio to give true sideral time—should be 2,584,922.7. So writes Lincoln K. Davis, who says it was incorrect as originally given to us. He gives the following for another set of gears: 45:2 x 73:61 x 100:1 x 100:20 x 192:1. Motor 1800 r.p.m. and error 0.156 second per day. But what's the use, for the average man, if his current is already "off" by 5 seconds? As is the case with hard times, something ought to be done about it, but what?

IN spite of Ellison's remonstrance (page 97 of A.T.M.) against fancy dingbats for measuring zones, folks will make them, and Frank H. Smith, 505 Prospect Avenue, Lima, Ohio, reports his own experiments as follows:

"I enclose photographs of a 'wrinkle' I have been using in my knife-edge testing apparatus. The value is measured with a

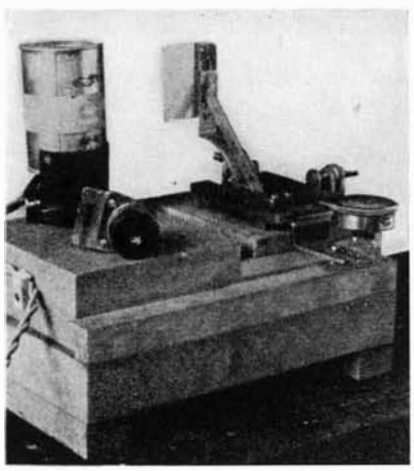




The King design, in which the distance between the prisms is artificially stretched by means of lens systems, in order to gain certain mechanical ends

dial indicator such as is used in machine shops for testing the accuracy of lathe setups and so on, and gives direct readings in thousandths of an inch.

"In using this instrument in the knife-edge test, the mirror is masked in the usual way, and the knife-edge is brought to the correct point where the tones in the two points in the outer zone match. The indicator is then attached so that the indicating post touches the piece carrying the knife-edge, and the dial of the indicator revolved until zero coincides with the pointer. The knife-edge is next moved into the point where the tones in the next zone are matched and the indicator will give the number of thousandths of an inch the knife-edge was moved. By this means one may be



Smith's equipment for measuring the radius of zones on a mirror

able to determine accurately how close he is coming to the calculated value of each zone, to the third decimal place."

We accept this latter—the third decimal place—provided the worker can estimate the comparative darkness of shadows that closely. Beware, however, of fictitious accuracy. Would not the question of the contrast sensitivity of the eye be involved here? This is given in Hardy and Perrin's "Principles of Optics" as about 0.1 percent, though variable. That is, it will vary with the intensity of the illumination, but 0.1 percent is about right.

J. M. VURE, 991 East 163 St., New York City, submits the following note:

"I should also like to call attention to a much simpler formula for calculating the focal length of a refractor than the one used in 'Amateur Telescope Making,' on page 106-110. The formula is

$$f_1 = \frac{F(v_1 - v_2)}{v_1} \qquad f_2 = \frac{F(v_2 - v_1)}{v_2}$$

"The explanation of this formula is as follows: To produce an achromatic combination from two glasses taken from makers' lists, look to the column headed V, subtract the V of the flint from the crown, multiply the result by the required focal length, divide the result by the V of the crown; the final result is the focal length of the crown. To get the f.l. of the flint, subtract the V of the crown from the V of the flint, multiply by the required f.l., divide by the V of the flint. By using this formula in your example on page 109, *27.9* is the f.l. of the crown and *44.43* is the f.l. of the flint."

CURRENT BULLETIN BRIEFS

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

THE LATEST ARCHAEOLOGICAL DISCOVERIES IN ITALY is a fascinating guide book which supplements Baedeker and deals with discoveries which are sometimes only a few months old. It is beautifully printed and is admirably illustrated. *Italian Tourist Information Office, 745 Fifth Avenue, New York City—Gratis to intending tourists.*

THE KAMPOMETER (Smithsonian Miscellaneous Collections, Vol. 89, Number 3), by C. G. Abbot, describes an instrument which has advantages over both the bolometer and the thermopile. *Smithsonian Institution, Washington, D. C.—5 cents (coin).*

AERONAUTICAL AND MISCELLANEOUS NOTE-BOOK OF SIR GEORGE CAYLEY (1799-1826) gives interesting sidelights on an early scientist who may be regarded as a pioneer of aeronautics. The note-book testifies to the wide range of Cayley's scientific and mechanical interests. It is published for The Newcomen Society by *W. H. Heffer and Sons, Ltd., Cambridge, England.—seven shillings and six pence.*

"SPIRITS" is a new monthly trade paper published in anticipation of the speedy repeal of the 18th Amendment. Harry Schwarzchild is the editor. *Spirit Publications, 220 East 42nd Street, New York City.—$2.00 per annum, single copies 25 cents.*

TOURISM is a bi-monthly bulletin of information relative to travel in Netherland-India. Each number deals with a special place or event. Netherland-India consists of an archipelago of many islands which contain beautiful scenery. A sample copy will be sent on request by the *Travelers Official Information Bureau, 36 Noordwijk, Batavia, Java.—Gratis.*

ELECTRIC STEAM STERILIZATION AND WATER HEATING IN THE DAIRY (Report No. 7, May, 1933), contains information which will tend to make clean utensils and good sterilization easy. Over 50 illustrations. *National Rural Project, College Park, Maryland.—13 cents (stamps accepted).*

CHEMICAL ENGINEERING ADVANCES IN THE RUBBER INDUSTRY, by George Oenslager, covers much of the progress made by the rubber industry in the last 25 years. *The B. F. Goodrich Rubber Company, Akron, Ohio.—Gratis.*

FANCY CABINET WOODS AND THEIR USES, by Albert Constantine, Jr., describes the use of veneer for amateurs, giving prices and directions for use. *Albert Constantine & Son, Inc., 780 East 138th Street, New York City.—Gratis.*

TO make this page of greater value to our readers, the editor shall be glad to consider for review papers and bulletins on any phase of science, engineering, or industry. However, we do not wish ordinary catalogs, and we will not mention what is obviously propaganda.

