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FEBRUARY · 1941

SHIPS FOR DEFENSE

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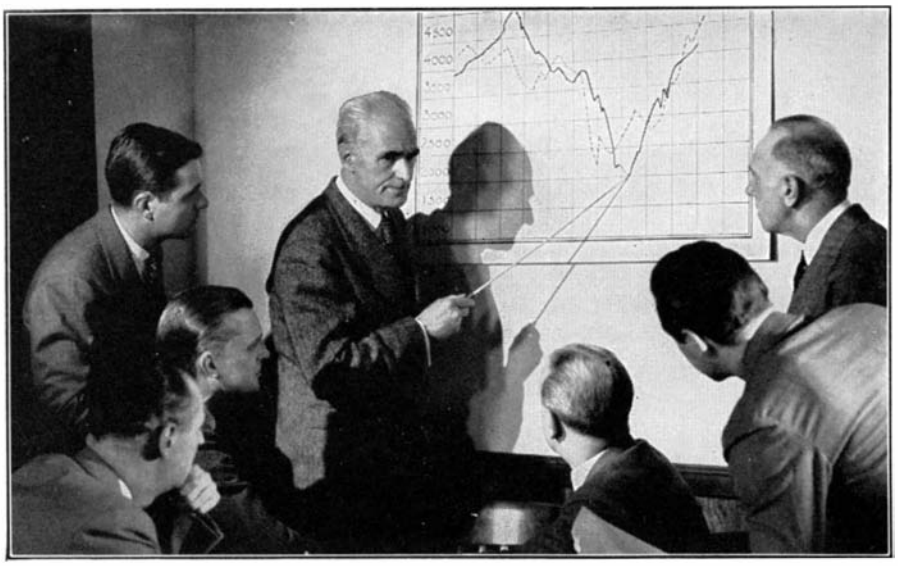

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IF you merely admire and envy the executive ability of leaders in business, finance, and industry, you will never be endowed with their capacity, or be able to duplicate their success.

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Please mail me, free, a copy of "Forging Ahead in Business."

Modern Business

Name.....

Business Address.....

Position.....

NEARLY 50 merchant vessels were put into service during 1939 and 1940, comprising the nucleus of the new U. S. Merchant Fleet. Built to recapture the "cream" of international trade, this new fleet will be composed of vessels that are efficient, economical, and safe. The story of this work, and its significance to our national defense, is told on page 86.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

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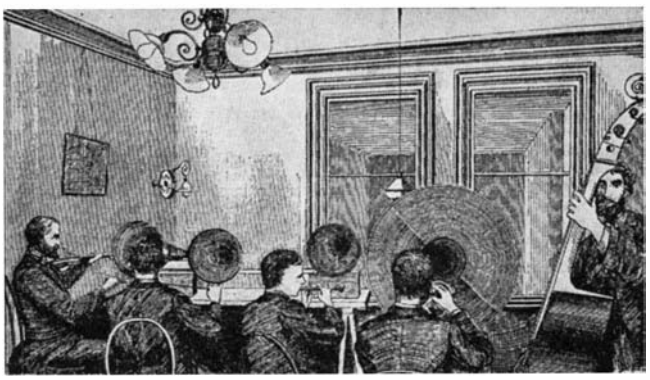
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of February, 1891)

WIRED MUSIC—"One of the interesting developments of telephone work is that which is now steadily going on —the transmission of orchestral music over long distances. . . . This work has been carried on by the American Telephone and Telegraph Company, known as the 'Long Distance Company.'. . . In a lecture recently delivered in the Town Hall at Newton, Mass., Mr. Pickernell described the methods employed in the transmission of music by tele-



phone. His remarks were very forcibly illustrated by the reception in the lecture hall of music transmitted over the long distance lines from the telephone building, at No. 18 Cortlandt Street, New York, and our engraving, made from a photograph taken at the time, shows the arrangement of the performers. . . By using separate transmitters for each instrument, due prominence may be given to each of the instruments at the receiving end. . . At the receiving station, when it is desired to fill halls of considerable size, as many as six loud-speaking receivers are used."

CHIMNEYS—"There is no doubt but the form of a roof has much to do with the draught of a chimney. The flat roof offers no resistance to the passage of air, but as the pitch is increased, the current is more and more disturbed, until with a high-pitched and many-gabled roof it is broken into innumerable eddies, some of which are sure to curl down and force the smoke and gases in the flue into the rooms below. Chimneys on such roofs should be built higher than ordinarily."

FALL RIVER LINE—"The *Puritan* is the most successful achievement of the Fall River Line and is the largest and finest vessel of the fleet. . . Her total displacement, ready for a trip, is 4,150 tons, and her gross tonnage is 4,650 tons. The Puritan is fireproof and unsinkable. She has a double hull, is divided into 59 water-tight compartments, 52 between the hulls and 7 athwartship bulkheads. . . Her wheels are of steel, and are 35 feet in diameter outside the buckets."

RAILROAD TIES—"The annual consumption of railroad ties is placed at 73,000,000, which requires 365,000,000 cu. ft. of raw material. The destructive effects upon forests of the present demand for tie timber is shown by the fact that this material is now largely cut from trees that will make only one tie, or, at least, only one tie from a cut."

FINGERPRINTS—"At a recent meeting of the Anthropological Institute, Mr. Francis Galton, F.R.S., exhibited a large number of impressions of the bulbs of the thumb and fingers of human hands, showing the curves of the capillary ridges on the skin. These impressions are an unfailing mark of the identity of a person, since they do not vary from youth to age, and are different in different individuals."

TRANS-SIBERIA—"The great Siberian railway, which will more closely connect Europe with the teeming millions of China, Japan, and Eastern Asia, will be commenced this spring. The total length of the line will be 4,810 miles, and the cost about thirty-two millions sterling. . . . It will not only help to open out the immense resources of southern Siberia, but will enable Russia to compete more successfully for the Japanese and Chinese carrying and import trade."

TIN PLATE—"The manufacture of tin plate has been commenced in this country, and has come to stay. . . The consumption of tin in this country is enormous, and it will require many gigantic establishments to supply the demand. The world's production of tin plate is 562,000 tons per annum, of which the United States require 369,000 tons nearly all of which at present comes from England."

SHIPPING—"It seems certain now that the winter will be a dull one in the shipping trade. . . The only vessels that seem to be doing any good at all are the newest and largest class of steamers supplied with the latest improvements of triple expansion engines. These are enabled to take large cargoes and make quick voyages as a rule, and, as they are said to save about 15 percent in the cost of fuel, there is no wonder that they can be kept working while others are altogether unemployed."

ROPE—"The wire rope made by the Washburn Iron Manufacturing Company, Worcester, Mass., in 1890, for the Denver Tramway Company, Denver, Col., is six miles long, and is made of crucible steel wire."

MILITARY SMOKE—"Smokeless powder and the results of its use in the battles of the future are being much discussed by military men. An enemy not concealed behind works will, there is reason to believe, be under considerable disadvantage with no smoke to cover him. . . With the advance of cavalry not covered by the smoke of infantry fire till at least near to striking distance, the quick-fire gun is likely to do some terrible work, if not to make such cavalry advances altogether impracticable. Troops operating in the smoke of their own guns can often see across a field to the enemy while he cannot see them."

GERIATRICS—"Old age has its special dangers and its special safety with regard to disease. For instance, whereas in a child the temperature goes up on the slightest provocation, in old age it can hardly be moved at all. The aged body is not, as a rule, prone to any acute disease. If a person passes eighty, it is rare for him to be seized with any special malady. . . There is, on the other hand, a tendency in old age for slight diseases to become chronic."

Your Voice Is You...

Do you realize the value of a smile when telephoning? It helps a lot. Of course, the other person can't see you but the smile is there just the same. It's in your voice. And it reflects a friendly, cordial personality.

In times like these, "The Voice with a Smile" is especially important and worth while. It is a characteristic of the American people. And one of the fine traditions of the Bell telephone business.

BELL TELEPHONE SYSTEM

THE BELL SYSTEM IS DOING ITS PART IN THE COUNTRY'S PROGRAM OF NATIONAL DEFENSE

OUR Point OF VIEW

BRITAIN, OUR LABORATORY

"MOST people don't seem to realize how much we are getting from the war in the form of secret and technical information that will aid us in our own armament effort." So said an American general recently upon his arrival home from an observational trip to England.

Passing over the obvious fact that we are saving our own skins by aiding Britain, let us emphasize here the general's remarks: We are learning much and saving ourselves millions in money. Consider airplanes, for example. Were it not for Britain's use of our military planes—pretty much under our observation, of course—these machines, in simple Army maneuvers, would get no such grueling try-outs. Under strenuous war test, their failings are discovered in short order, so that we may take steps to remedy the deficiencies. Take guns, for example. Without the war, we might continue making large numbers of 3-inch or 4-inch anti-aircraft guns. The one would not have the range needed; the other too much, and at too high a cost. Consequently, we have adopted and are making an in-between gun, the 90 millimeter.

Our observers are learning about war-efficiency of industrial plants. When a plant can continue to make its product in spite of raining bombs, certainly it can teach production tricks to industries in peaceful countries. Close contact with friendly belligerents are showing us how to eliminate wasteful and time-consuming operations and methods all along the line. Vastly important is the problem of keeping a steady flow of supplies of all kinds moving to beleaguered points. The experience of the British is aiding us to organize our transportation systems accordingly. Fire-fighting under war-time hazards teaches us short cuts to greater efficiency; our hospitalization methods, city traffic control, water supplies, an uninterrupted source of gas and electricity—all these are benefitting by observation.

Increased efficiency of production methods, short-cuts, and solutions to old problems are important, but so is the economic phase of the question. Looming importantly over all is the amount we are saving by the speeding up of our own national defense program —which is costing us enough billions already.— *F. D. M.*

ALONG CAME PHYSICS

IN THIS column 25 months ago the belief was expressed that, until a really hard and actual physical working principle underlying the long-mysterious art of dowsing, divining, or water witching by means of forked boughs was discovered and identified, so that physical laboratory instruments could be substituted for the vague uncertainties of the human factor, any investigation of that art must necessarily remain premature. We did not deny that dowsers locate water —we believed, and still believe, they often do—but we wanted the physicists to take over the problem, take some of the occult-mystic-obscurantist hocus-pocus out of it and work it out as an ordinary problem in physical research, leaving the mystics and occultists high, dry and lonesome.

Exactly this now has been accomplished, with a degree of apparent success, by two Englishmen, the biophysicist J. Cecil Maby, B.Sc., Associate of the Royal College of Science, and T. Bedford Franklin, M.A., Fellow of the Royal Society of Edinburgh. Their report takes the form of a generous book, "The Physics of the Divining Rod," having typical earmarks of a technical, laboratory finding in conventional physics.

The investigation proved to be arduous and complex and the report is by no means sketchy. Boiled down to a painful degree, its many conclusions come approximately to this: Every material object and, especially, good conductors in the midst of relatively insulating media, is surrounded by secondary radiation from cosmic rays. The zones of this radiation from these objects can be definitely mapped out in space by means of several physical recording instruments of conventional type, including ionization counters; and, thus mapped out, they check with those mapped out by the ancient method of divining. The working basis of dowsing is the nerves and muscles of the operator, which act as natural ionization counters of electron showers caused by the cosmic rays. One person in ten can learn the art. Both authors learned it.

There is vastly more to the report than can even be summarized here. One ramification of the research puts a possible scientific leg under the famous "Electronic Reactions of Abrams," investigated and pronounced against by this magazine in 1924. This, however, is far from saying that the numerous Abrams proponents were scientific in their methodology, or even that a majority of them weren't exploiting the various "sucker machines" based on the Abrams claims for pelf. Hence we are not upset by the new findings. In fact, at the time the Abrams investigation was made, it was stated here orally that if there actually were any real physical basis to the Abrams reactions, it would not be worked out by the type of "scientist" who mainly was making the most of it (and, we believe, in some measure still is) but by the physicists. The authors lend no real comfort to the followers of Abrams—unless their statement that Abrams' methods are obscure on the technical side, savor of puerility and charlatanism, and are repellent to scientific men, can be called comfort! If Abrams ever "had something there," he and his followers effectively blacked its eye for a long time to come.

It is particularly pleasing, however, to note that our early suspicion that dowsing was not a fake, but has a true physical basis, is apparently verified. The new report will not altogether please those few scientists who all along have pooh-poohed dowsing in toto (without looking into it). Those whom it really will most displease are the occult-minded, for it substitutes the ordinary for the nebulous, the known and commonplace for the mysterious which, to that type of mental makeup, is always the more attractive.—*A. G. I.*

Personalities in Industry

C. V. WHITNEY

It was 1917. The United States had just declared war and a 17-year-old boy named Cornelius Vanderbilt Whitney was in Texas ready to be taught flying by members of the Royal Flying Corps. He had enlisted in the then microscopic United States Air Force after receiving special permission from his parents. Shortly after his arrival at the field young Whitney was introduced to his instructor. He was given an hour and forty minutes flying instruction before lunch. Intensely excited by his new adventure, the boy talked about flying throughout the meal. Immediately after lunch Whitney climbed into a training ship of the "crate" type, so widely used in those days, and set a possible new record for brief instruction by soloing.

He rose quickly from one of the army's youngest air cadets to become an instructor himself—in advanced acrobatic and combat flying at Carruthers Field, Texas, a tough and dangerous job in those days of embryonic aircraft building. Through the years after the war, Whitney showed that same streak for picking tough jobs, persevering through many trials, and finally attaining success.

Despite a background of wealth and social standing, young Whitney had an irrepressible knack for finding his own way, usually with his coat off and shirtsleeves rolled to his elbows. After finishing at Yale, he went to work in the mines at Comstock, Nevada, and for many months dug ore in the lowest levels as a sampler. He rose to assistant mine foreman and then resigned to work in mining camps in other western states. Later he joined one of his father's ventures, the Metal Exploration Company, as assistant to Roscoe H. Channing, Jr., internationally known mining engineer.

Together, Channing and Whitney managed to salvage a little more than a million dollars from a series of mining ventures the elder Whitney had written off his books as a dead loss. The two men set up a small experimental laboratory in Denver in an effort to solve the problem of obtaining commercial quantities of metal from low-grade ores taken from a tremendous copper deposit in northwestern Manitoba—a deposit which other mining companies had been forced to abandon after sinking hundreds of thousands of dollars in the property. It took more than a year of experimentation before a flotation process could be perfected which would insure profitable reduction of the ore.

Within a week he had obtained an option on the ore deposit. He then hurried to New York and showed the option to his father.

The elder Whitney agreed to permit his son and Channing to go ahead. Both men went up to the mine—an arduous journey that required a 100-mile trip by canoe and a trek of another 70 miles along rough trails carrying packs—and set up a pilot plant. Today the Flin Flon Mine, with C. V. Whitney as chairman of the board, is the second largest zinc producer in Canada, the third largest producer of copper, and also mines millions of dollars worth of gold, silver and other metals as by-products every year. Moreover, the town of Flin Flon, built through Whitney enterprise in the heart of the Manitoba wilderness in the early 1930's, now houses 5000 people, while the mine provides jobs for more than 2000 workers.

Whitney carried the same kind of vision and ability into Pan American Airways, which he helped found in 1927 with Juan Trippe, John Hambleton, Grover Loening, Sherman Fairchild, and W. H. Vanderbilt. By sheer gall and persistence this group, led by men like Whitney, built Pan American from a 90-mile line (Key West to Havana) to its present position as the greatest airline in the world, touching 55 countries.

Two other successful ventures backed to the hilt by Whitney's hard cash and intense personal interest are the Beryllium Corporation of Pennsylvania and the Marine Studios at Marineland, Florida, site of two huge oceanariums housing more than 50,000 deep sea specimens.

20 YEARS OF BROADCASTING

IN 1920, radio station KDKA inaugurated broadcasting, using a small antenna and 100 watts of power. Today, 50,000 watts are used; the antenna is 718 feet high. This Westinghouse photograph shows linemen connecting the radio-frequency transmission line, with the antenna in the background. 1940, 20th anniversary of broadcasting, also saw rapid growth of frequency modulation, new broadcasting system that may in time completely replace present-day conventional methods. Details of this new system will be found on page 96 of the present issue.

97TH YEAR SCIENTIFIC AMERICAN FEBRUARY 1941

TIME TO THE SECOND

Modern Tempo of Living Requires Close Timing

MORTIMER H. COBB

MOVEMENT of world events, measured by split-second-timed radio bulletins describing the precision of modern armies, has brought home to a lethargic public that 12:03 P.M. is not "about 5 after 12."

Correct time used to be a luxury; it was hard to get unless one happened to be in a telegraph office when observatory signals were coming over the wire. Today, such exact hours as 11:52¼ have become everyday commodities since the local Bell Telephone Companies in a number of large cities have established accurate Time Bureaus.

A list of persons who require time to the second no longer confines itself to amateur and professional astronomers, railroad men, marine navigators, jewelers, and watchmakers. An up-to-the-minute roll call would also include 360 mile-per-hour airplane pilots to whom an error of 10 seconds would mean a land distance miscalculation of one mile. Radio control men whose daily broadcast schedules may require fitting three foreign programs into one 15-minute period must have time-keepers, even though thousands of miles apart, that agree to a fraction of a second. And so must the interested radio audience. Time study engineers with chronographs (stop watches) reading in tenths of seconds work out the methods of speeding up mass production of textiles or tanks.

To these to-the-second workers must be added the sportsmen: amateur photographers, race track bookmakers, dog field trial judges, the myriad of week-end racing yachtsmen, track coaches, pigeon racing enthusiasts, football, basketball, and hockey referees, and many others. Then there will always be the timepiece collectors and cranks who carry incredibly accurate $1000 pocket watches.

The history of time indicators dates back to about 2000 B.C. To the average man, however, only the year 1600 is important, for it was about that time that the history of modern pocket watches began as a result of German Peter Henlein's invention of the mainspring in 1500.

Courtesy Patek, Philippe & Co., Inc.

The day of the week, date, month—phases of the moon—an alarm—stopwatch—*plus*—in this complicated Swiss watch

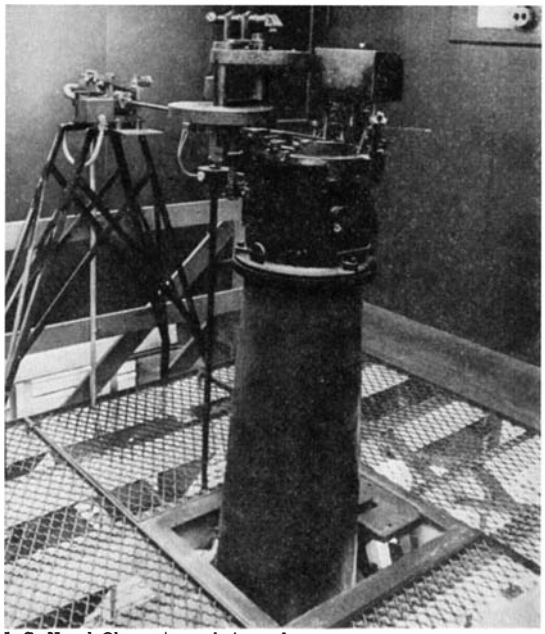
To understand what time it is on an earth where man makes *his own* time requires definitions of time itself and the various kinds of time he uses. Time is well defined as *measured duration* and the accuracy of that measurement concerns everyone.

There are four kinds of time: Sidereal, true or apparent solar, local mean solar, and standard. Only standard time, as computed by formula from sidereal, is used by the public's clocks and watches. Sidereal time is obtained officially from the stars by astronomers at the United States Naval Observatory in Arlington, Virginia. This star-time is the most precise that man can get and is accurate at its source to within a few thousandths of a second.

True or apparent solar (sun) time was all right for ancient sundials, but with days varying in length at different seasons of the year, only a very complicated clock or watch could keep that kind of time. Local mean solar time would also be impractical for the busy world of today. It would vary for different towns and cities unless they lay in exactly the same longitude; local mean solar time in towns 15 miles apart in the latitude of New York differs by about one minute! Furthermore, scientists with modern instruments can get sun time, by observation, correct only to within 1/10 of a second.

STANDARD time, adopted by nearly all countries of the world between 1890 and 1895, has as its base Greenwich, England, which lies at $0^h\ 0^m\ 0^s$ Longitude. Mean time anywhere in the world is calculated as so many hours faster or slower than Greenwich, though for convenience the world is divided into 50 time zones. According to standard time, New York City and Flagstaff, Arizona, are exactly two hours apart. Flagstaff mean solar time is actually $2^h\ 30^m\ 54^s$ earlier than New York and $7^h\ 26^m\ 45^s$ earlier than Greenwich, England.

Several times a week, weather and atmospheric conditions permitting, United States Naval Observatory astronomers obtain sidereal time by using a photo-



U. S. Naval Observatory photograph

The zenith tube through which stars directly overhead are photographed to check time

graphic zenith tube or telescope. This instrument, that recently has replaced the old stand-by transit or Meridian Circle, is rigidly fixed in a vertical position and cannot photograph any star except those passing very close to the zenith. After making these photographic observations, the procedure is to note the error of the three British Shortt precision clocks that are located in an underground time vault, the temperature and air pressure of which are controlled. These extraordinary timekeepers are never reset or disturbed and maintain an average variation of $0^s.005$ daily. Thus the finest timepieces in the world today are more than 1,450,000 times as precise as those of only a few centuries ago.

Sidereal time is next changed to Eastern Standard Time and the master distributing clock corrected to within a few hundredths of a second. At noon, and other hours when Naval Observatory signals go out over the country by telegraph and wireless, they are correct to within tenths of a second. It should be obvious that the more time is "handled," the less precise it becomes.

FOR American household clocks and watches that make it easy, difficult, or impossible to catch early morning commuters' trains, the best and most convenient source of correct time is a telephone. In cities where local companies have Time Bureaus, the buzz following the oral announcement is correct to within 1/20 second. In New York City alone, 55,000 time-conscious people use this service daily. In rural sections, the oral response of an operator would be accurate enough for catching a train or ringing a curfew, but not for testing stop watches or rating chronometers or fine watches.

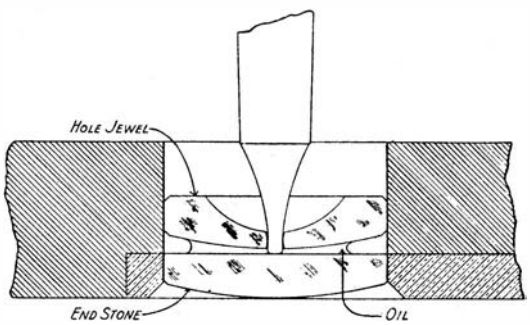
The prototype of really time-conscious radio stations are those with hourly signals (buzz) that originate in the United States Naval Observatory. These are carried by telegraph and transmitted superimposed on the broadcast circuit. Such signals have an average error of less than 1/25 second. This method might well be adopted by radio stations having oral announcements—or bells, chimes, gongs—that frequently vary as much as 15 seconds one way or the other. The worst error on record: a broadcasting company's announcement more than seven minutes late.

The public also has a time service in the electric clocks of the Self-Winding Clock Company that bear the familiar legend "United States Naval Observatory Time Hourly By Western Union." These rented timekeepers, soon to be remodeled according to specifications drawn up by industrial designer Donald Donner, are just what the legend indicates: correct on the hour. Many of these units have no second hands; time is kept only *to the minute*. Real bugaboos of accuracy include electric clocks whose minute hands jump from one minute to the next. For any home, however, the precision of a good electric shelf clock with a sweep second hand will surprise even time cranks.

Another source of correct time that heckles owners of fine pocket watches are the chronometers in watch repair shops and in jewelry store windows. In walking along the better shopping streets of the country, critical and observing persons have noted that several of these boxed and gimbaled portable marine instruments may disagree by many seconds or even a minute or more. Paradoxically, each *might* be correct. Fine chronometers, costing from $400 up, are seldom set. Such chronometers have a known error that, for example, might be an average of 0.2^s slow per week. If the instrument had been set on November first, 10 weeks later the exact time would be the chronometer's reading *plus* two seconds. The same situation exists with reference to large glass-encased precision clocks with long pendulums. Thus, the legend "Correct Time" would be true if such notices also gave an instrument's average error and the date when last set to the second. Even travelers' sentinels—railway station tower clocks—occasionally go berserk. On July 7 last the Grand Central Terminal's clock facing south on Park Avenue cavorted ahead 33 minutes. Station master Smith blamed the heat, not the humidity, for its bad behavior.

MAN has always been fascinated by time and its keepers. In the United States, 70,000,000 persons own pocket or wrist watches and continue to buy them at the rate of 5,000,000 a year. A jeweler's or even a pawnshop window well filled with watches invariably attracts a crowd 90 percent of whom are men. Put small diamond or gadgeted watches (ring, lapel, and clip) on display and the lady window shoppers will push the men around.

The Golden Age of watchmaking (1890-1923) has not yet died, but the buying public with its eyes and ears open to the magazine and radio advertising of merchandise stylists will probably kill it. Prior to 1923, domestic and foreign watchmakers made timekeepers in which precision was all important. Wrist watches came in just prior to the first World War and were followed later with wafer-thin pocket models of odd shapes. No watch case having the thickness of a $20 gold piece or the diameter of a dime can possibly have the stamina to stand the jars and jolts of today's fast moving life. Grandfather's old "turnip," the massive



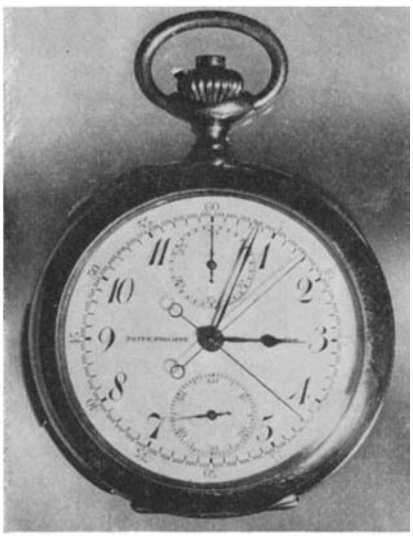
Cross-sectional drawing to show how the all-important jewel bearing is mounted in a watch. The wheel shaft rides within a hole in one gem and against the flat of another, a film of oil being between the two tiny gems

Courtesy Waltham Watch Co.

gold watch that was once the mark of a successful man, may be heavy or even clumsy from a mass selling point of view, but as a time measurer it is still the equal or superior of today's watch in the same price range. American "railroad" watches are still thick and #16 size—movement diameter about 1½ inches.

Nearly three-quarters of the watches imported to the United States come from Switzerland and among these are surely *the best and worst watches made anywhere!* Few Swiss factories make all their own parts but instead do a peerless hand assembly, finishing, and adjusting job. Very fine and accurate 14kt gold Swiss, pocket watches that meet the rigorous Class A certificate tests of the observatories at Geneva and Neuchatel start at a minimum retail price of about $250.

The foreign watchmakers are also the producers of very complicated and exceedingly expensive



Courtesy Patek, Philippe & Co., Inc.

This exceptionally accurate, complicated watch—16 size, 39 jewels—costs $2750 and worth it

hand-made watches of which any owner can justly be proud. Drawing plans, making parts, and assembling such intricate and delicate machinery frequently takes eight years. One of the most complex timepieces ever made was a double-faced pocket watch with 975 working parts. It was valued at 20,000 gold francs in 1900.

Aside from telling the time of day with precision, its versatile dials and attachments include: (1) day of the week, (2) perpetual calendar of months and dates for 100 years, (3) moon phases, (4) the four seasons, (5) apparent solar time, (6) chronograph in fifths of a second with register for hours and minutes, (7) dial showing how long since the mainspring was last wound, (8) automatic striking of hours and quarters, (9) manually worked repeater striking hours, quarters, and minutes on three gongs of different tone, (10) Boreal sky with sideral time and 460 stars, (11) Austral sky with sidereal time and 250 stars, (12) the local time in 125 towns and cities, (13) hour of sunrise and sunset, (14) a thermometer, hygrometer, and barometer, (15) altimeter registering up to 5000 meters, (16) a complete regulating system, and (17) a compass. On the face of it, this watch would meet the everyday requirements of almost anyone except a race track tout who wants to time two horses running in the same race. It was no doubt an oversight, but this museum piece lacked a double split-second timer.

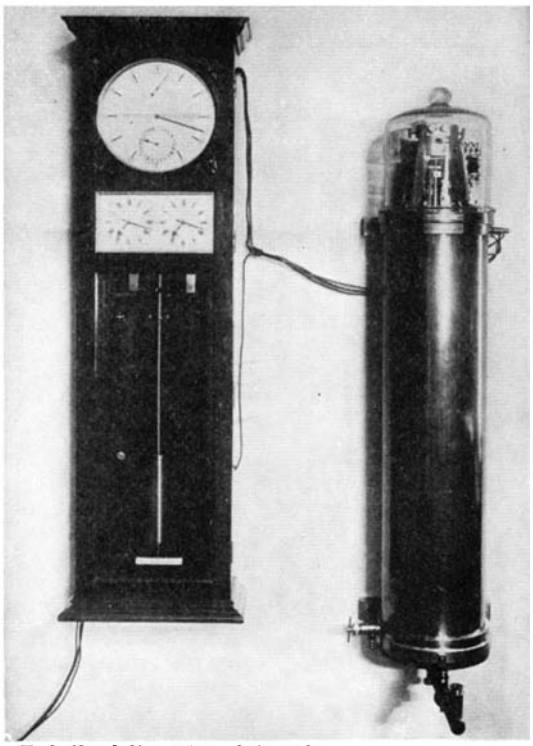
American watches on the other hand are machine-made and microscopically inspected for mass production. It would be unfair, however, to compare stock models of the Elgin National, Hamilton, and Waltham Watch Companies that retail for less than $300 for a 14 kt. gold pocket watch with a hand-made foreign watch costing $1000. Late in the golden age of watchmaking, both Elgin and Waltham made $750 pocket timekeepers in 18 kt. gold cases with no gingerbread on them. These magnificent #16 size watches probably marked the peak in the American industry and were unquestionable as precise as the world's best. Dollar for dollar, today's American railroad watches will measure time with any others.

NO PARALLEL can be drawn between wrist and pocket watches. When checked against an accurate time source, a medium-priced pocket watch will far surpass an expensive wrist watch. Compare the two-week performance of a $150 wrist and $37.50 pocket watch used simultaneously by a business man:

In 15 days, the wrist watch lost nearly three minutes and its rate was irregular, for on the fifth and ninth days it gained. The pocket watch gained a little over two minutes, and while its rate was regular, its error was large—8.7^s per day. Neither is a good timekeeper, but the pocket watch was more consistent.

