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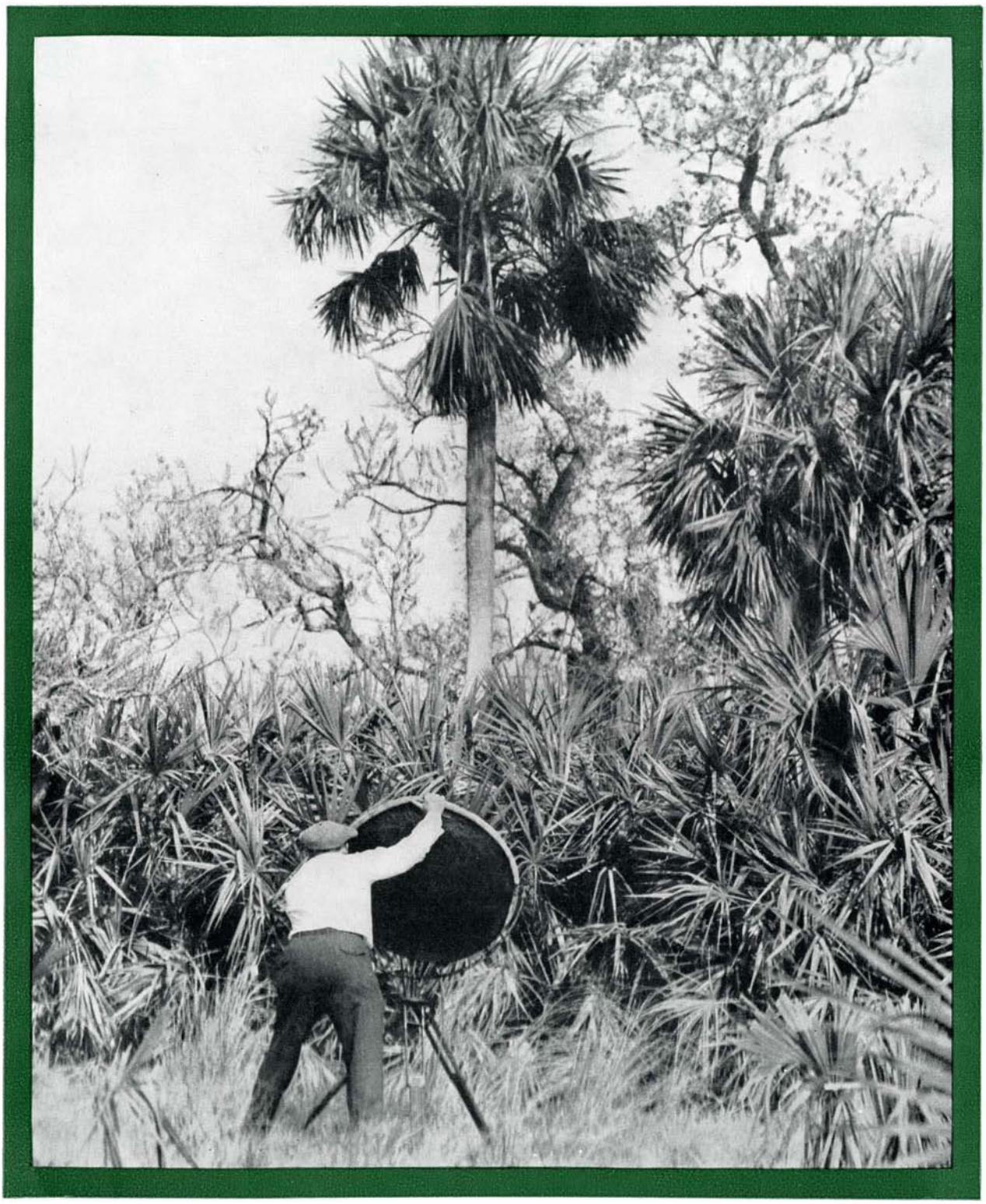

Capturing the Songs of Birds (See page 281)

VOLUME 152 • NUMBER 6

HEAVY WATER

By Harold C. Urey, Ph. D.

JUNE 1935 • 35c A COPY

Dear Editor—Your Aviation

Articles Are More Than News

¶ Readers of SCIENTIFIC AMERICAN are appreciative of the distinctive value of the editorial service they receive. For years we have consistently devoted space to the education, in things aeronautical, of the American public. This work has been carried on under the able direction of our Associate Editor,

PROFESSOR ALEXANDER KLEMIN

in charge of the Guggenheim School of Aeronautics, New York University. Each month, illustrated by authentic photographs and drawings, the significance of each new aviation development is lucidly explained.

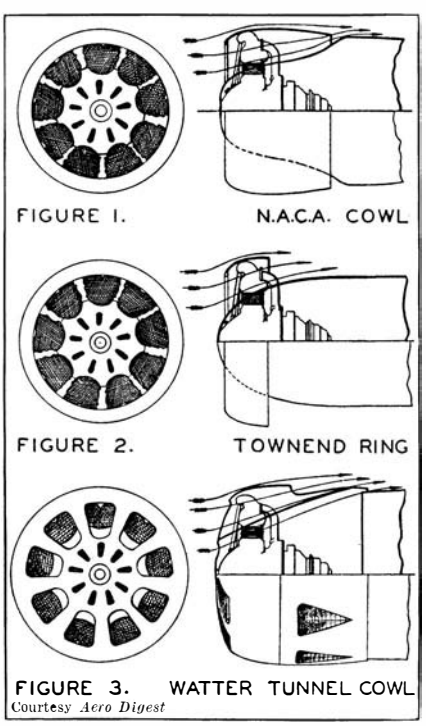

FIGURE 1. N.A.C.A. COWL

FIGURE 2. TOWNEND RING

FIGURE 3. WATTER TUNNEL COWL

Courtesy *Aero Digest*

EVERY business day the postman brings letters in large numbers to the desks of the Editors of SCIENTIFIC AMERICAN. The range and diversity of the inquiries on every phase and subject of Science and Invention are a revelation of far-reaching influence and a startling testimonial of the confidence of the readers in the Research and Service facilities which are made available by SCIENTIFIC AMERICAN.

A pilot's flying ability is checked by the use of this co-ordinator

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The wingless Autogiro in flight over Mt. Vernon

SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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Number Six of a Series of Statements From Noted Men

COVER

SONGS of wild birds in their native habitats are now being recorded by the American Museum-Cornell Ornithological Expedition. (See page 331 of this issue.) Our cover illustration shows one of the sound collectors set up in a wild part of Florida to record the notes of Audubon's caracara. A parabolic reflector serves to gather the sound and concentrate it on a microphone which in turn is connected to the apparatus for recording on movie film. A telescopic sight on the reflector enables the operator to aim the reflector directly at the bird and thus secure greatest efficiency in recording the sound.

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ACROSS THE EDITOR'S DESK

WHEN J. N. Darling, probably better known to the American public as "Ding" of cartoon fame, first took over the job of Chief of the United States Biological Survey, he was in a position to offer great hopes to game conservationists throughout the country. Mr. Darling's proposals were hailed with great acclaim and he was looked to as the one man who could save wild life in the United States for posterity. Now, however, he apparently finds himself in the position of a sincere worker for a cause, severely handicapped by the red tape of politics. For more than a year Mr. Darling has worked faithfully toward the enactment of legislation which would have definite and favorable effects upon wild life conservation. Failure of Congress to include wild life restoration activities in the Works Relief Bill, inaction on legislation favorable to wild life, and general lack of co-operation, now appear to be the only rewards which he has reaped so far. Mr. Darling's position is entirely unenviable and we sincerely sympathize with him. He is writing for SCIENTIFIC AMERICAN an article dealing with the subject of game conservation and this is scheduled for early publication.

●

"UNDER a high powered microscope, the radiating surface of the firefly presents a gorgeous display of pyrotechnics. After the eye becomes dark adapted, one sees a soft glow broken here and there by bright flashes at irregular intervals and climaxed finally by a brilliant flash coming from the whole surface." Thus Professor W. J. Parlin of Dickinson College describes the light-source of a firefly in his short article telling how he measured the candle-power of the illumination given off by this well known insect. Professor Parlin's article is scheduled for publication next month.

●

THE interest which readers of SCIENTIFIC AMERICAN showed in a series of articles on telepathy and tests for telepathy, which appeared some months ago, assures a welcome reception to an article on the same subject which has just been prepared for us by Dr. J. B. Rhine, Associate Professor of Psychology at Duke University. A first report of Dr. Rhine's work was written by our friend, the late Dr. Walter Franklin Prince and published in our July 1934 number. Dr. Rhine has continued his experimental work in telepathy and clairvoyance, both with persons in the normal state and with a well known British trance medium, Mrs. Eileen J. Garrett. In an early issue Dr. Rhine will tell of the results which were obtained in the experiments conducted with the assistance of Mrs. Garrett. Meritorious scientific research such as this, conducted in a field of which little is known, is certain to uncover eventually the reasons for certain phenomena which up to the present time are considered unexplainable. In Dr. Rhine's article is given an excellent summation which endeavors to answer many of the queries which will naturally arise in the mind of the reader.

COMING

℄ J. N. ("Ding") Darling, on the Aspects of Game Conservation Today.

℄ "How Bright Is a Lightning Bug?" by Professor W. J. Parlin.

℄ Dr. J. B. Rhine on Telepathy and Clairvoyance as Demonstrated by a Trance Medium.

℄ Glands and Their Effect on Personality, by Dr. R. G. Hoskins.

℄ "Fight Corrosion," by Philip H. Smith.

℄ The Story of the Subsistence Homesteader, by John Herrick.

●

PERSONALITY is one factor which has so far successfully defied definition. In probing the whole subject of personality, Dr. R. G. Hoskins, Director of Research, Harvard Medical School, has made it possible to align certain phases of personality definitely with the glands of the body. An article to be published soon tells of these glands and of their effects upon certain bodily functions. The correlation between body functions and personality is so clearly drawn in Dr. Hoskins' article that the reader is given a definite picture of personality as it is determined by glandular functions.

●

NEXT month Philip H. Smith, whose articles on various phases of industry have met with wide acclaim, will write upon the broad subject of copper and copper alloys. Of vital importance to industry are corrosion and the struggles which have been made to combat it. Under the title of "Fight Corrosion," Mr. Smith draws a clear-cut word picture of copper and its present-day place in industry. The multitude of uses to which copper and its alloys can be put and the possibilities of future commercial development are so wide-spread that we cannot even hint at them here. Our only suggestion is that you should not miss Mr. Smith's next article.

●

MUCH has been written in the newspapers and elsewhere about "going back to the land" in an endeavor to relieve some of the effects of business depressions. Of a piece with the "back to the land" movement is the subject of subsistence homesteading, which, however, is something more; it is living *on* the land rather than going *back* to it. Just what forms the background of subsistence homesteading and the economic effect which it may have is clearly told in an article by John Herrick, Assistant to the Manager, Federal Subsistence Homesteads Corporation, to be published shortly. Mr. Herrick outlines the need for subsistence homesteading for hundreds of thousands of people, what it can do for them, and what it can do for the country in general. Here indeed is a new frontier waiting for intensive development and the development is sure to come if present plans can be carried to completion.

Orson D. Munn

Editor and Publisher

Books SELECTED BY THE EDITORS

FROM GALILEO TO COSMIC RAYS

By Harvey Brace Lemon, Ph.D., Prof. Physics Univ. Chicago

THIS book is something entirely new under the sun and is called "a new look at physics" by its author, who is a widely known teacher. Its most notable feature is the effort that has been made to avoid all the earmarks of the old stuffy textbooks—it does not look and is not written like a textbook. It does not even smell like one. It has reading continuity and it reads more like a talk than a lesson—in fact, many of the old school doubtless would label it physics with a jazz accompaniment, especially because of the innumerable humorous marginal sketches intended to brighten the treatment. It covers both classic and modern physics in 440 pages, with 100 plates and a million sketches, more or less. But let the reader put aside, if he has it, the idea that this book presents "physics made easy," a thing which can't be done. The book is full of hard work.—$5.20 postpaid.—*A. G. I.*

DESIGN IN WOODWORK

By Percy A. Wells

GOOD taste and an artistic sense as applied to home craftsmanship constitute the keynote of this little book. The reader is shown the right and wrong way of designing things to be made of wood. A series of 46 halftone plates shows some of the really fine looking furniture that is within reach of the average home craftsman.—$2.15 postpaid.—*A. P. P.*

NEW MINDS FOR OLD

By Esmé Wingfield-Stratford

WE approached this book with some misgivings for there have been so many so-called mental training books published in recent years that we have become somewhat cynical. We found, however, that this is a serious attempt to arrive at a method of improving the mind principally by bringing order out of disorder and developing the memory, through which improvement future actions of the reader may be controlled. While some of the chapters may sound as though the author expects to develop his hearers through the mysticism of ancient India or present-day faith healing, we find that these chapters are necessary to give proper balance and perspective to the subject. One reading should be a boon to the man whose thought processes are disordered by tension of today's stress and strain; more complete study should result in marked mental improvement.—$3.20 postpaid. —*F. D. M.*

METALLIC ARC WELDING

By H. Harris, Ph.D.

IN recent years arc welding has made such rapid strides both in manufacture and in structural engineering that a complete treatise of this sort finds an important place in the libraries of engineers, job foremen, and even of the mechanic who does the actual job. Its 193 pages cover the whole field of arc welding, beginning with a discussion of the theory of the electric arc, and proceeds to explain the various types of welding, welding equipment, electrodes, alloys, influence of gases on steel and weld metal, arc welding of various alloys, and application of arc welding to various products and structures. Printed on glossy paper, well illustrated with diagrams, photographs, and photomicrographs.—$6.20 postpaid.—*F. D. M.*

SCIENCE AND SOCIAL NEEDS

By Julian Huxley

JULIAN HUXLEY has made an extraordinary tour of Great Britain, visiting research laboratories all over the country, in order to ascertain, if possible, the influence of scientific discovery on our lives. In this book he reveals the result of his investigations, and explains to what extent scientific research is catering to the needs of the people, not only as regards its industrial applications, but also as regards the current problems of health, education, housing, the menace of war, and so on. He found that science has made tremendous strides in its development as a social function intimately linked with human destiny, but that there is also an appalling lack of broad social outlook in both the scientific specialist and the layman. Because he maintains that it is essential that everyone understand the interactive nature of science and society, and to support his conviction that the true purpose of science is to serve the needs of humanity, Professor Huxley offers many stimulating suggestions for bridging the wide gap between scientific knowledge and its practical application.—$2.90 postpaid.

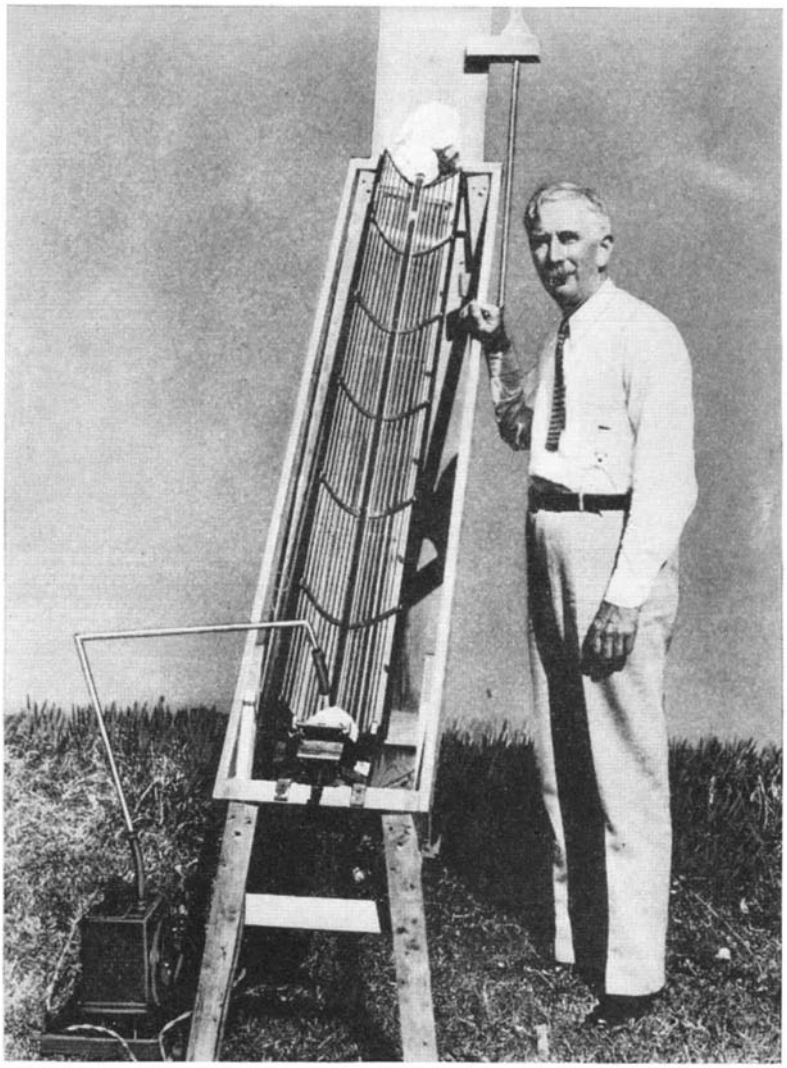
ARMS AND MUNITIONS

Compiled and edited by Joseph H. Baccus

IN this day of excited talk of war, of war profiteers, of munitions investigations, and Federal laws intended to eliminate the financial attractions of warfare, this book comes as a distinct aid to those who argue on any side of these questions. As Volume I of the Pi Kappa Delta Series, it is called by the publishers "The University Debater's Help Book." And it is just that since it is composed chiefly of abstracts from the

(*Please turn to page* 333)

Personalities in Science



Science Service Photo

DR. CHARLES G. ABBOT

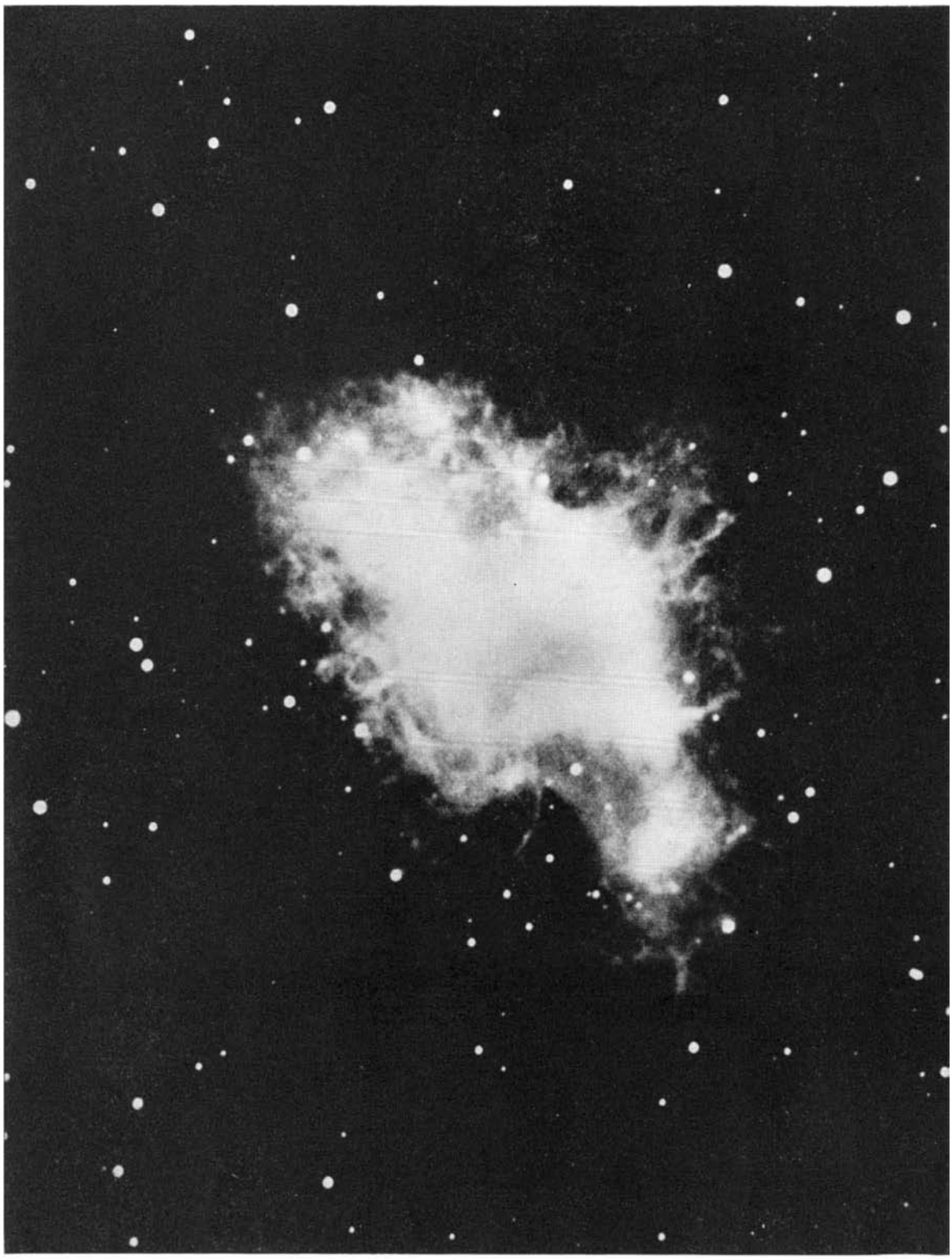
DR. CHARLES G. ABBOT, head of the famous old Smithsonian Institution, is an astrophysicist, and is best known to other scientists as an investigator in the realm of solar physics. To scientifically inclined laymen he is known widely as the author of a standard semi-popular book entitled "The Sun," and to the newspaper reading public he is the scientist who has made experiments with the sun's radiation as a source of heat for running a true "fireless cooker" of the kind shown here.

In the chapter on "Utilizing Solar Energy," in his book, "The Sun," Dr. Abbot describes various attempts that have been made to derive energy applicably and economically—which means competably with other familiar sources of energy—and includes a picture of a solar cooker which he constructed some years ago and set up outside his residence on top of Mount Wilson, California. The same cooker has become somewhat famous, pictures of it having been reproduced in scores of books, magazines, and newspapers during the past two decades or so. It was 7½ by 12 feet in breadth and length, and consisted of aluminum covered steel sheets bent to parabolic section, which focused the sun's heat on a blackened, 1½-inch metal tube, through which oil, the heat-absorbing and conveying medium, was circulated to the ovens. Bread was baked and other general cooking was done with it. The scientist was merely combining some interesting fun with something of immediate utility, and possibly of later applicability.

The solar cooker shown here is a sort of "pocket edition" of the earlier one just described, but it has a higher efficiency and greater refinement. Instead of the single bent sheet of iron, which was used previously, this one employs 12 long, narrow mirrors, arranged individually in such a way that together they reflect the sun's radiation to their common focus. At this focus is a glass tube containing black oil. This tube is surrounded by a second sheath, with a vacuum between the two tubes. This permits the sun's radiant heat to reach the oil, but prevents partial loss of the received heat by ordinary convection and conduction. There is a reservoir of hot oil a short distance away. The entire cooker is propped up to face the sunlight, and provision is made to keep the mirrors facing the sun throughout the day.

Men of science and engineers, who do not overlook practical factors, are not so inclined to make glowing predictions about the cheap recovery of direct solar energy as some others. It is possible to make use of solar energy in some special circumstances to fair advantage, but there seems to be a wide difference or spread between (1) the glowing predictions and promises contained in, or in one way or another implied by, certain magazine and Sunday supplement articles which have appeared at quite regular intervals down through the years, and doubtless will continue to appear because they at least make good reading, and (2) the actual development of solar energy utilization. For this spread there must be some reason. Either the whole thing is a humbug or engineers and scientists are a stupid lot. It is neither. It is quite possible to recover solar energy, sometimes economically, but the installation must compete with other sources of power. It seldom can.

But this does not prevent a scientist from having a little fun with a most interesting scientific plaything. And the same fun may someday turn out to have had more significance than the present participants ever thought.



Science Service Photo

WAS THIS GAS CLOUD ONCE A STAR?

ARE some of the diffuse types of nebulae, which consist of highly rarefied gases still in irregular internal turmoil, simply the later stages of new stars that explode, like the present new star in Hercules? At Mt. Wilson Observatory Dr. Gustaf Strömberg thinks the Crab Nebula in Taurus (shown above) represents a case of this kind, and from a study of its spectrum concludes that the explosion took place about 900 years ago. Is it a coincidence that Chinese astronomers recorded a new star in the same spot 900 years ago? The circumstances look suspicious.

Southern progress in utilizing waste materials: plant producing turpentine, rosin, pine oil, from pine stumps

INDUSTRIAL DIXIE

Scientific Research Aids the South . . . Industries Growing . . . South Now Employs 20 Percent of Nation's Factory Workers . . . Promising Future

By DANIEL C. ROPER
Secretary, Department of Commerce

CERTAIN basic factors—the increasing availability of cheap electric power and the relatively low living costs—place the South in a position especially advantageous for industrial development. These factors, together with its proximity to sources of raw material, particularly cotton, indicate, in the light of its past record, a continuing advance in its industrialization.

Scientific research is doing much to assist in the development of industries in the South. While these trends have not as yet assumed major proportions, they are contributary factors of increasing consequence.

For instance, as a result of scientific research in developing the lumber industry through the South, modern pulp and paper mills have sprung up in many sections during the last ten to fifteen years and are doing well. Research has proved that spruce is not the only wood that can be used for the manufacture of rayon and that other southern wood growths could be satisfactorily used for paper manufacture. As the result of such studies, encouraged by the Forest Products Division of the Department of Commerce, much progress has been made in wood construction technique.

ANOTHER industry that has forged to the front in the South is canning, particularly the canning of citrus fruits and fruit juices. This has come as the result both of scientific research and commercial demand. The first figures in these lines were gathered by the Foodstuffs Division of the Bureau of Foreign and Domestic Commerce, Department of Commerce, in 1920. Since that time the upward curve of southern production of canned grapefruit, and orange and grapefruit juice has been steady. Success with these products prompted further experiments in the canning of peas and tomatoes in the Lower Rio Grande Valley region of Texas and these are proving to be very successful.

Chemistry has played a very important part in the industrialization of the South. Chemical engineers, utilizing this section's abundant natural resources, have been able to replace much of their loss in naval stores with paper, cellulose, nitrates, bromine, alkali products, wood preservatives, protective coatings, and other chemical manufactures. In 1934 more than 20,000,000 dollars was invested in these last named enterprises in the South.

The recent development of the tung oil industry is another example of the partnership between science, agriculture, and business. Tung oil is extracted from the seed of the tung tree which is native to central and southern China, but which science has successfully

TABLE I—GROWTH IN POPULATION AND INDUSTRY

The South in comparison with the United States: 1869-1933

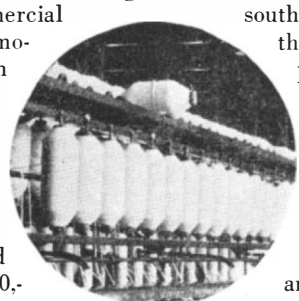
POPULATION	1870	1880	1890	1900	1910	1920	1930	1933[1]
United States	38,558,371	50,155,783	62,947,714	75,994,575	91,972,266	105,710,620	122,775,046	125,693,000
The South	12,288,020	16,516,568	20,028,059	24,523,527	29,389,330	33,125,803	37,857,633	38,665,000
Percent of U. S.	31.9	32.9	31.8	32.3	32.0	31.3	30.8	30.8
MANUFACTURES	**1869[2]**	**1879[2]**	**1889[2]**	**1899**	**1909**	**1919**	**1929**	**1933**
Number of wage earners:[3]								
United States	2,053,996	2,732,595	4,251,535	4,712,763	6,615,046	9,096,372	8,838,743	6,055,736
The South	245,725	301,677	550,654	748,940	1,129,307	1,431,682	1,587,260	1,227,475
Percent of U. S.	12.0	11.0	13.0	15.9	17.1	15.7	18.0	20.3
Wage earners—percent of total population:								
United States	5.3	5.4	6.8	6.2	7.2	8.6	7.2	4.8
The South	2.0	1.8	2.7	3.1	3.8	4.3	4.2	3.2
Value added by manufacture in thousands of dollars:[4]								
United States	1,395,119	1,972,756	4,210,365	4,831,075	8,529,261	25,041,698	31,885,284	14,538,018
The South	126,620	172,613	442,728	563,497	1,128,819	3,253,332	4,333,112	2,231,305
Percent of U. S.	9.1	8.7	10.5	11.7	13.2	13.0	13.6	15.3

ELECTRIC LIGHT AND POWER	1902[5]	1912	1922	1932
Number of employees:[6]				
United States	30,326	79,335	150,762	244,573
The South	3,904	10,398	20,932	43,623
Percent of U. S.	12.9	13.1	13.9	17.8
Thousands of kilowatt-hours:				
United States	2,507,051	11,569,110	40,291,536	79,657,467
The South	256,896	1,191,509	6,250,661	16,760,955
Percent of U. S.	10.2	10.3	15.5	21.0

[1]Estimated.
[2]Figures for 1889 and earlier years include data for "hand and neighborhood industries" (blacksmithing, carpentry, custom tailoring, etc.) and therefore are not strictly comparable with those for 1899 and later years, which do not include such data.
[3]Not including salaried employees.
[4]Value of products less cost of materials, containers, fuel, and purchased electric energy. This is a rough measure of the net new value created by the manufacturing processes.
[5]No data for earlier years.
[6]Total salaried employees and wage earners.

propagated in the South. This oil, because of its waterproofing qualities, is much used in the manufacture of varnish and in the manufacture of insulating compounds for the electrical industry. It is likewise used as an ingredient of some automobile brake linings. The American tung oil has been found superior to that of China.

