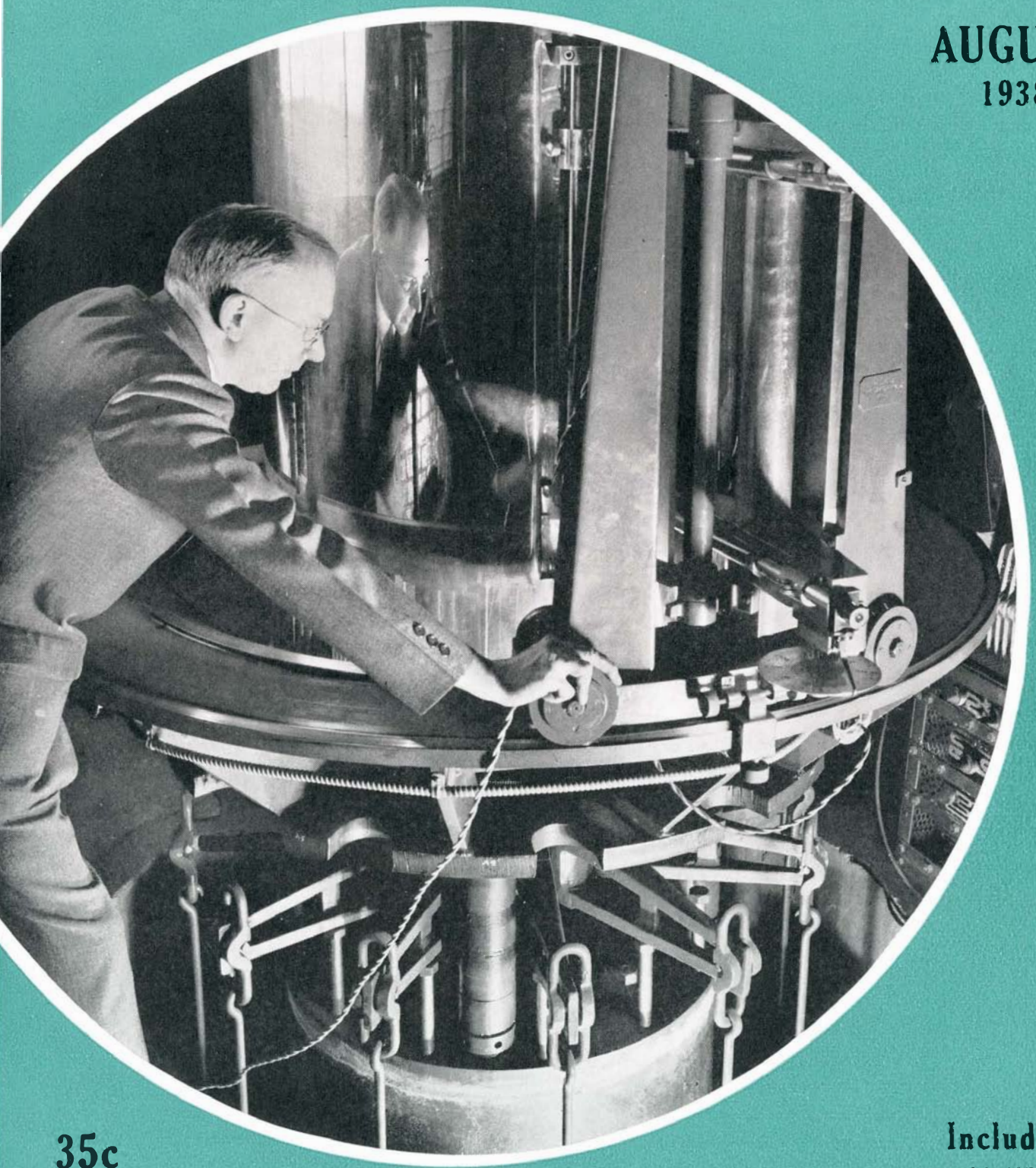
# THE SKELETON TALKS

By Wilton Marion Krogman

# SCIENTIFIC AMERICAN



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## The SCIENTIFIC AMERICAN DIGEST




# SCIENTIFIC AMERICAN

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**NINETY-FOURTH YEAR • ORSON D. MUNN, Editor**


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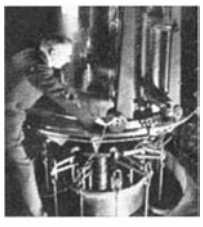

OF vast importance to mechanical engineers is the study of the "creep" of steel and metal alloys. In order to accumulate data on this subject, new furnaces have been designed to test metals under conditions of temperature reproducing those in actual service. The furnaces are described in detail on page 84 of this issue; a close-up of one of them is presented on our cover.


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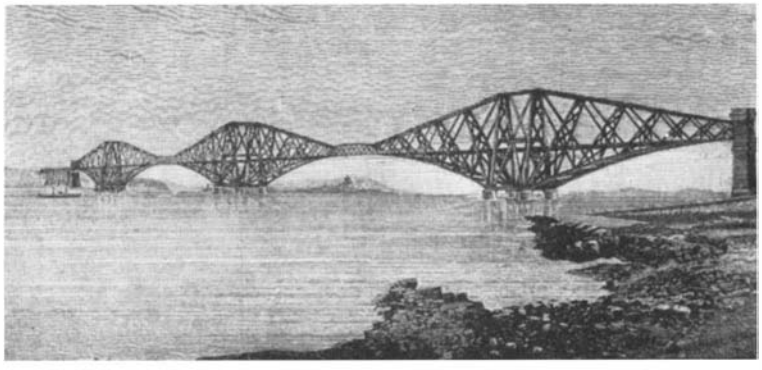
# 50 Years Ago in . . .

## Scientific American

*(Condensed From Issues of August, 1888)*

FORTH BRIDGE—"We give . . . a sketch of the Forth Bridge, showing it as it will appear when finished. . . . The great work is now approaching completion. This remarkable structure is situated at Queen's Ferry, about ten miles from Edinburgh. It crosses the Forth, an arm of the North Sea. We are apt to think that the great suspension bridge between New York and Brooklyn is a work of great size, but it is rather small when compared with the Forth Bridge. The latter has two main spans, each 1,710 feet in length, which is 114½ feet longer than the span of the Brooklyn Bridge. The three main towers of the Forth Bridge are 375 feet high. The total length of the bridge is 8,084 feet. The bridge is built on the cantilever system, of steel, of which there will be about 42,000 tons used in the superstructure."



MARS—"The observations of M. Perrotin at Nice, and M. Terby at Louvain, and, in England, of Mr. Denning at Bristol, have confirmed the presence on the planet of most of the 'canals,' or narrow dark lines, which were discovered by M. Schiaparelli in 1877, and at subsequent oppositions."

BALLOONS—"Captive balloons are to be employed at sea during the next stage of maneuvers by the Toulon evolutionary squadron, under Vice-Admiral Amet."

STRAIGHT—"The new Argentine Pacific Railroad from Buenos Aires to the foot of the Andes has on it what is probably the longest tangent in the world. This is 340 kilometers (211 miles) without a curve. In this distance there is not a single bridge and no opening larger than an ordinary culvert, no cut greater than one meter in depth, and no fill of height exceeding one meter."

ANTI-FOULING—"The Japanese Admiralty has finally decided upon coating the bottoms of all their ships with a material closely akin to the lacquer to which we are so much accustomed as a specialty of Japanese furniture work. . . . Experiments . . . have resulted in affording proof that the new coating material remains fully efficient for three years and . . . completely withstands the fouling influences so common in tropical waters."

MICE—"The mouse pest in Australia is much worse than the rabbit pest. The climate is so soft that they have thrived enormously, and there is said to be hardly a residence or store that is not pestered by the plague . . . while from every side come tales of crops devoured so rapidly that many fields have had to be abandoned, what was left not being worth reaping."

Q AND A—"How many miles of railway in the United States? One hundred and fifty thousand six hundred miles—about half the mileage of the world. How much have they cost? Nine billion dollars. How many people are employed by them? More than a million. How long does a steel rail last with average wear? About eighteen years. What is the cost of a palace sleeping car? About $15,000, or $17,000 if 'vestibuled.' What is the cost of a high-class eight-wheeled passenger locomotive? About $8,500."

ECLIPSE—"Four thousand blanketed Comanches, Kiowas, Cheyennes, Arapahoe, and Delawares were at the Anakee agency to get their rations when the recent total eclipse of the moon occurred. The savages were greatly excited. The principal chief ordered them to shoot at the 'evil thing,' and the force of Indians opened fire in the air, keeping up the shooting for upward of an hour, and until they were out of ammunition. When the moon appeared in view after the eclipse, wild whoops went up for what they believed to be their victory."

PLASTIC—"Poteline is the name of a mixture of gelatine, glycerine, and tannin, to which sulphate of barium, or of zinc, may be added, and which may be colored by vegetable colors. It may be kneaded while warm. When cold it may be used for numerous purposes. It can be turned, filed, bored, polished, and can be used for hermetically sealing bottles, etc. The proportion of ingredients varies according to the uses. For sealing bottles, of course, it must be used liquid."

GAS MASKS—"There was recently an exhibition . . . of Loeb's appliances which are designed to enable the wearer to breathe and work with comfort in dense smoke, and also in poisonous gases. The device consists of a respirator with an india-rubber mouthpiece. The air is drawn in by the wearer through a series of small filters, containing, respectively, wet sponge, cotton wool, cotton wool damped with glycerine, and animal charcoal."

COLD—"Dr. Hann gives an interesting account of the winter temperature of Werchojansk (Siberia), deduced from several years' observations. . . . Monthly means of —58 degrees F. occur even in December, a mean temperature which has been observed nowhere else in the polar regions; and minima of —76 degrees are usual for the three winter months (December-February) . . . while in January 1885, the temperature of —89 degrees was recorded."

OHM—"M. H. Wuilleumier has recently made a redetermination of the true value of the ohm, using Lippmann's method. He concludes from his experiments that its value is the resistance of a column of mercury of a square millimeter section, 106.27 centimeters long, this result being practically the same as that obtained by Lord Rayleigh and others."

### AND NOW FOR THE FUTURE

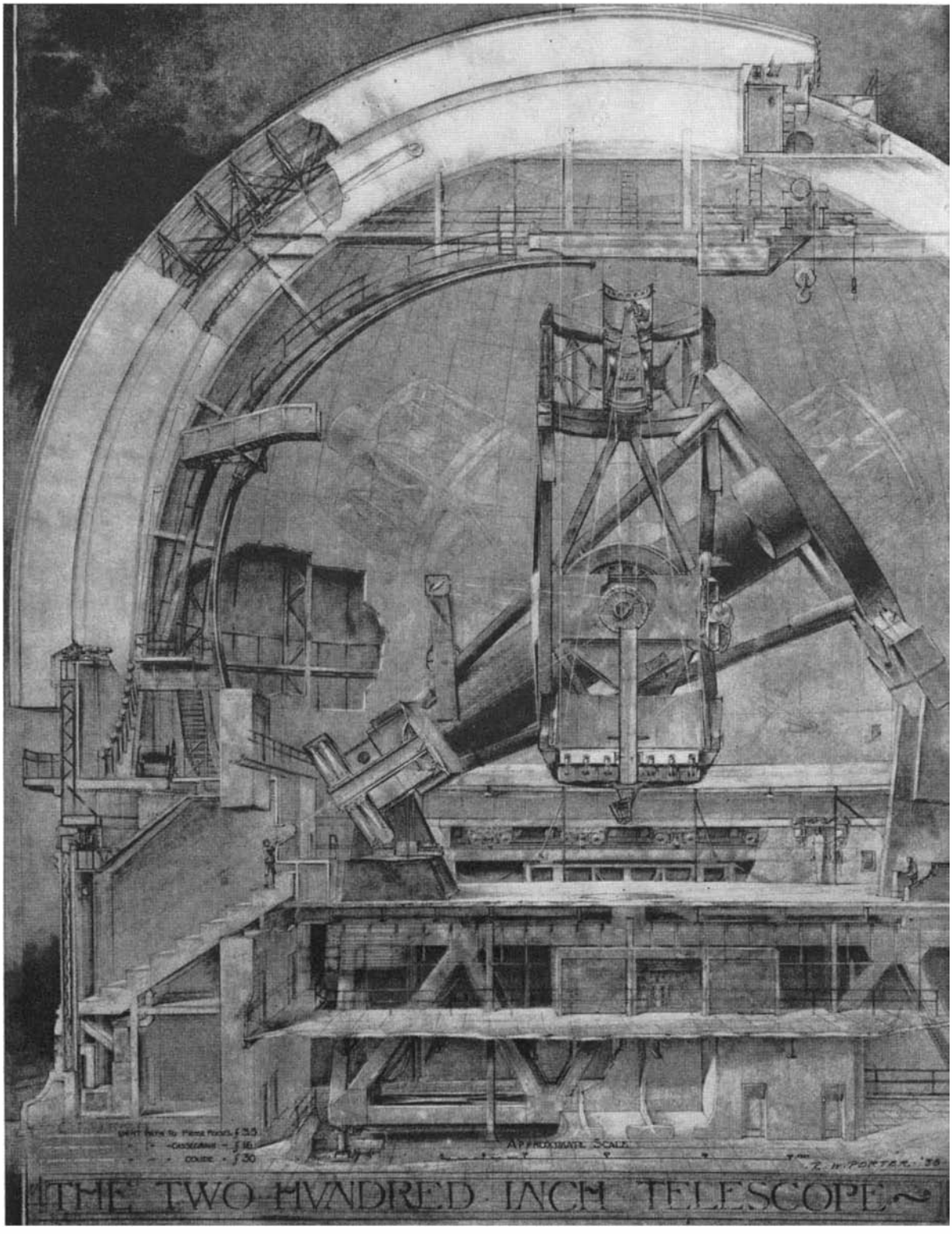
**¶Wall-board—an industry built on waste, by Philip H. Smith.**

**¶Diesels make a place for themselves in aircraft powerplants, by Paul H. Wilkinson.**

**¶New international bridge is an unusual engineering project, by D. B. Steinman.**

**¶Lessons learned from the centuries-old vegetarian diet of the Chinese, by William H. Adolph.**

**¶Making new atoms in the laboratory by artificial transmutation, by E. U. Condon.**




## AN UNPRECEDENTEDLY LARGE PIECE OF FINE MECHANISM

HOW gigantic will be the 200-inch telescope now within but two years of completion in California is revealed by the scale of the three human figures in Russell W. Porter's drawing shown above —so small in comparison that they are even difficult to find. But only after reading the article on page 68, and especially after minutely studying each of the five illustrations, will the reader come to sense how complex a mechanism this instrument has been to design. In size, as a mechanism, it is unusual; in complexity, likewise; in precision—that of a refined watch, though it outweighs 5,000,000 watches. When these three are compounded it is phenomenal.

Comparison of three skulls with features that are obvious to the layman. On the left is the typical skull of an adult white male, aged 18. Its size and proportions are those of a man who grew up. *In the center:* Skull of white male, aged 18, who merely grew —of infantile proportions and contour. *At right:* Skull of an infant, aged about one year, of infantile size and proportions

# THE SKELETON TALKS

## Bones of Skeleton Give Amazing Data . . . Tell Age, Race, Sex, Stature, and so on . . . Study Is Important in Anthropology, Archeology, and Criminology

By WILTON MARION KROGMAN
Associate Professor, Anatomy and Physical Anthropology, Western Reserve University

WHOEVER said "Dead men tell no tales" certainly didn't figure on the physical anthropologist who makes it his business to interpret and translate the tales that dead men *do* tell. Give him merely a few skeletal fragments—a thigh-bone or part of a skull —and this trained scientist will construct a story complete almost beyond imagination.

Suppose we take as an illustration the following, and not unusual, example of "skeleton analysis." Some children playing in a ditch discovered several bones of a human being. After studying these skeletal remains, the anthropologist produced a full-length anatomical portrait of the person to whom the bones had belonged. She had been, the analysis disclosed, a female mulatto, 33 years old, 5 feet 6½ inches tall and had weighed about 120 pounds. These clues led to the identification of a missing colored woman, whose physical measurements were on file with the police at the time of her disappearance. Observe, now, the close agreement between the anthropologist's conclusions and the actual facts. According to police records, the deceased had been half-negro, half-white, 33½ years old, 5 feet 7 inches in height and had weighed 125 pounds!

This startling accuracy is no fluke, no random thrust at probability. The skeleton of a human being, alive or dead, reveals infallibly that person's physical history and will continue to do so for centuries beyond the grave. Race, sex, age, stature, serious illnesses, and sometimes the cause of death are recorded permanently in skull, pelvis, and the "long" bones of the arms and legs. The method is so accurate that today it is of primary importance to the criminologist, the historian, and the archeologist. It is even applied to the living skeleton by means of X rays as a valuable check on growth and health.

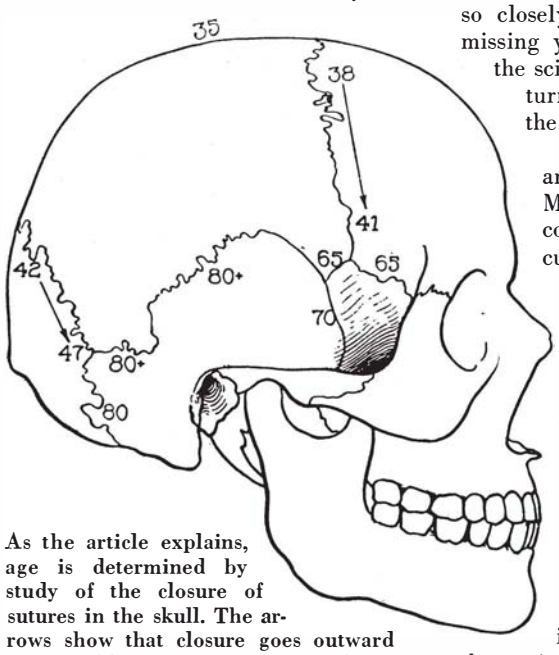
THE skeleton yields up its secrets principally through accurate comparative measurements. Racial characteristics, for example, show clearly in the proportions of the skeletal elements. Thus, Negro skulls are long and flat; the eye sockets are wide apart, and the facial plane slants strongly. The pelvis is narrow and the arm bones are very long in proportion to the legs. These elements are quite different in the white race. The anthropologist not only identifies each type with ease but, if the subject is not "pure," can usually determine the exact degree of intermixture of the two.

Sex shows itself plainly in the general proportions of the bones of a skeleton, whether still alive or dead for thousands of years. A skull alone will determine sex in nine out of ten cases, while the pelvis will do it 98 percent of the time. The two together give *positive* identification. The female skull capacity is some 200 cubic centimeters less than that of the male; the eyebrow ridges and mastoids are less prominent. Woman's pelvic bone is much wider and her whole skeleton finer and more graceful. The male frame is robust and massive and the bones are more rugged.

The scientific bone-detective computes the stature of a dead man by mathematical formulas based on the lengths of arm and leg bones. The thigh bone is the most useful for this purpose. Statis-

tics show that the height of a man will be 1.88 times the length of this bone, plus 813.06 millimeters. In a female, the stature is 1.945 times the length of the thigh bone, plus 728.44 millimeters. Similar formulas apply to the upper arm-bone and shin-bone, and give results *closer than 1 percent* to the actual stature!

These formulas may be applied to the whole anthropological panorama from the Ice Age down. The Neanderthal Man of 100,000 years ago, for example, was only five feet four inches tall, while Cro-Magnon Man 75,000 years later had achieved a full six feet. Shortly after




**As the article explains, age is determined by study of the closure of sutures in the skull. The arrows show that closure goes outward from middle line. Sutures around ear-hole close after 65 years or not at all**

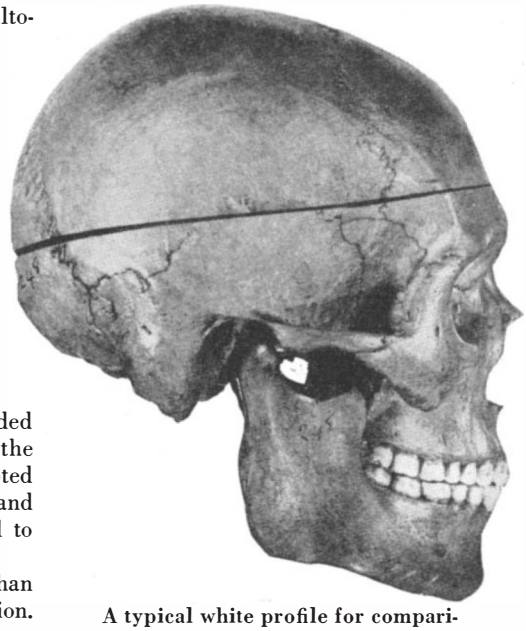
that an adverse environment must have overtaken him, for he dropped back to five feet seven inches. On the other hand the famous Pitcairn Islanders, who had ideal genetic conditions in their remote retreat, soon produced a type taller than either their white or Polynesian forebears. Today, the younger generation in America is taller than its parents and the parents, in turn, top the generation behind them. All of this is divulged by an exact study of the major bones which for nearly a million years have been recording the height of man above the ground.

A SCIENTIST'S ability to determine the *race* of a skeleton meant a fortune in oil to a half-breed Indian in Oklahoma not long ago. The half-breed's son had disappeared several years before, at the age of 18, leaving behind him a tract of land on which oil was later discovered. The father's claim to his son's royalties was contested because it could not be proved that the boy was dead. Meanwhile various other claimants appeared and the Indian was in danger of losing his fortune altogether.

It was known that a youth answering the boy's general description had been killed riding a freight in nearby Arkansas, and before settling the case the court ordered the body exhumed and studied. After three days in the laboratory, the anthropologists were able to establish that the skeleton had belonged to a half-breed Negro-Indian male, about five feet seven inches tall, midway between the ages of 18 and 19. Other bone measurements corresponded so closely with the description of the missing youth that the court accepted the scientists' proof of his death and turned over the fortune in oil to the father.

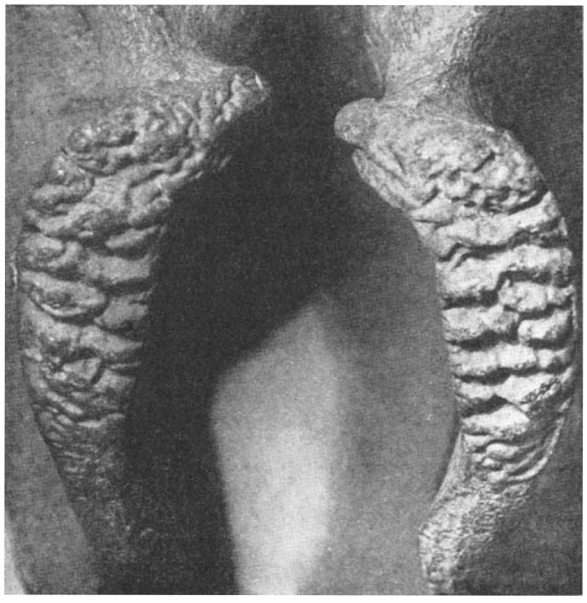
We know more about age than any single item of identification. Methods of determining it are complex but are amazingly accurate. All the long bones grow from maturation areas, or "centers," by the addition of calcium and other materials. This process is known as the "appearance and development of centers of ossification." From birth to five years of age, these centers appear in order; they almost literally punch a time clock and register their owner's age. From five to 12 years these centers grow in size. From 12 to 21 years, they unite with each other. By noting the various aspects of these centers, it is possible to determine the age of anyone under 21 years, within two or three months.

After 21 we must look for other age-changes—particularly in the skull. The 23 bones of the skull are separated by divisions called "sutures." As age advances, these sutures disappear one after the other, according to a rigorous schedule. The three sutures on top of the head, for instance, begin to fuse in a certain order, the first at 22 years, the second at 24, and the third at 26. They are completely erased, in the same order at 35, 42 and 47, respectively. During this quarter century the degree of elimination of the sutures reveals the subject's age usually within a year or less.

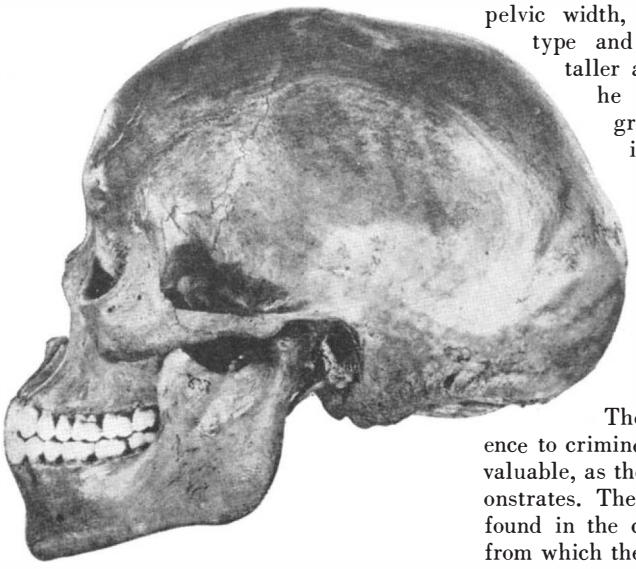


**A typical white profile for comparison with that of a Negro, opposite. It is the skull of a white male, aged 21 years. The vault is high arched, there is but a slight slant, if any, in the face, and the two eye sockets are set relatively close together**

The texture of the bones is another guide to age. After 30, the flat bones, such as the shoulder-blade and brim of the pelvis, begin to lose their blood-supply. As a result, they become dry and brittle; sometimes they warp and shrink. The long bones develop roughened areas at their ends; these areas are called "pseudo-arthritic," for they close-



**The texture of bones changes steadily with age. For example, this pubic symphysis may be compared with the one opposite. This one is of a white male, aged 18 years, and shows the characteristic "ridge and valley" appearance of an immature, poorly outlined surface**



By contrast to the white man's skull, opposite, this Negro skull is long, has a prominent occiput, and a lower, rather flat, vault. The facial profile slants obliquely forward and downward, providing the foundation for the Negro's typical face

ly resemble the bone-changes in rheumatism and arthritis. And either way the bones creak in old age.

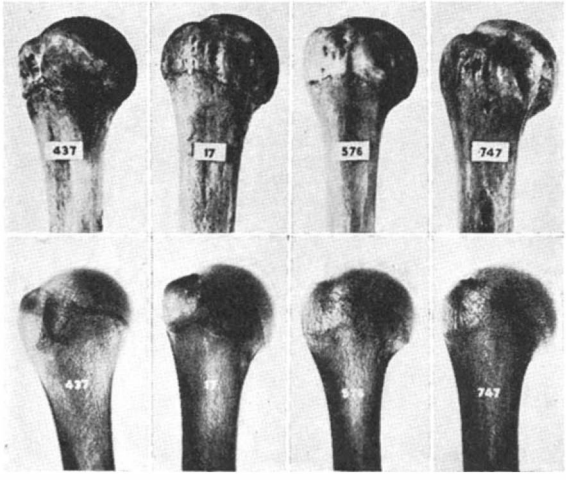
These characteristics remain intact even after thousands of years in the tomb. The age of the famous King Tutankhamen was accurately read from his skeleton to be about 18 years, and of his father-in-law, buried nearby, only 30. The two were also found to be blood relations, for their bones bore a close family resemblance. These facts helped Egyptologists in completing the picture of that ancient dynasty; thus the physical anthropologist often fills in a historic gap that cannot be closed in any other way.

How about weight and build? These questions are answered by the knowledge that the dimensions of stature and pelvic width, generally indicate body type and weight. Obviously, the taller a person and the broader he is across the hips, the greater his weight. But this is not so exact, for avoirdupois *does* have the annoying habit of disregarding the skeletal framework. Sometimes the weight guess is good, sometimes poor. In general, it is the least satisfactory of the anthropologist's findings.

The applications of this science to criminology are self-evident and valuable, as the following example demonstrates. The skeleton of a man was found in the charred remains of a car from which the number plates had been removed. Murder was suspected. A man had recently disappeared in the vicinity after receiving threatening letters. The skeleton was minus a leg, which had apparently been burned away, but to make the matter more complicated, a wooden-legged man of the same age and general build had also disappeared from the neighborhood, threatening to commit suicide. Was it murder or not? In the laboratory the skeleton tallied closely with a description of both men. The solution of the case depended on that missing leg! Had it been burned off, or had it been amputated years before?

The anthropologist reasoned that if the leg had been amputated, the pelvic bone on that side should be smaller and its internal texture weaker, due to years of lighter service. A short examination with calipers and microscope showed that these things were true; this was a man with an artificial leg. For a check, it was found that the bone did not show a ragged burned end, but was smooth and round just as it had healed long before. Therefore, the suicide theory was proved.

The bones may or may not register cause of death. A knife-wound in the abdomen, a slit throat, most poisons (lead is an exception), leave no trace to be discerned in the skeleton. But bullet-wounds often leave bony evidence. The ballistics expert must aid in determining caliber and other vital facts, but often only the anatomist can gage direction of fire, angle of penetration, and even—in shotgun cases—distance, based on the spread, or "pattern," of the shot. In a recent case, a study of these factors substantiated a claim of self-defense, thus changing a murder charge to one of manslaughter.

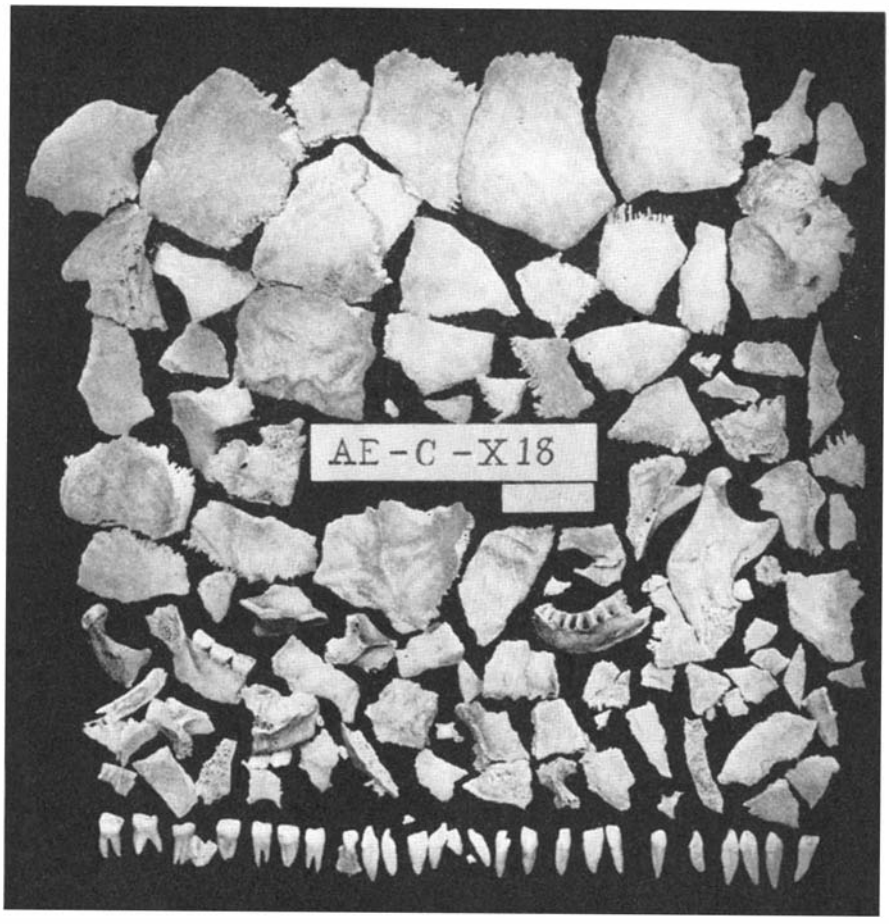



Reading from left to right, the photographs at top and the X-ray pictures at bottom are the upper arm bones of: White, female, aged 18; Negro, male, aged 19; Negro, female, aged 20; and white, male, aged 37. This series illustrates the progressive union of epiphysis (cap at end of bone) with diaphysis (shaft of the bone), according to age

At the age of 38 years, the pubic symphysis shows a radical change from that of a younger age (see opposite photograph). Due to decreased blood supply, the surfaces become dry and brittle. In this one, the "billowing" has been replaced by a clearly outlined, rough granular area

The bones do not always tell of guilt; they sometimes establish innocence. In a case of suspected child-abduction, the cellar of the suspect was dug up and a number of small bones was found. Were they the bones of the child? No. They were: the bones of sheep of five different ages, the bones of a rat, the bones of a pigeon, the bones of a barnyard owl, the bones of a goose, the bones of a turkey, the bones of cows of four different ages. Where did they all come from? Man and rodent had placed them there—the former, by throwing away mealtime remains of sheep, turkey, goose, cow; the latter, by dragging in pigeon and owl, and leaving his own bones.