For anyone to guarantee absolute accuracy in a watch would be absurd; there is no such thing as a perfect time measurer. The number of jewels in a watch should be a guide to its quality. When carried, a seven-jewel pocket timekeeper should maintain a steady variation rate of 15-20 seconds daily; a 15-jewel, adjusted to several positions, should be accurate to within 4-8 seconds; and a 21- or 23-jewel, adjusted to five or more positions and temperature and isochronism, to within one second. In the latter class, however, only 16 size, U. S. railroad watches or fine Swiss movements will live up to that high standard. Anyone who wants to better the second-a-day average will pay for it to the tune of about $500 for each quarter-second increase in daily accuracy of rate.

If one is lucky enough to own a fine watch, here are some simple rules that will tend to keep it that way: Wind it in the morning at the same hour and not too tight; set it infrequently, merely note its error; do not place it on a cold object as a sudden change in temperature will change its rate and might snap the mainspring; have it cleaned and oiled once every two years by a competent watchmaker (the work may cost 10-15 percent of a watch's value, but it's worth it); don't ever open its inner case, and protect it from pocket dirt with a small chamois bag; within reason, avoid all possible sudden jolts, X-ray machines, and machines that are magnetic. Is that asking too much thought for an instrument you wish to tick accurately 157,680,000 times a year?



U. S. Naval Observatory photograph

The Shortt precision clock—with its slave—is regularly checked against known stars

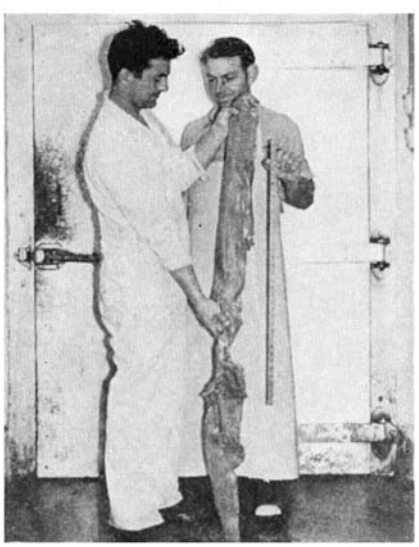
Better Health From the Sea

Vitamin A from Shark Livers, Varied Products from Weeds, Form Growing Industries

ANDREW R. BOONE

AROUND the fringes of 45 submarine forests off the southern California coast and along fishing banks scattered from Seattle to San Diego, fishermen are staging an unusual "gold strike." They're harvesting vitamins in unbelievable numbers from shark livers and from oils of other deep-sea fish; iodine, minerals, and laxatives from sea weeds forming the vast under-water forests.

This strange rush for health-giving products of the ocean started in earnest three years ago when A. H. Meyer, a fish buyer of Monterey, California, sought to purchase livers of the six varieties of sharks found in San Francisco bay and along the coast to Point Loma. This unusual offer resulted in the landing of 914,205 pounds of shark during the following season. Last year, some 13,000,000 pounds entered seven harbors, producing more than 1,600,000 pounds of livers. Most valuable specie is the soupfin, whose livers, many times more potent than any other natural source, yield in late summer 75,000,000 vitamin-A units per pound. The sardine, tuna, northern halibut, and the sable fish, or rock cod, provide excellent sources of vitamin D, negligible in shark livers.



Some soupfin shark livers weigh 20 pounds, are four feet long

Meyer's sensational buying order resulted from visits made by two groups of industrial chemists, sent from their eastern headquarters to investigate the possibility of finding high-vitamin content sea foods and medicines. Their analyses revealed tuna oil to be very high, with northern halibut even richer. Then two western scientists became interested. Dr. H. N. Brocklesby, through research at the Prince Rupert Fisheries Experiment Station, found that certain shark livers contained 100 times more vitamin A than do cod livers, oil from which long has been a stand-by in the nation's medicine chest. "Vitamin A in fish," he explained, "probably comes from microscopic sea plants known as photoplankton, through small marine animals called zooplankton, which in turn form the food supply for smaller fish, later consumed by larger species. The livers of some retain the vitamin A and accumulate a reserve."

Packed in five-gallon cans, the livers are frozen before shipment to canneries, where the vitamin-rich oil is extracted

Frozen smelts: good shark bait

Meanwhile, 1500 miles farther south, at Terminal Island, W. L. Scofield, fish-oil expert for the California Division of Fish and Game, urged that large fish-canning organizations employ research men. He pointed out that as sardines are disappearing, sardine meal, widely used as a poultry food, must be fortified with vitamins from other sources to make smaller amounts carry larger food and therapeutic values. As a result, canners today are scrambling for vitamins. Oil from mackerel, tuna, and shark is being added to sardine meal; poultry and stock gain pounds and flavor accordingly.

WITH fishing in the Norwegian countries greatly curtailed by war, and imports from other nations diminished, scientists expect the Pacific Ocean to furnish a great quantity of vitamins, plus important minerals and other medicines, during years to come.

How rich the shark livers will prove ultimately has not been definitely determined. Pinback, grayfish, bonita, thrasher or whiptail, and leopard sharks all supply vitamin A, but the soupfin has the highest potency of all. These fish weigh from 35 to 90 pounds, and some soupfin livers measure nearly four feet in length. Smart fishermen, wise in the ways of their finny

victims, try for female soupfins carrying eggs. At the start of the gestation period, in late May, livers may run only 8000 units a gram. In two weeks, they increase to 12,000; week by week, the potency leaps to 18,000, 42,000, finally 180,000. Since buyers pay according to strength, fishermen hope for the golden harvest about six weeks after the season opens.

These sharks are not man-eaters and, although they have no bones, strength being supplied by cartilage, they are true fish and are caught in nets and on set lines. The latter consist of as many as 6000 hooks suspended at intervals from a horizontal line, tied at the ends to buoy cables leading to kegs and corks, and hauled up at three-hour intervals. Sharks inhabit the bottom, and are taken at depths of 60 to 1500 feet.

EVERY night fleets of refrigerated trucks race along California highways carrying sharks to packing sheds. By midnight, livers have been pulled from the carcasses and packed in five-gallon cans. When the sun rises, each liver has been frozen; and by the next evening, it has reached a reduction plant, where machines begin to extract the oil and chemists measure the vitamin content.

Fresh from the sea, tons of sharks are loaded on trucks, like cordwood, then rushed to refrigeration plants

Methods of extracting vary from heating minced livers in open tubs and skimming off the oil to secret techniques where every step follows a laboratory control. Each company keeps its process a deep secret, but basically the new processes require coagulation and pressing. One canner recently developed a three-phase separator which dumps the solids in a bowl while the oil is flowing out the top, speeding production and extracting nine tenths of the oil content.

So rapidly has the business grown in recent months that fishermen and canners alike say a $20,000,000-industry, based upon shark livers alone, will soon be developed. Already, many skins are made into leather articles such as shoes and traveling bags; the teeth make novel jewelry; Chinese use the fins as soup stock; the flesh, finely ground, becomes nutritious live-stock feed; and the liver oil, undiluted or added to other products, helps restore health to ailing individuals. In many cases the liver alone proves more valuable to the fisherman than did the entire fish only three years ago.

While men in boats angle for vitamin-laden fish, others along the shore, from Los Angeles harbor to Point Loma, shove forks under the water, into rocky clefts, and bring up a queer, red seaweed known as Gelidium. Sometimes divers walk along the bottom, snipping Gelidium for surface harvesting.

For five days, the Gelidium lies on the beach, drying. Following dehydration in this manner, trucks carry the fronds to National City, where they are washed in open vats, then forked into iron baskets, which are transferred to closed digestors and heated by steam coils until a jelly emerges from the cookers. The jelly is dried, pressed through a wire screen, and the stringers frozen to force out the remaining moisture. You may know the final dry product as agar, widely used to treat constipation, while every hospital and research laboratory in the country employs the jelly as a culture medium, in which bacteria multiply with incredible speed. This common weed has no other known value, yet it has saved countless lives by enabling scientists to view rapidly growing disease bacteria while patients await treatment or surgery.

Thousands in the so-called "goiter belt" of the midwest have good reason to thank another weed of the sea, which thrives off the southern California coast, for better health. These submarine forests grow luxuriantly along a 250-mile stretch of sea from Point Loma to Gaviota, where 45 beds have been surveyed, some singles and others groups of forests. Mostly, they thrive within a half-mile off the shore; several sway with the tides around groups of islands, as far as 40 miles out.

Three raw kelp factories send out harvesters equipped with long, curved scythes to prune the top branches from the plants, the only known perennial of marine algae. Much as you mow the lawn, the scythes draw the branches back; an endless belt lifts them up, depositing the slippery stems on the floor of the harvest boat. When loaded, the barge-like boat steams under its own power into San Pedro or San Diego. Because the mowers take only the top six feet, and the stems grow rapidly, the submarine forests, owned by the state of California and leased to the harvesting companies, contain a seemingly inexhaustible supply of kelp.

YOU seldom hear of this weed, yet very likely it reaches your dinner table or medicine chest in some form. At waterfront plants, the leaves and stems are first hung to drain in the sun. In a day or so, they move on to low-temperature dryers designed to preserve the nutritional properties which otherwise would escape into the air, finally are pulverized to a flour by grinding, and screened. Some is

sold in bulk as animal feed, the balance formulated for dietary deficiencies.

Not long ago eight head of cattle, fed exclusively on kelp, won first prize as the finest displayed at a western stock show. Many cows in the midwest, fed kelp meal, give milk containing iodine, necessary in treatment of goiter. Recently,

Unloading kelp, harvested from under-sea forests of Pacific

Michael J. Walsh, San Diego chemist, discovered that kelp meal pressed into tablets will bolster some inadequate diets. This year he will turn out nearly 1,000,000 pounds of kelp products. Algin, taken from the same weed, when used in manufacturing ice cream, prevents formation of ice crystals and yields a smoother, more velvety texture.

Neptune's locker of riches has scarcely been tapped. These seagoing farmers first will harvest the easily available crops. Gold, radium, untold quantities of bromine and iodine, plant forests nearly a quarter-mile below the surface remain to be exploited. The seas hold sources of health and wealth beyond the dreams of Midas.

• • •

VERIFICATION

An Ice Bag on The Forehead Lowers Brain Temperature

HEADACHE victims who find an ice-bag on the forehead soothing, really are cooling off that part of the brain right through the skull. So Dr. William Bierman, and Dr. Mae Friedlander, of Mount Sinai Hospital, New York, recently reported to the American Congress of Physical Therapy. *Science Service* asserts that this came about as the result of an unusual opportunity to measure brain temperature of a human being.

While ice bags lay on the forehead of a patient from whom a brain tumor had been removed, Dr. Bierman inserted a thermocouple into the frontal part of the brain. Two inches below the forehead surface, the brain was found to be cooled a degree and a half, Fahrenheit.

Cold has received less attention than heat as an ameliorating influence in disease, the investigators stated, but they predicted greater use for cold. Their experiments with human beings indicate that cold applied to skin surface penetrates deeply. Ice bags on the calf of a patient's leg lowered the temperature deep within the leg muscles as much as 26.4 degrees, Fahrenheit. Testing the general supposition that drafts of cold air have no particular effect upon structures lying beneath the skin surface, they blew cold air on the leg calf and found that within the muscles the temperature dropped as much as 11 degrees. Cold applied to the abdomen seems to influence organs within, though the cooling was not very great.

EYESIGHT

Given to Blind Person Necessitates Adjustments

THE average person, blessed with sight from birth, cannot easily imagine the plight of one blind from birth who has his sight restored. The Better Vision Institute reports on such a case, a boy who received his sight after he had reached the age of 18.

This boy, George Campbell, had sightless opaque lenses in his eyes at birth. Three years ago the opaque lenses were removed and specially designed spectacles of great focusing power were provided. George Campbell could then see, but because co-ordination of mind and body had for 18 years been adjusted to the senses of touch, hearing, and smell, a complete readjustment had to be made, based on the appearance of things as he saw them.

The normal person takes for granted such simple things as a glass of water and a glass of milk. George Campbell, however, could not determine which was which merely by looking at them; even if he had been told, when blind, the difference between transparency and opacity, he still had to learn by experience exactly what those two terms meant. He had to learn to distinguish visually between a foot rule and a yard stick. His eyes required long training to work together in unison. For months, when he saw two cars approaching each other to pass on a road, his vision was so inexperienced that he shrank back in fear because the cars appeared to his eyes to be rushing into unavoidable collision.

TWO HEARTS

Beat As One, in a Manner of Speaking

"TWO hearts that beat as one" may be only a poet's fancy, but a scientist has just discovered that if the two hearts belonged to husband and wife, even though they do not really beat as one, they are likely to stop beating at the same age and even from the same cause.

Husbands and wives tend to have the same length of life or vitality, and when one of them dies of cancer, heart disease, tuberculosis, influenza, or pneumonia, the other is more likely to die of the same disease than could be accounted for by mere chance, Dr. Antonio Ciocco, of the U. S. National Institute of Health, has reported to the National Academy of Sciences.

Death records of 2571 married couples who died in Washington County, Maryland, between 1898 and 1938 revealed these surprising findings.

Being subjected to the same environment and living conditions and a tendency to select a husband or wife of the same constitutional type as one's self may be the reason or reasons why husbands and wives live about the same life span and die from the same one of five diseases which kills one of the couple. The tendency of both husband and wife to die from cancer cannot be explained on the basis of contagion, which might conceivably explain why both would die of tuberculosis, influenza, and pneumonia if one of them died of such a germ-caused disease.—*Science Service.*

BROWSING with the Editor

THROUGH THE SCIENCE LITERATURE OF THE WORLD

SKIDDING AND TIRES—Results of 3000 actual tests on packed snow and icy surfaces, made in Michigan, show that, although tires having good treads are preferred to smooth tires on dry and wet roads, they give no better performance than smooth tires on snow and ice; also that while lowering tire pressure or increasing the load over the rear wheels gives increased traction on slippery surfaces and a slightly increased traction for stopping, this is more than offset by reduction in safe speed on curves.—*Highway Research Abstracts,* November, 1940.

LAZY SHARKS—Speaking of the insensitiveness of whale sharks, Captain R. W. Mindte, of the motor vessel *Invader,* says: "I know of two authentic occasions when fishermen have stepped off the fishing racks on to the backs of these sharks and walked and jumped on them, the sharks apparently taking no heed of this action."—*Science Service,* October 18, 1940.

GAS, CHEMICAL RAW MATERIAL—Chemists are using 350,000,000,000 cubic feet of gas a year as a reactive agent between nitromethane and formaldehyde, to form a product that can be acted upon by nitric acid to make a new explosive more stable than TNT.—Notes, American Petroleum Institute.

COUSINS MOVING IN—At present there are eleven gorillas living in the United States—*Fauna,* Zoological Society of Philadelphia.

A MAGNET!—The magnet of the new 4900-ton cyclotron to be built at the University of California will be 56 feet long, 30 feet high, and over 15 feet wide. The cyclotron should be completed by 1944.—General Electric Company notes.

HOW BOMBED WINDOWS BREAK—Instantaneous photography of seven-foot-square, quarter-inch, plate glass windows used in experiments shows that the damage occurs in two stages. In the first, during the compression period the center of the glass is forced inward as a diaphragm, and ring and radial cracks develop. In the second, before the pieces have had time to separate, the "suction" half of the wave comes into effect and the pieces fall toward the bomb, except when the bomb is very near the glass—in which case the broken pieces are driven away from the bomb from the beginning.—*Journal of the Institute of Physics.*

ADAPTATION—Duck-bills illustrate an important principle of evolution. They show that various lines of animals at different times adopt similar modes of living, as the duck-billed dinosaur of sixty million years ago, a reptile, the duck-billed-platypus of Australia, a mammal, and the ordinary duck, a fowl.—Henry Fairfield Osborne: "Evolutionary Trends."

EGGS BY FREIGHT—Due to better methods of packing, loading and handling, loss and damage to eggs shipped by rail has been reduced 84 percent since 1921.—Notes, Association of American Railroads.

MORE MILES PER GALLON—An increase from 87 to 100 in octane number allows a plane to carry 1200 pounds less fuel, 1200 pounds added useful load, on a 1400-mile flight.—*Science and Culture* (Calcutta, India), October, 1940.

MILK WOOL—Add to rayon and nylon another word with an "on" ending. "Prolon" is the name suggested by F. C. Atwood for the new family of protein-base fibers such as those made from the casein of milk.—*Industrial and Engineering Chemistry.*

MACHINE TOOLS—Practically the entire output of the nation's vastly expanded machine-tool industry is destined for the national-defense program of the United States. Machine-tool production which totalled $185,000,000 in 1929 and averaged $23,500,000 in 1932 and 1933, rose to $200,000,000 in 1937, reached $400,000,000 in 1940, and probably will reach $600,000,000 in 1941. Nearly half our national tool employees have been trained on the jobs since September 1939.—Notes, National Machine Tool Builders' Association.

MAGNETIC STORM POWER—During the great magnetic storm of April, 1938, energy was expended at the rate of two billion kilowatts for a two-hour interval. This is 100 times the capacity of all the hydro-electric developments in the country.—A. G. McNish, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, in *Edison Electric Institute Bulletin.*

MOLASSES FOR ROADS—Numerous attempts have been made in many parts of the world to find inexpensive binders to stabilize earth surfaces (for low-cost country roads) and attention has inevitably turned to the employment of by-products or waste-products of local industries. Of these, molasses, obtained in the refining of cane sugar, has been found to give results of considerable promise.—*Civil Engineering* (London), October, 1940.

SUBMARINE SPOTTING—When a belligerent aviator sees a submarine, he drops aluminum powder to form a "slick" because he is travelling too fast to keep the location in view otherwise. Returning, he easily finds the submarine's location.—Notes, Reynolds Metals Company.

STOMACH ACID—The destructive action of carbolic acid on the skin is not due to its strength as an acid. Actually the acidity of the human stomach (due to hydrochloric acid) is 25,000 times that of a fatal dose of carbolic acid.—*Monsanto Magazine,* November, 1940.

VITAMINS IN INDUSTRY—One company feeds vitamin A to employees and saves money on its electric range production. This vitamin maintains normal level of visual purple in the retina of the eyes of workers, so that they can detect off-color parts of electric ranges. The result has been a saving of thousands of dollars.—Westinghouse Electric & Mfg. Co.

"GAS" FOR THREE MONTHS—If some fanciful cataclysm were to destroy every oil well in the United States, there is so much oil and gasoline in storage tanks that we could supply ourselves and part of the rest of the world for three months while new wells were being drilled.—*Oil Weekly.*

Fighting Friction

Just How Friction Operates Between Metals Is Not So Simple as it Sometimes Seems

WALTER L. FINLAY, Ch.E.
Research Chemical Engineer, Remington Arms Company

BLITZKRIEG or war of attrition? Whichever form of suicide the war lords of the future select, man's ancient struggle with friction will quite literally, as in the long dim stretches of the past, be one of grinding attrition—a mutual wearing down of human energy on one side, and of the obstacles which bar man's insatiable drive to move bits of his environment about on the other. Whether for good or for ill, this ofttimes seemingly aimless motion is nevertheless essential. It is at once the surest characteristic and the imperative necessity of life. And, as every schoolboy knows, negativing and almost inseparable shadow of motion is friction.

It is of course a commonplace to point out that friction is both friend and foe to man—likewise are fire and water. The battle centers about their control, and the good news is that, in the past several years, the control of friction has been greatly strengthened by important advances in both knowledge and technique.

Just how does friction operate? The first cave man who grumbled and cursed when he had to shove a log along the ground undoubtedly was well aware that the smoother he trimmed the branches off the trunk the smaller was the amount of energy he had to expend for shoving and the greater was the amount available for grumbling. Thus happily engaged, he probably blamed the remaining friction, if not on some evil spirit, then on the smaller protuberances still marring the smoothness of the trunk. In the present world of the machine, however, shoving logs over earth is a relatively unimportant operation, whereas the sliding of one metal over another touches the very core of a mechanized civilization. The simple view of friction—that it is the interlocking of more or less tiny roughnesses on the sliding surfaces—is only a very crude approximation to the true nature of friction for metals. A wholly clear understanding of the mechanism of sliding friction is even today not to be had, but the key to the picture is this: No surface is perfectly smooth. Under the heat and pressure of sliding, the high spots on the two surfaces weld together and the frictional resistance arises when these metallic junctions are ruptured by the continued motion of sliding. Sliding friction thus resolves itself into alternate sticking and slipping.

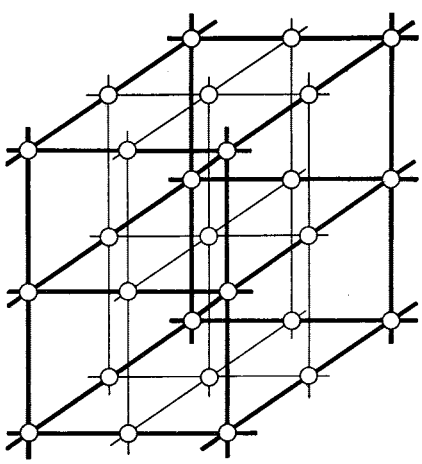


Figure 1: **Conventionalized representation of metal structure**

STARTLING and unexpected are some of the details of this general picture.

First, under many conditions of sliding the surface temperature rises rapidly to the melting point of the material having the lower melting point of the two, although there is no evident sign of heating and the bulk of the material remains cool.

Second, two seemingly perfectly flat surfaces, except under excessively high pressures, touch only in a very few high spots. For example, the actual area of contact between two highly polished steel surfaces may, under quite usual circumstances, be less than one ten-thousandth of the apparent area.

Third, not only is the actual area of contact between two highly polished surfaces very much smaller than the apparent area, but it is also practically independent of the apparent area. To illustrate, suppose one highly polished plate 10,000 feet square is placed on a very much larger but equally smooth plate. The actual area of the high spots which touch, and which form the only contact between the surfaces, would be in the neighborhood of only one square foot. Now, if the top plate were sliced into, say, ten thinner plates and these were placed side by side, the apparent area of contact would have been increased ten times, or to 100,000 square feet. But, notwithstanding this, the actual area of contact would still be only approximately one square foot. Conversely, if, instead of slicing, the 10,000 square-foot plate had been cut up into ten equal pieces and these had been piled one on top of the other, the apparent area of contact would have been reduced ten times, or to 1000 square feet. Nevertheless, the actual area of contact would still be only approximately one square foot.

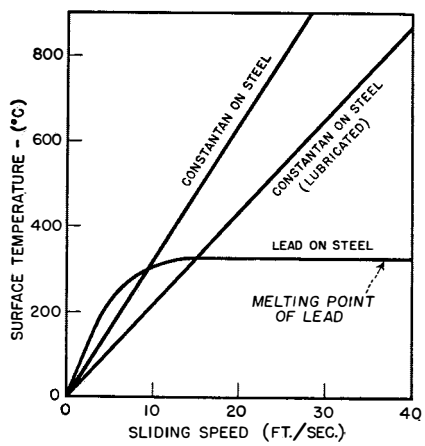


Figure 2: **Showing how easily friction melts lead. Constanstan (alloy principally of nickel and copper) does not similarly melt**

Fourth, if a group of very husky individuals took to pushing the aforementioned steel plate around, they would find that, no matter how they sliced it up, so long as they pushed it about as a unit, the frictional resistance would be about the same. And, furthermore, they would find that, no matter how fast or how slow they pushed it, the frictional resistance would still remain practically unchanged.

Such paradoxes could be multiplied, but it is more interesting to inquire into the mechanism which gives rise to them.

During the past few years a small group of English scientists — notably Bowden, Tabor, Leben, Hughes, and Finch — have been conducting a thorough investigation into the fundamentals of friction and it is largely to them that the present extent of our knowledge is due.

Bowden and Tabor arrived at a determination of the total area of contact between two surfaces by measuring the electrical conductivity. The electrical conductivity through the faces is in proportion to the actual area of contact; hence, the greater the area actually in contact, the greater the conductivity. They found that the actual area of contact was not greatly affected by either the size, shape, or degree of roughness of the surface, but that it depended mainly on the *pressure* squeezing the plates together. This finding makes quite a logical picture: the highest high spots make the initial contact. If their combined cross-sectional area is insufficient to support the load, the junctions flatten by plastic flow, thus increasing their cross-section and also bringing into operation new, lower, high spots. This augmentation continues until the total cross-section is just sufficient to support the load.

THE question now arises: what happens when one of these "smooth" surfaces is slid over the other? Perhaps the most significant contribution to answering this problem was made by Bowden and Leben a few months ago. They, painstakingly, and with considerable ingenuity, simultaneously measured the friction, the conductivity, and the surface temperature as two highly polished metals slid over each other. To understand their results one must first appreciate what happens when two high spots make contact.

In the first place, the modern concept of a metal is that it is an assembly of positive ions held together by the attraction of the intervening electrons. Figure 1 attempts a much simplified representation of a metallic lattice. The circles represent the nuclei of the atoms; the lines joining them, the cohesive bonds. The bonds of those in the center of the assemblage are completely satisfied, but those at the surface may be thought of as having excess cohesive forces extending out from the surface. Hence, when two high spots come into contact, the surfaces weld—that is, the excess cohesive forces clutch the newcomers, become mutually satisfied and the junction simply disappears. Meanwhile the base material, of which the high spots are a part, moves on, but since the new junctions resist this motion, whole blocks of atoms get ripped out and considerable heat is evolved. So sliding proceeds: a series of stick-slips which, with certain reservations, permits one to consider kinetic friction to be a series of static frictions.

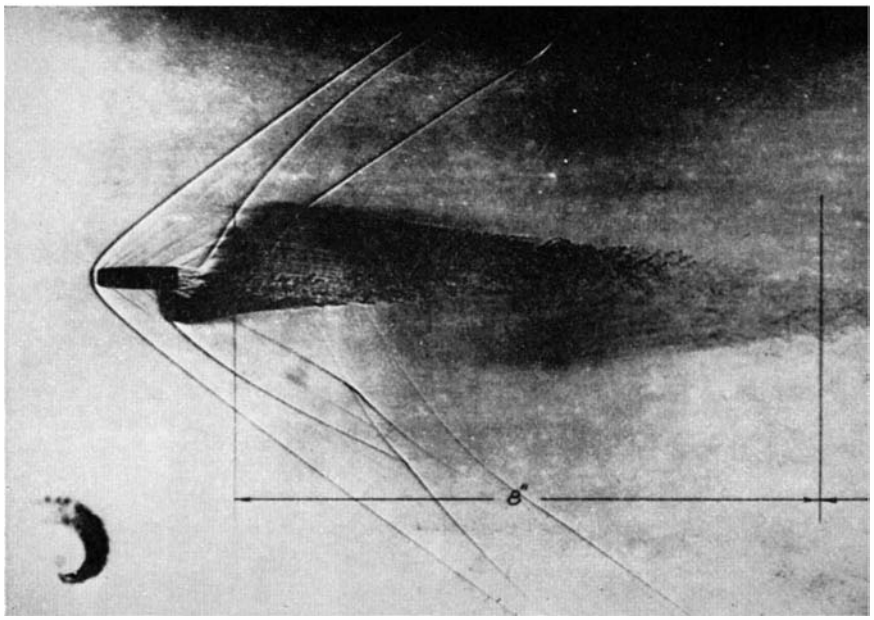


Figure 3: **A remarkable spark photograph taken at the Peters Ballistic Institute, showing the effect of sliding of lead on steel at higher than lead's melting speed. Insert is virtually an end view of the molten "tail"**

Shifting from the atomic viewpoint, Figure 2 shows what occurs over the surface in general during sliding. With a load of only one quarter of a pound, a block of lead moving at any speed faster than about 16 feet per second over a polished steel plate generates so much heat by the rupture of momentarily welded high spots that the temperature of the surface actually attains the melting point of lead. Yet, 16 feet per second isn't even a respectable speed; so-called low velocity bullets loaf along in a steel barrel at close to 1000 feet per second, while such speedsters as the .220 Swift reach a muzzle-speed almost 300 times faster than that necessary to melt the surface of a lead bullet. The unusual sparkograph shown in Figure 3 gives some idea of the frictional heat developed when a .25/35 soft point, jacketed bullet (2000 feet per second) inadvertently had its cupro-nickel jacket cut through by rust-roughened rifling. The heat of the friction melted the lead core and the spiralling "tail," photographed at 20 feet from the muzzle, is composed of drops of the molten core which the centrifugal force of the spinning bullet forced out of the perforation in the jacket. The left-hand insert is a photograph of the pattern made by the bullet and its tail when they impinged on a target paper four feet farther.

SURFACE melting is general on sliding surfaces and is common to all materials at relatively low rates of speed. And, furthermore, regardless of any increase in the load or in the speed, the surface temperature cannot be raised even one degree above the melting point of the material having the lower melting point. Hence, no matter how hard a material may be, it cannot polish another unless it has the higher melting point. Thus, camphor, which is quite soft and melts at 178 degrees, centigrade, can polish the much harder but lower melting Wood's metal, but cannot touch the softer but higher melting tin.

As a generator of heat, polishing is equally effective whether two sliding surfaces or two arguing scientists are concerned. Is polishing accomplished by abrasion—the filing off of solid aggregates of atoms on a submicroscopic scale—or by melting and smearing of the surface atom layers? Newton, Her-

schel, Rayleigh, and a host of others favored abrasion; after 20 years' investigation the late Sir George Beilby built up a very convincing case in favor of the melting and smearing hypothesis which pre-

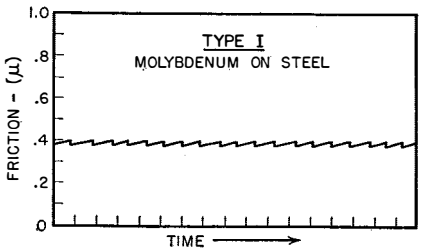


Figure 4: **Metallic friction, Type I: High melting on low melting**

sumably gave rise to the polish layer now universally known as the Beilby amorphous layer. Recent studies with the electron diffraction camera, not to be confused with the electron (refraction) microscope, have added further to the weight of evidence favoring the existence of this layer. Certainly it seems clear that part of the process, at least, is an intense, localized heating at the points of contact, so that melted or softened solid is smeared over the surface where it solidifies with extreme rapidity to form the Beilby layer.

THE depth of the Beilby layer ranges from 10-30 atoms to more than 100,000. It has been found that the "running in" of a piston results in the formation of an extremely thick Beilby layer. In the case of aluminum piston rings it was found that an amorphous layer of aluminum oxide was formed, but that continued running in converted the amorphous aluminum oxide into crystalline aluminum oxide, which is nothing more nor less than sapphire, a very hard material. Thus, although aluminum piston rings are softer and lighter than cast iron rings, they cause much greater cylinder wear because they become studded with tiny sapphire teeth.