Another chemical which formerly had to be imported to this country is bromine, used principally in making dyes and other like commercial products, and high-grade motor fuel. A plant has been established on the coast of North Carolina which is now extracting bromine from sea water. It is reported that 15,000 pounds of this valuable chemical are extracted and marketed daily from 37,000,000 gallons of sea water, or about one pound to every 2500 gallons of water treated. For these factual reasons, the future of southern manufacturing seems propitious in many lines.



Cotton

The South, with slightly more than 30 percent of the country's population, now employs about 20 percent of the entire country's factory workers. The South, as the term is used in this article, comprises the region lying east of the Mississippi River and south of Mason and Dixon's line (the southern boundary of Pennsylvania) and the Ohio River, together with four states west of the Mississippi, namely, Arkansas, Louisiana, Oklahoma, and Texas—a total of 16 states and the District of Columbia. As compared with the late seventies—say a half a century ago—when the southern states accounted for about 33 percent of the population and only 11 percent of the wage earners in manufactures, this betokens a noteworthy degree of progress in industrialization, although the South is still predominantly an agricultural region.

In the light of these facts, it is interesting to note that a century and a quarter ago, in 1810, when the first census of manufactures was taken, and when somewhat less than half the population of the country lived in the region south of Mason and Dixon's line, that region contributed approximately one third of the value of commodities manufactured in the United States. Virginia, with a total output somewhat above that of New York, then outranked all other states except Massachusetts and Pennsylvania, and was the leading state in cotton and flax manufactures. (The metal products of Virginia included 1081 swords, valued at 5405 dollars—this being the total production of swords in the entire United States according to the census of 1810.)

Seventy years later, about a decade and a half after the close of the Civil War, when manufacturing was done mainly in factories rather than in homes and in neighborhood shops—as in 1810—the South's share of the nation's industry total had dropped to less than 9 percent, as measured by "value added by manufacture" (see footnote 4, Table 1), and 11 percent as measured by number of workers employed. From that time (1879) onward the census records show, decade by decade, substantial increases in the amount of manufacturing done in the South, until in 1929 the southern factories employed nearly 1,600,000 workers, with products valued at more than ten billion dollars, and contributed a net of four and one-third billions to the nation's wealth. During the following four years the South shared in the general industrial depression, but it is noteworthy that its percentage of the nation's factory workers increased from 18.0 in 1929 to 20.3 in 1933, and that during the same period its percentage of the total "value added by manufacture" rose from 13.6 to 15.3 percent.

TABLE 1 sets out in condensed form the record of the South's progress in industrialization during the 64-year period beginning with 1869.

The most striking increase shown in Table 1 is in the electric light and power industry, where employment rose from 3904 in 1902 to 43,623 in 1932, and production increased from 257,-

TABLE II

This table presents statist

Industry	Number of Establishments[1]		
	1899	1929	193
All industries in the South	36,376	41,296	24,4
LEADING INDUSTRIES			
Cotton goods	417	821	7
Lumber and timber products not elsewhere classified	14,171	8,701	2,0
Knit goods	82	357	3
Railroad repair shops, steam	308	449	4
Cigars and cigarettes	1,184	188	
Steel-works and rolling-mill products	38	48	
Rayon and allied products	—	14	

[1]The figures for 1899 cover all establishments reporting products ued at $500 or more, whereas the corresponding minimum limit for 1 and 1933 was $5,000. This change materially reduced the numbe establishments covered by the census, but had only a negligible effect the figures for wage earners, value added by manufacture, and horsepo

000,000 to 16,761,000,000 kilowatt-hours. During this 30-year period the South's proportion of the total output of electric energy in the United States more than doubled—increasing from 10.2 percent to 21 percent.

The increase in number of workers employed does not afford a true indication of the actual increase in the amount of manufacturing. The industrial growth of a nation or of a region can be measured adequately only by a production index representing *quantities*. No such index has been prepared for the South or for any other section of the United States, but the results of a careful study of the manufactures-census figures for the United States as a whole indicate that the progress in mechanization of factory equipment during the 30-year period from 1899 to 1929 had brought about an increase of 65 percent in the average output per wage-earner, and that four years later this average was 50 percent above that for 1899. If it be assumed that the output per worker in the South has increased in like proportion, the quantity of manufactured goods made in the South was about three and one-half times as large in 1933 as in 1899. Moreover, it would not seem unreasonable to assume that the percentage of increase in this respect has been somewhat greater in the South than in the United States as a whole, for the reason that in those industries that have spread to the South during recent years mechanization has probably reached a somewhat higher level than elsewhere, since such changes would not necessitate the replacement of obsolescent equipment. The reluctance to abandon old equipment has doubtless retarded mechanization in some of the older industrial centers.

SOME measure of the increase in factory mechanization is afforded by the figures given in the last four columns of Table 2, from which it will be seen that the horsepower rating of the prime movers and electric motors used to drive factory machinery in the South increased from 1,715,000 in 1899 to

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Hon. Daniel C. Roper

8,067,000 in 1929. This is an increase of approximately 370 percent during a period within which the gain recorded for wage-earner employment amounted to about 110 percent.

Table 2 measures the growth, since the beginning of the present century, of the seven leading industries in the South. These seven industries, each of which employed more than 30,000 factory workers, together accounted for nearly half of the total number of factory wage-earners reported for the South at the 1933 census.

The cotton goods industry, as is well known, is by far the most important in the South. The record of cotton-mill development dates back to 1880, in which year the cotton-producing states operated only a little more than five percent of the spindles in the United States and consumed only about a quarter of a million bales of cotton, or approximately one seventh of the total American consumption. The increase in the number of spindles in the South was gradual until about 1895, but has been more rapid since then, until in 1927 the number of spindles in the cotton-growing states (including California) exceeded the number in the remainder of the United States. With only one exception—1905—each year from 1880 onward has shown an increase in the number of spindles in the South; and, beginning with 1922, each year has shown a decrease in the number of spindles in the remainder of the country.

Turning to the record of cotton consumption, we find that in 1911 the cotton-growing states consumed slightly more cotton than all other states and that the margin increased until in 1929 they accounted for approximately three fourths and in 1934 practically four fifths of all the cotton consumed in the United States.

The most striking rate of growth recorded for any southern industry, however, appears for knit goods, in which more than nine times as many wage-earners were employed in the South in 1933 as in 1899—67,000 in the later year as against 7000 in the earlier. The rayon industry is another southern industry which has developed rapidly in recent years. This industry (unknown in 1899) employed 24,000 southern factory workers in 1929 and 30,000 in 1933.

AT the beginning of the century, the leading industrial state of the South, as measured by factory employment, was Maryland, followed in order by Georgia and North Carolina. Ten years later North Carolina led all other southern states in factory employment; and in 1919 and subsequent years North Carolina has been well in the lead of all other states in the South, both in employment and in value added by manufacture. In 1929, the peak year, North Carolina employed nearly 210,000 wage-earners, or more than 13 percent of the total for the South, and contributed 693,000,000 dollars, or 16 percent, of the southern total for value added by manufacture. The marked growth in manufacturing activity in this state is due in considerable part to the development of the cotton textile industry, in which nearly 92,000 workers, or about 44 percent of the stat 's total in all industries, were employed.

(*Please turn to page* 332)

LEADING INDUSTRIES IN THE SOUTH: 1899, 1929, AND 1933

For those industries, 7 in number, each of which employed more than 30,000 wage-earners in the South in 1933

Wage-earners[2] (Average for the year)						Value added by manufacture[3]						Horsepower[4]			
Number			Percent of U. S. Total[5]			Amount in thousands of dollars			Percent of U. S. Total[5]			Amount		Percent of U. S. Total[5]	
1899	1929	1933	1899	1929	1933	1899	1929	1933	1899	1929	1933	1899	1929	1899	1929
748,940	1,587,260	1,227,475	15.9	18.0	20.3	563,497	4,333,112	2,231,305	11.7	13.6	15.3	1,714,603	8,066,924	15.2	18.8
102,593	275,280	274,372	34.4	64.8	72.3	41,344	372,983	256,078	26.0	59.6	66.6	223,820	1,332,641	27.8	58.7
120,715	226,123	99,531	42.6	54.0	52.6	87,242	371,592	92,124	35.0	43.5	40.6	571,513	850,286	35.4	42.8
7,401	58,906	67,447	8.9	28.3	35.6	2,620	82,267	73,860	5.9	18.6	28.3	4,116	47,388	7.1	26.1
39,990	104,366	62,168	23.0	28.3	28.2	23,219	175,997	77,117	21.4	26.3	27.1	19,952	347,862	20.1	32.3
16,030	40,779	38,079	17.4	38.7	49.4	[6]15,399	[6]494,417	[6]146,637	15.1	69.6	73.0	993	33,492	20.7	67.6
12,573	42,092	35,422	6.9	10.7	12.8	11,675	138,774	61,954	5.7	9.5	13.7	[7]191,215	[7]762,551	11.4	10.1
—	24,090	30,094	—	61.6	67.9	—	67,170	81,019	—	57.8	71.8	—	143,111	—	73.1

[2]Not including salaried employees. [3]Value of products less cost of materials, containers, fuel, and purchased electric energy.
[4]Rated horsepower capacity of prime movers plus that of electric motors driven by purchased energy. No data collected for 1933.
[5]The percentages for "All industries in the South" represent the South's share of the United States totals for all industries, and those for the leading industries represent the South's share of the United States totals for the respective industries.
[6]Figures for 1899 and 1929 not comparable with those for 1933.
[7]Includes horsepower for the blast furnace industry.

Courtesy Atwater-Kent

WORLD-WIDE RADIO

ALL-WAVE RECEIVERS

By M. L. MUHLEMAN*

IT is doubtful if international short-wave broadcasting would be the success it is today were it not for the vast improvements made in all-wave receivers. The complexity of circuits and circuit functions in these receivers is truly amazing. It is almost unbelievable that the feeble impulses picked up by the receiving aerial can survive the electrical ordeal through which they must pass before emerging from the loudspeaker. Yet the gymnastics to which the impulses are subjected account for the remarkable results that may be obtained from an all-wave receiver.

What happens to these feeble impulses? They are routed through two of a bank of some 12 to 15 coils and switch contacts, filtered during this passage, then pre-amplified at their own wavelength, again filtered, and thence fed to a converter tube. In the circuit of the converter tube, the impulses are mixed with a locally-generated group of impulses, modulated, and made to assume an entirely different wavelength than the original. The converted impulses are then re-amplified at the new wavelength, demodulated, amplified again at an audible frequency and finally fed to the loudspeaker. Moreover, during the demodulating process, a percentage of the impulses are tapped off through a separate circuit network, filtered, and used for the purpose of automatically controlling the sensitivity of the receiver. Yet, for all of this electrical pummeling, the impulses are heard a fraction of a second after their transmission from a station possibly 6000 miles distant, and remain almost an exact counterpart of the original.

Pre-amplification in all-wave receivers is a comparatively recent refinement. It contributes more to the efficient functioning of a receiver than any other component, and its importance cannot be overemphasized. The pre-amplifier bears resemblance to an optical system composed of magnifying lenses and color filters. It amplifies the intercepted signal and, through its selective properties, permits only the one signal to pass through. Its selective properties also eliminate "image interference," that peculiar property of a superheterodyne receiver of repeating a signal at some other point on the tuning dial—a point where there may very well be another station. But most important of all is that property of the pre-amplifier which leads to a much greater amplification of the signal than of local noise, with the result that the "usable" sensitivity of the receiver as a whole is considerably increased. That is, it makes possible the reception of a weak signal that would ordinarily be lost in a highly objectionable noise background.

NEXT in importance to the pre-amplifier are the new types of tuning scales and dial drives incorporated in modern all-wave receivers. The dials and the drives assume different forms, but in principle they are all much the same.

It is a curious fact that the lower or shorter the wavelength, the more difficult it becomes to tune in a station. Tuning in the standard broadcast band is a simple matter, but at 49, 31, 25, and 19 meters, tuning is a hopeless task unless special provisions are made to reduce the rate of motion of the dial or dial pointer with respect to the rate of motion of the drive knob.

In the earlier all-wave receivers, the dial drives have two ratios: one of about 10 to 1 for tuning in the standard broadcast band, and a second of about 20 or 30 to 1 for tuning in the short-wave bands. In modern all-wave receivers, the short-wave dial-drive vernier ratios run as high as 135 to 1, with the average in the vicinity of 50 or 60 to 1.

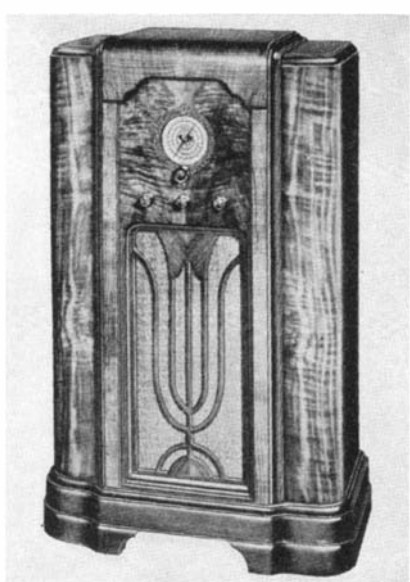
This mechanical reduction in movement offers almost the same ease in tuning as the 10 to 1 ratio provides in the standard broadcast band. The one drawback lies in the fact that short-wave stations may appear on the dial only a hair's breadth apart, with the result that station logging is difficult. To obviate this inconvenience, some manufacturers have added to the dial a supplementary scale and pointer, much like the second hand on a clock.

In effect, this is equivalent to "spreading" a waveband. For example, the 15-megacycle (19-meter) band occupies only two divisions on the average all-wave receiver dial scale. But the supplementary pointer forming the "band spread" travels through approximately 60 degrees or divisions as the main pointer is covering the two scale divisions encompassing the entire 19-meter band. Thus it is possible to log stations in much the same manner as one takes readings with a micrometer.

The third most important feature in an all-wave receiver is the automatic volume control system. This maintains the short-wave signal at a constant value. As the signal grows weak, the sensitivity of the receiver is automatically increased; as the signal grows stronger again, the sensitivity of the receiver is automatically reduced.

●

As a guide to our readers in the selection of all-wave receivers, we have prepared a list of representative sets by leading manufacturers, giving tuning range, number of tubes, special features, cabinet type, and price. This list will be sent on request. Stamp, please, for mailing.—The Editor.



Courtesy Crosley

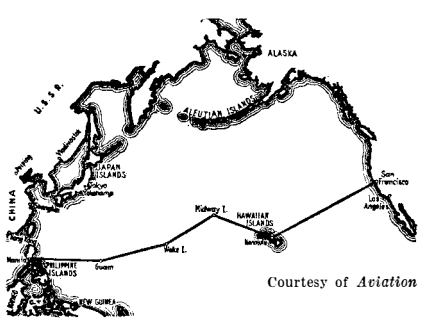
*Editor, Communication and Broadcast Engineering, Radio Engineering, (Radio) Service.

OUR POINT OF VIEW

Transpacific

THAT the American pioneering spirit is by no means dead is proved by the announcement of a dramatic plan to establish a transpacific air service during 1935. The foresight and determination which enabled our ancestors to carve a world power out of a wilderness lives again in the minds which have envisioned giant Clipper planes in a scheduled transport service to the Hawaiian Islands and the Philippines—and have laid the groundwork which will make such a service possible.

These pioneers of the Transpacific Division of Pan American Airways have planned carefully and well, and are deserving of the highest praise for their resourcefulness. They still have a large part of the job ahead—test flights with the Clippers as flying laboratories, airports to be built on small and lonely islands, trips by a steamship specially equipped to carry a group of aviation experts—but no single phase of it has been slighted or left to chance. Backed by a huge fund of aeronautical data



Courtesy of *Aviation*

accumulated by thorough-going research, and imbued with the pioneer spirit so essential to overcoming obstacles as they arise, Pan American is steadily forging ahead.

The extraordinary achievement which is being aimed at is an overnight service from San Francisco to Honolulu (2410 miles) and four daylight flights to Manila in the following stages: To Midway Island (1320 miles); to Wake Island (1260 miles); to Guam (1500 miles); and to Manila (1600 miles).

The same type of planning which has made possible regular aerial service over the Caribbean Sea to South America and along both coasts of that continent will be brought to bear on the transpacific problems. Highly perfected power plants and carefully designed aircraft, coupled with a well-rounded knowledge of the multitude of factors which are involved in successful air transport operation, all point to the probability of success.

Thus does science furnish the stuff of which dreams are made. Only a generation ago talk of a transpacific air service would have been considered as the mouthings of a maniac, or at least of one who preferred visions to realities. But man's conquest of the air has provided the wherewithal, and hard-headed business men are pushing to completion the fulfilment of a dream—but a dream founded on the solid rock of accomplishment in the past, now being projected into the future.

Alcoholic Gasoline

THEY'RE at it again! The "Soak Everybody" boys, having flooded the nation with their economic nostrums which, somehow, usually hit hardest the purses of those they are designed to help, again propose helping the grain farmer at the expense of motorists, or, to be exact, all operators of gasoline engines. The attempt made three years ago by pseudo-economists or out-and-out vote-exploiting politicians to care for a glut of farm products by compelling use of farm-product alcohol in all gasoline, was defeated by incontrovertible scientific facts. Yet at the moment, both houses in South Dakota have passed a measure intended in this manner to relieve agricultural distress; and Iowa, Minnesota, Nebraska, Idaho, and California would likewise fly in the face of facts, for they have similar measures pending.

The United States Bureau of Standards proved—in our opinion, conclusively—that the economic reasoning of the alcohol-gasoline advocates was untenable. Others, with an equally impressive body of evidence, condemned the thesis on both economic and engineering grounds. Yet this bête noir of logic and common sense is at large again to delude gullible constituencies. Some of the salient facts are, therefore, worth iteration.

With a mixture of 90 percent gasoline and 10 percent alcohol:

1—Engine performance will be less efficient and mileage will drop—unless carbureters and engines are redesigned, and this would be so costly as to be unworthy of a moment's consideration. 2—There is no known way to prevent absorption of water by the mixture in all the handling between producer and consumer; alcohol is irremediably hygroscopic. 3—Alcohol can not be produced cheaply, and its addition to gasoline would increase the price of the inferior fuel two to three cents per gallon. 4—Since farmers use 25 percent of all the gasoline we produce, the above-mentioned penalties attached to this particular "farm relief" would leave farmers but little, if any, profit from its operation. 5—There is no real surplus of usable (alcohol producing) farm products now, so the ethyl alcohol—not to be confused with gasoline containing tetraethyl lead now on the market—to be used would take up only farm wastes and unmarketable fruits and potatoes. While this last fact might seem climactic, there is yet a powerful economic argument against the scheme. 6—Grain (ethyl) alcohol can be made from petroleum by cracking and even from lumber wastes by the magic of chemistry. Sensibly, therefore, lumber and oil men would command a sizeable share of the profits and help abort the relief feature very quickly.

Convincing though these facts may be to thinking men, the demagogs will not listen. Theirs is a personal purpose, not to be balked by mere science or the innate sanity of the people—a personal purpose to exploit human misery, as someone so aptly phrased it. And they will continue their pretense of aiding so long as it attracts the votes of the unthinking mass. In high offices and low, theory and experiment are the order of the day, and the long view unimportant. Ensuing poverty, radicalism, chaos matter not: "After us, the deluge." Handouts, doles, anything to undermine character; and every day we get closer to Lenin than Lincoln. No one seems to have thought of the simple expedient of giving business, industry, science, and American initiative a chance to assure their own survival—*and* prosperity. (Other nations have, however, and are seeing the light while we still are at the bottom of the pit.) Such a measure for rehabilitation would demand cutting the shackles of uncertainty—a difficult job for the devious lariat-wielding politicians and one which might show up many of them as superfluous parasites.

Seemingly, we have digressed and run into the field of politics which we should eschew. Actually, ours is a plea for fewer excursions by our elected representatives into fields of science in which they are incompetent, of which they are ignorant, and to which they apply so few grains of common sense.

BACK TO PROSPERITY WITH HOUSING

Intense Housing Activity Needed . . . Jobs for All . . . Billions Will Go Into Circulation . . . Financing Simple and Easily Arranged . . . Insured Mortgages

By JAMES A. MOFFETT
Federal Housing Administrator

(In Two Parts. Part 2)

WHY the National Housing Act at once starts America back to prosperity, as pointed out last month, is easily demonstrated:

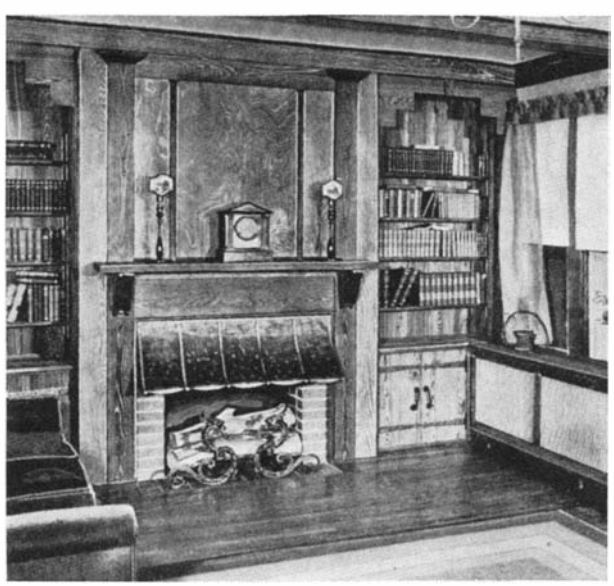
Authorities on the movement and behavior of money have found that out of every hundred dollars spent on home construction or repair 74 dollars goes to the workers in supply industries such as lumber yards, saw mills, mines, and quarries; to men engaged directly on the job, such as carpenters, painters, and electricians; to employes in offices of architects, engineers, and other professions profiting from building activities; and to workers for such transportation agencies as railroads and boats.

Most of these people earn comparatively small incomes, and they usually spend their money as they get it, paying it to grocers, butchers, clothiers, doctors, and so on. That is, practically three-quarters of the millions, the billions of dollars which America must pay out to catch up on its housing, will go into immediate and continuous circulation.

THE money experts have discovered that wage money travels from pocket to pocket so fast that in one week one dollar pays four dollars' worth of bills. For example: A dollar is paid to a carpenter, who uses it to settle a bill with his grocer, who hands it in wages to his delivery boy, who puts it into a payment to a jeweler for a ring for his sweetheart—all within a week.

We, of the Housing Administration, confidently expect that by December 31, 1935, America will have spent at least 1,500,000,000 dollars on modernization and repair. Add that to the three billions which, we believe with equal confidence, will be spent within the next year or so in new home construction; and we have 4,500,000,000 dollars going to the builders, building supply dealers, and others. Furthermore, there will be another tremendous sum that home owners and industrialists will pay out for new furnishings and equipment for their modernized and new buildings.

And three quarters of all those sums go at once into circulation and continue to circulate. It is now plain, I think, that I did not exaggerate when I said that builders, durable goods industries, and business generally had never before been offered the opportunity to develop so immense and so varied a market.



Loans will cover any permanent improvement such as re-decorating or building of book shelves and cupboards

Bear in mind that the National Housing Act, through the Better Housing Program, is the cause and source of that opportunity. The Housing Program opens the way for business to profit by its unprecedented opportunity. Through nation-wide educational work and the community campaigns, it tells the citizen how he can borrow money for repair and building; it tells the lending institutions that the Housing Administration will insure them against loss from such loans; and it tells the builder how he can finance construction of groups of buildings.

As directed by the Act, we have developed the Better Housing Program in two distinct sections: first, modernization and repair; second, new construction. We have appointed Regional Directors and State Directors and their Assistant Directors. We have other men in the field. The duty of them all is to co-operate with, and support, the Community Better Housing Committees.

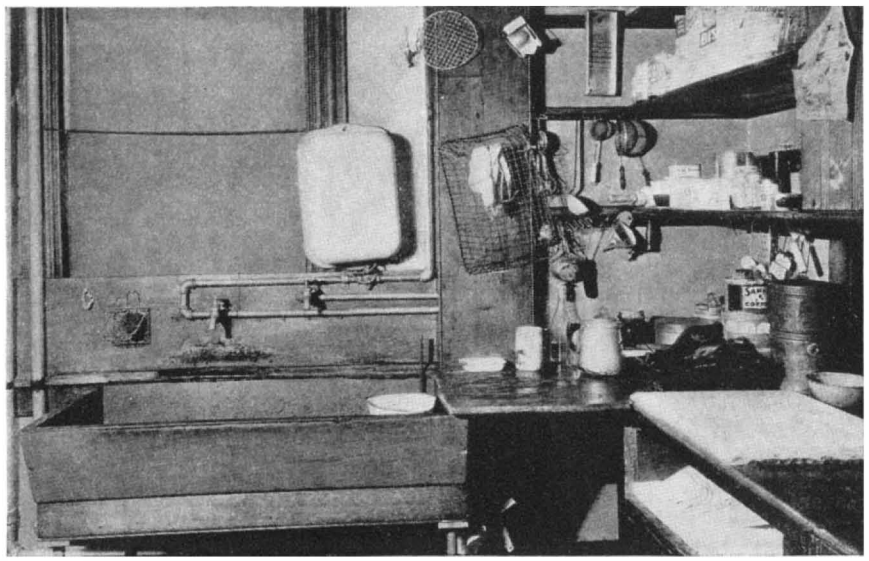
The community is the unit of effort and accomplishment under the Housing Act. The Federal Housing Administration is not authorized to repair or build. It has no money to give away. The American people are doing the modernizing and building, and they are paying for the work with their own money. They do it all through their community organizations. And right here let me say: They are making a fine job of it.

Under our Modernization Credit Plan in the Better Housing Program, the owner of a home or business property may borrow up to 2000 dollars to modernize, repair, alter, or otherwise improve his building.

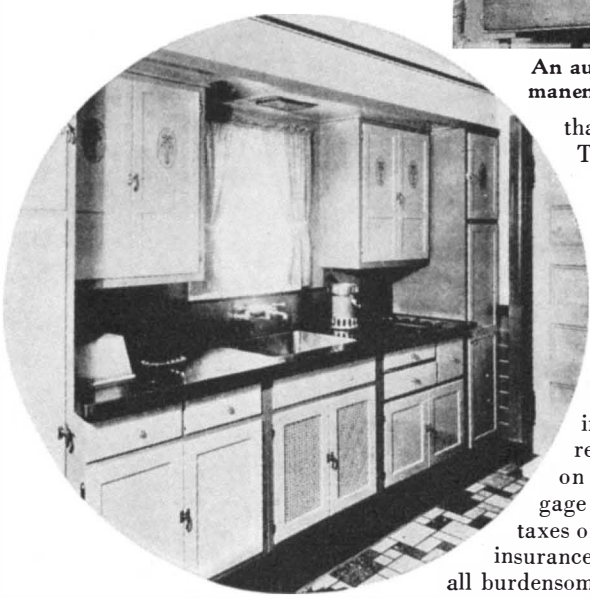
He gets the money from a local lending institution which has contracted for us to insure its loans. He needs no other

signature or endorsement on his note than his own—except that, if he is married, his wife's name goes on his paper. The only requirements he has to meet are that he shall have a reputation for reliability, and an income or job which will enable him to repay the loan in monthly instalments over a period of three years or, in special cases, five years. Farmers may repay at longer intervals, since their earnings are seasonal.

With the money thus secured as a "character loan," the property owner can put on his land any sort of improvement that is permanent or "built in" (a burglar alarm or a front porch or even landscaping of the grounds around his home is permanent; a radio or a bookcase that is not built in does not meet the requirements).