Can the bony remnants of the human




face give us any idea of how the *features* looked in life? Yes, the face can be rebuilt so accurately that it is a 90 to 10 chance that identification can be made at a glance. The medical dissection of hundreds of bodies, and the careful measurement of tissue thickness at certain points all over the jaw, face, and skull have established the difference between measurements in the living and the dead. On the skull selected, depth-points are indicated by small bits of clay modelled to the exact tissue thickness at that point. When these are all in position, the space in between is filled out to a more or less uniform thickness, depending on contoural variations. "Soft" details of lips and ears are added, the skin-color touched in, and the clay takes on the likeness of the living person. The race to which the living person belonged having been determined from his bones, the facial features are molded accordingly.

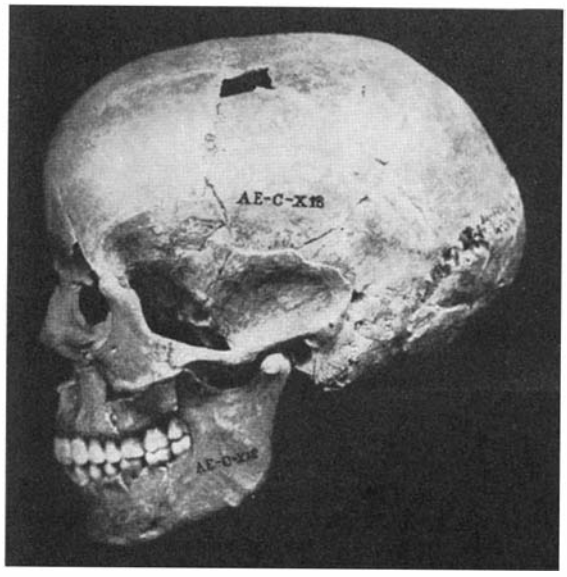
THE skeleton, especially of a child, carries with it the evidence of disease, which may appear in the texture of the bones or in their size and shape. In malnutrition, the bones will be twisted, brittle, or imperfectly formed. In such cases, the X ray reveals white lines running across the bones, representing the times when their growth was halted. Measles, scarlet fever, and many other illnesses leave these telltale scars of arrested development. Knowing the normal rate at which bones build themselves up, the scientist can easily compute the age at which such illnesses occurred.

A few years ago the skeletons of two small children were found in an Indian mound in Missouri. Examination showed them to have been white, however, aged two and five years. A few wrought-iron coffin nails around them indicated an orderly burial about 100 years before. Why had they been buried there, in what must have been hostile country? A study of the little bones gave a partial answer. Both children had been victims of long-continued malnutrition. The picture recreated by the scientists was of an emigrant family, wearily trekking westward across Indian-infested plains, their throats parched by heat and dust, their bodies emaciated by lack of fresh food and good water. The children had finally died, to be buried in haste in the one place the Indians would be least likely to find them.

Today the scientist's knowledge of bone growth is turned to answering the all-important question: What is a healthy child? He can tell, almost to the day, when this bone or that should increase in size, shape, appearance, and texture, and whether the bones are taking minerals and salts as they should. With the X ray, he is able to make his studies as accurately as though he held the bare skeleton in his hands. If all is going well with the child's development, its bony structure will be exactly on schedule in every detail. But if the X ray shows that the bones contain the telltale white lines of arrested growth, or if they have wandered from the norm in shape, size, or proportion, then the danger signal has been hoisted and something must be done. Health history is then checked minutely, the diet is remodelled and the necessary treatment is started before it is too late.

Thus the mute and nerveless skeleton, which seems to the layman the one unvarying human constant, is actually never the same in two persons, nor for that matter, does it remain unchanged for long in any given individual. It alters with our years, and is a telltale index of our health, our way of life, and frequently enough the manner of our death. The bony structure which supports our fleshy envelope is in truth science's best indicator of the history of the individual and the race, and a valuable source of data which could never be found in any other way. All of our knowledge of Man's evolution and development rests on the firm foundation of his bones.

**Above and to the right are 104 fragments of a skull as received, and the skull as restored. It is the skull of a white female, aged about 25, and is one of the oldest historic skulls recovered to date, going back to before 3000 B.C. Recovered in Anatolia, Asia Minor, it was restored by W. H. Sassaman, Western Reserve University**




All photographs are from the Laboratory of Anatomy and Physical Anthropology, Western Reserve University.

# OUR POINT OF VIEW

## Monday Holidays

CALENDAR reform, discussed in past issues of this magazine, has many drawbacks, many opponents. Planned to simplify and systematize our daily social and business lives, many of the proposed reforms would require such an upheaval of existing routine as to make them economically impractical.

There is one reform, however, that does not necessitate major calendar changes, does not interfere with established programs of business and industry. This is the proposal to shift each year the dates of all national holidays so that they will fall on the nearest Monday. The sociological implications of the idea are immediately apparent. Leisure today is something that produces tangible results, is of as great benefit to those who utilize it as it is to their employers. With all holidays falling on Mondays, the resulting two, two and a half, or three day holidays would permit workers to take full advantage of available recreational facilities, to pursue to the fullest their chosen hobbies, to return to their daily labors with a new zest that could not be fully regenerated by shorter weekends and single holidays scattered by the variations of the existing calendar.

Few if any business men and industrialists will dispute the logic of Monday holidays, unless they are motivated by emotionalism. Those whose emotions rule their logic probably will make a strong fight against moving the dates of holidays that have become fixtures through long association, however erroneous in conception. For example: Astronomically a new year does not start exactly on the first second of January 1; Washington was not born on February 22; Memorial Day is an arbitrary date; The Declaration of Independence was not signed on July 4; Thanksgiving Day need not always be on Thursday; December 25 as the birth date of Christ is a moot question with many people.

Enough has been said to show that Monday holidays are desirable and do not involve sacrilege. If sentimental emotions regarding certain dates on the calendar can be suppressed long enough to legalize Monday holidays, and for people to become reconciled to the change, a worthwhile contribution will have been made to life and its enjoyment. Since holidays are desirable, are necessary to life as we live it today, why should not the opportunity be grasped to make the most of them? A start was made years ago when, in 1894, Labor Day was created as a legal Monday holiday. Why not extend the same idea to cover all holidays and thus reap greater benefits for each individual and for the economic and social structure of which he is such an important part?—*A. P. P.*

## Ducks or Mosquitoes?

"WHEN it comes to a question of ducks or human lives, let us forget the ducks." Thus does our friend, the *Engineering News-Record*, hurl a challenge in an editorial decrying the efforts of game conservationists to establish marsh refuges for "ducks, birds, and marsh animals." The argument, as that journal sees it, lies between mosquito control and no mosquito control, the latter situation resulting in 10,000 deaths per year from malaria—a mosquito-borne disease—in the southern states alone.

By all means let us forget the ducks, if that is the only alternative. Fortunately it is not. Nevertheless, the quoted sentence tends to obscure many pertinent factors, for it appeals to emotions which, once called up, blanket all reason.

Having no more than a scientific interest in waterfowl, this writer feels that the *Engineering News-Record* views the subject narrowly. Some engineers, perhaps, enjoy the job of draining lands indiscriminately. On the other hand, for every such engineer in this country, there are dozens of bird lovers—men, women, and children who wish to preserve our native bird life. These are not "a privileged few" who "may slaughter at leisure." Man has already upset Nature's balance too much. It is time to begin working out certain readjustments, and these bird lovers want to see the work begun. Of course many sportsmen also are interested—and their interest has an economic value totalling hundreds of millions of dollars annually.

As to mosquito-borne malaria, let's not sugggest that the entire 10,000 annual deaths in the south are due wholly to mosquitoes from marshy areas frequented by waterfowl (mosquitoes also breed in tin cans and rain barrels), or that the marshes whence they came could ever be drained economically, or that the deaths might not be lowered greatly by proper precautions and medical attention. In other words, there are too many other relevant factors for the blame to be laid to waterfowl marshes, some of which no one would ever bother to drain anyhow.

The subject is too big to cover in a few hundred editorial words which wind up with such a pessimistic alternative as that quoted. It is suggested, therefore, that all the facts be examined. There surely must be a point of compromise that can be found by those studying the facts intelligently and with open minds and humane hearts.—*F. D. M.*

## Our Rebel Collection

TO those of our readers who admit an interest in the odd and unusual, as exhibited in the workings of the human mind, we have often thought of revealing one aspect of an editor's duties for which no corresponding evidence appears in the published periodical. Arriving with the manuscripts that are considered seriously for publication are usually to be found a few which, could they but be published, might provide the readers—or at least those of them having curiosity about curiosa—almost as much return in entertainment, even if not of value, as the more dependable information regularly presented. These are the scientific hypotheses of the studiously unorthodox. All men of science frequently receive such hypotheses from those who are in rebellion against what they term "orthodox science," but the editors of journals of popularized science probably receive more than any scientist—unless it be Professor Einstein, who recently told us that one of his biggest problems was to sort his worthwhile mail from this kind of communications.

It seems to be almost nothing for a man without much scientific training to sit down and solve the subtlest secrets of the universe—the nature of matter and of life, for example—in a single session. Failing to obtain publishers after trying all magazines, they do their own publishing, and thus for many years we have been receiving curiosa, both pamphlets and books: "Newton's Law Disproved." "The Riddle of the Universe Solved." "Rex Rays—the Great Discovery." "Avity, the Secret of Gravity." These are but four—we could go on naming them to a pageful. But for a sense of detachment and perhaps of humor, these offerings, usually attacking prominent scientists with venom, might jaundice an editor's life. Instead, we collect them!

Years ago, when starting this collection, we wondered whether it would not pay science to deputize a scientist to examine them all, in hope of finding occasional pay-dirt. Today we believe we were wrong. Instead, we hope to deposit them permanently in some university library of the history of science. Future historians might otherwise judge that, in our era, pseudo-science was already extinct.—*A. G. I.*


# The Japanese Navy at a Glance

"PROBLEM CHILD" of world naval discussions, the Japanese Navy is also one of the least known outside of Japan. Hence this drawing by the naval authority, Dr. Oscar Parkes, is as illuminating in its completeness as it is interesting in its technique and detail. It is the first of several on navies of the world naval powers which we will publish this year through the courtesy of *The Illustrated London News*. In this drawing we note certain characteristics unique in Japanese men-of-war. The enormous pagoda-like foremasts, around which the Japanese have clustered an extreme number of navigation, fire control, and operating cabins, constitute the first. These, together with excessive top hamper elsewhere, make many Japanese ships "stiff"; they roll less and thus are steadier gun-platforms, but, on the other hand, are more likely to sink


rapidly after being hit badly enough to let in a quantity of water. One new torpedo-boat, the *Tomoduru*, actually capsized during maneuvers, and there have been rumors—the Japanese jealously guard all naval data—that other new ships have performed badly on trials. Consequently, the design of the *Ariake* class of destroyers and of the *Tidori* torpedo-boats had to be changed. Another feature of Japanese warships is the abundance of curves in hull and superstructure. Many stacks also curve in awkward fashion, while many "rake" very sharply. In this drawing is shown the reconstructed aircraft carrier *Kaga*, a longer flight deck having been provided by an extension over her forecastle. Alterations have also been made on the battleships *Nagato* and *Mutu*—increased deck protection, new machinery, aircraft, and other improvements.

There can be given no details of Japan's program for future naval construction. Great Britain and the United States attempted, last February, to obtain a statement of Japanese building plans, but the request met with a sharp reply. Hence these two countries have decided, in conference, on an upper limit for battleships of 45,000 tons, with 16-inch guns.

# THE 200-INCH TELESCOPE

## A Progress Report . . . Two Years to Go . . . The Big Moving Mechanism Weighing a Million Pounds Has the Precision Characteristics of a Fine Watch

By CAPT. C. S. McDOWELL, U.S.N., Supervising Engineer
With Illustrations by Russell W. Porter

THE general story of the 200-inch telescope was given by Dr. George Ellery Hale in Scientific American, May, 1936. In the November number of that year some of the developments of the project also were described and illustrated in an article prepared by the author and the illustrator. At that time —two years ago—we were talking about designs which were still mostly on paper, and were describing what was going to be done, but now many of these designs have become a reality and some of the parts of the telescope have been completed. There will be probably two remaining years of work in checking, assembling, and testing the main parts of the telescope itself, and in completing the grinding, polishing, and testing of the main and auxiliary mirrors.

I have been told by the editor that there is a desire on the part of the readers of this magazine to know more of the details of the telescope tube and its mounting; also, of the dome which will house it. The five sketches which illustrate this article show the special features better than words can tell, though some explanatory notes have been added.

A concrete and steel dome, 137 feet in diameter (see the frontispiece, page 60), has now been completely erected on Palomar Mountain and is ready to receive the 200-inch telescope. The 200-inch telescope tube and its mounting are nearing completion at the South Philadelphia Works of the Westinghouse Electric and Manufacturing Company and will be shipped to Palomar Mountain for installation this summer.

The lower, or stationary part of the dome, has a steel framework to take the bearing loads and has a double outer wall of reinforced concrete, 30 feet high. Between the outer and inner walls there is a 12-inch air space which permits the escape of heated air through connections to a similar air space in the upper dome, where it is vented at the top. This space helps to eliminate heat from the lower spaces of the dome. Also, the inner wall is insulated. These two precautions, aimed at the reduction of the ill optical effects of small temperature differences on the telescope mirrors and on the path traversed by the light, will keep the space below the observing floor near the outside night air temperature. Early each night the air in the lower dome will be pumped out and this space filled with cool night air, so that there will be no gradual accumulation of heat in the lower dome.

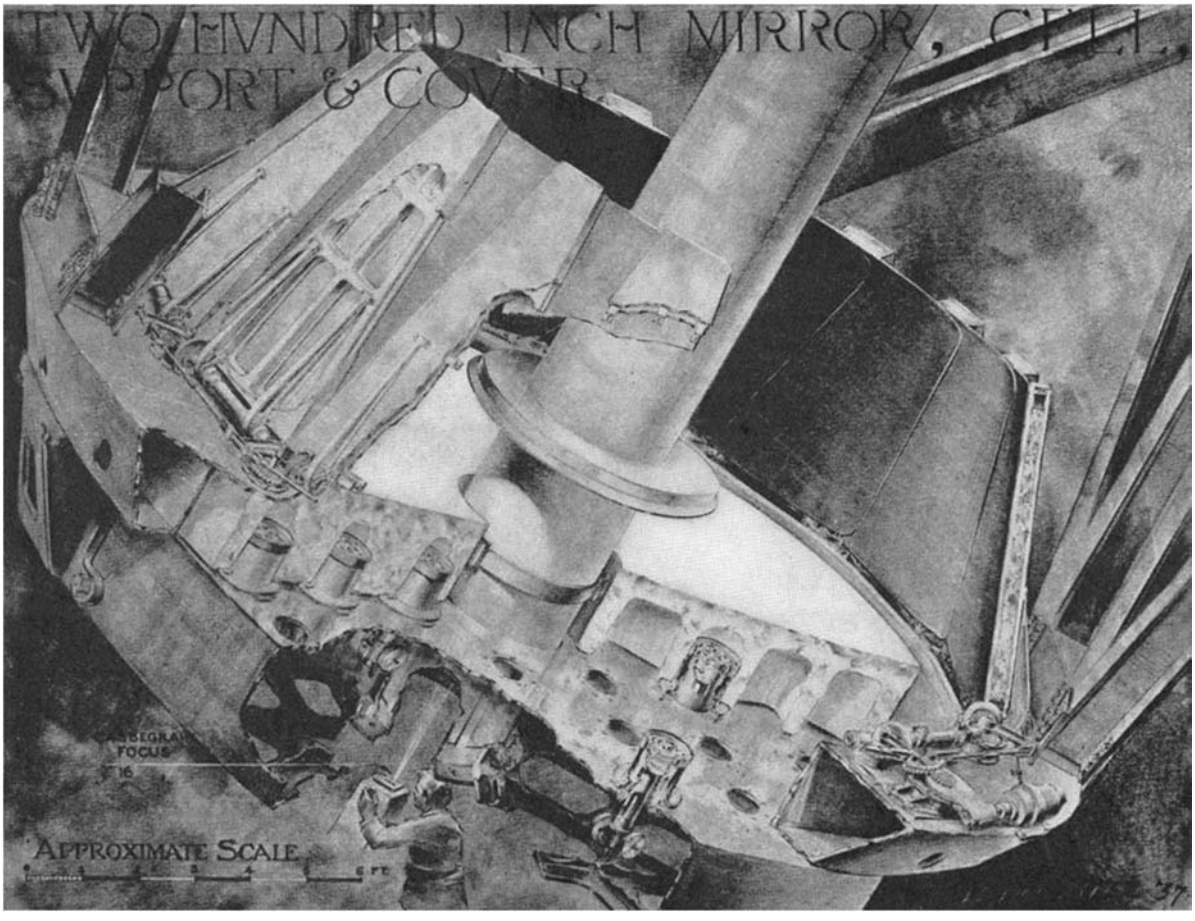



Figure 1

On the lower floor, shown in the frontispiece, there is the astronomers' workshop—where they will develop plates, carry on their studies and "loaf," —consisting of dark rooms, physical and chemical laboratories, a library and lounge, lunch room, astronomers' offices, air-conditioning machinery, and a storage space for material and equipment. A passenger elevator is provided between the ground floor and mezzanine and operating floors and the balcony just above the operating floor. From the balcony landing a short stair leads to the prime focus platform extending toward the prime focus observing station at the top of the telescope tube, which is accessible by a method to be explained later. Thus the facilities on this lower floor are easily and readily accessible to the astronomers from all observing stations.

THERE is a structural steel base-frame which supports the telescope mounting. This base-frame has its own foundations separate from those of the dome. Tests have shown that there is a very low "coefficient of coupling" between this base-frame and the dome, practically preventing any vibrations, which may be set up in the dome, from reaching the telescope. The base-frame supports, on its upper part, four pedestals which project through the upper floor and carry the cross girders, which in turn provide supports for the north and south—or polar axis—bearings. Midway between the lower and observing floors is a mezzanine floor extending over half the dome. This provides space for the main electrical distribution and control panels, motor-generator sets, time standards, storage batteries, and so on. It will also provide storage space for spectrographs and other equipment.

The upper or rotating part of the dome is a completely welded steel structure covered with ⅜-inch butt-welded steel plates. These plates form the outer shell of the dome. This dome is supported through springs on 32 four-wheel trucks which roll on an accurately ground circular track. The meridian section shown in the frontispiece is taken along one of the main arches with the shutter open. One of these shutters is seen over the main arch. Directly under the arch is the 60-ton crane, installed to facilitate the assembly of the telescope. An adjustable wind screen is arranged in the 30-foot-wide shutter opening to avoid any undesirable air currents when the telescope is pointing to the region of the skies near the zenith.

In order to keep the day temperature inside the dome close to the prevailing night temperature, the rotating dome is lined on the inner surface with panels of aluminum foil insulation. These panels are inside the ribs of the dome and provide a four-foot air space, with vents at the top of the dome. The panels are faced with aluminum on their inner side, thus providing a smooth interior surface of aluminum for the dome.

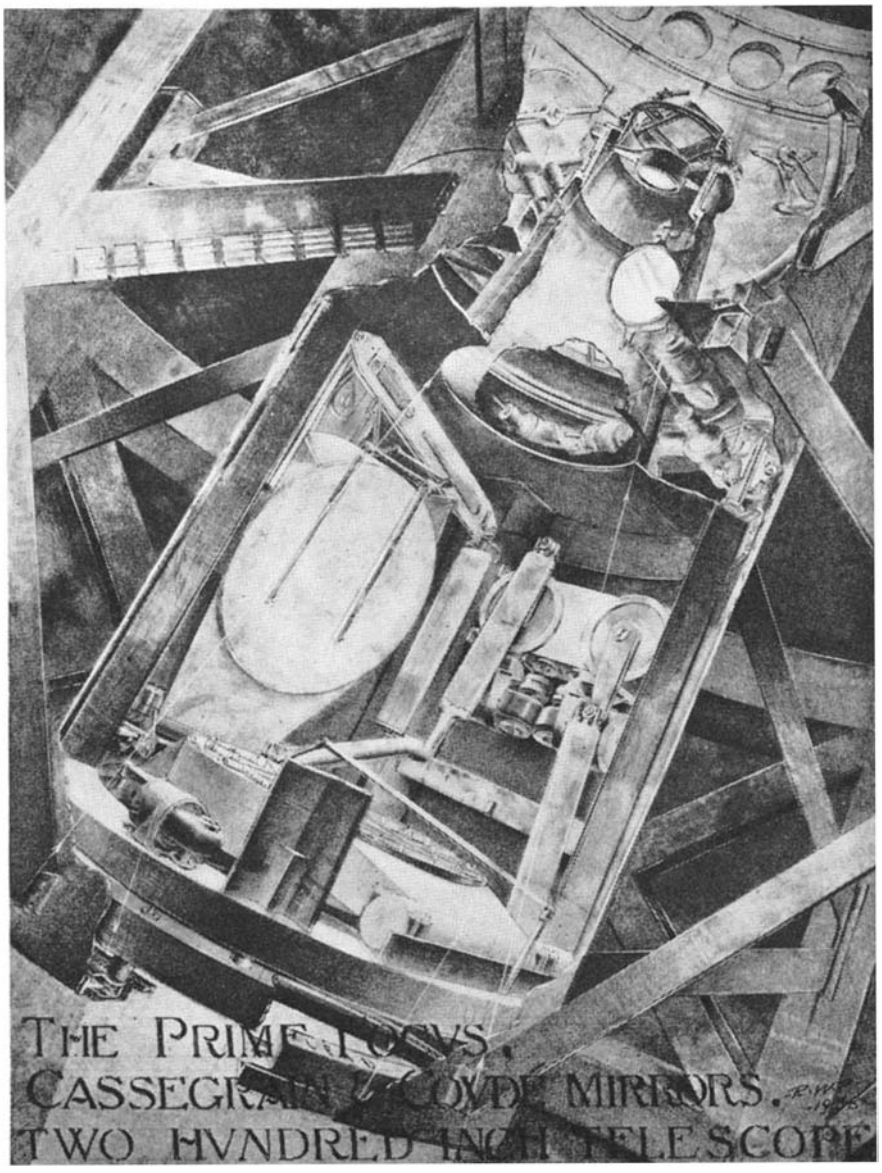



**Figure 2**

The 200-inch telescope has an equatorial type of mounting. The complete optical system comprises eight mirrors which are carried entirely on the telescope tube and mounting. The 200-inch mirror, supported on 36 compensating mechanisms, is located within the bottom ring of the tube (Figure 1). The reflected image is formed at the prime focus (*f*/3.3) in the observer's house, which house is supported on knife-edges —thin edgewise strips of steel best shown in Figure 3—from the cage at the upper end of the tube. Underneath the observer's house and only narrowly separated from it is another chamber mounted on the cage or upper, circular part of the square tube, and containing three auxiliary mirrors with their moving mechanisms. These mirrors, shown in Figure 2, are used, one at a time, for forming images at (1) the Cassegrain focus, *f*/16, located beneath the lower end of the tube, as shown in the frontispiece and in Figure 1, and (2) at the coudé focus, *f*/30, located in a constant temperature room at the south end of the dome (frontispiece, at left side); either two or four auxiliary mirrors are used for the work at the coudé focus. (3) Another three-mirror combination forms an image inside the tubular girders of the mounting at the coudé-Cassegrain focus (*f*/16). The light path for various mirror combinations used is indicated on the sketches. The prime focus is intended to be used generally for direct photography, while the work at the coudé and the Cassegrain foci will be mainly with spectrographs.

The entire tube, over 55 feet long and 22 feet wide, weighing approximately 250,000 pounds, is suspended on the declination axis trunnions from the mounting which forms the polar axis of the telescope. The mounting or yoke (frontispiece) consists of two 10½-foot diameter welded steel tubular girders

joined at the south (lower) end by a cross-member (Figure 4) containing the south bearing and at the north end by a horseshoe-shaped, 46-foot diameter box girder forming the journal of the north bearing. The bearings of the telescope are of the forced-feed oil-pad type. At the north end, the horseshoe is supported on two equalized pairs of oil pads spaced at an angle of 60°. The south bearing is formed by an 84-inch diameter spherical cup resting on three self-aligning pads (Figure 4). When a continuous flow of oil, under high pressure, is delivered through orifices to the surface of the pads, an oil film is formed between the pads and the horseshoe or the spherical cup at the north and south ends, respectively, thus floating the 1,000,000 pound weight of the 200-inch telescope.

The tube is turned north and south in declination by an accurate 14-foot 3-inch diameter worm gear, shown in the frontispiece at the lower end of the polar axis, also in Figure 4. Two worm gears of the same size are carried on bearings at the south pedestal and drive the entire telescope east or west in right ascension through a torque tube. One of these gears is used for setting the telescope on the star at a relatively high speed of ⅛ of a revolution per minute, while the other gear is driven by a synchronous motor through a suitable worm reduction at a corrected sidereal rate of one revolution per day. By using a separate gear for driving the telescope at the higher setting speed, which imposes heavier loads and strain on the gear, excessive wear of the accurate right ascension gear is obviated.

There is a main control desk, located on the operating floor within the north pedestal (frontispiece, at right edge), from which the setting of the telescope in position and actuating the mechanisms of the shutter, dome, and of the wind screen are performed.

The 200-inch mirror (Figure 1), ground and now being polished to a concave spherical surface, later to be completed as a paraboloid, is made of boro-silicate glass having a low coefficient of thermal expansion. In order to obtain high reflectivity of light, the surface of the mirror will be aluminized.

THE total thickness of the mirror is about 25 inches and, in order to reduce its total weight, the back of the mirror is of ribbed construction. It provides a rigid structure which is relatively light and permits rapid equalization of temperature in the entire body of the glass.

The mirror is attached to the welded steel cell by means of 36 balancing mechanisms placed in ground pockets within the ribbed structure. In its turn, the cell is bolted to the bottom ring of the telescope tube.

Essential parts of the balancing mechanisms coming in contact with the glass are made of 38 percent nickel steel alloy which has a coefficient of thermal expansion identical with that of the glass. The function of these mechanisms is to distribute the mirror load evenly among them and prevent re-distribution of the individual loads on the supports at any position of the tube. The tendency of the mirror to distort, when rotated from one position to another, is thus eliminated.

In the center of the mirror is a 40½-inch diameter hole which permits the light, reflected from an auxiliary convex mirror at the top of the tube, to pass through the 200-inch disk and form an image at the Cassegrain focus (*f*/16).

When not in use, the 200-inch mirror is protected by a strong, mechanically operated cover. This cover is thermally insulated and, by means of overlapping auxiliary leaves on the under side of the main leaves, a modified iris diaphragm (Figure 1) is formed. This permits "stopping down" the aperture of the 200-inch mirror, when desired, during some astronomical observations.

Directly underneath the observer's house is another six-foot diameter chamber containing the auxiliary Cassegrain and two coudé mirrors. All these mirrors have to be out of the way of the light beam when work is carried on at the prime focus, and only one of them is used at a time for work at the Cassegrain or coudé foci. Accurate positioning and locking mechanisms are therefore provided in the chamber, in order automatically to operate the mirrors with their counterbalances. A quick change-over for work at different focal points will thus be obtained on the 200-inch telescope. On smaller telescopes built previously, single mirrors are permanently attached to several cages; changing of the cages on the telescope tube

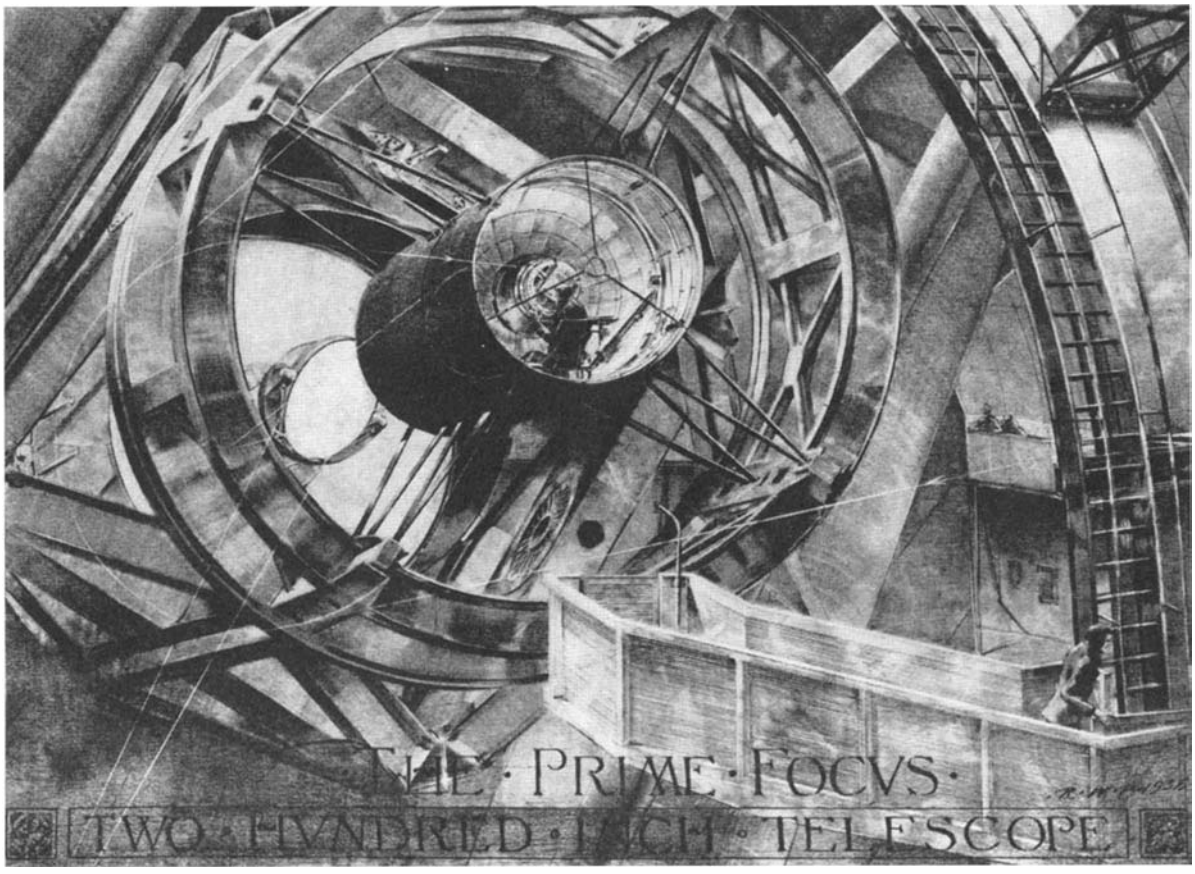



Figure 3

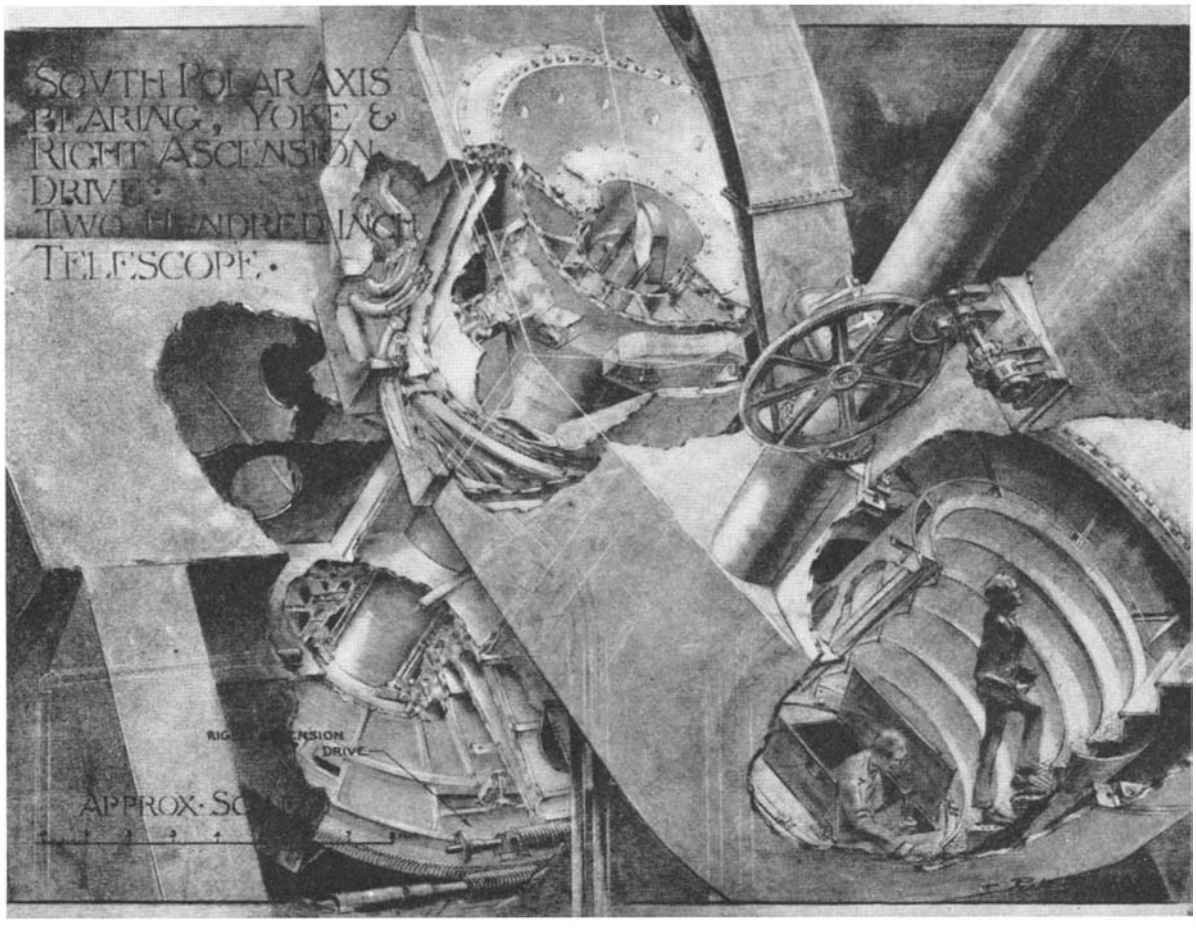



Figure 4

naturally consumes considerable time.