It must be emphasized that it is only the surface—and, indeed, only the high spots of the surface—which is raised to the melting point at the relatively low speeds graphed in Figure 2. The bulk of the material may remain quite cold. This is strikingly illustrated by the fact that, although a meteor, whizzing for a brief moment through the atmosphere at 30,000 to 150,000 miles per hour, becomes white hot on the surface, it nevertheless is quite cool before the startled person it just missed can collect his (almost) scattered wits and go over to examine it.

Bowden and his collaborators found that there were at least three distinct types of metallic friction, and that these were determined largely by the melting points of the metals:

Type I—High Melting Sliding on Low Melting: This has appropriately been compared with pulling a number of plowshares through hard ground. As the pull increases, the plowshares are pulled into closer contact with the earth. Suddenly the ground gives and the plowshares jerk ahead. The cycle then starts anew.

Figure 4 shows how Type I friction varies, as exemplified by molybdenum sliding on low-carbon steel. The high spots on the molybdenum dig into the softer steel and the friction increases. Then there is a sudden slip before repeating the process. During the sliding, well-defined furrows are grooved

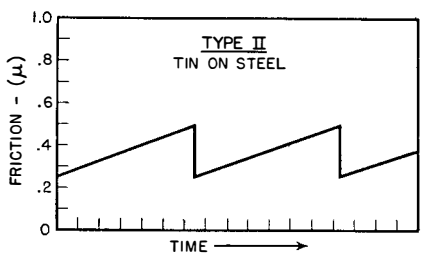


Figure 5: **Metallic friction, Type II: Low melting on high melting**

out of the metal having the lower melting point, but the metal of higher melting point remains unscratched.

Type II—Low Melting Sliding on High Melting: As in Type I, the friction varies in jerks, as shown by Figure 5 (tin on steel) but the extent of the rapid slip is much longer. In Type II the heat and pressure of sliding weld the high spots of the slider to the high melting surface. Then, as the friction increases, the junctions are drawn out finer and finer, until, with a "flash" of heat, they break. After the resulting sudden slip, the process repeats.

Type III—Two Surfaces of the Same Metal: In this case widespread welding takes place and both surfaces are deformed and locally melted by the subsequent ruptures. Hence, as Figure 6 (silver on silver) shows, there are no rapid slips, although large fluctuations occur and the average value of the friction is considerably higher than in the other two types.

In everyday experience an overlapping of these three distinct types often occurs. Consider, for example, the common case of a lead bullet fired through a steel barrel, that is, a low-melting metal sliding on a high-melting metal. If the lubrication on this bullet is at all faulty, then metal-to-metal sliding occurs and the friction is of Type II. In this type, it will be remembered, the lead high spots solder to the steel. Thus, eventually, the steel becomes smeared over with lead and the shooter grumbles that his barrel has leaded up. If this deposit is not removed, then succeeding bullets encounter Type III frictional resistance, which constitutes much greater drag and usually involves greater distortion of the bullet surface, since essentially one is then dealing with a lead bullet in a lead barrel. Where friction is to be minimized, the sliding surfaces should, of course, be of dissimilar metals. If this is not possible, then some non-homogeneous alloy like steel (which is composed of at least two quite dissimilar constituents—soft iron, and hard iron-carbide crystallites) should be employed, rather than a homogeneous metal like pure iron, which is composed of soft iron crystallites alone.

THE preceding analysis of friction into three types is for unlubricated surfaces exposed to the air. Such exposures mean, in general, two things: an oxide layer is formed and a film of gas molecules (oxygen or nitrogen, or both) is rather strongly attached to the surface by the excess cohesive bonds of the base material. Both of these sheaths tend to insulate the excess cohesive bonds of the two surfaces and thus to reduce the friction.

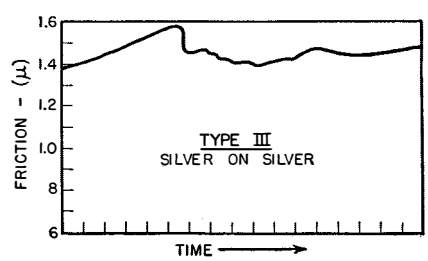


Figure 6: **Metallic friction, Type III: Two surfaces, same metal**

Hence, when both oxide and adsorbed gas are removed and the friction is measured in a vacuum, the resistance to motion is found in every instance to have increased considerably—in the case of nickel sliding on tungsten, for example, it increases nearly 20 times.

Lubrication, of course, also modifies the mechanism. But the value

of the Bowden analysis is that it represents the normal basic condition and upon it, as a foundation, a rational picture of everyday friction can be built. Flooding the surfaces with a suitable lubricant and using light loads, for example, is one common condition. In this case, the excess cohesive bonds of the surfaces are drowned in the thick film of lubricant and the frictional resistance is due entirely to the viscosity of the lubricant. Hence the variations of friction with the pressure, the thickness of the oil film, and the velocity of sliding can be entirely accounted for by the laws of hydrodynamics.

But in this day of high speeds and great pressures it is often impossible to maintain such a cushion of lubricant. Hence one characteristic of a good lubricant is that it be adsorbed on the sliding surfaces. If this primary adsorbed film constitutes all the lubrication, the lubrication is termed "boundary." But, even with boundary lubrication, the surface, as shown by Figure 2, undergoes a rapid temperature rise. One therefore concludes that the adsorbed film is continually being punctured as the high spots break through and weld. The ability to prevent puncture up to very high pressures is the outstanding property of so-called "E.P."—extreme pressure—lubricants but, in view of the high local temperatures which are now known to be involved, it has been suggested that E.P. lubricants might better be termed "extreme temperature" lubricants.

From the constant emphasis on the high spots of apparently smooth surfaces it is obvious that, the more these can be leveled off, the easier will be the job of the lubricant. An outstandingly successful move to accomplish this on a wide industrial scale has been achieved by the Chrysler Corporation's recently introduced "Superfinish" process. The basic principle of Superfinishing is that the abrading agency shall never retrack, but shall always trace out a new path. The path of least resistance is to follow and hence to perpetuate a previous scratch. By simultaneously moving both the abrader and the work, Chrysler has avoided this and has thus set up a new and higher standard of surface finish.

Thus, in the past few years the reconnaissance by Bowden and the flanking attack by Chrysler have considerably reduced the stature of Foe Friction. Needless to say, however, the war of attrition on attrition will go on, for each advance in this war is the essence of progress itself—the more efficient utilization of energy to make more things better.

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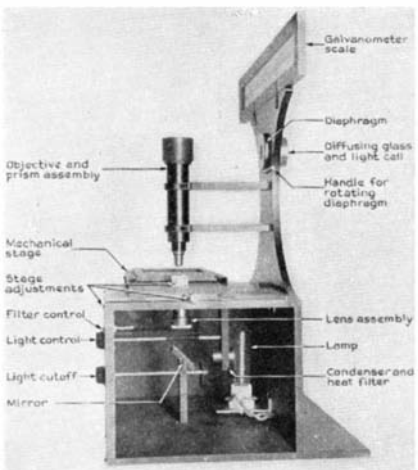
PHOTOMETER

Eliminates Human Element In Spectrographic Analysis

A NEW photometer for application to transmission measurements where small areas are important has been developed by the General Engineering Laboratory of the General Electric Company. The instrument is especially valuable in such work as quantitative spectrographic analysis because it eliminates the "human element" in comparing the densities of spectral lines, thus reducing errors to the minimum.

The new photometer shown in our illustrations was developed to provide the compactness, mechanical simplicity, ease of operation, and flexibility necessary to give the best results in applications such as this. The arrangement of the instrument allows the operator to see a magnified portion of the exact field which is being measured.



Cutaway of transmission photometer for spectrographic plates

Several apertures are provided in the screen, but these may be easily changed by changing the position of the diaphragm. The slit diaphragm can be rotated to align closely the image of the spectral line with the slit aperture, and there is provision in the diaphragm for any shaped aperture to accommodate special conditions of measurement as may be required by the work in hand.

Newly developed transmission photometer, especially valuable in quantitative spectrographic analysis and transmission measurements involving small areas

After final adjustment, the optical parts remain fixed and require no further movement for focusing. Spectral lines are focused on the screen by moving the plate plane with respect to the objective; thus the magnification always remains constant.

MARCH OF TECHNOLOGY

Research Necessary to Plan For More Stable Economy

IN THE report on Technology on the Farm, prepared by an interbureau committee of the U. S. Department of Agriculture, the foreword opens with the following two paragraphs:

"In this book we count the cost and values to American farmers of some new changes in machines, animals, plants, tillage, and processes. During the industrial revolution of the 18th and 19th Centuries, workers tried to stop a relentless transition to mechanization by breaking the machines they thought would eliminate their jobs. They failed.

"Our times are like that period or are, perhaps, a continuation of it. It would be useless for us to try to curb this march of technology, for we know that it gives jobs, as well as takes them away. Our task, rather, is to study ways to equalize the advantages brought by technology and to help plan a more stable economy."

Sun-Spot Distribution

What Had Seemed to be an Anomaly Proves to be an Optical Effect with Odd Cause

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

FOR more than 50 years the Sun has been photographed on every clear day at Greenwich, and for almost as long at other observatories, with telescopes giving images some inches in diameter, upon which small spots can be clearly seen. At any one station, the records will be often interrupted by clouds; but the observatories at Greenwich, Mount Wilson, the Cape, and Kodaikanal in India, have for a long time co-operated, sending to the others copies of plates made on days when their friends had bad weather, so that an almost continuous record is available. On every day's plates the number of spots is counted, their areas are measured, and the position of each on the Sun's surface is determined—in heliographic latitude, measured from the solar equator, and the corresponding longitude.

These records provide the source material for many important investigations. They tell us of the distribution of the lives of individual spots—from a single day to a maximum of six months; of the growth and disappearance of spots and spot-groups; of the rotation of the Sun, and the differences in its rate at different latitudes. Followed over a longer interval, they exhibit the great cyclical changes in spot-activity, with maxima recurring at intervals of about 11 years, but not accurately periodic, and the equally noteworthy changes in the latitudes at which spots appear.

ALL these topics have been extensively studied; but they do not exhaust the material. In 1907, Mrs. Maunder, wife of one of the staff at Greenwich and an astronomer in her own right, studied an apparently simple matter—the distribution of spot-groups upon the apparent disk of the Sun.

In any given year of the sun-spot cycle, the spots are practically confined in latitude to two fairly narrow belts on each side of the Sun's equator. This must have a real physical significance: It means, doubtless, that the outbreaks of spots are symptoms of some deep-seated process occurring in the Sun's interior; but we do not yet know what this process is.

The distribution of spots in longitude, along one of these belts, when measured with respect to a starting point rotating with the Sun, would be uneven, if there were regions of the surface especially prone to these disturbances. But if the longitudes are measured from the central meridian of the disk, as seen from the Earth, we should expect a uniform distribution—especially since the Sun's rotation carries the spots across the disk in a fortnight, so that, from day to day, they are recorded in different longitudes on this system. Yet Mrs. Maunder found that, in equal intervals of longitude, there were five times as many groups recorded near the central meridian as were recorded close to the edge of the disk.

This enormous difference cannot possibly be due to a real influence of our tiny Earth upon the Sun's surface. It must be an optical effect of some sort, and mean that our chances of observing a sun-spot are much better when it is near the middle of the apparent disk than close to the edge.

Why something of the sort should happen is obvious. At a point near the middle of the disk, our line of sight comes down almost at right angles to the surface. Near the edge, it approaches the disk more and more obliquely. Markings on the surface (which we will, for the present, imagine to be spherical and perfectly smooth) will therefore be seen foreshortened at an increasing angle, and, close to the edge, may appear so much narrowed as to be practically unrecognizable; and the finer details will certainly be lost.

The effect is illustrated in the drawing, which represents a cross-section of the spherical Sun. The Earth is far away at the top. The black lines represent the region occupied by sun-spots of the same sizes at different distances from the central meridian. For a circular spot, the diameter at right angles to the plane of the page will not be foreshortened, and the spot, on the solar photograph, will appear elliptical. Very near the limb the spot will appear narrowed almost to a line, of length equal to the true diameter.

With the recognition of this effect, the matter was practically dropped for more than 30 years. It has been taken up by Dr. Archenhold—a German refugee, working, when his paper was written, at the Solar Physics Observatory, Cambridge, England.

The apparent area of a spot, as measured on the photographs, will be greatly diminished by foreshortening. It is a simple matter of geometry to correct for this, and the "Greenwich Photoheliographic Results" give, in addition to the apparent area, the "corrected area" increased by a factor corresponding to the foreshortening. One might expect that this correction would get rid of the difficulty altogether; but things are not so simple as this.

IT is evident that, for a given telescope and a standard quality of seeing—that is, of blurring of the photographic image by dancing of the image—there will be a definite lower limit to the size and area of a sun-spot which can be detected. On the Greenwich plates, for spots near the center of the disk, this area is close to one millionth part of that of the Sun's visible hemisphere, which corresponds to an apparent diameter of 2".7 for a circular spot.[1]

As far as 70° from the central meridian, the apparent areas of the

[1] A spot having a millionth of the area of the visible disk would be of 1/1000 of the Sun's diameter, and this is 1".92. But the curved area of the visible hemisphere is just twice the flat area of the apparent disk, so that the unit is twice as great, and corresponds to an apparent diameter $1.92 \times \sqrt{2}$, or 2".7.

smallest visible spots average about the same. But, not a single spot out of more than 5000 was recorded more than 80° from the center unless its area was at least ten times this limit. Such spots on the photographs would be distant from the edge of the disk by less than 1/100 of its diameter, and greatly foreshortened, appearing almost like lines parallel to the edge. Dr. Archenhold makes the excellent suggestion that such a line (really, a very narrow ellipse) will escape observation unless its maximum width exceeds a certain limit which, on the Greenwich photographs, he finds to be 1″.4. Moderate-sized spots, close to the limb, would then be lost, because their images were too narrow to appear. On this assumption, the change in this corrected area of the smallest visible spots can be accounted for up to 85° from the central meridian. Here a spot is lost unless it has 33 times the area (or, if circular, nearly six times the diameter) of a spot visible at the center. Simple geometry shows that the image of such a spot on the photograph would be but 1/12 as wide as it was long, and be distant from the edge by only 1/500 of the diameter of the disk. It is rather surprising that it shows up at all!

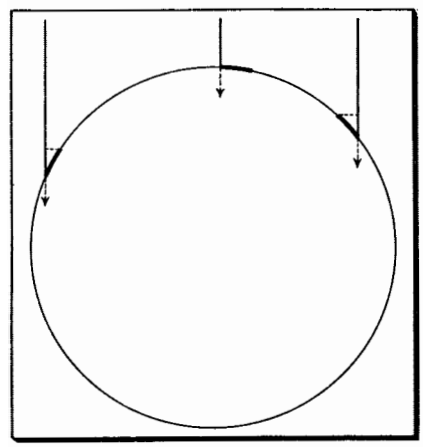
THE geometrical effects appear now to be satisfactorily allowed for; but they do not by any means account for all the observed lack of spots near the edge. Comparing, for example, the zones 60° to 70° on each side of the central meridian with the central zone within 10° of it, Archenhold finds that the numbers of spots of corrected area five "millionths," found on equal areas of the Sun's surface, are as 12 to 52.

There seems to be no other way to account for this than to assume that a sun-spot looks smaller when seen obliquely than when seen squarely. The geometrical foreshortening has already been allowed for, and the "narrow-line" effect should not appear, as the area is more than double the limit of visibility, even at the edge of the outer zone.

To get 12 spots for the standard area in the central zone we must go to those of corrected area 13, which may be taken as the "normal" area corresponding to an observed area of 5 (corrected for foreshortening) at 65° from the central meridian.

Dr. Archenhold finds that this effect is present for spots of all sizes, from the smallest up to 200 millionths. The actual increase in area is greatest for the larger spots, the percentage increase for the smaller ones: Spots 70° from the meridian, and of "corrected" areas 10, 30 and 50, correspond to "normal" areas of 28, 55 and 80.

We are now faced with an insistent question. This effect is



Foreshortening of sun-spots

clearly indicated by the observations; but does it make sense? How can it possibly be that a sun-spot should shrink to only 60 percent of its apparent diameter, just because we look at it at an angle of 70° to the Sun's surface, instead of squarely down at it?

If the Sun's surface were solid or liquid, or an opaque flat sheet of clouds, this question would be unanswerable. But it is nothing of the kind; the gases of the outer layers are simply hazy, with an opacity increasing gradually downward, so that, even when we look squarely at the surface, we "see down" to a considerable depth—that is, much of the light which we receive comes from well down in the luminous fog, though weakened by scattering by the overlying haze as it gets out.

When the light comes out obliquely we "see down" to a smaller depth, as is clear from the dotted arrows in the drawing. Now a sun-spot is a region where the gases are cooler than elsewhere, and therefore shine less brilliantly. If, for any reason, this cooling is greater in proportion to the depth from which, on the average, the light comes out at right angles to the surface than at the shallower average depth for obliquely emitted rays, the spot might look smaller when seen by the latter.

The problem thus comes down to one of the detailed constitution of a spot. We have a fairly good general idea what happens. A column of gas, ascending from the unobservable depths, is cooled by its own expansion, and, when it reaches the surface, forms the spot. There is little doubt that these ascending columns are in rapid rotation, with a motion the reverse of water running out of a basin, and that this rotation produces the magnetic field. On this picture, we should expect the upper portions of the ascending, funnel-shaped vortex to be the widest, and, as Dr. Archenhold points out, to find the spot bigger if observed in its upper layers. But this assumes that the ascending vortex reaches right up to the surface. There is pretty good evidence, however, that the level at which the ascending vortex flattens out into outward radial motion (think of the wash-basin, again backward!) is below the very small depth to which we can see, and that in the outer, visible layers, there is no further cooling by expansion. In this case, the visible layers simply form an atmosphere above the cooler pocket of gases below and the size of the visible spot should correspond to the size of this pocket, no matter at what depth within the outer layers we made our observations. The smallest visible spots are 1500 miles in diameter, while the depth to which we can see, below the level where haziness begins, is probably not more than 100 miles. How the influence of the cool pocket underneath could be neutralized in such a very thin, superficial layer, sufficiently to reduce the apparent size of the spot, is by no means easy to imagine.

THE "physical foreshortening" of the spot-areas discovered by Archenhold is, however, apparently well established, and adds one more to the problems of the solar physicist, and to the clues which may lead him ultimately to a logical solution.

Mrs. Maunder's work brought out the still more curious fact that the diminution in the numbers and areas of spot-groups is greater at the western edge of the Sun than at the eastern. Archenhold finds that, for individual spots, this effect, though present, is much smaller. The solution of this puzzle can hardly be expected to precede that of the other.—*Princeton University Observatory, 1940, December 4.*

Robot Photographic Observer

Army Air Corps Develops Power-Driven Movie Camera for Test Flights

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

IN THE early days of test piloting the observer was required to jot down readings of several instruments on a pad loosely held on one knee. As plane speed increased, the accurate recording of flight data via pad and pencil became well nigh impossible. The Materiel Division of the Army Air Corps has met this situation through the development of a "Photographic Observer," an apparatus in which the readings of all necessary instruments are simultaneously recorded by an automatic camera.

Preparing flight observer for installation in rear cockpit of two-seater military airplane

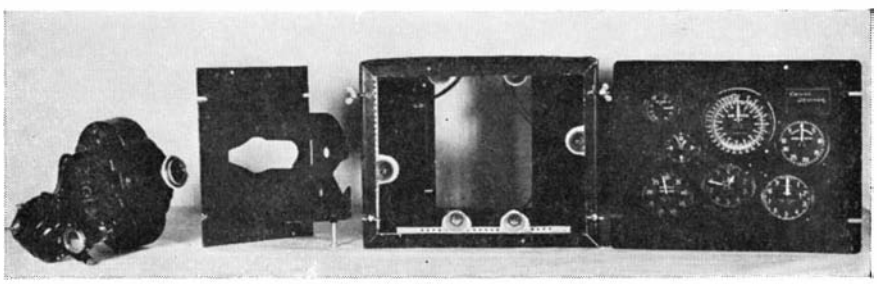
The component elements of the photographic observer unit, which is approximately 20 inches long, are a 35-millimeter, motor-driven motion picture camera, a two-part lamp house held together by toggle bolts, and the instrument panel on which are mounted the recording instruments essential to the evaluation of airplane operation, or for some flight research work. Although these instruments are identical with others of the same type on the pilot's instrument board, the duplication is unavoidable.

The device is the result of several years' development work, and has proved entirely satisfactory. The camera has a special wide-angle lens in lieu of the standard

Antiquated pad and pencil method of observation recording, now replaced by motor-driven motion picture camera

lens so that seven instruments may be photographed simultaneously. The instrument panel is of sheet aluminum with black finish to eliminate light reflection. As sufficient light is of prime importance to obtain clear pictures, there are six Mazda lamps located 4½ inches in front of the instrument panel, but outside the field of the photographed area. Operation is a simple matter, since lights and camera operate from a single electric circuit which is plugged into the gun-control system. During test flights, the electric gun-switch is turned on so that when the pilot wishes to actuate the photographic observer, he does so merely by pressing the gun trigger on the control stick.

The photographic observer is particularly valuable during take-off tests, when the various instrument readings change rapidly. During climb tests the pilot must make a three to five second photographic run of the instruments at every 1000 feet of altitude. In radiator tests, a multiplicity of temperature readings must be taken. The new device makes the lot of the scientific test pilots and observers a good deal easier.



Left to right: **35-millimeter, motor-driven motion picture camera; two-part, toggle-bolted lamp house, and recording instruments on the panel**

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INEXPENSIVE

Network of Seaplane Floats Dots Waterways

THANKS to co-operation between the National Youth Administration, the Civil Aeronautics Administration, and certain municipal authorities in the erection of floating bases, the owner of a light seaplane may now fly the entire length of the Atlantic coastline with greater comfort and safety. Starting from the float of the Downtown Skyport in New York City, the private flyer would find similar seaplane landing facilities at Philadelphia, Atlantic City, Baltimore, Washington, and Norfolk. Ports along the North Carolina

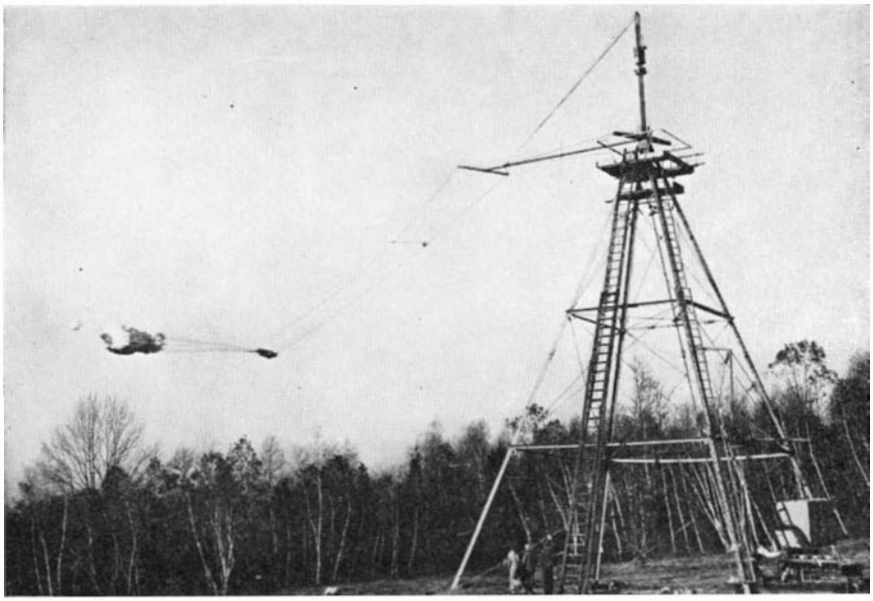
coast include Elizabeth City, Beaufort, and Wilmington; in Florida, Daytona Beach, Miami, and Key West, all of which, together with many others, are listed in the Civil Aeronautic Authority's "Directory of Seaplane Floats and Anchorages," a compilation of bases, anchorages, and refueling facilities throughout the country.

Buoyancy of a typical 10 by 22-foot float is provided by ten 55-gallon steel drums, which may be moved individually by running them through one of a series of hatches built into the floor boards, thus eliminating the necessity of overturning a float for drum repairs. Skids are attached to the bottom of the float to facilitate winter removal from the water, and the deck is painted the standard international orange color, with black triangles for identification. Although labor costs may vary under the co-operative plan, each city pays only $150 for the materials, and private flyers are delighted with the availability of these bases and are patronizing them in increasing numbers.—*A. K.*

At lower end of Manhattan Island and symbolic of days to come, is New York's Downtown Skyport, patronized by many sportsmen flyers and business men who daily fly to work

COCKPIT RELEASE

AT WRIGHT FIELD, the experimental station of the Army Air Corps, there has been developed an automatic release for instrument flying hoods. A Pitot tube type airspeed indicator, instead of actuating an arm on a dial, actuates two pairs of electrical contacts. By suitable adjustments, electrical contact is made at two predetermined speeds —for example, 130 miles per hour and 230 miles per hour. When the single-seater pursuit type training plane reaches either the low or the high limit of air speed, a relay operates a solenoid. The solenoid automatically releases the hood of the cockpit, reducing a hazard in blind flying training for the student who may be diving or stalling without knowledge that he is doing so.—*A. K.*



Motor-driven boom, revolving at 70 to 300 miles per hour, tests the action of parachute opening, which is recorded in slow-motion pictures

TEST TOWER

Parachute Action Studied Through Slow-Motion Pictures

AS SEVERAL things happen almost simultaneously and with considerable rapidity in the course of a parachute jump, the jumper is not ideally situated to take observations, a dilemma that has created considerable difficulty in the past in studying the functioning and aerodynamics of the parachute. The wind tunnel, a magnificent instrument of aeronautical research, is adapted to study constant conditions rather than the rapidly altering conditions of the opening of a parachute. The Pioneer Parachute Company offers a solution by erecting a special parachute test tower, shown in the photograph.

The parachute test tower is a mechanism built for the purpose of whirling a dummy "jumper" around in a 200-foot diameter circle at speeds varying from 70 to 300 miles an hour. A horizontal boom is mounted on the tower about 50 feet above the ground and is rotated by means of a gear train and a vertical drive shaft driven by a 320-horsepower marine engine. To the end of the boom are fastened flexible streamlined rods which support the dummy. To the dummy, in turn, are fastened the parachute harness and pack. The tower functions in somewhat the manner of the "flying machines" which are seen at pleasure resorts. As the boom revolves, the dummy swings up from the ground and ultimately travels in the same plane as the boom itself. A light cable is attached to the "rip cord" of the parachute at any desired position, and at about one third the distance from the boom end to the dummy there is a spreader fastened between the flexible streamlined rods. On the spreader is mounted a high-speed motion picture camera which operates automatically after the rip cord has been pulled and provides excellent slow-motion pictures of the functioning of the parachute during the process of opening.

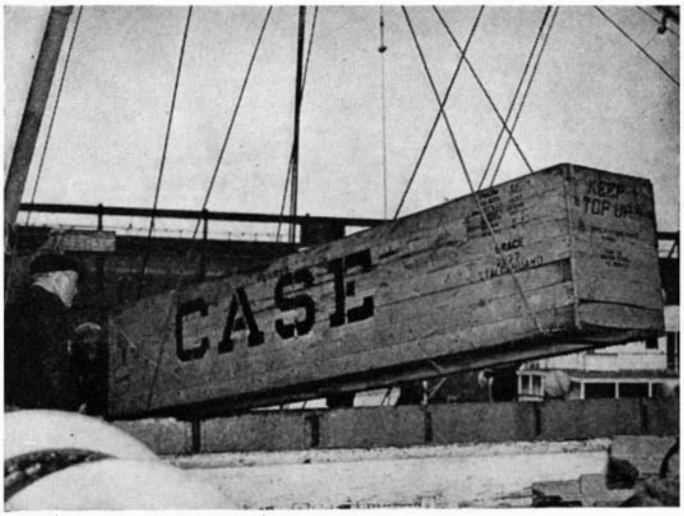
As the dummy does not act gravitationally, and as centrifugal force is a factor in the tests, but not in the actual jump, the method is open to minor criticisms. It is, nevertheless, a valuable addition to the art of parachute jumping, and experiments with the test tower and its automatic camera observer should produce additional information and clear up doubtful points in parachute theory and practice.—*A. K.*

We Build More Ships

Our Merchant Fleet Adds About One Ship A Week — Efficient, Economical, Safest

W. CREIGHTON PEET, JR.
Secretary, U. S. Maritime Commission

FROM the middle of the Nineteenth Century to the World War period, the American merchant marine was only a minor factor in international trade. There are numerous reasons for this, among the most important of which are the facts that American initiative following the Civil War was turned inward to the development of the enormous resources of the western United States, and that European merchant fleets were able to operate at costs which American ship operators could not meet. It was not until 1917 that the need for a fleet of merchant vessels, able to serve in time of need as naval auxiliaries, became obvious to our government. Since that time, the problem of merchant shipping as it affects national policy has been centered more and more in our fleet of merchant ships in international trade.



Photos courtesy The Grace Line

Symbolic of the unity of the western hemisphere nations: a shipment of machinery for Latin America

Carriage of our foreign trade in American ships could never, of course, be a monopoly. If American ships were to handle 40 or 45 percent of the total of our international trade, there would be work for all our ships and a guarantee of adequate service for our foreign trade. But, regrettably enough, we are carrying no such percentage of our imports and exports. As a matter of fact, the percentage has been decreasing steadily for several years. In 1928, 38 percent of the total tonnage of our imports and exports was shipped in American bottoms. By 1938, the figure had shrunk to 26 percent of the total.

The reasons for this decline are simple. First and among the most important of the reasons is our aging, slow, and relatively inefficient merchant fleet, for the most part a relic of the wartime fleet which was designed to be built in a hurry, primarily to transport troops and supplies, and not to carry peacetime foreign trade. A second reason is the increasingly nationalistic practices of some foreign nations which seek to build up foreign exchange by requiring that goods shipped from their shores be carried in their own vessels. A third was the large increase in the volume of our foreign trade—from 51 million tons in 1933 to 75 million in 1938—with, at the same time, a decrease of over 50 percent from 1933 to 1940 in the number of United States vessels registered for foreign trade.

There was a time in America's past when she actually was merchant queen of the world. In the age of the clipper ship, 1845-1860, United States vessels skimmed the cream from practically all international trade. The clipper ships were the fastest things afloat. They cut days of time from the schedules of ordinary sailing vessels. In the 1850's, our clipper fleet carried approximately 72 percent of our total imports and exports! The reason was, quite simply, that the clippers led the world in speed and efficiency. There were not many of them—but they were the best ships in the world.