An authentic "before and after" kitchen. Another striking example of permanent improvements that are permissible under the rules for FHA loans



The second section of the Better Housing Program is a long-range plan for the construction of new homes and the refinancing of mortgaged homes. It has been worked out under the Housing Act as the best conceivable means of accomplishing two things absolutely essential to the nation's recovery and permanent prosperity: First, revival of the at present dead mortgage market by adoption of a standard form of home mortgage throughout the country, and 100 percent mutual insurance of the mortgages under supervision of the Federal Housing Administration; and second, as a result of all that, the nation's catching up on its home shortage and thereafter continuing the steady rate of building required by a country as large and populous as ours.

THE whole new home construction part of our Program is based on the new form of mortgage and the rules governing its insurance. The new mortgage is given on 80 percent, or less, of the appraised value of the property—that is, the house and the lot. The mortgage can be for any amount and on a house of any value, so long as the mortgage itself does not exceed 16,000 dollars. It must be paid off in not more than 20 years by regular equal monthly payments on both the principal and interest. Also there must be regular monthly payments on such items as the mortgage insurance premiums, the taxes on the property, and the fire insurance, the total being not at all burdensome.

To enable financial institutions and other holders of mortgages to turn the insured mortgages into ready cash whenever they wish, national mortgage associations, under the supervision of the Housing Administration, will be established to deal in them.

If a man wants to build a new home and finance it with a mortgage, he submits complete plans and specifications of the structure to an approved lending institution which, in turn, submits them to a local representative of the Housing Administration. When the plans are approved by the Housing Administration, it gives in writing an agreement to insure the mortgage on his house, when completed. With the Housing Administration's agreement as security, he gets from a lending institution a construction loan. Upon completion of the house, he signs his mortgage and pays off the construction loan with the proceeds.

These hastily drawn pictures of the methods by which we make money promptly available for new building and for repairing of old structures are sufficient, I believe, to give a clear indication of how convenient and practical it is for the people to do the work, and how at the same time we insure financial institutions against loss from advancing the money needed for that type of work.

I am often asked, in letters and by visitors to my office: "How can the private citizen help to make the Better Housing Program 100 percent successful?"

My answer invariably is: "By working with the Better Housing Committee in your community; and if your town has not yet organized its committee, by doing everything you can to speed its formation. Tie in your business advertising with Better Housing. Help to put over the house-to-house canvass which in any and every community is the only way to produce the greatest possible amount of modernization, repairing, and building. And, above all, modernize and repair your own home and business property, and see to it that your office or plant equipment is brought up to date."

THEN, too, there is the Los Angeles Plan. That city and the state of California as a whole are going great guns in their modernization work.

One morning in Los Angeles I picked up a newspaper to see a full-page advertisement announcing that 100 of the leading citizens pledged themselves and invited others to join them, to undertake and get started 100,000,000 dollars' worth of modernization and new construction in their city.

There is no reason why any city or town in this country should fail to do the same thing—in proportion, of course, to its population and resources. If all the communities go in for such a schedule, there will be employment for every man and woman in America within 60 days.

In some states already, as a result of the Modernization Campaigns, towns have reported that all their building mechanics have jobs and they are sending to other places for more workers.

THE NEWER TELESCOPES

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

EVERYONE who has used a camera knows that a good lens should meet severe conditions. It must bring the rays to a *sharp focus*, not only at the center of the image but over a *wide field* of view. It must bring light of all colors to the same focus—that is, it must be *achromatic;* and it is very desirable, though not necessary for all purposes, that it should give a bright image, permitting short exposure—it must be *fast.*

We all know, too, that to get an achromatic image even approximately, our objective must be made of two component lenses of different kinds of glass. To get a sharp focus over a wide field there must be three or four components in the objective, instead of two. Finally, a fast lens must be of large diameter compared with its focal length.

To meet all the conditions, which have here been merely outlined, demands the highest skill of the designer and the optician, so that good lenses are necessarily costly, even in the small sizes used in ordinary cameras. For the larger apertures used in astronomical work there is added the great difficulty of casting perfectly flawless disks of glass.

Some of these difficulties may be altogether removed and others greatly diminished by using mirrors instead of lenses. A reflecting telescope is perfectly achromatic, and the ratio of its aperture to its focal length can be made much larger than is practicable for a two-component lens. Moreover, by figuring the surface to an exact paraboloid of revolution, all the light of a star may be brought to a geometrically exact focus—barring the inevitable effects of the diffraction of light waves, which are alike in all instruments of a given aperture.

DESPITE these important advantages, the reflector has one very grave disadvantage. Its field of good definition is severely limited. The condition that all the parallel rays of a beam of starlight shall be brought by reflection to a sharp focus fixes the *form* of the mirror surface completely. It may be obtained by rotating a parabola about its axis. The only freedom left the designer is to determine the size of this parabola—that is, the focal length of his mirror—and of course to decide how large a portion of the infinite geometrical surface shall be arbitrarily brought into being upon his glass disk. But this paraboloidal surface will perform ideally well only when the stars' rays come to it along the direction of its own axis. If they are inclined to this at even a small angle, the rays reflected from different portions of the mirror will not converge to the same point. Those from the outer zone do not come to a focus at the same distance from the mirror as those from a zone near the middle of

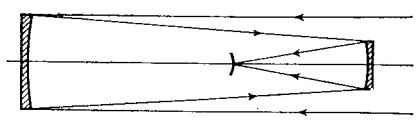


FIG.1

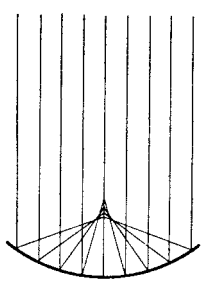


FIG.2

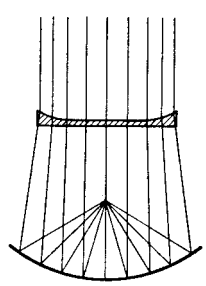


FIG.3

the mirror and their best approximation to a focus is displaced laterally away from the center of the field, so that the image becomes a roughly triangular mass like a half-opened umbrella or a tiny comet with a wide, bright tail.

This "aberration" of the image is called coma. It is always present, theoretically, except at the very center of the field. Its amount increases proportionally to the distance of the star from the center, and also to the square of the ratio of the diameter of the mirror to its focal length. The brightness of the image of any extended object, such as a nebula, is proportional to this last quantity. It is therefore impossible, with a single reflecting surface, to secure a bright image and a wide field at the same time. The star images go bad quite near the center.

With an aperture one fifth of the focal length, as in the 100-inch telescope at Mount Wilson, the deterioration of the images becomes perceptible to a trained observer at 3′.6 from the center, so that the field of really satisfactory definition is only one eighth of a degree in diameter. The 200-inch telescope will have to be made shorter in proportion to its diameter, to avoid enormously increased cost, and Dr. Ross calculates that the images will be really sharp in a portion of the plate less than one inch in diameter. It may be repeated that this property of the simple reflecting telescope arises from simple, though not quite elementary, considerations of geometry. It is incurable—unless we decide to make our telescopes more complicated in design. Then there are many ways of escape. By using two mirrors which divide the image-forming work between them, additional degrees of freedom become available and coma may be eliminated over a wide field.

THE first such scheme worked out in detail was by Schwartzschild, the most distinguished German astronomer of all times, in 1905. It employs a main mirror of small concavity, with a second more concave and of half the diameter placed in front of it (Figure 1). This gives a flat field, with good images over a region two degrees or more in diameter, and has great light-power, since the effective focal length, as determined by the scale of the image, is three times the diameter of the large mirror. But the tube from one mirror to the other is 25 percent longer than for an ordinary reflector. The loss of one quarter of the light by interposition of the second mirror is not very serious.

A reflector of this type is under construction for the University of Indiana. A second type, in which the small mirror is convex, 30 percent the size of the big one, and much nearer to it, was designed by the French astronomer Chrétien. A 40-inch telescope of this design has been constructed for the United States Naval Observatory by Mr. G. W. Ritchey.

It is also possible greatly to increase the available field of a parabolic mirror by interposing a specially constructed lens not far in front of the focal plane. The very complicated theory necessary for the design of such "correctors" has been developed by Dr. F. E. Ross, and lenses of this sort have been adapted to the 60-inch and 100-inch reflectors at Mount Wilson with great success, and will be provided for the 80-inch in Texas

and for the 200-inch in California.

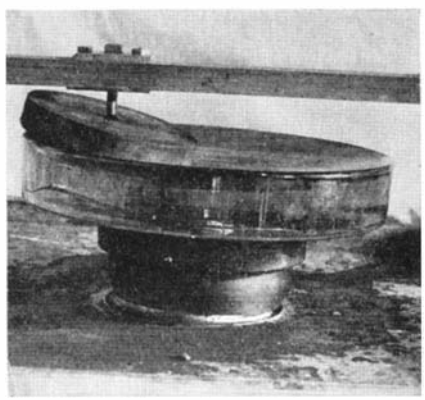
These devices, while of high value for use with large telescopes, do not permit the construction of mirrors with as favorable a speed-ratio as can be attained by the best lenses. A ratio of $f/3.3$ (that is, a focal length 3.3 times the aperture) is about the best that has been attained, while specially designed lenses have gone almost to $f/1.0$. Such image-forming systems of short focus and great speed are especially important for astronomical spectographs. The collimation of such an instrument—a small reversed telescope which receives the diverging beam of light after its passage through the slit and turns it into a parallel beam so that it may pass through the prisms without distortion—has perforce to be designed with the same ratio of aperture to focal length as the telescope which feeds it. (Even with the reflectors this is small, for the spectographs are used with a secondary concave mirror which lengthens the focus.) When there is plenty of light a long camera behind the prisms gives a large image full of rich detail. But, for faint objects and especially for extended surfaces such as nebulae, a short camera is necessary. This increases the intensity of the image by diminishing both its length and its breadth. Moreover, the spectral lines of the plate, being reduced images of the slit, are very narrow, and the slit may be widened, admitting more light without fuzzing up the negative perceptibly.

IT was by inventing this short camera that V. M. Slipher at the Lowell Observatory succeeded, with a telescope of moderate size, in obtaining the first good, detailed spectrograms of the spiral nebulae, and so began one of the most striking advances of modern astronomy.

Now short focus lenses up to an inch or so in aperture can be perfectly well made, though it is skilled work. But a lens six inches in aperture and of similar shape would be so thick that much light would be lost in passing through the glass, and would be extremely costly to make.

A most ingenious solution of the problem has recently been made by Dr. B. Schmidt of Bergedorf, in Germany. The "Schmidt camera" uses a mirror instead of a lens, and returns to a very old practice by making its mirror spherical. Now every telescope maker—amateur or professional—knows that a spherical mirror is much easier to make than a paraboloid—indeed most mirrors are originally made spherical and then parabolized by gradually polishing away the excess material. But a spherical mirror, as all workers know, gives a most unsatisfactory image. The rays reflected near the edge cross nearer to the mirror than those which come nearer the center, and no sharp image can be secured, as is shown in Figure 2 (where the effect has purposely been exaggerated by taking the diameter more than twice the focal length).

This effect may be eliminated by changing the mirror to a paraboloid, but only at the price of introducing coma and narrowing the field of good definition. In place of this, Schmidt introduces a "correcting plate"—really a very thin, concave lens in front of the mirror.



While Professor Russell was writing his article, Harold A. Lower, an amateur of San Diego, unbeknown to him, was polishing the primary mirror of a Schmidt telescope camera, pictured above. The diameter of the Pyrex disk is 12 inches, its focal length 8 inches. Note, however, that this does not make the focal ratio $f/.66$, as might be assumed, since the aperture is four inches smaller than the diameter of the primary. The focal ratio is actually $f/1$. Its nickname is "The Soup Bowl." While the actual grinding and polishing of a mirror having so deep a curve as this presents no great difficulties, the testing is extremely laborious because the shadows are an unsafe guide for estimating the sweep of the curve; hence many narrow zones must be individually measured. Furthermore, putting the fine transition curve on the corrector lens, near the edge, is a job fit to tax the skill of a genius. The projected supplementary volume to "Amateur Telescope Making" will explain how to design one, but they are poorly adaptable for conversion to visual purposes

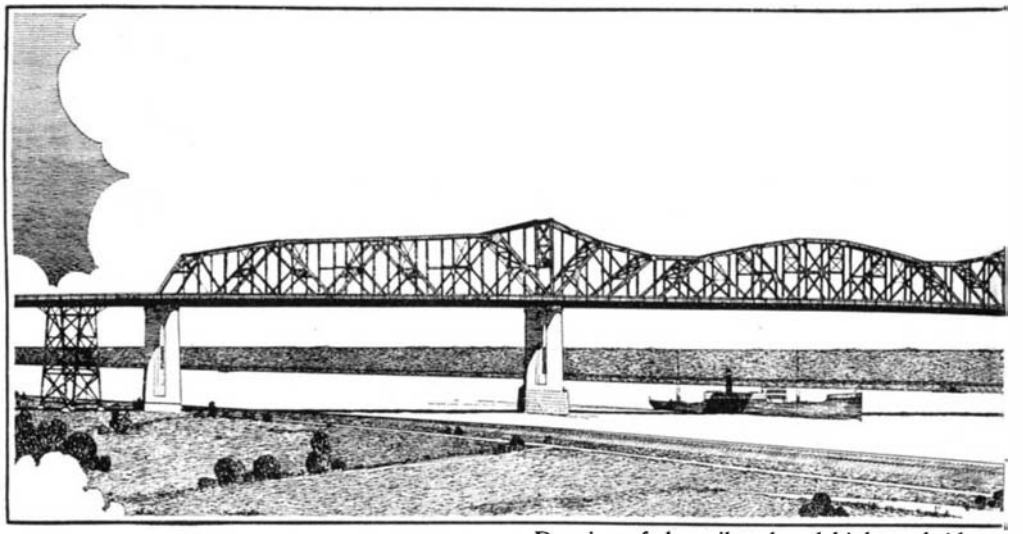
Its action is obvious from Figure 3. The rays near the center are very little deviated, while those passing near the edge are bent outward, and these strike the mirror at such angles that all are reflected exactly toward the same focus.

Even for the enormously exaggerated case shown in the picture, the plate is thin in comparison with its diameter, and its surface is considerably curved only near the edges. In practical application the curvature of the surface is so small that it is only perceptible by optical testing. A plate 12 inches in diameter, for example, will have surfaces which are never more than a thousandth of an inch removed from planes. After it has been carefully figured to its proper shape one would take it for an ordinary piece of parallel-faced glass—unless, indeed, one applied the severe test of looking through it at a very oblique angle.

With such a correcting plate the central image of a star becomes substantially as good as with a parabolic mirror. (Theoretically there is a slight departure from achromatism, due to the dispersion of the glass, but this is usually negligible in practice.) But the great advantage of this device is that the images of objects several degrees from the axis are almost as good as those at the center of the field. The spherical mirror itself produces no coma—only spherical aberration, and this to exactly the same amount no matter whether the rays fall on it from one direction or from another, for all parts of a sphere are alike. Inclined rays differ from axial rays only in passing through the plate at an angle. Now the whole effect of the plate is to introduce a distortion into the beam of rays, just sufficient, when they traverse it squarely, to undo the spherical aberration of the mirror. Rays traversing the plate at a moderately oblique angle will suffer very slightly greater deviations, the effect being a minimum for perpendicular incidence. As the deviations are small anyway, this change will be almost imperceptible, and the effect will be almost perfectly adapted to neutralize the aberrations of the mirror. In consequence, the images are good over a remarkably wide area. Mr. Schmidt has obtained photographs having a workable field 12 degrees in diameter.

A SERIES of Schmidt cameras is under construction for the large spectograph at Mount Wilson. By careful calculation of the curve of the correcting plate, an extraordinarily high speed-ratio can be secured. A camera with ratio $f/1$ is already in successful use, and one of $f/0.57$ is under construction, with an aperture $1\frac{3}{4}$ times the focal length! This should be of extreme value in observing faint stars.

At present this new device is likely to be of more service to the professional than to the amateur. The cross-section of the correcting plate is a curve of the fourth order, which must be calculated by the maker, and the figuring of the surface demands a rather unusual type of work. Moreover, the final focal image is not flat, but upon a spherical surface of radius equal to the focal length, so that special curved films would be required to cover a wide field. The very novelty of these problems, however, may be a challenge to the student who has already mastered the simpler technique of the ordinary mirror.—*Princeton University Observatory, April 5, 1935.*



Drawing of the railroad and highway bridge

BRIDGING THE

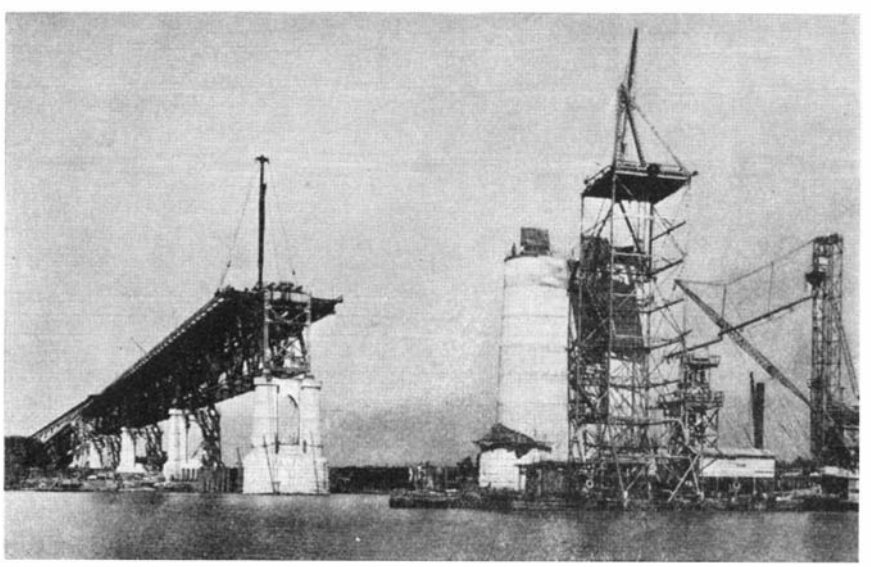
THE city of New Orleans, one of the principal ports of the South, is served by various trunk line railways on both the east and west sides of the river. Traffic is carried over the river and into New Orleans by ferry crossings. The port has been extensively developed on the east side by the city of New Orleans, but interruptions to ferry traffic, as well as the expense and hazards of its operation, have been a serious handicap to commerce.

For those reasons, a railroad crossing or a combined railroad and highway crossing of the Mississippi has been under consideration in various forms during the last half century, the projects including low level movable bridges, tunnels, and high level structures similar in type to the bridge now under construction. In 1892, a bridge was designed for the Southern Pacific Railroad, and bids were received on it, but due to a business depression it was never built. Tunnels were judged uneconomical because of depth of water and other physical conditions. The idea of a bridge persisted, sponsored principally by the Public Belt Railroad, which provides terminal facilities and freight connections for all the railroads entering New Orleans.

In 1924, the Public Belt Railroad presented to the Board of Army Engineers representing the War Department their plans for a low level bridge with a vertical lift span for the passage of large ships. This design met with such serious objections from navigation interests, who contended that it offered an obstruction to shipping on the river, that the War Department rejected these plans. It was at this point that Ralph Modjeski was engaged by the Public Belt Railroad as chief engineer on their project, to consult with the Army engineers and to prepare final plans for the structure.

The site of this bridge and of all structures proposed by these interests is at a point on a straight stretch of the river about eight miles above the center of the city. The river circles around the city in a general west to east direction, so that the site is actually to the west of New Orleans. This point is particularly convenient for rail connections. Highway traffic reaches the bridge by way of Jefferson Highway, a principal traffic artery running up the river on the New Orleans side. The fact that it is a combined railroad and highway structure differentiates it from other recent bridge projects at the city, these others having been for highway traffic.

Deep water navigation continues up the Mississippi as far as Baton Rouge, above which only 65 feet of vertical clearance over high water is required by the War Department; but at New Orleans the requirement is 135 feet, equivalent to the clearance under Brooklyn Bridge. Although a permit was issued in 1925 for a high level bridge with only 112 feet vertical clearance over mean high water, the lapse of Congressional authority to build the bridge necessitated the securing of a new permit, for which the 135-foot requirement was stipulated.

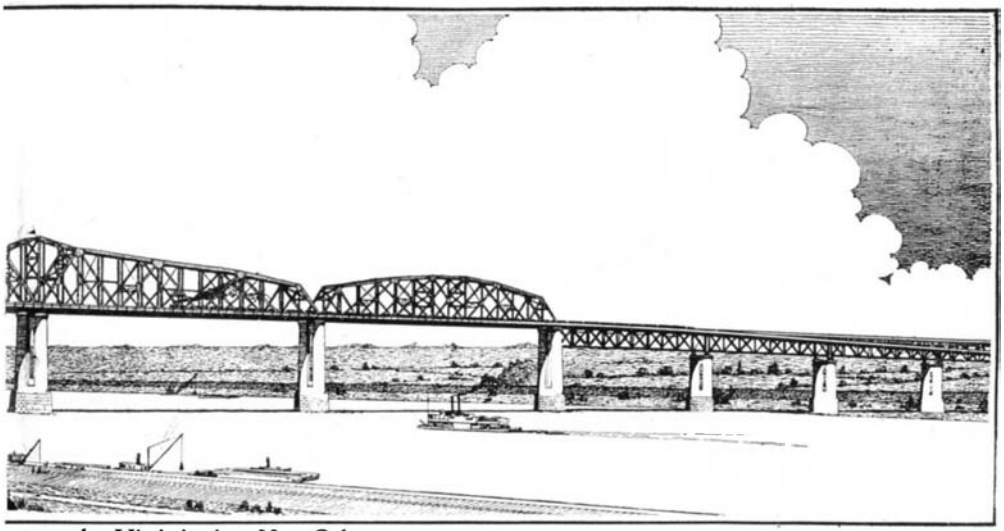


Pier four under construction, showing the special tower derrick used for placing concrete on top of pier. Masonry facing on lower part of pier can also be seen

THE final design of the bridge provides this vertical clearance above average high water, which is 18 feet above mean gulf level. The length required for the approaches is determined by this height, and by the railroad grade of 1.25 percent. High water of the river on the lower Mississippi is well above normal ground level, requiring further increase in the length of these approaches. The New Orleans Bridge is, therefore, one of the longest important bridges in the world, with a total length of steel structure of 22,995 feet, or almost 4½ miles.

Two railroad tracks are provided on the structure, and two 18-foot roadways with sidewalks are cantilevered outside the main trusses. On the approaches, the highways descend on a 4 percent grade outside the railroad structure, and because of their steeper grade, reach ground level before the railroad deck.

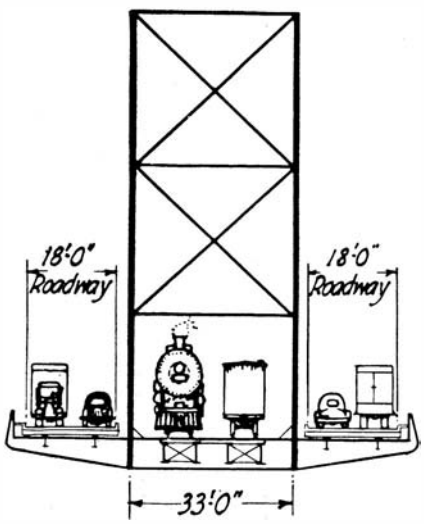
For horizontal navigation clearance,



over the Mississippi at New Orleans

MISSISSIPPI

By HARRY J. ENGEL



Arrangement of railroad tracks, roadways, sidewalks on the bridge

the War Department required a principal span of 790 feet, which is made the cantilever span of the main bridge. The anchor arms are each 530 feet long. A through truss span on the New Orleans side of the cantilever is similar in appearance to the suspended span. Four deck spans, one of 330-foot length and three of 267-foot length, complete the main bridge superstructure. The approaches are of steel trestle type, on wooden pile foundations.

The foundations under the main bridge provide one of the most interesting features of the work. The depth of the river here is as much as 75 feet below gulf level at the site of one of the piers. The river bottom is composed of alternate layers of sand, silt, clay, or mixtures of these materials, all of which are delta deposits of the Mississippi River. Using Professor Terzaghi's principles of soil mechanics, studies were made on samples of the materials brought up by the borings, and these studies revealed that the larger piers would reach a stable condition if carried to 170 feet below gulf level, resting finally in compact sand.

This considerable depth made desirable the use of open dredging well caissons for the foundations. This type of caisson has been used for the deepest bridge foundations on record. Consisting only of vertical cellular walls of steel, timber, concrete, or combinations of these materials, the bottom having a metal cutting edge, only skin friction limits the depth to which this type can be sunk. Since there is no working chamber under compressed air, the limit of about 110 feet in pneumatic caissons, fixed by the hazard of caisson-disease, is surpassed. As a general type, the open dredged caisson has, therefore, been recognized as most suitable for the deepest bridge foundations, and by 1915 had already been carried to a depth of 160 feet below low water in the piers of the Hardinge Bridge across the lower Ganges, and to a comparable depth in a bridge over the Atchafalaya River at Morgan City, Louisiana. More recently it was used with only slight modification in the foundations of a new bridge at Morgan City, where it was carried to a depth of 176.5 feet below water level; but here conditions were less hazardous than at New Orleans.

In the preparation of the New Orleans plans, open dredged caissons of the conventional type were designed for pier construction.

When bids were called for on these plans, conceived around the idea of the conventional method of sinking such open dredged caissons (which method depends largely on caisson weight to ensure even sinking), Siems-Helmers, Inc., who were bidding, proposed to use the sand island method of sinking, to ensure stability during the entire operation.

This sand island method is not new. Rather, there are historic examples of its use in Asia; but the revival of its use for important foundations has been only recent, dating from the construction of the foundations for the Suisun Bay Bridge of the Southern Pacific Railroad to California in 1929. The method consists of first building a cylindrical artificial island of sand to above the water level, thus creating artificial ground on which all future work can be carried out, the caisson being built in place on this island and sunk through it by stages.

WORK is begun at the pier site by sinking woven willow mattresses under a burden of rip-rap to the river bottom at the planned location of the pier. Following this, a circular ring of falsework piles is driven around the outline of the sand island. Within these piles large metal rings of more than a hundred feet in diameter are sunk one above the other by means of hoist frames mounted on the piles. Inside this built-up metal shell, which rests on the river bottom and rises to above high water level, sand is filled, also to above high water level.

The metal cutting edge is assembled and riveted together in the correct plan position on the top of this island, and removable forms are placed for the first lift of the reinforced concrete caisson walls above this. This lift, and all subsequent ones, are placed above water level, in the dry where they can be easily inspected. The concrete caisson walls thus built make up the outer shell and also outline the dredging wells. With the completion of the first lift, of say 20 feet height, excavation is carried on through the wells, and the caisson sinks under its own weight. When the top of this first lift has been lowered by the sinking to the elevation of the top of the sand island, work is begun on the next lift, and so on until the caisson has reached its planned depth. Then the seal course is placed with either bottom

Erecting steel for the superstructure of the main bridge. The quick incline down from extreme left is the roadway; the gradual incline is the railroad

dump buckets or tremie, and the caisson can be unwatered for future work if filling with concrete is intended; or left filled with water if it is only to be decked over as it is at New Orleans. The fact that all these operations take place within the artificial island of sand suggests the high degree of stability of the caisson during the entire process of sinking. Moreover, the extreme variation of river height during spring floods and subsequent low water can have no effect on the work, since the height of the artificial ground provided by the island is above these influences.

ACTUAL construction on the foundations of the New Orleans Bridge was begun early in 1933. The sand island method of caisson sinking has been since successfully applied to all of the river piers, numbered I to V. The remaining piers B, C, and D under the main bridge on the New Orleans side of the river are founded on piles, and the single main bridge pier A behind the levee on the other side of the river was founded in an open-dredged caisson sunk by the conventional method.

In the use of the sand island method at New Orleans, natural conditions created difficulties which had not been met before, but they were successfully overcome, and the last of the river piers was sealed during August, 1934. These difficulties were caused by the tendency of the foundation material to blow into the caisson during dredging. As a rule, it was found necessary to keep the weight of the concrete caisson as great as possible in order to follow closely the dredging operations, and to dredge out some of the overburden of sand in the outlying island in order to prevent a pressure blow-in of river sand from the outside. In the instances where such blows occurred, however, no lives were lost nor was any valuable equipment destroyed. All caissons were finally sunk accurately to their planned position and sealed in good sand.