Material submitted should give full information as to where obtainable and the price, if any, so that the reader may obtain copies directly without unnecessary correspondence.

AN EPICURE'S BOOK OF CHEESE RECIPES is a cleverly devised book of recipes. It was written by John B. Rosebrook and illustrated by John Atherton. *The Borden Company, New York City.—Gratis.*

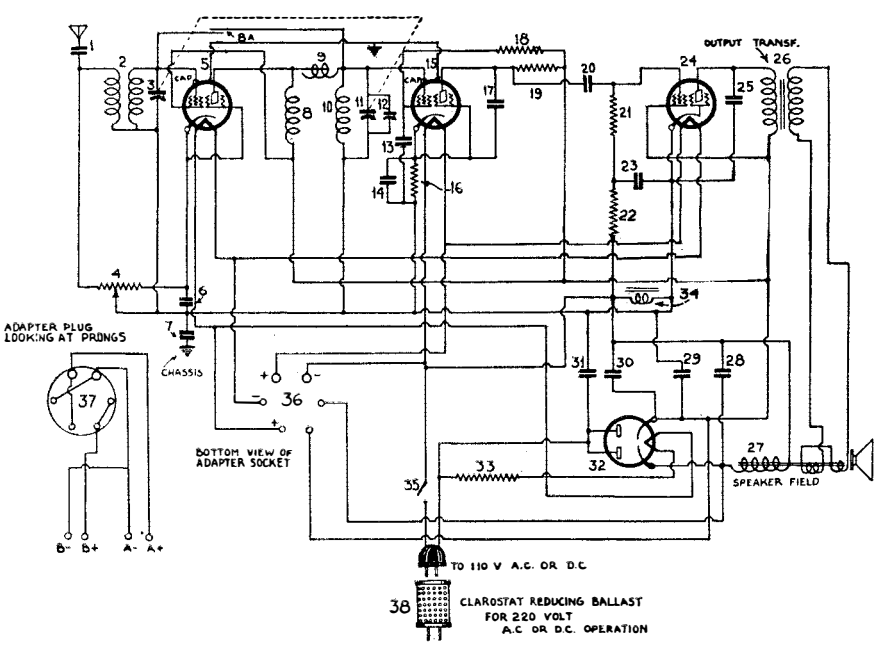
VOCATION GUIDANCE IN ENGINEERING LINES —Elicited and edited by the American Association of Engineers. Cloth—6 by 9 inches; 521 pages, fully illustrated. *The Mack Printing Company, Easton, Pa.—$2.50.*

COMPOSITE LIST OF NON-THEATRICAL FILM SOURCES tells how commercial and trade promotion films may be obtained. *Motion Picture Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.—10 cents (coin).*

AMERICAN CIVIC ANNUAL (Volume IV), edited by Harlean James, is a record of recent civic advance with a list of "who's who" in civic achievement among the members of the American Civic Association. 276 pages. *American Civic Association, Union Trust Building, Washington, D. C.—$3.00 to non-members.*

THE NEW STORY OF ANCIENT WROUGHT IRON describes in detail new processes for making wrought iron in quantity, doing away with hand-puddling and its limited production. *A. M. Byers Company, Pittsburgh, Pennsylvania.—Gratis.*

HURLBUTT'S PAPERMAKER GENTLEMEN is a piece of trade literature which tells the story of Thomas M. Willcox, a close friend of Benjamin Franklin, who erected a paper mill in 1729. The Ivy Mill was the third to be built in the United States.—*Hurlbutt Paper Company, South Lee, Mass.—Gratis.*



THE UNIVERSAL A.C.-D.C. SUB-MIDGET RECEIVER will operate equally well on any type of power supply. It will work on 105 to 120 volts alternating current, 25 to 60 cycles, on 105 to 120 volts direct current, or it may be used with "A" and "B" batteries where lighting current is not available. It can also be used on 220 volts A.C. or D.C. by means of a Clarostat line reducing ballast. The set uses the newest tubes, including the spray shield 6-E-7 and 6-D-7 tubes, the small envelope 43 output tube and a 25-Z-5 rectifier. A small, but powerful dynamic speaker is employed. Compact Find-All coils are tuned by a new-type Cardwell variable condenser. No transformer is required. Additional diagrams and views, complete list of parts, and other information regarding this receiver may be obtained from *Allied Engineering Institute, Suite 541, 98 Park Place, New York, New York.—10 cents.*

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 232*)

teeth to mesh correctly as the chain comes into contact with the wheels. Self-pitching of the chain to any tooth width or wheel diameter is thus assured. At each engagement of the chain and wheels, the slats are regrouped within their separate containers, but do not slide nor move under working pull. Their movement in engaging with the wheels is complete before the load is applied.

All elements of the P. I. V. gear are built into and protected by a compact oil-tight housing, and are automatically splash lubricated.

New Synthetic Anti-Freeze

AS these words are written the city is sweltering in a September heat-wave and the last thing we're thinking about is what to use in the radiator of the old "bus" this winter. However, chemists of the Standard Oil Company of New Jersey have been thinking for us on that subject, and they've evolved an entirely new anti-freeze compound that promises to give the manufacturers of alcohol and glycerine something to worry about. The new anti-freeze is a mixture of isopropyl and methyl alcohols. The mixture contains approximately 65 percent isopropyl and 35 percent methyl, and it is learned that the production contemplated for the coming season is about 3,000,000 gallons of the new anti-freeze.—*A. E. B.*