Today's problem of recapturing our fair share of world shipping is being solved by imitating the example of our forebears in sail: by building for ourselves a merchant marine which will be, not the largest and not even necessarily the cheapest, but the speediest, the most efficient, the most economical, and the safest in the world.

We are modernizing our merchant fleet with replacements which can compete in the carriage of freight in practically every one of the world's sea lanes. We do not expect ever again to obtain such a monopoly of shipping as we had back in the 1850's. We do not want it, for it is bad economics. What we do expect is that as a result of the current shipbuilding program of the Maritime Commission, we will once again be able to "skim the cream" of international trade.

As of July 1, 1940, the United States fleet of merchant vessels in foreign trade numbered 425 vessels of 1000 tons and over, nearly 90 percent of which were 20 years old or more. Such vessels are considered "overage."

An overage vessel, while not necessarily worn out, is swiftly reaching the point where it cannot compete satisfactorily in international trade against modern vessels. By actual count, all but 39 of the ships built prior to the Maritime Commission program in our merchant marine will be overage in 1941.

NEARLY 50 merchant vessels, put into service during 1939 and 1940, as a result of the construction program of the United States Maritime Commission, comprise the nucleus of our new merchant fleet, as authorized by the Merchant Marine Act of 1936. This Act defined the national policy on the nation's merchant marine, and set up the Maritime Commission to put it into effect. In the preamble to the Act, two principal reasons are stated for an adequate, modern merchant marine carrying the American flag. These are: such a

fleet is necessary to serve our industry and agriculture by protecting our vital export markets and by providing ourselves with the essential materials which we do not produce; and the national defense requires a merchant fleet to act as the service arm of the Navy in time of war.

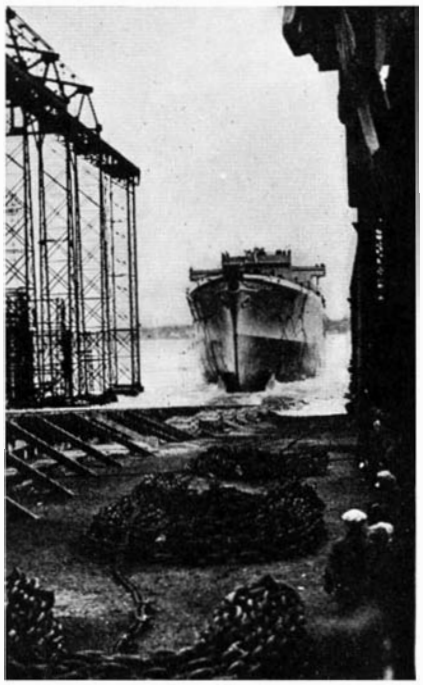
THE principal features of the Act through which the Maritime Commission is directed to achieve its aims are: It abolished indirect subsidy of the merchant marine as it had been practiced through the ocean-mail subsidy contracts. It provided for a direct operating differential subsidy to private lines serving essential trade routes; that is, payment of an amount representing the difference in operating costs between American vessels and foreign-owned vessels on a given trade route. It provided for a direct construction differential subsidy—payment of the difference in cost of construction of approved vessels in American and in foreign shipyards. It provided for the gradual replacement of aging and obsolete vessels by modern, efficient, and safe ships. It provided for the training of American seamen, and the establishment of minimum wage and manning scales and working conditions.

In other words, this Act put the United States on record that insofar as possible the government would place domestic operators on a parity with foreign competitors in order that a substantial portion of our trade might be carried in vessels of United States registry. Originally, the program contemplated the construction of 50 ships a year for 10 years. Actually, in the three years since the first contracts were signed, nearly 200 vessels have been contracted for. As of October, 1940, 49 of the vessels, including the *America,* had been completed and placed in service. Twenty-two of them are serving the increasingly important inter-American trade routes.

More than half a dozen distinct types of vessels are being included in this broad, carefully planned building program.

The *America* is a 26,500 gross ton passenger liner built at Newport News, Virginia. The largest merchant ship ever constructed in the United States, it was assigned to transatlantic service but, because of the war, it is being utilized successfully as a cruise ship to Caribbean ports.

One of the early projects of the Commission was the construction of 12 high-speed, twin-screw tankers which would be valuable to the Navy. Ordered by the Standard Oil Company of New Jersey, with the Commission paying the cost of national defense features, they have already demonstrated their commercial



Ships to carry our foreign trade go down the ways regularly

efficiency, and at least one operator runs them at their full speed of 18 knots. The Navy has bought four. In addition, 11 single-screw tankers with national defense features are now being built.

The C-1 cargo vessel is a small, 14-knot freighter designed to fit the minimum requirement on American trade routes of the world. Thirty-eight of these have been ordered.

The C-2 cargo vessel is a 15½-knot vessel. This was the Commission's original design, intended to provide the most urgently needed replacement in the American commercial fleet. These ships have already proved themselves the most efficient of their type in the world. Sixteen are already in operation. Forty have been ordered thus far, as have also three adaptations of the basic design, which will carry a certain number of passengers.

The C-3 cargo vessel is somewhat larger and faster — 16½ knots. It will serve trade routes requiring rapid carriage of goods. Some of this type are already in service on the American Republics Line to South America. Eighteen have been ordered.

With the same hull design as the C-3 cargo vessel, a combination passenger and cargo ship, which will permit passenger travel on similar trade routes, is being constructed. Fifteen of these have been ordered, of which seven are intended for 'round-the-world service.

The Seas Shipping Company, operators of the Robin Line to South Africa; the Mississippi Shipping Company, operators of the Delta Line from the Gulf to the east coast of South America; and the American Export Line, which operates into the Mediterranean and to India, are all building vessels of their own design with the help of the Commission. They will replace aging vessels of the fleets of these companies. Eighteen have been ordered.

In addition to these, the Maritime Commission plans to build two fast passenger liners for the Pacific trade, even larger than the *America.* They will be about 30,000 gross tons with an overall length of 760 feet and with engines capable of a service speed of 24 knots. They will be convertible into fully equipped aircraft carriers; with stacks on the starboard side, an unobstructed flight deck can be quickly erected.

BECAUSE the United States merchant marine is vitally important to the nation, it is receiving extensive support financially and otherwise from the Government; but it should be emphasized that it is operated by private industry and is still part of our private profit system. The ship operators in most cases own their own ships, and if they do not, they charter them from the Government on a bareboat basis just as one would rent a house.

The new Commission vessels are fast; they are economical to operate; cargo handling gear is of the most modern type; extreme precautions have been taken to make them the safest ships afloat. The safety features of the new vessels have been planned to cover every conceivable contingency which could be met with on shipboard. A list of the new developments in safety equipment alone would take up more space than this article has had allotted to it. Every precaution has been taken to make the vessels as nearly fireproof as it is possible

to build them. The dangers of sinking as a result of collision are minimized, since every ship is compartmented so that even though one compartment might be flooded by some accident, the vessel still will float and be able to proceed under its own control.

There is no doubt but that the new fleet of 500 vessels planned by the Maritime Commission under the authority of the Act of 1936 will restore to the United States its rightful percentage of world trade. The costs of the program are not heavy, when all factors are taken into consideration; and, moreover, every cent spent on our merchant marine is well spent not only from a trade point of view but also from the point of view of national defense. The Navy will have an efficient and capable service arm in the new merchant marine, ready for any emergencies.

However, the first purpose of a merchant marine is—trade. And as far as trade goes, world conditions have changed rapidly since the Maritime Commission was first created. Many countries have ceased to exist as separate entities. Markets that were here yesterday are gone today. Trade restrictions have multiplied and an urgency for foreign trade has become inextricably interwoven with the ambitions of great nations. As these developments take place, we hear of the enormous losses of shipping facilities suffered not only by the belligerent powers but by neutral nations as well. United States flag vessels, however, are increasing steadily in number and are still operating over many essential trade routes. They are carrying our exports to those geographic areas where markets still exist, and are bringing back to this country those critical and strategic materials so vital to the maintenance of our own economic structure.

Fire inspection drill: an officer going down into a ship's hold

Finally, with modern, fast cargo and combination cargo-passenger ships constantly being added to the merchant marine of the United States, one may expect that, as the merchant fleets of other nations become depleted, the vessels of this country will be in a position to carry—at least for some time to come—a substantial portion of the total cargo tonnage which will move in international trade during the post-war period.

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FLOATING POWER PLANT

Would See Service In Emergencies

INTEREST in national defense being what it is, the thoughts of A. P. Kellogg, General Electric turbine engineer, have turned to the question of floating power plants. Recently he made designs of a 50,000-kilowatt floating power station which may be constructed as part of the national defense program. In the event the generating facilities of a city of 150,000 to 200,000 were destroyed by bombs, this power plant would, in a short time, be towed to a near-by spot and hooked in to the town's electrical distribution system to keep industries going and to provide lights.

In describing the proposed ship to the Wisconsin Utility Association recently, Kellogg said the west coast, Great Lakes region, and a large portion of the eastern United States could be reached by generating stations housed in vessels designed to pass the United States Barge Canal. The plants, he said, would always be useful to meet varying industrial needs.

Generators of the aircraft carrier *Lexington* supplied power to Tacoma, Washington, in 1929 during a water shortage. Since 1930, a 20,000-kilowatt floating power plant in the S.S. *Jacona,* owned by the Public Service Company of New Hampshire, has been in service on the Piscataqua River near Portsmouth, New Hampshire.

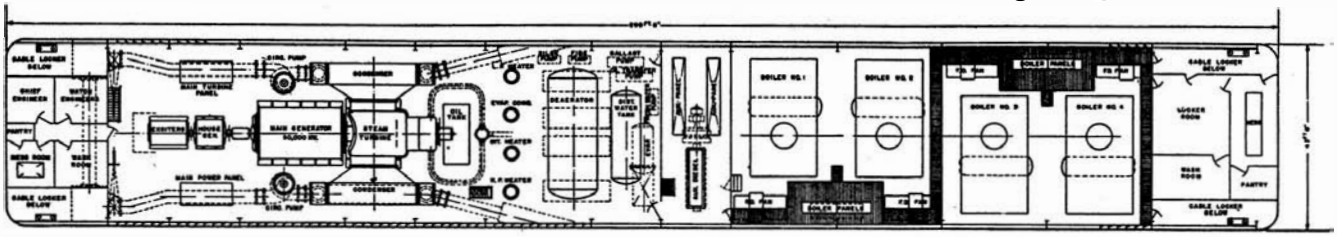
TEST BOMB

Determines Power Of Explosives

EXPLOSIVES are specifically developed for their destructive powers. However, in order that they may be used with perfect safety, it is necessary that their explosive powers be accurately known. That calls for laboratory testing, a ticklish job which demands absolutely dependable equipment. A failure may be fatal.

In the laboratories of one American explosives manufacturer, testing is accomplished in a 30-inch "test bomb" 12 inches in diameter. Explosives are placed inside and detonated. The bomb is so strong that, instead of bursting, it confines the gases, measures the pressure of the explosion, and thus determines the potency of the explosive.

The test bomb is a veteran of many bombardments. Research men have exploded countless charges within its chamber. It has withstood their force because it is made of a special chromium vanadium machinery steel which is tough enough to confine the tremendous generated pressure without damage.



Plan view, at turbine deck, of the proposed 50,000 kilowatt floating power plant

Eye Science Moves Forward

Vision, Precious to All of Us, is Aided and Saved By Optical Industry's Developments

DR. J. F. NEUMUELLER
Director, Bureau of Visual Science,
American Optical Company

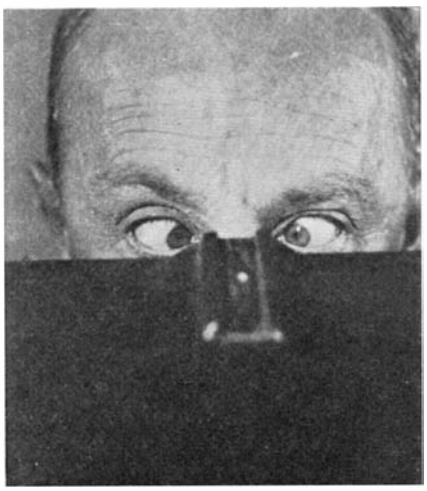
IF YOU are one of those millions suffering from defective eyesight, thank your lucky star you are living in the year 1941 A. D. The modern oculist, optometrist, and optician, assisted by the optical industry's scientific developments —sensitive measuring instruments and versatile lenses that are truly precision-ground—can now test and correct your faulty vision with a degree of accuracy undreamed of a few years ago.

At the turn of the century, for example, a paper test chart and two or three crude, simple examining devices constituted the equipment then available for eye diagnoses. Leaf back the pages of history a few more years, and there were no eye-testing instruments available at all. Trial and error was the only procedure for prescribing glasses.

Consider the case of the aging gallant of 1850. When his eyes could no longer recognize the fair ladies promenading down the avenue, reluctantly he visited a spectacle shop or called in an itinerant spectacle peddler and tried on successive glasses until he found a pair that seemed to help his failing vision! Nowadays we need not gamble in such fashion with nature's most precious gift: sight.

The human eye is the hardest worked of all bodily organs, one of the reasons why 25,000,000 Americans wear glasses and 60,000,000 should. The majority of eye defects are errors of refraction—that is, some part of the eye is so constructed that the organ cannot focus light rays correctly on the retina. Located in the back of the eye, the retina corresponds to the film in a camera and transmits the images formed upon it to the brain via the optic nerve. The four common refractive defects are near-sightedness, far-sightedness, astigmatism, and double vision, all of which are now understood and corrected by use of eye glasses.

Six years ago, Dartmouth research scientists announced the discovery and treatment of a fifth eye defect to which had been given the musical name of aniseikonia—Greek for "unequal images." It may be explained that aniseikonia is present when a person looks at



Pair of very crossed eyes exercised on the stereo orthopter

an object and the image received through one eye differs in size and shape from the image in the other eye. The brain's visual center gallantly attempts to fuse the two unequal images but often fails dismally. This futile struggle may result in headaches and stomach and nerve disorders.

The most important effect of aniseikonia in single binocular vision is loss of the capacity for judging depth and distance. Obviously, a motorist or airplane pilot so afflicted is a potential menace to himself and others. Significantly, it was concluded that aniseikonia was a possible solution to those baffling eye cases not aided by the customary examination and correction. And of these there were many.

An exceptionally complex instrument is used to detect aniseikonia whose correction necessitated the development of a new type of lens to produce equal images in both eyes. These lenses were designed by Dartmouth research scientists. To the American Optical Company was entrusted the problem of translating these designs into actual lenses. These iseikonic lenses are tailor-made; that is, each one must be individually designed and ground, and no two are ever alike. They are the most difficult and intricate of all prescription lenses to manufacture. Yet thousands of aniseikonic victims have had their faulty vision corrected since the discovery was announced in 1934.

The detection of aniseikonia illustrates splendidly the optical industry's never-ceasing effort to give better vision to the millions of Americans with defective eyes. Years of patient research, large sums of money, and the accumulated knowledge born of centuries of scientific investigation were poured into the solving of aniseikonia. And the same statement can be made of every important advance in optical science.

NEW types of lenses—the climax of intense optical research—play fantastic tricks with visible and invisible light. Polaroid lenses screen out the blinding and dangerous reflected glare so familiar to all who drive cars. And if your eyes are sensitive to excess light, your doctor can now prescribe for indoor or outdoor use absorption lenses that admit varying degrees of light, reduce glare, and absorb the potentially dangerous invisible ultra-violet and infra-red rays. (Ultra-violet causes sunburn while infra-red is heat radiation.)

These mysterious absorption lenses protect the eyes of welders and furnace and foundry men whose work is exceptionally eye-hazardous because of the glare and unseen radiation. Specially toughened lenses, some of them of the absorption type, have also been developed; and these lenses, strongly resistant to flying objects, annually save thousands of eyes in industry.

One of the great scientific contributions to spectacle precision is the development of Tillyer lenses. These lenses give clear vision to their very edges, and so enable defective eyes to see better with exceptional comfort.

Cataract operations comprise approximately 25 percent of eye surgery, according to a recent re-

port issued by a large eye hospital. This delicate operation consists of the extraction of the diseased lens from the eye. Scientists have designed special lenses to compensate for the missing eye-lens and these restore sight. For sub-normal eyes which are nearly blind, scientists have designed telescopic lenses with tremendous magnifying power.

Movie star Ida Lupino receives a demonstration on the ophthalmoscope, the machine which diagnoses reading ability

Recent years have witnessed the development of new and improved eye-examining instruments which are even more dramatic than the new lenses. Some of these instruments assist the eyeman to determine the patient's eye errors and, equally important, provide clues to the state of his general health. The ophthalmoscope, for example, projects a beam of light into the eye and permits the eyeman to examine the retina and background of the eye—the only part of the body where arteries, arterioles, veins, and capillaries with the blood circulating in them can be viewed in their naturally living state. With the aid of the ophthalmoscope, symptoms of eye, brain, blood, and systemic diseases can be observed in the eye's background. Recently the instrument was improved by the addition of Polaroid material which eliminates the glaring reflections that formerly handicapped doctors when looking into the eye.

At the present time it is not possible to make an objective examination of diseased conditions along the retino-cerebral pathway. The nature and location of these conditions can only be inferred from an analysis of disturbances in the field of vision. Your field of vision is the extent of space seen while your eyes are looking directly ahead. Normal eyes see approximately 120 degrees in the vertical plane, and together 180 degrees in the horizontal plane.

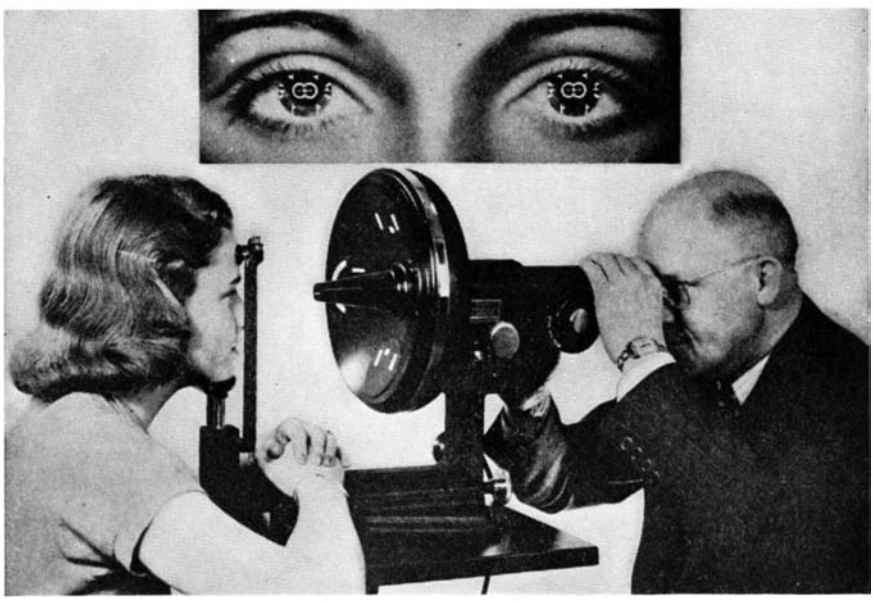
Two optical instruments—the perimeter and stereo campimeter—are used by professional men to observe and chart changes in the field of vision. These field studies are now considered indispensable in the study of diseases of the optic tracts, brain diseases, and other pathological conditions which produce functional disturbances in vision. Through field studies, the development of such conditions are often detected long before they are observable by other means.

Night blindness—the inability of the human eye to readjust itself quickly to normal sight after exposure to brilliant light—has been studied intensely in recent years. All of us have experienced the sensation of temporary blindness upon entering a darkened theater from a brightly lighted lobby. Persons in normal health quickly readjust their sight. Those suffering from night blindness require a longer interval of readjustment before they can see in any darkened room. Interestingly, night blindness may be caused by a lack of vitamin A or by certain eye and other diseases.

To facilitate night blindness studies, Dr. J. B. Feldman, Philadelphia physician, recently developed an instrument to detect night blindness. The adaptometer partially bleaches out the visual purple in the eye, a substance needed for night vision, and the time required for the eye to regenerate its visual purple is the basis for measuring the degree of night blindness. Eye authorities now consider a night blindness test an essential precaution for motorists, airplane pilots, railroad engineers, and certain industrial workers.

It should be emphasized that scientific research inspired by a definite need, is the motivating factor behind the development of present eye-examining instruments. A case in point is the recent phoroptor into whose creation refraction experts, research scientists, engineers, and designers poured their respective talents.

THE phoroptor, an optical miracle which literally dials your prescription, contains only 36 lenses, but these lenses can reproduce 61,060,386,816 different prescriptions for glasses! Heretofore, it was necessary to slip different lens combinations, by hand, into a spectacle frame until a satisfactory prescription for the wearer was found. The phoroptor performs the same task in a fraction of the time and with considerably greater accuracy. An ingenious mechanism within the instrument automatically adds up the individual lens

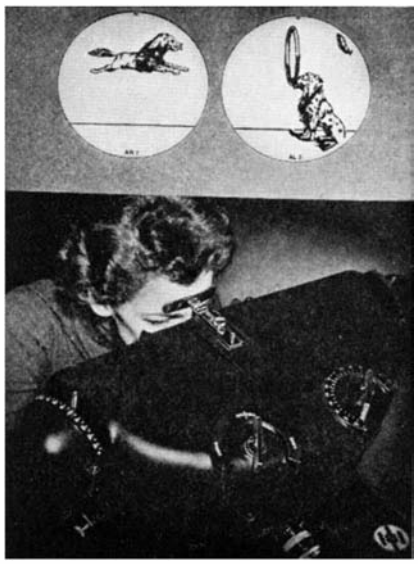


When the eyeman looks into eyes through the ophthalmometer, used to measure astigmatism, he sees striking designs (inset) on the eyes' corneas

powers and records the total correction on an indicator.

Another step forward in determining accurately the visual acuity of eyes was the development of a special projector, and special slides, designed to take the place of the old-fashioned test chart hung on a wall.

Your eyes are each equipped with six muscles which permit them to be turned in any direction or converged or diverged. These muscles perform a tremendous amount of work in the course of a day. More than 100,000 eye muscular movements are made by the average good reader in a single half-hour's perusal of non-technical material. Those of a poor reader may run as high as 300,000. If eye-coördination is below par, the attempt of the eyes to focus on



An eye muscle exercise used as a target in the stereo orthopter. Look between the two pictures and draw the page close to the face. The dog will appear to jump through the hoop

an object, and the brain to fuse the images, may cause eyestrain, headaches, or even cross eyes.

It goes without saying that eye muscles, like other parts of the body, may get out of kilter. This has long been a challenge to eyemen, and the challenge has been fairly met by optical scientists who have developed a unique device for exercising and training weak or lazy eye muscles. An almost automatic mechanism, the stereo orthopter forces the eye muscles to function correctly by means of a complicated arrangement of mirrors, lenses, lights, and stereoscopic images. Cases of squint, more familiarly known as cross eyes, formerly corrected only by surgery, have been successfully treated by the stereo orthopter.

Educators report that inefficient reading habits contribute tremendously to school failures. Of great importance, therefore, was the introduction, several years ago, of two instruments to diagnose and correct defective reading habits—the first scientific attempt to improve reading ability on a large scale. Essentially, the ophthalmograph is a motion picture camera which photographs light reflected from the eyes as you read. The resulting film, or reading graph, reveals, upon analysis, the nature of your reading habits, such as speed of reading, fixations, span of word recognition, and other data.

If your reading graph discloses defective reading habits, the metronoscope can be called into action. This instrument has three shutters in front which open and close in sequence, exposing words printed on a revolving reading roll. You are thereby forced to read correctly, for the operation of the instrument will not permit you to pause excessively long or to retrace in your reading. In addition, the roll can be speeded up, teaching you by degrees to increase your reading speed and improve the efficiency with which your eyes take in words or groups of words at a glance.

It is startling to learn that ophthalmograph reading graphs of over 5000 subjects of all ages, taken at random from various sections of the country, revealed that not more

The stereo campimeter, at left, is used to measure blind spots, while the chart is a simple test to show up blind spots

than 25 percent of them read with real efficiency. Obviously, a more effective approach to the teaching of reading is urgently needed.

In a review of the new instruments and lenses now providing better vision for those with defective sight, tribute should be paid to the many scientists whose ceaseless research has made them possible. This research never ends.

And during this year, perhaps, this inexorable march toward new frontiers in optical science will attain objectives now seemingly beyond realization—new lenses, new instruments, new techniques that may revolutionize present procedures completely. Such achievements are not impossible. The optical industry will see to that.

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EXTRUDED METALS

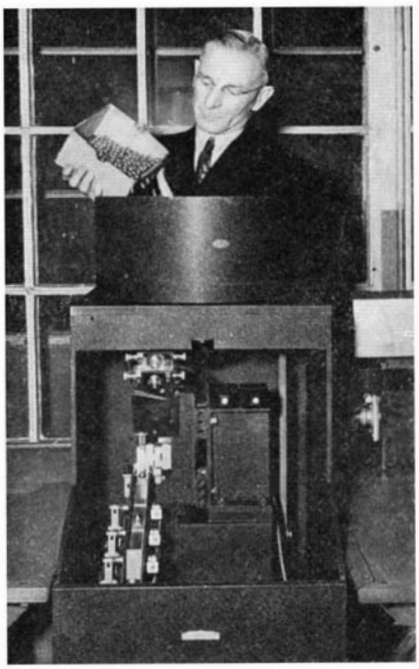
Process Common Abroad, Little Known Here

STAINLESS steel, nickel alloys, bearing steel, and non-ferrous alloys are now being extruded in the form of tubing, structural shapes, and rods as a result of notable developments in extrusion presses and metallurgical methods during the past five years, British engineer Albert B. Cudebec, recently told the Metals Engineering Division of the American Society of Mechanical Engineering.

Metal alloys which do not work well by rolling, welding, or piercing can now be economically extruded. "Several such alloys are being extruded in large quantities in Great Britain," Mr. Cudebec said, "but these have not yet been commercialized in the United States.

"Soon after the British defense program got well under way, the metal-extrusion process quickly became so vital to national-defense purposes that 40 or 50 of these large plants are now in production in Great Britain. Moreover, several plants for the British commonwealths are either in production or are now being rushed to completion.

"It is not definitely known how many of these plants were in operation in France before its recent collapse, or how many are in use



Ball bearings are automatically measured for size, roundness

in Greater Germany, but it is probable that several dozen of them are now operating upon a 24-hour basis. From these figures, one can visualize the probable expansion in extrusion plants which may occur in the United States before America's present national-defense program is completed.

"The extrusion process does not compete in the ordinary field of carbon steel and is only economically interesting in handling expensive ferrous alloys and all non-ferrous products. This field, however, is very wide as special alloys are now being substituted for heavier parts in almost every branch of mechanical-engineering design."

BEARING CHECKER

Automatic 'Umpire'

Calls Bad Balls

A NEW automatic machine that checks, to millionths of an inch, the size and roundness of balls used in ball bearings is the latest guardian of accuracy on the Ford Motor Company's Rouge plant production line. The gage is primarily used to check the balls, $^{15}/_{32}$ of an inch in diameter, which are used in transmission bearings.

Operating in a glass-enclosed room at the end of the ball-bearing department, the automatic gaging device measures by electricity dimensions so small they almost defy human imagination. And after checking the balls, the gage sorts them in five different size classifications.

The gage is an ingenious device housed in a cabinet five feet high. Balls are fed into a hopper at the top and they drop into classified drawers in the base at the rate of 5000 an hour or slightly less than 84 a minute. As each ball is fed from the hopper into the gaging unit, it is held momentarily at a single measuring point. Before the machine is started, the operator makes four micrometer adjustments to the measuring "head" to establish the size desired for the ball. Only balls of one size are run at a time, so that the settings remain untouched during the run.

During the momentary pause of each ball in the measuring unit, it is checked for four dimensions—oversize, undersize, under-high limit, and over-low limit. If the ball is found to be in any of these categories, the gage head operates an electric relay to open one of four small trap-doors along a trough leading from it. An oversize ball, for example, will automatically open the trap-door that consigns it to the proper receptacle. Out-of-round balls are also automatically rejected.

When a ball of the right dimension drops from the gage unit, it rolls down the trough to the bottom without being caught by any of the four intervening trap-doors.

GLYCERIN

Synthetic Type

Developed from Petroleum

A NEW and commercially practical way to make glycerin, important chemical raw material for nitroglycerin, was disclosed recently to the American Institute of Chemical Engineers. Dr. E. C. Williams, vice president and director of research for Shell Development Company, Emeryville, California, announced that his company already was operating a semi-commercial plant for making synthetic glycerin from petroleum.

In peace-time the largest use of glycerin is in the manufacture of alkyd resins for varnishes and lacquers, but appreciable quantities are used to impregnate materials such as Cellophane and parchment, to process tobacco, and to make nitro-glycerin for dynamite. During World War I, however, the British used huge quantities of glycerin to make cordite, a propellent powder similar to smokeless powder.

At present, glycerin is a by-product of the soap industry and the fat splitting industry; consequently, the supply of the chemical is dependent upon the activity of these industries. The price of glycerin has been extremely erratic, varying from 10 to 32 cents per pound in the past 20 years. The present price is around 12 cents. Due to war needs, the price rose to 70 cents per pound in 1917 and supply fell short of demand.

Chemically, the development of the process is one of the great achievements of this decade. Essentially, the steps in the process are as follows: Isolation of propylene, a gas, from petroleum (a well-known procedure); reaction of propylene with chlorine gas to form allyl chloride; reaction of allyl chloride with caustic soda to form allyl alcohol; and conversion of allyl alcohol to glycerin. An alternate synthesis may be used in which the third step is replaced by the formation of glycerin chlorohydrin instead of allyl alcohol.