After each caisson had been sealed with a tremie, the water in the timber cofferdam above the caisson top was pumped down to elevation −35. This was done to permit the pouring of the distributing block, and the decking over of the wells outside the distributing block in order to prevent the wells from gradually filling with silt borne down the river by the current. Since this unwatering placed a hydrostatic head on the seal, it offered a good test of the soundness of the concrete, in each case demonstrating that the seal was tight.

SOME of the details of operation on this completed river work are of interest. After the preliminary ring of falsework piles had been driven through the mattress at the site of a pier operation, 12 hoist frames were mounted on the circular platform provided above it, in order to lower the rings which constituted the steel shell periphery of the sand island. The diameters of the steel shells varied from 111 feet to 121 feet. In general, the steel rings were 10 feet high, those at the very bottom being only 5 feet and 2½ feet to reduce loss in case they could not afterward be salvaged. They were assembled in place, three 10-foot sections at a time, resting on needle beams spanning the false-work, and lowered from this position with the hoist frames. When a section had been lowered, the shell weight was again transferred to needle beams and another section assembled above it. Thus the shell was built up gradually, always supported from the top, until it rested on the mattress. The mattress was then cut through, the part inside the shell removed, and the sand island fill placed as explained above.

The sand for filling the islands was obtained by pumping sand off the river bottom with a high pressure pumping barge originally intended to be used when necessary to jet away obstructions to the caisson during sinking. Jetting was never actually found necessary during the work.

The floating concrete plant used on the river work contained two two-yard mixers, capable of producing 120 cubic yards of concrete an hour. This plant was fitted with the most modern mechanisms for weighing, batching, and measuring the materials, and produced excellent concrete. River water was used for mixing.

The river piers extend 145 feet above low water, the lower portions being faced with granite for protection against water action. To place concrete at the tops of the piers, a special tower derrick was built, consisting of two barges framed together, supporting a structural steel tower 100 feet high, having on top a stiff-leg derrick, and equipped with a hoisting engine and boiler plant.

BY the close of 1934, all substructure work had been completed, as well as the superstructure of both approaches. Only the superstructure of the main bridge remains to be completed, and this is in process of construction. This work on the main bridge steelwork began about the middle of March, 1934.

The main bridge superstructure is being erected by the balanced cantilever guy-derrick erection method. An adjustable erection bent is placed near pier I, and another near pier II, permitting steel to be erected in both directions from each of those two principal piers. The derricks move forward on skids on the stringers of the railway floor, erecting truss members ahead of them and turning around to fill in the other members behind them. On the cantilever, work proceeded inward from piers I and II toward the centerline of the suspended span. The two halves were joined on meeting in the center.

The bridge is owned jointly by the State of Louisiana, and by the City of New Orleans acting through the Public Belt Railroad Commission.

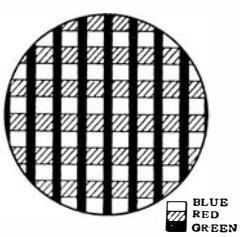
Contractors for the main bridge foundations were Siems-Helmers, Inc.; for the approach foundations, MacDonald Engineering Corporation; for the main bridge superstructure, American Bridge Company; for the approach superstructure, the McClintic-Marshall Corporation.

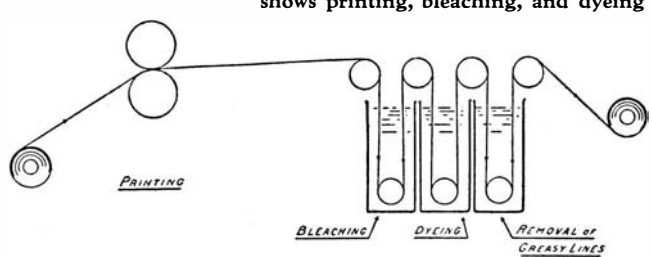
Modjeski, Masters and Case, Inc., of New York, Philadelphia, and Harrisburg, are the designing and supervising Engineers. Moran and Proctor were the Consultants of the Engineers on the main bridge foundations. C. Glennon Melville is the Engineer of Construction for Modjeski, Masters and Case, Inc.

Color Photography
For the Amateur

Dufaycolor . . . Uses Fine Three-Color Screen . . . Needs No Special Equipment

AMATEUR motion-picture film that photographs scenes in natural color, announced in the Scientific American Digest last month, has now been available to serious-minded photographers in the United States for several weeks, and has been giving excellent results. This film, known as Dufaycolor, may be used in any camera without expensive accessories, and may be shown with any projector. Another desirable feature is that, while the film which the photographer exposes in his camera is reversed in processing to give a positive for projection, any number of additional positives may be made by special equipment to be available soon. The color effect is obtained by the use of a three-color screen or "réseau" which is mechanically printed on one side of the film, and a special panchromatic emulsion over the réseau. Contrary to conventional practice, the film is loaded in the camera with the emulsion side away from the lens. Thus the light passes first through the film base, then through the réseau, and finally onto the emulsion.





Left: **The three-color réseau of Dufaycolor film, magnified.** ***Below:*** **Diagram shows printing, bleaching, and dyeing**

In the preparation of this film, the stock is processed by a highly accurate printing machine and a series of dye and bleaching baths, shown diagrammatically above. By applying first a dye, then a series of greasy, moisture-resisting lines, and bleaching the uncovered areas, and repeating these steps until the three-color screen is completed, the film stock is completely covered with a color réseau in which the edges of each dot (see small illustration above) are accurately aligned with those adjacent to it, yet there is no overlapping of colors, nor is there any space between the dots. Much of the success of this film is due to the design of the machinery used in processing; the screen system of color photography is not new, but by refined methods of production is now commercially practical for amateur or professional use.

It is obvious that with this screen on the film stock, all light reaching the emulsion will first pass through the screen and be filtered into its various components. The dots of the screen are each approximately 1/500 of an inch square and act both as filters for exposure and as a means of "putting the color back" in projection. The film is available for 16- and 35-millimeter work, and in the latter size is furnished for miniature cameras. Speed of the film is one half of standard black and white film.—*A. P. Peck.*

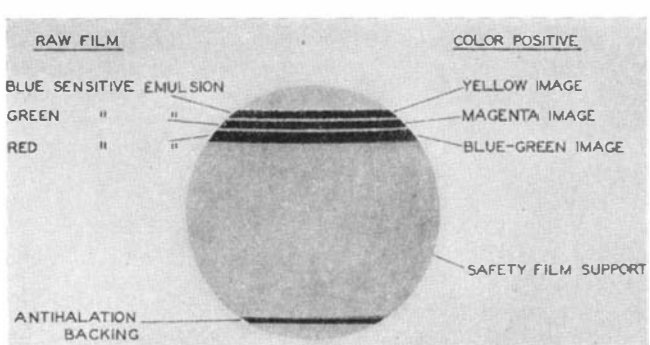
Kodachrome . . . Self-Contained Screenless Filters . . . Simplicity a Feature

ABOUT five years ago when Kodacolor was announced by Eastman, this remarkable advance in colored movies for the amateur was considered to be very nearly the ideal. With this process, however, it was necessary to use on the camera a special multiple color filter, and in projection a similar filter had to be used. In addition, the film itself had embossed upon it tiny lengthwise lenses so that the final projected picture had a linear "grain" which was objectionable. Thus Kodacolor did not follow the principle of simplicity laid down in the early days by Mr. Eastman.

For 16-millimeter motion pictures, this basic principle has now been attained in full through Kodachrome, just announced by the same company. This new film can be used in an ordinary 16-millimeter camera with no extra equipment and no adjustment except use of next larger stop. The finished film when projected shows true colors and tones without any sort of grain.

In the Kodachrome process, the film is coated five times, as shown in the accompanying diagram. Nearest the base there is a strongly red-sensitive emulsion. Over this is an extremely thin separating layer of gelatin containing some dye which acts as a filter. Above this is a green-sensitive emulsion followed by another separating layer. Finally, the top coat is blue-sensitive. Light from photographed objects is separated into its color components by the various coatings, the blue-green image being formed in the red-sensitive emulsion nearest the base, the magenta image in the middle layer, and the yellow in the top.

Processing of films will be done in Rochester until enough complicated processing machines can be built for it to be done at other strategic points. At the present time, the film is available only in 16-millimeter size but will probably be available later in 35 millimeter. No arrangement has been made to produce duplicates but no doubt this problem will soon be solved by the Eastman laboratories.



Cross-section of Kodachrome film, showing emulsions

Kodachrome is the invention of Leopold Mannes and Leo Godowsky, Jr., both of whom are well-known in the musical world. Their original conception was brought to fruition in collaboration with and under the able guidance of Dr. C. E. K. Mees, to whom much credit is due for this outstanding development.—*F. D. McHugh.*

HEAVY WATER

A New Hydrogen and a New Water . . . Chemical and Physical Properties Distinctly Different From those of Plain Hydrogen and Plain Water

By HAROLD C. UREY, Ph.D.
Professor of Chemistry, Columbia University

THE discovery of the isotope of hydrogen, the so-called "heavy hydrogen" or deuterium, and its successful separation from the light variety, has excited great interest in scientific circles. In order to understand this interest, it is necessary to review briefly some of the important rôles which hydrogen plays in the sciences of chemistry, physics, and biology.

Hydrogen is not the most abundant element on earth—that position goes to oxygen—but it is the one which is present in more chemical compounds than any other. Moreover, it is present in many of the objects which we meet in our scientific studies and every-day life.

Water consists of molecules, each of which contains one atom of oxygen and two of hydrogen, and being the most common liquid on the surface of the earth, is used most extensively in scientific work. A very large fraction of our chemical reactions which are studied in our scientific laboratories and used in industrial processes take place in the presence of water. On the other hand, since all living organisms live essentially in water, it is most important, from the standpoint of biology and in everyday life.

Moreover, the hydrogen atom is the simplest in its structure of all the atoms we know. It consists of but two particles, a heavy central positively charged particle, and a light negatively charged particle. Because of the simplicity of this atom, it has been possible to devise theories of its structure which can be checked exactly against the experimental properties, and this exact theory of the hydrogen atom has enabled us to understand in a less exact fashion the structure and properties of more complex atoms.

FOR these reasons, a new hydrogen, a new water, and all of the new chemical compounds containing hydrogen, make possible some very interesting studies in three of the major sciences. We have already secured a much better understanding of the details of chemical reactions involving hydrogen by using the heavy variety. Physicists also have made some very interesting experiments on the properties of heavy, positively charged particles of atoms, the so-called nuclei, by means of heavy hydrogen. Little has yet been done on the biological effects of heavy water, but such experiments also will probably be valuable in understanding more of living processes.

HOW important is heavy water likely to be in a practical way? The Science Advisory Board of the National Academy of Sciences and National Research Council, composed of K. T. Compton, Campbell, Bowman, Dunn, Jewett, Kettering, Leith, Merriam, and Millikan, makes the following pertinent comment in its Report: "A 'scoop' for American science was the discovery of the heavy isotope of hydrogen—hydrogen of twice the atomic weight of ordinary hydrogen. This opens up the possibility of forming an entire new group of hundreds of thousands of organic chemicals, with properties differing somewhat from those which are now known. This is a most interesting problem, whose technique is pretty well mapped out, which is of enormous extent, and which is practically certain to yield chemical compounds with valuable new properties—particularly in the field of drugs, medicines, and dyes." Thus heavy water will not be a laboratory plaything, and we venture the prediction that it will reach every reader's life in some practical way within five years. The article here presented is published in cooperation with the American Institute, New York organization of scientists.—*The Editor.*

Until about 1911, it was generally supposed that all of the atoms of each element were exactly identical. At that time we knew that they consisted of a positively charged heavy central nucleus and a number of electrons carrying negative charges moving in some fashion about this nucleus. It was assumed that the masses of these particles were the same for all atoms, and that the number of charges was the same. However, a study of radioactive elements showed that two varieties of atoms of a single element, differing only in mass from each other, the electrical charges throughout being the same for the two atoms, certainly existed, and it was found that two such atoms had precisely the same chemical properties. They formed compounds of the same kind, and it was impossible to separate these two atoms by the usual methods which are used in chemistry for the separation of elements. Two such atoms were referred to as isotopes.

Later, by deflecting charged atoms in electric and magnetic fields, Sir J. J. Thomson showed that the element neon consisted of two varieties of atoms, the one variety having a mass of 20 units and the other a mass of 22 units, using the mass of the oxygen atom as equal to 16 units. Following this, studies by Aston, using a similar method of investigation, have shown that a large number of our chemical elements consist of mixtures of atomic species differing in mass. The element tin consists of 11 such varieties; the element sodium has but one; and the element chlorine two, and so on. The methods which these men used were able to detect an isotope if it were present to the extent of about one percent of the total number of atoms.

ANOTHER method which has been used in recent years for the detection of isotopes is the method of molecular spectra. The wavelengths of light emitted by molecules depend upon the masses of two atoms in the molecule, and the theory is sufficiently well developed so that it was possible to predict exactly what the effect of mass on the spectrum should be. By the use of molecular spectra, oxygen was shown to consist of three isotopes having masses 16, 17, and 18; carbon of two, whose masses are 12 and 13; nitrogen of two, whose masses are 14 and 15. In this way it was possible to detect the presence of an isotope which constituted only about one part in 1000 of the total number of atoms.

Indications that there should be an isotope of hydrogen came from the de-

termination of mass of the hydrogen atom by two different methods. The one method depends upon the average mass of the two hydrogen atoms in their proportions in natural hydrogen, and the other determines the mass of the light one only. When reduced to the same standard of mass, these two results disagreed, and the difference, as pointed out by Birge and Menzel, could be understood if there were one part of a hydrogen atom of mass 2 in 4500 of hydrogen atoms of mass 1. This indicated that if the hydrogen isotope were present in natural hydrogen, it must be so rare that none of the methods used for its detection would be successful. Some other method of attack on the problem was necessary.

A THEORY of the solid state proposed many years ago by Debye made it possible for us to calculate the difference in boiling points of hydrogen and deuterium, and this calculation showed that their boiling points differed by appreciable amounts, and that they should be separable by distillation, much in the same way that water and alcohol are commonly separated.

A special method of detecting this isotope was required, for the deflection of charged atoms in magnetic and electric fields could not be used for the detection of the hydrogen isotope, since its abundance even in the prepared samples would be too low. The method of molecular spectra also could not be used, for the spectrum of hydrogen gas is particularly difficult to analyze. In 1913 Bohr showed that the wavelengths of light emitted by hydrogen atoms should depend on the masses of these atoms, and his theory gave a quantitative relation between these masses and these wavelengths so that this method could be used in the case of the hydrogen isotopes, though it cannot be used in the case of other atoms. The spectrum of hydrogen in the visible region consists of four wavelengths lying in the red, the blue-green, and two in the violet. Calculations using Bohr's theory showed that the wavelengths of the light emitted from the deuterium should be displayed toward the violet side of these lines by about 1.8, 1.3, 1.17, and 1.08 Angstroms for these four wavelengths respectively. We found that these wavelengths were present both in ordinary hydrogen and also in the concentrated sample, thus proving the existence of the heavy isotope.

The method of distillation of liquid hydrogen for separating the two isotopes of hydrogen would be a long and expensive process, and much of the interest in this problem has come as a result of the discovery by Dr. E. W. Washburn of the Bureau of Standards of the electrolytic method for separating the hydrogen isotopes. In the industrial production of hydrogen and oxygen for use in oxy-hydrogen blowtorches and other purposes, a large nickel cell is used, containing two electrodes which are separated from each other by an asbestos diaphragm. When the current flows through a potassium hydroxide solution in the cell, hydrogen is formed at the one electrode and oxygen at the other. The hydrogen gas which escapes from the cell contains about one-quarter to one-sixth as much deuterium as the water in the cell. As a result, the heavy isotope increases in concentration in the residual solution of the cell.

Professor Urey, who has just been awarded the Nobel Chemistry Prize for his discovery of heavy hydrogen

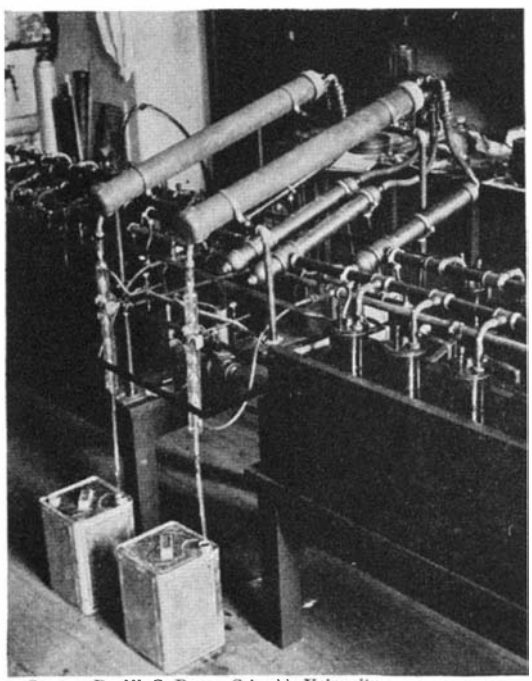
As a result of this, the liquor in these electrolytic cells contains about 1 part in 1200 of deuterium, so that the concentration of deuterium in perhaps 100,000 gallons of water in this country is already as high as that which Dr. Brickwedde was able to produce by the distillation of hydrogen. By modifying this method, it is possible to prepare pure heavy water, which is now being done in quite a number of laboratories in this country and abroad. Professor G. N. Lewis of the University of California was the first to secure it in a highly concentrated form. The cost of this heavy water is now about 75,000 dollars a gallon.

In science, we are constantly attempting to rationalize our observations and experiments by means of theories, the theories being really only exact methods of describing the observed phenomena. Throughout all our chemical theories, the masses of the atoms play an important part. Our kinetic theory of gases, for example, states that the number of collisions between the molecules of a gas is inversely proportional to the square root of their masses; and the velocities with which chemical reactions proceed also depend upon the masses of the atoms concerned. Many other considerations enter into such theories, but this is always one important constant. Up to this year, we have never been able to determine directly whether the theory and experiment agree, for, if we worked with atoms of different elements, their characteristics changed in other ways in addition to the mass. Only with the separation of the two hydrogen isotopes were we able to attack this problem directly. We can now test the theories dealing with the velocities of chemical reactions, the thermodynamic properties of substances, and other similar phenomena by using the two varieties of hydrogen. The ratio of masses is conveniently large, so that comparatively large effects are to be expected.

Early in 1932, Dr. Rittenberg and I made some calculations on the equilibrium constants of certain chemical reactions involving hydrogen, chlorine, and iodine. Thus, if hydrogen iodide gas, whose molecules consist of one atom of hydrogen joined to one atom of iodine, is heated to 300 or 400 degrees, Centigrade, the gas partially dissociates into hydrogen gas and iodine gas, so that only about 20-25 percent of iodine remains in the form of hydrogen iodide. Our calculations show that the percent dissociation of hydrogen iodide should depend upon whether the light or the heavy hydrogen was used. The differences to be expected were rather small—of the order of magnitude of a few percent. During the past year, we have checked the predictions of the theory, and have secured exact agreement between them. Other examples have been observed. Thus we find that the chemical properties of the two hydrogens are different by measurable amounts, and in fact, they are so different that, had the two hydrogens been present in natural hydrogen in approximately equal amounts, the variation in the chemical properties of hydrogen could not possibly have been overlooked and would have been evident from the

beginnings of scientific chemistry.

The physical properties of the two hydrogens and their compounds are also distinctly different. First of all, the melting points of the two hydrogens differ by about 4.7 degrees, Centigrade, which is a very large percent change, for the melting points are 13.9 and 18.6 degrees above absolute zero. Moreover, the melting points of the light and heavy water differ by 3.8 degrees, Centigrade, and the boiling points by 1.4 degrees. Other physical properties differ for the two compounds of the light and heavy hydrogen respectively. The refractive indices, surface tension, melting points, boiling points, densities, viscosities, and so forth, may all be different. All these differences must be due just to the change in the mass of these atoms, and though none of them can be said to be clearly understood at the present time, the deuterium and its compounds enable us to make a much better attack on the problem.



Courtesy Dr. W. G. Brown, Columbia University

Apparatus for obtaining heavy water by the electrolytic method described in the text

DURING recent years, we have made extensive studies on the velocities of chemical reactions in water solutions, particularly, and also in the gaseous state. The theory of these reactions is in a fair state of development, but the effect of mass on such phenomena will certainly be clarified by a study of reactions in which deuterium and its compounds replace hydrogen and its compounds. For example, we have found that the velocity of reaction between the light water and aluminum carbide to form methane is about 23 times as great as the reaction between heavy water and aluminum carbide to give the heavy methane. This is really an enormous difference, and very easily measured. Such studies give us a grasp on reaction kinetics quite beyond our dreams of a few years ago.

The biological interest of the heavy water can hardly be overemphasized, since all living things live essentially in a water solution. Up to the present time, experiments, particularly by G. N. Lewis and H. S. Taylor and their coworkers, indicate that animals die when placed in deuterium of high concentration, though they are able to live in the 30 percent water. The evidence in regard to plants is more contradictory. Professor Lewis finds that tobacco seeds do not sprout in deuterium oxide, while Dr. Chessley and Dr. Suguira find that wheat seeds do sprout in such water. In other cases that have been investigated, certain fluorescent bacteria do not give out their fluorescent light in the presence of heavy water, while other varieties continue to emit light. It is my own expectation that both animals and plants can be acclimatized to high concentrations of heavy water, but that probably their living processes will be much slower.

The medicinal effects have often been mentioned, but mostly without adequate foundation. Experiments made on the effects of deuterium on cancer seem to indicate that there is little difference in the behavior of such tissue in the presence of either light or heavy water. The contribution which deuterium will make to medicine will be through a better understanding of the fundamentals of living processes rather than through its use as a medicine directly. By its use we can follow the course of food, for example, through the body. We feed the animal a food containing heavy hydrogen, and then watch for the heavy hydrogen in various parts of the body.

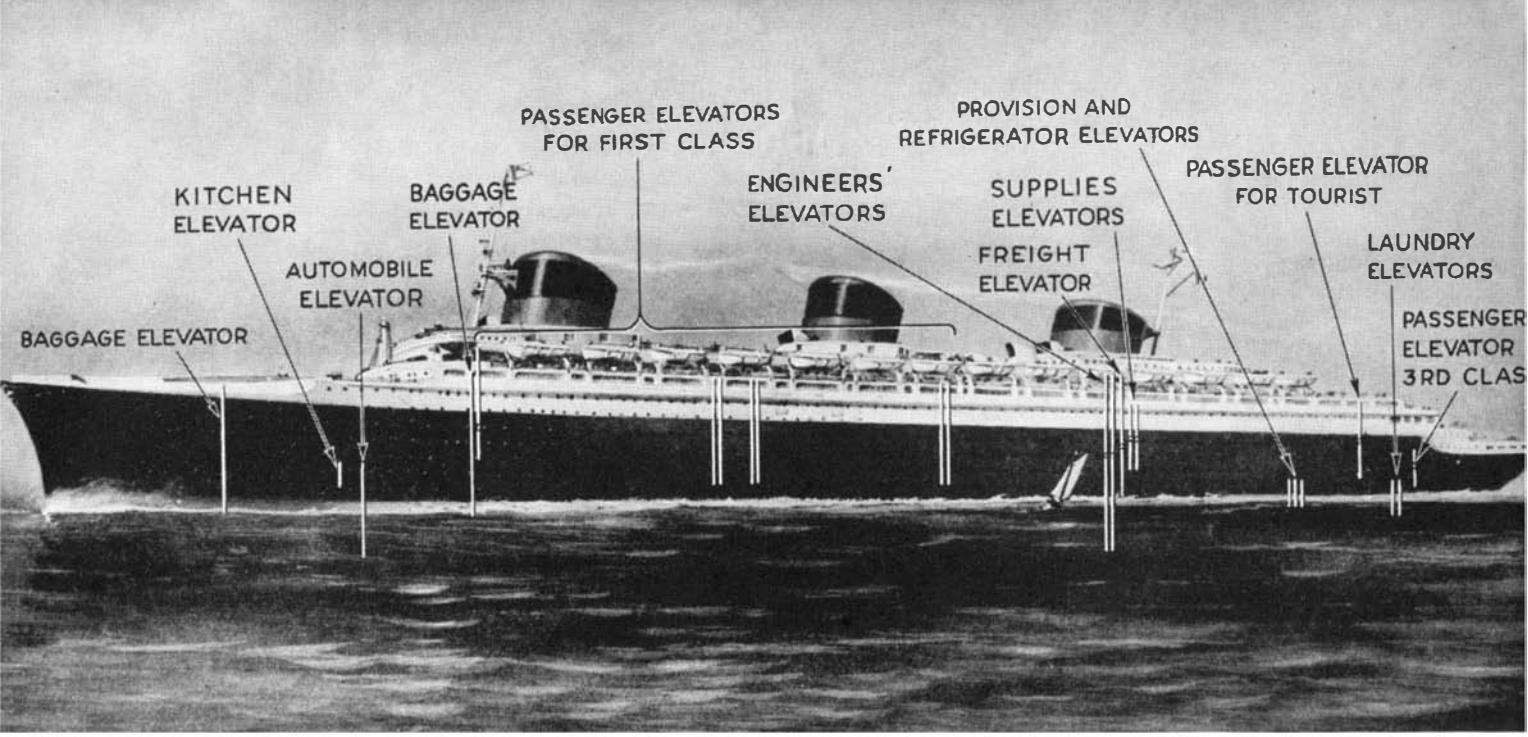
The nucleus of the deuterium atom is at present one of the most delightful playthings for physicists. In recent years, we have learned to transmute the elements one into another. This is accomplished by bombarding these atoms with very high speed particles, using the high-voltage machines which have been developed particularly by Lawrence, Lauritsen, Tuve and van der Graaff in this country, and by Rutherford and his associates in England. The particles which have been used in the past are the proton, which is the nucleus of the hydrogen atom, and the alpha-particle, which is the nucleus of the helium atom.

Recently, we have discovered the neutron, which is an uncharged particle of small dimensions having a mass nearly equal to that of the proton, and the deuteron or nucleus of the deuterium atom. The most intense source so far known for the neutrons is secured by bombarding beryllium with the deuterium nuclei.

As a result of such bombardment, lithium is converted by helium, and beryllium, boron, carbon and nitrogen are converted into other elements. One of the most interesting of these is that observed by Rutherford in England, and by Professor Ladenberg and his colleagues at Princeton. They bombarded deuterium atoms with the deuterium nucleus and succeeded in producing a hydrogen atom of atomic weight 1 and another hydrogen atom of atomic weight 3. This still heavier variety of hydrogen of atomic weight 3 has also been observed to be present in natural hydrogen to the extent of about 1 part in 10 billion. Its separation from the light hydrogen would involve an enormous expenditure of effort and if it could be separated, would cost millions of times the cost of the hydrogen of atomic weight 2. In these processes large amounts of energy are liberated in the individual process. The over-all consumption of energy is much greater than that produced, however.

One problem which challenges physicists particularly at the present time is the structure of the atomic nucleus. We understand fairly well the structure of the electronic atmosphere of atoms, that is, the outside structure, but the structure of this minute central sun of the atom is quite unknown at the present time. In unraveling this structure of the nucleus, the deuterium nucleus, or deuteron, will certainly play an important part. It is the simplest nucleus except the nucleus of the light hydrogen atom, and it is supposed at the present time that it consists of two particles. Just as the hydrogen atom enabled us to develop an exact theory for that atom, and to understand in a less exact fashion the structure of other atoms, so we may expect that the deuteron will enable us to make an exact theory for it, and a less exact one for other atomic nuclei.

I HAVE indicated some of the uses for heavy hydrogen. In the past the uses for it multiplied so rapidly in the hands of a host of research workers that I think it was quite impossible for any of us to foresee at the time of the discovery the many uses to which this atom could be put in research work. I think probably that the developments of the future will also be beyond the few indications which I have given.



Location and shaft lengths of the many different types of elevators aboard the *Normandie*

SEA-GOING ELEVATORS

World's Largest Liner Has 23 Elevators Especially Designed for Ocean Operation

THE new world's largest liner *Normandie*, which was built by the French Line and is now on her maiden voyage, is more than a great merchant vessel. She is a self-contained city with a potential population of 3500. This luxurious "city-structure" of 14 stories has, in addition to modern plumbing, lighting, telephones, radio broadcasting, fire and police systems, the most complete elevator service of any ship afloat. There are, to be exact, 23 elevators—for passengers and freight, for storerooms and kitchens, and even for motor cars which passengers may carry with them to Europe.

Elevators in buildings are comparatively simple because a building maintains a vertical position. At sea the elevator problem becomes more difficult because of the pitching and rolling of ships, and further because of constant exposure to the corrosive action of salt air.