The six-foot diameter observer's house (Figure 3) at the prime focus contains the plate holder with its guiding eyepieces and Ross correcting lenses which permit sharp definition of the image over a field larger than ordinarily obtained. A special chair with a leveling device permits the observer to remain in a comfortable upright position independently of the position of the tube. The chamber will be fitted with telescope position indicators, and a telephone to permit the observer to communicate with his assistant at the main control desk 65 feet below him.

The access to the prime focus is obtained from a special platform running on an arc along the main arch of the dome. It maintains a constant clearance with the observer's house so that the observer may get in and out at any position of the tube.

Other interesting features seen in Figure 3 are, just above the end of the platform, one of the flexible spoke gimbals at the declination axis on the east panel of the tube[1]; and, in the center of the tube, in line with the declination axis, the first coudé flat mirror. This mirror is not used when observations are carried on at the prime and Cassegrain foci.

In Figure 4, the 84-inch diameter spherical cup and the three oil pads forming the south polar bearings previously mentioned, are shown in greater detail. The south bearing carries part of the radial and the entire thrust load of the telescope. A heavy flange is welded to the upper end of the spherical bearing cup. This flange is bolted to the cross-member of the telescope yoke and is connected by means of a flexible diaphragm to the torque tube protruding through the bearing and yoke. The south end of the torque tube is connected through a similar diaphragm to the "fast" setting right ascension worm gear. While the instrument is being set in position, the accurate driving worm gear arranged directly above the setting gear is floating on its bearings. When the telescope is pointing to the desired object in the heavens and is ready for observation, the worms driving the two gears are synchronized and both run at the clock speed. The accurate gear driven by the clock worm is then clutched to the lower gear connected to the torque tube, the thrust of the "fast" worm being simultaneously released. The two worm gears are of split wheel construction, permitting correction of the initial tooth spacing errors by means of lapping during their manufacture.

On the under side of the yoke cross-member is seen, just at left of center in Figure 4, a sheave carrying two four-inch diameter electrical wire cables which distribute current to the declination drive and other motors on the yoke and tube.

A spectrograph will be installed in the east 10½-foot diameter tubular girder of the yoke with its slit at the Cassegrain-coudé focus. A circular stairway and rotating platform inside this tubular girder permit free access and work at the spectrograph.

The tilting arch-shaped gantry crane mounted on the yoke (shown also in the frontispiece as an upward-projecting arm) carries the second flat of the 5-mirror coudé combination. This gantry is mounted on its bearings on the 24-inch diameter diagonal stiffening members of the yoke and when not in use is swung back toward the south cross-member of the yoke.

The third coudé flat for the same mirror arrangement is seen in position inside the torque tube of the telescope.

To realize the magnitude of this undertaking, the layman must note the law confronting the engineer: line dimensions increase in volume as their cube. So, by jumping from the largest existing telescope, 100 inches, to double that aperture, mechanical conditions have arisen which explain in part the complex problems described.

The design of the various parts of the project has been the result of intensive study by many people throughout the country, to whom it is impossible to give proper credit, but all their combined efforts are gratefully acknowledged.

[1]The declination trunnion, of which these gimbals are a part, was described and illustrated in Scientific American, February, 1937, page 116.

# HELIUM—HOPE OF THE AIRSHIP

## Commercial Quantities Produced Only in United States . . . Safer, More Economical Lifting Gas than Hydrogen . . . Stringent Sales Regulations

By PAUL H. WILKINSON
Author of "Diesel Aircraft Engines"

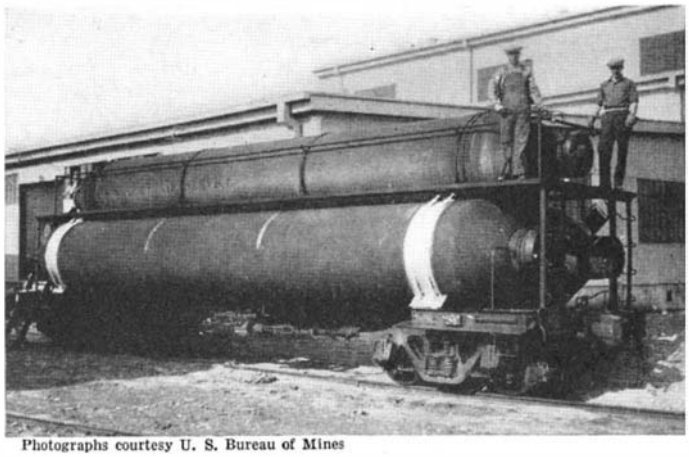
WHEN Congress approved the Helium Act on September 1, 1937, it appeared that a new era was being inaugurated for lighter-than-air transportation. Previously the Zeppelin, dependent upon inflammable hydrogen for its lifting gas, had proved far too dangerous; now, with fireproof helium, it could again assume its place in aviation.

The story of helium is one of the romances of science. It was in 1868, when the French astronomer Janssen and a group of fellow scientists were in India to view a total eclipse of the sun, that they first found the bright yellow spectrum line of the element in the chromosphere surrounding the sun. Simultaneously with its discovery in the Far East, Sir J. Norman Lockyer, the brilliant astrophysicist, announced the finding of the spectrum line of the new element while making observations of the sun in England. So convinced was the Englishman that the gas was not any substance known on earth, that he coined the name "helium" for it, from the Greek word "helios," sun.

The presence of helium on the earth was not detected until 1895, when Sir William Ramsey, the eminent English scientist, identified it as an inert, colorless and odorless gas which he obtained from radio-active ore. Later, it was found to exist in the atmosphere in the proportion of 1 part of helium to 185,000 parts of air, and in minute quantities in sea and river water and in gases emitted from mineral springs and volcanoes. As the quantities obtainable from these sources are far too small for commercial purposes, it is indeed fortunate that an adequate supply has been found in natural gas in certain parts of the United States.

Helium belongs to the family of rare, inert gases, so-called because of their comparative scarcity and extreme chemical inactivity. It will not support combustion, nor will it explode when mixed with air. Prior to 1917, it was obtained in very small quantities in scientific laboratories from radio-active minerals such as cleveite, pitchblende, and monazite. Costing $2500 a cubic foot, its production in this manner was commercially impractical. When the United States entered the World War, the urgent need for non-inflammable gas to replace hydrogen in observation balloons and airships led to intensive search for an adequate source of supply. Helium had been found in natural gas in various parts of the country; the Bureau of Mines, together with the Army, the Navy, and the Linde Air Products Company, worked on the problem until commercial production of helium was assured. That they were highly successful is evinced by the fact that many millions of cubic feet of helium have since been produced at a cost of less than one cent a cubic foot.

**AT press time, it appears that the National Munitions Control Board will not permit the sale of helium to Germany. Five members of that board, fully aware of the desirability of that sale and of the salutary effect that it would have on lighter-than-air craft progress, were over-ruled by the sixth member. It is a crime against science, a shameful commentary on human nature, that obvious personal prejudices should be permitted to shut the door against development of a useful science.—*The Editor.***



Photographs courtesy U. S. Bureau of Mines

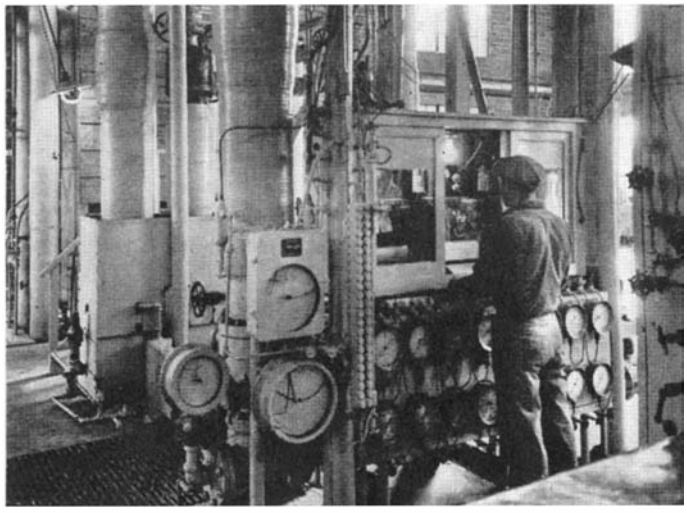
Special Army Air Corps steel tank car for transportation of helium, under a pressure of 2000 pounds per square inch

Most of the helium used today comes from the vast natural gas resources in North America. It is found on other continents, too, but not in sufficient quantities to warrant production. Canada has two helium-bearing gas-sand areas in Alberta and Ontario, where the precious gas has been found in content up to 0.82 percent. An experimental plant set up at Calgary produced some 60,000 cubic feet of it before it was closed down. In much smaller quantities, it has been found in natural gas in Germany, Rumania, Australia, New Zealand, and Japan. In Germany, where it is needed so badly, the content is said not to exceed 0.2 percent. Ample supplies appear to exist in the U.S.S.R., inasmuch as helium-filled dirigibles are reported to be in operation there.

The United States has a virtual world monopoly on helium, as it is the only country where it is now produced in commercial quantities. Most of it comes from natural gas wells on the government-owned Cliffside structure near Amarillo, Texas, where 50,000 acres have been reserved for its production. There the helium-bearing gas-sands, lying at a depth of 3600 feet, are conservatively estimated to contain 1,800,000,000 cubic feet of the precious element. Other government reserves are located at Woodside and Harley Dome in Utah, where 600,000,000 and 100,000,000 cubic feet of helium respectively lie undeveloped as a safeguard for our national defence. In accordance with the powers granted to it by the Helium Act, the government recently completed its helium control in this country by purchasing from the Girdler Corporation its properties and extraction plants at Dexter, Kansas, and Thatcher, Colorado, from which 10,000,000 cubic feet of the gas have been obtained during the past ten years.

Separation of the helium from the other constituents of natural gas is comparatively simple and makes use of the fact that helium is more difficult to liquefy than the other constituents with which it is mixed. At the temperature of 300 degrees below zero, Fahrenheit, to which the natural gas is subjected, air is a liquid and carbon dioxide is a solid. Produced by this method, helium has a purity of about 98.3 percent.

Storage facilities are provided at the Bureau of Mines extraction plant near Amarillo for 3,500,000 cubic feet of helium, which is compressed in steel cylinders at a pressure of 1500 pounds per square inch. For shipment, it is compressed into small steel cylinders of the oxygen type, or into larger containers mounted on flat cars. The small cylinders hold 180 cubic feet of helium compressed into 2½ cubic feet of space, while the three containers comprising a tank-car lot have a capacity of 1500 cubic feet and hold 210,000 cubic feet of the gas. The maximum pressure allowed for shipment is 2500 pounds per square inch.



**Equipment for isolating helium from natural gas at temperatures ranging lower than 300 degrees below zero, Fahrenheit**

THE chief use for helium, of course, is as a lifting gas for airships and balloons. Although it weighs nearly twice as much as hydrogen, nevertheless it has 92.6 percent of the lifting power. By way of comparison, 1000 cubic feet of helium weigh 11.11 pounds and exert a lift of 65.82 pounds, while the same amount of hydrogen weighs 5.60 pounds and exerts a lifting force of 71.04 pounds. This difference in weight and lifting power is quite important when large airships the size of the *LZ-130* are concerned. The *LZ-130* originally was designed for approximately 7,000,000 cubic feet of hydrogen; when it was decided to use helium instead, this resulted in an increase in weight of 38,570 pounds and a loss in lift of 36,540 pounds. This could only be compensated for by increasing the size of the airship or by reducing its payload. Structurally, the ship was too far advanced to make any changes and so its passenger accommodations have been reduced from 70 to 40 persons. The *LZ-131*, on which construction has just commenced, will be 12½ percent larger in volumetric capacity and thus will have sufficient lift for 80 passengers.

Gas diffusion and contamination is one of the major problems of the airship. The slow but constant diffusion of air into the gas cells, and of the lifting gas out into the atmosphere, gradually contaminates the gas and reduces its lifting power, making it necessary to empty the cells and replenish them at frequent intervals. If the airship is filled with hydrogen, this may have to be done several times a year and the contaminated gas discarded, as it is much too dangerous to try to purify such an explosive mixture. When helium is used, however, the rate of diffusion and contamination is much slower, and the gas can be drawn off safely, purified at low temperature, and pumped back into the airship for further use.

Three helium purification plants have been designed by the Bureau of Mines and constructed under its supervision. That at Lakehurst, New Jersey, which is used for servicing the Navy lighter-than-air craft stationed there, has a capacity of 20,000 cubic feet an hour and can turn out helium of 98 percent purity. Another permanent plant, at Scott Field, Illinois, has a capacity of 10,000 cubic feet an hour. This plant, and a mobile installation mounted on a flat car, belong to the Army. The cost of purifying helium varies according to the amount processed and ranges from $0.50 to $1.00 per 1000 cubic feet. This constitutes a considerable saving over hydrogen which would have to be replaced at $2.00 per 1000 cubic feet.

Cost of helium is governed to a great extent by the yearly production of the extraction plant. During the eight years that it has been in operation, the Amarillo plant has produced approximately 77,000,000 cubic feet of helium at an average cost of about $11.50 per 1000 cubic feet. At no time has the plant been operated at capacity, the largest output being 15,000,000 cubic feet during 1932. Last year, the production for the small non-rigid airships of the Army and the Navy did not exceed 4,000,000 cubic feet. During this time, the sale of the residue gas to the city of Amarillo brought in over $200,000 to the government, so that the average net cost of the helium produced to date is $8.80 per 1000 cubic feet. If the Amarillo plant should be operated at its full rated capacity of 24,000,000 cubic feet a year, it is estimated that the net cost of helium to the government could be reduced to about $4.00 per 1000 cubic feet.

Recently, the American Zeppelin Corporation, representative of Deutsche Zeppelin Reederei (the operating company), made application for 17,900,000 cubic feet of helium for the airship *LZ-130* now completed in Germany. [See accompanying Editorial Note.] This should be sufficient for a year's supply—to fill the 7,000,000 cubic-foot dirigible and replace its diffusion and valving losses.

So jealously guarded is our helium supply, that most stringent regulations have been enacted for its sale and export. Before it can be purchased at all, the approval of the Bureau of Mines and the permission of the Secretary of the Interior must first be obtained. Then, if it is desired to export the gas, a license must be obtained from the Secretary of State who issues it with the unanimous approval of the National Munitions Control Board and the Secretary of the Interior. These restrictions have been imposed to prevent its purchase by other countries for military purposes, and to conserve our national resources. In addition, there is another restriction which governs its use in the airships of other countries. This is to the effect that an airship filled with American-produced helium must always use the United States as one of the terminals of its route. In other words, an airship so filled can operate between Germany and the United States, but not between Germany and South America even though it makes this country a port of call en route.

HOW this will all work out remains to be seen. As things now stand, Germany can build the airships but has no helium, while we can produce the helium but have no large airships in which it can be used. In view of the obvious need for airship service across the ocean between North America, Europe, and South America, perhaps a compromise will be reached that will further the cause of lighter-than-air craft and will not create military complications. Whatever the arrangements may be, however, it is a foregone conclusion that the only lifting gas which will be used in these airships will be the safety gas—non-inflammable helium.

# DIFFUSE NEBULAE

## The New Struve Wide-Slit Spectrograph Permits the Observation of the Faint Galactic Nebulae

By HENRY NORRIS RUSSELL, Ph.D.

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

ASTRONOMERS are always eager to extend their powers of observation. The most obvious way of doing this is to build bigger telescopes. This affords the only known way of advance along many important lines, and thus fully justifies its great cost. But there are other fields in which success depends upon ingenuity in design—adapting the whole instrument to the particular problem to be solved.

This is notably the case in the study of faint nebulae, and, above all, of their spectra. At first, the power of photography seemed here to be limitless, for the capacity of the plate to add up the impression made through long hours of exposure revealed details which eyes like ours can never hope to see with any telescope. Powerful cameras, with objectives of large diameter and short focus, and more sensitive plates, added their contributions; but in time a limit appeared. This comes, not from any lack of instrumental excellence or power, but from the general light of the sky. The direct light of individual stars is not seriously disturbing, for, with a suitable instrument, these show as sharp bright points on the plate (or, rather, on a positive made from it), and, were they alone present, there would be a clear dark background between them, on which nebulosity would be clearly visible. But it has been known for many years that the greater part of the light of the clear, cloudless, moonless sky is continuously distributed and forms a faint luminous veil through which the heavens are seen. Part of this comes from starlight scattered by the Earth's atmosphere—just as sunlight is scattered to form the blue daylight skies; but this is relatively small. Most of the illumination comes from two other sources—one in the atmosphere, the other far outside.

The former is of the nature of a permanent aurora. Its spectrum shows bright lines arising from oxygen atoms, and bright bands coming from nitrogen molecules, and its intensity varies considerably from night to night—rising enormously, of course, when visible auroral arches or streamers appear. The latter is caused by sunlight reflected by particles distributed in interplanetary space. These are relatively numerous near the Sun, and in the plane of the ecliptic. In this part of the skies they produce an illumination fully as bright as the Milky Way—the familiar zodiacal light—but this fades out gradually and extends, more feebly, all over the visible heavens. Could we escape from the Earth, and set up an observatory on the Moon, we would be rid of the aurora and of scattered starlight; but the zodiacal light would remain and the darkest parts of the sky would be more than one third as bright as we find it from good terrestrial stations. To get a really clear sky for observing nebulae, a space-voyager would probably have to go to the outer asteroids, or the satellites of Jupiter, if not farther.

IF we make our exposures too long, this featureless light fogs our plates, so that we gain nothing. The sky brightness may be ten times as great as that of the nebula without drowning it out entirely, if a well-timed exposure is made on a contrasting plate; but nebulae less than 5 percent as bright as the luminous foreground would probably be lost. Elvey and Rudnick, who have recently made a long series of measures of sky-brightness, conclude that the limiting brightness which could be photographed under favorable conditions corresponds to the light of a seventh magnitude star spread over a square degree.

To photograph the spectrum of a gaseous nebula is not much more difficult than to obtain a direct image, for the light is concentrated into a few bright lines. With a wide slit, or with no slit at all, each of these is replaced by an image of the nebula, and a moderate increase in the exposure time should record the strongest, at least. But if the spectrum is continuous, observation is much more difficult. The light of the nebula, already very faint, is spread out into a long band, and thus weakened, so much that, with an ordinary spectrograph designed for stars, the exposure becomes prohibitively long.

The problem was solved more than 20 years ago by Slipher, with a specially designed spectrograph, with a camera lens of large diameter and very short focus. This concentrated the light which got through the slit into a short and narrow image, and thus greatly shortened the exposures, while retaining enough detail upon the resulting plates to permit a satisfactory interpretation. It is with spectrographs of this type, fed by great telescopes, that it has been shown that the spectra of the great extra-galactic nebulae are such as would be given by clouds of stars, and that the enormous shifts of the spectral lines have been detected and measured. Of the diffuse nebulae, which lie within our Galaxy, some show gaseous spectra, and other continuous. These last are opaque or partially opaque clouds, shining by light reflected from near-by stars. In the others, most of the light comes from gas, set shining by the action of ultra-violet light. There is usually a faint continuous spectrum also, showing that some cloud-forming dust is present.

Hubble found, some years ago, that the gaseous spectrum appeared only when the star which illuminated the nebula was very hot (of spectral class B1 or earlier). This was easily explicable, for the energy necessary to get the atoms of the nebular gases into the states which emit the nebular lines is large, and to get so much into single atoms demands light of very short wavelength. Bodies approximating the properties of a standard radiator would give off such light in appreciable amounts only at temperatures of 20,000° or more.

There was however one noteworthy exception—the North America Nebula. This is named from a marked resemblance to the outline of the continent—detailed enough to enable Max Wolf, when he observed it spectroscopically, to say that the region he had photographed was "in Guatemala". Wolf found a bright-line spectrum; but there is no bright star of high temperature near-by in the sky, and the only plausible source of excitation is the great star Alpha Cygni. This is one of the most luminous stars of which we know—so bright, indeed, and so far off that its parallax is almost beyond the limit of direct measurement—but its spectrum is of Class A2, indicating a temperature less than 10,000°. If this star really excites the nebula, it must give off very much more ultra-violet light than corresponds to the surface temperature indicated both by its color and by the lines of its spectrum.

Further study of this problem was much to be desired, but, unfortunately, the nebula is so faint that only its

brightest portion was observable with the spectroscopic means which were available.

A notable advance in the spectroscopy of such faint objects has recently been announced by Dr. Otto Struve of the Yerkes Observatory. Once more the method has been the construction of a spectrograph designed especially for the purpose.

As for all faint objects, the camera, which forms the image of the spectrum, had to be of short focus and very high relative aperture. In this instrument it is a Schmidt camera, of 3¾ inches clear aperture, and the same focal length. There are two prisms—of quartz, which transmits ultra-violet light freely, 3¼ inches along the refracting edge and with faces 5½ inches long (to allow for the oblique incidence of the rays upon them).

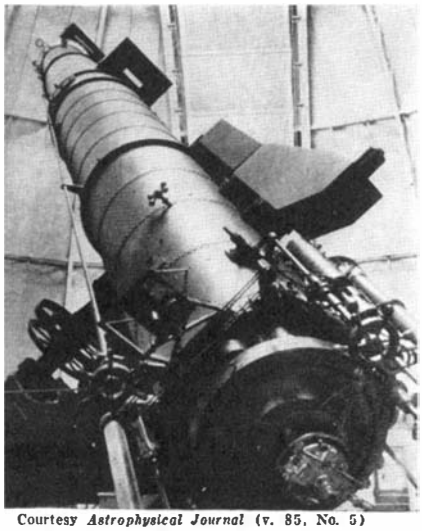
ALL this, while obviously constituting a powerful instrument, has nothing very novel about it. But the other half of the spectrograph, which feeds light into the prisms, is quite unusual.

Ordinarily there would be a slit—worked with the utmost precision of the machinist, perhaps a quarter of an inch long, and with width adjustable, but at most a few hundredths of an inch—and a collimating lens to render the light diverged from the slit parallel before it passed through the prisms. This is necessary, because a divergent beam of light, after passing through a prism, becomes astigmatic, and can no longer be brought to a sharp focus. To feed the light into the slit a large telescope is required (or, not to put the cart before the horse, such a spectrograph is designed to be used with some large existing telescope).

This rather complicated optical system involves a considerable loss of light, partly by reflection from the surfaces of the lenses, partly by absorption of light by the glass. Struve calculates that, with the Yerkes 40-inch refractor, 70 percent of violet light (λ4000) would get through, 50 percent of the ultra-violet at λ3750, and none at all at λ3500 (for which flint glass is practically opaque).

Struve has escaped these difficulties by substituting a very wide slit—two feet long and an inch across!—for the narrow slit of the ordinary instrument, and placing it 55 feet from the prisms. With this device, the rays of light diverging from the slit are so nearly parallel that the distortion produced by passing through the prisms is too small to make any trouble, and there is no need of a collimator lens in front of the prism, or of a telescope objective in front of the slit. The slit is used only to cut out from the sky a small portion, including the nebula to be observed. Being photographed with such a short-focus camera, its image on the plate is less than 1/150 of an inch wide and abundantly sharp for practical purposes.

The whole affair is mounted on one side of the tube of the great 40-inch refractor—because this happened to be there as a convenient carrying mechanism fully equipped for pointing at any given spot in the sky and following it for hours. A very much less costly mounting, fed by a mirror turned by a driving-clock, would have served every purpose if the great telescope had not been available; and an instrument of this sort,



Courtesy *Astrophysical Journal* (v. 85, No. 5)

**The spectrograph, showing slit at top, diaphragm to block out sky, prism box, and the Schmidt camera. As is pointed out in the article, these elements are merely mounted *on* the great 40-inch telescope at Yerkes, because this most easily provides a suitable mounting, and they are not in any other manner related to the big telescope itself**

with an effective length of 150 feet, is under construction for the McDonald Observatory in Texas.

The light-gathering power of the new spectrograph is very great. The green auroral line in the spectrum of the night sky comes up with ten minutes' exposure, and one of three or four hours brings out 20 bright lines or bands. The bright lines emitted by gaseous nebulae are different in position from these bands, and may be clearly distinguished from them, even if they are very faint. This provides a far more powerful method for detecting gaseous nebulae than a direct photograph—on which the whole light of the sky is superposed on that of the nebulae. Struve calculates that, under good conditions, a nebula may be detected which is only one sixtieth as bright as could be observed directly.

The first results obtained with this instrument are of great interest. Greenstein and Henyey have investigated a number of diffuse nebulae, most of them too faint to be studied previously. For the nebulosity near the Pleiades they confirm Slipher's results, finding that it resembles those of the brighter stars of the cluster, and shows that the nebula shines by reflected light. Almost all the other nebulae show bright lines, often accompanied by continuous spectrum. The faint nebulosity which covers a great part of the constellation of Orion shows bright lines of hydrogen, and the ultra-violet line λ3727 a forbidden line of singly ionized oxygen. In the Great Nebula of Orion, the strongest lines come from doubly ionized oxygen—showing that the atoms are much more strongly excited. As the outer nebulosities are probably at least 50 light-years distant from the stars whose light sets them shining, this is not hard to understand. Other nebulosities in Orion, nearer the very hot stars in the middle of the group, show bright lines, but a higher degree of excitation.

In the North America Nebula, Wolf's observations are confirmed. Bright lines are found and the excitation is almost as great as for the Orion nebula.

MOST interesting of all is a faint nebula near the star Gamma Cygni. This shows bright hydrogen lines, and λ3727, superposed as a fairly strong continuous spectrum. The exciting star in this case, though a super-giant of very high real brightness, has a spectrum about like that of the Sun, and both the color of its light and the relative strength of the spectral lines, throughout the visible region, indicate that the temperature of its atmosphere is very nearly the same as for the Sun.

The evidence of these two nebulae indicates very strongly that some relatively cool stars emit ultra-violet light, of very short wave-length (less than 1000 Angstroms) of very much greater intensity than hot solid bodies could do if they gave off the same sort of visible radiation.

This is by no means inexplicable. The light we get from the Sun, or from any star, is a mixture of radiation from different depths in the hazy outer layers. For visible light, the opacity is considerable, and the depth from which the light succeeds in escaping is not great. If the gases are much more transparent for ultra-violet light, this will be able to escape from deeper and hotter layers, and will be much stronger than it otherwise would.

It is noteworthy that both Alpha and Gamma Cygni are stars of very high luminosity. Some recent theoretical work by Kosirév and Chandrasekhar predicts that such an effect should occur in stars surrounded by extensive atmospheres of low density—that is, in just such cases as the present.

Further observations with this powerful instrument will be awaited with great interest.—*American Farm School, Saloniki, Greece, April 28, 1938.*

A battery of scales at this filling table in a mushroom packing plant makes it possible for the operators rapidly to fill each of the cans with exactly the same quantity of the delicacies

# SCALES OF INDUSTRY

By ROGER WILLIAM RIIS

ONE of the marked trends in present-day industry is toward the use of weight as a means not only of checking quantity and quality, but of actually controlling processes of manufacture. Like many trends, this one has advanced so steadily that the full scope of it is not generally realized. A critical view of some of the principles involved and of some of the actual applications of those principles is likely to be strongly suggestive to any manufacturer.

There is an excellent mechanical reason for using weight as a means of control whenever possible. Weight is gravity in action; gravity is the one unchanging force known in the world. Every other force, every other source of power, changes and shifts. The heat received from the sun fluctuates from day to day, even from minute to minute; tides vary; different kinds of fuels give different values in heat units; electric voltages rise and fall and at times are accidentally stopped. Gravity alone, at any given point on the face of the earth, knows no faintest change, at any time. The force exerted by gravity on any object may conveniently be indicated with great accuracy. Hence gravity makes an ideal measuring medium.

Again, there's no likelihood of a stoppage in supply. If there ever should be, none of us would have to worry about the results; we wouldn't be here!

With these peculiar advantages, control by weight should logically have come into its own many years before this. But important applications of it were only possible after the development of the automatic scale. In the old days of steelyards and beam scales, when hand-setting was essential, there was no possibility of using control by weight in, for example, a fast-moving production line or process. The automatic scale, however, eliminated the human hand; as soon as a load came to its mechanism, it functioned instantly. It did not take alert engineers long to realize that here was a new and useful instrument.