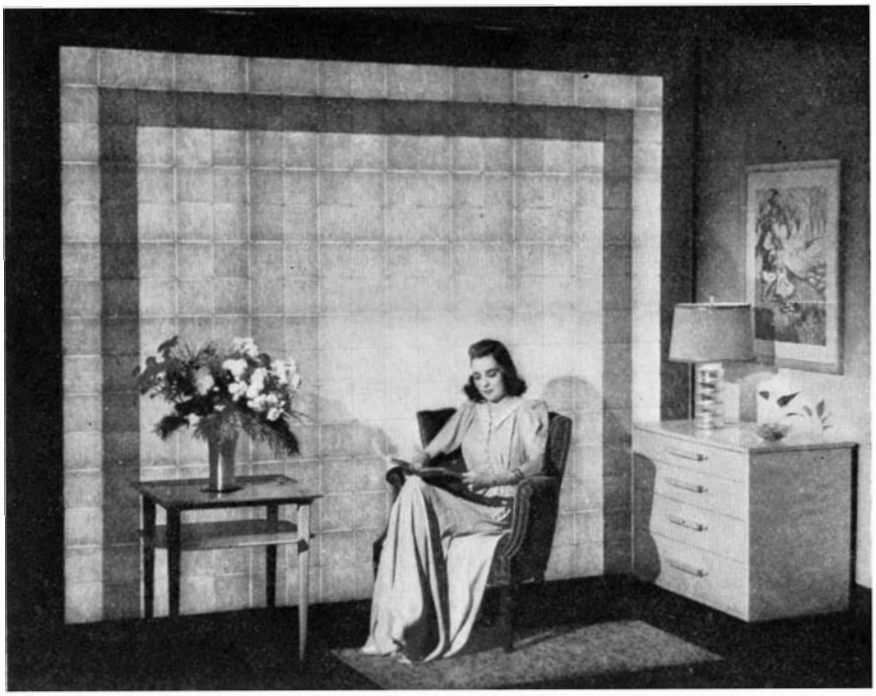
PLASTIC TILES

Give Promise for

Decorative Walls

SOME years ago we watched with interest the development of glass bricks for use not only as architectural trim but for making entire walls in buildings and homes. Similar use of plastic is forecast in a recent announcement of the makers of Lumitile. These tile-like hollow blocks are molded of Monsanto

Plastic tiles, light in weight, offer a range of decorative possibilities



A wall section of new plastic tile, translucent, with back lighting

Lustron, a relatively new polystyrene plastic.

So far, apparently, there is no intention of using Lustron tiles, or Lumitile, to make exterior walls, though the material is extremely resistant to water; and hot humid conditions will not affect its beauty or strength. Architects and designers, however, believe that the new material opens wide possibilities in decorating living and dining rooms, lobbies, reception rooms, and cafes. Beautiful color effects can be obtained, and it is possible to bring out these colors to best advantage in interior decorations by the installation of lights behind walls made of the material. One such decorative treatment, with back lighting, is shown in the photograph at the top of this column.

Lustron is a light plastic, so the tiles are easy to handle. In temporary walls or where the rear of the wall is accessible, the individual hollow blocks are simply fastened together with concealed bolts. In permanent installations, special cements are used, welding the individual blocks into one solid unit.

GOGGLE TEST

Machine Gun Determines Toughness of Glass

THE average compensation and medical cost for eye accidents in industry is almost twice that of other injuries. Because many of these injuries, resulting in the loss of eyes or the loss of sight, occur from flying chips, Bausch and Lomb technologists have devoted much attention to the development of hardened lenses which will withstand or break the shock of flying missiles.

By a suitable selection of glass and unique methods of annealing, a lens can actually be case-hardened by a uniform strain. Industrial goggle lenses are now made which will stand up indefinitely under a barrage of ⅝-inch steel balls, weighing 0.57 ounces, fired at a range of 40 inches under a pressure of 28 pounds of compressed air. This new machine-gun test, shown in the illustration, supplements the older drop test and closely simulates the effect of flying chips.

The process of hardening lenses has so improved that it is now possible to have a workman's prescription ground into these lenses. Previously it has been necessary for the workman to wear his regular glasses under his safety goggles.

WELDING SAVINGS

Can Help Open The Bottlenecks

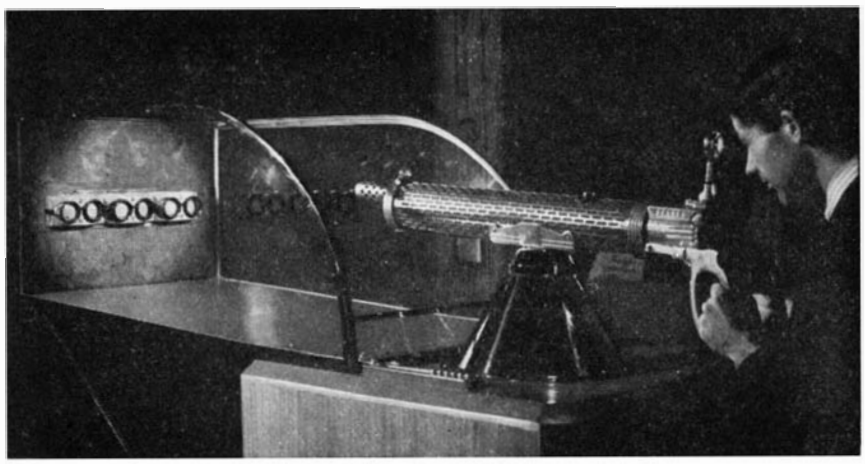
THE machine-tool industry has been called the bottleneck of industrial production during our rearmament program for so long that people are beginning to believe it. The James F. Lincoln Arc Welding Foundation has seen fit to do something about this problem. It has made a study of savings in time and expense that may be effected by the use of electric arc welding. Those savings, according to the Foundation reports, amount to a reduction of more than 25 percent in machining time, alone, for a number of finished products.

Out of the 109 welding case studies made by the engineers, the Foundation reports on 15, of which we give one as a typical example. In making a drill jig for a tractor front axle, the welding cost was $12.76 as against $17.93 by the former method, and the amount of machining saved by welding was 27 percent.

ALUMINUM PAINT

Fine Finish Without Filler or Surfacer

IN THE manufacture of aluminum paints, the difficulty has been to secure one that would dry quickly yet carry film-value solids suffi-



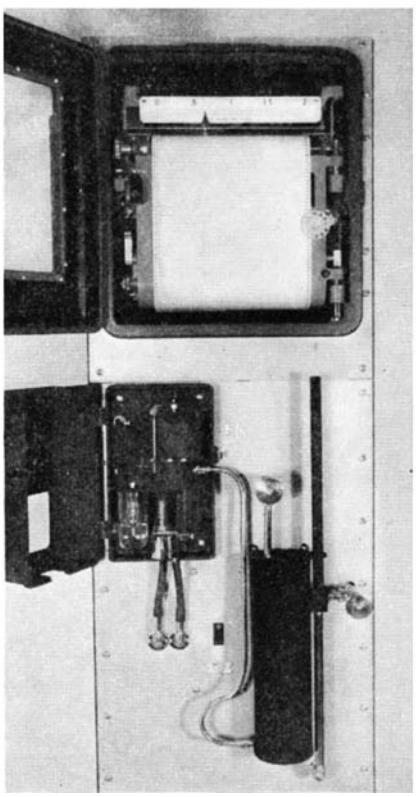
Industrial goggles withstand a barrage of steel balls

cient to give cast iron a smooth, fine finish without an additional filler or surfacer. The Red Spot Paint & Varnish Company has solved this problem in a new aluminum finish which was made particularly for the mechanism of a line of refrigerators. The development comprises primarily a new vehicle, plus the addition of certain other pigments with the aluminum. After development, the resulting coating was found to have good heat and grease resistance, and good color stability even in ready-mixed form.

WATER TESTER

Determines Dissolved Oxygen In Boiler Water

IN STEAM plant operation, one important source of boiler corrosion is the amount of dissolved oxygen in the feed water. Hence various tests and instruments have been developed for determining the amount of this dissolved oxygen.



Dissolved-oxygen recorder for measurements of boiler water

The Cambridge Instrument Company, Inc., has just announced a new dissolved-oxygen recorder which is sensitive to one part of oxygen in 400,000,000 parts of water. The water to be analyzed enters a cooler regulator where temperature is reduced to about 85 degrees, Fahrenheit, and maintained at that point. A constant-head device maintains the correct flow of water through a scrubbing tower of the analyzing unit. Hydrogen, generated in an electrolytic cell, flows to the scrubbing tower where it comes in intimate contact with the sample water. From this point on, the operation is essentially chemical, involving generation of hydrogen in an electrolytic cell; the water then dissolving some of the hydrogen and giving off part of its oxygen; the resultant mixture of gases diffuses to a meter block which contains sensitive elements connected in the form of a Wheatstone bridge. Action of the gases on platinum spirals causes an unbalance in the bridge circuit which is shown as a deflection of the recorder needle which, in turn, indicates the concentration of dissolved oxygen in the sample water.

BEAN OIL

Substitute for China Wood Oil

AMERICAN industry took another step recently toward achieving economic independence of foreign sources of raw materials; discovery of a substitute for China wood oil was announced by Pabco Industrial Research Laboratories.

The new substitute comes from an American bean, though Pabco does not as yet say just what bean. Advantages of the new development are lower cost; freedom from dependence on China's war-disrupted, tung-oil production; and more profits for the American farmers—estimated at twenty million dollars—who grow the bean.

Tung oil is used in making traffic lacquer for highway striping. In this one use alone there should be wide adoption of this substitute which can be sold for 13 cents a pound, whereas tung oil cost about twice as much in 1940.

TANK PROTECTION

Rupture Disks in Tanks Relieve Pressures

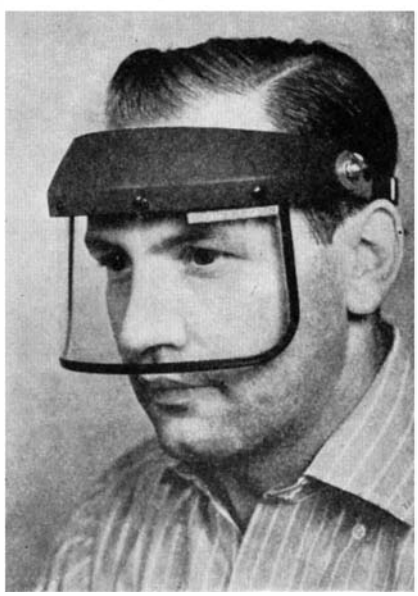
AN OKLAHOMA CITY engineer, Mr. Merl D. Creech, discussed recently before The American Society of Mechnical Engineers the fact that little work has been done toward safeguarding industrial pressure storage vessels against explosions. He said that even high-pressure air containers may often contain an explosive mixture introduced in the form of a small quantity of oil from defective compressors or by some faulty operation of equipment. Relief valves commonly used may take care of slow increases in pressure, but storage vessels are not protected from the rapid pressure during a combustion explosion of their contents.

Experimental work has been done with rupture disks mounted in the walls of such vessels. These disks would be made in large diameter of some relatively soft metal that is ruptured at a pressure point far below that of the bursting point of the vessel itself. Mr. Creech says that for the less violently explosive mixtures, a rupture disk of this sort will give absolute protection.

FACE SHIELD

Gives Protection For Workers

A NEW low-priced face shield for industrial workers has a plastacele window which hangs over the face like a small veil. It provides perfect vision, is flexible, gives good protection for the eyes against flying particles, and yet does not confine any portion of the face. This plastacele window, which is made in two sizes, is bound with flexible black binding and hangs from a broad head band of fiber.



Plastic face shield for workers

INDUSTRIAL TRENDS

INSTRUMENTS AND AIRCRAFT

As AVIATION goes, so goes many another industry; the electrical measuring instrument industry is no exception. When, back in 1888, a company was incorporated to manufacture measuring instruments invented by Dr. Edward Weston, powered flight by man was one of those things of which dreams are spun. In 1939, some 20 percent of sales of that same company were to the aviation industry; incomplete figures for 1940 indicate that this percentage will be exceeded.

Diversified uses of electrical measuring and indicating instruments give a broad field to this industry. Weston Electrical Instrument Corporation, alone, manufactures more than 600 different types, including such a wide range as voltmeters, frequency meters, ohmmeters, and wattmeters. With industry in general gearing up for greater production, more and more systems of automatic and remote control of processes will be developed and installed. Part and parcel of practically every such installation will be indicating and recording instruments of all types.

HEADLIGHTS TO PLASTICS

Remember the gas-operated headlights of early automobiles and motorcycles? Water dripping on a man-made stone produced the acetylene gas that, burned, furnished a lighting system of more or less reliability. Linkage between this cranky gas supply and industrial oxygen, plastics, safety glass, synthetic fibers, and a host of other modern developments may seem remote, unlikely. Typical of many industrial trends, however, the linkage is there, pointing the way to even greater developments for those who have the vision to see.

Again we go back to the last century for the beginnings of the story, this time to the Gay Nineties. The man-made stone was calcium carbide, product of the fusion of coke and limestone in the electric furnace. Short-lived, indeed, was the era of acetylene for lighting. The very force that gave birth to the carbide from which the gas was generated proved to be its successor. Electric lighting quickly supplanted gas. Under other conditions, the Union Carbide and Carbon Corporation might well have passed out of the industrial picture at this point. Research, however, as it has done in so many other cases, took hold and shaped the course of the future. Acetylene could be used for other purposes than lighting; burned with oxygen in properly designed burners, it found wide use in welding. By means of the oxy-acetylene torch, many industrial jobs could be done better than by other methods; new operations became possible that could be done in no other way.

From oxy-acetylene welding and cutting it was a logical step to investigating uses of oxygen itself. We can here pass lightly over the oxygen part of this story, since it was well told in the September, 1940, issue of Scientific American. Sufficient to say that oxygen now plays a substantial part in industrial processes not alone because of developments in technique but also because shipping problems were solved to the point where heavy pressure containers were replaced by tank cars and trucks that economically rushed liquid oxygen to consumption points.

Now the trend of this industry becomes clearer. Obviously, research in acetylene and oxygen uses would point the way to chemical applications of gases. Hydrocarbon gases, once obtained from acetylene but now to be had more conveniently from petroleum, are a fertile source of many organic chemicals that cannot be obtained economically from coal tar. From synthetic alcohols to solvents to ethylene glycol to a host of other synthetics goes the parade and, marching with these, go entire new industries built on research.

One of the turning points of the Union Carbide parade was the production of acetic anhydride, basic raw material for certain types of rayon, plastics, and film. Then came the vinyls, a chemical group stemming from acetylene and leading to, among other things, Vinylite, a plastic material of many uses. Here also started vinyl acetal, the plastic filler for safety-glass sandwiches.

Another branch of this parade of research is that concerned with iron alloys. Hark back again to the electric furnaces that first made calcium carbide. It is no wonder that the men who worked with these furnaces should become skilled in the manufacture of alloys that required tremendous heat for proper fusion. Hence the development of ferro-alloys widely used by manufacturers of stainless steels.

Largely a supplier to other industries for many years, furnishing the chemicals that would eventually reach the consumer in various forms, Union Carbide has followed a trend that has virtually forced it to become, itself, a supplier of consumer goods. Plastics for a multitude of purposes, textile fibers, safety glass, rayon, ethylene-glycol anti-freeze, all have changed the picture.

Beyond all this is the limitless chemical horizon. Plastics, ubiquitous though they may seem, are only in the toddling stage. Now Union Carbide is toying with a new process for obtaining phenol, basic raw material of one type of plastic, from hydrocarbon gases. Experimental work has been successful; only a definite need for a new source of phenol is required to press the button for commercial production.

COMPETITION FOR GLASS

Glass building blocks, widely used for architectural and decorative purposes, have a new competitor in a plastic tile that is light in weight, easily installed, translucent, colorful. This new tile, while it cannot be used as a structural member as can glass block, nevertheless can find ready application where colorful effects, combined with light-transmission properties, need not be combined with strength.

What effect this new Monsanto Chemical Company development will have on the glass-block business of Owens-Illinois Glass Company cannot yet be predicted, but past performance of Owens-Illinois in meeting competition can serve as an indication. Faced with inroads on the glass-container field, three metal-container companies were acquired; new outlets for glass containers in the food-packaging industry were developed; milk and beer bottles were improved. All of which is to the benefit of the consumer and to industry at large.

—The Editors

What is 'FM'?

Frequency Modulation Broadcasting Offers Improved Sound Range, Freedom from Noise

A. P. PECK

SINCE the first of 1941, broadcasting stations of a new type have been operating on commercial schedules in various parts of the country. Their signals can be heard only with special receivers. These stations employ the frequency modulation (FM) system first described in these pages in the May 1939 issue. Since that first description was published, experimental work has refined the system to a point where the Federal Communications Commission has given its blessing and sent FM out into the commercial world to make a living.

Boiling the whole thing down to the essence, we find that FM broadcasting, as compared with conventional or amplitude modulation (AM) broadcasting, differs in three important aspects. First, and possibly most important to the music lover, is a broadened range of tonal reproduction. Second is an almost total freedom from both natural and man-made static. Third is the lack of interference between transmitters operating in the same channel. This last point is not only important to the listener, who will not be troubled by heterodyne whistles when using an FM receiver, but has far-reaching economic aspects, as we shall see.

Before investigating in more detail the relative merits of FM and AM broadcasting, it would be well to point out the essential differences between the two systems. It has been said that many a good engineer has gone down to defeat in attempting to make the theory of FM easily understandable; thus we will make no attempt to delve into technicalities here, but will merely skim the surface.

As is well known, all radio waves have characteristics of both frequency and amplitude. The frequency of the wave is the number of times that it vibrates per second and is measured in cycles, kilocycles, or megacycles. Amplitude indicates the strength or intensity of the signal. Now, in order to transmit sound by radio, it is necessary that some characteristic of the wave be varied in accordance with that sound; modulated is the more technical word for "varied." That is, the sound to be transmitted is converted into electrical impulses and these impulses are used to modulate the radio wave. In conventional broadcasting (AM), the modulation circuit acts to vary the amplitude or strength of the radio wave, the wave staying at all times on the same frequency. In FM, on the other hand, the strength of the radio wave remains constant and the modulation circuit acts to vary the frequency.

It is all as simple—and complicated—as that.

With this background, it becomes easier to analyze the three important aspects mentioned above. Tonal quality of any reproduced sound depends on the range of the sound from bass to the highest notes. Cut off the bass or the treble and quality is sacrificed. Cut off both and things become worse. The tonal range of the best AM transmitters and receivers is from approximately 100 cycles to 8000. FM equipment, on the other hand, will handle frequencies from about 30 to 15,000 cycles. (Do not confuse these cycles with those of the frequency of a radio wave. We are dealing for the moment with sound, which is far removed in the spectrum from radio waves.)

ANYONE familiar with the physics of sound and music will tell you that the basic notes of all instruments are identical; the overtones, echoes, harmonics are the factors that give rise to the complex patterns of sound which distinguish the oboe from the piano, French horn from the violin. The vastly increased frequency range of FM, therefore, opens new fields to music, making it possible to transmit and reproduce all the exquisite overtones and harmonic notes that give to music its color, resonance, depth.

Now as to freedom from natural and man-made static: True enough, a modern AM receiver has little trouble from such interference, at times. Brute force of high-powered transmitters, combined with sensitive receivers, permits reception at such low volume-control settings that, unless the static is very bad, no interference is experienced. With FM, however, no such combination is necessary.

Lightning and electric razors, summer static and vacuum cleaners, automobile ignition systems and dial telephones all act as miniature (sometimes gigantic!) AM transmitters. Such are the characteristics of the FM receiver, however, that these impulses never get as far as the loud-speaker, hence are not reproduced; reception can go on during the worst barrage of interference.

The third virtue of FM—lack of

W2XOY, General Electric station near Schenectady, New York, used for both television and FM. At right is frequency-modulation antenna

interference between transmitters —is important to the ultimate use and success of the system. With AM transmitters it has been the practice to place them long distances apart when they are to operate in the same channel—that is, on the same frequency or wavelength. Alternatively, stations are required to share time, to use directional antennas, or indulge in some other form of co-operation or necromancy to keep down interference between stations. When two or more FM transmitters are operating on the same wavelength, however, the receiver automatically selects the strongest one; not a whisper of interference is heard from the others. Only where the receiver is located on the fringe of

Transmitter at W2XOR, frequency modulation radio station

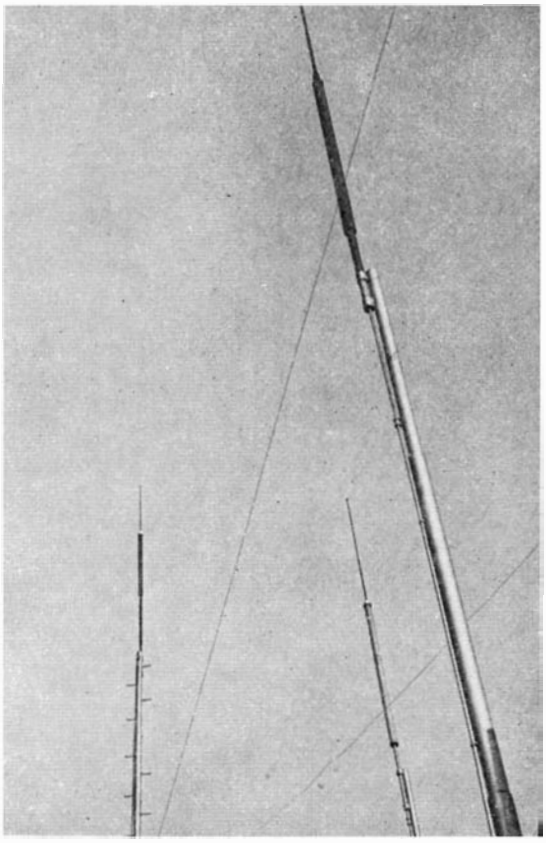
the service areas of two transmitters, where both signals are received with equal intensity, are there indications of interference. Here a simple directional receiving aerial will solve the problem neatly.

So far it would appear that FM holds the upper hand, but there is still one advantage on the side of AM that must not be overlooked. AM, operating in the conventional broadcast band, usually has a greater coverage area than FM. This is particularly true with high power. FM cannot approach the night-time coverage of a 50 kilowatt AM station operating on a "clear channel." Even the most powerful FM stations cannot reach out more than 100 miles with anything akin to constancy. This service limitation, however, is a characteristic of the high frequencies used for FM operation, rather than of the system itself. When AM is used in these same bands, FM proves superior. Thus we find many high-frequency police installations changing over to FM operation.

In all fairness to AM it must also be said that high fidelity of reproduction is not inherently a characteristic of FM alone. It can be had with AM, but not in a practical manner. Amplitude-modulation stations are assigned to channels with 10-kilocycle separation; true high-fidelity transmission would so widen the transmission band that there would be unmerciful interference between stations. Therefore AM, compelled as it is to observe legal limitations, cannot avail itself of its own possibilities and must, of necessity, get along as best it can.

IT IS obvious from the foregoing that an AM receiver cannot satisfactorily receive from an FM station, and vice versa. This has the effect of leaving the listening public out on a figurative limb. Will FM so soon replace AM broadcasting as to make obsolete all existing AM radio receivers? The answer is not quite as simple as the question. At the moment it appears that FM will fit into the radio picture in a logical, careful manner; there is no revolution, no wholesale junking of receivers in sight. It must be remembered that American broadcasting is an industry which has in excess of $75,000,000 invested in AM transmitting equipment alone; more millions are represented by existing receivers; still more millions are spent annually by the great networks. Investments and institutions such as these cannot be disrupted overnight.

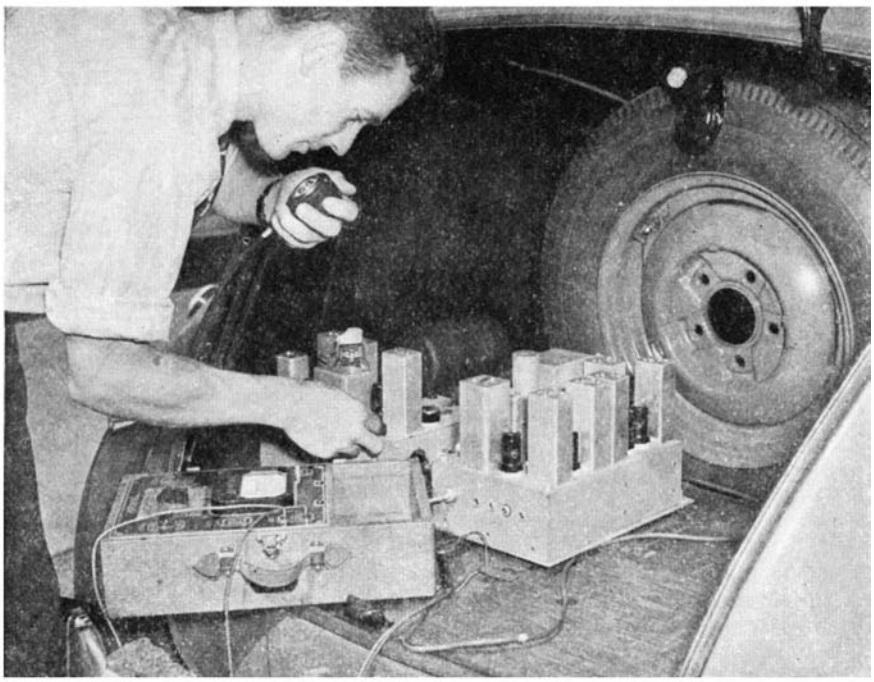
Where FM fits into the picture is in the "replacement market." This applies to transmitters and receivers as well. The receiver situation was well explained recently by Dr. W. R. G. Baker, of General Electric, in the following statement: "So far as FM receivers are concerned, we need only review the history of short-wave reception. First came the attachment which utilized our existing receiver, and finally the short-wave bands as they now appear on the modern radio receiver. It is not too much to expect that FM will follow the same path so that eventually the FM band will appear as a third or fourth band on the radio receiving set in practically every home."



Needle-like antennas atop a New York City skyscraper, used by station W2XOR for transmission of experimental FM programs

Already this prediction is coming true. It is possible to purchase an adapter for existing AM receivers, although it must be remembered that the high-fidelity characteristics of FM can be realized only with receivers of superior tone; the merit of FM may well be bottlenecked by a poor loud-speaker. In addition, several manufacturers are producing receivers for both systems; turn a switch and select FM or AM at will. These receivers fit perfectly into the replacement scheme, and will make the change-over process one of natural and normal absorption over a long period of years.

The economic significance of FM provides room for interesting speculation. No matter how we look at radio broadcasting as an entertainment, educational, or communicating medium, it must be admitted that its most important aspect is that of commercialization. Broadcasting stations compete for your attention and stand or fall in their chosen business by their degree of success in this direction. If you, as a member of the listening public, patronize the sponsors of programs over a certain station or chain, that station or chain will stay in business. If you don't, that station or chain will fail. Hence, in the past, the method of assuring commercial success has been to use such high power in transmission that you would find it easier to tune to a particular station and you become a member of its regular



Extensive field tests have been conducted in studying characteristics of FM transmission and reception. Here is a General Electric portable set-up that is carried in a car trunk. The transmitter is at left, receiver at right

audience. With FM, however, the picture changes. Governing regulations of FM transmitters will rate them on the basis of coverage area, not of power. Hence, tuning across the FM band, you will find that all stations in your service area come in with equal or nearly equal volume. You will, therefore, no longer tend to listen only to those stations easiest to receive, but will make your selection on the basis of program quality. This fact will naturally put strong emphasis on good programming, and we may well expect that future FM programs will be presented on increasingly higher planes.

It is expected that, by the time this article reaches the reader, FM service will be available in a dozen widely separated major cities. There are still, however, those who look askance at FM. They see it as a newcomer that will endanger the big business of broadcasting; they see the day when AM will be relegated to rural areas, with FM serving metropolitan areas exclusively. There are others, more far-sighted, perhaps, who see AM and FM developing along parallel paths, as parallel services to increase and enhance the wealth of education and entertainment available to the radio audience.

Both factions, however, must bear in mind that the listening public, not the engineers, will be the deciding factor. FM stations are on the air. They already have large audiences. If these people find in FM something desirable, better, more adapted to their wants, they will demand it. And that demand will be heard and obeyed. In the final analysis it must be remembered that the public made broadcasting possible; that same group will determine the fate of FM.

• • •

HALF SOLES

Invisible Joint Depends on Aluminum Last

YOU'VE probably seen signs advertising "Invisible Half Soles" hanging in shoe repair shops. Our curiosity finally beat us, accustomed as we were to a rough, ugly joint about halfway back on the soles of our re-soled shoes, so in we walked to ask about "Invisible Half Soles." We also walked into a peach of an aluminum story.

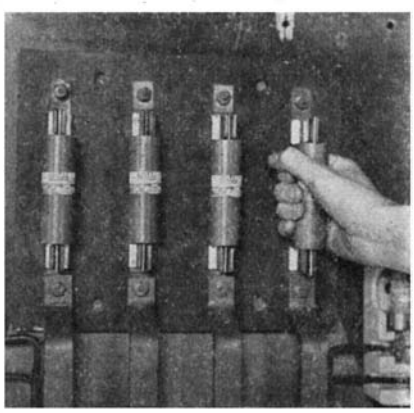
They are half soles and they are invisible, and there is a joint, but it doesn't show. But instead of the old, prominent stitching and nails, the new sole is applied by tough, weatherproof cement. Then the shoe is fitted with a scientifically designed aluminum-last body and sole plate which press the new sole tightly against the body of the shoe until the cement dries. The aluminum body and plate are carefully designed to retain the contour of the shoe and avoid changing the comfort of a pair of broken-in shoes.

These plates and bodies are part of the complete Shoepress System, developed by The Shoe Press Corporation. Aluminum is used because of light weight and its ability to withstand the strain imposed on the gooseneck of the body when in the press.—*Aluminum News-Letter.*

SHOCKLESS FUSE

Cartridge Type Fuse Simplified, Made Safer

FROM the laboratories of the Warren Lamp Company comes a new renewable cartridge fuse which may be inserted or removed without the use of fuse pullers. Its primary difference from standard fuses is its lack of ferrules on the ends. A tough casing of hard fiber, comprising the body of the fuse, extends all the way from one knife edge to the other, eliminating possibility of shock when removing fuses. Furthermore, the construction of this fuse is simplified as it has only two main parts besides the renewable link.



No shock from new fuse

ACID-RESISTANT ENAMEL

CHEMICALLY pure acetone kept at the boiling point day and night for over six weeks would, one might think, destroy the surface of even the best enamel. Such is not the case, however, with Devilac Bake Enamel, for exactly that kind of test has been run by the manufacturer—may still be running for all

we know—and no change in the glossy film surface has been noted.

Devilac enamels have been developed especially to resist concentrated sulfuric, nitric, and hydrochloric acids, as well as alkalies and gases. The air-drying types dry in less than 10 minutes, while the bake types require either 30 minutes at 250 degrees, Fahrenheit, or 20 minutes at 275 degrees, Fahrenheit. It is claimed that they are resistant to all the chemicals mentioned above, and that neither the original hardness nor the color changes under their influence.