Ship elevators, therefore, are designed especially for sea-going service. The automatic electric switches of those on the *Normandie* will not swing with the motion of the ship and thus operate elevators prematurely; the machinery will not spill oil; and the electric cables beneath cars are confined in a protective sheath to discourage any tendency to whip around equipment in the hoistway. Safety devices are provided on the cars for the protection of the passengers—and on the counterweight for the protection of the ship and those members of the crew who may be stationed below the elevator's lowest landing.

To combat corrosion, all elevator parts are treated in accordance with the most rigid shipboard practice. All exposed metal surfaces are painted with red lead, and electrical equipment is coated with a special water-resistant varnish. Vital operating parts of the safety devices are rust-proofed to allow free motion at all times, and lead and armored-cable construction is used for electric wiring. Eleven of the elevators are for passengers and 12 are used to carry provisions, baggage, laundry, and so on. Fifteen of the total were manufactured and installed by Ateliers Otis Pifre, the French affiliate of the Otis Elevator Company.

FIRST class passengers have seven elevators at their disposal, four of these having a capacity of 4000 pounds each, or approximately 25 persons and being automatic, self-leveling, Otis machines. By means of these, first class passengers may reach A, B, C, and D decks, the promenade deck on which are smoking rooms, theater, winter garden, staterooms, and so on, and the main deck on which there are shops, a library, and staterooms.

Tourist class passengers have a single elevator aft which serves their section of the ship from the promenade deck down to E deck. This section of the ship contains, besides cabins and dining room, a children's playroom, a covered promenade, and a room for mechanotherapy.

Third class passengers have a single passenger elevator aft, near the stern, which serves from B deck down to F deck. Engineers and machinists have two elevators; the laundry is served by three; and other ship services are supplied by elevators, built to their needs, as shown in the diagram above which was especially prepared for use with this article.

Of particular interest is the automobile elevator which is provided in the forward part of the ship to carry automobiles from E deck down to the hold of the ship. A passageway is provided in each side of the elevator on E deck so that automobiles may be driven aboard from either side. Entrance is gained through a large hatch which opens at the side of the ship. By means of a gangway or a special dock elevator, automobiles are conveyed from the dock to E deck. By this special arrangement automobiles may be driven aboard and will no longer be hoisted on board by cable as has been the custom in the past. This special elevator carries the automobiles down to decks H and G and the hold. A special turn-table feature is provided on this elevator which permits the automobile to be swung to an angle of 90 degrees before leaving the elevator. As the hold is narrow in the bow, this greatly facilitates the storing of the automobiles.

THRILLS FROM A HOME-MADE POLARIZER

By PHILIP R. TARR

(In Two Parts. Part 2)

AS you will observe, when looking through the polarizing microscope described last month, the field becomes alternately light or dark for each consecutive 90 degrees as the analyzer is rotated. Except for the small amount of scattered light seen in the dark field position, and the slight, almost imperceptible distortion, the apparatus is as useful as one made of the more expensive Nicol prisms.

If you wish to improve the analyzer slightly, a better grade of glass may be obtained from a photographic manufacturer, in which case the grade of glass used for making photographic filters, known as "flat, optical glass," should be ordered. The price of this glass will be considerably higher than for ordinary lantern slide glass mentioned last month.

Adjust the analyzer for dark field and place upon the stage a thin piece of mica, such as may be obtained from a hardware store for use in oven door windows. The field immediately becomes light, and if the mica is of the proper thickness, beautiful colors are obtained, ranging from green or yellow to magenta. This color may be changed by rotating the analyzer.

If the color is not found to be present, the mica plate is probably too thick and a few layers should be removed. This may be done by splitting the edges with a small sharp needle, removing only a few plies at a time until the colors are obtained.

AS a further experiment, bevel the edge of the mica plate with a sharp razor blade, so that the beveled portion is at least one-sixteenth inch wide. Examine this edge while rotating the analyzer. A multitude of beautiful colors will be seen, arranged in rainbow fashion but many times more brilliant than a rainbow and ever changing as the analyzer is turned.

After adjusting the mica plate so as to obtain colors, it should be bound with paper tape (as in Figure 4, last month's installment) and retained as a part of the equipment. By placing this plate just below the stage (Figure 6), or between the stage and black mirrors (Figure 7), many of the otherwise plain effects will be shown in varied colors. When examining crystals the mica plate may be used to produce beautiful colored backgrounds, and at the same time for varying the crystal color patterns.

Crystals producing color belong to the class of double refracting materials. Others simply appearing as seemingly luminous crystals on a dark background may also belong to this class, but transmit a limited amount of one of the polarized rays to the analyzer, with the result that few or no colors are produced. Often a slight fringe of color may be seen around the edges and very thinnest portions of such crystals.

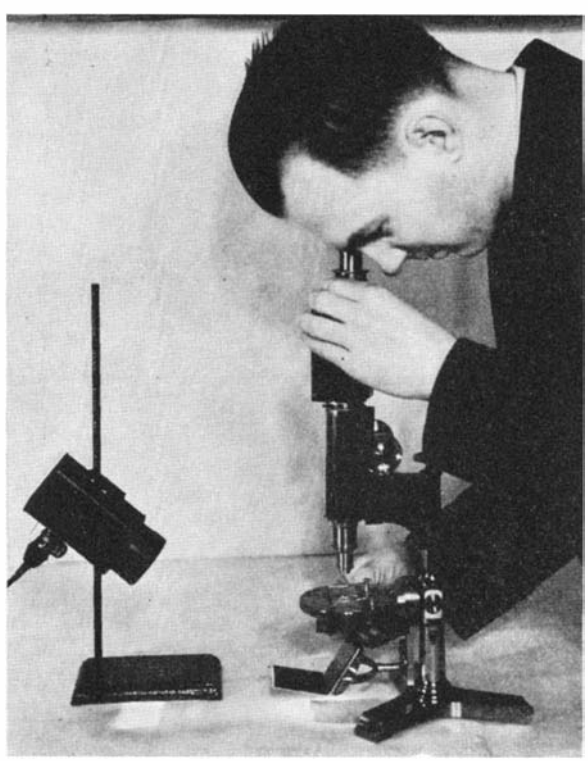


Figure 6: **The polarizing apparatus in use. Mica plate is being held below the microscope stage**

Crystals of the cubical system have no polarizing effect and therefore appear only as shadowy forms on the field.

Quite frequently improperly prepared or dulled surface crystals of double refracting materials may appear to belong to the cubical system. When this condition is suspected, the addition of a few drops of water to the crystals while examining them will show whether or not this is the case. If the crystals are double refracting they will immediately appear as such when their surface is wetted.

In most cases it is relatively easy to prepare chemical crystals for either permanent or temporary mounting. A great many chemicals will crystallize in beautiful forms from water or other solutions. The same chemicals will often give forms in dilute solutions different from those obtained from stronger solutions. Ordinarily a few drops of dilute solution may be placed on a clean slide and set aside in a cool place for a few hours. The best results are obtained when the slide is cleaned thoroughly with the cleaning solution mentioned last month, so that the chemical solution spreads out, preventing an otherwise concentrated mass of crystals. In other cases crystallization may be speeded up by gently applying heat to the slide. Few chemicals produce the best crystals by this method, however, and slow crystal growth is preferable.

POTASSIUM dichromate, potassium chlorate, potassium oxalate, oxalic acid, copper chloride, copper sulfate, nickel ammonium sulfate (one of the most beautiful crystals formed), cobalt chloride, and innumerable other such chemicals may be crystallized in this manner.

Other chemicals may be prepared by melting a small amount on a glass slide and allowing to cool slowly. Salicin, menthol, sulfanol, and others may be treated in this manner, but are preferably dissolved and crystallized from their respective solutions in liquid.

Materials such as starch, plant sections, and some crystals are most beautiful when mounted in Canada balsam. It is a good plan to try the balsam mounting in all cases, since crystals are quite often more brilliant when embedded in this medium.

A most beautiful sight may be seen by preparing a slide containing a solution of nickel ammonium sulfate and patiently watching it under the microscope until crystal growth begins. The thrill of seeing crystal growth with po-

Experiments that are Beautiful but Equally Practical . . . Many Useful Applications in the Industries . . . Examining Structural Models

larized light, especially against a dark field, undoubtedly constitutes one of the "ultimate thrills of the microscope."

Many useful applications of polarized light have been made in industry, such as measuring the concentration of sugar solutions, the analysis of stresses in various machine parts and beams, and the study of liquid flow around various shapes. Measurement of the concentration of sugar solutions is based on the fact that the plane of polarization of light transmitted through the solution is rotated, and the amount of rotation is a function of the concentration. This cannot be shown with an ordinary microscope, since a fairly great depth of solution is required. A special instrument known as the "sacchrinometer" is used for this purpose.

STRESS examination in structural parts is shown in the accompanying illustrations of two small Celluloid angles (Figure 8), one with a rounded, smooth corner, the other with a sharp, square corner. The small areas enclosed within the circles should be placed in the field of vision under the microscope, and by clamping one leg to the stage as shown in Figure 7, the corners may be stressed by pressing inward on the free end. The effects are shown plainly in Figure 9. Notice that the sharp-cornered angle is very brilliant when seen against a dark field, while the smooth, rounded corner is only slightly luminous; and further, that the illuminated area is more evenly distributed. These lighted areas bear an almost direct relationship to the amount of stress, and show clearly that rounded corners distribute stress, whereas sharp corners concentrate the same stress in small areas.

In actual practice the stress in variously shaped machine parts is studied by making scale reproductions of the part under investigation in Celluloid and studying the effects under polarized light. Gear teeth shapes, beam shapes, structural frames, and many other such subjects are studied by this method. [This was described in SCIENTIFIC AMERICAN, November 1932, pages 280-283; "Looking at Stresses," by Prof. M. M. Frocht.—*Ed.*]

Another easily prepared illustration of stress may be obtained by clamping

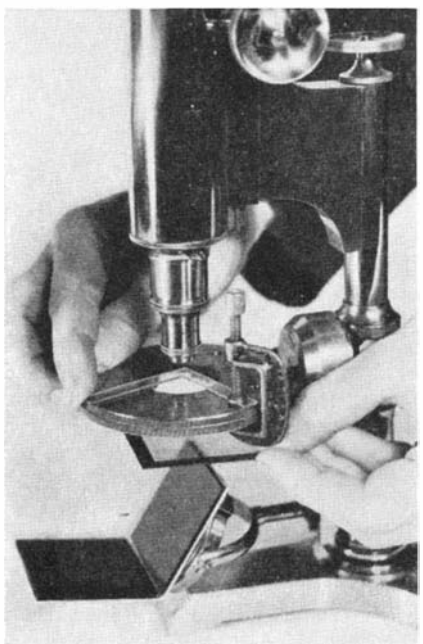


Figure 7: **Mica plate held lower than in Figure 6. A Celluloid angle being examined for corner stresses**

a small glass plate between the jaws of a small clamp or calipers, as shown in Figure 10. When either point of contact between clamp and glass is viewed with the analyzer set for dark field, the effect shown will be seen. Notice how the clamp jaw is attempting to push a wedge-shaped area of glass away from it, which is consequently being held back by similar wedge-shaped areas on either side. The two dark areas between the three wedges are holding all three together at the same time. These dark areas are "between two fires," so to speak, and since they are holding together three parts of a body, two of which are being stressed in one direction and one in the opposite direction, they are said to be "in shear stress."

The effect of stress as shown in the illustrations is produced because singly refractive materials, such as glass and Celluloid, often become doubly refractive when compressed. By placing the

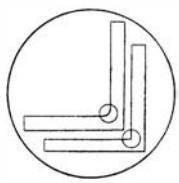


Figure 8: **The two angles of Celluloid employed in the experiment**

mica plate below the stage the stress effects will be seen in varied patterns of color.

THE flow of liquids around variously shaped objects, such as experimental boat hulls, has been studied with polarized light in a most interesting manner. A water canal with glass sides is placed between a large illuminated polarizer and analyzer. The canal is connected to large pumps which circulate the water at the desired speed. The scale models of sections or other objects are then arranged in the water on wires, so as to be held within the field of vision of the polarizing apparatus. So far, not a thing can be seen, other than the usual light and dark fields. However, with the field adjusted to the dark position, a regulated amount of oil having a certain refractive power is introduced into the water canal and immediately things begin to happen. Each small particle of oil produces a luminous path showing every minute eddy and current around the object.

Editor's note: So far as we know, there is no general treatise on polarized light, of a suitable nature to recommend to the amateur as a theoretical and practical guide. All physics textbooks explain polarized light, of course, and such books as Edser's "Light for Students," and Houston's "Treatise on Light" contain chapters on its theory. The author of the above article recommends Thorpe's "Dictionary of Applied Chemistry," and Clark's "Practical Methods in Microscopy."

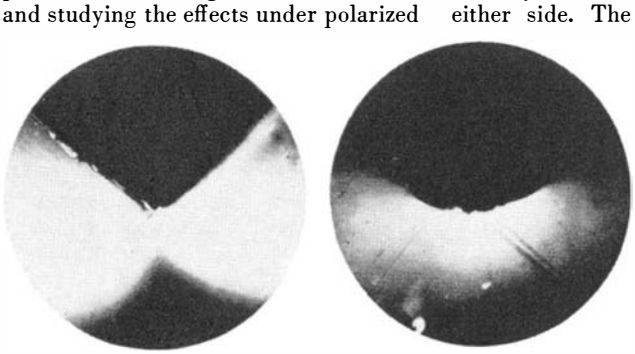


Figure 9: **Stresses exhibited at the corners of the two angles shown in Figure 8. The rounded one is the one at right**

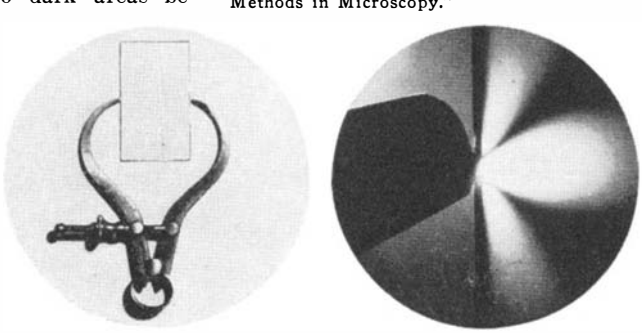


Figure 10: Left, **Glass plate under localized stress.** *Right:* **The stresses at one of the (magnified) jaws. See the text**

Did Man Exist in the Miocene Epoch?

By J. REID MOIR
Fellow of the Royal Anthropological Institute,
Member of L'Institut International D'Anthropologie

IT IS now some 25 years since the first flint implements were found in a deposit of the Pliocene Epoch in Suffolk, England. In those days it was generally believed, with an almost dogmatic intensity, that the earliest human beings had only appeared on this earth at a much later epoch, and the announcement of the discoveries in Suffolk was the signal for the waging of a fierce scientific battle, which continued with increasing violence for many years, and has only recently come to an end. At long last, the majority of competent investigators who have examined the specimens excavated from the Pliocene deposit of Suffolk are agreed that they represent the work of man, and with this acceptance the first stage in the fight for the recognition of the greater antiquity of man may be said to have terminated.

The Suffolk Bone Bed, as it is called, in which the Pliocene works of man have been discovered, is clearly from the nature of its contents formed largely of the remains of an ancient land surface which existed in eastern England for a very prolonged period prior to the submergence of that area beneath the sea which laid down the shelly sands, called the Red Crag, which overlie the Suffolk Bone Bed. We know that this land surface must have been present for a greatly extended epoch of time, because in the Bone Bed are found the remains of certain terrestrial mammals which by their types can be referred with confidence to the Miocene Epoch, while others are to be relegated to phases of the Pliocene. The Suffolk Bone Bed was laid down toward the close of the latter epoch, and thus we can say that the flint and bone implements in this deposit cannot be later in date than the Pliocene.

But recent examination of the large series of specimens now available for study has shown that we are not dealing with implements of only one kind and period in the Suffolk Bone Bed. This examination has, in fact, made it clear that at least four distinct groups of artifacts occur in this deposit, and that these were made by successive races of men who inhabited eastern England before the marine beds of the Red Crag were laid down.

TO attempt to explain what happened in the remote past in this part of the world, it is necessary to imagine our present land surface with its various deposits containing relics of man, together with the material evidences of our modern culture, being by some process destroyed and finally swept by marine action into a widespread residual accumulation. In such a deposit would lie, cheek by jowl, artifacts of very different kinds and antiquity. The manner in which the Suffolk Bone Bed might have been formed is shown in Figure 1, where the Red Crag Sea is supposed to be encroaching upon a slowly sinking land surface composed of early Pliocene and Miocene deposits. As the land surface was eroded by marine action a shore-line accumulation would be formed by slow degrees, in which would be incorporated flint implements and mammalian remains embedded in the deposits attacked by the sea, and those lying upon the land surface.

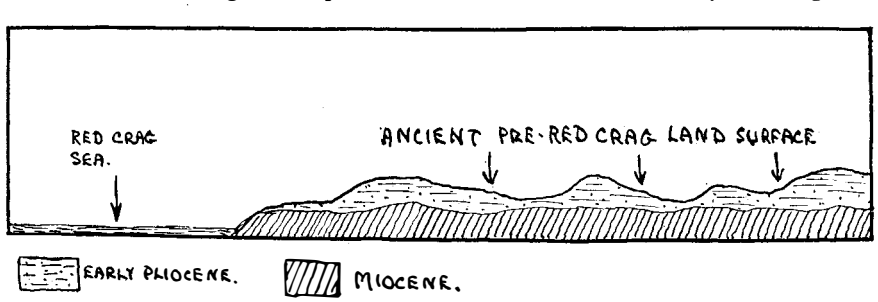


Figure 1: **Diagram showing the ancient land surface of eastern England in process of submergence by the Red Crag Sea. The encroachment was gradual**

For a considerable time after the first announcement was made of the discovery of Pliocene flint implements it was necessary, in view of the opposition to this claim, to concentrate upon the primary task of establishing the fact that these specimens had been humanly flaked. This led to the carrying out of a prolonged series of experiments in the natural and artificial fracture of flint, and threw much light upon an hitherto obscure problem. But the further critical examination and classification of the Pliocene artifacts of eastern England which it has now been possible to undertake, is leading to certain unexpected and far-reaching conclusions regarding the antiquity of the specimens, and it is my purpose briefly to set forth these conclusions here.

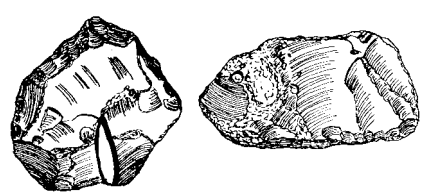


Figure 2: Left. **Primitive implement**
Figure 3: Right. **A rostro-carinate**

IT will be realized that it is by no means an easy task to decide as to the relative age of the flint implements assembled in the Suffolk Bone Bed. In the case of the remains of terrestrial mammals, the paleontologist can sort them out according to their various types, and by means of acquired knowledge assign them to the Miocene and early Pliocene Epochs. But, in dealing with the flint artifacts, no such acquired knowledge is available. It is not known, by other discoveries in different parts of the world as it is with the mammalian remains, that a certain type of primitive flint implement found in the Late Pliocene bed of East Anglia in a derived state occurs elsewhere in an Early Pliocene or Miocene accumulation under conditions which make it prob-

able that such specimens were in use in either of those epochs.

It becomes necessary, therefore, to approach this problem from another angle, and to endeavor, by an examination of the types, patination, and condition of the Suffolk Bone Bed specimens, to form a judgment as to their relative antiquity. As is known, the somewhat unsatisfactory term "patination," as applied to the flaked surfaces of a flint, refers to the changes in color and texture which, so far as we know, are brought about by some process at present not satisfactorily explained, operating over a considerable period of time.

When the Pliocene implements of eastern England are examined it is seen that among them are numerous examples which exhibit, on one and the same specimen, flaking of one or more periods, and that the patination of these non-contemporaneous flake-scars exhibits a markedly different coloration. A similar state of affairs is, of course, well known among flint implements of later ages, and testifies to the fact that ancient man, when he sometimes found a specimen made in the past, and already patinated, proceeded to re-flake it to suit his own purposes.

IT IS also apparent, in the case of the Pliocene implements, that the four types of patination represented upon the reflaked specimens can be precisely matched by that to be observed upon a series of artifacts which are each different in their forms and condition. Thus, for example, the oldest implements are thick and coarsely flaked, exhibit a peculiarly archaic washed-out yellow color, and have evidently been subjected to very considerable striation and abrasion. The latest specimens, on the other hand, are usually white or light blue in color, are little if at all abraded,

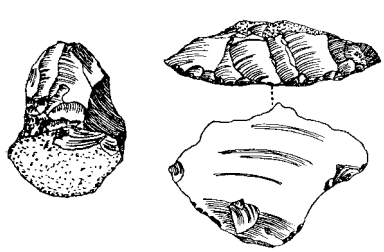


Figure 4: Left. **Primitive hand axe**
Figure 5: Right. **A side scraper**

and are not thick and coarsely flaked. This can easily be recognized by an examination of the illustrations accompanying this article. Those referable to Group 1 (Figures 2 and 3) in which rostro-carinates, or beak-shaped implements occur, are clearly to be distinguished from Group 2 (Figures 4 and 5), in which, as in Group 3, a primitive hand-axe has appeared, while Group 3 (Figures 6 and 7) appears to be distinct from the two preceding groups, and from Group 4 (Figures 8 and 9).

There cannot, in fact, be much doubt that in these various groups of Pliocene implements we see a gradual improvement in technique, and this fact, together with the evidence afforded by the differing patinations, makes it reasonable to conclude that we are dealing with four "industries," the development of which must have occupied a considerable space of time. There appears, indeed, to be as much divergence in the matters mentioned between Group 1 and Group 4 of the pre-Red Crag implements as there is, for example, between the Early Chellean and Late Acheulean hand-axes of paleolithic times, and it may well be that the gap in time between Group 1 and Group 4 of the Pliocene industries is actually greater than that separating the paleolithic industries already mentioned above.

We see, therefore, that although these Pliocene implements are now found as a residual deposit, laid down

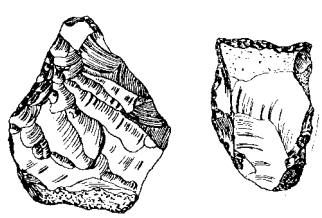


Figure 6: Left. **Primitive hand axe**
Figure 7: Right. **Square scraper**

toward the close of this epoch, they nevertheless extend backward to periods long prior to that in which the Suffolk Bone Bed was accumulated. Is it possible more accurately to define these periods? Among the large series of specimens recovered from the Suffolk Bone Bed is a rostro-carinate which appears to be of much significance, for it has attached to various parts of its surfaces patches of material which, so far as a very careful visual examination goes, is completely indistinguishable from what is known as Diestian sandstone.

The Diestian deposit, which occurs in Belgium, and at one time existed in Eastern England, is represented in the Suffolk Bone Bed by rolled lumps which, when broken open, often contain the casts of shells and other objects. The tooth of a mastodon was found many years ago embedded in this characteristic material, and its discovery showed that this creature existed prior to the Diestian period of Lower Pliocene times. In the same way the maker of the rostro-carinate implement mentioned must, if my conclusions are correct, have lived prior to the Diestian epoch. Moreover, the patination of the flake-scars of this specimen is precisely similar to that to be observed upon others which are clearly later in date than Group 1 of the pre-Red Crag implements.

It would seem necessary, therefore, to relegate the Group 1 specimens to some period still further anterior to the Diestian epoch than is the rostro-carinate to which reference has been made. If these conclusions are found to be sound, they give us much additional information upon the question of

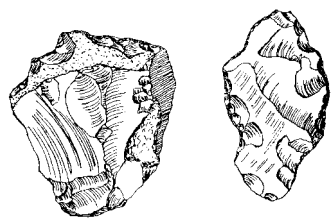


Figure 8: Left. **Scraper, Pliocene**
Figure 9: Right. **A side scraper**

the antiquity of man. We have seen that there is reason to believe that well-made rostro-carinates and other implements were being made at least as early as Lower Pliocene times, perhaps upward of a million years ago. But, while this is the case, it seems obvious that, old as these works of man are, their forms and flaking are not such as we would associate with the first efforts of emerging human beings to shape flint intentionally.

The specimens of Group 1 are in many cases of eolithic types, such as were first found by Benjamin Harrison in very old deposits in Kent, England, but the pre-Crag examples show an advance upon the Harrisonian eoliths in that they are usually made from intentionally struck flakes. It appears that in the pre-Crag Bone Bed of Suffolk, we have now revealed a series of industries made by various races of people who existed long before the later makers of the well-known paleolithic hand-axes came upon the scene. It is also possible that these implements which now lie in the Suffolk Bone Bed were at one time embedded in various deposits which, in the course of great periods of time, had been laid down on the old land surface of Eastern England. From these they were finally removed by marine action when East Anglia sunk beneath the sea, about 500,000 years ago, and today they are confronting archeologists with a very complex and important problem.

IF the evidence they afford can be read aright, we shall be able to know much more about the antiquity of our species, and perhaps at last be enabled to say when the momentous appearance of man upon this planet took place. But this cannot be done at present. The trail of ancient man is leading us into strange and archaic regions and its beginnings remain hidden in the mists of antiquity.

A leader of the tribe of Diesel-powered main-line trains: The famous *Zephyr*

DIESELS

Diesel Most Economical Pri
to Demand for Lower Ope
or Switching Service . . .

By GEORGE W
President, Winto

THIS is the last of a series of three independently written articles concerning railroad motive power. Since the Diesel engine for main-line work is the newest entry into the field, it quite naturally came after publication of the articles on steam locomotives and on electrification. From the three we have no conclusion to present as we believe that our articles have given sufficient facts for the reader to judge for himself. However, since Mr. Codrington's article was necessarily written

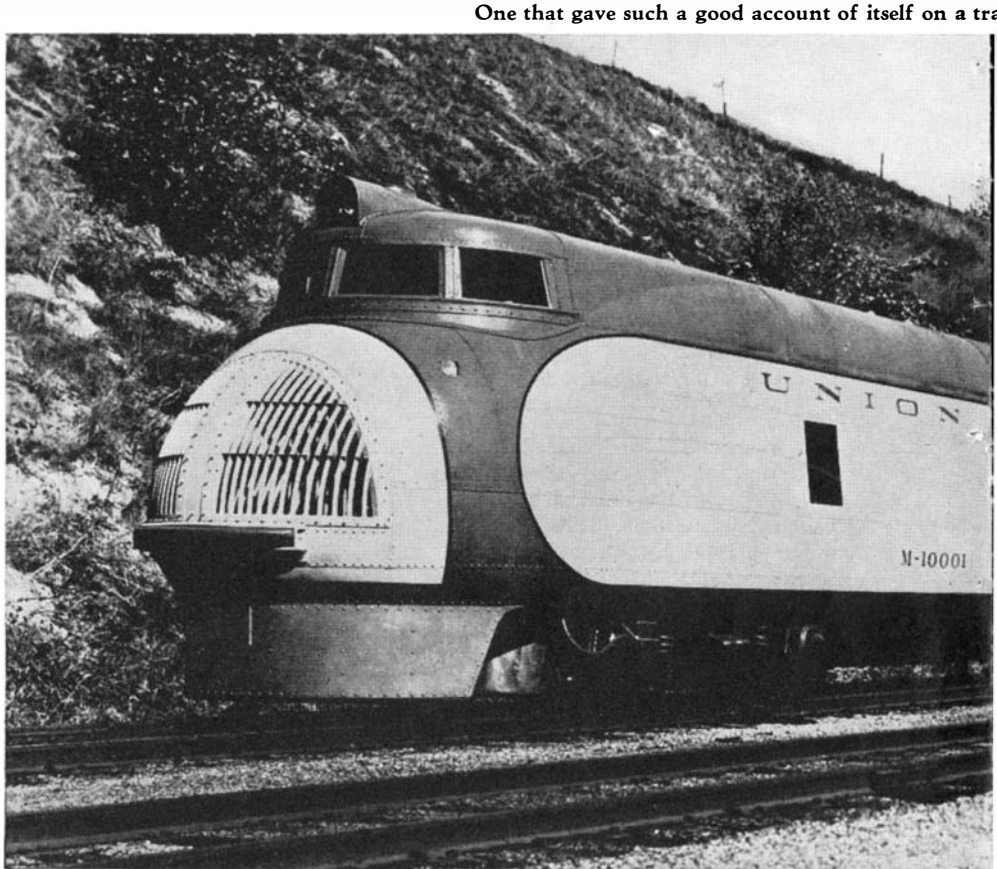
THE railroads of the United States are confronted today with the most acute crisis in their entire history. Whether any of the programs for rehabilitation that are now being offered are adopted or not, I am satisfied, in view of the courage and genius for achievement which have consistently characterized America's railroad executives, that they will find a satisfactory solution to their present difficulties. Aside from any program that may be adopted, the fact remains that the railroads will still be faced with an imperative demand for reduced operating costs. Because I am entirely confident that this demand for more efficient operation will remain after all of the other now pressing problems have been resolved into a satisfactory answer, I am optimistic with reference to the future of the Diesel engine in railroad service.