Development of the automatic scale has been rapid; its uses are now innumerable. Yet it is only fair to say that the development of the "gravity motor" as a control and check is in its early stages. If whole factories ever are run by panel control from a central G. H. Q., it will be because clever applications of control by weight have made it possible. Indeed, at the last Chemical Show in New York, this futuristic picture was very plainly foreshadowed in the panel control display of one manufacturer.

THE principle of automatic weighing is applied today in industry in order to check quantity; to package and fill; to ascertain breakage, yardage, and moisture content; to count small parts; to check quality; to direct, supervise, and check mixing and batching. It is obvious that these functions fall into three general groups. The simplest includes such jobs as checking quantity and ascertaining breakage, yardage, and moisture content. The next is automatic packaging and filling. The most advanced is the automatic control and supervision of batching and mixing. More or less in a class by itself is the system of obtaining accurate printed records of many of these processes.

Note that few of these functions are those which one ordinarily thinks of as customary functions of a scale. Nor are they, in actual fact; the instrument which performs them is no longer a scale in the simple sense. It operates by gravity and it uses scale mechanics; but it does much more than weigh.

Matching of suspension springs for automobiles offers a good example of the expanding uses for scales. No mat-

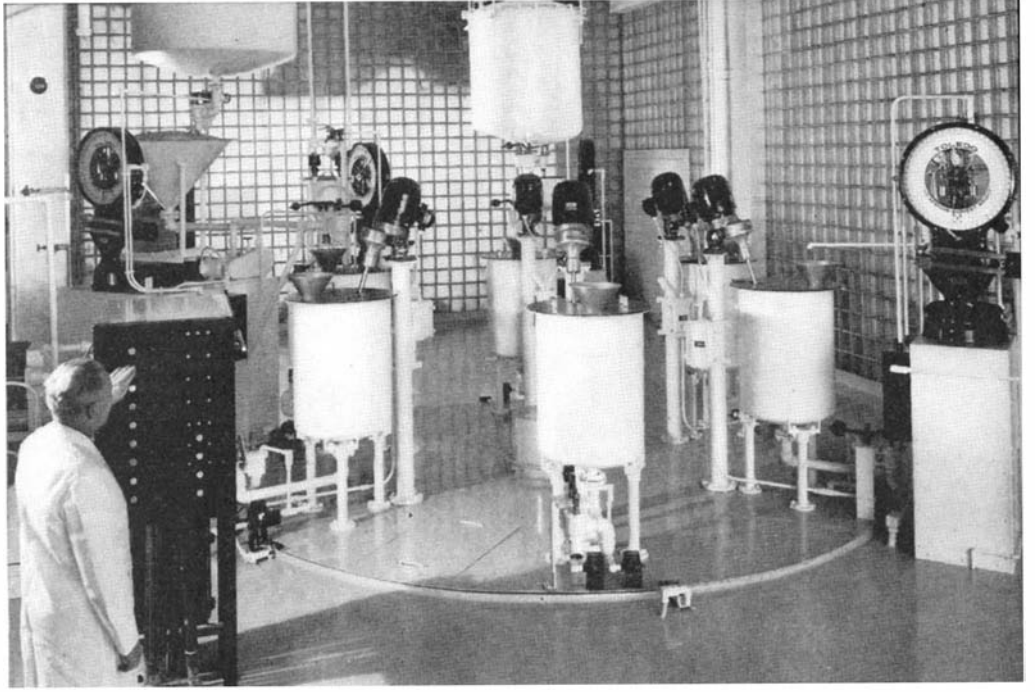

Counting by weight. Bin in foreground is on scale platform; number of items in scale pan, multiplied by the scale reading, gives number of items in bin

ter how careful the manufacture, men cannot produce a thousand springs of identical compression. There is bound to be a slight variation, and that variation is going to have bizarre and unfortunate results if a spring of strength-A goes on the forward left corner of your chassis, and a spring of strength-B goes on the rear right corner. It is not important that all springs be of the same strength; it is important, however, that all four springs on any given car be of identical strength.

It is possible, of course, to test each spring separately and sort them by human labor. But that's not the way the automotive industry grew up. Instead of that slow and unreliable method (human labor makes occasional errors), the industry now generally uses a spring sorting device which is actually a scale, plus. Fed into it automatically, the springs are compressed, their strength measured, and then ejected from the device in one of three classifications. Discharge takes place when the indexing table stops over the upper end of two spouts. Normally, the spouts are held in a vertical position, but when a spring registers weaker than the low-compression limit, one of them is actuated toward the left. Whenever a spring comes along that registers stronger than the upper tolerance limit, the same spout is actuated toward the right. Springs which fall within the compression requirements are ejected through another spout.

THE problem here was to measure rapidly and automatically a certain force, and then to sort out the articles measured. This application falls into the first grouping outlined above. It is really a checking of quality and quantity, plus a sorting operation. The same idea has been applied to matching pistons by balance, so that a car may have a full set of pistons that are mechanically identical and hence will work in harmony and with maximum efficiency.

Early applications of control by weight were in the manufacture of sand paper, roofing paper, tarred or proofed fabrics, and so on. The basic idea is that a continuous production line brings along a strip of the material to which must be applied a covering substance such as sand, tar, paint, ink, or gum. It is of vital importance that the flow of the covering substance remain constant, in order to insure uniform quality. This insurance is obtained by passing the production line over a bar or lever which is actually the platform of a scale. The scale, however, is of the "over-and-under" type; its face or chart, if indeed it has any at all, contains but three marks: a middle zero, a lower-limit tolerance to the left, and an upper-limit tolerance to the right. As long as the production line passes along in proper manner nothing happens. Should a section come along with too much or too little of the recently added material, the scale steps in and automatically actuates switches which stop the line.



Cosmetic components are pre-weighed by the scales at right and in background. As tanks on revolving table reach indexed positions an exact quantity of material is injected into each one

## Do More Than Weigh . . . Manufacturing Processes Automatically Controlled . . . Quantity and Quality Checked . . . Saving Time, Material, and Labor Costs

Typical of batching installations is the use of scales in bakeries. Wholesale bakeries are among the greatest users of industrial scales in the United States. One of the most interesting of the recent bakery installations is that found in the Omar Baking Company in Indianapolis. Here a scale measures exactly and automatically the quantity of flour required for each batch. In the past the bakery had used beam-type equipment, and some difficulty had been encountered in maintaining the uniformity of batches. Uniformity is one of the most serious problems in a bakery; if the ingredients are not batched accurately, the batch may prove too moist when it reaches the dividers. As a result, unreasonable quantities of dusting flour must be added to correct this fault and to keep the loaves moving smoothly through the produc-

Pipe smokers are sure to get the correct amount of tobacco in each package filled in this room. Content weight is checked accurately by individual scales

tion machinery—all of which involves problems of production, inventory control, and quality. The new installation permits positive control and rigid adherence to formula. The budget of material-required can now be checked with actual inventory to within a fraction of 1 percent. The hopper scale installed in this case is equipped with a 500-pound dial, and the photo-electric cut-off is of the single zero type.

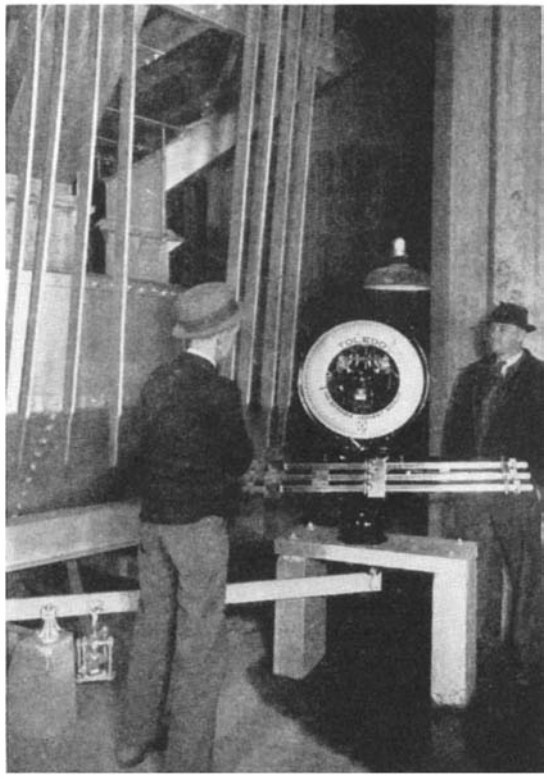
In operation the flour is brought from two floors below by an endless-belt bucket-conveyor to a storage-hopper on the floor above the scale. When the operator pulls the starting-chain, a screw conveyor carries the flour to a point immediately above the weigh-hopper. When the predetermined amount is in the hopper, the photo-electric control instantly closes a clam-shell type cut-off above the hopper, and stops the screw conveyor, which stops the flow of the flour.

All weighing is done on a live-rail section above the center mixer. The load can then be discharged either into that mixer, or moved along the rails to any one of the mixers in the battery. Thus one scale weighs the flour for several mixers. The bakery officials have commented: "It will pay for itself several times each year."

INTERESTING features are incorporated in modern concrete batching plants. All units are electrically operated. All batch mixing operations can be controlled by one operator at a control panel located between two scales. An automatic signalling system warns the operator when the supply bins are filled. The feed of materials to supply bins and weigh-hoppers is electrically controlled. Batches are mixed on trucks, en route to the job.

Two scales of the hopper type automatically and accurately weigh up the cement, sand, and gravel going into each batch. They have an automatic cut-off device and a means of determining and compensating for moisture content. One scale weighs the cement; the other weighs the sand and gravel. The operator has only to set the scale at the predetermined weight and to press a button to start the flow of material into the weigh-hopper. The hopper is automatically shut off when the predetermined weight is reached. Pressing another button discharges the material into the batch-hopper. The process is simple and fast; the batch is exactly proportioned.

A thorough-going installation with many potential uses is the totalizing device which, applied to belt conveyors, controls amounts of materials going into a batch. It is in effect a flow meter for dry materials, automatically and continuously proportioning two or more such materials. In accuracy it functions down to something less than 0.13 of 1 percent.

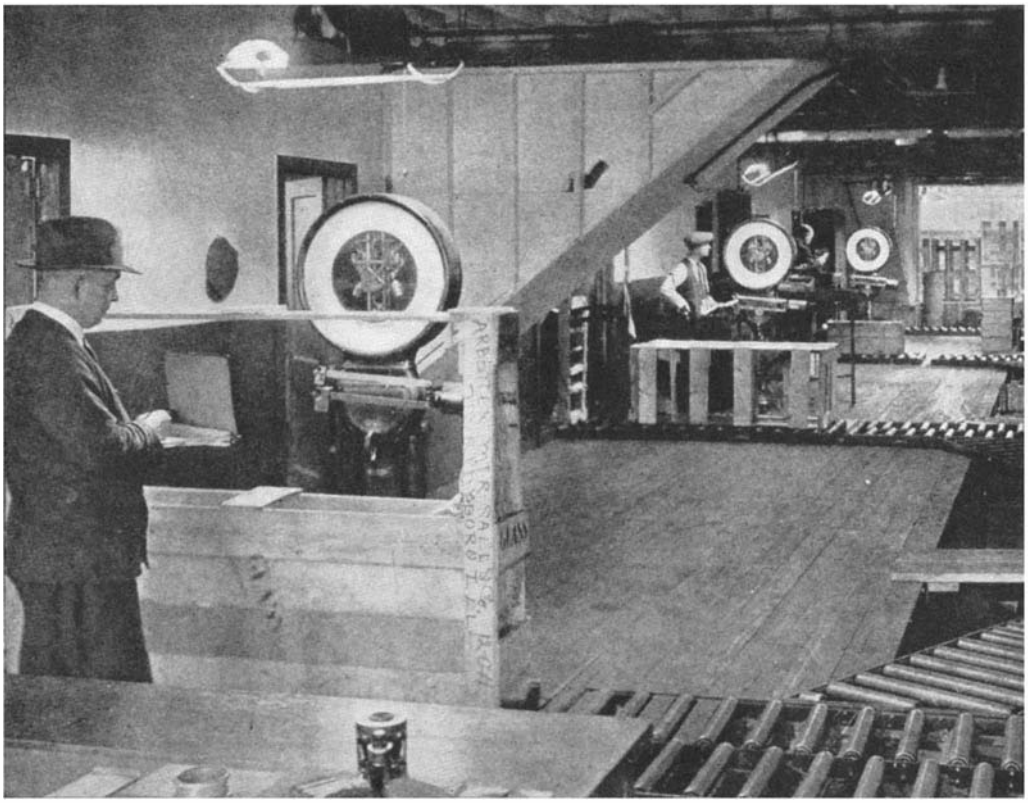


**Quality of finished concrete is governed by accurate proportioning of materials. This long-beam scale batching equipment in a concrete mixing plant gives instant hair-breadth control**

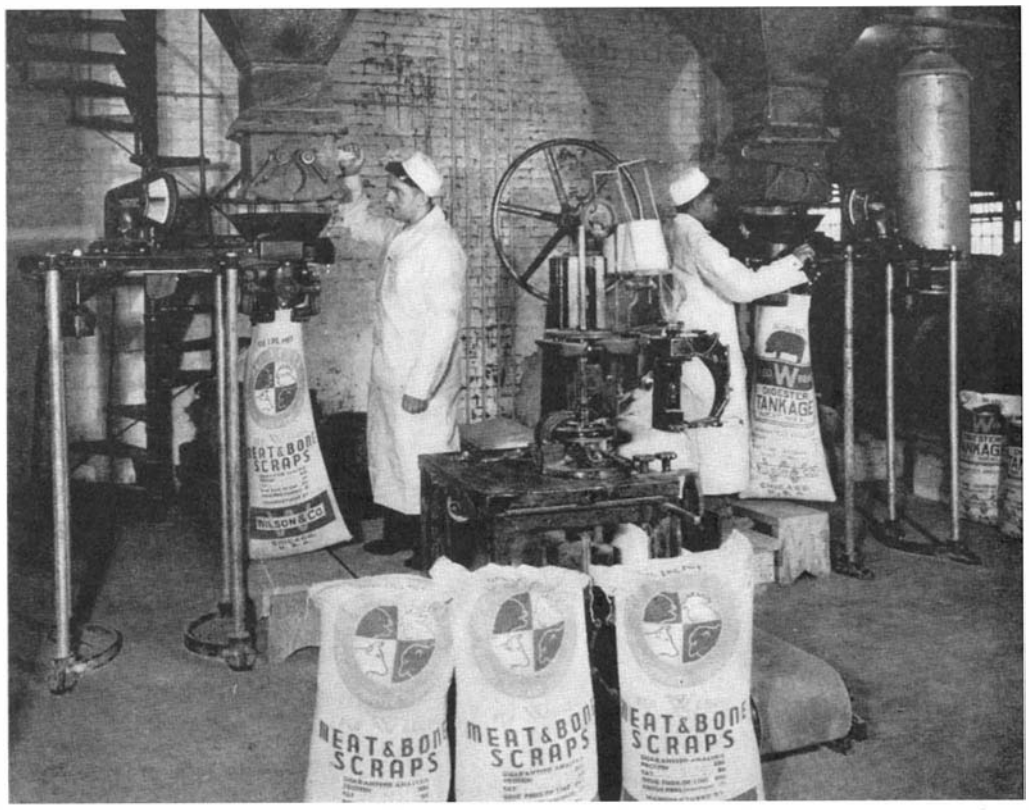
Two principal variables are involved: belt loading per unit of length, and rate of belt travel. A transmitter, part of the scale apparatus, sends instantaneously to the totalizer any variations in belt loading as accurately measured by the scale. Similarly, a belt-speed compensator detects any change in belt speed and projects them into the totalizer. The latter instrument automatically combines or multiplies the two variables and translates them to motion in the counter on the face of the totalizer unit. This unit is separate and can be located at any point remote from the operation. The installation as a whole has been highly perfected to take care of such bothersome factors as belt slippage, variable tare of the belt, and so on.

While the totalizer unit is described as handling dry materials on conveyor belts, an increasingly useful application is in the mixing of liquids. Colored inks, for example, are mixed by a weight-control device. In the control mechanism is a photo-electric cell, "watching" a scale dial. As the scale indicator passes before the cell, the circuit is closed, or closed and reopened, and any required compensating action is controlled.

One of the most thoroughly modern plants in the world is that of the Campana Company, in Illinois, where cosmetics are manufactured in exceptionally attractive and sanitary surroundings. Weight-control installations are used throughout the processes. The heart of this plant is the automatic control of the weighing, proportioning, batching, and mixing of the ingredients throughout production. The specifications covering Campana products are exacting; they require, in some instances, accuracy



**Scales built into shipping room conveyors give a quick reading of the weight of outgoing shipments as the crates pass over a "live" platform**




Bags can be hung, filled, and accurately weighed at the rate of eight bags per minute with this sacking equipment

within the limits of 1/50th of 1 percent.

The first operation consists of accurately blending high-priced essential oils on a scale sensitive to 1/100th of an ounce. The exact amount of material is weighed out within a tolerance of 1/50th of 1 percent. The blended essential oils are then automatically proportioned and mixed with alcohol, to make a concentrate of specified consistency. This is done by means of a scale equipped with photo-electric cut-offs. This concentrate is then pumped to storage above another scale, where it is further batched with several other ingredients, all automatically controlled by weight. The processes are electrically interlocked so that diverting valves are opened or closed when necessary, agitators are started at the proper time, and each individual ingredient is weighed out within very close tolerance and in proper sequence.

This batching equipment is so designed that once the operator starts on a certain batch of material, each ingredient is automatically introduced in sequence, agitation takes place at the proper time intervals, and the batch must be completed before the operator can start another batch, either of the same or different material. Furthermore, temporary interruptions of electric service cannot disrupt these operations. When electric service is resumed after such an interruption, the sequence of batching operations proceeds automatically from the step at which it was stopped.

Following these pre-mix batching operations, batches are delivered to storage tanks from which they are automatically released for the further injection of other ingredients, agitation, milling, filtering, and additional processing operations.

A particularly ingenious method of handling and further processing these pre-mixed batches has been developed by the Campana engineers. A revolving table carrying glass-lined tanks is automatically indexed at definite intervals, ⅛ revolution at a time. Each tank is equipped with its own agitator. At each indexed position of the table, a tank receives an injection of new material, pre-weighed and discharged into it by scales equipped with photo-electric cut-offs.

Millions of egg whites are yearly distributed to large users. Here they are being canned and weighed in one operation through use of floor-type scales fitted with top-reading dials

THESE scales are interlocked electrically with each other and with the indexing and timing operations; each tank thus receives an exact pre-determined amount of material. Any deviation from the established cycle of operations stops everything. In this way, the exact amount of ingredients is injected at the right time and with exactly the right amount of uniform agitation.

From this first table, the materials are discharged into storage tanks near the ceiling of the floor below. From here they are automatically fed into tanks on another table, below, indexed for ⅙ revolution position. Here the materials automatically receive additional injections and agitation in accordance with pre-set times and quantities, controlled again by electrically operated scales. From the second table, the product is again discharged, from each tank in sequence, for bottling, packaging, and shipping.

There are many scale applications where a printed record is required or desirable, held in a roll, or in card or tab form as dictated by the needs of the situation. A result of this recording-scale feature has been the elimination of much argument as to weights delivered—an achievement of no mean value at receiving stations where farmers deliver milk or sloops deliver the day's catch of fish.

Counting by weight is, of course, a simple and established procedure in the handling of large quantities of small objects such as nuts, bolts, and so on. Equally simple is the seemingly complex job of measuring yardage in a bolt of cloth, or checking cases of liquor to determine breakage without opening the case. Simple though the method is, the saving in time, materials, and labor costs is very marked. Innumerable instances are seen throughout the chemical industry, particularly. Experience has shown that the pencilled and thumbed figures of foremen or checkers, no matter how conscientious, may be in error. Foremen get tired, scales do not.

The scale engineer of today is so much more than merely an engineer of scales that he really deserves a new title. He has become a practical, technical expert in material control. Quantity, quality, and manufacturing economy are his stock in trade.

Illustrations courtesy The Exact Weight Scale Company and Toledo Scale Company.

# PROPERTIES OF MATTER

## Unfamiliar Effects Produced by Pressures Up to More than Half a Million Pounds per Square Inch . . . Ice that Melts Only at 376 Degrees, Fahrenheit

AT least 99.80 percent of the material of the earth, and 99.99975 percent of the material of the Sun, exists under pressures greater than 1000 atmospheres—approximately 15,000 pounds per square inch. The importance of a knowledge of the effect produced by high pressures on the properties of matter, if we are to understand very deeply the construction of the physical universe, therefore hardly requires any argument.

For a number of years I have been studying in the laboratory various effects of high pressure on the properties of matter, and I am glad to accept the invitation of the Editor of the Scientific American to describe some of the results. Although the pressures with which we shall deal are all higher than 1000 atmospheres, and therefore are high by the standards of everyday life, they are nevertheless absolutely insignificant when compared with the pressures at the center of the earth or of the Sun. The highest pressure which up to now has been subject to laboratory control and accurate study is about 50,000 atmospheres; this is the pressure to be found in the crust of the earth at a depth of about 100 miles. About 92.5 percent of the material of the earth lies below a depth of 100 miles, so that our ignorance of earth conditions is still profound, but it is nevertheless significant to have got this 7.5 percent under some sort of laboratory control, when one reflects that before pressure studies were made only a negligible fraction, that is, the matter on the surface, was under such control.

THERE are a number of technical problems that must be solved before one can begin to make measurements in the laboratory, and we will stop for a brief preliminary look at some of them. The problem of preventing leak of the liquid with which pressure is transmitted is probably the first that naturally occurs to one, and it is certainly the first that one encounters in the laboratory. The early experimenters solved this problem to a certain degree by brute force—by making the packing as tight as possible with powerful screws. But such packings always leaked as soon as the pressure in the liquid reached the pressure which had been applied with the screw to the packing, and since a screw is a very imperfect means of getting high pressures, leak usually occurred at a few thousand atmospheres. The solution of this problem, as of so many others, was obtained by applying a little finesse and tact to the situation. It proved to be not difficult to modify the design of the glands retaining the packing so that the pressure itself should automatically always maintain the pressure in the packing higher than the pressure in the liquid that was trying to leak past. With such packings, leak becomes impossible until the pressure vessel itself breaks, and the problem was thereby transferred to building pressure vessels so strong that they would not burst.

Perhaps one's first impulse here is to think that the problem may be easily solved merely by making the vessel heavy enough, but actually it is not as simple as this. There is practically no advantage in making the walls of a pressure vessel thicker indefinitely, for the reason that nearly all the stress and strain is concentrated near the inside, so that additional thickness on the outside does practically no good. If, however, we could apply pressure to the *outside* of the vessel, then we could very much increase the pressure that could be carried by the inside. The trick is to make the pressure vessel in multiple units, one inside the other, internal pressure in one vessel being external pressure on the vessel inside it. In practice, one very convenient way of producing the external pressure on a vessel is to give it a slightly conical shape, and then to push it as hard as is safe into a conical sleeve, which it fits accurately. The action is the same as when we push a conical stopper tightly into the mouth of a bottle.

Another part of the problem is to produce the pressures, and this requires the action of some sort of piston. Steel is not strong enough for the piston, but most fortunately a new material has been recently developed, which for this purpose is about twice as strong as steel. This material is "Carboloy"; I am much indebted to the General Electric Company and particularly to Dr. Zay Jeffries for most generously supplying the Carboloy necessary for these experiments.

The force which drives the piston is best generated by a hydraulic press, which is very much more efficient than a screw. One may get an idea of the appearance of the apparatus from the illustrations.

WE are now ready to discuss some of the effects produced by high pressure. One of the most interesting of such effects, and one which has a long history, is the change of melting temperature produced by pressure. When thermodynamics was still in its infancy, Lord Kelvin's brother, James Thomson, proved that the melting temperature should be raised by pressure if the substance expands when it melts, as do most substances, but if the substance is one of those abnormal ones which contract when they melt—of which the best known examples are water, bismuth, and gallium—then the melting temperature should be lowered by pressure. Lord Kelvin made a spectacular experimental demonstration of this prediction from thermodynamics of his brother. The experiment was difficult, however, because it was possible to produce a change of the freezing temperature of only a fraction of a degree with the pressures then available. But with the pressures now at our command it is possible to bring about large changes in melting temperature: the melting point of ordinary organic compounds may be raised by many hundred Centigrade degrees, and even a metal like mercury may be made to

**So persistently and successfully over a long period of years has the author of the accompanying article pursued his experimental researches in the special corner of physics dealt with that his name is linked with it in the minds of scientists and engineers the world over. In his book, "The Physics of High Pressure," also in over 70 published papers, he summarized his work up to 1931. Some of his later findings are now described here.**

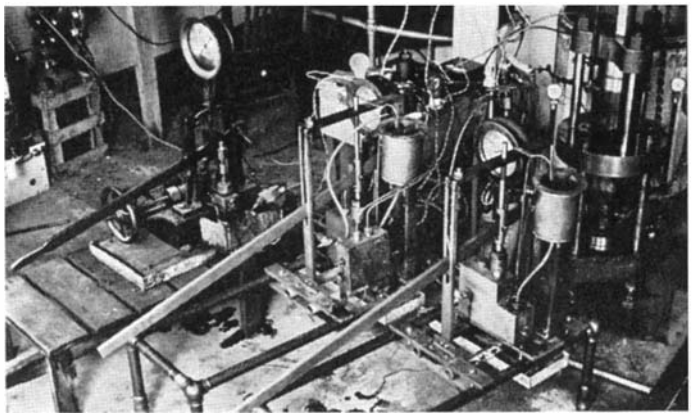
**Prof. Bridgman is also widely known for his contributions to the philosophy of science—specifically the logic of modern physics—dealt with in his book, "The Nature of Physical Theory" (1926). He is a member of the National Academy of Sciences and of the American Philosophical Society.—*The Editor.***

# UNDER HIGH PRESSURE

By P. W. BRIDGMAN
Professor of Physics at Harvard University

freeze solid at the temperature of boiling water under a pressure of about 28,000 atmospheres.

The situation presented by water has interesting features. What is to be expected if the pressure on water is raised indefinitely? Will the melting temperature drop indefinitely, or will something else happen? There was much theoretical speculation on this topic in the few decades after James Thomson's discovery, but the imagination of physicists did not prove equal to divining the true state of affairs. Tammann was the first experimenter who applied pressures as high as 3000 atmospheres in studying problems of this kind, and he found at once that something almost sensational happens. The melting temperature of ice continues to drop until a pressure of about 2200 atmospheres is reached, where the melting temperature is about —22 degrees, Centigrade, which is a trifle colder than can be reached with the most advantageous mixture of ice and salt in the old fashioned ice cream freezer. Now if a pressure greater than 2200 atmospheres is applied to our ice at a temperature lower than —22 degrees, Centigrade, the ice suddenly collapses, with a decrease of volume of 20 percent, and its molecules take up an entirely different crystalline arrangement, as has been proved by actual X-ray measurements by Dr. McFarlan. That is, ordinary ice, by the application of sufficiently high pressure, is made to undergo a "polymorphic transition" to a new crystal system. The loss of volume when this polymorphic transition occurs is so great that the new ice which replaces ordinary ice at higher pressures is denser than liquid water. Hence, if James Thomson's argument is sound, the melting temperature of this new ice should rise when pressure is increased on it, just like that of any normal substance. Experiment brilliantly confirms this prediction. The actual situation is, however, much more complicated than even this, because if too much pressure is applied to Tammann's new ice—3500 atmospheres, to be precise—it in turn becomes unstable and experiences a polymorphic transition with further decrease of volume, and from here on the melting temperature rises still more rapidly with increase of pressure. Even this is not all, for there are seven different kinds of ice in all which may be produced by high pressures. The last and most recently discovered kind of ice melts, under a pressure of 40,000 atmospheres, only at a temperature of 190 degrees, Centigrade—considerably above the temperature of melting solder.



The double hydraulic press, at the right, with the three hand pumps (note their three levers) that are used in its operation

Reasoning by analogy, one would expect that the other two substances, namely, bismuth and gallium, which expand like water when they freeze, would also presently have polymorphic transitions, and that the melting temperature would eventually rise. For a good many years search was made for this suspected phenomenon, especially in the case of bismuth, but with negative results. It finally turned out that the difficulty was merely that the pressure was not high enough. Recently I have found that, by applying 25,000 atmospheres to bismuth and 13,000 to gallium, the long suspected transitions may be made to occur. At pressures beyond these the melting temperature of these substances also rises with further increase of pressure. It appears then that the abnormal expansion on freezing of water and these other substances is only a temporary and somewhat accidental phenomenon; it is probable that at high pressures all substances contract when they freeze. Nevertheless, the expansion of water when it freezes is enormously important for the biological organization of the world in which we live.

The polymorphic transition which turns the abnormal forms of water, bismuth, and gallium into other forms proves to be a very widespread phenomenon at high pressures, and I have studied altogether some 100 different examples among elements, inorganic and organic compounds. Many substances have more than merely two polymorphic forms: thus water has seven, bismuth four, and gallium three. The record is at present held by camphor, which has certainly nine, and probably eleven, different modifications.

Polymorphic transitions must be of very frequent occurrence under the conditions of high pressure and temperature prevailing in the crust of the earth, and we must expect new forms differing in their properties from the familiar forms. This means that one can never feel secure in his geological speculations about conditions in the earth's crust unless he has positive knowledge that a polymorphic transition has not vitiated his analysis, and emphasizes the importance of studying in the laboratory materials under the actual conditions to which they are exposed in the crust.

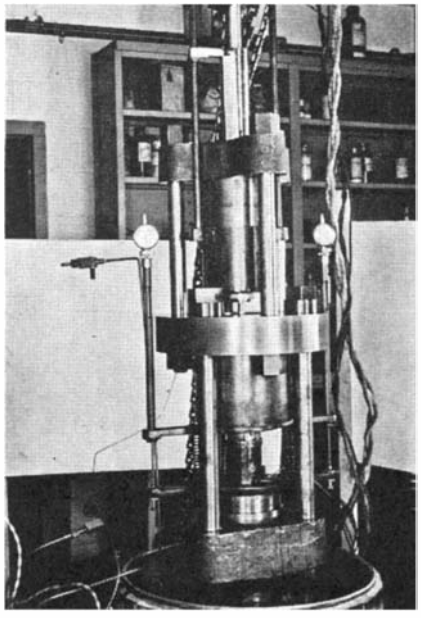
ALL these polymorphic transitions which we have been discussing are similar to the melting of water, in that when pressure is removed the material reverts to its original form. That is, these transitions are reversible, and do not involve permanent changes. A single isolated example has been found, however, of a permanent, irreversible change produced by pressure. Ordinary white phosphorus which, as everyone knows, is so unstable chemically that it catches fire spontaneously when exposed to air, is permanently altered by high pressure and temperature to a new form, previously unknown under any conditions. This new form does not catch fire in the air, is black instead of white, and is a conductor of electricity instead of an insulator. Black phosphorus is much like graphite in appearance. The subject of the mutual relations of all the modifications of phosphorus is not very well understood and is complicated; recently Dr. Jacobs has found another kind of black phosphorus which is more active chemically than the other form.

A permanent alteration like this

kindles the imagination; one wonders whether it is not possible to alter permanently other materials by the application of sufficiently high pressure, and produce a multitude of brand new substances, some of them perhaps with important commercial properties. It is not inconceivable that diamond may be another transformed element of this kind, in the formation of which high pressure may be a vital factor. But, just as in the case of black phosphorus, temperature is also probably an essential factor. The fact that no one has yet succeeded in producing diamonds artificially, at least in commercial amounts, may be because high enough pressures and temperatures have not been used in combination. It is known that 100,000 atmospheres at room temperature is not adequate. The whole subject is one on which some sort of theoretical enlightenment would be most desirable; we would like to know in advance whether other such transformations are possible, and if so among what substances, and what pressures and temperatures are necessary. But at present the prediction of changes like this appears to be even more difficult than the prediction of ordinary reversible polymorphic transitions.