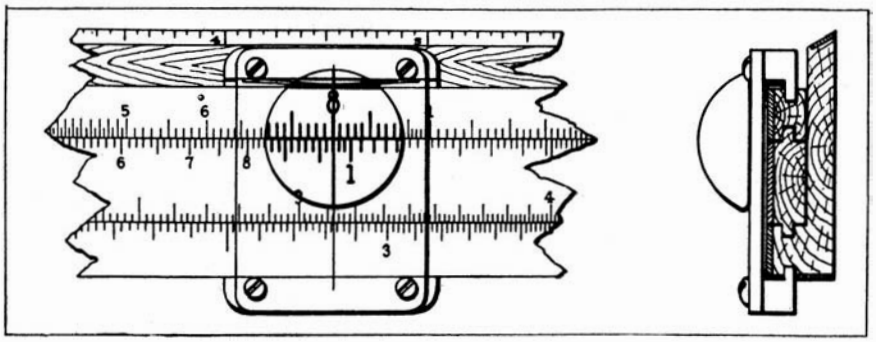
New Fire-Fighting Foam Generator

A CONTINUOUS foam generator embodying new ideas of design and construction has been announced by the Pyrene Manufacturing Company after extensive experimentation and practical testing. The new generator, called the Phomene Hopper, is a device for converting a fire line from a continuous water stream to a continuous foam stream. This unit is coupled into a hose line. Water enters at one side; Phomene powder is poured in the hopper and foam is discharged through the hose line at the other side of the unit. At the same time, pressure at the delivery nozzle is increased by the action of the chemical, a desirable feature in outlying districts where water pressure is often low. The Phomene Hopper is designed for fire department and industrial service wherever quantities of flammable liquids are used or stored.

The Phomene Hopper has no levers, valves, gages or moving parts. It is a complete unit built ready for use. In spite of its rugged construction the unit weighs only 42 pounds and is easily carried in one hand.

Metal-Plated Plaster

PLASTIPLATE is a new and inexpensive medium for use in making objects of art and certain utilitarian articles. Briefly described, it is a special composition of plaster of Paris which is treated so



An eye-saver for slide-rule users is this magnifying lens which is simply moistened and attached to the slide. It enlarges the figures about two diameters

that it may be electroplated with copper in a regular electroplating tank. The copper-plated plaster may then be replated with gold, silver, chromium, nickel, bronze, or any plating compound. The finished product has good appearance, and is sturdy and durable, the metal plating serving as a protective shell to prevent chipping.

The most outstanding feature of Plastiplate is its low cost, while its appearance justifies comparison with mediums of almost prohibitive cost, yet its cost (depending upon the size and intricacy of the object) is anywhere from one half to one tenth the wholesale price of objects cast of antimony-lead or white metal, which are the cheapest mediums now on the market.

Whereas the electroplating of plaster of Paris is not a new idea (patents being granted in this field as far back as 1871) the Plastiplate process is unique from the low cost standpoint due to the accelerated electroplating action. At the present time there are bronze plated plaster of Paris objects on the market which are sold at prices substantially higher than antimony lead and white metal objects. These bronze plated plaster articles require from 36 to 72 hours in the plating bath—a far longer time than is the case with the new process.

Motor Oil Changed in Five Minutes

A TIME saver for motorists and an efficient, economical equipment for garages and gasoline stations has been developed by the Sharpsville Boiler Works Company, Sharpsville, Pa. This new apparatus, called the "Sharpsville Five-Minute Oil Changer," is designed to simplify the routine of changing automobile motor oil. With the oil changer, it is no longer necessary for a garage attendant to crawl under the car, open a petcock, and let gravity drain the crankcase. Electrically-driven pumps suck the oil from the crankcase through the dip-stick hole into a glass tank where the car owner can see for himself the condition of the oil. If it should be changed, the attendant merely throws a switch and the oil changer flushes the crankcase. If the oil is in good condition, a reversible pump forces it back into the engine. The entire procedure does not require more than five minutes.

The apparatus consists of a drum divided into two compartments, one to hold approximately 24 gallons of crankcase drainings and the other to hold about five and one-half gallons of clean flush oil. On top of the drum is mounted a 12-quart glass container, or visualizer, equipped with a graduated gage. A basket-type strainer is located in the suction line so that it is possible for the motorist to inspect the babbitt, grit, and other foreign material drawn from the crankcase.

The operating mechanism consists of an electrically-driven pumping unit controlled by one three-way valve and one switch, making the operation simple and rapid. The electrical equipment used on the oil changer is of General Electric manufacture.

Bread Wrapped in Aluminum

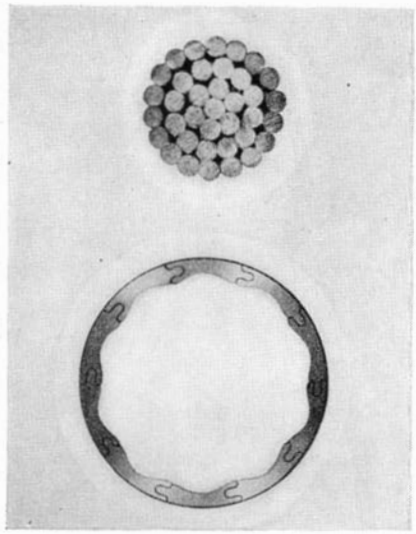
ALUMINUM foil is used in Germany as a wrapping material to preserve the flavor of cut bread, especially pumpernickel and "dark" bread, says K. Seidel in a German technical paper. The quality of this foil is tested by the action of acid solutions on the foil and by correlating these tests with observed effects when the foil is used for packing bread.—*A. E. B.*