We know that the Diesel engine is the most economical prime mover available, and we know further that this type of power plant can be successfully applied to main line railroad trains and locomotives. In short, because Diesel power provides the most satisfactory answer to the railroads' demands for economy, a most vital need at present, I feel certain that they will adopt this type of power as widely and rapidly as their financial condition will permit. This does not seem unduly optimistic to those who are familiar with the history of the Diesel engine in other fields as well as with recent engineering advances, some of them quite revolutionary in character, in the design and construction of the Diesel-type engine.

Operating figures for the high-speed, main-line, Diesel-powered passenger trains which have recently been placed in service in this country do not cover a period long enough to be conclusive. Nevertheless, such figures as are available indicate the possibilities of this type of equipment and they are most encouraging. For instance, figures compiled for one month's scheduled service of the Burlington *Zephyr* show its operating cost to be only 25 percent of the total revenue derived from its service. So great has been the public's acceptance of this train, that its capacity is being increased from 72 passengers to 112 passengers, by the addition of a fourth car now under construction.

The Diesel-type engine presents advantages other than economy which appeal to progressive railroad executives, but on the basis of economy in operating cost alone, the Diesel engine cannot be ignored when plans for securing more efficient operation are being formulated by our railroad leaders. The introduction of Diesel power into main-line railroad service comes at a time which, although most distressing to the

One that gave such a good account of itself on a tra



ON RAILS

e Mover . . . Offers Solution
ıting Costs . . . Main Line
ecord Runs Point the Way

CODRINGTON
ıgine Corporation

A Down-Easter, New England's first venture into the field of Diesel-powered trains

concurrently with the two former ones three months ago, it was impossible to present within the body of the story any detailed figures as to operating costs of the new type of train. Therefore, for further guidance of interested readers, we present in the Digest section of this issue certain late information concerning operating costs of the famous Burlington *Zephyr* which now is on a regularly scheduled run. These cost figures were obtained independently of Winton.—*The Editor*.

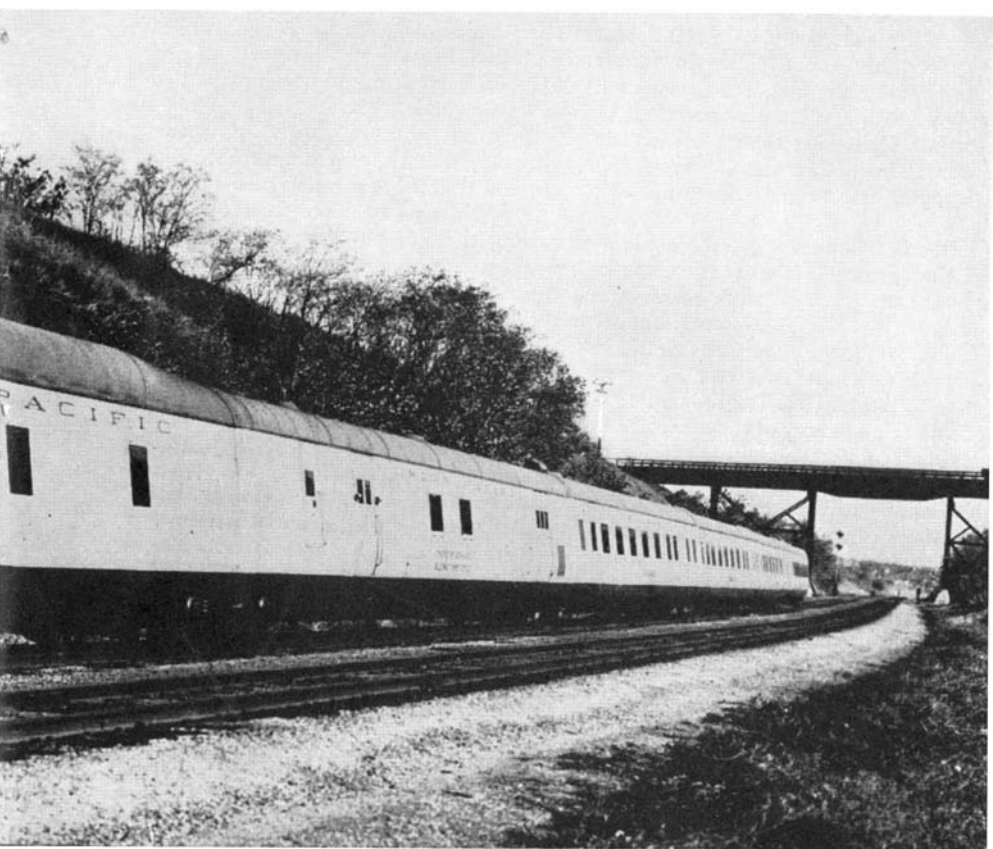
railroads themselves, is quite favorable to the adoption of new equipment. The railroads must do something to improve their condition and one of the things that presents itself as a solution to a major problem is the Diesel engine. To provide means and ways whereby the roads may emerge from the distressing condition of the past five years into the light of a new and more profitable era presents a challenge which railroad executives have accepted with courage and confidence. In no other phase of the situation has this been more forcefully demonstrated than in the introduction of revolutionary new equipment, such as the new streamlined, high-speed passenger trains.

While the percentage of obsolescence in equipment is extremely high, nevertheless many roads will undoubtedly find it impossible to make extensive purchases in this direction for the present. This will probably result in revamping some of the equipment now in use. However, even in the face of such a condition, the Diesel engine stands a good chance of displacing some of the motive equipment now in use. At present, Diesel locomotives are being developed in 600, 900, 1800, and 3600 horsepower units, suitable for main-line and switching service. The economy of these new power units gives every promise of resulting in their widespread adoption by railroads.

Another factor which must be considered is the fact that conservative estimates place the deficiency in purchases for maintenance alone which has accrued during the last five years at 400,000,000 dollars, which is the difference between the expenditures made by the railroads for maintenance materials in that time and the expenditures the railroads would have made to move the same volume of traffic had they spent proportionately as much during the period out of earnings as they did before the depression. This deficiency cannot be permitted to go much higher without disastrous consequences.

The present low earnings of the railroads are, of course, due to loss of traffic. Some of this loss is due to general economic conditions and some of it to competitive forms of transportation. The new high-speed, streamlined, passenger trains offer one method, and a most important one, of returning a large part of this lost traffic to the railroads. New engineering advances have made such trains possible, and it is fortunate that streamlining, air-conditioning, and the Diesel engine can be combined in such equipment, in order to provide the essential features of comfort, cleanliness, speed, and economy. The Diesel engine can hardly be left out of such a picture of the future of railroads.

ontinental run that it smashed many railroad records



An Oriental Plant

By FRANK A. MONTGOMERY, Jr.

In the grove of giant timber bamboo on the farm near Savannah, Ga. This grove is about 35 years old

ON a farm on the Ogeechee River, near Savannah, Georgia, the Federal Government is conducting experiments with some 275 species of bamboo, with the hope of assisting southern agriculture to meet the domestic demand for this commodity with a steady supply. As a result of these experiments groves have been and are being established in many states where the climate is not too rigorous. With their waving crests and almost impenetrable thickets of round, reed-like stems, these groves are not only commercially valuable but also an attractive addition to the landscape.

About two million dollars' worth of bamboo is imported into the United States each year, and some time ago the Department of Agriculture and other interested organizations and individuals decided to investigate the possibilities of growing at least a part of this volume in the South. The results of these painstaking experiments are now becoming available and it may be said that the growing of bamboo will become a source of profit to southern farmers—a crop that may be likened to the fruits of orchards on the farms. Bamboo grown in the South is being used in a variety of ways, and bids fair to become increasingly profitable.

THE grove at Savannah is part of a 46-acre farm known as the "Barbour Lathrop Plant Introduction Garden." It was presented to the Federal Government by Lathrop who has long been interested in collecting bamboo plants. The grove itself was started from Japanese plants imported by a Cuban, Andreas E. Maynelo, and was called to Lathrop's attention as one of the largest groves of bamboo in the United States. When it was purchased and turned over to the government about a decade ago it covered only about half its present area. But it has rapidly increased in size and importance, until at present, bamboo is being shipped from the grove for paper making, the manufacture of tooth-brush handles, yacht masts and booms, flagpoles, plant stakes, fishing poles, radio aerials, furniture, ladders, and many other commodities.

This versatile plant has many other uses. One which is becoming increasingly important in America is the use as food of bamboo shoots, or tips that have just come up out of the ground. These shoots—sliced, peeled, boiled, and served in butter sauce—have been among the favorite dishes of the Orient for centuries. Quite a few Americans have acquired a taste for them and a wider market for the food is gradually being developed, much of the shoots being canned for the trade.

The great timber bamboos which form the spectacular and successful grove in Georgia are also extremely useful in their growing forms. They act as effectual windbreaks and they have a distinct appeal to the landscape gardener. Very little decorative bamboo, however, is to be found in the United States, mainly because people consider it unsuited to the rigors of North America's climate. This is a mistaken idea and it is a fact that bamboo will grow in the east as far north as Maryland. In England and along the south coast of France there are many strikingly beautiful bamboo gardens. Since bamboo is an evergreen, these gardens, from a standpoint of beauty, are as attractive in winter as in summer. In fact, the green of a bamboo grove against a background of snow is a sight long to remember. The eastern shore of Maryland offers many such sights during the winter months.

THE most important of these plants being grown in the South at present, both in the Savannah grove and elsewhere, is the large Japanese timber bamboo. In Japan, and especially in China, this species is a veritable staff of life to the natives. It produces food and shelter and many of the other necessities and comforts of existence for at least 300,000,000 people. It was, in fact, the ingenuity of Oriental peoples in the utilization of bamboo that first attracted American manufacturers to the possibilities of this remarkable plant, and which has led to the present status of bamboo culture in this country. It was believed that if users of bamboo in this country could have a ready access to a domestic supply, they would develop new Occidental uses. Such seems to be the case, for already the stem of the bamboo is being put to uses undreamed of by Orientals.

For example, many growers of pecans, almonds, walnuts, and prunes have discovered that there are no poles as light and efficient as bamboo poles for harvesting their crops of nuts and fruits, while other orchardists are beginning to use light bamboo ladders when picking their fruit. They are also using bamboo poles as props for fruit-laden limbs. And, as has been mentioned, bamboo for tooth-brush handles is popular, while the familiar bit of bamboo used as a phonograph needle has long been a familiar sight to Americans. The possibilities of bamboo, so growers and manufacturers insist, are extensive.

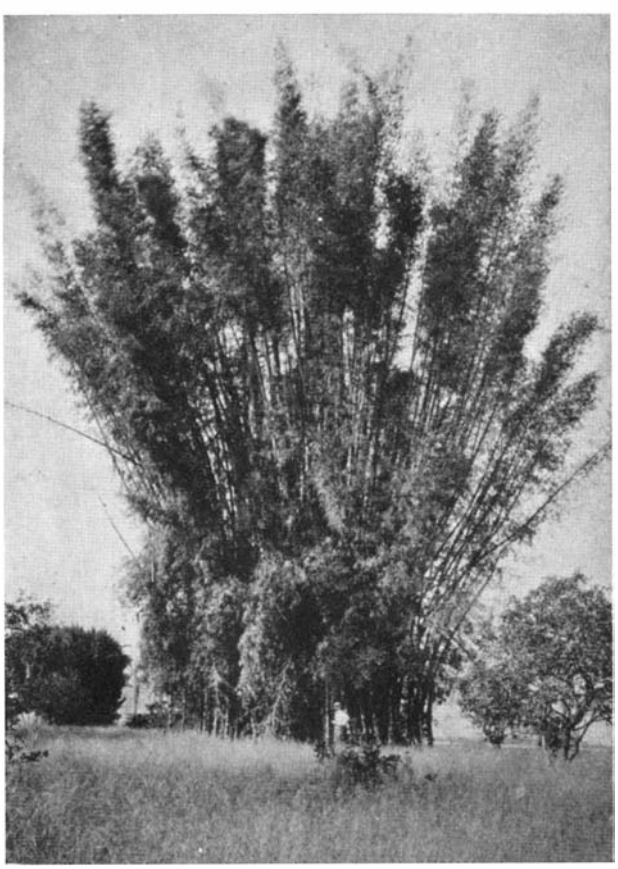
Strangely enough, in view of its size, bamboo is a grass and not a tree at all, as some people have long thought. The hollow, jointed stems are very dissimilar to tree trunks, for they are produced in a single season from a mass of roots and rhizomes, as grass stems grow from sod.

IN THE OCCIDENT

Bamboo as a Farm Crop . . . To Supply a Two Million Dollar Demand . . . 275 Species Being Investigated . . . New Uses Are Developing

These stems, when they burst through the earth along about May, are as large in diameter then as they ever will be. When the young bamboo shoots first appear they look for all the world like shells from a small-calibre field gun, and they are covered with overlapping scales like the husk of an ear of corn. At this stage they are extremely tender, and a slight kick will serve to break them off on top of the ground. Corn, wheat, oats, rye and barley are all near relatives of this unusual plant.

Bamboo plants have more or less rounded stems divided into joints, each joint marking the point where there is a partition or brace in the stem. These stems are practically all hard and woody when mature and capable of withstanding a great amount of stress and strain in spite of their lightness. They produce flower and seed clusters resembling those of rye and barley. However, with most varieties of bamboos, flower and seed production occurs at extremely rare intervals; quite often 50, 75, or even 100 years intervene between blooming times. Many bamboos die immediately after flowering. The plants grow with great speed, in some varieties as much as sixteen inches in twenty-four hours, and they reach considerable heights, some in the Georgia groves being 70 feet high.



Clump bamboo growing in Florida. This is one of the most spectacular and useful of the various bamboos

THE plant is indigenous to mild climates, none ever having been found native to the colder temperate regions. There are only two native species in the United States—the canes at one time found so plentifully in the southern canebrakes from Virginia to Louisiana and along the lower reaches of the Mississippi River. Central and South America boast of more than 150 species, but Asia, and especially China, is the richest of all regions in bamboo species. Nearly 500 different kinds of bamboo have been identified, and of this number approximately two thirds are found in Asia.

Bamboos may be divided roughly into two groups: Those that spread in all directions by means of underground runners, and those that grow in more or less compact groups or tufts, spreading slowly by a gradual enlargement of the clump. The giant timber bamboo spreads rapidly in good soil and attains a height of 60 to 70 feet, with stems three to five inches in diameter. This is one of the most useful of bamboos, especially for domestic purposes. Two other bamboos similar to the giant form, but hardier and smaller, have been found adapted to climates as far north as Kentucky, Arkansas, Tennessee, northern Texas, California, and western Oregon and Washington. These forms are known as the forage and stake bamboos and the dwarf hardy bamboo. Under favorable soil conditions these bamboos reach a height of 20 to 25 feet and may act as valuable storm shelters and windbreaks, as well as furnishing poles, canes, stakes, and so on.

Two other bamboos of the clump style have been found suitable for the warmer parts of Florida and to some extent for extreme southern Louisiana and Texas. They are the Calcutta bamboo and the Indian cane bamboo. Both grow readily from seed, which is produced in India. They are rather slow growers, beginning to yield fair-sized poles in clumps around the age of five years. The stems are nearly solid and are therefore rather heavy in comparison with some other species. When full grown, 80 feet is an average height.

The first systematic attempts to introduce bamboo in the United States were made by the Federal Government about 25 years ago. So little was known of proper cultural methods, however, that there were many failures in the work. As it went forward, more knowledge was accumulated until at present, as exemplified especially in the grove at Savannah, most of the difficulties of growing bamboos in the United States have been overcome.

OWING to bamboo's relationship to the canes found growing wild in the bottom lands throughout the South, it was once believed that to grow well it must be set out only in damp, low places. Some species, it is true, do grow best in such places, but it has been learned that most varieties thrive wherever cotton is grown and really prefer fertile, well-drained soil. Thus is it easy to understand why the plant has been so successfully grown in all the South Atlantic States, the Gulf Coast States, and parts of Kentucky, Tennessee, and, in fact, wherever the climate is not too severe. More and more interest is being shown in this one-time curiosity, until undoubtedly the day is not far distant when a crop of bamboo to the farmers of this country will seem no more unusual than a crop of corn.

●

The question "How Bright is a Lightning Bug?" is answered in a short but highly interesting article by Prof. W. A. Parlin, scheduled to be published in an early number.—The Editor.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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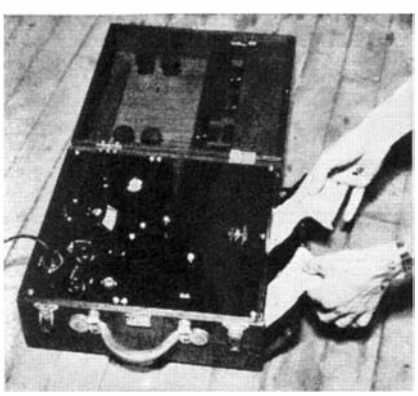
Matching Colors Photo-Electrically

THE problem of matching colors exactly is of vital importance to many industries. In the manufacture of textiles, ceramics, dyestuffs, beverages, inks, paints, and many other commodities where color is involved, wide discrepancies often occur which have an adverse effect on sales. Varying degrees and qualities of light, as



Two cloth samples being inserted in the photo-electric color matcher

well as differences between human eyes, often make it impossible to reach an agreement on a color "match." However, by means of an ingenious application of the photo-electric cell, there has been developed a device called Hays Telecolor which is completely free from all such influence. It not only tells definitely whether or not two samples of a color are an exact match but also shows at what points of the color spectrum these differences occur. By means of color filters it is thus possible to make up a chart from which color corrections can be quickly and accurately made. For example: If in breaking down the color components of a "standard" and a "test" sample, the operator finds that there is a difference in the readings of 1.25 percent when the green filter is used, this would indicate that there was 1.25 percent difference in color in the green band of the spectrum.

Briefly, Telecolor is an instrument weighing less than 25 pounds in which is located a light source and two photo-electric cells. These are connected in a circuit with an indicating galvanometer and a calibrated variable resistance which is used for balancing the circuit and indicating color differences in percentage of reflection. The equipment is so designed that it can be used on any lighting circuit and is not affected by differences in voltage.

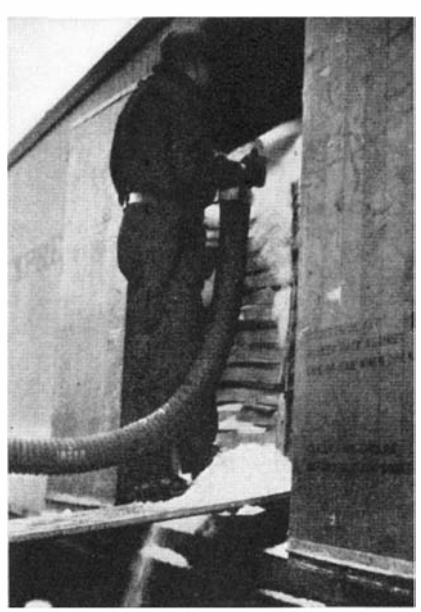
The device may be used not only for checking colors of cloth and so on, but also the opacity of liquids or solids or the transmission of light by various types of glass.

Top-Icing Cars With Snow Ice

"FOR years it was the habit of steam lines to use block ice for cabbage and lettuce, a process that broke fully 7 percent of the crates. Some research department finally conceived the idea of using electric motor-driven machines, mounted on light trucks for movement to car doors, that pulverized blocks of ice, blowing the particles through a hose." This statement is taken from an article by George Creel, on "The Railroads Wake Up," which appeared in a recent issue of *Collier's*.

Top-icing refrigerator cars of green vegetables with snow ice provides moisture and refrigeration to insure arrival of the produce in an attractive condition, thereby commanding the highest market prices. It is suitable for use with all such green vegetables as cabbage, celery, corn, lettuce, peas, spinach, beets, carrots, cauliflower, broccoli, endive, and parsley.

With a machine developed by Link-Belt, called the Ice-Slinger, an operator at the car door manipulates the discharge hose, thus placing a heavy blanket of snow ice on the crates or hampers. Top-icing eliminates the necessity of bunker icing and prevents center heating. The settling of the ice over and around the contents provides a packing effect which reduces damage due to rough handling. The high speed blast of ice forces out all warm air, and thus precools the car. "Slinger-iced" cars have crossed the continent without re-icing.



Left: **The "ice-slinger" mounted on a truck, pulverizing blocks of ice.** ***Above:*** **The delivery hose "slings" snow ice into a refrigerator car**

Heredity, Germs, in Dental Decay

HEREDITARY immunity, or lack of it, and the presence of a germ, bacillus acidopholis, in the mouth seem to be the fundamental factors in the decay of human teeth, the Michigan Academy of Science,

Arts and Letters was told by Dr. Russell W. Bunting, of the University of Michigan Dental School, in summing up five years of group research in this field.

Heredity plays a definitely known part in this most discussed disease. About 7 percent of the hundreds of persons studied showed a natural immunity to dental decay. At the other extreme, some 10 percent had very active caries which was controllable only by the most heroic measures. Most persons fall within the middle 83 percent who may be protected from dental caries by proper dietary measures, Dr. Bunting stated.

Among the large non-immune majority, the thing that seems to foster the heavy growth and activity of the bacillus is a diet rich in carbohydrates, especially sugar. A high bacillus count, in turn, was almost always found to be associated with a high rate of decay. This has been repeatedly checked during the past five years at an orphanage of 300 children, where the diet was well controlled. At the orphanage it was found that caries could be practically eliminated, except in the over-susceptible group, by the feeding of a uniform, fairly adequate, low sugar diet, reported Dr. Bunting.

The whole problem of dental caries is not solved by these findings, which are complicated by the factors of age and general health, Dr. Bunting was careful to state. Certain "nots," discovered from the study are as important as the positive findings, he pointed out. One is that decay is not determined by the hardness or softness of the teeth. Another is that the amount of calcium or phosphorus in the blood exerts no influence, nor does the ammonia, acid, or diastase content of the saliva. Poorly formed teeth, it was found, are no more liable to decay than normal ones, while an unclean mouth is not necessarily a sign that the teeth are decayed or will decay.

SUPERFINE

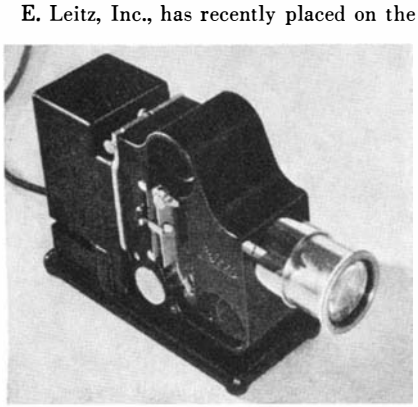
BY A special process, aluminum can be drawn into a wire .0001 inch in diameter. One pound would reach nearly around the earth.

PICTURE PROJECTOR

IT is often desirable to project "stills" made on 35-millimeter film so that a group may view them. In business offices or in sales conferences 35-millimeter film used instead of cumbersome lantern slides and their still more cumbersome projecting equipment proves highly satisfactory in the results obtained.

E. Leitz, Inc., has recently placed on the market a projector for such pictures made with miniature cameras. The projector itself might be called a miniature because it is only 5½ inches high, 7 inches long, and 2½ inches thick. Made of Bakelite, it weighs only 2¼ pounds. It uses either 50- or 100-watt projection bulbs. Of extremely simple design, it can effectively be used on a table to project screen images up to about six by four feet. It uses, of course, positives which may be made from either ordinary black and white film or from Leica Dufaycolor pictures.

This projector is recommended by the maker for equipment demonstrations from pictures made in the factory, to show people at work or products in actual use, to show graphs and printed pages, or for the many purposes to which the older and less satisfactory lantern slides may be put.



35-millimeter single frame projector

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By WALTER P. CHRYSLER

THE world today needs more than ever men of trained intelligence—men who can use their minds scientifically—men who can look inside and outside and all around a problem, getting down to its fundamentals and finding a practical, workable answer.

The world needs well-rounded men—men who are scientists in the true sense—men who know something about everything and everything about something—men of inquiring mind who are curious as to the why and wherefore of things and equipped with the proper scientific training to find out.

I call that type of man intelligent.

As I see it, intelligence is versatility—adaptability to environment—ability to change and to suit one's methods to conditions.

And conditions in this country are changing, as we all know—changing, I believe, for the better. This is too big a country, with its vast resources of men and material, not to recover eventually all that has been lost and more.

It seems to me that the institutes, colleges and universities of America, in helping to develop the scientific attitude of mind in their students, are laying a sound foundation for this country's growth.

It is this happy combination of scientific training and practical experience which is responsible in no small degree for the many great practical improvements in automobiles — improvements which the motorists of America recognize as fundamental contributions to greater riding and driving satisfaction.

The right kind of thinking plus the right kind of practical skill—that's the foundation of progress in engineering, in industry, in business, in every human endeavor.

CHEMICALS IN AIR CONDITIONING

CONDITIONED air is usually dried by cooling it below its dew-point to throw out excess moisture. Recently, however, a process of chemical drying has been developed by C. R. Downs, in which the great affinity of calcium chloride for water is utilized. The device is known as the Calorider and employs a combination of calcium chloride and other materials for dehumidification and deodorizing of air.

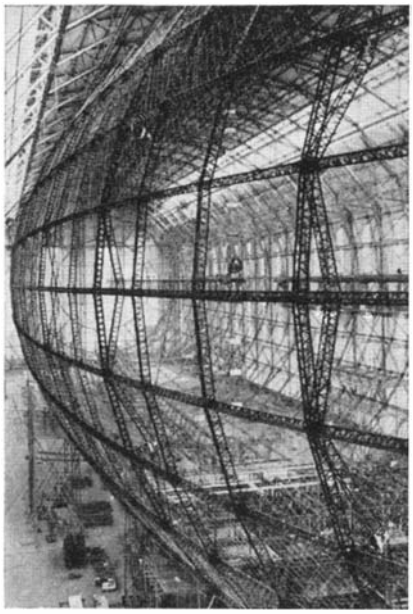
The system is adapted both to industrial work and to comfort air conditioning. The air passes through numerous cascades of solution and sweeps over shallow trays containing the liquid. After it is partially dry, it passes through lump Caloride where additional absorption of moisture reduces the relative humidity to about 25 percent. Cooling coils are supplied to remove the small quantity of heat liberated during the drying. For winter operation, the Caloride is removed and warm water put into the apparatus to increase air humidity to the desired extent.—*A. E. B.*

OPERATING COSTS FOR THE "ZEPHYR"

AS promised on pages 308 and 309, we give here a summation of the experience gained in the first few months of operating the Burlington *Zephyr*, America's first streamlined Diesel-electric train.

First of all an increase of from 150 to 200 percent in number of passengers carried, a reduction of almost half in operating expenses, and a cost for fuel and lubrication only slightly more than one fourth the previous cost are among the advantages which have accrued to the Chicago, Burlington and Quincy Railroad. According to figures received by the General Electric Company, which supplied the electric equipment, savings in operating expenses have averaged approximately 4450 dollars per month, or 53,400 dollars per year.

Patronage on the Lincoln-Omaha-Kansas City run has increased beyond the capacity of the train, so that a fourth section is being added to the original three-section articulated train, to increase accommodations from 72 to 112 passengers. So successful has



The triangular girders and braced main rings of the German *LZ-129*

been the new type of train, producing net earnings sufficient to pay for itself in two years, that the Burlington is obtaining two more such trains, also electrically equipped by General Electric, for traveling the 431 miles between Chicago and St. Paul and Minneapolis in 390 minutes.

The *Zephyr* has been operated at a cost of 5152 dollars per month, or 34.21 cents per train mile; the replaced steam trains cost 9601 dollars per month, or 63.75 cents per train mile. Fuel and lubricating oil for the *Zephyr* cost 585 dollars per month, or 3.88 cents per mile, and for the steam train 2073 dollars per month, or 13.77 cents per mile. Combined maintenance-of-power expenses have been 902 dollars per month or 5.99 cents per mile for the Diesel-electric, and 2291 dollars per month or 15.21 cents per mile for the steam trains.