NEXT in simplicity and ease of measurement after polymorphic transitions are mere changes of volume. One is of course sufficiently familiar with the compression of a gas into a small volume when pressure is exerted on it, as dramatically demonstrated by the air that rushes out of one's tire when one has a puncture, but the compression of liquids and solids is not so evident or so readily demonstrated. This has led to sometimes fantastic popular ideas about the absolute incompressibility of liquids like water, ideas which were supported by early crude experiments by physicists, as in the celebrated experiments by the Florentine Academy at the time of Galileo. Nevertheless, both solids and liquids, as well as gases, are compressible; the difference is merely one of degree, requiring much more delicate apparatus to disclose it. In fact, it was not until about 175 years ago that the compressibility of water was demonstrated by placing it in a vessel provided with a very narrow capillary, like a large thermometer, with which the changes of volume could be sufficiently magnified.

It is even more difficult to demonstrate the compressibility of solids; iron, for example is 100 times less compressible than water, and it was only much later in the development of physics that adequate means were found for measuring the compressibility of such substances. However, when pressures of thousands of atmospheres become available, the volume changes of liquids and solids become large enough to be accurately measured with comparatively simple means. Liquids may lose 30 or 40 percent of their volume. Of course every liquid eventually freezes to the solid when pressure is applied to it, no matter how high the temperature, so that measurements on liquids are eventually terminated by the liquid turning into the solid, and measurements of compression have to be continued at high pressures

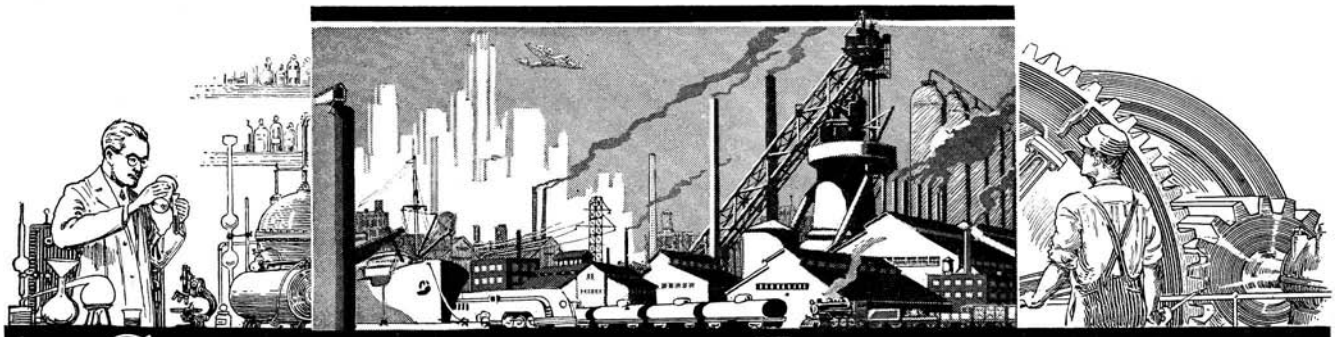


**A close-up of the double hydraulic press shown on the previous page**

on the solid. Thus, the volume of ice at room temperature at 50,000 atmospheres is found to be only 60 percent of the volume of the water with which the experiment started. Metals are in general much less compressible than liquids, but there is a great deal of variation, and the most compressible metal, caesium, is more compressible even than ordinary liquids, and may be reduced to less than one half its initial volume by a pressure of 50,000 atmospheres.

Two stages are to be recognized in the compression of a liquid and to a less extent in the compression of a solid. At first, while the pressure is low, the compressibility is comparatively high; this is followed at higher pressures by a relatively extended range of lower compressibility. The first stage is due to squeezing the atoms or molecules into tighter contact—"taking out the slack" from the atomic structure. The second more extended phase is due to more deep-seated changes which may affect the constitution of the atoms and molecules themselves. The first stage can be understood with the stock of older ideas which was adequate to explain the relations between liquids and gases, but to understand the more deep-seated alterations it is necessary to use some of the newer ideas of quantum theory. It is easy to imagine that a rigorous solution of the problem of the behavior of any body composed of parts as numerous as the atoms in an ordinary body is of prohibitive complexity, and that approximations must be invented. The approximations are of different kinds for different sorts of body, and have been worked out in detail only for the simplest. It turns out that the situation is particularly simple for caesium, and for others of the alkali metals. The structure of caesium consists mainly of positively charged cores of atoms embedded in what is effectively a uniform jelly of negative electricity; the uniformity of the jelly arises from the fact that the negative electricity is in incessant motion. This motion of negative electricity is something of which we had no adequate conception before the advent of wave mechanics, and our recognition of it constitutes one of the great advances of the last few years in our understanding of the construction of ordinary bodies. The speed of motion of the negative electricity is found to depend on the space which it occupies; like a crowd of insects the electrons buzz about more angrily the narrower the space in which they are confined. Here is to be found the explanation of the resistance to compression offered by substances like caesium: when such a substance is compressed the electrons buzz about with greater velocity and therefore greater energy. It is the work done by pressure in overcoming the resistance to compression that supplies this increase of energy of the electrons. On the basis of this sort of picture it proves to be possible to calculate the compressibility of substances like caesium, and Dr. John Bardeen at Harvard recently has succeeded in making calculations which agree surprisingly well with the experiments. Similar calculations will eventually give an understanding of polymorphic transitions.

MANY other changes in the properties of bodies are produced by pressure which there is not space to discuss here. One only may be mentioned—electrical resistance. The electrical resistance of the majority of substances decreases under pressure. Some substances, which under normal conditions are not very good conductors, like tellurium or silver sulfide, may be made by high pressures to conduct thousands of times as well as normally. On the other hand, there are a number of substances which are made poorer electrical conductors by pressure, and there are more complicated instances which combine both sorts of behavior. It is most gratifying that the picture of the structure of metals which wave mechanics is developing is proving adequate to explain the broad features of the complicated experimental situation, and we may anticipate even more success when more powerful mathematical methods have been worked out.



# SCIENCE AND INDUSTRY

## A MONTHLY DIGEST


**Conducted by F. D. McHUGH**

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer


### Chlorinated Rubber Rust-Proofs Steel

RECENT extensive tests under severe corrosion conditions have shown the high value of paints made with a chlorinated rubber base as an undercoat on steelwork. Paints of this type dry rapidly to form films resistant to acids, alkalies, and other corrosive agents. Applied directly to metal, this highly resistant film adheres well and prevents contact with corroding agents.—*D. H. K.*

### Largest Quartz Crystal

ONE of the largest and finest quartz crystals ever to enter the United States went into the vaults of the Bausch & Lomb Optical Company recently. Coming from the Province of Minas Geraes, Brazil, where it was brought by mule pack from the diamond section of the Serra da Mantiqueira range, 1500 miles from the coast, the huge crystal weighs 63 pounds and cost $18 per pound. Based on optical quality, experts believe that it surpasses any museum piece of this type in the country.

Although quartz, a form of silica occurring in hexagonal crystals, is distributed throughout the world, no deposits of suitable optical quality have been found in the United States. Brazil is the chief source of supply.

**Revealing the geometrical form of the huge quartz crystal described**

The crystal is solid matter in its most perfectly developed and naturally organized condition. Its exterior is characterized by a form of extraordinarily regular geometrical design. The internal structure is, likewise, so regular that the arrangement of the structural units, or chemical molecules, is precisely the same about one point as every other point.

**Measuring the quartz crystal prior to cutting it for commercial use**

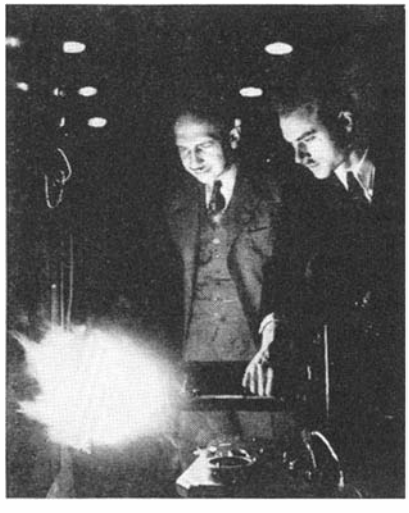
Biologists, cytologists, and histologists benefit by the use of quartz accessories for the microscope because of the ability to differentiate better between various cell and tissue structures, while the spectroscopist utilizes quartz instruments in detecting various elements whose identifying lines lie in the ultra-violet portion of the spectrum.

### Flame Tailoring

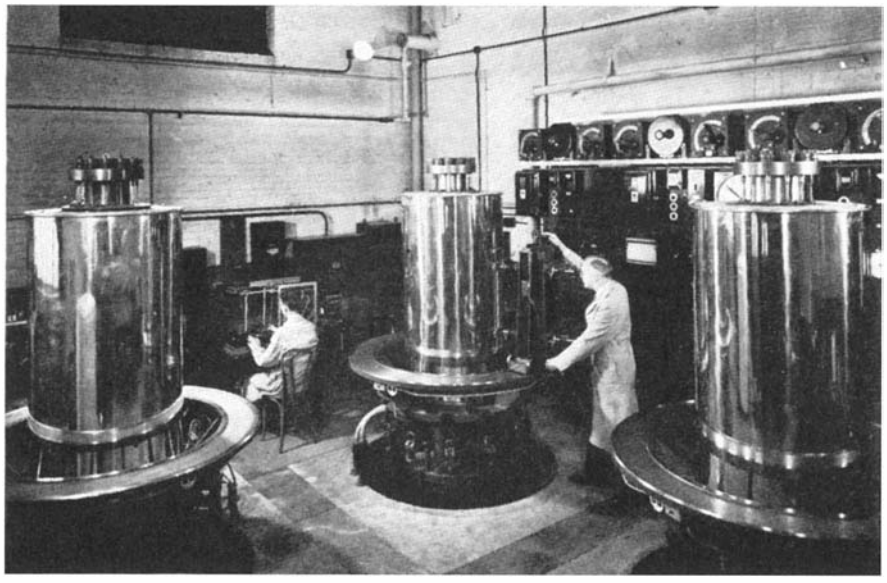
AFTER 10 years of intensive and literal playing with fire, engineers in General Electric's air-conditioning laboratory believe that they have tamed the unruly flame of the oil burner. Indication of their complete satisfaction is found in the fact that for the first time the company is placing on the market the device it began to investigate a decade ago—an oil burner for installation in existent furnaces, operating at low pressure and with a clear, quiet flame that can actually be tailored to fit the combustion chamber of most furnaces.

In spite of the fact that a million and a half home owners have installed oil burners, the inherent difficulty of proper installation, resulting from lack of co-ordination between burner and the many types of existing furnaces, has always been recognized by heating engineers. Inefficiency too often resulted when oil was adopted as fuel for a heating system that had been designed for another method of firing, although the resulting convenience and cleanliness of the oil burner were undeniable. Expensive complications in wiring the burner-to-boiler controls, and nozzles worn by the high pressure needed to atomize oil mechanically, accounted for some dissatisfaction. But more often the trouble has been inherent in the fact that the flame produced by the burner did not fit the combustion chamber, and air pressure had to be distorted to make it fit, lowering the unit's efficiency.

Both the motor-compressor unit and the controls of the new burner—almost human in their vigilance—are identical with those used in the G-E oil furnace. Operation of the device at from 8 to 15 pounds pressure results in quiet operation and indirectly in fuel economy, since the use of compressed-air atomization enables the burner to employ an unusually large atomizing orifice.



**The type of oil-burner flame now obtainable through flame tailoring**



**Three newly completed "creep" recording machines. See also cover illustration**

The larger orifice does not become clogged easily, the nozzle is not worn away by oil at high pressure, and the compressed air cools the nozzle and prevents carbonization. All of which means fewer service calls.

Incorporated in the new burner is a fast-action flame detector, a safety device which automatically shuts off flow of the oil-air mixture, unless a flame is propagated within five seconds after the electric arc ignition is applied. In case of flame failure at any time during operation, the flame detector cuts off the flow of mixture and the controls re-cycle. If no flame appears after two attempts at combustion, the two-try re-start device automatically shuts down the burner completely.

A high-pressure fan minimizes the effect of draft variation, causing the burner to operate efficiently with less dependence on the chimney for proper draft. And a high-lift pump will draw oil from a tank as much as 15 feet below the burner, eliminating the cost of an auxiliary pump.

## Electric Furnaces for Metal Testing

THE finishing touches have just been added to the third of a battery of unique electric furnaces by means of which engineers at the Westinghouse Research Laboratories will study the "creep" of steel and metal alloys. The three new testing machines comprise the most elaborate creep-testing apparatus in the world. (See also the cover illustration of this issue.)

Before a piece of metal can be safely used in a modern high-speed machine, such as a steam turbine, engineers must know exactly how much it will stretch, or "creep," under working conditions. For example, the steam inside a turbine is so hot at 850 degrees, Fahrenheit, that the steel interior glows a dull red. Under the combined action of high temperature, centrifugal force, and steam impact, the grains in the metal slide; the blades creep. Turbine blades are made of alloys which will resist creep, and thus prevent collision after a few years' use, because blades are spaced only a few thousandths of an inch apart to operate efficiently.

Mr. P. G. McVetty, designer of the new testing apparatus, in effect, has combined 60 creep machines into a single unit. With all three of the new machines in operation, it will be possible to conduct 180 simultaneous tests. Each machine is a heavy alloy-steel block housed in a three-walled cylinder taller than a man and supported on a foundation of sand. In order to retain the heat inside the furnace, the outer shell is made of concentric sheets of polished nickel and aluminum separated by powdered silocel.

Sand was used in the six-foot-deep foundation pit because of its ability to minimize the effects of vibration which are known to hasten the creep of metals.

Three electric windings on the metal core of the furnace produce temperatures up to 1000 degrees, Fahrenheit, and a photo-electric cell maintains the temperature within 10 degrees or less by automatically operating a resistance which controls the electric current. The cylinder revolves once an hour in order to distribute the heat equally to all parts of the furnace.

When all three units are in operation, the operator will be able to "plug in" by means of a telephone switchboard and determine exactly how the heat is being distributed inside the furnace. One hundred and twenty-five pairs of wires will connect thermo-couples in the furnaces with instruments for measuring and recording the temperatures.

Each heating core has 12 spaces for holding twelve 20-inch test samples which may be subdivided into five sections to make 60 tests. Dial gages connected with comparison rods extending through the top of the furnace measure the relative vertical displacement of the rods by the samples which may be "loaded" by weights and levers to carry 50,000 pounds per square inch of metal under test.

For a double check, Mr. McVetty equipped the machine with a circular track and a micrometer microscope called an "extensometer." A technician welds two platinum spots or targets at the top and bottom of the sample metal, scratches very fine lines

**As pointed out in our editorial in July, Oglethorpe University's Crypt of Civilization, in which is to be sealed a complete record of our present civilization for the benefit of a far distant one, has been progressing rapidly. Here we show the scene at the recent dedication of the handsome stainless steel crypt door which has been presented by The American Rolling Mill Company. From left to right: Dean Raimundo de Ovies and C. M. Broome, both of Atlanta; T. K. Peters, Director of Archives at Oglethorpe; David Sarnoff, president of Radio Corporation of America; Dr. Thornwell Jacobs, president of Oglethorpe; Bennett Chapple, vice president of The American Rolling Mill Company; James Adams Colby, director of Roger Williams University; James B. Murphy, Director of the Division of Cancer Research, Rockefeller Institute; J. O. La Gorce, vice president of the National Geographic Society; J. Robert Rubin, vice president and general counsel for Metro-Goldwyn-Mayer, Inc.; F. D. McHugh, of Scientific American; and Colin English, Supt. of Public Instruction of the State of Florida. This crypt will probably be permanently sealed in about two years**

on the spots, and fastens the sample metal in the furnace. When it is time to take a measurement of the creep, the cylindrical shell is revolved until the sample is opposite two quartz windows which pierce the 10½ inch wall. The microscope is rolled in place on the track, peers through the quartz windows and measures the distance between the two platinum targets. Its measurements are within one one-hundred-thousandth of an inch of perfection.

**HELIUM**

**THERE are now in sight 25 billion cubic feet of helium in developed gas fields in the United States, or enough to inflate to capacity 3575 dirigibles of the size of the LZ-130. Other gas fields unquestionably hold additional supplies.**

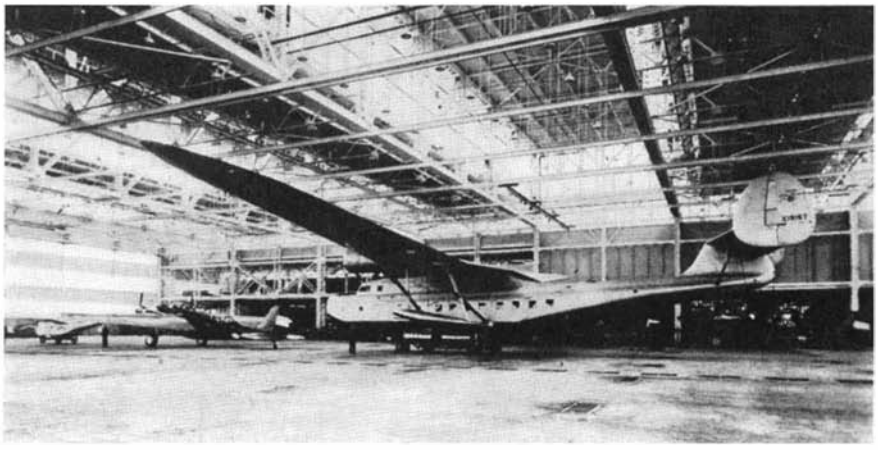
## Le Bourget

IT is the fashion to say that France is in the throes of fatal civil disorder; that, menaced by a powerful neighbor, it is incapable of building up its military aviation; that, in general, France is going rapidly to the dogs; that nothing can save this beautiful country.

This fashion has appeared off and on for 50 years; somehow or other the French manage to survive and to unite solidly when the need becomes sufficiently pressing. In the meantime, in spite of all their troubles, the French do some remarkable work in many fields. A personal friend, R. C. Wood, of Paris, sends us first-hand information on the latest developments at Le Bourget, the Paris airport. For the first six months of 1937, Air France carried 83,000 passengers. The Le Bourget Airport has been rebuilt and considerably extended to meet the ever-increasing air travel. Government subsidies have actually been decreased, which is welcome news.

Our friend writes: The airport building, a steel frame structure situated on the easterly side, is 750 feet in length, 97 feet in width, and 39 feet in height. The Control Tower in the center is 55 feet high; from it a view of the entire field is available. It consists of a ground floor and two upper floors, is lighted by solid panes of glass extending practically from floor to ceiling in all rooms. Each of the floors fronting on the airport is set back so as to give a small terrace on which people can sit (and enjoy refreshments), while the roof is constructed to accommodate some 3000 persons. The offices of the Commandant of the Airport are provided with every possible means of control and aid to navigation. There are hotel rooms, complete restaurants, and so on. Provision is to be made for transatlantic air traffic later on.

When we think of the bleak looking fields, ugly buildings, hot-dog stands, and poor lunch rooms of some of our own airports, we might do well to remember that the French (and the English and Germans, for that matter) are giving their main airports the attractiveness and even the magnificence which modern aviation thoroughly deserves.—*A. K.*



**Huge planes require correspondingly large factory facilities**

## Plants to Keep Pace with Clippers

THE Wright Brothers built their first airplane in a bicycle shop. For 20 years after that time an airplane plant was just a shop without any special functional characteristics. But with the advent of the giant clippers and their special requirements of overhead clearance and huge dimensions, architects have developed a new type of aviation factory. The structure shown in one of our photographs was designed by Albert Kahn for the Glenn L. Martin Company and, in spite of a width of 300 feet and a length of 450 feet, has not a single interior column. The height from the floor to the underside of the roof trusses is 43 feet. The entrance at one end of the building consists of a door having a clear opening 300 feet in width and 40 feet in height. To eliminate any obstructions in the interior of the building, the heating and ventilating system is installed underground. All electrical and mechancial conduits are also placed underground as a further means of eliminating obstructions. We do not believe that any other American industry calls for such special characteristics in its factories.—*A. K.*

**Le Bourget: A well-designed and completely modern airport**

## Encouragement of Private Flying

PRIVATE fliers have long complained that air-traffic regulations have become too complex and that the main concern of the Department of Commerce is with the scheduled airline operator. They will draw hope from the announcement that a section for the encouragement of private flying has been established in the Bureau of Air Commerce. The Chief of the new section is being selected, and is to be a man thoroughly familiar with the problems involved.—*A. K.*

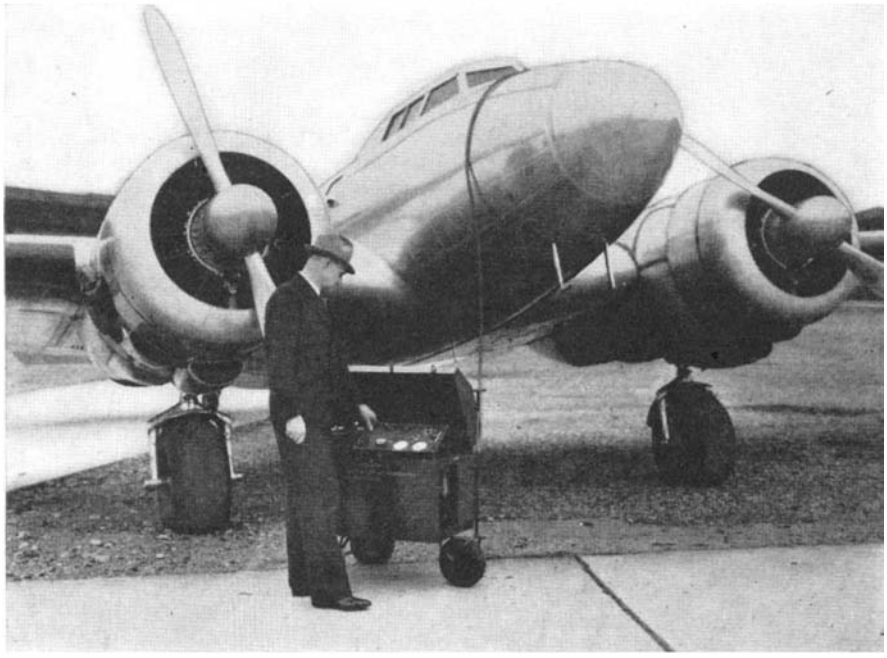
## Flying Blind in Formation

IT is necessary in air tactics that a group of airplanes flying in formation shall arrive at their destination in approximately the same relationship to one another. Otherwise the tactical benefits of formation flying are completely lost. The question arises: Can a formation flight be maintained in conditions of exceedingly low visibility; that is to say, in flying blind?

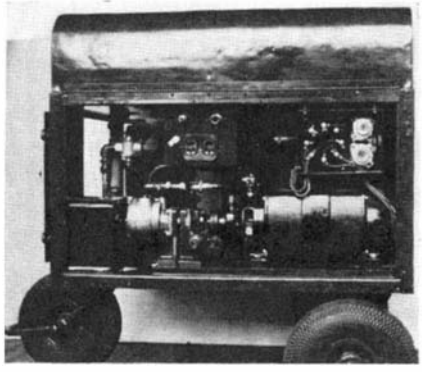
A recent flight by the 11th Bombardment Squadron of the Army Air Corps shows that it can be done.

A flight of three bombers took off from Hamilton Field, California, headed for Bakersfield, California. The Army men climbed to an altitude of 3500 feet in the vicinity of Mt. Diablo. Then visibility ahead became nearly zero.

The Commander of the flight issued radio orders that an altitude of 8500 feet was to be sought. If visibility was still bad at this altitude, then the overcast front was to be penetrated. At 8500 feet visibility remained as bad as ever. Just before the front was



*Above:* **Using the new equipment for testing airplane instruments without removing them from the plane.** *Below:* **"Power plant" in the interior of the portable testing unit**



penetrated, the navigator took the drift of 10 degrees and changed the compass course accordingly. Then, boldly, all three ships sailed into the blind front, with speed reduced to 135 miles per hour owing to icing conditions. Throughout the flight violent snow and rain squalls broke wing antennas and generally interfered with radio communication. The de-icers kept the wings free of ice, but on the Commander's ship it was found necessary to open the navigator's hatch and hit the front antenna mast in order to free it of ice. Nevertheless, on arrival at Bakersfield, after an hour and thirty minutes of flying, the planes were in sight of one another and only three miles apart. Such a formation flight, with reliance solely on instruments and radio, in zero visibility, aggravated by snow and rain, would have been unbelievable only a few years back.—*A. K.*

## Testing Airplane Instruments in the Field

WHEN a pilot on landing reports the poor functioning of any of his instruments, it is customary to remove such instruments from the cockpit to the laboratory, check them, and then return them or retain them for repair as the case may be. Such removal and replacement of the expensive and delicate instruments of modern aviation involves delay as well as appreciable wear and tear.

Now the Matériel Division of the Army Air Corps has developed a portable instrument laboratory consisting of a cabinet approximately 30 inches long, 20 inches wide, and 32 inches high, mounted upon three wheels. The equipment includes vacuum and pressure pumps, instruments for checking tachometer speeds, electrical cables, flexible cables, and so on. Master instruments mounted on the top of a panel in the cabinet include a thermocouple tester, pressure gage tester, and an altimeter tester.

As at present designed, the field test unit can check the accuracy of air-speed indicators, bank and turn indicators, flight indicators, fuel pressure gages, manifold pressure gages, oil pressure gages, rate-of-climb indicators, tachometers, turn indicators, and other devices which help the pilot so much but also serve to make his life such a complicated one.—*A. K.*

**PETROLEUM CHEMISTRY**

**TWO billion barrels of crude petroleum were saved to the world in 1937 by the chemical process of cracking heavy crude oil. Without this process the world would have required four billion barrels of oil to make the necessary gasoline, whereas the world production was only about two billion.**

## To Avoid Collisions

A SUGGESTION in regard to aircraft safety from such a man as Lieutenant Richard Aldworth, distinguished war pilot with many years of practical experience in aviation and now Manager of the New York Airport, is always worth considering. He proposes the development of an instrument or instruments that will give the direction and distance from one aircraft to another while in flight. Of course it is always easier to suggest a device than to develop one. The difficulties in this instance are very great. Should research be in short-wave radio with reflection of waves from one aircraft to another? Should acoustic reflection be employed? Or sighting and triangulation by two mirrors placed some distance apart? It would be interesting to hear from readers what line of attack they would suggest.—*A. K.*

## Plane Detection by Television

IN the preceding note we asked for suggestions for the measurement of the distance of one aircraft from another. Perhaps a device now being developed by R.C.A. will some day make possible just such measurements.

Quite accidentally the British have made the discovery that the metal structure of an airplane in flight collects and re-radiates or reflects the ultra-short-wave impulses employed in television broadcasting, so that receiving sets produce a double or "shadow" image. The "shadow" image is formed by the waves which reach the television receiver direct and by those which rebound from the plane flying within range. The shadow is comparable with the shadow images caused in such sets by waves reflected from the Heaviside layer.

Again it was also discovered, still by accident, that the width of the shadow image cast by the airplane reflections bears a definite relationship to the distance of the plane from the television receiver.

From this it was but a step to experiments in airplane detection on the basis of this curious phenomenon. The British Air Ministry has established a number of television receivers which utilize this principle combined with the elementary principles of triangulation and may lead to a new system of plane detection far more sensitive and accurate than any of the acoustical methods available to date.

Then why not employ the same principle in the device proposed by Richard Aldworth?—*A. K.*

## Bright Nickel Plating

SAVINGS of from 25 to 50 percent in the cost of nickel plating are claimed for a recently developed "bright nickel" process which eliminates nearly all of the buffing, "tumbling," and coloring operations usually necessary to give nickel coating the proper luster before applying the final chromium plating. The new solution also eliminates buffing the copper base on which the nickel finish is applied and secures bright nickel deposits in deep, inaccessible places in complicated shapes otherwise expensive to finish.

## Alcohol Protects Against Trichinosis

FOR protection against trichinosis, take a drink of beer, wine, or other alcoholic beverage with your hot dog, hamburger, or other meat that might harbor the larvae that cause this serious ailment.

The alcohol will keep the larvae, called trichinae, from burrowing into the walls of the digestive tract, Drs. James B. McNaught and G. N. Pierce, Jr., of Stanford University

School of Medicine, told members of the American Society of Clinical Pathologists at their most recent meeting.

Trichinosis is surprisingly widespread in the United States, recent surveys have shown. The disease is acquired by eating meat, usually pork, containing the trichinae. Thorough cooking kills the trichinae and makes the meat safe.

Alcohol does not kill the larvae, the Stanford scientists found. However, a single dose of alcohol given to rats simultaneously with trichinous meat gave 80 percent protection against the disease. The alcohol cuts down the number of trichinae larvae developing in the rat muscles and reduces the severity of the infection.

Alcohol, the studies showed, is no good as a treatment for the disease, only as a preventive.—Copyright, 1938 by *Science Service.*

## Drying Air for Air Conditioning

ALTHOUGH air conditioning to the average person consists principally in cooling the air, drying it is probably more important. Among the materials successfully used to dry air for air-conditioning purposes is activated alumina, which has the ability to absorb large quantities of moisture. In use, the absorbent becomes saturated with moisture and must be revivified by heating. In many cases this method of air conditioning is more economical than de-humidification by cold alone.—*D. H. K.*

**LOCOMOTIVE**

**WHAT is believed to be the longest continuous run by a steam locomotive in regular passenger service was made by Engine No. 3461 of the Sante Fe recently on the run from Los Angeles to Chicago, 2227 miles at an average speed of 45 miles an hour.**

## Submarine Telescope

INTERESTING and educational views of marine life are possible with a new under-water telescope recently placed on the market by the Boyce-Meier Equipment Company. A boatman can see exactly what has fouled his propeller or locate objects lost overboard, or can observe under-water hull shapes in the study of the design and construction of water craft.

The new device is similar in appearance to an ordinary megaphone except for the lenses. In the larger end is a water-tight porthole of glass, while in the smaller is an adjustable telescope. When in use, the larger end is held under the water and the scene is viewed through the lenses at the smaller, dry end. Magnification is about 3½ in air, and about 3½ to 4½ in water.

## Packaged Photo-Electric Burglar Alarm

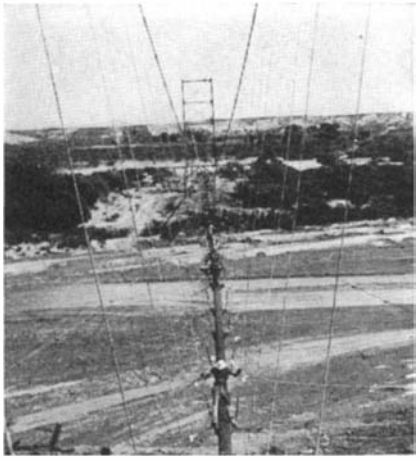
IN the past, burglar alarms employing photo-electric cells have usually been custom-made products costing up to 100 dollars and more. A new burglar alarm, produced by Universal Control Devices, is a packaged unit stripped down to the simple essentials, so that anyone may understand and install it. Furthermore, it is quite inexpensive.

This new "electric eye" burglar alarm is a compact device consisting of two units—a light source which can be mounted anywhere and plugged into any convenient 110-volt alternating or direct current outlet, and a small boxed photo-electric cell which also plugs into a similar outlet. The units may be hidden from sight under a table-top, a desk, in a bookrack, or in any other convenient location, so that the beam crosses the door or window where the protection is needed. Any type of alarm (bell, gong, siren) may be used in connection with this equipment.