Safety in X-Ray Film

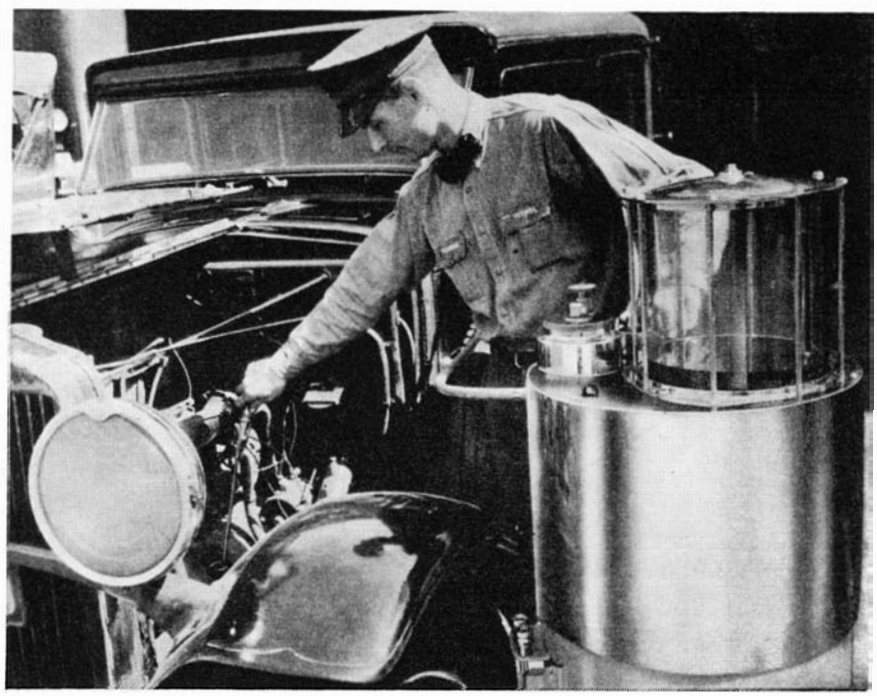
IT will be recalled that a number of disasters have occurred in hospitals as a result of fire caused by burning X-ray film. This hazard, unfortunately, is always present when films made from nitro-cellulose (gun-cotton) are used. Cellulose acetate film on the contrary, is relatively non-inflammable, but its use has been restricted because of its higher cost. The Eastman Kodak Company, by far the largest manufacturer of the film, has recently arranged to provide the safety film to hospitals for X-ray purposes at the same price as nitrocellulose film. Acetate film is considerably more costly to manufacture but the Eastman company has eliminated the price differential as its contribution to safety and the prevention of repetition of hospital disasters.—*A. E. B.*

Hollow Conductors for Transmission Lines

IN the design of conductors for high-tension transmission line service, voltage, current, and corona losses must all be considered. As the voltage increases and the current decreases for the transmission of a certain amount of power, the cable may be reduced in size. But a point is reached where corona losses, due to small size of cable, become too great for economical



New conductor for transmission lines, compared with stranded cable



The five-minute motor oil changer in use

operation. It is well known that a copper tube of the proper size and strength would be almost the ideal conductor for this purpose, but manufacturing limitations and lack of flexibility have ruled the tube out.

Recently, however, a flexible conductor has been introduced by General Cable Corporation that gives all the desirable electrical advantages of the tube and all the mechanical features of the familiar stranded cable. This conductor is made up of individual strip segments interlocked to form a tube, yet capable of sliding lengthwise relative to each other. The tongue of one strip, as shown in the illustration, is engaged in the groove of the next, but cannot come out. This type of construction gives flexibility, simplicity of fabrication, lowest corona losses for a given diameter, high resistance to vibration, mechanical stability, and elimination of the "skin effect" problem in the transmission of alternating current.

Non-Corroding Pipe

EVERLASTING water-mains seem to be an accomplished fact. One of the largest manufacturers of iron pipe has concluded an extensive research program on a corrosion-resistant lining for iron water pipes. As a result there is now on the market a pipe lined with a special cement composition which is said to have three times the durability of ordinary cement mixtures. During the setting of the cement, special curing methods result in a minimum of shrinkage. The pipe used is of the same quality as this company's regular black or galvanized wrought pipe. Lining is accomplished by a centrifugal process combined with a method of curing involving the use of moist air, steam and hot and cold water treatments extending over a period of several days.

This pipe is intended primarily for carrying waters or solutions which rust, corrode, and otherwise attack unprotected metal pipe. The lining is said to be resistant to salt water and many diluted chemical solutions.—*A. E. B.*

Cold to Within Eight Hundredths of Absolute Zero

THE lowest temperature ever produced and measured by man, eighty-five thousandths of a degree on the Absolute scale, has been achieved in the Kamerlingh Onnes laboratory at the University of Leyden, Holland. This is extraordinarily close to the absolute zero point or minus 459.6 degrees on the Fahrenheit scale, at which all atomic motion would cease, electricity would flow without hindrance, and other strange things would happen.

The new greatest cold breaks records of about twenty-five hundredths of a degree which were made at both the University of California and the Leyden laboratory about two months ago.

Prof. W. J. de Haas of Leyden and Prof. H. A. Kramers of Utrecht who made the experiments used the method that is known as the "adiabatic demagnetization of paramagnetic salts." This takes advantage of the fact that when a substance is magnetized, it heats up. Using liquid helium, a substance is cooled as low as possible. Then it is magnetized. It heats up. Liquid

helium is used to remove that heat. Then it is demagnetized taking care to keep it heat insulated. It becomes colder as a result of the demagnetization. Thus a lower temperature than ever before attained has been reached.—*Science Service.*

Unique High Pressure Steam Unit for Yacht

WE have just learned of an order placed for an American account with a German yacht builder, for a 72-foot staysail ketch. While it is not particularly pleasing to know that such a craft is going to be built abroad for an American owner, it is certainly pleasing and unusual to know that her entire machinery plant will be of American design and construction, and will be of the modern high pressure, high temperature, high efficiency type, resulting in unusually low weight and space characteristics.

The yacht and machinery are to be built to the designs and engineering of Jasper Morgan, rising young naval architect of New York, in conjunction with Cox and Stevens. While the ketch is designed particularly for ocean cruising and racing under sail, the complete steam propelling plant is provided instead of the usual gasoline engine propelling unit for obtaining approximately nine knots speed when unable to make headway under sail, and in order to maneuver to and from dock or anchorage.

Designed to develop 60 ship horsepower at 600 revolutions per minute, the triple expansion reciprocating marine engine will operate on steam at 600 pounds gage pressure and total temperature of 800 degrees, Fahrenheit. Steam will be generated in a vertical boiler, in the casing of which will be included the economizer and superheater. Ordinary furnace oil will be burned in a patented burner which does not atomize, but which gasifies, assuring complete freedom from soot, smoke, and noise.