The Burlington system, experiencing an increase of 26 percent in passengers carried on the whole, has reported an increase of from 150 to 200 percent in the case of the *Zephyr*. The train leaves Lincoln, Nebraska, at 7:30 o'clock each morning and, 55 minutes later, arrives in the Omaha station, 55 miles away; the steam train required 75 minutes. The Omaha-Kansas City run of 195 miles is now done in 240 minutes, including a station stop at St. Joseph, Missouri; the steam train required 320 minutes. On the afternoon return trip the same speeds are maintained by the *Zephyr*.

Eckener Almost Ready

WHILE the disaster to the *Macon* has temporarily stunned the American exponents of the airship, the imperturbable Hugo Eckener is still sailing the *LZ-127* and steadily working on the *LZ-129*. Dr. Eckener was recently in the United States testifying before the Federal Aviation Commission, negotiating for a base at Lakehurst, and discussing the raising of capital for a transatlantic venture. It is doubtful whether under the present circumstances American financial co-operation is feasible, but it is quite clear that the German Government has not lost faith in the military and commercial possibilities of the airship since it announces a new large airship company to be financed mainly with Nazi official funds. The completion of the *LZ-129* has been delayed again and again, but rumor has it that its first flights will take place this spring. A first-hand description of the new craft, received from the Zeppelin Werke in Friedrichshafen, Germany, may therefore be quite timely.

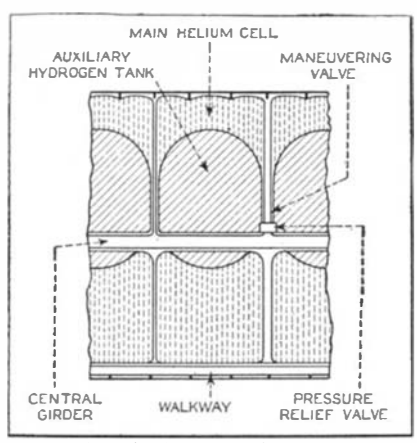
As compared with the *LZ-127* (*Graf Zeppelin*), which has visited the United States twice, the new rigid will embody many changes and improvements, and for the first time in German practice the use of helium is contemplated, at least partially.

The *LZ-129* is only a trifle longer than the *LZ-127*, but of larger diameter and greater gas capacity. The comparative dimensions of the two airships appear from the following table:

	LZ-129	*LZ-127*
Length	815 feet	770 feet
Maximum Diameter	134 feet	100 feet
Gas Capacity, cu. ft.	6,700,000	3,700,000
Horsepower	4800	2750

In the *LZ-129*, the fineness ratio—length divided by maximum diameter—is 6 to 1, and the cross-section is in the form of a regular 36-sided polygon.

The navigation compartment is placed under the hull almost at the bow. Behind



Auxiliary hydrogen tanks are mounted within helium cells on *LZ-129*

the navigation quarters, in the lower part of the hull, are located the passenger quarters. Amidships we find the four engine nacelles which are located in pairs on each side of the hull. A strong keel girder runs the whole length of the ship and provides the service walkway. On each side of the walkway are located the fuel tanks, ballast and fresh water tanks, quarters for the crew, and freight and mail compartments.

The main rings are heavily braced with steel wire, and are placed at intervals of 54 or 49 feet. In between the main rings (which mark out the gas bag compartments) two unbraced rings are located. The wire bracing of the main rings is carried to a central girder. The longitudinal girders connect the 36 corners of the rings, and the rings and longitudinal girders combined serve to give the airship its outline. Duralumin is used throughout for the girder construction.

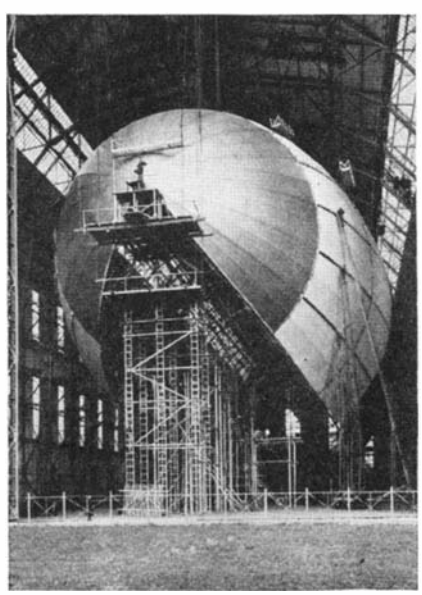
By means of the main braced rings, the hull is divided into 16 gas compartments, each of which encloses an independent gas bag. The gas bag fabric has been developed to give maximum resistance to leakage.

Helium has the advantage of being non-explosive, but it has 10 percent less lift than hydrogen, and is very expensive. Therefore, helium is to be used in combination with hydrogen. Within the outer helium bags there will be placed auxiliary bags filled with hydrogen, which will be entirely surrounded by the non-inflammable gas. As on a long trip, fuel is used up and the ship becomes too buoyant, the hydrogen will be released. Thus the problem of lift equilibrium will be solved without the use of the rather cumbersome and speed-reducing device of exhaust gas water recovery which is common American practice.

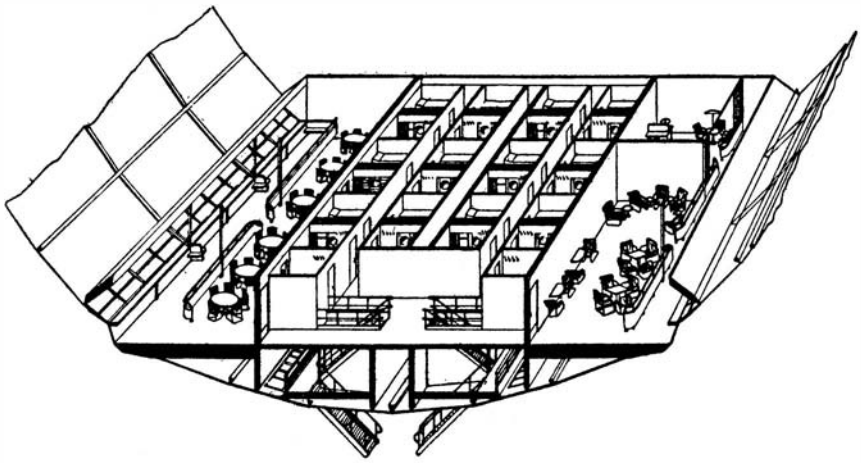
The power plant consists of four Diesel engines rated between 1100 and 1200 horsepower, carried in the nacelles, which are supported by struts and cables from the main hull. The speed of the ship with these engines will be 84 miles per hour. Each power "egg" will be fully equipped for engine maintenance and repair, and accessible from the keel by a special gangway. The amount of heavy fuel oil to be carried will be between 60 and 70 tons. The fuel tanks in the keel are connected by pumps with the operating fuel tanks mounted inside the engine gondolas.

The navigation unit is divided into two parts. The front part is for the actual control of the ship, with steering wheels and leads to the rudder and elevators. In the rear are the navigating quarters proper. Above the control room is the wireless cabin with provision for two-way transmission and direction finding. The various ground handling lines are in the navigation unit.

The most radical departure has been made in the design of the passenger quarters. These have been artistically designed, laid out to be thoroughly comfortable but with all unnecessary display avoided. The passenger rooms have a width of 46 feet and a length of 72 feet. Window space at the sides gives a magnificent view. For the first time in airship history passengers will be provided with a real smoking room, so fireproofed that all danger of fire is com-



Bow of the *LZ-129* in process of being covered with its outer fabric



A sketch of the arrangement of the two passenger decks on the *LZ-129*

pletely eliminated. This will be a real blessing to the great majority of the traveling public! The passenger quarters are divided into a main upper deck and a smaller lower deck. The upper deck will have on one side a dining room with promenade near the windows; on the other side are a salon, and a writing and reading room. Between the two day rooms there will be located twenty-five cabins, each with two berths. The lower deck will house auxiliary rooms, a shower bath, the ship's offices, and the smoking room. Heating will be by means of a hot water system, with a heating plant making use of the cooling water in the engine cylinders.—*A. K.*

Wiley Post's Glorious Failure

THE second attempt by Wiley Post to fly the continent in the sub-stratosphere was cut short, but it was a glorious failure. From Los Angeles to Cleveland he had covered 2044 air miles in 7 hours 19 minutes, creating an unofficial world's record. The time Mr. Post made from Los Angeles to Cleveland was much better than that made by Roscoe Turner in his transcontinental flight of 10 hours 2 minutes and 51 seconds; it took Turner 8 hours and 25 minutes to get to Cleveland.

Post's flight again drew the attention of the public, the airplane constructors, and the mail operators to the possibilities of aviation in the stratosphere or at least the sub-stratosphere, since the flight was at 30,000 feet and the stratosphere begins roughly at 38,000 feet altitude. It showed further that with an ordinary plane of 1930, the Lockheed *Winnie Mae*, whose maximum speed when built was round 150 miles an hour, double supercharging could boost the speed to 340 miles an hour. There is not the slightest doubt that this figure was attained several times on the trip.

Even though Post failed, his attempt showed wonderful care and skill in preparation. The *Winnie Mae* demonstrated remarkable qualities of strength and endurance, taking the added equipment and the added strains of supercharging without sign of any difficulty. The flight also added new laurels to Post's altitude suit and oxygen supply system which we described in October, 1934.

Some additional information of technical interest is now available:

It is apparently quite possible to remove the conventional landing gear so as to reduce air resistance, and to make a safe landing on the belly of the ship, equipped with a landing skid.

The question of lubrication at very low temperatures has been solved. The Phillips Petroleum Company provided a lubricant which functioned admirably at temperatures of 70 degrees below zero.

Another technical problem due to the cold was in the contraction of the control cables, until they were as tight as fiddle strings. To meet this situation, spring tension was introduced into the control leads.

The Westport transmitting and receiving radio set functioned perfectly under the severe conditions involved, as the world learned from the messages received during the flight.—*A. K.*

Soloing in Less than an Hour

THE Department of Commerce is reported to be busily at work on the development of an airplane in which the novice may be able to learn to fly quickly. Perhaps it is already possible to learn to fly as quickly as any one can wish in the conventional but modern plane of to-day. Thus, an air transport student of New York University, Herbert Sargent, recently made his first solo flight at the Jersey City airport after only 55 minutes of instruction. His instructor, Eddie A. Schneider, was a young man of only 23, former holder of the junior transcontinental flying record. It is true that Mr. Sargent had the benefit of an aeronautical training at the University, and also of glider experience with the student glider club of this institution. Nevertheless, the 55-minute period is highly significant. As ships improve in the normal course of events and as training methods develop, it may become possible to guarantee almost any member of the public that he or she will solo in a few hours. And even learning to drive an automobile takes a little time and trouble!—*A. K.*

Photographing Landing Speed

IT is impossible to measure landing speeds with the ordinary air speed indicator. The pressures developed in the Pitot (the long slender tube placed ahead of the wing) are affected by the presence of the ground, and there is too much inertia in the transmission of pressure from the Pitot through the many feet of tubing leading to the indicator mounted in the pilot's cockpit. That is why landing speeds are apt to be so wildly and optimistically advertised for commercial airplanes offered to the public.

The constructors of the Boeing airliners do not sell to the general public but to the skilled operators of the airlines. Therefore they are anxious to measure landing speeds accurately. Accordingly they have devised a photographic method of obtaining this important characteristic.

The equipment consists of a 35-millimeter motion picture camera, a wire grid and an anemometer for measuring wind speed. The grid, a large wood frame with vertical and horizontal wires evenly spaced, is set up ten feet from the motion picture camera, which is carefully calibrated to determine the number of exposures per second. Cloth strips are placed 400 feet from the camera, parallel to the grid, to mark the line on which the plane must land.

As the airplane comes in for a landing, the camera is set in operation and the wind speed is simultaneously measured on the anemometer. The resultant motion picture shows the forward travel of the airplane and its angle of glide. By plotting the line of flight across the grid screen, by allowing for the ground wind as measured by the anemometer, and by taking into account the speed of the photographs and the distance

How a camera is applied to the job of measuring airplane landing speed

of the airplane from the grid, engineers can calculate accurately the actual speed of the airplane at any instant, including that of the actual landing.—*A. K.*

GASOLINE FROM COAL

GASOLINE produced by the low temperature distillation of coal is now used exclusively by nine squadrons of the Royal Air Force of England. The results have been declared generally satisfactory.

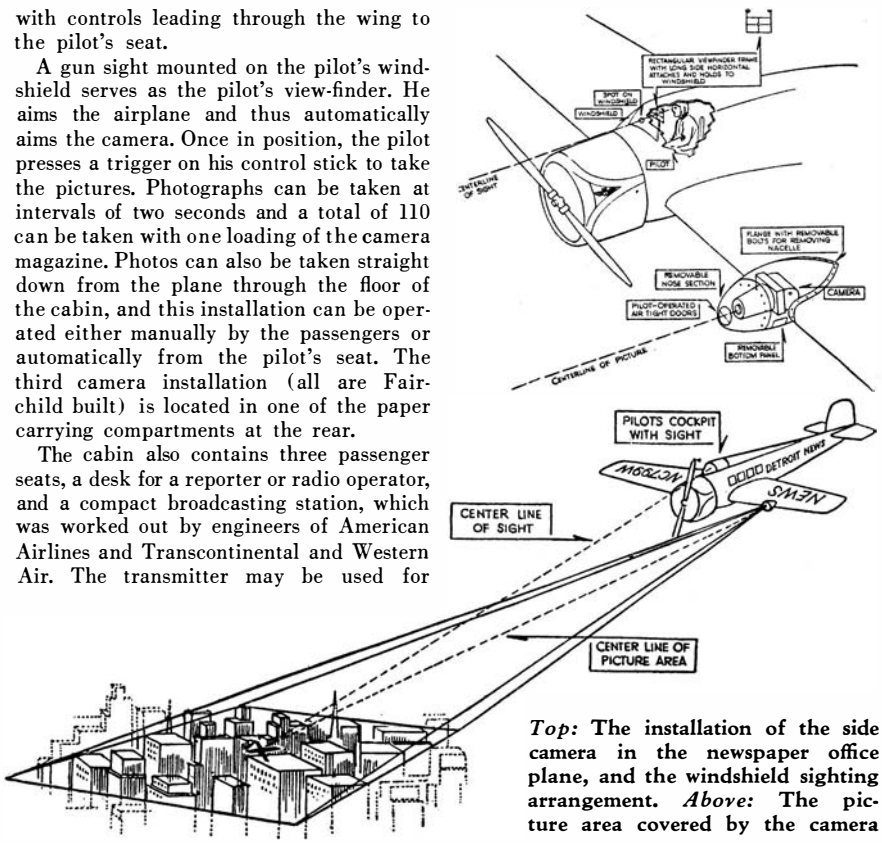
A Newspaper Office in Flight

AVIATION Editor James V. Piersol of the *Detroit News* is an enterprising man who has been news gathering by air for many years. Out of his experience grew the desire to own a special newspaper-man's airplane. From his specifications the Lockheed Aircraft Corporation has built a low wing ship, on the general lines of the one piloted by Colonel Lindbergh in his last transatlantic expedition. The plane itself, efficient and well designed as it is, offers little of special interest. Perhaps the one noteworthy point in the design is a reversion to wood, instead of the metal which has become customary in modern practice, to minimize camera vibration and background noises deterrent to broadcasting. The *Detroit News*' plane is equipped with the Sperry Automatic Pilot and a Pratt and Whitney Hornet engine. But the real interest lies in the camera and cabin installation, and in the radio equipment which includes a new transmitter to be used as an auxiliary of station WWJ.

Three camera installations make it possible to take pictures at any angle from the plane—forward, above, or below. One camera is mounted in the left wing, eight feet from the fuselage. It is installed in a fixed position parallel to the line of flight and is enclosed in a neatly streamlined nacelle. The camera is operated by an electric motor with controls leading through the wing to the pilot's seat.

A gun sight mounted on the pilot's windshield serves as the pilot's view-finder. He aims the airplane and thus automatically aims the camera. Once in position, the pilot presses a trigger on his control stick to take the pictures. Photographs can be taken at intervals of two seconds and a total of 110 can be taken with one loading of the camera magazine. Photos can also be taken straight down from the plane through the floor of the cabin, and this installation can be operated either manually by the passengers or automatically from the pilot's seat. The third camera installation (all are Fairchild built) is located in one of the paper carrying compartments at the rear.

The cabin also contains three passenger seats, a desk for a reporter or radio operator, and a compact broadcasting station, which was worked out by engineers of American Airlines and Transcontinental and Western Air. The transmitter may be used for either voice or code and can also be operated either from the pilot's seat or from the passenger cabin.—*A. K.*



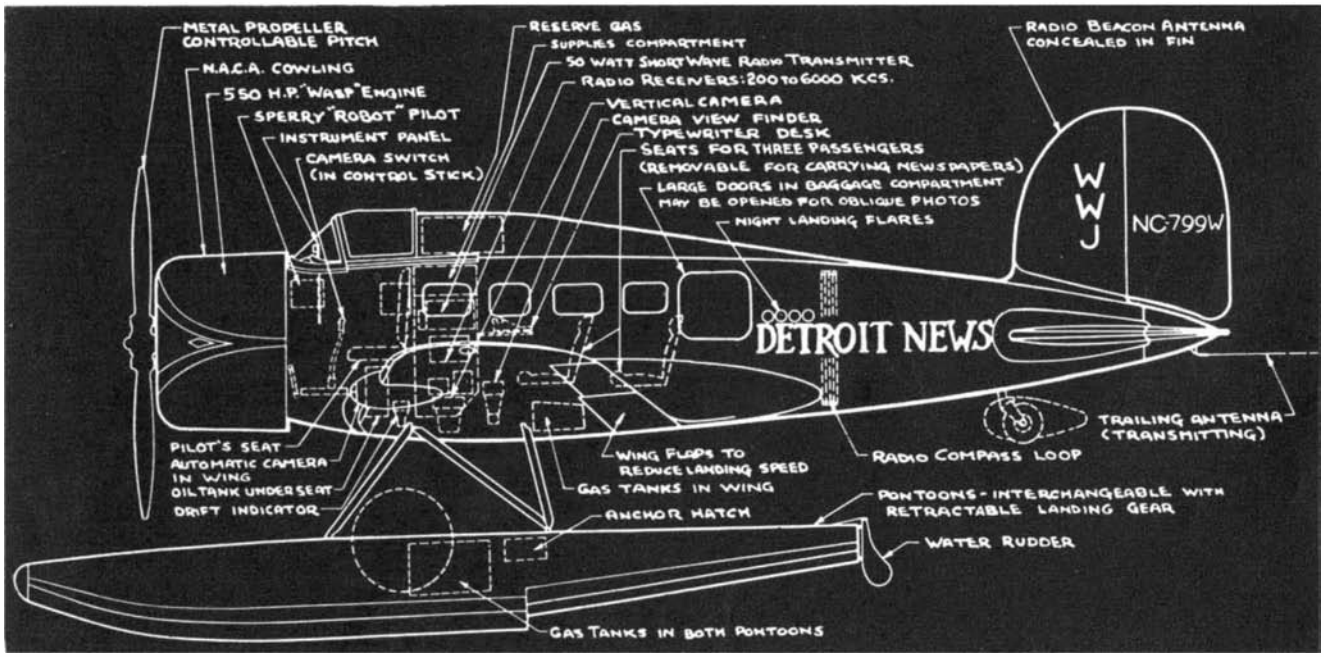
Top: **The installation of the side camera in the newspaper office plane, and the windshield sighting arrangement.** *Above:* **The picture area covered by the camera**

Report of the N.A.C.A.

EVERY year the National Advisory Committee for Aeronautics transmits to the Congress of the United States a message or summary accompanying its full report. This message is always of particular interest because it reviews aeronautical research and development in a broad and authoritative way. The Twentieth Annual Report is no exception to this rule, as the following brief extracts will show.

"As aerodynamic efficiency increases with the size of airplanes, the trend of development probably will be toward larger aircraft of greater range and weight-carrying capacity. Larger aircraft can be made adaptable to simplified internal bracing and structural refinements, so that cost of construction need not increase proportionately with size." We may cite the construction of the Pan-American Clippers in support of this view.

"For certain types of large airplanes, engines of larger horsepower are desirable, and a number of promising developments are now under way in this country." We may state that a Prestone cooled engine of around 1100 horsepower is being developed very successfully. For very large engines the drift is away from air-cooling back to



Drawing of the flying newspaper office, showing the placement of the special equipment

liquid cooling, because the cooling of radial engines of high capacity seems to offer increasing difficulty.

"With the development of large airplanes and large liquid-cooled engines, there will come a need to house the engines entirely inside the wings. This consideration will call for different types—different shapes—of engines." It is an open secret that the large liquid-cooled engine now in process of construction will have a very long propeller shaft, so that the engine may be housed inside the wing, with the propeller at the leading edge of the wing.

The Committee's laboratories at Langley Field are perhaps the most completely equipped aeronautical laboratories anywhere in the world. With the aid of P.W.A. funds some extremely valuable and interesting new apparatus is being added to these laboratories, some of which is mentioned in the following paragraphs.

"Refinements in design, reduction in drag, and increased engine power will make possible greater speed. The 500 mile per hour wind tunnel to be added to the research equipment should provide important new knowledge on problems of flutter, vibration, and the forces acting on aircraft structures, and thus make possible the use of the highest speeds with relative safety. . . . A 24-inch high velocity jet-type wind tunnel . . . will be used primarily to study air flow over propeller tips at speeds approaching the velocity of sound in air, with a view to improving the aerodynamic characteristics of propeller tips."

Altogether, a very encouraging picture of American progress is given by this excellent message.—*A. K.*

The Direct Take-Off Autogiro

SENOR Juan de la Cierva has been working on his Autogiro for over 20 years, yet every year sees some definite advance due to his tireless and fertile engineering imagination. His latest improvement, announced in a lecture before the Royal Aeronautical Society, is that of the direct take-off 'giro which accomplishes at least partially one of the long-sought-for objectives of the helicopter.

While exact details of the mechanism involved were withheld in the lecture, it is possible by careful interpretation to arrive at a reasonable understanding of the new principle.

We know that the Autogiro is now equipped with a mechanical starting system whereby the blades are brought up to autorotative speed much more quickly than by the old process of running the machine up and down a field. Now let us suppose that, prior to take-off, the blades are set to a small angle of incidence; that is, the blades lie flatly in their plane of rotation. The drag of the blades is then reduced to a minimum and the starter can raise their speed of rotation far above that of normal. Next suppose that the starter system is declutched, and that simultaneously the blades are returned to their normal angle of incidence, with the forward propeller given the full power of the engine. The inertia of the blade system will then carry them 'round for a short time at "over-speed." The coning and the lifting power of the blades will then evidently be far above the normal.

With the lift in excess of the weight of the machine, the Autogiro will immediately leave the ground on a steep, almost vertical path. When the machine is some 60 or 70 feet off the ground, the "over-speed" of the blades is gone, the excess lift disappears and the path of the machine is likely to be downwards. But by this time the thrust of the forward propeller has given the aircraft the necessary forward speed so that the drop is not pronounced and hence normal climbing is soon attained.

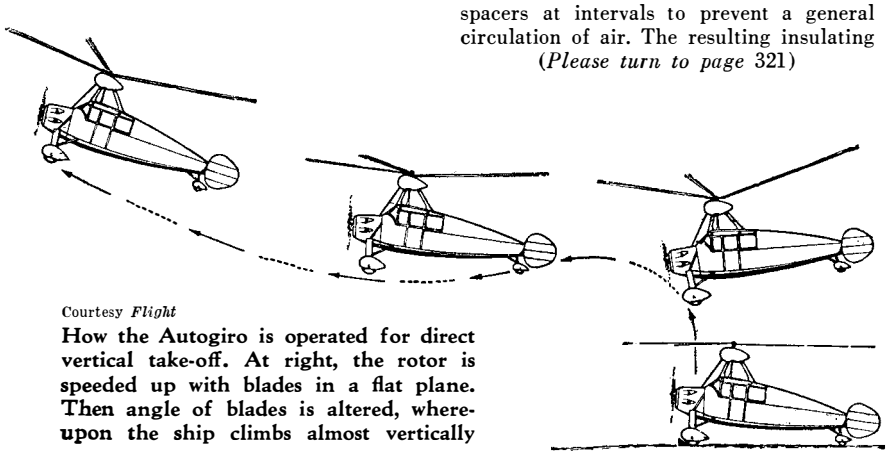
The whole process is illustrated schematically in the diagram and has decided possibilities for taking off from restricted territory, ploughed fields, or even the roofs of buildings.

Rumor has it that the method for changing the angle of incidence of the blades is one of extreme simplicity. The blades of the Autogiro are hinged about a horizontal axis, but also have a vertical axis mounting. The motion about the vertical axis is strongly damped by a rubber mounting. Now, if we imagine the vertical pin to be inclined slightly outwards, then if the starter is at work and the blades lag behind, it will be seen that their angle of incidence will tend to diminish. This is precisely what is required for the process of direct take-off. Therefore substantially no changes in design were required to achieve this remarkable step forward.—*A. K.*

Iron Insulation

A RECENT development in heat insulation consists of parallel plates of black sheet iron, creased into angularly arranged surfaces, with small ribs at the junctures of these surfaces. This insulation, known as Ferro Therm, makes use of several sheets of the formed metal installed at distances apart best suited to the requirements, with spacers at intervals to prevent a general circulation of air. The resulting insulating

(*Please turn to page* 321)



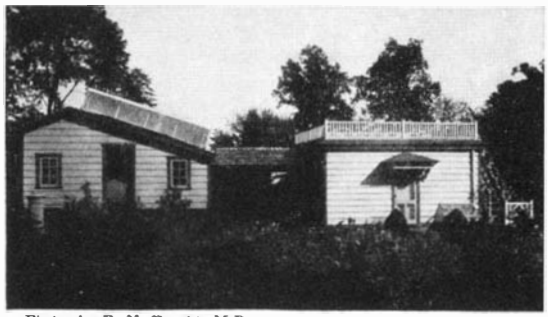
Courtesy *Flight*

How the Autogiro is operated for direct vertical take-off. At right, the rotor is speeded up with blades in a flat plane. Then angle of blades is altered, whereupon the ship climbs almost vertically

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

JAMES STOKLEY, Associate Director of the Franklin Institute Museum and Director of the Fels Planetarium at that institution in Philadelphia, at our request, has prepared the following description of the new horizontal refractor owned by Gustavus Wynne Cook of Wynnewood, a Philadelphia suburb. Mr. Stokley has used this and the other astronomical equipment at Mr. Cook's observatory, and thus writes from considerable first-hand knowledge. He says:

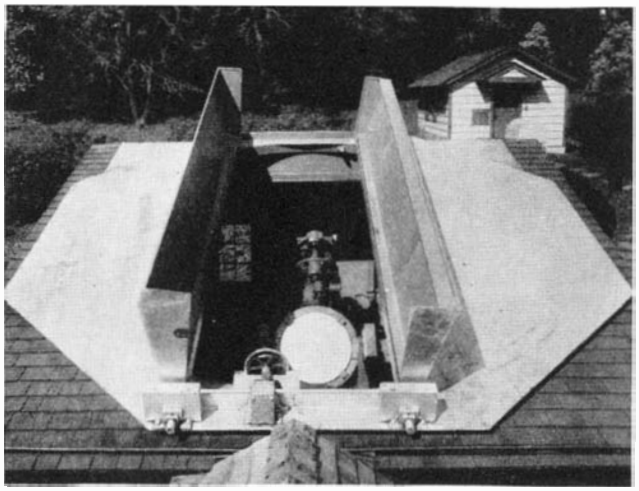


Photos by E. N. Fought, M.D.

The Cook telescope housing. *Left:* Siderostat house. *Center:* Tube. *Right:* Observing room

"Protection against temperature effects is not necessary to those who use a new telescope at the Roslyn House Observatory, Wynnewood, Pennsylvania. This unique institution, the private observatory of Mr. Gustavus Wynne Cook, Philadelphia banker and manufacturer, has been described in previous articles in SCIENTIFIC AMERICAN (August 1932, p. 74; January 1934, p. 17). To own a well-equipped 28½-inch reflecting telescope, provided with a large spectograph so that it is used regularly on a research program for measuring the radial velocities of the stars—not to mention the 40-foot focal length sun camera, the spectrohelioscope, the astronomical transit instrument, a 7-inch aperture and meridian circle and other items that would be creditable in any college observatory—might satisfy many persons. But Mr. Cook is not happy unless he is putting up a new telescope, and the latest addition has now been in use only a few months. With it he sits in a nicely furnished, and heated, room. At one end is an assortment of dials that reminds one of the control room of a submarine, and an eyepiece tube that might represent the end of a periscope. Without moving his head, the observer can press buttons and view almost any part of the sky. The dials automatically show exactly the position of the region at which he is looking.