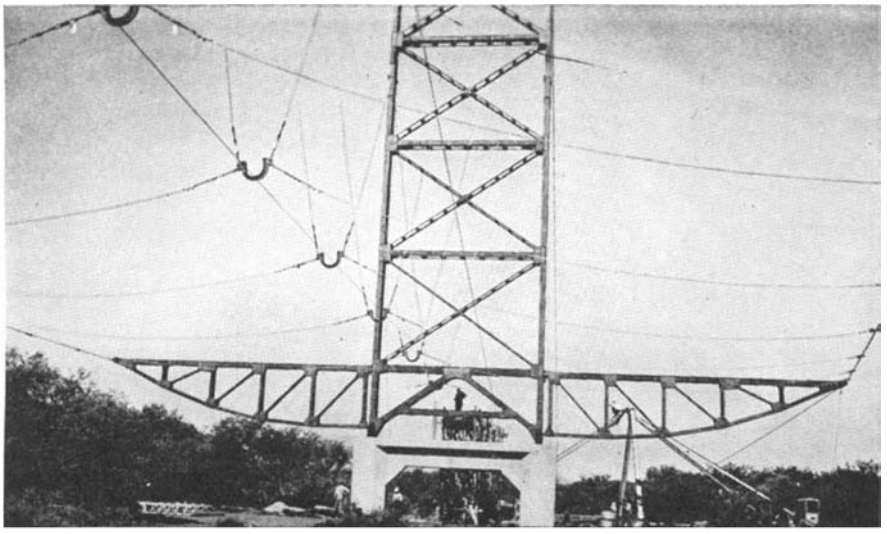
The manufacturer explains that with slight modification of the wiring of the amplifier, the unit can be used as a door-opening device, a switch for turning lights on or off, a counting device, a sorting device, or a detector of practically any kind of motion within the range of the light source.

## Pipe Line Bridge

IT is often necessary to suspend pipe between piers or towers to cross rivers. It is most unusual, however, for engineers to build a pipe bridge resembling a cross-country electrical power line. The two accompanying photographs show one such job which was recently completed, according to the Linde Air Products Company. It was constructed by the El Paso Natural Gas Company near Benson, Arizona, to carry natural gas.



*Above:* **A general view of the pipe line bridge.** *Below:* **A close-up of one of the towers, showing structural steel work and guyed saddles**



The towers on this pipe suspension bridge are each 85 feet high and are 1000 feet apart. As will be noted in one of the photographs, two catenary cables swinging between towers support suspension cables, each pair of which terminates in a saddle to receive the 12¾ inch pipe. The pipe itself was welded in sections and fed out in different lengths from opposing towers. Cables pulled these lengths in, while men along the line steered the pipe in the saddles. After meeting in the center a tie-in weld completed the unusual engineering job.

## Indium

METALLIC indium, one of the rare elements, is added to silver used for plating to prevent tarnishing. The method used is to apply a plate of silver first and then a thin plate of indium over it, followed by a heat treatment which alloys the two metals.—*D. H. K.*

## Aluminum Dust Effective Against Silicosis

DUST against dust, is the possible safeguard against silicosis suggested by researches of Dr. R. C. Sniffen, H. L. Collins, and Miss H. E. Williams of the Banting Institute, reports *Science Service.* The three researchers found that animals exposed to a silica dust similar to that found in many mines and quarries readily contracted silicosis, but that when aluminum powder was mingled with the flying dust the animals were protected.

## Printer's Error Spotlights Macrozamia Trees

THE error of a printer out in Australia centered international interest on Macrozamia trees.

Professor Charles J. Chamberlain, of the botany department of the University of Chicago, had gone on a trip to make a world-wide study of Cycads, which include the Macrozamia. In the Tamborine Mountains of Queensland, Australia, he found an un-

usually large tree, 20 feet high, and spent some time studying this specimen known locally as the "Grandfather Peter" tree.

He told a local reporter that from his study of the leaf cycles he estimated the tree to be between 1000 and 1500 years old. A printer, inadvertently, added a zero to the number, making it 10,000. A contemporary paper boosted it to 15,000 and the American press copied the article under such headings as: "Our Sequoias are Mere Saplings."

California was especially interested as the age prestige of her *Sequoia Gigantea* was threatened.

When Merrill B. Pratt, State Forester of California, received a newspaper clipping to the effect that Australian Macrozamias were the oldest trees known, he came to the defense of the sequoias by writing directly to the Forestry Department of Queensland, Australia.

A letter from Dr. D. A. Herbert, in answer, explained the error and stated the age as estimated by Dr. Chamberlain. He also stated that this famous "Grandfather Peter" tree had recently been cut down by some thoughtless boys.

Thus the mantle of antiquity has been restored to the Sequoias.—*Cora L. Keagle.*

**VIBRATIONS**

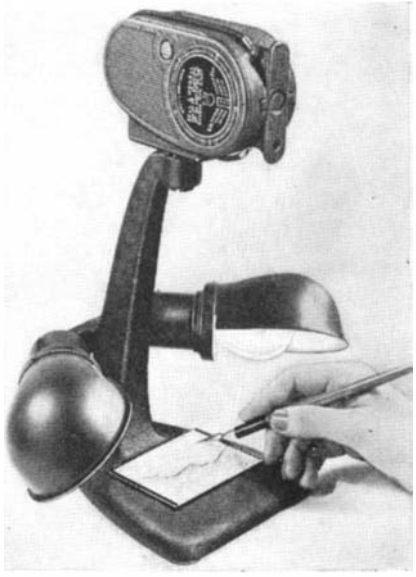
**A QUARTZ crystal oscillator developed for maintaining constant frequencies in radio transmitting, vibrates at the rate of 20 million vibrations per second, or just 16,666,666 times faster than the normal human heartbeat.**

## Film Titler

OWNERS of Filmo 8-mm cameras will find one of their most puzzling problems solved in the new titler just announced by the Bell & Howell Company. Designed especially for Filmo 8's, this new titler is a precision instrument consisting of a base and camera stand cast of aluminum in one piece, and an illumination arm which fastens securely to the camera support and bears two lamps. At the upper end of the camera stand is a special, highly-corrected copying lens in a snap-on-mount, to which the camera is fastened in the usual way after the regular photographic lens has been removed. The titler lens is accurately prefocused on the title card holder on the base, directly beneath the camera.

The holder takes title cards of a convenient size; snapshots, magazine cut-outs, and other suitable backgrounds are readily available in this size.

Since the newer Filmo 8's are all equipped with a single exposure device, the titler is



Making a movie title

actually an efficient miniature animation stand. Animated maps, drawings, cartoons, and the like are all easily made. Since the titler lens has the remarkable depth of field of more than one inch, objects of considerable depth may be photographed in sharp focus. Insects, flowers, butterflies, will show up beautifully in color as well as in black-and-white; the titler permits interesting enlargement of all kinds of small objects.

## Air Cleaner for Industrial Operations

A NEW machine, which conditions air by filtering out dirt particles and which is said to remove approximately 95 percent of the dirt from the air in the vicinity of grinding, welding, and other shop operations, is announced by The Lincoln Electric Company.

The machine also draws smoke and heat away from the work, thus contributing materially to the efficiency of welders and to the general improvement of shop conditions. It can also be adapted for blowing smoke away where such operation is desired.

The new air-conditioning machine, known as the "Linconditioner," has been developed to provide work-shops a more economical solution to the problem of cleaning shop air than that obtained with the conventional shop ventilating system. It removes the smoke and dirt at their source rather than after they have combined with large quantities of air. This requires less power, a motor of only one-half horsepower being required. Also, since no air is taken in or blown to the outside of the building, the new machine conserves plant heat.

The "Linconditioner" consists of a motor-driven fan which produces suction through a flexible metal tube. The fan draws the air through the flexible tube and exhausts it in a filter which is located in the periphery of the power unit.

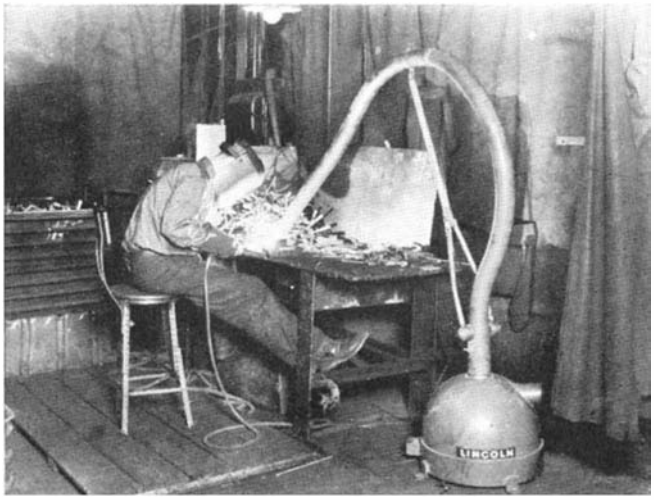
When the "Linconditioner" is used for removing and filtering the air, a rubber cap is kept over the blower outlet. When used for blowing, the rubber cap is removed and the flexible tube is placed in the blower outlet.

## New Vitamins Not Always New

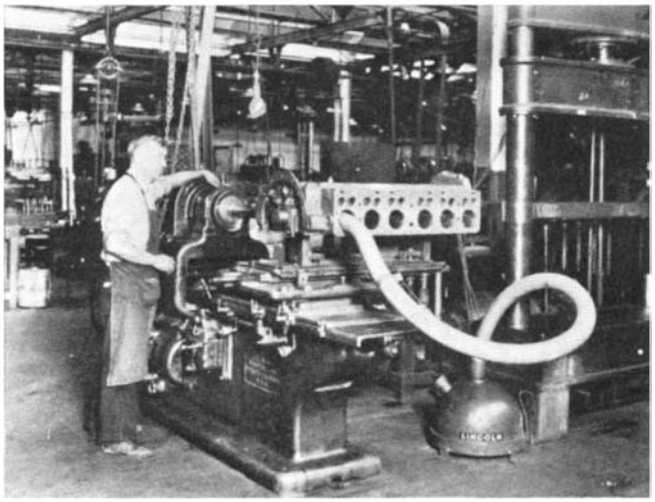
WHEN you hear that a new vitamin has been discovered, take the news with a grain of salt. Maybe the curative results reported were not due to a new vitamin but to larger quantities of an old familiar one. This has been the case in a number of instances, Prof. George R. Cowgill of Yale University School of Medicine has pointed out, according to *Science Service.*

Vitamin B, the anti-beriberi vitamin found in whole grains, is a case in point. For a time scientists kept discovering apparently new vitamins in the natural source until seven or more vitamins B were reported. At least three of these vitamins, $B_3$, $B_4$, and $B_5$, have turned out to be, in Dr. Cowgill's words, "a liberal supply of vitamin $B_1$."

Besides the vitamins there are other substances just as necessary for normal growth and development. These include the essen-




Air conditioning where it is most needed in a factory—at the source of air pollution. Carrying away welding fumes



Dust particles from a machining operation, as on a cylinder block, are removed with the new air conditioner

tial fatty acids and the amino acids. If these had not happened to be discovered first in already known food classes (fats and proteins), Dr. Cowgill suggested, they might also have been called vitamins.

Dr. Cowgill stressed the important difference for good health between a barely sufficient supply of vitamins and an optimal amount.

**HOUSES**

**IT was recently estimated that at least eight million housing units will be needed in the United States during the next decade.**

## Glare Curbed in New Goggles

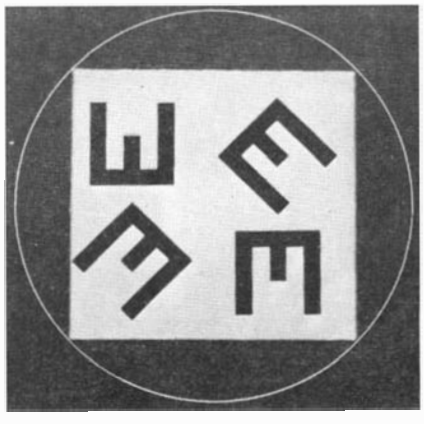
A NEW anti-glare lens, designed to absorb all radiant energy which does not contribute to vision and to transmit the radiations by which detail is seen, has been announced by the Bausch & Lomb Optical Company.

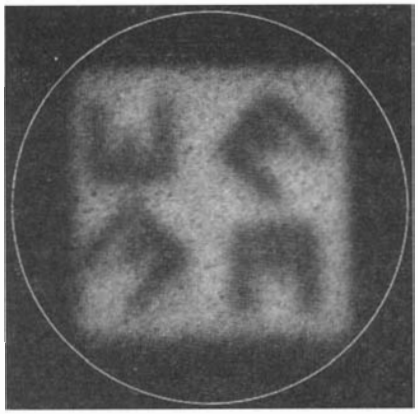
Developed primarily for fliers, to relieve eyestrain induced by the intense illumination in the upper atmosphere, the new lens is made of a dense new optical glass of a soothing green shade. Tests at Wright Field, Dayton, Ohio, indicate that the lens exceeds specifications laid down by government services for aviators' goggles.

The new lens is opaque to the harmful radiations of ultra-violet and infra-red, but completely transparent to the yellow and yellow-green radiations at the peak of the visibility curve of the eye. "The result is," says Scott Sterling, Bausch & Lomb technician, "that this lens achieves the utmost in visibility with the lowest transmission of useless energy radiations."

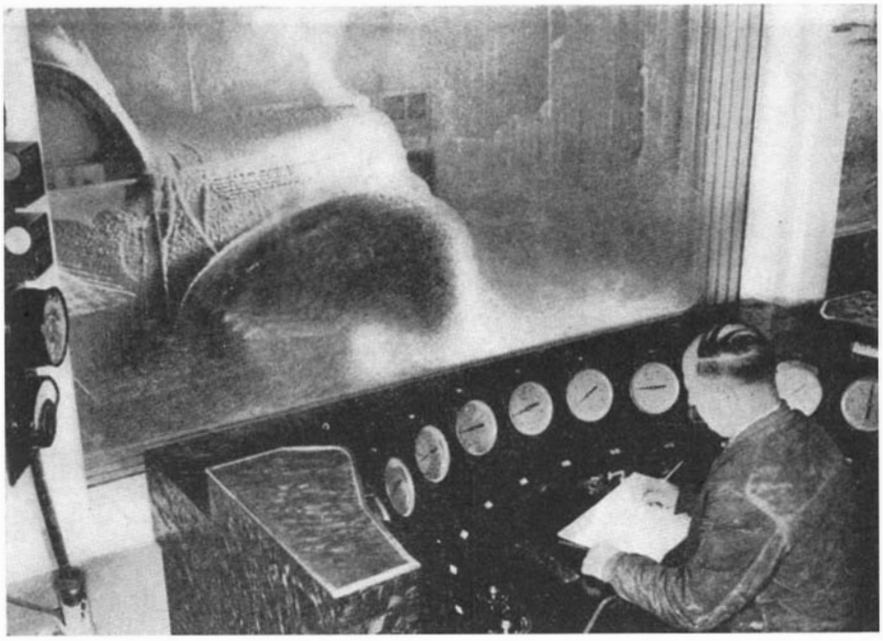
Sterling referred to a psycho-physical fact known as Purkinje's phenomenon as a probable explanation of the result achieved in the lens. "Under conditions of ample illumination," he explained, "the eye is most sensitive to yellow and yellow-green radiations; and under conditions of dim illumination it is most sensitive to green. A possible explanation is found in the theory that the cones of the retina, by which detail is perceived, are attuned to yellow radiations, whereas the rods of the retina which dominate vision in dim light are tuned to green radiations. We have succeeded," he said, "in developing a glass which transmits both the yellow and green, providing maximum visibility under the conditions for which it was designed and reducing undesirable radiations to the minimum. The lens does not alter the color of objects."

There are many colored lenses on the market, states Dr. E. H. Padden, flight surgeon of United Air Lines, but nearly all of them distort color to some extent.





*Left:* **The sharp image cast by light which has been projected through a ground and polished goggle lens such as that described in the text.** *Above:* **Note the distortion and aberration of the same image when cast through an ordinary pressed goggle lens of poor optical quality**



***Above:*** **An ice-sheathed automobile under test in the new Ford "weather" tunnel where weather can be made to order.** ***Right:*** **Henry Ford at the control panel of the refrigerating system that reduces tunnel temperatures to 20 degrees below**

## Ford's New "Weather" Tunnel

A HUGE new "weather" tunnel, the first of its kind ever built solely for scientific research in motor-car design, has been put in operation at the Ford Motor Company Engineering Laboratory in Dearborn, Michigan.

The new weather tunnel laboratory will be used, in conjunction with three new motor-car test tracks, to extend and broaden the intensive research carried on by the company's engineers, thus greatly simplifying the problem of perfecting motor cars of new design to meet all conditions, before they are put on the road.

The three tracks include a ribbon of concrete two and five-eighths miles long with banked turns for high-speed tests, and two other tracks, one of gravel, the other of various "rough road" surfaces. These provide a wide range of highways for "road" tests, complementing the laboratory tests in the tunnel. One million miles of such tests were driven in a recent seven months' period.

The tunnel is equipped to produce at any time inside a laboratory virtually every conceivable weather condition, enabling tests to be conducted regardless of actual road or weather conditions and without waiting for Nature to create the particular condition desired.

The purpose of the tunnel is two-fold. First, it makes possible reproduction in a laboratory of any kind of weather to be found anywhere on earth at any time of year. In the second place, it dispenses with the time factor.

Before the tunnel was available and when engineers had to rely exclusively on actual road tests, they were forced to send test cars all over the country and sometimes had to wait for long periods for appropriate weather before tests could be completed.

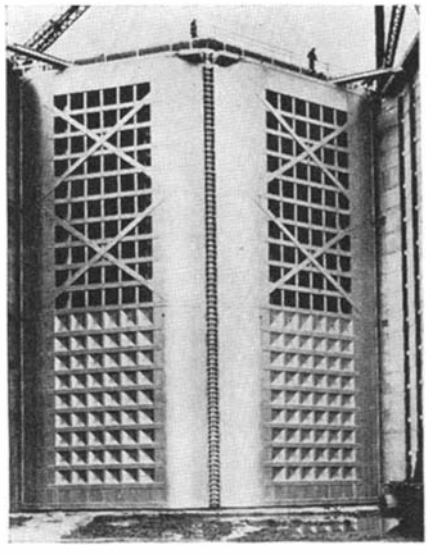
A 500-ton refrigerating system powerful enough to maintain a temperature of 20 degrees below zero in the tunnel, and other devices, including a rain machine and a sand and dust blower, now enable the engineers to duplicate at any time a wide variety of extreme conditions under which motor cars are forced to operate in actual use. In connection with the refrigerating system a "cold" chamber has been installed, in which temperatures as low as 40 below zero can be maintained. The room will be used for cold-weather tests of engine, oil, battery, and starter.

**INGENUITY**

**A ROADSIDE fried-fish stand in New York uses six washing machines to exercise live trout in order to keep them from getting flabby. A Connecticut goat farmer uses vacuum cleaners regularly on his horned and bearded flock. A potato-chip manufacturer in Texas has used for years a spinner washing machine to "wring" the water out of fresh potato slices.**

## Tallest Lock Gates

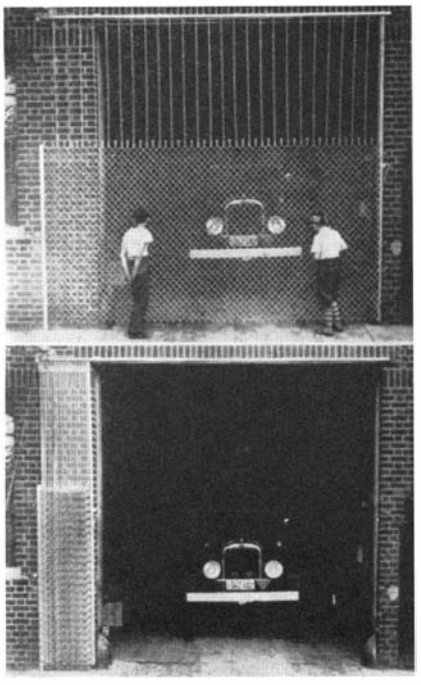
THE lower pair of lock gates that will close against the waters of the Columbia when a ship wants to pass Bonneville Dam, tower up like diminutive Flat Iron Buildings. Made of riveted plates supported by a steel framework, each leaf or gate represents 600 tons of fabricated steel work, and stands



**A vivid impression of size is given by the men atop these lock gates**

100 feet high. Yet they are fabricated and hung so accurately that, when closed, they form a metal-to-metal union that is perfectly water tight.

They are the tallest lock gates ever constructed, surpassing by 18 feet the 82-feet-high gates that serve the Miraflores locks of the Panama Canal. McClintic Marshall, now the Construction Division of the Bethlehem Steel Company, which constructed the gates for the Panama Canal, is likewise fabricating and erecting the Bonneville Gates. Gates of the same design, 46 feet high, are employed at the upper end of the lock. The



**Grille-gate, closed and open**

lock is 76 feet wide and each leaf of both the upper and lower gates is about 44 feet wide.

The gates were fabricated in sections at Bethlehem's Pottstown Works. After each section was planed to precision measurements, the gates were given a trial assembly as a check for accuracy, then separated again into sections for shipment to the dam site. Silicon steel was employed for main sections in both upper and lower gates, and carbon steel was employed in the remainder of the construction.

## Photographic Records for Business Houses

FOR years, business offices, industrial firms, libraries, historical associations, museums, and similar institutions have been troubled with the problem of how to preserve in economical, space-saving form their records, correspondence, valuable papers, manuscripts, books, and the like. Microphotography has found the answer by making it possible to record such material on film. And a new invention called the Photorecord, manufactured by Folmer Graflex Corporation, places this service within the reach of anyone desiring it.

The Photorecord, by permitting as many as 800 newspaper pages or 1600 smaller pages to be recorded on one roll of 35-mm film four inches in diameter and two inches thick, permits a reduction in storage space of as much as 95 percent. In fact, the contents of 32 filing cabinet drawers may be filed in one drawer in film form. The acetate film used will last as long as record paper of the highest quality.

Duplication is also made easy with the Photorecord. Thus, organizations and institutions may keep a permanent file of original material and make copies for use in branch offices or other distant points.

In spite of this great versatility and usefulness, probably the greatest advantage of the Photorecord is its economy. It is a compact, completely portable camera apparatus weighing only 42 pounds when packed. In it is combined everything necessary to photograph anything occupying a relatively flat plane up to and including a full newspaper page, and to record it in miniature form on a strip of film that takes up but a tiny fraction of the space occupied by the original. It will produce 800 double-frame pictures and 1600 single-frame pictures on a single loading of 100 feet of 35-mm film.

A convenient foot pedal operates the equipment and leaves the hands free to handle the subject being photographed. Each time the pedal is pressed down, the film is positioned, the lights are turned on from half to full Photo-flood intensity, and the shutter is actuated. So simple is its operation that speeds of from 500 to 1000 exposures per hour may be made.

## Telescoping Grille-Gate

AN ingenious new grille for a gate or doorway which provides perfect closure against intruders and yet permits free circulation of air, has been developed by Cornell Iron Works, Inc. This grille is a flexible steel curtain hung from an overhead track, as illustrated in the two accompanying pictures. Made of heavy galvanized chain link mesh, it is extended to any height of opening by galvanized vertical rods running to the supporting track above.

Because of its clever construction, this new sliding grille telescopes together and will nest at the side of an opening in very small space. It will also travel around a sharp curve and lie at a right angle to the opening. For more complete control a bottom track can also be furnished. The entire structure can be made in aluminum throughout or of stainless steel.

## Resinous Coatings for Paper

A NEW method has recently been developed for applying coatings of resinous mixtures directly to paper without the use of a solvent. A mixture of resins, waxes, and other materials melting at a low temperature is spread on the paper in the roll as a continuous operation. The temperature and thickness of the coating are controlled.

**Photorecording the pages of a book**

The process is said to be cheaper than lacquering since it avoids the use of solvents and its cost is little higher than that of wax coatings. By selection of the ingredients of the resin mixture a variety of results can be easily obtained to meet any ordinary requirements. The weight of the coating can be varied at will by proper adjustment of the machine for applying it.—*D. H. K.*

**HARNESS!**

**GAS and oil are closer than hot dogs and mustard! To harness the power of every 50 gallons of gasoline in the automobile tank, one gallon of oil goes into the crankcase. A gallon of transmission and differential oils is needed for every 282 gallons of gasoline. For every hundred gallons of gasoline, a little more than a pound of grease is used.**

## "Doctor Jones" Says—

"UP in the city, here a while back, the chief of police (he was raised down here in our place), they'd been having an examination to fill some places on the force and one of the most promising applicants—his Wassermann test was positive. The question came up right away whether they ought to turn him down or put him on. He admitted he'd had syphilis, this fellow did, but he'd been taking treatments for something like six months. That same question—I suppose it comes up a lot of times when folks are looking for jobs. He asked me—the chief did—what I thought about it. When I said 'I'd put him on,' it seemed to sort of surprise him.

"Well, when you stop to think of it, why shouldn't they? Here was a husky young fellow—he'd been under treatment right from the start, before any permanent damage had been done. His condition wasn't infectious and it wasn't going to be, providing he kept up his treatment 'til he was cured—and, of course, they were in a position to see that he did. There was no reason why he wouldn't make a perfectly good cop and last just as long as any of 'em.

"Then you take folks working in restaurants and such places—food handlers. In some towns they have regulations that they've got to have Wassermann tests. Of course it's a good thing for *anybody* to have the test, for that matter, but the main trouble with such a regulation is—when they get a positive reaction they seem to think, a lot of 'em, they ought to take 'em away from their job. Well—there's just about as much danger of getting syphilis through food as there is fracturing your skull falling over a splinter from somebody's wooden leg—if you can figure that out. I said something like that to one man a while ago and he said, 'All right—would you like to think your food was being handled by somebody that had syphilis?' Well, for that matter I wouldn't like to think of its being handled by a lot of 'em that haven't got syphilis, either. The ones to worry about are the ones where there's some real danger—like typhoid carriers, and so on.

"No. There's people working all around us that have syphilis and sometimes even they

themselves don't know they've got it. Everybody ought to have a Wassermann test for his own protection—and his children's—but we can't expect 'em to warm up to the idea if they're liable to lose their job as a result of it. What we want to do is get 'em under treatment—those that need it—before serious damage has been done. The syphilis cases that are infectious, if they spread the disease it's pretty safe to say it won't be by working at their jobs."—*Health News*, New York State Department of Health.

## Sulfur from Gypsum

SCARCITY of sulfur in India has fostered the development of a process for recovering sulfur trioxide from gypsum and bauxite. These two minerals are mixed in the proportions of two of bauxite to five of gypsum and heated for six to seven hours between 1200 and 1250 degrees, Centigrade. The sulfur trioxide produced can be used in many ways. As a by-product of the reaction, calcium aluminate is produced from which alumina can be recovered by treatment with water.—*D. H. K.*

## The 20 Percent Industry

TRANSPORTATION contributes more dollars to national income than agriculture does. For each seven dollars that agriculture adds to our total income, transportation contributes eight dollars. If you think that agricultural prosperity is important for our national well-being, you ought to think that the prosperity of transportation is equally important. Railroad transportation is by far the largest element in total transportation.

Railroading is our 20 percent industry. At present prices, the values of railroad securities are equal to 20 percent of the total values of all our listed corporation stocks and bonds. The railroads purchase 20 percent of our bituminous coal and 20 percent of our fuel oil. They buy 20 percent of our total output of lumber and 20 percent of our iron and steel. Railroad prosperity is an essential component of national prosperity. —*Colonel Leonard P. Ayres*, in *Railroad Data.*

## Science Still Baffled

SCIENTISTS are still searching for a hidden clue or perhaps a new and unknown principle of physics which can explain the large magnetism of the earth and the far vaster magnetism of the sun, says Dr. M. A. Tuve of the Department of Terrestrial Magnetism of Carnegie Institution of Washington.

For 10 years, the Department, under the leadership of Dr. J. A. Fleming, has searched for the answer to the baffling question, the solution of which would make clearer the rôle played by the earth's magnetic field in man's daily life—a rôle which affects radio, wire communication, cosmic ray intensity, the amount of ultra-violet light striking the earth, and many other factors in man's existence.

The program which began and still seeks explanations of earth and solar magnetism has led into the hearts of the tiniest things in the universe. But neither the tremendous force there discovered nor any other fact of

modern physics has yet led to a clue which might explain the permanent magnetism of the earth. To explain these large magnetic fields in the sun and earth, it appears that either some new complexity will have to be introduced into the fundamental concepts of physics or that some new and yet unfound principle of physics will have to be discovered.—*Science Service.*

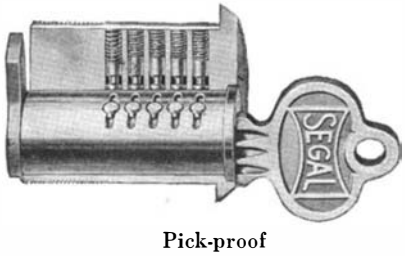
## Electrolytic Flavoring of Sherry

PART of the flavor of fine old sherry wines has been found to be caused by the presence in them of acetaldehyde. This is produced in the wine by oxidation; a recent investigation has shown that electrolysis is the most satisfactory method of accomplishing this. By combining electrolysis with a heating process, a more satisfactory flavor can be produced in California sherry wines.—*D. H. K.*

## Pick-Proof Lock Cylinder

A FORMER detective on the New York Police force, Samuel Segal, inventor of the Segal Jimmyproof Lock, has just perfected a non-pickable lock cylinder which is so constructed as to prevent its opening by the use of any instrument other than the owner's key.

This device successfully solves the problem which has baffled foremost engineers of the hardware industry since the invention of the pin-tumbler type of lock. It may



Pick-proof

not be generally known except to the initiated, who make it their business to track down crime, that a very large majority of mysterious burglaries are committed through the use of lock-picking instruments inserted in the keyway of a lock with uniformly successful results.

The Segal Pick-Proof Cylinder, the first answer to the lock-picking menace, retains the essential features of the pin-tumbler mechanism but, with important improvements, is rendered impregnable. A lock-pick, usually in the form of a thin piece of steel or wire inserted in the ordinary cylinder while tension is exerted on the cylinder plug, can manipulate the pin tumblers to an evenly aligned position above the plug and up into the cylinder shell so that the lock can be opened.

The Segal Pick-Proof cylinder contains an oscillating protective sleeve fitted over the cylinder plug. The pin drivers are headed and undercut. When a lock pick is inserted in this cylinder, the pins uncontrollably trap and are locked by recesses in the protective sleeve. The failure of even one pin to rise above the plug can prevent a cylinder from turning open. In the Segal Pick-Proof Cylinder, ten built-in locking devices prevent the control of all interlocking pins.

The cross section photograph of the pick-proof cylinder shows the series of locking points, the undercut drivers, and the interlocking protective sleeve which afford complete protection against all methods of lock picking.

The new pick-proof invention can easily be installed on any lock by merely replacing the present cylinder.

## Deodorizing Paper Mills

MANUFACTURE of kraft paper by the sulfate process produces disagreeable odors which threaten to become a nuisance to the neighbors of such plants. Recent investigations have shown that treatment of the fumes from pulp digestors with chlorine will destroy this odor. The amount of chlorine required is about 25 pounds per ton of pulp produced but its application is expensive. No valuable by-products have been found as yet to cover the cost of the operation.—*D. H. K.*

## Mr. Skunk Teaches the Railroaders

THE cute little fur-bearing animal with the smelly way of warding off personal danger, which has long made him a social outcast, now has reason to be proud and happy. For at last he has taught man a useful lesson, one that is proving especially helpful in railroading.