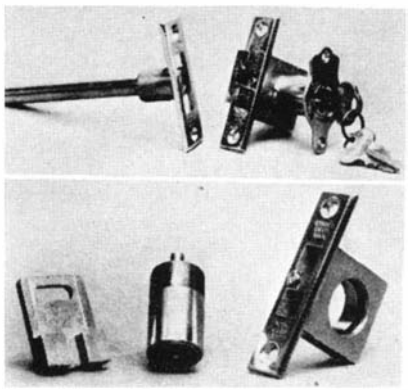
Due to inherent restrictions in this type of hull, the engine will sit directly over the line shaft, driving it through a Morse silent chain drive, having a simple ratio of one to one. The shaft thrust will be located just aft of the driven sprocket. A three-pass surface condenser, manufactured by the Condenser Service and Engineering Corporation, will take the exhaust from the main engine. Electrical power to charge the 32-volt Exide storage battery will be provided by a one kilowatt Westinghouse marine generator, driven at 1750 revolutions per minute by cog belt drive from the end of the engine crank shaft. All necessary auxiliaries are driven from the main engine. The plant is designed so that steam may be raised in 10 minutes by hand pump. Steam once having been raised, the pilot light will keep it up, ready for instant operation at full power.

Control is extremely simple and positive, consisting merely of a throttle and reverse lever to the Stephensen link of the engine, both being mounted near the steering wheel.

The complete plant, including fuel and make up feed water, will weigh about the same as a marine gasoline motor with reduction-reverse gear clutch, fuel and lubricating oil, and will be remarkable for complete freedom from fire hazard, noise, and vibration. It is expected that the fuel

consumption will not exceed 0.7 of a pound of furnace oil per ship horsepower-hour for all purposes, which compares favorably with the consumption to be obtained in Diesels of corresponding power and turbine-driven ships of many times the power.

Beyond question, the performance of this plant will bear watching, since it will give valuable data concerning an old type of drive "brought up-to-date," and which should have real promise as an efficient prime mover, not only for auxiliary drives in sailing yachts, but as the main drive in such craft as small and large cruisers, tug boats, commuter yachts, and possibly to drive generators on passenger, cargo, and naval vessels.



This new motor-car lock for sedans secures both doors with one turn of the key. There are only three essential parts to the lock proper; as the bolt goes through the striking plate, it moves the plunger which locks the second door. Lock was invented by Charles Courtney

The Boundless Realm of Chemistry

"HOW in the world are you supposed to remember all the chemical compounds?" asked a discouraged student recently. The answer is, you can't remember them—in fact, life is too short even to begin to name *all* the chemical compounds. W. H. Dehn, writing in the *Journal of Chemical Education*, figures that, of the R-substituted derivatives of triphenylmethane alone, more than 8,000,000,000,000,000 compounds might be prepared. And if each was described on a page of chemical reports, the books would circle the earth 627 times.

Thus, chemical discovery becomes astronomical in its scope. But, fortunately, such knowledge is useless, and for man's purposes, the working chemist confines his researches to a limited field of practicability, and even a limited field of "pure" theory, in which knowledge can be applied.—*A. E. B.*

Cellophane Bags for Quicklime

ONE of the greatest obstacles to shipping quicklime has been the fact that it absorbs moisture from the air and swells in volume tremendously when kept in storage for short periods.

This has been definitely overcome by means of a moisture-proof Cellophane-lined bag, developed by the Rockland & Rock-

port Lime Corporation of Rockland, Maine. In this new type of bag, lime may be stored for a year or more without absorbing moisture. As a result, the usual hazard of having the lime heat up or swell and break out of its container is eliminated.

Another new development by the same company is a process of water-proofing the lime itself so that once it has been slaked and used as mortar, it absorbs no more moisture.

Thus, water-proof lime bound masonry will retain its strength instead of softening when wet—a former disadvantage in comparison with cement. It is expected that this development will mean a return to the use of age-old lime by architects and engineers as a masonry binder, since cement, though possessing greater strength, is subject to shrinkage and has been found a cause of leaks in many of our modern buildings.

Rubber Tires Superior for Tractors

RUBBER tires on tractors have been shown to be more economical than ordinary steel wheels by Prof. C. W. Smith of the University of Nebraska, who recently reported his findings to the Society of Automotive Engineers.

Savings in fuel and time were evident from the tests conducted by Prof. Smith. Tractors equipped with rubber tires often took a load in high gear that would almost necessitate low gear with the conventional steel wheels and lugs.

Another feature pointed out was the reduction in the tearing up of the soil and the consequent decrease in dust stirred up by the rubber tires. Prof. Smith thought that the rubber tires, in addition to affording traction, act as a spring, first absorbing energy and then feeding it out in an even way that more nearly utilizes the engine's full power than the rigid wheels and lugs will do.—*Science Service.*

NS Fluid—New Medium for Heat Transfer

WATER is so universally used as a medium of heat transfer that it is difficult for the average person to conceive of boilers or heating systems operating without water, or steam, as the circulating medium. However, while water is ideal when relatively low temperatures are required, its use is restricted at elevated temperatures because of the pressure developed by steam.

An ideal heat carrier would be a substance that could be manufactured at reasonable cost and present the highest possible heat capacity. Working temperatures up to possibly 1650 to 1830 degrees, Fahrenheit, should be possible without decomposition. The substance should not corrode the ordinary metals and should be as fluid as water within the widest possible range of temperature so that excessive pressures would not be developed. By this means dangerous stresses in the heating apparatus would be avoided.