LINEN FOR DEFENSE

THERE is a great deal of talk about this or that material being a national-defense essential, yet most often these materials simply enter into the industries which prepare totally different kinds of products in the defense program. Linen might at first glance be considered as one of these. Yet it is actually vital to a piece of equipment very necessary in military operations; linen is used in making the cords for parachutes.

Normally much linen is imported, but since the supply from such countries as Belgium and the Baltic states is shut off, American farmers have increased their production of the fiber. Particularly in Oregon, Washington, and Michigan, has the production of flax gone up—to a point almost double normal production. We do not quite produce all the fiber flax required, but, to help make up for this deficiency, the U. S. Department of Agriculture reports that a heat-resistant type of cotton and other substitutes have been found satisfactory for certain purposes in parachute rigging.

NEW PLASTER

Of Magnesium Sulfate, Is Stronger

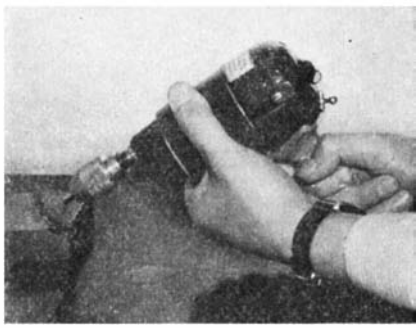
THOUGH chemically the same as plaster of Paris, a new gypsum plaster, described recently at a meeting of the American Institute of Chemical Engineers, is about twice as strong as the old-fashioned article. In fact, it approaches Portland cement in strength.

The new product was announced by E. P. Schoch and William A. Cunningham of the University of Texas. It is prepared, they explained, by heating gypsum in a magnesium sulfate solution, whereas plaster of Paris and ordinary wall plaster are made by the dry calcination, or burning, of gypsum.

Experiments in a small pilot plant indicate, they stated, that it can be made at a cost of $8.82 per ton, a figure that may be reduced by large-scale production. Probably the magnesium sulfate plaster will find its chief application in wall board, tile, and other factory-cast products.—*Science Service.*

HAND ELECTRIC TOOL

DELICATE carving or engraving may easily be done by the Whiz electric tool produced by Paramount Products Company. This light-weight tool has a pistol grip



Multi-use hand tool

and may be had in either single-speed or two-speed models. A large cooling fan in the motor prevents overheating when the tool is used constantly. A flip-over switch is conveniently placed under the thumb of the user.

For use with this handy device there is a vast assortment of small grinding wheels, steel burs for carving, drum sanders, saws, polishing wheels, cutting disks, and brushes. Drills in sizes from 1/16-inch to 3/16-inch are also available.

CROSS-EYES

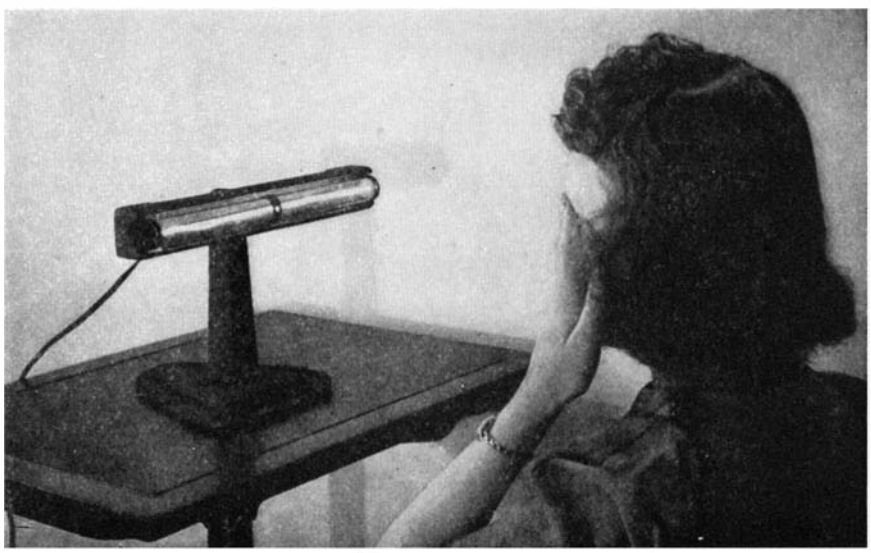
Device Shows Whether Treatment Will Succeed

THE perplexing problem of deciding the possibility of treating cross-eyes successfully has been solved by the development of a new testing device, first of its kind, which determines in advance of treatment whether the eyes of cross-eyed persons can work together as a unit after they have been straightened by eye-muscle exercises or surgery.

The new instrument, announced by Dr. J. F. Neumueller, whose article on eye-science appears on page 89 of this issue, requires only a half minute for the diagnosis, and its performance is based on the phenomenon of the after-image—the sensation of seeing an image after the stimulation causing it has ceased to exist.

The after-image tester consists of a glass tube containing an electric wire. The current is switched on and as the wire glows the patient looks through only one eye at a red dot on the center of the tube. The tube is then turned from its horizontal position to a vertical position and the patient peers at the red spot through his other eye only.

Then the light is turned off and



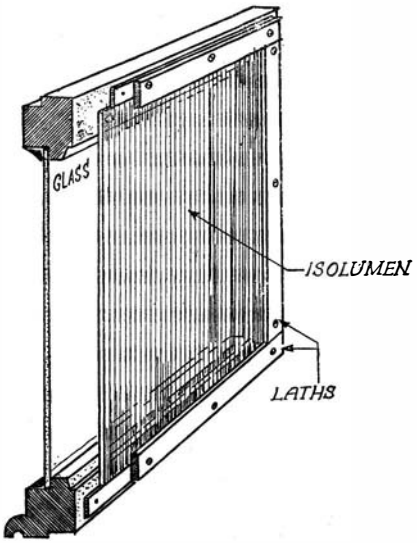
After-image phenomenon determines desirability of cross-eye operation

the patient, both eyes now open, looks at a fairly bright wall. Soon he notices two dark lines, the negative after-images. If these two lines form a cross, his cross-eyes can be successfully treated. But if the two lines do not meet, the chances of restoring binocular vision are remote.

BOMB-RESISTANT

Plastic Sheet in Windows Resists Bomb Concussion

BECAUSE the concussion of bombs falling on London smashes windows over a very wide radius even when there is no actual damage from bomb splinters, many people have wondered how Londoners will keep warm this winter and at the same time get some daylight into their



Isolumen sheets reduce window damage from bomb concussion

homes. A number of measures have been taken to care for this situation, but one of the most interesting is the use of a new type of plastic sheet called Isolumen.

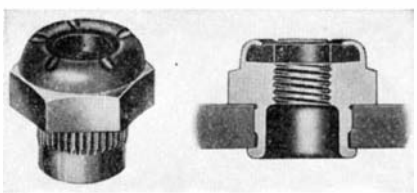
Isolumen consists of a corrugated transparent sheet sandwiched between two clear acetate sheets to make a product very similar in construction to our ordinary corrugated packing cardboard. The corrugated construction provides not only strength and rigidity but also air chambers which enable the slab to act as a thermal insulator. There is no fibrous or metallic reenforcement, and the plates have self-supporting stability against wind or snow pressure, though the material is not as rigid as glass plates. On the other hand, it is considerably lighter than glass.

Whether a window pane has already been smashed or not, the Isolumen sheets may be attached to the window frame by a simple arrangement of laths tacked in place. Besides providing for the transmission of daylight and insulating against heat loss, this sheet gives protection aganst flying glass and even against bomb splinters. Concussion due to a bomb would probably lift it as a whole from the window frame, but the elasticity of the plastic would cushion the force.

ELASTIC NUT

Knurled-Shank Clinch Type Is Self-Locking

FOR fastening sheet-metal assemblies in which the parts must be readily removed and returned to position, a clinch type of self-locking nut with knurled shank is offered by Elastic Stop Nut Corporation.



Unthreaded fiber collar locks screw, takes up thread play

To install the nut, a hole is drilled in the structure and the shank is pressed into the hole. The mouth of the shank is then spread against the back of the structure to effect a clinching hold. The knurling engages the drilled surface and thus assists in eliminating any turning of the nut.

The head of the nut is fitted with the vulcanized fiber collar which characterizes all types of Elastic Stop Nuts. This collar, being unthreaded, resists the entrance of the screw, thus automatically taking up all thread play and bringing the load-carrying thread faces of nut and screw into a tight pressure-contact.

CATTLE FOOD

Urea Useful in Cattle Ration: May Mean Savings

UREA, a simple nitrogen compound hitherto used principally in fertilizers and plastics, can be mixed with cattle feed as a substitute for more expensive sources of nitrogen, nutrition researches at the University of Wisconsin indicate.

Comparative feeding experiments, conducted by I. W. Rupel, G. Bohstedt, M. I. Wegner, and E. B. Hart, showed that groups of cows receiving urea as their principal source of nitrogen produced as much milk as similar groups which got their nitrogen in the form of the much more expensive linseed-oil meal.

The experiments lend support to the theory that bacteria in the digestive tract of cattle assist in their nutritional processes. When natural stomach juices from the animals were mixed with urea and cattle feed, under proper chemical and physical controls, as much as 95 percent of the urea disappeared, to reappear in the structure of bacterial cells.

WIROMETER

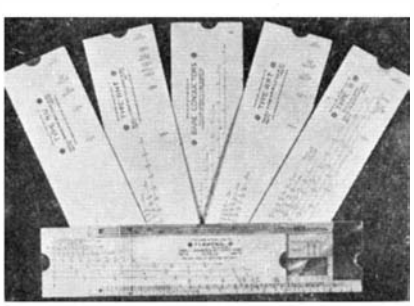
For Computing Common Wiring Problems

A POCKET-SIZE wire calculator, called the Wirometer, for use in computing wiring problems in accordance with the latest National Electrical Code, has been announced by the General Electric appliance and merchandise department. The Wirometer provides a quick method for arriving at code requirements.

Information which may be obtained quickly by the use of the device includes: conduit fill of all approved types of building wires, including wires of different sizes in one conduit; current capacities for wires when more than three wires are run in one conduit; corrections in current-carrying capacity for ambient temperatures over 30 degrees, Centigrade; and voltage drop for eight distribution systems.

The Wirometer is 8 inches long, by 2⅜ inches wide, and is made up of two sliding celluloid covers and six interchangeable cardboard slides.

Still another slide-rule type of wire calculator is of durable cardboard, with an inner slide, made by the General Cable Corporation. Both sides of this calculator are slotted to read, in three different



For determining wire data

holes, data printed on the inner slide—one side being for new work and the other for rewiring. Data obtainable are current capacity, size and type of wire, and conduit size. A temperature correction is also given on each side.

SOUND-PROOF

Room Not Sealed From the Outside

OUT in East Springfield, Ohio, there is a new listening laboratory in which the sound of your own breathing resembles that of a small air bellows, and the snap of your fingers sounds like a pistol shot.

It is used as a sound inspection chamber for household refrigerator units.

This new laboratory of the Westinghouse company is the only sound-proof chamber in the world which is not completely sealed from the outside when in operation. Therein lies its unique character. In construction it resembles a labyrinth, or maze; it consists of a series of winding passages with 90-degree and 180-degree turns. Near the middle of these passageways is the actual sound-proof chamber, a 21,000-pound "floating room," which is supported in the air by 20 steel springs.

The winding passageways act as baffles to destroy reflected sound waves. But in addition, all walls of the labyrinth are covered with soft padding to absorb sound waves.

HEATING

"Reverse" Air Conditioning Now Used in Office Building

HIDDEN units of heat extracted from cold outside air and water soon may provide a new source of low-cost heating for the modern home.

Final tests of a plant to "reverse" air conditioning were recently made in a new two-story office building of the Ohio Power Company in Coshocton, Ohio. Cold well-water, used to cool the building in summer, will supply winter heating when a switch is thrown. The reverse cycle refrigeration process which makes this possible has been developed at the Springfield plant of the Westinghouse Electric & Manufacturing Company, as discussed in our pages some years ago.

There is heat in everything—

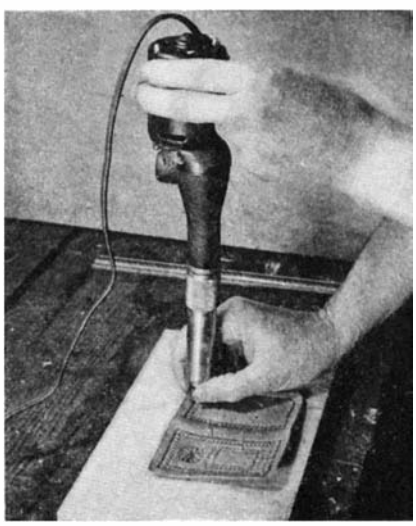
even down to 459.6 degrees below zero, Fahrenheit. The air in an ordinary-size room at 32 degrees, Fahrenheit, still contains over 1300 hidden units of heat. If they could all be extracted from the air, these heat units would be able to melt a six-inch cube of ice and bring the water which resulted to boiling point.

In the Ohio installation, "refrigerated heat" is taken from cold air by a process which literally puts a refrigerating system "in reverse." First, well water is drawn into the system at the rate of 80 gallons a minute. Heat units are extracted from the water to heat the building, thus making the cold water colder. These heat units heat water in a condenser used to warm the air in the building, while the cold water goes outdoors to "warm up" again. In summer, the well water is heated with heat units extracted from inside the building and is then thrown out to "cool off."

"JACK-HAMMER"

Electric Hand Tool Makes Hammered Metal

ESPECIALLY well received by our readers was our discussion of the Handee electrically powered hand tool for all kinds of grinding and



Leather-working with the new electric reciprocating hand tool

drilling operations. The producer of this efficient tool now announces a reciprocating plunger type of tool, called the Handee Artizan. The tool, held in the chuck of this machine, instead of rotating, delivers perfectly graduated blows to the work at the rate of 800 times a minute.

With the Artizan, small saw-blades may be used to do a job equivalent to that of a jig-saw. Or, again, files may be attached to do some types of filing jobs. Other pointed or knob-ended tools can be used for leather-tooling or for what the manufacturers call hammer-smithing of metal. For the

Electric hammer-smithing of metal opens new hobby fields

hobbyist these last two uses might prove the most fascinating, for a tool especially designed for metal working can be used to make all manner of small hammered metal objects such as trays, plates, candlesticks, and the like.

SHIFTING TRUCK

For Shuttling Railroad Cars

OCCASIONALLY, in an emergency, motor trucks have been used in freight yards to shuttle cars. At the Pacific Coast Terminals of New Westminister, British Columbia, is a large Mack truck whose sole job is that of shifting freight cars. It travels on the floored areas of the yards, and can move as many as six loaded freight cars at a time, or a load of no less than 420 tons.

This truck carries a ballast of five tons of lead and is equipped with a sub-frame to which front and rear bumpers are attached. The sub-frame is bolted to the regular chassis frame by means of rugged gusset plates. The bumpers are mounted on heavy springs so that in bumping and pushing the heavily-loaded cars there is no shock to the chassis. Likewise, the tow-hooks used for pulling are spring-mounted.

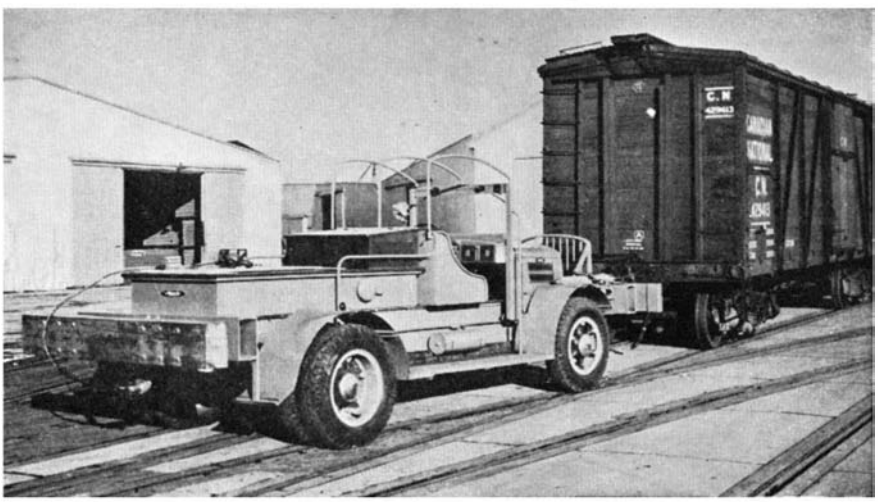
This Mack, with a three-man crew, can switch approximately twice as many cars in one day as can be accomplished with an ordinary switching engine and a crew of four.

COLCHICINE

Of Dubious Value in Animal Experiments

STRIKING results reported by plant scientists in treating plants with the chemical colchicine, have led many laymen to speculate as to whether the method has parallel possibilities in the animal world—whether the chemical tinkering with hereditary makeup of cells can be extended to animals, even perhaps to mankind.

In a review of the short history of colchicine technique, Haig Dermen of the U. S. Department of Agriculture, writing in the *Botanical Review*, makes clear that the prospect of advances in the plant-breeding field is much brighter than with animals. The first experiments with colchicine, in 1934, were in connection with animal



Lead-ballasted motor truck takes over a locomotive's work

tissue, and proved deadly to the animal cells, which degenerated and did not reproduce. One of the first experiments was an effort to kill cancer cells. By 1937, plant scientists, following with somewhat similar treatments, found that plant cells when treated at favorable stages and with suitably weak solutions not only doubled the number of their chromosomes but were able to resume growth and reproduction.

The difference in the response of cells in plant and animal tissue is so marked, says Doctor Dermen, that colchicine experimenting by amateurs is *definitely dangerous*. A minute quantity of the solutions used on plants might cause blindness if it reached the eye, or might cause skin irritation if carried to the face.

It seems evident, says Doctor Dermen, that plant treatments, for the present, offer a much more promising field.

COLOR-BLIND FLYERS

In Demand Now; They See Through Camouflage

FOR years Uncle Sam has been turning away color-blind flyers who wanted to go through the Army Air School at Randolph Field; now he is looking for them, according to *Ethyl News*. It has recently been discovered that camouflage, so successful in hiding guns and barracks from enemy aircraft, doesn't fool a color-blind man the least bit. He can see right through it.

The answer is, of course, that camouflage is almost entirely a matter of color—airplanes, for example, will be painted ground-color on top and sky-color on the bottom. Yet to any one who sees everything as various shades of gray, the familiar outlines remain unchanged. Even a thin screen of leafy branches does little good.

The discovery was made by accident at Fort Sill, Oklahoma, when the Army was testing the effectiveness of camouflaging heavy guns so they could not be spotted from the air. A regular air corps observer picked out 10 of the 40 guns which had been disguised. An observer from the field artillery picked out all 40—and confessed, after landing, that he could not distinguish one color from another. The answer was of course that he was color-blind.

According to the commandant

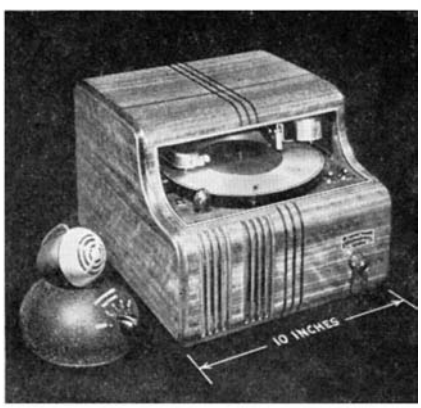
of Randolph Field's school of Aviation Medicine, this chance discovery suggests that a totally new scheme of camouflage will have to be developed for guns, airplane hangers, fuel or ammunition dumps, and other strategic objectives.

DICTATING MACHINE

Makes Use of Electrical Recording Principles

THE SoundScriber Corporation has announced the production of a new type of dictating recorder using wafer-thin alloy disks. It is light in weight, has low operating cost, and can record conferences. The set consists of a recorder with a microphone, and a transcriber.

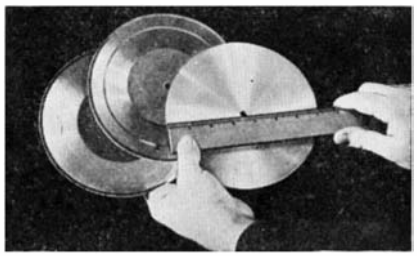
The disk, one of the most interesting features, is of a metal alloy, 0.006 of an inch thick and seven inches in diameter, and is practically indestructible. It can be dropped, bent, and written on without destroying the sound tracks. Fifteen minutes recording is obtained on each side, or one half hour per disk, by the use of low turntable speed and close groove spacing. A carton of 100 disks—which stack to a height of only 0.6 of an inch—thus contains 50 hours of recording capacity. The disk can be filed like a letter or mailed without special packing, and weighs only one-third of an ounce.



Compact recording unit and microphone of dictating machine

The microphone can record a whisper, or all the voices at a conference up to a distance of 20 feet.

The dictating recorder has a seven-inch turntable, and the recording head is equipped with a permanent diamond-tipped needle embossing the sound groove in the disk without chips or shavings. This unit also includes a built-in loud speaker and play-back head with a permanent sapphire-tipped needle. Dictation may be instantly played back on the same instrument by simply turning a control which automatically lifts and locks the cutting head while the disk is being played back.



Seven-inch dictating disks

The transcriber contains the play-back features of the recorder, but it also provides a gooseneck "soft-speaker," audible only at the secretary's ear.

GUM IMPORTS

Industrial Essentials Still Come In

IN SPITE of the fact that the war has disrupted shipping of many types of essential materials into and out of this country, *Chemical News* recently reported that the outlook is favorable for the continued shipment of gums from the Far East and central Africa. They report that gums will continue in sufficient quantities to meet the requirements of American industry.

Congo gum formerly entered the United States by way of Antwerp but is now coming directly from Africa. This gum is an important natural resin for use in oleoresinous varnishes of all types.

There seems also to be no shortage of other natural gums, important for varnishes, which are imported regularly from the Netherlands East Indies. This is reflected in the prices which jumped upward when the war began but are now sufficiently low to stimulate a further increase in the use of these natural gums.

PLANETARIUM

"Vest Pocket" Installation Does Full-Size Job

A TEN-CENT mirror, electric clock motors, and a radio switch are the basic parts of a new invention which is a sort of "vest-pocket" planetarium. It had its preview some time ago in the Berkshire Museum at Pittsfield, Massachusetts. Called a "Stellarium," the

machine was built at a total cost of $250 by three young electrical engineers, Willard F. M. Gray, Stephen C. Leonard, and Guiles W. Bradshaw.

In the natural history room of the Museum is a small drum, two and a half feet in diameter, containing all the mechanism. From this are reflected the pictures of the heavens. They are slides of star maps made by Stewart Greene of the Museum staff, which are both scientifically accurate and extremely effective artistically. The maps are flashed from a mirror onto a flat ceiling by an air-cooled projector with a short focal-length lens. Ingeniously contrived so that they revolve, showing the heavens at any given date, the star slides also move back and forth, permitting the placing of constellations at any given point. Inexpensive electric clock motors move the projector for the planets. The entire mechanism is run by remote control.

This unique machine can do almost anything in its scale that the Hayden Planetarium can — and more. For example, it shows the planets enlarged, the moon in its various phases, and a total eclipse of the sun with the corona appearing.

VERTICAL FILING

System Eliminates Cabinet Troubles

A NEW method of vertical filing has been introduced, in the "Pendaflex" line, by the Oxford Filing Supply Company. This system consists, principally, of a method of holding the letter folders vertically within the filing drawer. In order to achieve this, a simple steel frame is inserted in any letter- or legal-size drawer. The two upper side-bars of this frame act as runners or slides for the ends of hanger rods mounted in both upper edges of each "Pendaflex" filing folder. These hanger rods are hooked to engage the side-bars positively.

Use of this new system eliminates the follower block, prevents the inconvenient jamming of fat folders, and never runs into the difficulties encountered when folders fall forward or backward.

In the new filing system described, folders are equipped with hooked hanger rods that engage side bars, holding the folders always vertical. Folders are easily removed or replaced

CATTLE TB

Bovine Tuberculosis Now Practically Wiped Out

BOVINE tuberculosis is now practically eradicated throughout the United States, the U. S. Department of Agriculture has announced. The last two counties, Kings and Merced, in the last state, California, have completed their testing and re-testing for infected cattle, and now every county in every state in the Union has fewer than 0.5 percent of its cattle infected.

The campaign has been going on for 23 years, in the course of which more than 232 million tuberculin tests and re-tests have been made, and about 4,000,000 tuberculous cattle detected and removed for slaughter.

This does not mean, it is pointed out, that nothing further remains to be done. Re-testing is still called for, especially in herds from which tuberculous animals have been removed in recent years, to prevent re-infection and a new spread of the disease.—*Science Service*

"MYSTERY" GUNS

British Lead; We May Have To Follow

BRITAIN'S new "mystery" anti-aircraft weapons, reported as filling the air with strange noises when Nazi planes try to pass overhead, have started a grand guessing game among ordnance men in this country, according to *Science Service.* Since it is admittedly just about impossible to describe anything merely from the sound it makes, the guesses do not pretend to be more than that—just guesses.

Most plausible would seem to be the one about the sound described as "a heavy single explosion disin-

THUMBS UP!

"If you have readers who would care to post me used back numbers of Scientific American," writes a reader from the "edge of the gun barrage" in London, *"they would be appreciated and passed on to our soldiers, thus helping to a community of ideas between our two countries.*

"Cheerio! Thumbs Up!
F. J. Young
5 Forest Drive,
Theydon Bois,
Essex, England"

(Any reader wishing to make this friendly gesture may forward copies to the address given above. Postage on Scientific American going to England is at the rate of 1½ cents per ounce.)

tegrating into staccato cracks high up in the heavens." This sounds as though it might be a large-caliber shrapnel projectile containing explosive bullets or small shells instead of the conventional pellets of ordinary shrapnel. Fired at a mass formation of bombers, a shrapnel shell of 6-inch caliber (or even larger) could create a menacing cone of danger that might force the plane formation to break up, even if it did not immediately destroy any of them.

A second weapon, described as making a flat roar striking a ceiling several miles up and then bumping along the top of the sky, may possibly be a rocket. Military rockets make a peculiar flat roar; the "bumping" effect heard on the ground may simply be echoes of the explosion reverberating, thunder-like, from the clouds.

The third weapon, nicknamed a "carpet-slipper machine gun," may be nothing more mysterious than a machine gun equipped with a muffler or a Maxim silencer, which removes most of the bark (though none of the bite) from single-shot firearms.

The fourth, which is said to have no more noise than the "frou-frou of a taffeta gown," seems to be nobody's guess. What is any honest ordnance man to think of a weapon that doesn't make even the suggestion of a bang?

Since the four sounds described seem to be in a descending order of noisiness, is there, perhaps, still another, a fifth weapon that operates in absolute silence?

ANTI-OXIDANT

Vitamin E in Animal Fats "Keeps" Them Longer

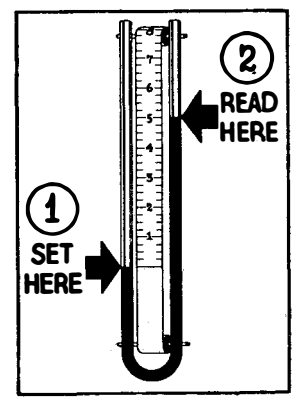
ANIMAL fats and oils, such as lard and cod-liver oil, tend to become rancid easily. On the other hand, vegetable oils such as cottonseed and wheat germ oils may be stored for long periods of time and yet remain perfectly fresh and stable. The vegetable oils but not the animal fats are rich in vitamin E (tocopherol).

When vitamin E is isolated in its three pure forms (alpha, beta, and gamma tocopherol) and added in small amounts to animal fats, it acts as a stabilizer (anti-oxidant) for these fats. That is, lard containing the vitamin remains fresh much longer than lard having no added vitamin E. Evidently, the presence of vitamin E, and possibly other as yet unknown stabilizers in vegetable oils, contributes to their excellent keeping qualities. When the vitamin is removed from the vegetable oils by various means, the recovered oil has the behavior of an animal fat.

MANOMETER

Direct-Reading By Simple Setting

EXPERIMENTERS and researchers using ordinary manometer tubes usually have two readings to make, and must subtract one from the other in order to learn the true difference between the height of liquid in the two legs of the U. A new direct-reading, U-tube manometer,



Help for the laboratory worker

developed by Trimount Instrument Company, permits a simple setting of a graduated scale so that the difference is read directly.

Between the two legs of this manometer is mounted an "endless-belt" flexible-steel scale operated from the side. When a reading is desired, the technician rolls up this tape until the zero point is opposite the lower surface of the liquid. The reading on the steel tape opposite the upper surface of the liquid in the other leg of the tube is the exact difference between the two levels.

WHEELS

The Nation Rides, And Depends on Them

IN ONE generation the American people have taken to wheels. But definitely!

As recently as 1915, a motor trip was an adventure. In 1940, some 1,000,000 farm motor trucks brought crops to market; 86,000 baking trucks delivered baked goods to American homes; 20,000 trucks delivered coal and oil; 100,000 "fire engines" were motorized;

12,000 police cars patroled city streets; 4,000,000 children rode to school daily by motor bus; 26,000,000 people got their RFD mail by motor car; 7000 public health nurses traveled by automobile; and even the steam railroads operated 1800 motor buses over 45,000 miles of highway route! In addition, the railroads employed 63,800 motor trucks for station-to-door deliveries. Topping all, 600,000 vehicles of the trucking industry transported countless tons of freight over the nation's network of highways and byways.

DWARF APPLES

DWARF apple trees seem to be gaining rapidly in favor as attractive ornamentals. This fact is of no interest to the commercial fruit grower, but the amateur gardener will be pleased to learn that these may now be obtained from nurserymen.

These dwarfs do not grow taller than a man can reach; they bear fruit the first or second year after planting; and are especially well suited for training to special shapes. In reporting these facts, the New York State Agricultural Experiment Station adds the thought that often the bloom alone is sufficient to repay the planter for his time and labor.

PLASTIC MOLDING

Alloy Makes Harder Dies After Hobbing

QUANTITY production of intricate plastic parts has been considerably simplified since the introduction of "Plastalloy," a nickel-alloy steel produced by Henry Disston & Sons, Inc., in Philadelphia.

A large proportion of plastic molds are made by the "hobbing process," in which a hardened steel master hob, the exact shape of the finished plastic piece, is forced into a block of soft "hobbing" steel to a considerable depth. The resultant mold is then carburized and hardened. The hobbing steel must obviously be as soft as possible, extremely clean and sound to avoid any chance of pits, cracks, or inclusions on the face of the cavity, and it must case-harden well.

Until a few years ago it was common practice to use for this purpose a very low carbon "ingot iron," but when industry began to demand larger plastic parts in great quantities it became apparent that such molds would not stand up in service. They either wore out very quickly or sank under the increasingly heavy pressures involved in the process.