Witness a recent bulletin directed to Southern Pacific trainmen and enginemen by W. L. Hack, superintendent of the company's Sacramento division:

"Roller bearing boxes on the streamliner *City of San Francisco* are equipped with odor bombs which discharge an obnoxious odor in the event the journal bearings run excessively hot. When you detect such odor, train should be stopped and an inspection made."

Passengers, of course, will never be aware of the latest means of preventing operating delays, for they ride in air-conditioned cars with sealed windows and tight-fitting doors. So they can give whole-hearted thanks.

## Draw-Casting New Trick in Making Copper Rods

ONE of the older arts of metallurgy is the fabrication of castings by pouring molten metal in a mold and allowing the whole mass to cool. Then the mold is broken away and one has the casting. The method, of course, is a great advantage over the alternate task of trying to fashion the crude block of cold metal in the desired form.

The art of making castings, then, is old but there is a new technique which is only now coming into production. It is called draw-casting. It consists of drawing, directly from a bath of molten metal, rods and tubes of copper.

Dr. Byron E. Eldred, new president of the Engineers Club, New York City, and one of the nation's few remaining independent research scientists, is the inventor of draw-casting.

Dr. Eldred melts his copper in a furnace which has one or more holes in the bottom.

In each of these holes is inserted a copper rod that is going to be the "parent" of hundreds of feet of additional rod the same size. These parent rods are cooled by a surrounding water chamber and transmit their coolness up into the molten copper. Around each of their tips the melted metal starts to "freeze" and in turn becomes cooler. As the metal in the bath freezes, from the inside out as it were, the rods are pulled out and continually solidify more metal within the furnace.

The process, in one sense, reminds one of the old-fashioned method of making candles by dipping. At each dip the cool candle froze more crystals of wax and the candle continually grew larger and fatter. Since Dr. Eldred is not seeking "fat" copper rods he continuously pulls out the newly frozen copper at the end of the rods and gets continuous production that is a time- and effort-saver over present casting and rolling and drawing methods.—*Copyright, 1938, by Science Service.*

## Caliper Map Magnifier

THE utility of road maps is so well known that an attempt to ameliorate their worst fault—illegibility—has been made by the Bausch & Lomb Optical Co. It has introduced a new magnifier of high quality,

**To measure or magnify**

mounted in zylonite, with a pair of hinged calipers for the estimation of distance between towns. The little instrument is about two inches in diameter and comes in a neat, full leather, pocket case.

## Coloring Copper

COPPER can be given various colors for decorative purposes. A simple treatment consists of cleaning the metal thoroughly in dilute sulfuric acid (1 to 15) and immersing the clean metal in a solution of one ounce of potassium sulfide per gallon of water at room temperature. This produces colors from golden brown to almost black, depending upon the length of time the copper is left in the solution. Reddish purple can be produced by immersing clean copper in a freshly prepared warm solution of 1 ounce of ordinary hypo (sodium thiosulfate) and half a dram of nitric acid in 20 ounces of water. This solution should be warmed to 120 degrees, Fahrenheit, and the copper need be immersed in it for only 30 to 60 seconds.—*D. H. K.*


**Conducted by JACOB DESCHIN**

## Color for All

THERE are so many people at work attempting to bring good color photography to the masses that it is inevitable we shall one day see color methods so perfected that even the amateur, following printed instructions, will be able to turn out creditable work. Today we already have such color media as Kodachrome and Dufaycolor, but the amateur, and even many professionals, must turn to the manufacturer to do the processing so that the best possible results may be achieved. In the case of Kodachrome, there is no choice as the processing is a highly complicated procedure and Rochester insists on doing the processing in order to insure getting the best results.

**The new "one-shot" color camera designed for amateur photographers**

So the amateur taking color pictures has only two things to think about: 1, to give the correct exposure; 2, to illuminate the subject properly. That sounds simple enough and yet it is surprising how many, professionals included, will sin on both counts. In "black and white" photography it has been a matter of long experience that the film has such wide latitude that one may make any one of quite a number of different exposures and get a printable picture from each of the resulting negatives. In color photography, however, it is important that the absolutely correct or very nearly the absolutely correct exposure be given in order to achieve good results. This is generally known but often overlooked. Ascertainment of the correct Scheiner, Weston, or other speed rating for the film used, use of the proper filter where called for, and selection of the correct shutter speed for the diaphragm opening employed, based on the manufacturer's rating and determined through the use of a good photo-electric exposure meter—these will win half the color battle.

The other half lies in proper lighting. This means simply that illumination should reach all parts of the subject more or less in the same intensity. Deep shadows are taboo, however much they may add to the effectiveness of a picture in black and white. Flat, all-over lighting is the general rule, because in color photography the contrasts that must, in black and white, be obtained by varying shades of gray, are already provided in the varying hues embodied in the subject. In the one, different tones of the same color are manipulated, whereas in the other, different hues or colors provide the contrasts.

That seems plain enough and obvious enough and yet it is a truth honored more often in the breach than it should be, even among professionals, as those who visited the recent First International Show of Color Photography in New York City can testify. At this show, the attendance at which indicates the high interest in color photography prevailing today, it was made at once apparent that the man behind the camera is still the deciding factor in the production of beautiful pictures. The materials are here, the equipment is here, but not all are Nickolas Murays or Paul Outerbridges. The same applies in black and white photography, of course, but in color those who excel are still a very, very small minority.

At this show the new Devin color camera was introduced that is destined, according to its distributors, to make good color photographers of us all. The price is some-

## Prize Winners in Our

1ST Youthful happiness in one of its many forms was captured photographically by the Rolleiflex of R. B. Stewart, Yellow Springs, Ohio. Exposure was made on Agfa Superpan

what on a par with the highest priced miniature cameras. The camera, which is a one-exposure tricolor outfit, making three exposures at the same time, one for each of the three primary colors, red, green, and blue, makes three 6.5 by 9 cm (2½ by 3½ inches) color-separation negatives from which color prints are later produced. The "miniature" color camera is modeled on a larger professional outfit now being used by such men as Nickolas Muray, Anton Bruehl, and others.

The new camera is equipped with a highly color-corrected F:4.5 anastigmat lens and affords, besides the usual ground-glass focusing, a coupled range finder and direct view-finder.

The possibility of exposing three negatives at the same moment is brought about through the use of so-called pellicle semi-transparent mirrors, two of which are employed in the Devin camera. The procedure is explained by the distributors as follows:

"The image is formed by a single lens as in the case of any ordinary camera. The image reaches a first semi-transparent mirror, which reflects part to a plate at one side of the camera and transmits the balance. This reaches a second mirror of the same type and part is reflected to a plate at the other side of the camera, the balance being transmitted to a plate at the rear.

"The standard red, green, and blue filters are placed in front of the three plates. The result is three negatives identical in every respect except the way in which the various colors have been recorded. These 'color separation' negatives are then used for the production of a paper color print."

## Contrast Theme

OBVIOUSLY what attracted the photographer to the scene pictured in "Beauty is Where you Find it" was the juxtaposition of the "Celia Beauty Shop" and the back view of the line of tenement houses, with their wash hanging out to dry and household paraphernalia on the fire escapes. The contrast between the two elements of the picture is emphasized and made unmistakable by the quiet highlighting of the little beauty-shop house. Without this highlighting the picture would not have quite the appeal it now possesses. Incidentally, the strolling figure in the foreground, though practically a silhouette, certainly helps to make the picture complete. The shot was made from the seventh floor of an apartment house on the opposite side of the street.


"Beauty is Where You Find It"

## "Happiness" Competition

2ND Domestic happiness—simple, deep, sincere—as interpreted by the Graflex of Stephen F. Harris, Dover, Massachusetts. This picture was taken on Eastman S. S. Pan film

## "To Sea or Not to Sea"

TO add a light note to our department this month, we offer our patient (we hope) readers this example of what happens when the photographer runs into a bit of luck. You will observe that the snipped ribbons of light are broken up in places by elongated black areas, giving the illusion of weird floating masks. We caught the bird on the brink of the water looking dubious, we presumed, about flying over that grotesque area. And so, "To Sea or Not to Sea." Get it?

"To Sea or Not to Sea"

## Mounting Kink

IN mounting large prints on 16 by 20-inch cardboard mounts you may have observed that unless you placed the mounted picture in a glass frame the mount eventually bent inward somewhat. This is due to the pull of the print. A way to overcome this is to paste on the back of the

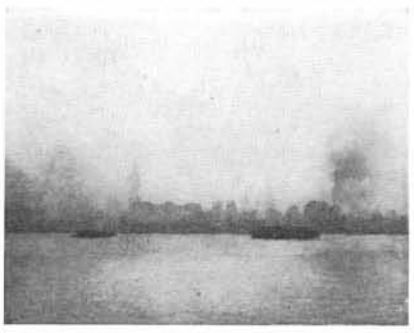
mount a sheet of heavy brown paper about the same weight and size as that of the mounted print itself, or, better still, a discarded print of the same weight and size. With the print on one side and the paper on the other each pulling on its own account, a balance is met and the mount remains flat.

## Misty Days

DON'T neglect your picture-making on days when there is no sun or because there is a heavy mist all about. There is some attraction in pictures made on such days that is not to be equalled on sunny days. Misty days are peculiarly days of mood, when scenes ordinarily without interest because so thoroughly familiar or for some other reasons, acquire a strange mystery that lends a newness and charm the camera user would do well to attempt recording photographically. The sharp lines and clear distinction of subject-matter that is revealed by normal lighting are softened and shrouded so that only their outlines are seen.

Scenes on the water on such days provide some of the best material for the photographer in search of the pictorial elements of our daily existence. Go to the waterfront, take a ferryboat, or mount some high elevation so that you may hunt your subjects without the interference of nearby material. Obviously, you will not wish to use mist-penetrating filters because the mist is what you want to get. Your negative will look flat but that is as it should be and your print may look fogged, and that too is all right. You will generally get no blacks and the picture will seem to lack contrast. Actually, however, nothing that is visible, either to the eye or the lens, is really lacking in contrast because if it were you would not be able to see it. It is merely that this contrast in misty pictures is weak or low.

"The Ferryboat Leaves"



"Mist on the North River"

Both pictures illustrating this discussion were taken from the vantage point of a ferryboat. It is interesting to note that while "Mist on the North River" shows a gradual recession of tones from the boat in the fore-

ground to the skyscraper in the distance, revealing at least four different tones (despite the "lack of contrast"), "The Ferryboat Leaves" shows contrast much more abruptly. This is due, of course, to the fact that although mist pervades the atmosphere, objects closer to our vision are seen more clearly than objects in the distance. In "The Ferryboat Leaves" the ferryboat in the foreground shows good black tones although the skyline in the distance is barely perceptible through the mist. Also, it must be noted that a large expanse of uninteresting water was eliminated in "Mist on the North River," thus taking in more of the distance, while in the other picture, the foreground was retained entirely and the distant scene cut down considerably.

# WHAT'S NEW

## In Photographic Equipment

*If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.*

### PANTHERMIC 777

THE long-talked-about Harold Hervey developer, Panthermic 777, is finally available to the public. Panthermic 777 ($3.00 for the unit to make two quarts—one quart of basic developer and one quart of replenisher) is distinguished by the fact that the temperature of the developer may run anywhere from 70 to 90 degrees. The developer, therefore, never requires chilling, being used at whatever the temperature in the room happens to be at the time development is started. The recommended temperatures are from 80 to 84 degrees, with the standard at 80 degrees. Times of development vary with the temperature, the higher the temperature the shorter the developing time.

### VUESCOPE

EQUIPPED with a high-power magnifier said to produce a stereoscopic effect, the Vuescope ($12.50) for viewing 35-mm black and white positives or color transparencies, as well as two by two-inch slides, is equipped with an adjustable lighting system. An adjustable stand is available for setting the device at the proper height and angle for comfort in use. (Vuescope with stand $15.00.)

### FILM WINDER AND MEASURER

WINDING 35-mm film from bulk rolls is simplified by the Robot Film Winder and Measurer ($23.00). The device is set in advance in ordinary light, but winding is done in the dark. In use, the photographer sets a dial in the face of the instrument to the length of film to be used. The bulk film is then fed over a protecting guide, under the measuring sprocket, and to the camera spool. The operator then simply turns the take-up knob till it will go no farther. A built-in knife cuts the film at this point, the bulk film is removed and the wound roll en-

closed in its cassette. A chart enclosed with the winder gives the number of exposures at various lengths for every type of 35-mm camera.

## Spun-Glass Diffuser

DESIGNED for use with the Eastman Kodaflector reflector, the Kodaflector Diffuser ($1.25 each; $2.25 pair) is now on the market. The diffuser, a disk of white spun-glass fabric 13 inches in diameter, is mounted in a metal rim. A bracket and U-shaped rod are supplied for attaching to the socket of the Kodaflector.

## Elkay Adjustable Rapid-Drain Tank

ACCOMMODATING cut film, film pack, or plates and instantly adjustable to take any of four negative sizes, 6 by 9 cm, 3¼ by 4¼ inches, 9 by 12 cm, and 4 by 5 inches, the Elkay Adjustable Rapid-Drain Tank ($6.50) is designed to develop, fix and wash negatives in the same tank. All operations, after the loading of the film and adjusting the tank cover, may be carried through by ordinary artificial light or full daylight. The tank is resistant to acids and bases of photographic solutions; the negative holding slots or grooves are made of stainless steel and so designed that no damage is possible to the film or plate.

Following the loading and covering of the tank, the developer is poured in through the top, special channels carrying the liquid down the inside edges of the tank. A plug in the bottom of one side empties the tank rapidly and completely. The inside bottom is gently sloped so that all the liquid drains without tilting or turning the tank. Stop bath and hypo are introduced in the same way. The washing is done with the cover removed.

## Adjustable Reflector

DESIGNED particularly for the different sizes of flash bulbs now on the market, the Mendelsohn adjustable reflector has been introduced as an accessory reflector for the Mendelsohn Speedgun flash synchronizing equipment. The holder for this reflector is inserted in the same slot which ordinarily carries the leg of the fixed-focus reflector. The reflector slides up or down on this support and is locked in position by a set screw. The new reflector is used in centering the bulb in the reflector in order to gain maximum lighting efficiency.

## Ihagee Projection Lantern

DESIGNED to accommodate either two-inch square glass slides or film strips in single frame (¾ by 1 inch) or double frame (35-mm miniature negatives), the Ihagee Projection Lantern ($67.50) is now made available for projecting on a screen

both color films and black and white positives. The large light output demanded in the projection of color films is facilitated in this projector by a special large-aperture projection lens and a triple condenser with heat screen. In addition, the design includes a special concave mirror, rotating device for upright or longitudinal pictures, and a special arrangement for moving the film strips continuously or picture by picture, as desired.

## Three Contax Items

THERE is now available a 15th Contax lens—the Orthometar F:4.5, 35-mm focal length, wide-angle lens covering 62.5 degrees. ($90.00.) Built according to the formula of the Zeiss Orthometar for photogrammetrical use (aerial survey photography for map-making), the Contax Orthometar gives full correction over the entire negative area.

The Contax may be used as a reflex camera by the employment of the recently introduced Flektoscope. Designed for use by owners of long focus lenses and affording a magnified image, the Flektoscope is made in three models with long focus lenses, the Sonnar F:2.8, 18 cm, the Tele-Tessar F:8, 30 cm, and the Tele-Objective F:8, 50 cm.

The third accessory is the Contax Harness ($20.00) which is supported from the neck, enabling the Contax user to have his camera in position at all times, leaving the arms free. The device consists of a leather strap around the neck, a brace across the middle of the body, and metal arms from the brace to the swivel to which the camera is attached at eye level.

## Auto-Focusing Precis 66A

COMPLETELY automatic focusing is the principal feature of the Precis 66A enlarger ($85.00), just announced. Interchangeable for either condenser or diffuser illumination, the Precis has an auxiliary manual control for adjusting the focus to the individual lens, although the focusing cam is synchronized only to the regularly provided 9-cm lens. With other lenses the focusing is manual. The enlarger outfit includes the Laack F:4.5 anastigmat 9-cm lens mounted in a standardized board; negative holder to take any size negative up to 6 by 6 cm. (2¼ by 2¼ inches); linear magnification up to 7½ times and with supplementary lens up to 12 by 16 inches enlargements; double condensers and opal glass; oversize lamp-housing accommodating 75 or 100 watt lamps, with lamp position adjustable; baseboard 18 by 19 inches of specially seasoned plywood, polished, balanced by rubber legs; red filter; and other details.

## Hollywood Enlarger-Projector

DESIGNED for use either as an enlarger, projection camera, or copying stand, the Hollywood Enlarger-Projector, equipped with a two-inch F:4.5 anastigmat lens with iris diaphragm ($35.00) or with a two-inch

F:3.5 lens ($40.00), encompasses a number of attractive features.

The Hollywood takes 35-mm and half vest pocket negatives. While the enlarger-projector may be purchased with either an F:4.5 or F:3.5 anastigmat lens, the apparatus may also be supplied with an adapter permitting the use of Leica, Contax, or other miniature camera lenses. The negative holder eliminates the use of glass pressure plates; the condensers are two 2⅛-inch improved French ground and polished crown optical glass condensers; the baseboard is of five-ply Philippine mahogany and measures 15 by 20 inches; the revolving head permits vertical or horizontal projection; the extension arm, which slides back and forth, permits the making of larger prints right on the baseboard and allows the head to be tilted sideways for elongation or caricature effects or for use in copying or photomicrography; the 15-foot cord is of No. 18 black rubber covered tandem wire with a toggle switch and rubber connecting plug.

## Eight-oz. Nikor Tank

A NEW model of the Nikor stainless steel daylight developing tank is now on the market. Designed to develop, fix, and wash full-length 35-mm rolls of 36 or 40 exposures in only 8 ounces of water, the tank is known as the Model 35 ($5.75) and employs the new, smaller type reel, the same size as the ones used in the Model 33 which develops either one reel in 8 ounces of solution or two 35-mm rolls simultaneously in 16 ounces.

## Leitz Continuous Projector

PERMITTING up to 12 slides to be shown repeatedly, in consecutive order, for intervals ranging from 10 seconds to a minute for each slide, the Leitz Automatic Continuous Projector ($90.00) is designed principally for use in educational displays, museums, public buildings, or expositions, and, in some cases, even for lectures. The projector, for use either in standard front-projection or rear-projection on a translucent screen, takes the regular two by two-inch square glass slides, either in black and white or color transparencies. The essential feature of the automatic projector is a revolving circular disk with twelve two by two-inch slots, equally spaced around its outer edge, which serve to hold the slides to be projected. An AC-DC motor mounted on the baseboard of the continuous projector causes the disk to turn at pre-set intervals.

## Keep It Clean

A CAMEL-HAIR brush is a handy thing with which to keep camera lenses and shutters clean, as well as for dusting off negatives and enlarger parts in the dark room. Made especially for these purposes, the Dustoff Photo Brush ($1.00) consists of soft bristles embedded in a dust-proof case which is provided with a cap to protect the brush. Opened for use, it is only 2½ inches long.

# CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

***Q.*** **I should like to standardize on either S.S. Pan or Agfa Superpan film, so that I can take pictures by daylight and artificial light on the same film. The question is: what filter should I use to make S.S. Pan give me the same results in daylight as Verichrome film will?**
**—J. B. T.**

*A.* Many workers use panchromatic film for all their subjects because of its full color sensitivity as well as because of its greater speed. These are probably the reasons for your decision to use panchromatic film exclusively. While generally satisfactory when used without a filter in daylight, a green filter is often employed when it is desired to bring the panchromatic film more in line with the contrast afforded by such a film as Verichrome, panchromatic film being characterized by a low sensitivity to green. Similarly, when working by artificial light, because of the panchromatic film's great sensitivity to red, a blue filter is found helpful.

***Q.*** **I would appreciate it if you would tell me the name of the company which handles camera insurance. I read your article in the November issue and I would like very much to obtain some insurance for my camera.—Miss H. M.**

*A.* Due to the growing interest in camera insurance, many companies now write this type of protection, including most of the fire and casualty companies. Therefore, if you will consult the company which now covers your regular household belongings, you will probably have to go no further. We would be glad to include the names of such companies, but the list would be too long and may easily be consulted in the Insurance Brokers Placing Guide (published by the Insurance Advocate), which gives a complete list of the companies writing camera insurance.

***Q.*** **Could you recommend a camera to me? I don't want one that is too costly and I am not a candid camera fiend. I travel around the country a lot and frequently see things that I would like to photograph, so I want a camera that is small and uses a small film; one that does not require intricate adjustments to take a good picture under average conditions. I would like to be able to sit in the car and snap the camera and feel that I would get a good picture.—L. W. S.**

*A.* Of course, you understand that we are not in a position to recommend any specific cameras, but we can say that inexpensive, small cameras of the general-use type you are after have lately been introduced in great numbers on the American market. The prices start at about a dollar and many varieties are available for the man who wants to keep his expenditure under $25 or $30. A visit to one or two of the large photographic supply houses and inspection of the various low priced camera wares should give you some idea of the type of camera best suited to your purposes. Most of these inexpensive cameras are very simple to operate and require only a few minutes' instruction to acquaint you with their mechanical operation. As for snapping pictures while sitting in the car, we should say off-hand that relatively few pictures, no matter what the camera used, are possible from such a restricted vantage point.

***Q.*** **What is the fastest shutter speed available on modern cameras?—A. N. P.**

*A.* One popular 35-mm camera has a top shutter speed of 1/1250th of a second, while one of the larger models has a top speed of 1/2000th of a second.

***Q.*** **I have read that the short focus lens is not adapted to the taking of distant landscapes. I should not want to sacrifice entirely the distant scene even for the compactness and convenience of such (6 by 6 cm reflex) cameras. Can you advise me on the capacity in this direction of short and longer focus lenses?—B. N. W.**

*A.* The distant scene is not *entirely* sacrificed with the short focus lens. Naturally, you cannot expect to get the same results in this direction with a short focus (miniature camera) lens that you can with a lens of longer focal length on a larger camera. It is not so much a matter of focal length, however, as it is the degree of enlargement to which the negative is to be subjected. Miniature negatives are practically always enlarged, whereas larger negatives often are satisfactorily printed by contact. It has been

our experience that when using cameras of the 6 by 6 cm type, the distance has usually been satisfactorily rendered when included within the depth of field. Moreover, the question is largely an individual one—how much sharpness in the distant scene do you demand; that is, how much sharpness would you consider satisfactory? Such personal tastes must always be considered in connection with photographic problems which involve factors that may be perfection to some and anathema to others.

***Q.* I would like to use D-72 developer for roll film but I do not know how much stock solution to use to how much water. Some of my friends have told me to use 1 to 2 and others 1 to 4.—B. G.**

*A.* For film development D-72 is normally diluted one part stock to two parts water, the same proportions being used with contact papers. The dilution of one part stock to four parts water is for use when developing bromide (enlarging) papers. These are the standard dilutions although individual workers desiring less or greater contrast than the normal afforded by the recommended solutions sometimes use less water than that indicated, resulting in greater contrast, or more water for less contrast. One worker dilutes D-72 in tank film development as much as 1 to 14 and 1 to 16, although the time of development is, of course, prolonged thereby.

***Q.* Can you tell me the difference between a Rapid Rectilinear and an Anastigmat lens?—A. R. P.**

*A.* The principal difference between the Rapid Rectilinear (so called because it reproduces straight lines as straight, an effect not possible with the single lens) and the Anastigmat is that the latter is a fully corrected lens while the former is only partially so. The R. R. lens, as it is generally known, is composed of two single lenses with a stop or diaphragm in the space between them. Each of the lenses of the R. R. is really a long focus lens twice the focal length of the two lenses combined. The R. R. for this reason has been called the cheapest convertible type lens, although the effective aperture of one of the single lenses when used alone is only half that of the combined lens, requiring, therefore, four times the exposure of the complete objective. The chief advantages of the R. R. over the single lens consist merely in the greater speed of the R. R. and its capacity of rendering straight lines rectilinear. The Anastigmat, however, is free of astigmatism, the defect which makes a lens (or the human eye) incapable of focusing sharply, at the same time, lines running in different directions on a plane surface. The Anastigmat, which is free of other lens faults, is the most highly corrected lens commercially available today; it gives a sharper image when used at full aperture than is possible with the R. R. lens even with the latter stopped down.

***Q.* Can a miniature camera take a picture from a considerable distance and by enlarging the negative bring out a detail (such as a license number on a car) which the taker of the picture could not see with his naked eye at the time the picture was taken, assuming excellent eyesight? My position is that the result could be obtained if a fine enough lens and film were used and the negative enlarged, subject only to the limitations of the grain on the film. The contention of the person with whom a dispute regarding this point took place was that no image could be received on the film which the naked eye could not receive at the same time and that an enlargement would not improve the result. His contention was that the only way that the result could be obtained was by the use of a telescopic lens.—L. C. D.**

*A.* One of the principal factors to be contended with in connection with your discussion is the presence of atmospheric haze and the possibility that this will cause a veiling of detail in distant objects. However, for the sake of the argument, you probably would concede the use of a contrast filter in order to facilitate penetration of the blue haze. While we have not had occasion to make an experiment such as that which would be necessary to settle your dispute, we should say off-hand that unless one employed a lens with a circle of confusion greater, a film emulsion with a grain finer, and a film developer affording fine grain results more grainless than anything now available on the market, such a detail as a license number at a great distance could not be revealed in a great enlargement. With present facilities, even if the detail could be enlarged to the enormous degree that would be required under the circumstances, there would be such diffusion of fine detail that the latter would be lost. Much depends, of course, on the focal length of the lens employed; the longer the focal length the better your chances of defining detail at great distances, the use of a proper filter to penetrate haze being assumed.

***Q.* In your answer in June to a question by J.J.M., Jr. covering a schedule of U. S. Scheiner ratings for films, you list Verichrome as 20 degrees for daylight and 16 degrees for Tungsten, Kodak S. S. Pan as 23 degrees and 20 degrees, and so on. Kodak and Agfa film obtainable in Mexico is marked 18/10 Din or 28 degrees Scheiner. In setting photo-electric meters, should these ratings be taken into consideration? In other words, when using Verichrome, for instance, should the film sensitivity be adjusted at 28 degrees Scheiner or 18/10 Din in the meter? Why is the rating given on the film set at 28 degrees when, according to the above mentioned answer, it is much lower?—R. J. A.**

*A.* The rating you cite for Verichrome is evidently that of the European Scheiner System, which gives much higher ratings for the same film emulsions than those published in the United States. In this particular case, the difference is actually eight degrees higher than the rating in the United States. This is almost eight times the speed, requiring only one eighth the exposure, of the U. S. figure. No wonder you are puzzled! However, it makes little difference in the end if your meter is calibrated for the European ratings, as we imagine yours must be. Exposure meters imported for use in the United States are calibrated for the rating employed here and the U. S. Scheiner ratings, therefore, apply for films that are available in the United States.

# Books

## SELECTED BY THE EDITORS

### THE HISTORY OF MOTION PICTURES

*By Maurice Bardèche and Robert Brasillach*

LITTLE more than 40 years covers the lifetime of the motion picture. In this relatively short space of time it has grown from a novelty to a place of tremendous importance as entertainment, even though its status as an art may be disputed. The present-day advanced product is so far removed in technique from its earliest ancestors that it is indeed fitting to present an historical survey of the entire field. The authors have done a workmanlike job in the present book, gathering material which is presented in clear-cut periods—birth of the film, pre-war films, World War films, the emergence of an art, the classic era, talking pictures. Those who have seen motion pictures during a period of 20 years will revel in the reminiscences which the present book brings forth; younger generations will read it for the romantic background which it affords. (412 pages, 6 by 9 inches, photographic illustrations.)—$4.20 postpaid.—*A. P. P.*

### OUR COUNTRY, OUR PEOPLE, AND THEIRS

*By M. E. Tracy*

IN speaking of differences in the standard of living, in the earning power, in the production, banking, resources, and so forth of other countries as compared with the United States, facts are far more potent than generalities. This *is* a potent volume for it compares all the major features of the United States with other great powers, showing in dramatized graphs all the details that make our particular brand of civilization a more livable one in many respects. Some of the subjects covered are area, resources, population, agriculture, mining and manufacturing, business and trade, finance, transportation, education, health, crime and penology, human rights, and other vital subjects. Interesting *per se*, this volume is also important as a constant reference. (120 pages, 10½ by 13¾ inches.)—$1.90 postpaid.—*F. D. M.*

### ASTRONOMY

*By W. M. Smart, Prof. Astron., Univ. Glasgow*

A SHORT treatise covering only the salient features in a territory which is usually covered in full-length textbooks. Suitable for beginning readers of astronomy who wish a rapid survey in order not to lose themselves at the outset in the mazes of detail. Not, however, in any sense juvenile. The author is a very good explainer. (158 pages, 5¼ by 8½ inches, 38 drawings, 24 excellent plates.)—$1.65 postpaid.—*A. G. I.*

### SURVEY OF JOURNALISM

*By George Fox Mott and Twelve Co-Authors*

"WHY Don't You Write?" This volume is almost an answer to that question so often seen in the advertisements. The authors have taken various subjects in the field of journalism, analyzed them thoroughly and have given us, for example, "Journalism as a Vocation," "The Evolution of Journalism," "Police Blotter Stories," "Revealing the World of Business," "The Newspaper Sets Its Policy," "Making Journalism Pay Dividends," and several other pertinent chapters. It is recommended reading for all who write or want to write. (376 pages, 5½ by 8½.)—$2.15 postpaid.—*F. D. M.*

### PICTURE MAKING WITH PAPER NEGATIVES

*By Nowell Ward*

AMATEUR photographers who have never experimented with the production of artistic prints through the medium of the paper negative will find here a doorway opening on a whole new field of photographic enjoyment. Complete directions are given for manipulative technique—balanced lighting, exposure, development, and so on. Troubles are anticipated and suggestions for overcoming them are given in the "Trouble Bureau." (88 pages, 7¼ by 10¼ inches, illustrated with photographs, many of them comparisons of results achieved.)—$1.40 postpaid.—*A. P. P.*

### ASPECTS OF SCIENCE

*By Tobias Dantzig, Prof. Math., University of Maryland*

SEVERAL years ago this author's book, "Number, the Language of Science," attained a wide distribution and the honor of universal praise from men of science. His present volume deals with the philosophy of science—causality, number, the infinite, the quest of the absolute, the straight and the flat, models, universes of discourse, and so on. (285 pages, 5½ by 8¼ inches, 6 illustrations.)—$3.15 postpaid.—*A. G. I.*

### VALID OR FORGED?

*By Lloyd L. Jones*

AS criminology becomes more and more scientific, we are learning that writing either by hand or by typewriter has many secrets which are easily unfolded to the careful investigator. This book compacts a tremendous amount of information regarding such investigations into the space of 168 pages. It tells how the age of inks and papers is determined, how specific typewriters may be identified by the letters they make, how letters written by hand are disguised, how erasures invisible to the eye are discovered, and numerous other problems which require modern equipment. Some of this modern equipment is described and illustrated. This book is intended as an assistant to lawyers, bankers, cashiers, credit men, and insurance officials. (5¼ by 7½.)—$2.15 postpaid.—*F. D. M.*

### AMERICAN WINGS

*By Captain Burr Leyson*

FROM parachute diving to aerial photography, from military tactics through sport flying to commercial aviation, the present book tells the informal story of flying in the United States. Well authenticated in every respect, the material makes exciting reading for anyone who has the least interest in aviation. The photographs alone, most of them full page size, give a thorough grasp of many aspects of present-day flight. (216 pages, 6 by 8½ inches, 40 illustrations.)—$2.15 postpaid.—*A. P. P.*

### FIGHTING FOOLS

*By James E. Edmonds*

SOME people will not like many of the truths presented in this volume which the publisher calls "an impassioned and informed plea that America may be ready and disciplined; that not again shall we wage war like 'fighting fools.'" In it the author discusses in rather complete detail the military history of the United States from the beginning. At many points he notes that we have been entirely too swaggering and boastful. He says that we have been a truculent, touchy, land-grabbing people. His book is not, however, pacifistic in any sense of the word. It is, rather, a tabulation of lessons learned through our failures, our blunders, and our inadequacies in former wars. The serious student of such matters will have many pet delusions shattered through reading this volume, but the end result will be good if it achieves its purpose in showing us what to do and what not to do to maintain peace in the future. (373 pages, 5½ by 8½.)—$2.65 postpaid.—*F. D. M.*

### IMMORTALITY

*By W. G. Langworthy Taylor*

A LENGTHY volume which discusses in a calm, quiet, well-poised, philosophic manner the question of survival after death in some of its vital, moral, and physical aspects. While the author is definitely committed to a belief in survival, he also has some strictures to hand out to a certain naïve type of spiritualist. He is obviously familiar with the present background of physics and the philosophy of science. Possibly it boils down to this: most persons who already believe in spiritualism will like this book, and most others probably will not. (626 pages, 5¼ by 8 inches, no illustrations.)—$3.70 postpaid.—*A. G. I.*

# TELESCOPTICS

## A Monthly Department for the Amateur Telescope Maker

**Conducted by ALBERT G. INGALLS**

STEP up to the 2500-pound, 12″ telescope shown in Figure 1 and wrap your digits solidly around those two axes, each 2⅝″ in diameter, and get the feel of them. Try shaking them. Then run your hand over the two castings, each about like an elephant's leg, which surround them. Ruggedness. This reflector, as described at our request by one of the group which co-operated in the construction, "was designed and built by Frank J. Wanderer, for the use of the Amateur Astronomers' Association of Bergen County, New Jersey, members of the association assisting at various and sundry times. Mr. Wanderer is treasurer of the association. Much of the work on the mirror was done by J. A. McCarroll, president of the same association, whose interest and general assistance aided materially. Patterns were made by H. L. Barnes, vice-president. Other members who lent notable aid in the construction were John Lennon, S. E. Haines, R. Gilcher, O. P. Morrow and Marinus Rose. William Goehner, also a member of the association, machined with great precision all of the castings in his shop—The Jersey City Welding & Machine Co.