A substance closely approaching this ideal has been developed and patented by Ernst Sander, of Berlin, according to *Chemical and Metallurgical Engineering.* Mr. Sander's fluid is composed of the

three components—sodium chloride, aluminum chloride and iron chloride. A determination of physical data with the Bunsen ice calorimeter established the fact that the specific heat is 0.7 and the specific weight from 1.96 to 2.00. The heat-conducting capacity of the solution is so favorable that, for example, in passing water through a heater in which the temperature of the water varied from 64 to 79 degrees, Fahrenheit, no insulating scale of crystals developed which might have hindered the satisfactory transfer of heat.

The heating-cooling curve of the fluid shows that it has a softening range that can be regulated as desired below the determined melting point of 302 degrees, Fahrenheit. This is an important advantage in practical use because of the equalization of pressures within the apparatus. Once liquefied the solution remains in a surprisingly fluid condition, a very favorable situation. Its expansion at medium temperatures is about 10 percent. It can easily be melted in glass tubes without breaking the latter when the solution solidifies, as would be the case with a metal. This is an important factor in heating apparatus.

When used in a closed system, the solution does not decompose, but water will decompose the solution. Exposure to the air is not advisable, therefore, since the liquid absorbs moisture and changes its characteristics. No corrosive action on iron was found to exist.

The new substance is called "NS" fluid by its inventor, who predicts its use in distillation and cracking plants where its apparent advantages are numerous. Other possible applications are in the utilization of waste heat energy, the superheating of steam, in melting, roasting, and similar processes which are carried on in retorts, pipes, muffles, and other equipment in the temperature range from 750 to 1480 degrees, Fahrenheit. In many operations, heated air at absolutely uniform temperature is required. Electric heat assures such constant temperature, but is usually rather expensive. "NS" fluid gives the same assurance, since comparatively large quantities of fluid are placed as a buffer between the heat-taking and the heat-giving elements. In such cases it is entirely possible to use ordinary fuels for firing or, through the heat storage possibilities of the substance, off-peak electric power. A very wide field for "NS" fluid is possible in connection with household appliances, such as, for example, hot water heaters, kitchen stoves, room heaters, and so on.—*A. E. B.*

Aluminum Foil Heat Saver

ALUMINUM foil will ward off heat or cold, and shield foods and other perishables from temperature changes, research reported in *Industrial and Engineering Chemistry* discloses.

Because of its lightness, wide application for the foil in the transportation field is predicted by Ralph B. Mason, research chemist of the Aluminum Company of America, who conducted the experimentation. By careful design, Mr. Mason declares, the efficiency of the aluminum foil type of insulation can be made to approach the conductance of still air, the goal for which all insulation manufacturers strive.

"The aluminum foil air-cell insulation,"

he says, "is light in weight and this property makes it particularly useful in the transportation field, where there is today a great desire to decrease the dead load and increase the pay load."

Insulation which gives the highest resistance to the flow of heat has a spacing of one quarter of an inch between sheets of aluminum foil, Mr. Mason's researches disclose. He finds that aluminum foil insulations with corrugated separators between the sheets are slightly inferior to the plain air-cell type. A third variety—aluminum foil crumpled by hand—is somewhat less efficient than the corrugated structures.

"The aluminum foil is fireproof," Mr. Mason declares, "and may be used up to temperatures somewhat under the melting point of the metal. It is in this higher temperature range that an efficient heat insulator is greatly needed.

"The possible capillary absorption of water, so injurious to the efficiency of other insulations, is absent in the aluminum foil air-cell insulation, except as the material used to separate the aluminum foil may be absorptive."

Research Underlies Road Building Program

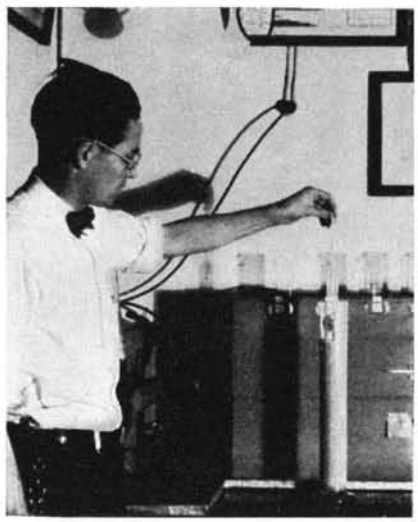
WITH 400,000,000 dollars about to be expended upon the nation's roads as a major feature of the public works program, the activities of the United States Bureau of Public Roads are likely to achieve a new significance to the public.

Drainage indicator, used in road building research, shows rise of water in soil sample under pressure

In the eyes of the average person there are just two major kinds of roads—good and bad. Knowledge of what makes a road good or bad is limited almost entirely to highway engineers, and is derived in large part from the laboratory and field research which the Bureau of Public Roads has conducted. Its studies have covered characteristics of the ground beneath the surface, as well as the problems of highway surfacing, with a view to the use of chemical and physical admixtures for surface treatment and to stabilize the sub-surface soils.

The performance of all types of roads depends upon cohesion of the soil (which in turn depends upon the surface moisture present) and upon four other basic, physical

soil characteristics: internal friction, compressibility, elasticity, and capillarity, or the extent to which moisture from the ground water is drawn up through them. Paved roads tend to obscure the fact, but even in the case of concrete roads it is the soil beneath the pavement rather than the pavement itself that carries the load. The physical characteristics which are of such primary importance are furnished by the



Determining proportions of sand, silt, clay, and so on, in a soil sample, by taking hydrometer readings

soil constituents and the investigation of these constituents, together with their performance in various combinations has provided the program for the Bureau's subsurface research.

Samples of soils from all parts of the United States are sent in to the Bureau testing laboratory at Arlington, Virginia, just across the Potomac from Washington. The findings which the laboratory technicians obtain from the tests frequently depend upon abstruse mathematical formulae unintelligible to the layman, but the tests themselves are not highly complicated, although they involve the greatest precision and care.

These tests, developed in the laboratory of the Bureau of Public Roads, have designedly been made general enough in nature and broad enough in scope to serve as a basis for the activities of State Highway Departments and highway engineers in determining the properties of soils differing radically in character and existing under the radically different climatic conditions encountered in the United States. They also contribute materially to the education of student highway engineers through providing engineering schools with the same basis for their educational activities.