To meet the growing demand for a better mold steel the tool steel works of Henry Disston & Sons developed Plastalloy. This is, essentially, a very low carbon steel containing enough nickel, balanced with other alloying elements, to provide very high core strength along with high surface hardness after case-hardening. Soundness is stressed in all stages of mill practice, and a special annealing cycle has been developed to soften the steel uniformly so that it is almost as easy to hob as the softer irons.—*Nickel Steel Topics.*

METALLIZER SAVINGS

Metal Coatings Salvage Railroad Equipment

IN RECENT years the metallizing process has found numerous new applications not only for coating metals but also for repairing machinery by building up worn parts with deposited metal. This process, described years ago in Scientific American, consists in the melting of a metallic wire as it passes through a hand gun, and squirting the molten metal in spray form against the material to be coated.

An important new application of metallizing has been worked out by a well-known middle-western railroad. That company is reclaiming many locomotive parts which would normally be scrapped, by first metallizing the worn part with stainless steel and then machining the part with Carboloy tools down to proper size. The company claims that such parts as shafts, water-pump piston rods, motor shafts, and other such equipment are giving 100 to 300 percent of their original service life after being thus reconditioned.

RUBBER SUITS

Conduct Electricity and Warm Aviators

RUBBER, ordinarily an insulator against electricity, has now had this characteristic so reversed that it not only conducts electricity but does a very useful job. Researchers of the United States Rubber Company have added certain chemicals during the rubber mixing process,

with the result that a sheet of rubber can be made to act very much like an electric heating pad.

To indicate the value of this development it is first necessary to look backward a bit. At the outbreak of the present war, the French air forces were at a disadvantage because their entire planes were heated. As the war progressed, air fighters went upward from three miles to an altitude of six or more. At these great heights, the outside temperature may be 20 to 30 degrees below zero; the heated French ships would frost up on the windshields so that visibility was cut to zero. All they could do then was to turn tail and go home. The Germans, on the other hand, equipped their air crews with silk underwear suitably wired and attached to the planes' generators to keep the men warm while the rest of the planes remained cold and did not frost up.

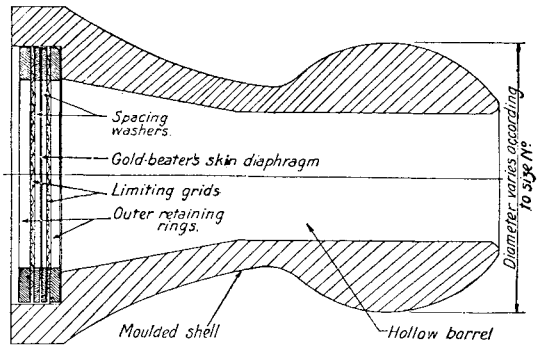
Thus it may easily be seen why the new electrically conducting rubber finds its first use—and a vastly important one—in new suits for aviators. When electrically connected to the planes' generators, the rubber conducts electricity and throws off radiant heat over its entire surface.

EAR PROTECTOR

Permits Hearing, Protects Against Bomb Blasts

CASUAL conversation regarding the dangers to the civilian population in London during bombing raids often comes around to the question of ear protection. Comment in the newspapers recently indicated that the British Government has issued ear protectors of several kinds to the public, and the magazine *Plastics* (London) recently described one of these, made of molded plastics.

This particular ear plug, known as the Mallock-Armstrong Ear Defender, was first invented before the World War as a result of experiences on gun-testing ranges. Present interest in it lies partly in the fact that it is now made of a plastic, but more so because of its ingenious construction. Our illustration, used through the courtesy of *Plastics,* shows the design of the plug and its grids and diaphragm; the vibrating diaphragm is of gold-beater's skin.



Cross-section of the British ear-protecting device designed to permit hearing of ordinary sounds, yet to protect against ruptured ear drums during heavy bombardment. Drawing shows how diaphragm is fitted into the molded shell

The bulbous end of the Defender is fitted into the outer canal of the ear which—if the Defender is a good fit—it completely fills, blocking all passage of air to the ear. The diaphragm, free to vibrate within the limits of the screens, faithfully passes on to the ear all sounds of normal amplitude, such as speech, music, and so forth; in the presence of loud noise, the diaphragm's movement is restricted and, in consequence, the passage of the noise is largely obstructed. Likewise, any sudden change of air-pressure such as would be caused by an explosion or series of explosions is unable to reach the ear-drum, as it causes the diaphragm to lean against the screen where any further movement is checked.

It will readily be seen that the presence of the Defender in the ear obviates all likelihood of a ruptured drum; even the temporary deafness, which usually follows exposure to excessive noise, is completely eliminated and the hearing remains fully sensitive for the reception of small sounds.

WET-SURFACE PAINT

A NEW paint which may be applied directly over a condensing surface covered with water, and which will hold as tightly as though the surface were bone dry, has just been announced. Called Underwater Paint, this coating works and brushes easily and will seal and paint in one coat such highly porous surfaces as wall boards, plaster boards, and gyp-

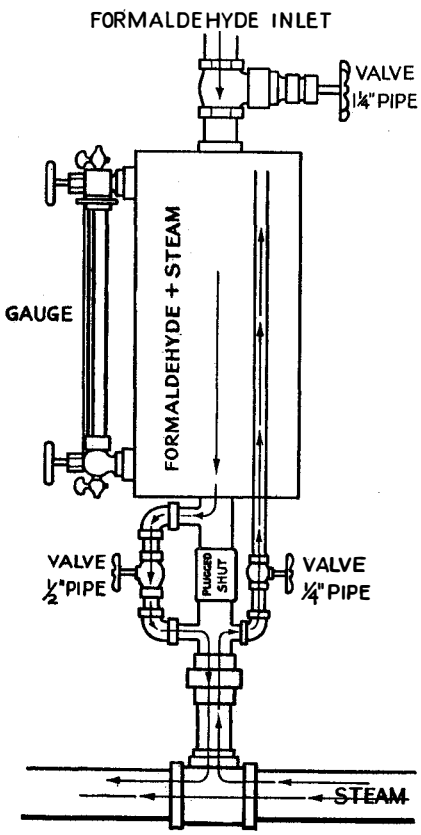
sum blocks. It is made in white or in tints. It is useful for painting below the ground surface on basement brick, concrete, and cinder block walls, as well as in tunnels, swimming pools, and the like.

GREENHOUSE SOIL

Sterilized by Formaldehyde and Steam Mixture

A NEW sterilization method for the control of wilt and club root in greenhouse soil, now being used by four growers near Toledo, Ohio, is described as unusually effective. The process, as applied by the Slayton Greenhouse Company, one of the four, is based on the admixture of formaldehyde with steam, and passage of the hot mixture up through the bed.

The cost is reported to be materially lower than the conventional treatment with steam alone, and requires only one third the time. In addition, the Slayton Company



Mixing device for sterilizing soil with steam, formaldehyde

describes their house as the "cleanest it has ever been" with respect to wilt and club root. Only one treatment a year, between spring and fall crops, is normally required.

W. L. Slayton, proprietor of the company, utilizes piping tile formerly employed for steam treatment alone. Formaldehyde and steam are introduced below the surface of the soil, thus combining the advantages of heat, steam, moisture, and hot formaldehyde. Uniform dissipation of the formaldehyde through the bed is reported. Changing of the soil is unnecessary.

The layout of the apparatus for adding formaldehyde is shown in our drawing.—*Agricultural News Letter* (Du Pont).

SCIENTIFIC PERIODICALS

Thousands are Regularly Published

IN 1934 a "World List of Scientific Periodicals" was published in England, containing the names of more than 36,000 scientific and technical journals, a number which sometimes staggers those who thought there were half a dozen, or perhaps half a hundred, or even half a thousand, but not 36,000. Today there are fewer, hard times and war costs having somewhat reduced the list. *Nature* (London) states that there now are 15,000 "containing useful articles." This leads to the hint that not all of the 36,000 were as useful as some of them. Just where to draw the line has always been a matter of opinion, and perhaps some of the journals were not outstandingly important, though each journal is in a position to contribute its share to science.

No single scientist possibly can read all these journals, nor can many keep track of all the periodical literature, even within their own branch of science. Therefore, some branches publish special journals which abstract major articles within those branches. *Biological Abstracts*, for example, does this but, even then, the reading consumes more time than a busy biologist always can find. The cry now therefore occasionally heard, for journals that abstract the journals that abstract the journals, is not altogether meant to be humorous.

In case any reader is suddenly inspired to write and ask this magazine kindly to write out and send him the list of 36,000 journals—and experience shows that when a list of any kind is mentioned some inevitably will do this—be it said that the list is a large, fat 780-page printed volume, which in the copied form of a letter would be rather fatter still!

CAMERA ANGLES

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

Shoot Color Outdoors In Any Light

IT USED to be said: never attempt a color subject unless the lighting is flat—that is, behind the camera. And then we'd all go ahead and do otherwise. The results were sometimes surprising; we found that, if the exposure was proper for the shadows, just as we would want with black-and-white film, the "pictures came out"—and with beautiful faithfulness, too! The rule still goes that, for the most brilliant results, direct sunlight, preferably softened and diffused by light clouds, is the light to use. But this does not mean that *unless* there is flat illumination, you might as well fold up the color camera and shoot, if you must, only black-and-white film.

Figure 1

What most amateur workers apparently fail to realize is that although color film, such as Kodachrome, does have a rather short exposure latitude, there is considerable latitude in the choice of lightings. Certainly, we have proved this for ourselves beyond any question during a recent vacation when we had occasion to expose Kodachrome in lighting varying from that available at sunrise to the darkish illumination of the dusk. Where, by employing an exposure meter of the photoelectric type, we gave an exposure within the range of the film, the results proved satisfactory and when projected on a screen before a group of guests elicited the comment that the scene looked real. And you can't ask for more than that!

Those who say that color is limited to box-camera technique when it comes to lighting must remember that even when shooting black-and-white,

Figure 2

shadow areas are darker and less brilliant than the high-lighted areas. For example, in shooting a sunrise, is it not a truthful portrayal of the scene to show the landscape or seascape as darkish, with much silhouetting of boatmasts, buildings, and so on? Why, then, argue against color on this account because the same thing happens? Perhaps this comparison seems a bit far-fetched because most persons do not object to underexposed landscapes in color shots of sunrises, but it will serve to make the point.

Recently, at the annual meeting and dinner of the Oval Table Society in New York City we had the pleasure of witnessing a remarkable proof, in 16mm Kodachrome movies, of the extreme lighting latitude permitted the color worker, John V. Hansen, of Washington, D. C., long noted for his excellent work in this field, showed movies of the beginning, progress, and culmination of a rainstorm over the Grand Canyon. If any of those present ever doubted that the pre-

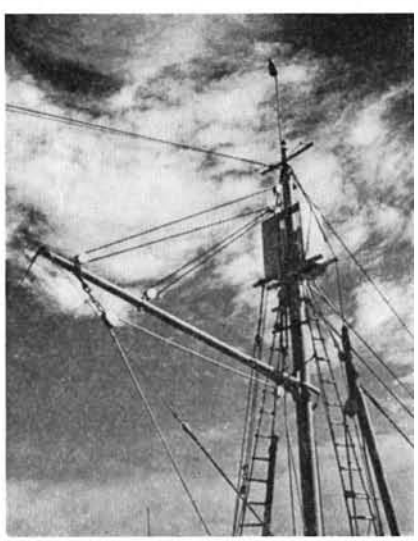


Figure 3

Grand Prize Winners

From the 36 prize and honorable mention winners in Scientific American's Fifth Annual Photography Contest were selected those three prints which, in the opinion of the judges, were the outstanding ones of the entire contest. Those photographers who submitted these Grand Prize winning pictures were awarded Weston exposure meters in addition to the regular prizes which they won.

1st Grand Prize

"*Pax Vobiscum.*" Submitted by Edwin McQuoid, Los Angeles, California. Taken with a Korona view camera, on Eastman Super XX film. Enlarged on Eastman G2 Projection paper with a Laborant enlarger.

2nd Grand Prize

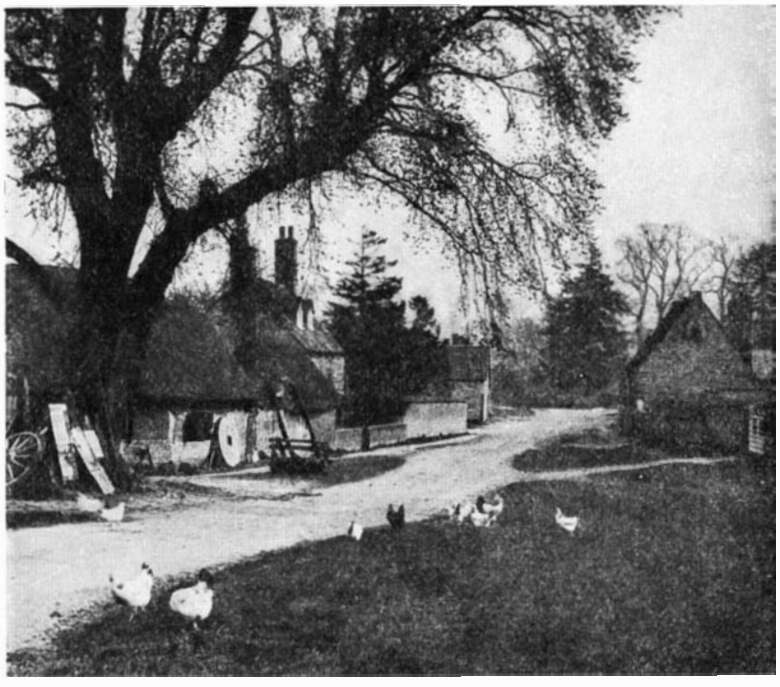
"*Before They Came.*" Submitted by D. P. Rudd, Los Angeles, California. Taken with a Voigtlander camera on Eastman film pack. Enlarged on Eastman G2 Projection paper with a homemade enlarger.

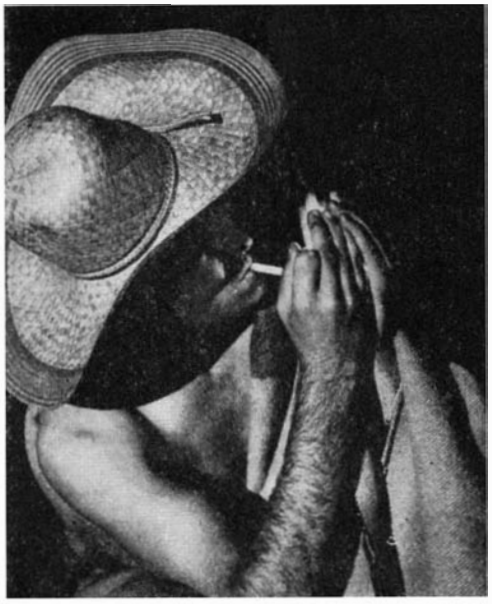
3rd Grand Prize

"*South of the Rio Grande.*" Submitted by H. C. Von Wald, Glendale, California. Taken with a view camera on Eastman Portrait Pan film. Enlarged on Kadabrom with an Elwood enlarger.

1st Grand Prize

2nd Grand Prize





3rd Grand Prize

Figure 4

dominant coloring of the mountains during certain lightings was rather purplish, here they had the evidence before their very eyes that it was really so. But the point we want to make is that the light varied from very bright to quite dark with never a false color that the eye could object to.

The answer lies, as we have said, in proper exposure. By suitable altering of exposure during the variations in the lighting, Mr. Hansen was able to tell his story in technically perfect knowledge that, because of his mastery of the exposure problem as well as the intrinsic beauty of the subject, also had a tremendous appeal to his audience's emotional responsiveness.

Returning to our own humbler efforts with still cameras employing 35mm and Bantam-size Kodachrome frames, the reproductions shown here are black-and-white prints of subjects we also shot in Kodachrome. Figures 1 and 2 are inevitable, of course, for the color worker on vacation. Sunrises and sunsets offer an irresistible attraction because black-and-white, no matter how well executed, can never equal the color shot of the same subject. But this is so patent that no argument is really necessary. Figure 1 in color shows the golden light of the sun in a way that is not only convincing but re-enacts the whole scene as the photographer saw it, while Figure 2 had a reddish cast in the sky with good rendering of the water. The boats are seen as black on the screen, just as the same boats, in black-and-white, are silhouetted in the reproduction.

Figure 3 is another example of the sort of subject, with average lighting, that works equally well for both black-and-white and color, and the same goes for Figure 4. The shadow areas have less color brilliance than the high-lighted areas, but the results in both mediums are highly satisfactory, because true.

The thought we would like to leave with those of our readers who are hesitant about shooting color when the lighting conditions are not at their best, is that, whatever the lighting may happen to be, if the subject looks good and the exposure is correct for Kodachrome, the result will please. Exposure, not slavish adherence to flat-lighting, is the keynote to good results.

The Contest is Over

OUTSTANDING examples of amateur photography characterized the Fifth Annual Scientific American Contest. From the many hundreds of prints selected, the judges were hard put to select the 36 prize and honorable mention winners; the selection of the three Grand Prize winners was even more of a task. Those who won through to the final judging and were awarded prizes were up against stiff competition and have every reason to be proud of their work.

Reproductions of the three Grand Prize winners appear on another page; those who won other prizes and honorable mentions are listed below. The prizes awarded in each of the three divisions were as follows:

1st: $125 Longines, Coronation Model, solid gold, men's wrist watch.
2nd: $85 Longines, Presentation Model, solid gold, men's wrist watch.
3rd: Federal No. 246 photo enlarger (List Price $49.50).
4th: Federal No. 345 photo enlarger (List Price $42.50).
5th: Pierce Chronograph men's

wrist watch (List price $19.75).

6th: Berman-Meyers flash gun complete with case (List Price $15).

7th: Fink-Roselieve vaporator (List Price $12.50).

HONORABLE MENTION

1st: Fink-Roselieve "Hi-Spot" Hollywood type spotlight.

2nd: Mimosa Perkino developing tank.

3rd: Raygram Wood-Chrome tripod.

4th: Fink-Roselieve audible timer.

5th: Fink-Roselieve Satin-Chrome range finder.

FIRST DIVISION WINNERS

PRIZE

First — Edwin McQuoid (See Grand Prize Announcement)

Second — H. C. Von Wald (See Grand Prize Announcement)

Third — Shigeto Mazawa, Chicago, Illinois

Fourth — Elmer L. Onstott, St. Louis, Missouri

Fifth — J. P. Whiskeman, Jr., Richmond, Virginia

Sixth — Paul J. Cohen, Brooklyn, New York

Seventh — William Eisenberg, Brooklyn, New York

HONORABLE MENTION

First — Matthew R. Barcellona, Buffalo, New York

Second — Henry M. Blatner, Albany, New York

Third — Henry Inn, Honolulu, T. H.

Fourth — Rowena Fruth, Connersville, Indiana

Fifth — Mrs. Eugene Landess, Fayetteville, Tennessee

SECOND DIVISION WINNERS

PRIZE

First — D. P. Rudd (See Grand Prize Announcement)

Second — H. Valdemar Lidell, Portland, Oregon

Third — John R. Hogan, Philadelphia, Pennsylvania

Fourth — Thomas O. Sheckell, East Orange, New Jersey

Fifth — Douglas Rudd, Los Angeles, California

Sixth — Albert Crownfield, Jr., Waltham, Massachusetts

Seventh — Waldo Ellis, Kansas City, Missouri

HONORABLE MENTION

First — Richard M. Stevens, Chicago, Illinois

Second — Marion Aldrich, Chicago, Illinois

Third — B. W. Leroy, Portland, Oregon

Fourth — Alvin W. Prasse, St. Louis, Missouri

Fifth — M. Richter, New York City, New York

THIRD DIVISION WINNERS

PRIZE

First — Jerry J. Kroutil, Woodside, Long Island, N. Y.

Second — Joseph G. Danley, Trenton, New Jersey

Third — Karl E. Ahlstrom, Boston, Massachusetts

Fourth — Nathaniel Field, Brooklyn, New York

Fifth — George L. Bewley, Philadelphia, Pennsylvania

Sixth — Charles Frank Dreyer, Mt. Vernon, New York

Seventh — Frank J. Roos, Jr., Columbus, Ohio

HONORABLE MENTION

First — R. E. Hine, Milwaukee, Wisconsin

Second — Thomas E. Benner, Urbana, Illinois

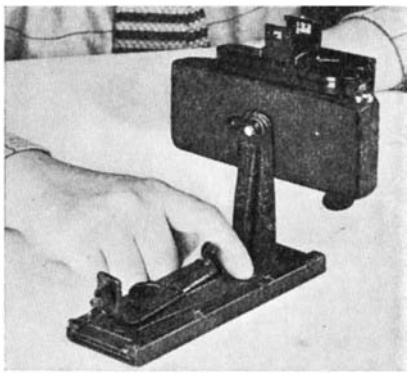
Third — Tom Brady, San Jose, California

Fourth — Yuichi Idaka, Chicago, Illinois

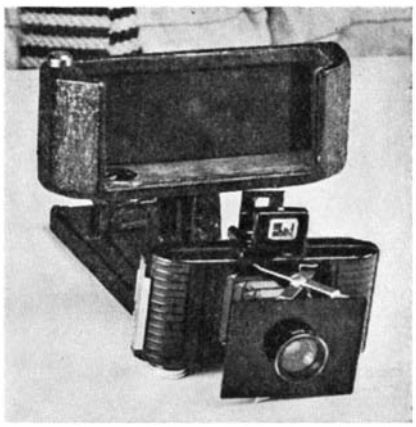
Fifth — Russell E. Smith, Tarentum, Pennsylvania

Sliding Bed

SMALL cameras of the miniature type, factory equipped with fixed-focus lens, normally enable the operator to take pictures as close as five feet from the object. For still life and other purposes, it is possible to slip a supplementary lens over the camera lens, the combination enabling pictures to be taken at much shorter distances, up to about 25 inches or



The sliding bed set-up



Camera and sliding bed

less, depending on the type of camera. These exact distances are stated for the supplementary lens intended for use with any particular camera and must be measured with a rule or tape, from the lens to the object.

When a camera so equipped is supported on a tripod in the usual manner, the problem of setting this exact distance sometimes proves awkward. The job can be made much easier by building a sliding base upon which the camera can be moved back and forth through a distance of a few inches.

Suppose the required exact distance is 18 inches. The tripod holding a sliding base and camera can be placed anywhere from one to two feet from the object; then, using the sliding base, the camera can be slid forward or backward the required few inches. A sliding camera bed of this description can be easily constructed from few materials; the photographs show one.

A metal shelf bracket from the 5 and 10 is affixed to a narrow piece of sheet metal about eight inches long. This strip slides in a second, heavier piece of metal of the same length. This heavy section is also drilled and tapped for a ¼ x 20 machine screw which is the same size and thread as the one in the top of your tripod.

The narrow piece of metal holding one side of the shelf bracket, and sliding back and forth in this base, is also fitted with a clamping screw so that it can be locked tight at any point.

The vertical section of the shelf bracket is fitted with a small snug-fitting plywood box to hold the camera. The box is fitted with two ¼ x 20 screws. One of these fits through the center of the back of the box, through the shelf bracket, and is made fast with a wing nut. This allows the camera to be used vertically or horizontally, by simply loosening the thumb nut and swinging the camera around. The second screw is short, and fits through the bottom of the box and up into the camera tripod bushing, thus preventing the camera from falling out of the wooden holders.—*Herbert E. Hayden.*

• • •

WHAT'S NEW

In Photographic Equipment

KODAK SENIOR SYNCHRONIZER, SPEED-GUN MODEL E ($16.50, complete with mounting bracket, reflector, cable release, but without batteries): For use with Kodaks and other cameras having setting-type front shutters and standard cable release sockets. Features: Two sockets, one vertical for Nos. 11A, 16A and 21 Photoflash lamps; other centered in back of reflector for No. 5 (midget-type) lamps; both sockets with lamp-ejector; pol-

ished, parabolic reflector adjustable for vertical centering; magnetic tripper, adjusted to critical accuracy with aid of photronic testing machine, rechecked after complete assembly, then sealed; simple synchronization to any shutter without exposure tests, up to and including 1/400 of a second; metal-covered cable release; prompt cocking by pulling down plunger at bottom of tripper unit; green signal on side of plunger cylinder, indicating if synchronizer is cocked; safety catch to prevent unintentional release; all-metal construction, including buffed chromium battery case; uses two 1.5-volt C cells (not supplied); compact overall design arranged for rapid assembly and demounting. Regular re-

flector distributes even spread of light over 60-degree angle. Also available, 5-inch aplanatic reflector.

YANKEE ADJUSTABLE FILM TANK ($1.85): Takes roll-film 35mm to No. 116, inclusive. Made entirely of non-corrosive Bakelite. Wide-mouth funnel in lid permits easy pouring; wide slot for emptying without spilling or dripping. Deep pitch of spiral groove in film spool makes for easy loading and unloading without scratching. Bakelite rod in slot for agitation; thermometer may be inserted when agitator rod is removed.

REPEATER KODASCOPE MODEL G ($150, lens extra): For automatic repeat projection of 16mm films with time interval between each showing. Intended for use in shop windows, exhibition booths, and so on. Projects any 16mm film up to 400 feet, or any desired part of film, then turns off lamp and rewinds self; then automatically opens another projection cycle. No cutting or loop-splicing of film required. Aside from repeat mechanism, Repeater Kodascope Model G is identical with regular Kodascope G. Available, six lenses in variable focal lengths and three lamps of various wattage, providing choice of 18 lens-lamp combinations. Carrying case, which may be used as projection stand, $13.50.

KODAK DAY-LOAD TANK FOR 35mm FILM ($6.95): Includes bottle of DK-20 Kodak Fine-Grain Developer to make 16 ounces solution, capacity of tank. Tank permits transfer of exposed film from standard 35mm miniature camera magazine to tank reel in full light. Affords protection from

dust, accidental kinking, fingerprints. Two chambers provided—small side chamber for magazine and developing chamber. Tank reel permanently attached to lid, permitting operation of both as unit. Empty film magazine can be removed after reel is loaded. Whole operation takes only a few moments.

EDWAL QUICK-FIX ($1 quart): Acid hardening fixer said to clear films in one minute or less and completely fix and harden negative in three minutes. Contains new fixing agent; sodium thiosulfate (ordinary hypo) not used in its manufacture. One quart makes gallon of working solution. Intended for negatives only. For fixing prints, or for negatives not requiring high-speed fixing, dilute quart to make two gallons of standard solution.

KODAK DIRECT POSITIVE PANCHROMATIC FILM (Bantam, 8-exposures, $.35 roll; 36-exp. 35mm, $1.25 roll; developing outfit, $3): Used in camera as usual but yields black-and-white positive film transparencies for mounting as 2 by 2-inch slides for screen projection in regular miniature Kodachrome projectors. High-speed, extremely fine grain, fine tone quality, suited for all-around photography, indoors or out, by daylight or artificial light. Suggested speed ratings: Daylight, 50 Weston; tungsten, 40 Weston. Panchromatic sensitization Type C, with same filter factors as for other films in this group. Although reversal film, re-exposure to light not required during processing. Suitable processing chemicals supplied in Kodak Direct Positive Film Developing Outfit in quantities to make one quart each of special solutions. Developing in regular tank.

FILMO VISUAL REVIEW: New 8-page magazine devoted to visual education, published by Bell and Howell. First issue leads off with article by Professor W. Gayle Starnes, of the University of Kentucky, entitled, "Looking Into the Future," in which rôle of motion pictures in education is discussed and analyzed. Another article covers use of film by athletic coaches; brief reviews cover important classroom films. Includes three departments, "Notes from the Screening Room," discussing such subjects as importance of color versus sound, in the educational film; "For Operators Only," in which various ways of using modern motion picture projectors are explained; and "New Visual Education Tools," illustrating and explaining new items. All schools and visual educators previously receiving "Filmo Topics," in which visual education page appeared, have been placed instead on the mailing list for "Filmo Visual Review." Scientific American will be glad to forward to Bell and Howell the names of new subscribers.

ISO-COLOR PROCESS ($5.95): Consists of seven vials, each containing necessary chemical, packed dry. Kit contains sufficient amount of each chemical to make at least twenty 8 by 10-inch color prints. Manufacturers say process makes possible simple, rapid, and inexpensive method of producing color prints from separation negatives "almost as quickly as black-and-white prints can be made."

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

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

"Let's Fight!"

TO OUR way of thinking, The National Rifle Association has summed up the various proposals to register privately owned sporting firearms most succinctly in its new publication, "Let's Fight This 'Fifth Column' Trap."

Pointing out the highly developed technique applied to subversive propaganda by Communist, Fascist, and Nazi machines in Europe and the Americas, the N.R.A. states that "it is well known that exactly this technique has been used for several years in the United States and that many honest Americans, falling victims to their smooth propaganda, have served as perfect 'fronts' for foreign propaganda agents in all walks of American social, business, and political life.

"Now," continues the N.R.A., "it appears that the familiar technique is being applied to strike at the roots of our preparedness program. In every part of America public officials are being propagandized with the idea that in order to save America from the 'Fifth Column,' the possession of firearms by citizens must be strictly controlled by the political authorities. All the old, familiar sugar-coating appears in the current propaganda; 'no inconvenience,' 'no registration fee,' 'no danger to those who have a good reason to possess a gun,' 'important to the national defense.' Sweet nothings! When a gun is registered with the political authorities of a nation, state, or community, the ultimate fate of that gun lies in the hands of those political authorities—or their successors! The question of what constitutes a 'good reason' to possess the gun lies in the hands of the political authorities—therefore the power to confiscate the gun or to jail the citizen gun-owner lies in the hands of the political authorities. Concurrently, the power to legally arm their own strong-arm squads lies with those same political authorities! Does such a condition promise defense for the American form of Government and homes against the 'Fifth Column'?"

To that question we hasten to go on record with an emphatic "NO!"

We heartily recommend that you read the entire story in "Let's Fight This 'Fifth Column' Trap," and we'll gladly send you a free copy. If you subscribe to the tenets of the American pioneers who made this country what it is, who stood unalterably for the inalienable "right to keep and bear arms," and said so in our Constitution; if you would keep these things inviolate, we maintain the answer is, "ORGANIZE!" The leading national organization of gun-owners in this country, the one that has upheld their best interests for the past 69 years, is The National Rifle Association of America. Nuf sed!

Gee! Haw!—Back up!