"The mirror is a 12″ x 1½″ plate glass porthole light. Focal length, 93″. It was ground by machine (made by Wanderer and Lennon) and figured by hand and machine by McCarroll.

"Lattice design of tube needs no comment. Tube rotates in saddle on 24 bronze rollers attached to tube. Three long rods (through roller axles) are for adjusting the mirror axis in proper optical line-up. Mirror has three-point adjustable flotation pads. (See Hindle, 'ATM,' 4th ed., p. 229.) The three short rods with wheel handles are for slow motion in R. A., declination, and clamping in declination. Clamp in declination is a bronze brake-band around declination housing operated by gears. Declination slow motion is by gears to declination housing. Rough adjustment in declination overhauls gears. Right ascension control is designed to operate by a flexible shaft—not so good and will be changed.

"Prism is 2¼″. Is secured by a 3-arm spider and is adjustable in all directions. Three finders make sky-scraping easy.

"Mount consists of three heavy castings, a flange casting to take the ¼″ plate saddle and two 6″ x 20″ castings for the polar and declination axes. The shafts are 2⅝″ cold-rolled steel, set in ball bearings at both ends of housings. Job is as solid as the Rock of Gibraltar.

"The bearing on top of the pedestal is a rocking device. It allows adjustment in latitude from 37° to 48°. A threaded adjusting rod with wheel is attached to the underside of the polar axis and a calibrated dial shows the latitude.

"Circles are brass bands, ⅛″ x 1″, etched by hand. Declination reads to 5 minutes of arc and right ascension to 15 seconds of time by means of verniers in each case.

"The equatorial system was the brain teaser, with very little simple and available precedent to go on, but the final result has turned out entirely satisfactory. The R. A. circle is adjustable to sidereal time, as suggested by Porter in 'ATM,' but the adaptation is only remotely related in detail. Two verniers are required for the R. A. circle, one for sidereal time and one for setting in R. A. Simply take R. A. out of the Ephemeris and set instrument at once to sidereal time, which can then be read directly like a clock any time while the instrument is in operation.

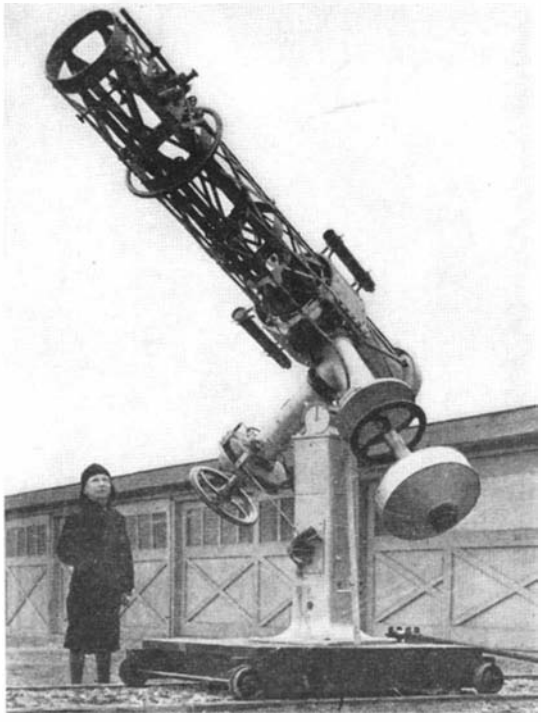


*Figure 1:* Made in Bergen County, N. J.

"Drive is by a 1/40 H.P., 1800 r.p.m. synchronous motor (in pedestal) with reduction gears, including a 1½″ worm to a 4″ *standard spur* gear wheel at bottom of worm rod. The latter drives the 15″ aluminum worm gear disk on shaft.

"The large gear disk and the R. A. circle are mounted on a collar or hub which can revolve on the polar shaft. The worm disk is permanently secured to this hub, and the R. A. circle is adjustable on this by setscrews. R. A. circle is set to sidereal time vernier and is then clamped in place. Pressure screws attached to shaft force a ring up against the hub which, in turn, forces the hub up to engage a friction clutch on shaft just below the end of the polar housing. Rough adjustment can be made at any time, the shaft revolving in hub through the slight friction of clutch.

"The worm rod is a ⅜″ ordinary round drill rod with a standard thread, machined, and the worm gear on the aluminum disk was cut by the thread on a hardened rod. It works!

"Pedestal is a 'Center Street Model'—of unknown lineage. A lucky break at a very nominal expense. [Center St., New York—second-hand machine equipment hunter's seventh heaven.—*Ed.*]

"The electric equipment (not fully shown) will include a small lamp and hood with switch at R. A. sidereal time vernier. Another lamp will be on the declination vernier. A red pilot light (not visible in photo) is installed to indicate running of motor. Plug for cable is shown under gear bearings on pedestal.

"The whole assembly weighs 1¼ tons and is mounted on a truck running on a track. 'Scope is housed in one of the garages shown in the background and when in use it is run out on track to a platform having a floor just under the counterweight. This is a 22-gage sheet metal container filled with concrete and steel plate punchings.

"Since the photograph was made a lining has been installed inside of the tube at eyepiece end to cut off extraneous light, which was found to be very troublesome, from nearby street lamps.

"Mirror was 'axed up' by McAdam's method—with some presumed improvements. We made a 'B' disk ('ATMA,' p. 272) with a 4″ dia. hole with cross threads to line up with pin-hole from 'A' disk. We found it impossible to sight through two small holes so far apart—8′.

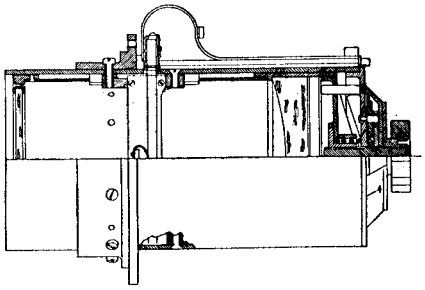
"The job has taken exactly three years to complete, working at odd times outside of business hours. Performance is entirely satisfactory. Of course we have improvements contemplated for the 'next one'."

ON page 74 of this number Professor Russell describes the Struve spectrograph and mentions a Schmidt camera, shown on that page only as a small bump on the big instrument. Amateur telescope makers will take further interest in this Schmidt camera, especially as it is the same one that was made for Yerkes Observatory by C. H. Nicholson, of DuQuoin, Ill., a member of the Amateur Telescope Makers of Chicago and described in this department in December, 1936. Therefore we present Figure 2, taken from *The Astrophysical Journal* for December, 1937, because it shows the camera in section. Its focal ratio is 1, its mirror is 110 mm (4¼″) in diameter and the correcting plate is 3¾″ in aperture. The mechanical parts of the design are by Dr. G. W. Moffitt, now of Perkin, Elmer and Moffitt, optical designers and consultants, New York.

MARKING mirrors is the subject of the following note which rounds up considerable research done by Fred M. Gar-

land, vice-president of the Astronomical Section of the Academy of Science and Art of Pittsburgh (the Pittsburgh club of amateur telescope makers). If a hospital nurse can accidentally give a mother back the wrong baby, so may mirrors be mixed up. He writes:

"Sometimes an amateur sends his mirror away to be aluminized, and then can't quite make up his mind whether the mirror he



Courtesy *The Astrophysical Journal*

*Figure 2:* The Schmidt at Yerkes

gets back is his own or not. The usual method of identification is knowing your own pet little chips (if any), or a small sleek at say 9 o'clock. If, however, your mirror is without chips and sleeks, here are a few suggestions that may help if you desire to identify permanently the ownership or maker's name:

"HF, hydrofluoric acid, is chiefly used for etching designs and markings on glass. The glass is first coated with a film substance impervious to HF, like wax, paraffin, and so on. The desired markings are then cut through the coating with a scriber or sharp instrument, the glass is exposed to the HF or dipped into its solution; and, upon removing the coating, the marks are found etched on the glass. The vapor of HF leaves opaque and white tracings; the solution leaves transparent lines. HF is a strongly penetrating corrosive and care must be used in handling. [It is poisonous, the fumes are dangerous, and good ventilation during its use is recommended.—*Ed.*]

"Silver ink, black or white glass marking ink, monogram inks, frosting solutions and glass etching materials may all be bought on the market. Precautions are necessary to avoid acid burns or destroyed clothing. Good ventilation must be maintained; properly inspected rubber gloves will help to protect the skin from painful irritation caused by contact with some of the chemicals. The trouble is that, with many solutions of this kind, the glass must be heated to complete the process, and that is too much of a risk for the amateur before or after his mirror is ground. With a glass tumbler or electric light bulb any slight stress, such as is set up by such heating, will make no difference, and marking articles of that kind with chemical preparations is entirely another matter.

"The experience of some amateurs and at least two large glass manufacturers may be of value to the reader. Several methods of marking the back or side are given:

(1) Sharpen an old dentist's tool and use it as a scriber or etching pencil for fine lines.

(2) Diamond point pencils, or carbon points used in a pin vise, may be bought on the market, and leave a well defined mark.

(3) Vibrating electric pencils may be purchased on the market; electric power is required, as is careful manipulation, since the tool is usually heavier than those mentioned in (1) and (2). A small electric hand

grinder, employing tools to cut or engrave, may be used.

(4) Sodium silicate (water glass) may be purchased at paint or feed stores. There is enough in a ten-cent can to mark hundreds of mirrors. This may be applied with a steel pen and will last a long time if protected. If the back or side of the disk is ground, the sodium silicate will etch into the glass and leave a permanent mark even after the sodium silicate has dried up. Also red or blue tallow or grease pencil marks will adhere to the glass and may be preserved by covering with a brushing of sodium silicate.

*Figure 3:* Wysor observatory

"After making many tests, the writer would recommend to any amateur the process used in (1): just scratch—that word sounds bad—just etch, not too deeply, your initials, date, or any identification mark, on the side of your mirror before you start grinding; or, if the side is to be rough ground, mark it after grinding—the scriber will leave a deep enough mark for the purpose intended."

Pursuing the policy followed in "ATM" and "ATMA," of naming names and giving addresses when publishing data like the above—that is, data about odd materials for which the isolated amateur would find difficulty locating sources—we asked Garland to give us the addresses and he writes:

"Diamond point pencils may be procured from the Arthur H. Thomas Co., 230 7th Street, Philadelphia, Pennsylvania; Carborundum pencils are furnished by the L. S. Starrett Co., Athol, Massachusetts—the body of the pencil is nothing more or less than a small pin vise—and Carborundum points are made by the Carborundum Company of Niagara Falls, New York. Tallow pencils are made by the Joseph Dixon Crucible Co., Newark, New Jersey; the trade name of the pencil is Dixon's Phano. Or one may be obtained from most hardware stores by asking for a pencil to be used on glass surfaces. One type of vibrating pencil is called 'Engrav-Rite' and is furnished by the Quality Merchandise Co., 2306 Lincolnwood Drive, Evanston, Illinois; or an electric engraving 'Handee' tool manufactured by the Chicago Wheel & Mfg. Co., 1101 West Monroe Street, Department E, Chicago, Illinois, may be used.

"Silver monogram ink, black monogram ink, glass frosting solution, and glass etching solution are furnished by the Westinghouse Lamp Division, Westinghouse Electric & Manufacturing Co., Bloomfield, New Jersey."

CLEAN design is a characteristic of equipment shown in Figures 3 and 4, owned by D. C. Wysor, 136 Brookside Avenue, Ridgewood, N. J. The observatory (Figure 3) is 15′ x 15′, with 7′ walls. Its roof rests on four roller-bearing flanged wheels, and by means of a winch and cable it can easily be rolled off on a steel track at one side, giving an unobstructed view. The telescope (Figure 4) is a 12½″ *f*/9.5 with a tube made of Johns-Manville Transite pipe—so far as is known, the first time this material has thus been used. It has .52″ walls and 14″ I.D., weighs 220 pounds and is very rigid. The cell was made by J. J. McGuckin, of Ridgewood, and has three bayonet joints. The pedestal is of 6″ pipe bolted to a 2-ton concrete pier. The mirror was made by Wysor at the astronomical workshop of the Hayden Planetarium, in New York, under the direction of Ramiro Quesada. The mounting proper is one of McCartney's "H.H." types, made for Wysor by E. B. McCartney, of Hempstead, N. Y. The drive is a 12-watt Telechron motor, controlled by a Bodine reversible motor with push-button control, which rotates the motor backward or forward for guiding at about 80 percent of sidereal rate.

TWO high school principals have sent us photographs of their telescopes. Figure 5 shows that owned by Principal J. Russell Smith, Smyer H. S., Smyer, Texas, who made the optics but obtained the mounting from H. L. Armiger of Detroit. Figure 6 shows the telescope made by Principal Theo. Skonnard, Fort Ransom H. S., Fort Ransom, N. Dak. Both are clean, smooth pieces of design.

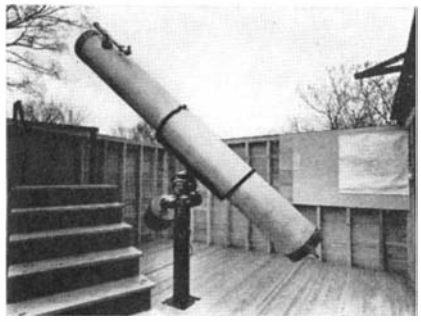


*Figure 4:* The Wysor telescope

IF you daub shirts, handkerchiefs, your hair, table linen and bed linen with rouge during your struggles with mirror making, you may be providing somebody with legal grounds for divorce for cruelty. However, as Everest states in a private communication, "if a man is slobbering himself all up with rouge he is probably getting sleeks and scratches also. Anyone who carries rouge from the lap to his clothes will also carry dust and grit from his clothes to the lap. If the necessary care is used during pitch polishing, one can even work in full dress without becoming untidy. In 'ATMA' I mentioned the need of becoming grit conscious, but probably didn't make it strong enough. Almost surgical technic is required, but it becomes second nature after some experience and is absolutely necessary with pitch."

F. C. Gebhardt, 140 East 29 Street, Erie, Pa., states that he has used Bentonite, often called "mineral soap" or "soap clay," for removing old rouge spots on white shirts and, while this took considerable elbow grease, it worked. Your scribe therefore obtained some of this peculiar clay material and similarly found it accomplished much with an old smock that bore many superimposed strata of rouge daubs dating back

*Figure 5:* Principal Smith

toward the pre-Cambrian. Bentonite is obtainable from the Eastern Clay Products, Inc., Eifort, Ohio, in one-pound packages, for less than the price of one shirt. Mix it with soap granules, ten parts soap to one part Bentonite. The soap will generally prevent the Bentonite from settling. The cleansing action is one of simple adsorption, due probably to the high surface area of this colloid (particles 1/25,000,000″ to 1/50,000″ in diameter). Laundries use a great deal of Bentonite, and it is also used in many diverse ways in many other industries not related to cleansing. It is a clay obtained mainly from the Fort Benton (Upper Cretaceous) shales of Wyoming, and is not a "chemical."

RFT fiends should alter *d* to *a*, in line 6, column 2, page 50, last month's number; also alter "eyepiece," in analogous position on page 52, to "object glasses," and add "corresponding to the well-illuminated field of view of a Galilean curiously depending on size of objective"—so Walkden writes.

Since last month John M. Pierce has prepared one of his Hobbygraphs on the RFT, containing much compact working data.

LAST call to Stellafane convention, atop Mt. Porter, near Springfield, Vt., Saturday, August 6. As this goes to press (June 21) Russell W. Porter writes that he is "highly likely" to be present.

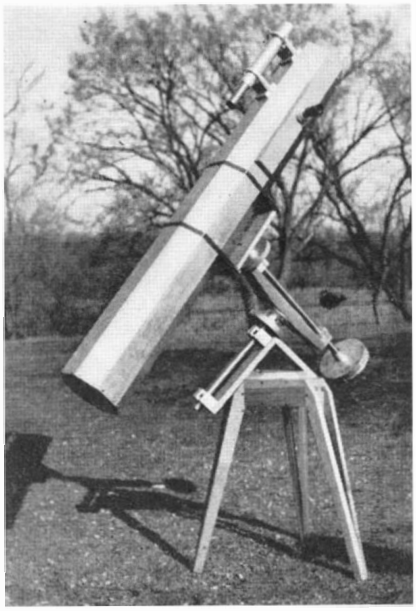


*Figure 6:* Principal Skonnard

## CURRENT BULLETIN BRIEFS

CAMERA CATALOGUE, 36 pages, 7 by 10 inches in size, is designed to be of interest not only to dyed-in-the-wool camera fans but also to serve as a helpful guide to newcomers in the hobby. Besides a listing of a wide selection of cameras and photographic supplies, there are included charts giving lens speeds as well as correct films and lighting for use under varying conditions. *Wholesale Radio Service Company, 100 Sixth Avenue, New York City.—Gratis.*

EYE PROTECTION GUIDE is an illustrated circular showing those industrial jobs that endanger the eyes and telling what type of goggles will give the surest protection under working conditions. The chart covers all principal industries. *American Optical Company, Southbridge, Massachusetts.—Free to industrial concerns upon request.*

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HOMES FOR BIRDS describes in detail the construction of various types of bird homes for attracting wild life for economic as well as for esthetic reasons. Illustrated with a number of constructional drawings. Farmers' Bulletin No. 1456 of the U. S. Department of Agriculture. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

FARM FENCE HANDBOOK, by Henry Giese, is a 64-page illustrated catalogue showing in the introduction various types of fences, from crude piles of boulders to woven wire. It then deals with the modern fabrication of wire for fencing and its application to various types of usage. For distribution to students and farm organizations only. *Hill and Knowlton, 1454 Builders Exchange Building, Cleveland, Ohio.—Gratis.*

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A NEW FINISHING SYSTEM FOR ARCHITECTURAL IRON AND STEEL PRODUCTS describes Bonderizing, a rapidly applied undercoating which promotes paint adhesion and affords protection from rust. It is applicable to a wide range of architectural units, from screen frames to air-conditioning equipment, from home medicine cabinets to steel window hardware. *Parker Rust-Proof Company, Luke and Rice Streets, Detroit, Michigan. —Gratis.*

USE OF CONCRETE ON THE FARM gives formulas for mixing concrete for farm structures, which vary according to the use to which the concrete is to be put. Factors other than composition, which are requisite for strength, watertightness, economy, light weight, and resistance to wear, are also discussed. These factors include consistency, methods of mixing, manner of depositing, and the care of newly placed concrete. Farmers' Bulletin No. 1772. *Office of Information, United States Department of Agriculture, Washington, D. C.—Gratis.*

HOW TO EXPOSE KODACHROME is a handy, vest-pocket size guide for use in both still and motion-picture photography. It gives complete details for achieving the best possible results with this color film and includes a convenient "conversion dial." *At your photographic dealer or direct from Eastman Kodak Company, Rochester, New York.—50 cents.*

ULTRA-VIOLET FLUORESCENCE is a single-sheet bulletin which describes an inexpensive outfit for producing ultra-violet light for use in experimental work. It also tells how this light may be applied in the study of many materials. Prices of the equipment are quoted. *Harry Ross, 82 West Broadway, New York City.—10 cents.*

SYSTEMATIC LOCATION OF DIESEL ENGINE TROUBLES, by Victor W. Pagé, is a large folded chart (38 by 25 inches), printed in two colors, showing the construction of a typical engine and its fuel system. It outlines all troubles causing lost power, misfiring, hard starting, and so on. *The Norman W. Henley Publishing Company, 2 West 45 Street, New York City.—50 cents.*

SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM, Farmers' Bulletin No. 1678, points out the most common hazards and the precautions which should be observed. It also gives information on extinguishing gasoline and kerosene fires. *Superintendent of Documents, Washington, D. C.—5 cents (coin.)*

THE CASE FOR FREEDOM FROM FEDERAL CONTROL OF WAGES AND HOURS is the statement of a conviction rising from the will to perpetuate individual and industrial freedom. Continuation of this freedom is desirable; from it has sprung our rapid economic and social progress. *Machinery and Allied Products Institute, 221 North La Salle Street, Chicago, Illinois.—Gratis.*

# LEGAL HIGH-LIGHTS

## Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

### Gin and Milk

THE Court of Customs and Patent Appeals has held that gin and milk are not goods of the same descriptive properties and we are pleased that we are confirmed in our opinion that we should not feed gin to our baby.

A distiller of gin sought to register the trade mark "GOLD CROSS" as applied to his merchandise. A milk products manufacturer who owned the same trade mark as applied to canned milk and cream opposed the registration on the grounds that his business would be damaged. In support of his contention the milk products manufacturer stated that customers who were prohibitionists would be antagonized by the fact that the same trade mark was applied to gin. It was also argued that the drinkers of gin would purchase "GOLD CROSS" gin, believing that it was a product of the milk products manufacturer. The Court rejected this contention, pointing out that milk and gin were not goods of the same descriptive properties and that the injuries claimed by the milk products manufacturer were too indefinite and remote to justify refusing to register the trade mark for gin.

### Double-Edged

WE have discussed from time to time on this page the so-called "Fair Trade Laws" which permit a manufacturer to fix by contract the re-sale prices of merchandise bearing the manufacturer's trade mark, brand, or label. Under most of the fair-trade laws, knowingly selling merchandise at prices lower than those fixed by contract constitutes unfair competition.

It appears from a recent decision in New York that the fair-trade laws are a double-edged sword and that the manufacturer cannot claim exemption from the provisions of a contract fixing the re-sale prices at which his customers may sell his merchandise. In the case in question a prominent razor manufacturer sold razor blades to both the retail and wholesale trade. The manufacturer charged the same price to both wholesalers and retailers, less discounts of 13 percent and 2 percent. However, retailers were allowed an additional discount of 8 percent for so-called "retail sales displays and promotion," whereas the wholesalers were only granted a discount of 3 percent for so-called "wholesale sales promotion."

One of the wholesalers who sold the razor manufacturer's products sold the products at a price lower than that specified by the manufacturer and the manufacturer brought suit to enjoin the wholesaler from advertising, offering for sale or selling the products at prices lower than the specified prices. The wholesaler raised the defense that the manufacturer was not entitled to the protection of the so-called "Fair Trade Law" for the reason that the manufacturer was selling merchandise to retail dealers at lower prices than to wholesale dealers and therefore the manufacturer was guilty of the very act of which it complained. The manufacturer took the position that the Fair Trade Act was not intended to apply to manufacturers and that accordingly the price at which it sold its merchandise to retail dealers was immaterial. The Court rejected the contention of the manufacturer and held that by reason of the manufacturer's acts in selling to retailers at prices lower than those at which the wholesalers were required to sell to the retail trade the manufacturer was not entitled to any relief. In this connection the Court stated:

"The Court is unable to agree with the position taken by the plaintiff. The benefits which it was designed to create by the enactment of the Fair Trade Act would be practically nullified by permitting a practice under which the plaintiff could compete with the defendants and undersell them while requiring them to maintain a stipulated wholesale re-sale price fixed by the plaintiff. The mere fact that the plaintiff refers to itself as a manufacturer does not warrant it in going into unfair competition with the defendants."

### Madonna

THE Court of Customs and Patent Appeals has refused to register the trade mark "Madonna" as applied to wine, on the grounds that it is scandalous.

A wine producer adopted and used the name "Madonna" as a trade mark for wine and sought to register the trade mark in the United States Patent Office. Registration of the mark was refused by the Patent Office tribunals on the grounds that it was scandalous and an appeal was taken to the Court of Customs and Patent Appeals. The Court sustained the Patent Office tribunals, pointing out that the name Madonna was generally understood among English-speaking peoples to refer to the Virgin Mary or to a representation of the Virgin Mary. The Court then pointed out that "the Virgin Mary stands as the highest example of the purity of womanhood, and the entire Christian world pays homage to her as such. Her representation in great paintings and sculpture arouses the religious sentiments of all Christians."

The abuses and excesses associated with alcoholic beverages was considered by the Court and it concluded that many people would be shocked to see the name "Madonna" displayed, among other places, in barrooms. The reasoning of the Court is succinctly set forth in the following quotation from the opinion:

"In our opinion, to commercialize the name of, or a representation of, the Virgin Mary as a trade mark is of very doubtful propriety, and we feel certain that its use upon wine for beverage purposes would be shocking to the sense of propriety of nearly all who do not use wine as a beverage, and also to many who do so use it; therefore, we think such use of the word 'Madonna' would be scandalous and its registration prohibited under said trade-mark act."

It is interesting to note that there was a sharp dissenting opinion by two of the Justices of the Court, in which it was pointed out that wine was an ancient and honorable beverage. The dissenting opinion stated in part: "Ordinary wine is used as a common and usual beverage by multitudes of our people instead of water. The Savior changed water into wine at the behest of His Virgin Mother at the wedding feast; it was used at the Last Supper, and, as a matter of common knowledge, it is a part of the very core of the most sacred religious rites of many of both Christian and other faiths."

### Amplification

IN a case of outstanding importance the United States Supreme Court has held that a patentee may grant a license to manufacture and sell a patented article for restricted purposes and in a restricted field, and that if a person purchases the patented article from the licensee with knowledge of the restrictions for use outside of the restricted field he is guilty of patent infringement.

In the case under consideration the plaintiff granted a license to a manufacturer under certain patents for amplifiers, to manufacture and sell the amplifiers for private use only as distinguished from commercial use. The licensee, in violation of the license restriction, sold amplifiers to the defendant who was engaged in the business of leasing talking picture equipment to theatres. At the time that the defendant purchased the amplifiers he had knowledge of the license restriction but he nevertheless leased the apparatus for commercial use.

The questions presented to the Court in this case were not free from difficulty in that it has long been held that where an article has been sold in the ordinary channels of trade it is free from any restrictions that may have originally been placed upon the article by a patentee. In the present case the Court pointed out that the licensee had no right to sell the amplifier for commercial use and that the purchaser knew of this at the time that he purchased the apparatus. It was held that under those circumstances the purchaser of the amplifiers who later leased them for commercial use in violation of the license restriction was guilty of patent infringement

As stated above the case presents questions that are not free from difficulty and one of the justices dissented from the majority opinion. Also it is significant that the Supreme Court has granted a rehearing in the present case and it will be interesting to note what disposition the Court will make in this rehearing.

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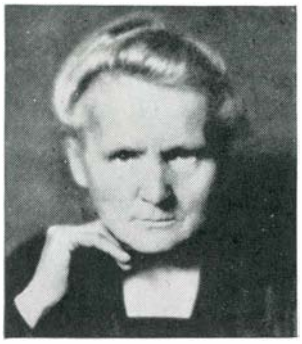

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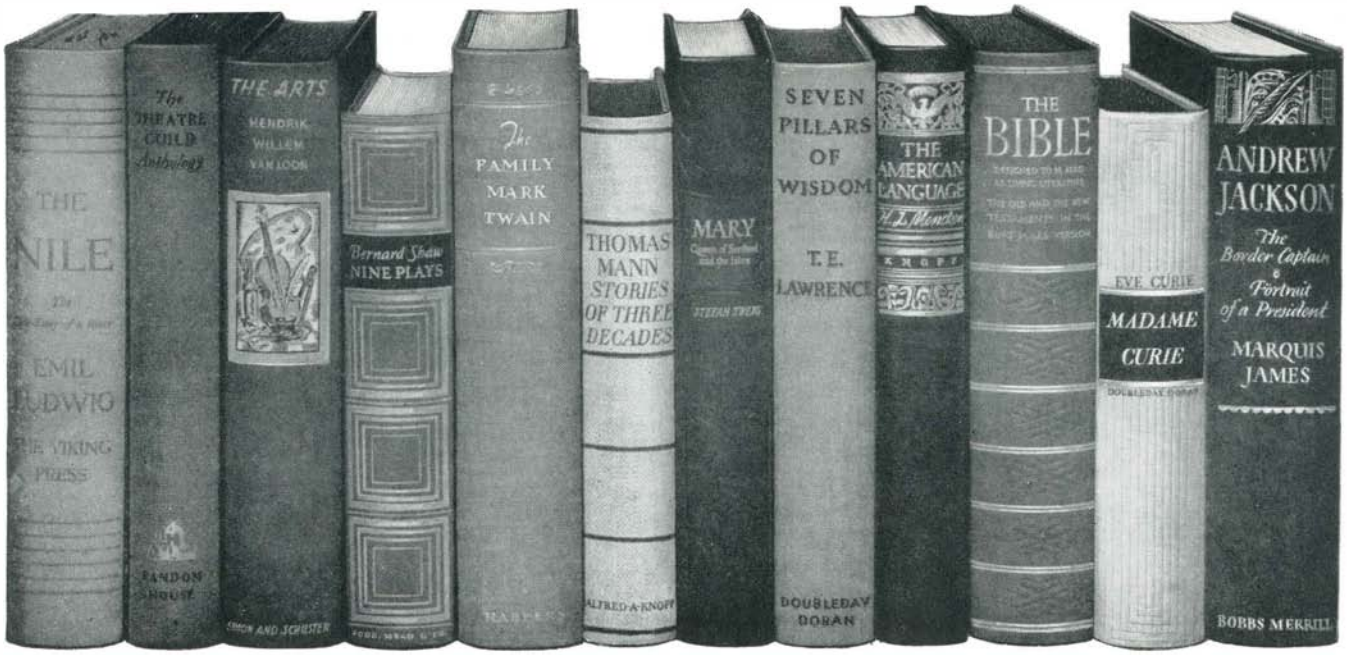


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