The knowledge made available by such tests enables the highway engineer to know in advance how the soils which he must work with will react under varying conditions of moisture, pressure, and climatic changes. If the soils are deficient in certain qualities, the tests indicate what materials should be added, and in what proportions. Although soils differ widely, and are subject to wide changes under varying conditions, the tests tend to give the highway engineer the same degree of exact knowledge about the materials he must work with, as is possessed by the engineer who works with steel and stone.

Books SELECTED BY THE EDITORS

THE HERSCHEL CHRONICLE

Edited by Constance A. Lubbock

THIS is the life story of William Herschel, the great astronomer, and his sister Caroline Herschel, edited by the former's granddaughter. Herschel was a German musician who emigrated to England and suddenly, at the age of 35, became deeply fascinated by amateur astronomy. He determined to own a telescope and tried a refractor but, discovering its drawbacks, became an amateur telescope maker and made a reflector. The rest of his romantic career followed according to ideal pattern, ending in old age with the highest attainments and honors, including the discovery of Uranus, and the origination of the island universe theory.

Herschel made no end of telescopes, small and large. How like 1933 reads the following, dated 1775, from this book: "Every leisure moment was eagerly snatched at for resuming some work which was in progress, without taking time for changing dress, and many a lace ruffle (which were then worn) was torn or bespattered by molten pitch, etc." It was Herschel's sister, boon companion in all his telescope making adventures, who wrote this. She continues, speaking of his mirror polishing: "By way of keeping him alive I was even obliged to feed him by putting the victuals by bits into his mouth: this was once the case when at the finishing of a 7-foot mirror (note: 7 ft.f.l.) he had not left his hands from it for 16 hours together." His eager enthusiasm met no rebuke at home: "I saw every room turned into a workshop," his indulgent sister and housekeeper wrote. "A cabinet maker making a tube and stands of all descriptions in a handsomely furnished drawing room, Alex putting up a huge turning machine in a bedroom, for turning patterns, grinding lenses, and turning eyepieces." She, too, made mirrors. She also read to Herschel while he polished his mirrors. Before 1795 Herschel had made more than 200 6.4-inch mirrors, his price being 200 guineas each (about 1000 dollars—and he got it!), 150 mirrors of 8.8-inch diameter, and 80 of 18.7-inch diameter (3000 guineas!).

The book is a minutely detailed account of his notable life, with many letters and anecdotes, and has 383 text pages. Most of it is about astronomy rather than telescope making.—$6.20 postpaid—*A. G. I.*

GREAT MEN OF SCIENCE

By Philipp Lenard, Prof. Phys., Heidelberg

THIS book contains accounts of the lives and the influence on the development of science of about 40 leading scientists of the past. It will interest those who are interested in the history of science. Though the translation from the German is good, the style is still Teutonic—not exactly sparkling. 382 text pages.—$3.15 postpaid.—*A. G. I.*

THE LOGIC OF SCIENCE

By William G. Ballantine

IF you have the itch to organize—plow, harrow, roll, cultipack, and reseed—your thinking processes as they apply to clear thinking in connection with scientific theory, here is a book which will give them heroic treatment. It concerns such things as facts, observation, primary inductions, secondary inductions, causation, hypotheses, inductive arguments, fallacies, proof, and so on. This book of 225 pages is not light reading but it will be good for you, if you have enough persistence to stick to it.—$2.15 postpaid.—*A. G. I.*

THE UNIVERSE AND LIFE

By H. S. Jennings, Prof. Zoology, Johns Hopkins

THIS 94-page book contains three lectures on religion in the light of science and philosophy. The author, one of America's foremost men of science and the writer of "The Biological Basis of Human Nature," a widely read book, is one of a group who link religion rather closely with science. He is against the mechanistic interpretation of the universe.—$1.65 postpaid.—*A. G. I.*

MANCHOUKUO, CHILD OF CONFLICT

By K. K. Kawakami, Washington Correspondent of The Tokyo Hochi Shimbun

SINCE the publication of "Japan Speaks", the author, who had obtained much of his data for that volume second hand, as it were, has visited Japan, China, and Manchoukuo. As an inevitable result, he speaks with greater assurance and authority in "Manchoukuo, Child of Conflict" and has incorporated in this latest book facts and observations obtained first hand, approaching the same problem from the viewpoint of human rather than historical factors. The book should be read by all citizens who wish to understand the present status in the Far East, and particularly by those who wish to understand the Japanese people, their viewpoint and problems, as they may bear upon future relations with this country.—$2.15 postpaid.

AIR CONDITIONING

By J. A. Moyer and R. U. Fittz

HERE for the first time in one volume is a complete treatise. The first half of the book covers theoretical fundamentals and discusses such phases of air conditioning as air filtration, refrigeration, humidity control, and so on. The second half gives a thorough study of design requirements, including such features as examples of typical air conditioning designs with the necessary calculations for theaters, restaurants, food factories, textile mills, and so forth, also giving attention to recent advances in household, office building, railroad train, and theater applications.—$4.20 postpaid.

ALTERNATING CURRENT CIRCUITS

By M. P. Weinbach, Prof. Elect. Engr., Univ. Missouri

"THAT circuit theory has the broadest general application in all fields of electrical engineering has long been conceded. That greater emphasis should be laid on the generality of the subject has been realized only recently by practicing engineers and by teachers of electrical engineering. This book has been written with this definite aim in view. It presents a rational treatment of circuit theory."—Author's preface. The book fits the requirements of college senior engineering.—$4.70 postpaid.

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY
Member of the New York Bar

Radio Tube Patents Granted

PATENTS No. 1909051 to Freeman and Wade, engineers of the Westinghouse Electric and Manufacturing Company, relating to the indirectly-heated cathode A. C. tube and No. 1911024 to Kimmel and Sutherlin, of the same company, relating to the directly-heated cathode A. C. tube, were recently issued. The Radio Corporation of America is now manufacturing these tubes under a license from Westinghouse.