EVERY trolling fisherman who has snagged his best line has experienced that momentary lump-in-the-throat feeling, especially when he discovers that it *is* a snag, and not a fish, that has retarded piscatorial progress. To Evinrude Motors, therefore, goes a vote of thanks from the trolling fraternity for introduction of a full reverse feature in 1941 models of ever-popular Evinrude "Sportsman" and "Sportwin." Former is a favorite light motor for family and fishing service, weighs only 26 pounds, gives speeds up to 7½ miles per hour, is equipped with rubber protection clutch, weedless propeller, develops 2.0 N.O.A. Certified Brake H.P. at 3500 R.P.M. under Evinrude's dynamometer test (September 1940).

"Sportwin," a powerful twin for rowboats and medium-size family boats, has same rubber-mounted propeller protection clutch, extra large fuel tank with 2½-hour cruising range, develops 3.3 N.O.A. Certified Brake H.P. at 3500 R.P.M. Both are popular priced power plants, incorporate full reverse feature in 1941 models, and may be equipped with Evinrude's Simplex Starter for small additional charge.

Streamlined housing for 1941

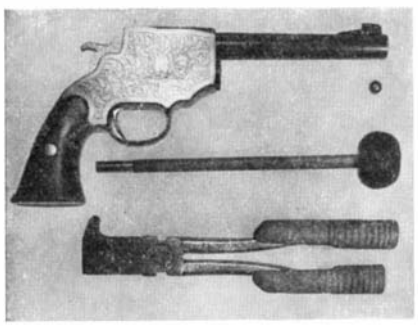
Use of outboard motors with full reverse feature will enable thousands of Waltonians to minimize wear and tear on lines, rods, tempers, nervous systems. Snagged hooks may be quickly released, often without stopping the motor, and by simply turning the motor the boat can be freely steered, or instantly put on new course. An automatic lock prevents the motor's tilting while in reverse position. Lengthened, tilting, steering handle assures comfortable tiller work at all times.

Evinrude also presents new, ultra-streamlined gear housing, free of irregular contours. Due to retention of automatic exhaust relief, unrestricted exhaust passages, and other tested and proved features, operation of new motors is as powerful, starting is as easy as before, while maneuverability has increased a hundred-fold. All Evinrude motors, including four exclusive "Fours," with complete specifications, are illustrated, described in 16-page 1941 catalog, regally done in Kodachrome. Want one?

Muzzle Loader

TELL some men, "It can't be done!" and they'll promptly accept the challenge to prove that you're wrong. Such a man is Fletcher D. Courtney, amateur gunsmith and toolmaker in the Canton, Ohio, plant of The Timken Roller Bearing Company. He spent 156 lunch and after-work hours in constructing a .423 caliber center-fire, muzzle-loading pistol just because a friend said it would be impossible to design such a gun.

Outlines of the pistol resemble the Colt Frontier model, but it is bigger,

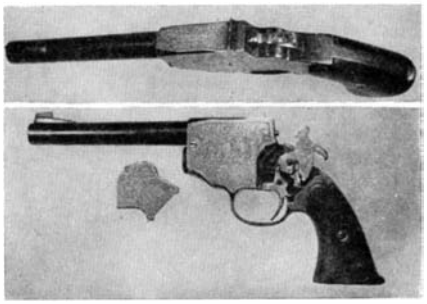


Courtney's muzzle loader

has a larger grip, and, of course, is a single shot. Frame was machined from one solid rectangular piece of Timken TW water hardening steel. Barrel was sawed from a Swiss .41 rifle, enlarged to .423 caliber, and the original lead of one turn in 33 inches was retained. Outside of barrel is tapered ⅜ inches per foot, threaded to fit the frame of the gun. Breech plug and nipple were threaded into end of the barrel. Gun is perfectly balanced and weighs 44 ounces.

Collar and sight ramp were made of one piece of steel which was bored, machined, and press-fitted on the end of the barrel. Rear sight was milled out of the frame. Hammer and trigger were assembled without screws and were fitted over special studs that were screwed into the side of the frame without projecting through the opposite side. Because of this unique characteristic, the action is easily assembled and disassembled.

The gun uses a charge of (triple) fff-g, fine-grained, black powder. To



Top and side, showing action

prepare for firing, powder is measured, dropped into barrel of gun, a linen patch is placed over muzzle of barrel, and a lead ball laid on the linen patch. Loading plunger is then used to force ball and patch solidly into base of the barrel, after which percussion cap is placed on nipple.

Although muzzle-loading feature does slow up target practice, it has its advantage in that $1.00 will buy enough powder, caps, lead balls, linen patches to shoot from 250 to 300 rounds. As to accuracy, Courtney scored a 49 x 50 on an N.R.A. official 25-yard pistol target, proving that he not only can make pistols, but also that he can shoot them.

Science Aids Anglers

WHEN you meet a fellow angler in your trout stream next spring and ask him what kind of terminal tackle he used to land that big rainbow, don't be surprised if he says, "I was using a March Brown, tied to a 9½-foot vinylidene chloride." And don't worry about him; he's just taking the long way around to tell you about "Vec," Weber Lifelike Fly Company's new leader material that so rapidly found favor last year.

Vinylidene chloride isn't actually the name of the substance (we had to have our little fun!), but it is the base of a group of new thermoplastic resins, known by the trade name "Saran," from a formula by Dow Chemical Company. Outstanding properties of Saran are extreme tensile strength, high abrasion resistance, toughness, great water and chemical resistance, non-flammability, colorability. Weber Lifelike Fly Company saw possibilities, translated them into leaders and snells under their own trade name of "Vec."

Vec's popularity has been due to its unusual adaptability to average fishing conditions. For bait fishing, for trolling, and for snelled hooks it is

practically ideal, for it never frays or deteriorates, is always pliable, needs no soaking. Correctly tied, Vec holds fighting fish securely, being actually much stronger on a wet test than foreign synthetics of similar diameters. Vec owes its superiorities to quality and uniformity in manufacturing methods under rigid laboratory control, and is entirely a product of the chemist's test tube, manufactured by Weber from the formula by Dow Chemical Company.

Introduced by Weber a year ago, Vec is now standardized in a wide range of sizes in coils and standard leaders down to .010 of an inch in diameter. In sizes below that, Weber Straintest Spanish drawn gut leaders are supplied in all standard sizes, level and tapered.

The 10th edition of the "Weber Moviegram Method of Fly Casting Instructions," pronounced clearest, most successful system of self-instruction for fly fishermen, is off the press. As a graduate of this system, we re-read it annually to brush up on technique. Like a copy?

Keep 'Em Clean!

HAVE you ever been ashamed of a dirty gun? Have you ever come home from a hunt, dog tired, and said, "Oh, I'll clean it tomorrow?" And "tomorrow" you were so absorbed getting back into the harness of business that the gun went uncleaned. Then, without warning, a friend dropped in, the subject of guns quite naturally came up, followed by the customary inspection of the gun cabinet or rack, and—one gun was dirty! Was your face red?

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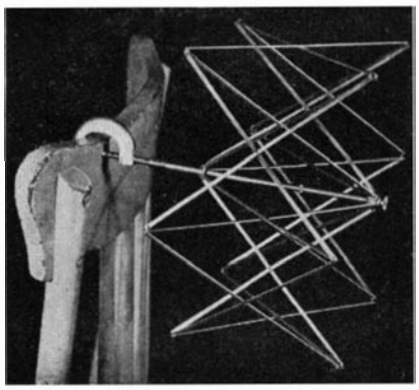
• • •

POT SHOTS

At Things News

THE "REEL-FOLD" line dryer clamps anywhere, folds into compact 1½ by 10½-inch unit, weighs six ounces, is rustproof, dries two or more lines simultaneously, reverses them end-for-end, coils them to any desired circumference, is pictured, described, priced in Mershon Company's new catalog, which is yours for the asking. Want one?



Folding line dryer

ARGUS SPOTTING SCOPE, product of International Research Corporation, continues to meet with approval of pistol and rifle target shooters. With indoor ranges in vogue during winter months, a good spotting scope materially helps promote winning scores. Argus is 14⅝ inches long, weighs 43 ounces, has 55mm prismatic lens, 14mm eye relief, standard magnification of 20X, with optional, interchangeable eye pieces for 12.8X and 26X. At 100 yards, Argus gives field view of 11.4 feet with 20X; 16.5 feet with 12.8X; 6.3 feet with 26X.

Argus spotting scope

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MARCH OF THE IRON MEN

By Roger Burlingame

THE review copy of this book luckilessly lay for two years where it had accidentally fallen behind a shelf, till a rare editorial housecleaning revealed it. Too late for review? Ordinarily yes, but as it was read it was seen to be far too excellent and deserving a book for such fate, hence it is reviewed anyway. This book tells in fascinating style and with penetrative interpretation not alone the story of American invention—for such books are quite common—but

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how our very history itself has been determined by our inventiveness, from wilderness days right up to modern times. Colonial handicraft, Ben Franklin's inventions and those that defeated the English economically in America before their colonial policy became enlightened, the cotton gin, Yankee machine tools, and many others are dealt with. An inventor's interpretation of American history, which also presents the social effects of the inventions. Reviewed in the third year of its life, with sincere apology to publisher, author and book, for regretted delay. (500 pages, 6¼ by 9¼ inches, illustrated.)—$3.85 postpaid.—*A. G. I.*

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By John F. Rider

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

WAY back in the year 1929, S. W. Casey, 314 Twelfth St., Eau Claire, Wisconsin, built a 3″ refracting telescope, and now he has built another of similar size (Figure 1). He says the first telescope was good enough to look at, but was not so good to look through. It seems he had not yet discovered the book "Amateur Telescope Making," not to mention its sequel volume "Amateur Telescope Making—Advanced," which gives even more detailed instructions for making refracting telescopes than the first-named book. More recently, using the instructions of Taylor and Haviland in the latter volume, he completed the instrument shown, using glass blanks obtained from the Bausch and Lomb Optical Co. The tube is stainless steel seamless tubing.

"I made all the castings, also machined them, and made the eyepiece," he states. "I spent about four months of spare time on the objective. The images are beautiful." Casey had previously made a reflector.

Figure 2 shows the two ends of this 3⅛″ refractor.

Figure 3 is a 4″ Pyrex-mirrored richest-field telescope of unusually attractive design and appearance—clean. Casey cast and machined the aluminum cell, screw-on cover, and screw-on tube bottom (identical with the cover). All optical elements are fully adjustable for collimation. The eyepiece tube has a spiral focus adjustment. The main tube is covered with leather.

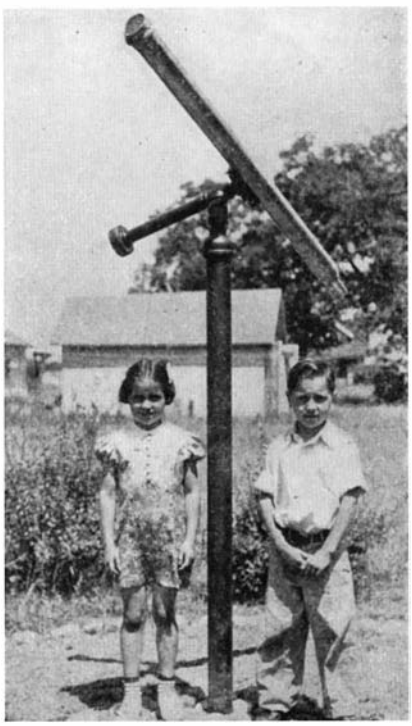

Figure 1: **Casey products**

Figure 4 caps Casey's climax, a telescoptical invention called the "Flexoscope," which he says is a technicratic aplanat of focal ratio 49.98.

From another amateur telescope maker who finally chose the refracting type of telescope comes the following: "After almost a year's use of my 7½″ refractor I have found its performance, for general, all-around observing, far superior to that of my former 6″ and 10″ reflectors." This is from the anonymous "Mr. X," of Mamaroneck, N. Y. (address on request), whose 7½″ refractor was described here last July.

Making an objective lens for a refractor is a more tedious but actually less exacting job than making a mirror for a reflector. Chief deterrent is the cost of the blanks, also the need of a flat, a lathe and a spherometer; otherwise nearly every amateur might try one. (It has been suggested by some genius that, in future copies of "ATMA," pouches be inserted at the end of Haviland's chapter on objective lens design and construction, containing the flat, spherometer, and a lathe.)

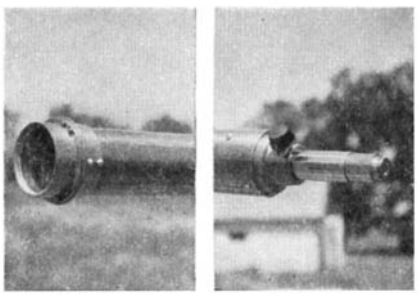

Figure 2: **Front and rear**

Despite deterrents, refractor making is gradually increasing, as more and more amateurs come to realize the truth of testimonials such as the one above. This is not, however, an attempt to depreciate the reflector. Nevertheless, many an amateur harbors in the back of his mind the hope that, some day, in some way, he can make and use a fair-sized refractor.

CASSEGRAINIAN telescopes appear to have a fatal fascination for the man who has not yet made any telescope, judging from this department's mail, and the main reason evidently is their high magnification. Most aspirants seem quite willing, however, to accept the advice of those who have been there before, to tackle a Cassegrainian only after making two or three less complicated types. A very few others have to experience the actual feeling of adversity before their self-confidence is tamed. Occasionally, too, a genius turns up who evidently can do difficult things without the preparation that others require. Rummaging among old letters, one was found in which Alan R. Kirkham, no longer active in telescoptics but "tops" while his health lasted, put the matter of lightly tackling a Cassegrainian in a new way. "A Cassegrainian or a Gregorian imposes extremely severe demands on the primary mirror. For illustration, with a secondary which amplifies the image four times, a 1″ eyepiece looks the same to the primary mirror as a ¼″ eyepiece, while a ¼″ eyepiece looks to it like a 1/16″—and just show me the hombre who can make a mirror which will take a 1/16″ eyepiece and not howl.

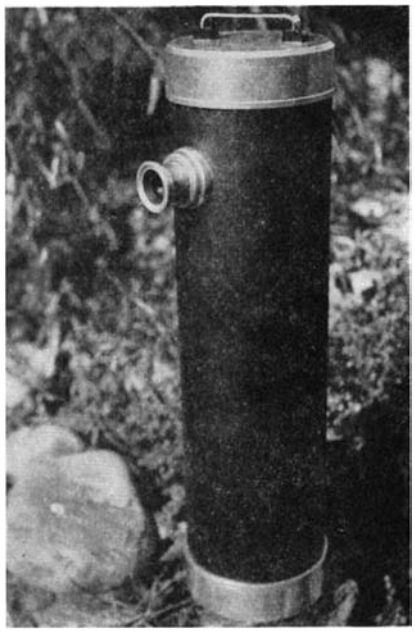

Figure 3: **Casey's RFT**

"My experience," Kirkham continues, "is that the difficulty of mirror figuring increases with the square of the magnification, right up to the point where the telescope reaches the resolvable minimum. If those who think primarily of high magnification would read what able designers like Conrady, Hastings, and so on, have to say about the wave nature of light and the relation of the instrument to the eye, we would hear less about it. It can be shown that a range of from 5 to 40 magnifications per inch of mirror diameter *more* than covers all the useful range, and should be obtained, on ordinary Newtonians, with ½″ to 1″ eyepieces. Both theoretically and practically these are the best eyepieces.

"In making a telescope one should put all the fussing into figuring the objective—mirror or lens—so well that it will concentrate as much of the light as possible within the diffraction disk, resulting in a practical telescope whose star images would not *break down* at 1000 per inch magnification if such could be used. But we will *see* all there is to be seen at 20 diameters per inch; Martin even says that 10 per inch enables sharp eyes to see all that an objective can show, and that, by doubling this, all the detail the image affords is rendered easily seen."

Unfortunately, until the telescoptician has laboriously plodded through the reasons, which in turn involves doing enough general background study of optics, in books like Valasek's "Elements of Optics," Hardy and Perrin's "Principles of Optics," and Martin's "Introduction to Applied Optics,"

Figure 4: **KC Flexoscope**

all of which would be a job to nibble away at for a year or more, such arguments don't usually seem very important and the enthusiastic tyro may deceive himself with the hope, altogether false, that high magnification will dig out the image detail even if the mirror, and therefore the image, isn't very good. But it won't! An exactly parallel experiment would be trying to compensate for poverty by writing a check for $1,000,000 payable to self; all of us could write the check but . . . . Similarly, the high magnification eyepiece on a less than fine mirror will "bounce." One may safely take this not merely from the armchair optical theorists but from experienced, flea-bitten old telescope users. High magnification requires high mirror perfection and, even then, it isn't good for much.

WHILE it is a practical certainty that all amateur telescope makers will play harps in another world, because

of saintliness in this, one amateur who turned professional and wished to make assurance doubly sure recently began taking lessons on a tangible, mundane harp in Illinois, and immediately invented a telescope accessory inspired by it.

One of the earlier amateur telescope makers was William A. Calder, then of Beaver Dam, Wisconsin, whose telescopes were described here years ago. Calder was studying to be a physicist at the time, but the hobby swerved him into astronomy. Now he is Professor of Astronomy at Knox College, Galesburg, Ill. The "harp" applied to the telescope is shown in Figure 5, but it isn't musical. Professor Calder explains it thus:

"When a series of equally spaced rods is placed over a telescope objective, the diffraction pattern which constitutes a stellar image becomes flanked with a series of images of decreasing intensity. The relative brightness of the central and auxiliary images, and their separations, may easily be computed according to

Figure 5: **Calder's grating**

well-known formulas (King, 'Celestial Photography,' page 138). This device, the objective grating, has been very useful in connection with the problem of the relative brightnesses of double stars, but its use has been photographic. Kuiper and Hertzsprung have estimated the relative brightnesses of visual binaries by placing an objective grating over the telescope and comparing the central image of the fainter component with a side image of the brighter component. It is, however, difficult to estimate the relative brightness of objects which differ by more than a few tenths of a magnitude. By means of a coarse grating, we can divert a known fraction of the light of each star into first order diffraction images and then compare the central image of the fainter star with the effectively weakened image of the brighter star. But, when one makes a grating with the opaque space having a definite, fixed ratio to the clear space, it is found in practice that double stars whose first order image of the brighter equals the central image of the fainter are rare. Nevertheless, the eye is at its best, photometrically, when it matches intensities, but it is unable to judge the amount by which light sources differ. To improve the existing inexact data on the relative brightnesses of binaries, would it not

Figure 6: **Same old pits!**

be fine if, therefore, the astronomer could use a variable grating? He then would simply set the grating so that the central image of the fainter matched the first order image of the brighter. Then he would note how the grating was set and, knowing the ratio of clear to opaque, he would have the exact difference of brightness of the stars to an accuracy limited only by the ability of the eye in equalizing intensities.

"It would be mechanically impossible, however, to make a grating whose capacity could be varied, after the manner of the Venetian blind, but the same thing can be accomplished by the simple method of changing the projection of the grating on the telescope objective. Here is where the harp came in. Seated at the harp after my first lesson, I noticed how the clear space between the strings appeared to vary with my position. I therefore hinged the grating on the end of the telescope tube.

"I believe that many amateurs would enjoy making this accessory and could do useful work with it. My first results indicate that many of the entries in double star catalogs can be improved. The grating shown in Figure 5, on my 12" reflector, is

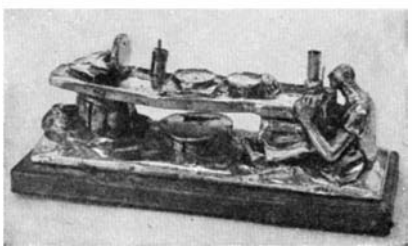

Figure 7: **Knife-edge test**

made of aluminum rods ⅛" in diameter, with ¼" spaces between. When the grating is perpendicular to the axis of the telescope, the first order diffraction image is 1.92 magnitudes fainter than the central image; when the grating is opened out to 40° on the hinges, the magnitude interval is reduced to 1.29."

IF any reader of this department listens to Amos n' Andy, on the radio, let him be advised that "de Lodge" has a chapter among amateur telescope nuts, three of whom, though widely separated, pass as Amos (Fred B. Ferson, 414 Reynoir St., Biloxi, Miss.), Mist' van Potah (Russell Porter, of Pasadena, Calif.) and Andy (your scribe, who inflicted that name on himself in a fit of sincerity). Capt. McDowell, who superintended the 200" mounting, is "de Kingfish."

Figure 8: **Solid discomfort**

Mist' van Potah found he couldn't sleep one night, so he sat up in bed with three hunks of sugar pine and a jack-knife and whittled the bed and the room full of shavings. What was left proved to be the patterns for the four- or five-inch brass statuettes shown in Figures 6, 7, and 8.

Figure 6 is an amateur telescope maker stopping work polishing to examine his mirror with a watch maker's loupe.

Figure 7 is quite complex: a TN seated on the floor, at right, making a knife-edge test on a mirror at left. Between is his polishing place on the same plank, with a little pot of rouge and a brush sticking up, all very faithfully cast in brass.

On the occasion of a visit to Amos' cabin in Mississippi, Mist' van Potah and he spent several days together, molding, casting, snagging, filing, scouring, chiseling and otherwise finishing these objets d'art. Amos still has the patterns for making more statuettes. He is the author of the chapter on molding and casting, in "ATMA," this work being a sort of side-hobby to his amateur telescope making.

Jim Barr, one of Wally Everest's satellites in Pittsfield, Mass., took the excellent photographs, and for this he is hereby inducted into de Lodge—as "Lightnin'."

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Editor, Scientific American

Secret Use

THE secret invention or use by a person other than the patentee of a patented machine prior to the application for the patent does not invalidate the patent. This principle was involved in a suit for the infringement of a patent on a quilting machine which blew thread, or yarn, into pockets formed in fabric to impart a raised or embossed design on the fabric.

One of the defenses raised by the infringer was that the patent was invalid because a machine similar to the patented machine had been used by another person for several years prior to the filing of the application for the patent. It apparently was established by credible evidence that the prior machine was used. However, it was also established that this use was a secret use and that every attempt was made to conceal the machine from the public.

The Court ruled that in spite of the use of the machine by another person prior to the filing of the patent application, the patent was valid since the use was a secret use. Under our patent law the Court concluded that a prior use of an invention must be a public use in order to invalidate a patent.

On Ice

IN A recent suit in the Federal Courts a former employee was compelled to assign to a corporation an invention relating to ice machinery which he made while employed by the corporation.

The corporation was engaged in the business of manufacturing and promoting machinery for producing small fragments of ice. It was originally organized to exploit a machine developed by the employee. In this machine ice was formed on a flexible member and the flexible member was than flexed to cause the ice to peel or flake off the member. While working for the corporation the employee developed another machine for making small fragments of ice wherein liquids were frozen on a stationary member and the ice was removed by a chipping action.

During the period when this machine was developed there was an employment contract between the corporation and the employee wherein the employee agreed to assign to the company "all past, present, and future inventions *** in any way relating to the same field or subject matter of the patents and applications now owned by the company." After the employee developed the "chipping" machine wherein the ice was formed on a stationary member and removed by a chipping action, he left the employ of the corporation and applied for a patent on the "chipping" machine. A demand was made that the former employee assign the invention and patent application to the corporation and upon a refusal the corporation brought suit to compel an assignment.

It was contended on behalf of the corporation that under the contract of employment the former employee was compelled to assign the invention and application to the corporation.

The former employee, on the other hand, contended that the "chipping" machine did not relate to the "same field or subject matter" as the original machine which was promoted by the corporation wherein the ice was formed on a flexible member and was released in flake form by flexing the member.

The court sustained the corporation and compelled the former employee to assign the invention and patent application to the corporation. The purpose of the contract, the court pointed out, was to protect the corporation and those interested in the corporation from competition. In order to carry out the intention and purpose of the agreement the court held that the contract must be broadly construed so as to compel the assignment of the invention and patent application relating to the "chipping" machine.

Thermostat

A PATENT for a thermostatically controlled heating system in which the thermostat is provided with an electric heating element was recently held to be valid and infringed by a Federal Court.

Most modern heating systems for homes are provided with thermostat controls. Thermostatically controlled heating units were not entirely satisfactory due to "overshooting," a defect resulting from the delay or lag in heat transfer causing the temperature in a room to continue to rise for some time after the thermostat

had shut off the heating system. This resulted in rather extreme fluctuations in temperature within the space controlled by the thermostat.

To prevent this difficulty, the patentee provided, in the thermostat, an electric heater controlled thereby so that the thermostat would operate in response to the temperature of the atmosphere in the room and also the temperature of the electric heater. It was proved that the addition of the electric heater to the thermostat overcame to a great extent the overshooting usually present in thermostatically controlled heating systems.

One of the defenses raised in the suit was that each of the elements shown in the patent was old. However, the court found that the combination was new and held that the patent was valid and infringed by the system sold by the defendant. In this connection the court stated:

"To be sure thermostats were old. The bi-metal strip was old. Heaters adjacent to a bi-metal strip are present in the prior art, but nowhere do I find a combination of means to control in this way a heating system of a house."

Clarification

THE assignee of a patent who has not recorded the assignment in the Patent Office may, nevertheless, maintain a suit for patent infringement, according to a recent Federal Court decision.

The patent law makes provision for the recording of assignments in a register maintained by the Commissioner of Patents. The law also provides that an assignment of a patent shall be void as against a subsequent purchaser without notice unless it is recorded in the Patent Office within three months of the date thereof, or prior to the subsequent purchase. This provision of the law has occasioned uncertainty and misunderstanding as to the consequences resulting from the failure to record an assignment. Some decisions have held that the assignee of a patent could not maintain a suit for patent infringement unless the assignment had been recorded in accordance with the patent law.

In the case under consideration, a suit for patent infringement was brought by an assignee under an unrecorded assignment and the Federal District Court dismissed the suit because of the failure to record the assignment.

On appeal, the Circuit Court of Appeals reversed the decision of the District Court and held that the assignee of the patent had the right to maintain the suit even though the assignment was not recorded. The Court pointed out that the recording provisions of the patent law were intended for the protection of subsequent purchasers or mortgagees and as to all other persons, an unrecorded assignment was valid.

CURRENT BULLETIN BRIEFS

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

METAL DUPLICATING WITHOUT DIES is a four-page illustrated folder that describes duplicating units for use in shops as a short-cut to the elimination of the expense of making dies or die sets for small quantity runs. Request this pamphlet on your business letterhead. *O'Neil-Irwin Manufacturing Co., 316 Eighth Avenue South, Minneapolis, Minnesota.—Gratis.*

RUBBER BLACK TESTING PROCEDURES is a 16-page leaflet that describes a group of tests used to evaluate blacks employed in the manufacture of rubber products. ***Godfrey L. Cabot, Inc., 77 Franklin St., Boston, Massachusetts.—Gratis.***

BAUSCH & LOMB AND OUR NATIONAL DEFENSE is an illustrated booklet designed specifically to refute attacks on this particular company's loyalty and patriotism engendered by the indictment which charged restraint of trade in military optical instruments. The company, incidentally, is reputed to be the largest manufacturer of these instruments. Request this booklet on business stationery. *Bausch & Lomb Optical Company, Rochester, New York.—Gratis.*

QUIZ is a compilation of 408 questions and answers dedicated to the curiosity of the American people. Concerned specifically with railroads and railroading, it presents accurate and succinct facts about the industry, its organization, its history, and so on. *Association of American Railroads, Transportation Building, Washington, D. C.—Gratis.*

AN OUTLINE OF MODERN FLASH PHOTOGRAPHY, by Karl A. Barleben, F.R.P.S., is a 32-page booklet providing a comprehensive review of the several factors governing flash photography today. While intended as a guide for users of the Goodspeed synchronizer, the information will be found useful by others as well. *Goodspeed, Inc., 220 Fifth Ave., New York, New York.—10 cents.*

NICKEL ALLOYS IN MINING AND MILLING EQUIPMENT is a 12-page illustrated pamphlet which gives technical data of interest to the mining engineer and mine operator. The *International Nickel Company, Inc., 67 Wall Street, New York City.—Gratis.*

FACTS YOU SHOULD KNOW ABOUT BORROWING is a 16-page pamphlet written to assist those who need to borrow money and to protect them from loan sharks. It deals with such things as building and loan associations, commercial banks, credit unions, industrial loan companies, illegal lenders, pawn brokers, and so on. *National Better Business Bureau, Inc., Chrysler Building, New York, New York.—3 cents.*

BRADLEY LUXTRON PHOTO-ELECTRIC CELLS is an eight-page illustrated catalogue of photo-electric cells as supplied to manufacturers of photo-electric measurement and control devices, or to individuals. Considerable technical information is included, with detailed data covering sensitivity, color response, and so on. *Bradley Laboratories, 82 Meadow St., New Haven, Connecticut.—Gratis.*

BETTER PICTURES WITH WATSON PORTRAIT AND VIEW CAMERAS is a 40-page booklet packed with information on the use of the view camera in making pictures in various fields. Among the subjects covered are portrait lighting, still life, commercial work, wide-angle interiors, architectural work, animal and tabletop photography, and so on. Copiously illustrated with photographic reproductions and lighting diagrams. *Burke & James, Inc., 223 West Madison St., Chicago, Illinois.—50 cents.*

BULLETIN OF THE TEXAS ARCHEOLOGICAL AND PALEONTOLOGICAL SOCIETY for 1940 is an illustrated, 252-page annual containing 12 papers on archeology in Texas and nearby states. *Cyrus N. Ray, Abilene, Texas.—$3.00.*

CALCULATE BY EIGHT, NOT BY TENS; BASE EIGHT ARITHMETIC AND MONEY, By E. M. Tingley. These are the titles of two reprints from *School Science and Mathematics*, on the advantages of the octic over the decimal system of numeration. *E. M. Tingley, 221 N. Cuyler, Oak Park, Illinois.—Gratis.*

INSTRUCTIONS FOR USING CARBOLOY STANDARD TOOLS is a 12-page vest-pocket size instruction manual for users of cutting tools. Designed specifically for machine operators, it contains information on speeds and feeds for different materials, machine recommendations, use of coolants, standard tool angles, general operating hints, and so on. *Carboloy Company, Inc., 11101 E. 8 Mile Road, Detroit, Michigan.—Gratis.*

BELL & HOWELL FILMOSOUND LIBRARY is a comprehensive catalogue of educational motion pictures which are available in 16mm size, both sound and silent. *Bell & Howell Company, 1801 Larchmont Avenue, Chicago, Illinois.—25 cents.*

BLISTER RUST CONTROL IN THE MANAGEMENT OF WESTERN WHITE PINE is a 34-page mimeographed booklet that is concerned specifically with the conservation of western white pine timber stands. Success in the control of blister rust depends largely on basic knowledge and careful planning of campaigns. *Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.—Gratis.*

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