It was the development of these two types of A. C. tubes by the Westinghouse research laboratories which made possible the change from battery operated to alternating current receivers, in the fall of 1927.

Eye "Institute" Curbed

THE Federal Trade Commission has ordered Natural Eyesight Institute, Inc., Los Angeles, to cease representing that as a result of the purchase and use of its "system" it will no longer be necessary for a customer to wear glasses.

The company is also not to assert that there is nothing which glasses can do that the eyes cannot be taught to do better, or that most people can get rid of glasses in 90 days or any other period.

The Commission found that in a substantial majority of cases where patients have used glasses to correct defects of vision, it is not possible through such "natural" methods as promoted by the respondent to remove these defects or so far alleviate them as to make it possible successfully to remove glasses.

The Commission issued its order with the qualification that, inasmuch as the question whether relief from far-sightedness, near-sightedness, astigmatism, cross-eyed conditions, or defects of vision due to advancing age, is obtainable in certain instances through the purchase and use of the respondent's "system," is a matter of opinion, nothing in the Commission's order shall prevent the respondent from representing that in certain instances relief has been obtained from such defects through use of its "system."

Suggestive Trademark Registered

IN *ex parte* The Atlantic Refining Company, First Assistant Commissioner Kinnan held that the company, of Philadelphia, Pennsylvania, is entitled to register, under the Act of 1905, the notation "Safety-Kleen" is a trademark for liquid dry cleaner.

In his decision, after stating that while the mark is highly suggestive, it is not merely descriptive and noting that registrations had been granted of fairly similar notations, the First Assistant Commissioner said:

"It appears further the applicant is the owner of registration No. 233413 issued Sept. 27, 1927 of the mark 'Safti-Klen' used upon a liquid cleaner. It is evident the applicant is seeking registration of a variant of this registered mark which it already owns. It is thought registration should not be denied in the instant case since the mark here sought to be registered is no more descriptive than that involved in some of these other registrations as, for example, 'The Super-Kleen.'"

British Patent Law

IN a recent bulletin, the Department of Commerce called attention to changes in British patent law under the new Patents and Designs Acts. One point, quoted below from the bulletin, is of particular interest:

"The Patent Office search should be of greater value than hitherto, for although the Act does not specifically direct the Comptroller to extend his search, yet it empowers him to cite documents other than British Patent Specifications, and it would, therefore, appear to be possible for interested parties, instead of going to the expense of lodging an opposition, to direct his attention to relevant documents."

Obesity "Cure" Advertising Restrained

THE Federal Trade Commission has ordered E. Griffiths Hughes, Inc., Rochester, New York, dealer in proprietary preparations, to stop representing that its "Kruschen Salts" constitutes a cure or remedy for obesity or that it will of itself reduce excess fat. "It's the little daily dose that does it," according to one of the advertisements of "Kruschen Salts."

"Kruschen Salts" is a saline laxative, containing magnesium sulphate, sodium sulphate, potassium sulphate, sodium chloride, citric acid, and potassium chloride.

Five physicians and one pharmacologist testified on behalf of the Commission to the general effect that a preparation of the constituents as listed above, and taken in the dosage recommended, does not constitute a treatment for obesity and will not of itself reduce excess fat.

Five other physicians testified on behalf of the company to the effect that they gave Kruschen Salts to various patients, who, after a time, showed losses in weight. However, the Commission found that these tests were not scientifically conducted and "were not of such a character as to warrant the conclusion or to be the basis of an opinion that the taking of the Kruschen Salts effected any reduction in weight that might have ensued in such cases."

The Commission found that "the representation that Kruschen Salts is a treatment for obesity and that it will reduce excess fat, taken in connection with the fact that Kruschen Salts is a saline laxative and is designated as such by respondent and is advertised as having the therapeutic functions of saline laxatives in general, gives it such an additional sales appeal as not only to increase its sale at the expense of others but also has the tendency and capacity eventually to drive other saline laxatives from the market that are not so represented and thus unduly to restrain trade in the general commodity of which Kruschen Salts is a type."

Radio Patents Put in Interference

PATENT applications involving a "transformerless radio receiver operable interchangeably on alternating or direct current" have been declared in interference in an action started recently by the United States Patent Office.

The applications involved in the action are those attributed to H. G. Cisin of New York, serial No. 592,586 and to Theodore Wuerfel, serial No. 638,549. According to notations on the papers covering the interference action, Mr. Cisin filed his application on February 12th, 1932, while the Wuerfel application bears a filing date of October 19, 1932.

The interchangeable A.C.-D.C. feature embodied in these patents is an essential part of the tiny midget receivers which have been introduced during the last year and which have had wide sale.

Trademarks in Different Fields

IT was recently held by First Assistant Commissioner Kinnan that Central City Chemical Company, of Chicago, Illinois, is entitled to register, as a trademark for an insecticide, the notation "Lix", notwithstanding the prior adoption, use and registration by Vick Chemical Company, of Greensboro, North Carolina and Philadelphia, Pennsylvania, of the notation "Vicks" as a trademark for medicated salve, nose and throat drops, et cetera.

In his decision the First Assistant Commissioner said:

"It is, of course, settled law that if the goods of the parties possess different descriptive properties the marks may be the same. . . .

"There is no showing that opposer ever intended or represented to purchasers that its goods were or could be used as insecticides. The opposer's goods, intended as they are for use by direct external application to the body of human beings or, as to the liver pills, internal use, are not deemed to belong to the same class as this term can be reasonably or is authoritatively defined to which the applicant's goods belong. The respective goods are wholly dissimilar in appearance, in purpose, function, operation, and would seem necessarily therefore to possess different descriptive properties to such an extent that confusion would be almost impossible."

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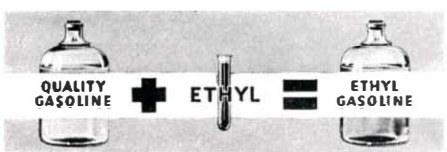

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