"This is the latest form of siderostat telescope. Such instruments are not new in principle, as the first was designed by the French astronomer Léon Foucault, who died in 1868, and a huge one was displayed at the Paris Exposition in 1900. But now, probably for the first time, such a telescope has been constructed which makes full use of modern electrical equipment so that the operation is not as much trouble as driving an automobile. The flat mirror is mounted in a vertical fork, so that it can turn freely around either a vertical or a horizontal axis. Attached to the back of the mirror, projecting out at right angles to its plane, is a rod. The driving mechanism is placed immediately to the north, and is equipped with a polar axis which turns once in 24 hours. Attached to this is an arm which moves north and south, and at the end of this arm is a sleeve on which slides the rod attached to the mirror. This mechanism is shown in one of the photographs. By means of it, the mirror is automatically moved at exactly the right speed for each declination. The instrument is adjusted in declination by moving the arm attached to the polar axis. The tube of such telescopes is usually placed to the south of the mirror, so that the eastern and western halves of the sky may be reached with equal ease.

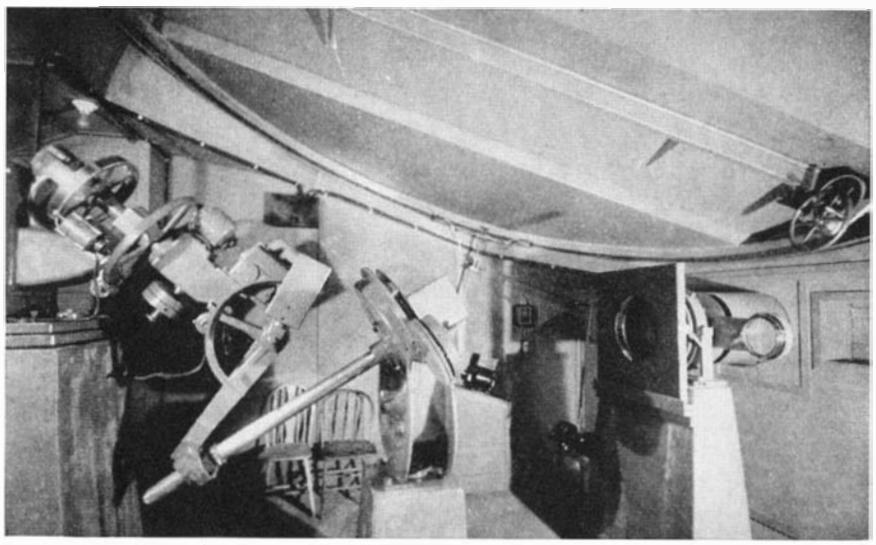


Revolving roof of the siderostat house, showing also the polar axis and the 26-inch Pyrex flat of the siderostat

"The objective of the Roslyn House instrument is of 15 inches aperture and 225 inches focal length. It was made in 1907 by John A. Brashear, and remained unused until purchased by Mr. Cook. It was tested by J. W. Fecker, of Pittsburgh, successor to the Brashear firm, who pronounced it excellent.

"Mr. Cook was undecided as to how he should mount this objective. The conventional mounting, with the dome, would have been as large as a two-story house, and out of keeping with the residence and other buildings nearby, in addition to lacking the advantages of a warm observing room. A polar telescope would have required the erection of a somewhat unsightly tower, so a horizontal telescope was definitely indicated.

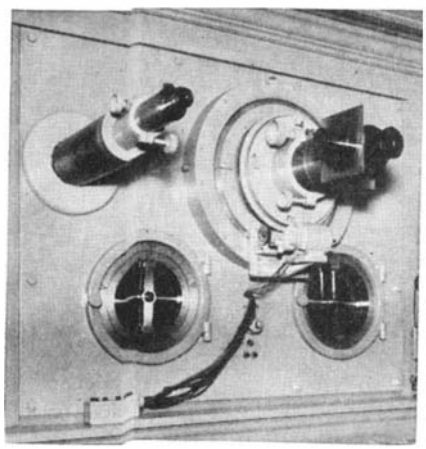
"Accordingly, Mr. Fecker was given the contract for the instrument, and the buildings were designed by Mr. Cook and built under his direction. The Pyrex glass plane mirror, 25 inches diameter, the driving mechanism, and the lens, are mounted on concrete piers in a small square building, provided with a circular, rotating roof, in which a wide slit can be opened to expose the mirror to the sky. At present the mirror is coated with silver, but equipment is being built to give it an aluminum surface. The tube of the telescope extends to the south, across a short open stretch and into the other building which, in turn, connects with the transit room, a clock room, and the room for the 28½-inch reflector. The observing room is heated from a heating plant some yards away. The breech of the telescope, and the various dials, are mounted on a third concrete pier to give the



West side of siderostat. Note 15- and 6½-inch objectives at right

greatest possible stability against vibration.

"A total of 12 motors is used in the operation of the instrument. One is a synchronous motor for the main drive of the polar axis. Two motors are used for the motions in right ascension and declination, the same motors serving for the fast and slow motions by shifting an electrically operated clutch. A motor-generator supplies direct current to operate the numerous relays. A second synchronous motor turns the eyepiece, when used for photography, as there is a rotation of the image, and a third operates a dial to show sidereal time so that the instrument can be set directly to a star's R. A. without stopping to figure out the hour angle, which is normally necessary. A pair of Selsyn motors connects this dial with the polar axis, and another pair connects another dial with the declination axis. Selsyn motors are "self-sychronizing," and when two are connected to the same power source the shaft of one turns in exact step with that of the other, as if they were mechanically coupled, even though miles of wire might intervene between them. Other motors operate an iris diaphragm over the lens, and the rotating roof.



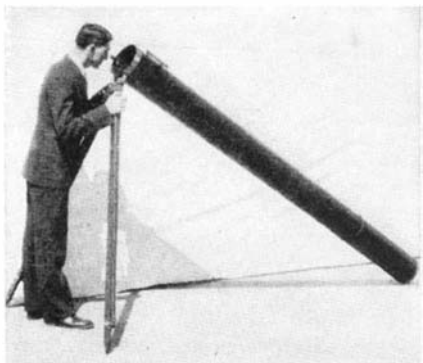
The observing and control panel. *Left, top:* Eyepiece end of the 6½" finder and guide telescope. *Right, top:* Eyepiece end of main telescope. *Left, bottom:* R. A. circle. *Right, bottom:* Declination circle. A smaller circle hidden behind eyepiece of main telescope indicates position of revolving roof

"Mr. Cook intends to use the instrument to a great extent for photography, and the support of the objective is now being slightly modified to simplify the attachment of the photographic compensating lens, which shortens the focal length. Guiding for photography may be done in two ways, one by using a double-slide plateholder, with two eyepieces on each side of the plate, through which stars just out of the field being photographed are kept in view on cross hairs. The other way is with a separate 6½-inch lens (see photograph), of the same focal length as the large objective, which is fed by a small flat mirror, attached to the side of the big one, and moving with it. This lens supplies a separate eyepiece, at the left on the observing panel. With this, however, the rotation of the image cannot be checked, as with the guiding stars on each side of the plate.

"The telescope cannot reach the pole, but can come within about 20 degrees of it, and thus can reach the most interesting parts

of the sky. Mr. Cook points out that it has one advantage over a polar telescope, for when such an instrument is directed to the southern sky, the plane mirror is used at a grazing angle, the least desirable position, as this emphasizes any of its defects. With the siderostat instrument, on the other hand, the light from an object in the south is reflected back almost at right angles to the surface.

"For comfort in use, and easy, convenient



A centenarian Herschelian telescope, made in the U.S.A., 1835

operation, the new Roslyn House telescope is to be commended, as anyone who has had experience with it, also with usual types of telescopes, can amply testify. But the fixed eyepiece has other advantages beside mere comfort for the observer. There are many problems of astronomy, such as the measurement of star brightness with photoelectric cells, where a considerable amount of delicately adjusted apparatus must be attached to the telescope. When this also has to swing around at all sorts of angles, the mechanical problem is a difficult one. At Roslyn House, a whole roomful of apparatus might be placed at the focus, and left there as long as needed. In fact, it is so effective that it will be rather surprising to the writer if, as it becomes better known, it is not duplicated again and again."

THUS ends Mr. Stokley's description. Mr. Cook, however fortunate in having so much fine equipment, is not reserving it for his own pleasure, but has also invited in and is maintaining two professional astronomers, Dr. Orren J. Mohler and Mr. I. M. Levitt, in order to keep it in steady use for routine scientific programs in connection with astronomy as a whole.

In his description Mr. Stokley refers to a siderostat, and so this is a good time to harp a bit on siderostats, coelostats, and heliostats—just precisely what are they? For years we have tried to find out. Few persons know *just* what each of these three is, though it is easy to jump at conclusions or discover that one really doesn't know. We once asked a professional to tell us. He started off in high gear, and then choked and discovered he didn't know *just* what each of the three was. The dictionary is as clear as mud about them. The other day, however, we blundered across the following, from an article in *Astrophysical Journal*, March 1900, by M. A. Cornu of Paris. Can anybody find any flaws in these? A *siderostat*, Cornu says, is especially constructed to send a reflected beam toward the southern horizon; a *coelostat* (we don't want to seem high-brow, but that word is pretty often mispronounced. It's seé-lo-stat) has a mirror that turns about an axis parallel to the earth's axis with an angular velocity half that of the diurnal revolution in the same direction; a *heliostat* sends the reflected beam in the direction of the northern horizon, rarely beyond NE or NW.

THE slanting telescope shown on this page is an old Herschelian now at the Smithsonian Institution, U. S. National Museum, Washington, D. C., and the following comment was sent in by Frank A. Taylor, Division of Engineering, that institution:

"The telescope illustrated is a professional job of 1835. It was made by Amasa Holcomb(e) of Southwick, Mass., who was probably the first man in the United States to make telescopes in any number for sale to astronomers. This telescope was recently presented to the United States National Museum at Washington by his descendents.

"Holcomb began the construction of instruments for students whom he instructed in astronomy and surveying about 1820. From the manufacture of small refracting telescopes he progressed to the construction of reflectors on the pattern of Sir William Herschel, only a few of which had been seen in the United States at that time. About 1833 Holcomb took two of his telescopes to Philadelphia, where they were examined by a committee of the Franklin Institute, which was very favorably impressed with their performance.

"The instrument at the Museum has a 9-inch Russia iron tube approximately 9 feet long, closed at the lower end with a slip-on cover within which is attached a tin-alloy speculum. On the inside of the upper end is a roughly-made rack which carries the eyepiece and which meshes with a small pinion attached to a focusing knob on the outside of the telescope. The lower end of the tube is supported on a brass bar which terminates in a spike at one end and a wheel at the other, designed to permit the tube to pivot easily about the spike as a center. The upper end of the tube is supported on a simple bipod [Similar bipod mounting in SCIENTIFIC AMERICAN, Apr., 1933, p. 241.—*Ed.*], each limb of which is readily adjustable by means of a cord wound about a winch and running through small blocks in combination with the two sliding parts of each limb. By working the two small winches properly, the upper end of the tube can be made to describe practically any motion required in sighting or following a star."

The speculum of the telescope is in good condition, and it has been used with some success since it was presented to the Museum.

TYPICAL of the wide variety of occupations represented by the followers of the amateur telescope making hobby is a compilation sent us by Leo. J. Scanlon of Pittsburgh, at our request, showing a cross-section of the membership of the Astronomical Section of the Academy of Science and Art of Pittsburgh, essentially a club of amateur telescope makers.

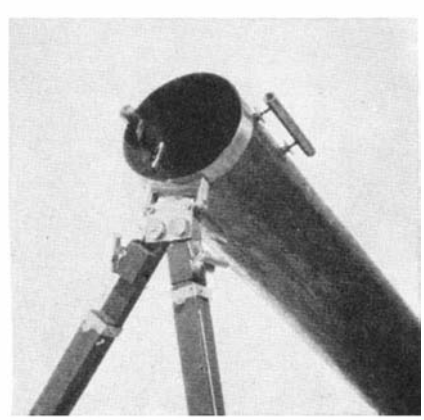
In this club are: electrical engineers 7, Westinghouse employees 8, electrical installation repairmen 2, cigar rollers 1, chemists 6, insurance salesmen 2, millwrights 3, clerks 11, sales executives 5, high school students 14, restaurant managers 2, salesmen 6, news photographers 1, stenographers 2, community house executives 2, draughtsmen 6, radio technicians 2, attorneys 1, vice-presidents of railroad 1, railroad engineers 3, baggagemen on railroad 1, grocerymen 1, news editorial writers 1, printers 2, chauffeurs 1, physicians 4, physicists 2; science teachers 1, commercial photographers 2, electricians 1, dentists 2, skilled mechanics 7, sign painters 1, Boy Scout executives 1, welders 1, research workers (Gulf) 2, projection machine operators 1, plumbers 1, college students 2, machinists 2, farm wives 1, refrigerating engineers 1, machine designers 1, credit men 1, editors farm journal 1, nuns 2.

So this is what amateur telescope makers are made of. A pretty solid cross-section of America, is it not?

THE test for approximate radius of a mirror, described on page 78 of "Amateur Telescope Making," involves wetting the surface with water, which is difficult to control, since the water soon runs off or dries. Dr. S. H. Sheib, a testing engineer and chemist, Box 737, Richmond, Virginia, states that he has found that the substitution of oil for the water affords a better opportunity to measure the radius. A mixture of ordinary machine oil and kerosene, 50-50, worked well.

WHAT, exactly, is rouge? We asked Dr. Sheib and he replied: "I understand that rouge is Fe_2O_3, and that black rouge is Fe_3O_4. If iron sulfate is precipitated with ammonia you can't get anything but $Fe(OH)_3$, or $Fe_2(OH)_6$ which is merely a multiple of the former. When you heat this you drive off the chemically combined water and get Fe_2O_3." Has anyone else any other light to throw on this question?

Another little matter: Dr. Sheib and your



Detail of the Holcomb Herschelian

scribe have been trying to work out the depth—not the diameter but the depth—of pits for different abrasives. Is any amateur equipped with a microscope having a vertical illuminator and micrometer, who can and will help us measure, if possible, the distance to their bottoms, possibly by focusing on them and using the flat surface as datum; that is, focusing the flat surface and making a reading, and then focusing the bottom and making another reading. This is theoretical and maybe it won't work. Good quantitative data on depths of pits for each size of abrasive ought to provide a basis for working out optimum grinding time for each stage of abrasive. Is depth strictly proportional to grains?

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 317)

effect, it is stated, is better than that of cork, while the material is said to be less costly than any other standard insulating material.

Ferro Therm depends for its efficiency on the high reflectivity of black iron for energy frequencies in the radiant heat range. The new insulation is applied to both flat and cylindrical surfaces and is said to be well suited for uses ranging from cold storage rooms to boilers and steam pipes and other high temperature applications where insulation is required.—*A. E. B.*

50,000 PLANETS

SPACE is filled with cosmic dust but how many of these particles of dust are large enough to be called planets? Professor A. O. Leuschner, University of California, estimates that in our small solar system there are about 50,000 so-called minor planets within reach of the largest telescopes.

AND NOW, HEAVY OXYGEN ALSO

JUST before going to press with the present number containing Professor Urey's article on heavy hydrogen, the following *Science Service* report reached the editor:

What is probably the world's rarest liquid, "heavy oxygen water," is now being produced at Manchester University, England, by means of a recently constructed diffusion apparatus.

Only a few drops of the heavy oxygen water exist. The new apparatus in which Lecturer J. B. M. Herbert and Prof. M. Polanyi of Manchester University demonstrated the production of heavy oxygen water is designed to produce 0.02 gram of the water per day.

One atom out of every hundred of the oxygen atoms in heavy oxygen water has a mass of 18 instead of the usual mass 16 of ordinary oxygen. In ordinary water the normal proportion is about one in 500. Scientists consider this concentration of the heaviest oxygen as a real achievement, since the difficulties are much greater than in separating the famous three kinds of hydrogen recently discovered.

Prof. G. Hertz of Berlin made the world's first sample of heavy oxygen water and presented the precious 10 drops (half a gram) to Prof. Polanyi, who was formerly professor of physical chemistry at the Kaiser Wilhelm Institute in Berlin. The isotopes or atom varieties of neon, the gas now used in electric signs, were also separated by Prof. Hertz.

The Manchester University apparatus for producing heavy oxygen water is very complex and consists of nine mercury vapor diffusion pumps circulating gas through porous clay called steatite. The very slight

difference in weight between the light and heavy oxygens in the water vapor makes the concentrating process slow and tedious. Even compared with its use upon gases like neon, the process is slow because the water vapor condenses upon the surfaces of the clay tubes.

Prof. Polanyi is at present in Moscow where he is consulting with Soviet scientists engaged in similar work.

CAVIAR FOR RICKETS

A REPORT from Russia reminds us of Marie Antoinette's "Then let them eat cake." In that country experiments have recently been carried out in feeding caviar to babies to prevent rickets, since caviar is rich in vitamin D.

MAKES PAINT STICK TO STEEL

A PROCESS for "conditioning" steel that is designed to promote paint adhesion and also to improve the rust resistance of the material, involves the use of a new crystalline material known as Cromodine. *Solvent News* reports that an excellent finish for high bake enamels, synthetic materials, and oil primers is obtained.

The process consists of first removing oil and rust from the steel surface in any approved manner and then dipping the parts into a heated solution of the Cromodine. The solution is held in a stainless steel tank and is heated by steam coils to 170 to 180 degrees, Fahrenheit.

The immersion lasts for one minute, following which the parts are rinsed in cold and then hot water and dried. When wiped of a powdery residue left by the process the surface is ready for the prime paint coat. The cost of the process is estimated at approximately ten cents per 100 square feet of surface to be treated.—*A. E. B.*

SPRINGS OF QUARTZ

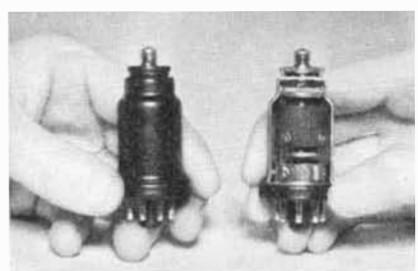
TO measure the amount of moisture taken up by paper samples from an atmosphere of a certain exact humidity is a delicate weighing job that must be done without breaking into the humidity chamber and upsetting the whole object of the test. The best way is to keep a continuous weighing device at work in the chamber, and scientists have found that under the given conditions a coil spring of pure quartz is the best device for fine and dependable weighing. A quartz spring does not rust or corrode, and it always comes back just to the mark when the load is taken off. Tests show that loading for two years or more causes no permanent sag. For a substance that looks like glass, the quartz filament is remarkably tough.

Forest Products Laboratory workers now make their own quartz springs for determining moisture characteristics of the new papers they are developing from American woods. A quartz rod is heated in an oxygen blowpipe flame and is pulled out into a long thread. This thread is then coiled, under less severe heat, into a spring about 6 inches in length, and a hook is formed at each end. After its stretch under standard known loadings has been carefully determined, the spring is ready for business. It is suspended, carrying its sample scrap of paper, inside a window of the humidity chamber, and its lengthenings and shortenings with changing moisture in the sample are accurately read by means of a cathetometer telescope mounted outside. Springs in use at the Laboratory are so sensitive that a change in weight of four one-millionths of an ounce can be easily measured.

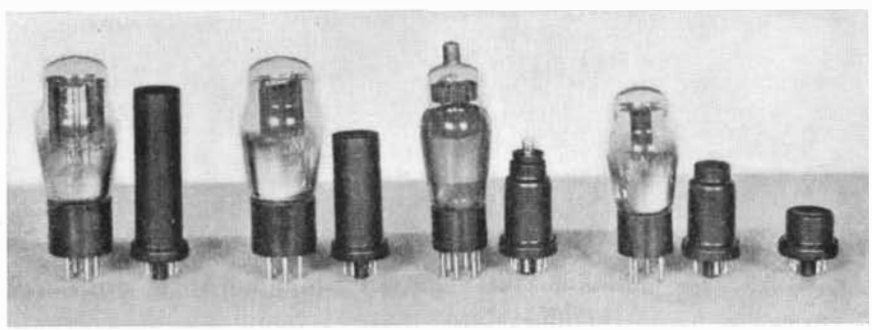
METAL RADIO TUBES

A NEW line of metal radio tubes, which tests indicate to be of greater continued efficiency of operation than the glass type now in use, was announced recently by the General Electric Company. Developed in the research laboratories of the company at Schenectady, these new metal tubes are not only much smaller and more sturdy, but are stated to offer improved electrical characteristics over the conventional tubes of today. They provide their own shielding and this metal shell is a better heat conductor and radiator than glass. They are particularly advantageous in the field of short wave reception. The short leads of the tubes permit greater amplification at the higher frequencies and the more effective shielding insures greater stability.

These new tubes are not interchangeable with glass tubes in the present type radio



Above: **One of the new metal radio tubes, and another cut away to show elements.** ***Below:*** **Glass tubes and their equivalents in metal; also, a "duo-diode" made only in metal**



receivers and will later make their first appearance in a new line of sets.

In the metal tubes, each lead-in wire passes through a tiny bead of special glass that is fused securely within an alloy eyelet, which in turn is welded to the metal container, thus assuring a long life vacuum. This alloy, having substantially the same coefficient of expansion as glass, is known as Fernico and is a combination of iron, nickel and cobalt.

The familiar metal shield which is necessary with the glass tube in radio-frequency portions of a circuit is no longer required with the new tube. The metal envelope itself serves as a shield, and, since closer proximity of shield to elements can be realized, the shielding is more effective. The new tubes have one more base pin than comparable glass tubes, in order to make provision for grounding the metal envelope.

ART

PAN-American Day, celebrated this year on April 15, was marked by the signing by representatives of 13 American republics of a treaty to protect art galleries and scientific museums in time of war. For humanity's sake, such institutions are, in effect, declared neutral territory and safe from attack.

Metallized Paper

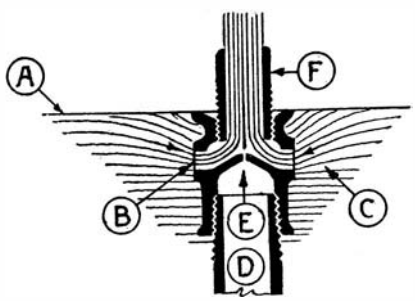
AMONG the recently developed packaging papers, DuPont announces the production of a metallized paper for labels, wraps, and inside liners. In this paper, the metal coating is deposited directly on any of a wide variety of paper stocks, providing a smooth, high-luster metallic finish resembling foil. Because the finish is applied directly to the paper, there is no lamination or possibility of peeling. The color is chromium-like. It will take printing and lithographing, as long as the inks used are suitable to the surface, which will not permit penetration. The paper can also be die-stamped or embossed.

When used as a wrap, this metallized paper can be cemented to itself with commercial types of adhesives. The finish resists oils, greases, water, humidity, tarnish, and corrosion, protecting the contents of the package or container. The product is available in continuous rolls up to 40 inches in width, and in sheets of even greater length. —*A. E. B.*

Ingenious Garden Fountain

MANY people would enjoy the play of fountains on their lawns were it not for the fact that they would have to use costly city water or install equally costly pumping equipment. An ingenious new fountain device which uses the steam injector principle commonly employed in boiler plants for keeping the boiler full has been invented by Mr. C. H. Andrews of New Castle, Pennsylvania. This fountain utilizes the fountain water for the large spray effect that is obtained, the power being obtained from the city water main. A

Above: **Garden fountain in operation.** *Below.* **Sketch of fountain mechanism. A, water level in pool. B and C, water inlets. D, water from main. E, pin hole opening from city main. F, sleeve regulating the flow**



tiny stream shooting at high pressure through the central orifice of the fountain draws with it a large volume of water from the fountain through annular openings. As can be seen from the illustration the device is extremely simple and is said to be inexpensive to operate.

The Luminous Woman of Pirano

CERTAIN animals and plants are well known to give off phosphorescent light, and from time to time luminous human beings have been reported. Generally, but not always, this emission of light has been noticed just before death. Little is known of the cause of this luminosity, and curiosity has been quickened by Anna Monaro, the Luminous Woman of Pirano, of whom Dr. G. Protti, of Venice, has recently published an account.

Dr. Protti first collected the evidence of eye-witnesses. The usual time of the light's appearance was during the early part of the night, never in the daytime, or when Monaro was only lightly asleep; it lasted never longer than three to four seconds, it always appeared in the region of the heart, it varied in color from green to red. Monaro herself was unaware of the light and it left no trace of odor, heat, or color.

Dr. Protti next made his own examination and found Monaro normal in every way, except that she suffers from asthma and has slightly raised blood pressure. She lives almost in indigence, but such food as she eats is in no way out of the ordinary. During Lent she fasts strictly, eating only soup and milk, and at this time the phenomenon manifests itself most frequently, particularly during Holy Week when the fast is almost absolute. In one night the light appeared 25 times.

No, the young lady is not playing a pipe organ, nor is she operating a telephone switchboard. She is demonstrating a model factory production control system introduced by Remington Rand. By means of this, it is possible for one girl to keep accurate records which now require the work of scores of time-keepers and clerks. At right is the automatic punch which produces the basic record

Convinced that the appearance of the light was not the result of collective hallucination, Dr. Protti installed a powerful cinematograph with a supersensitive film on which an automatic registration of the duration of the light could be made. Above the region of the heart he suspended a photoelectric cell connected with a sensitive galvanometer, and in order to eliminate all possibility of electricity being used he arranged an electroscope enabling him to examine the state of the electric charge of the air around the patient. The bed was insulated from the floor.

With the room in complete darkness a light was seen after a time to emerge from the bedclothes and Dr. Protti immediately started the cinematograph at 16 exposures per second. The light lasted 3 3/16 seconds and gradually faded away. It illuminated the jaw and cheek bones, but caused little shadow contrast. It arose from the region of the heart from an area the size of an adult's open hand, and was sufficiently strong to make the adjacent beds visible. No current was registered on the galvanometer, and when the observation was controlled there was no appreciable change on the electroscope. However, a definite shadow appeared on the cinema film. Monaro, whose sleep is usually broken and disturbed, woke with a start. At the time the light appears the heart accelerates to about double the usual rate.

An estimation of the radiating property of the patient's blood showed this to be three times that of normal blood, and it is considered that this is significant in connection with the origin of the light. This property is said to vary with the basal metabolic rate.

Having, as he believes, excluded trickery and the taking of phosphorus, Dr. Protti suggests that the religious complex which dominates the patient disturbs the endocrines, upsets the vago-sympathetic balance, and induces certain salts of the blood, notably sulfur compounds, to become phosphorescent. Such a change, he thinks, is facilitated by the fasting state. More recently Dr. G. W. Crile is reported to have demonstrated at Cleveland the emission of both visible and infra-red waves from the brains of dogs, the radiation being increased by thyroxine and adrenalin and decreased by anesthetics. Alcohol first increased and then diminished the radiation.—*The Lancet* (London).

PURE NICKEL

ETHIOPIA is now the 28th country to coin pure nickel as that country has just put into circulation 10,000,000 nickel coins of the 25 *roul* denomination and 5,000,000 of the *alati* denomination. Contrary to popular belief, America with its five-cent piece is not one of the 28 countries as this coin contains 75 percent copper.

CHEMICAL FLY-"SWATTERS"

"SWAT the fly!" is coming more and more to imply the use of chemical sprays, the efficacy of which is being constantly improved by experiment. Recently it has been found that certain synthetic organic substances such as santalyl acetate, the dialkyl phthalates and butyl-salicylate are repellent to certain species of flies, including the housefly, although they are odorless to human beings.

Two plants, derris and pyrethrum, are the noxious constituents in most fly-killing sprays. The former is to some extent replacing the latter, because a kerosene extract of derris provides a slow but distinct killing action extending and increasing over a period of 48 to 72 hours. Derris will give a larger amount of effective kerosene

extract than pyrethrum. Pyrethrum extracts provide great paralyzing and some killing action; derris extracts excel in killing action. Large quantities of derris and pyrethrum products have been used this past season for the control of truck crop pests, such as the cabbage worm on cabbage and cauliflower, replacing arsenical insecticides. Derris has also shown promise for controlling the squash-vine borer moth, as well as the cherry fruit fly. Pyrethrum is apparently a specific poison for the celery leaf tier worms.—*A. E. B.*

COBRA VENOM

THE pain of inoperable cancer is said to have been relieved by injections of suitable doses of cobra venom. Dr. David I. Macht, of Baltimore, in reporting this says that the pain-relieving effect is due to the venom's action on nerve centers in the brain. Of course, no curative effect is claimed.

BEAUTY IN CONCRETE HOUSES

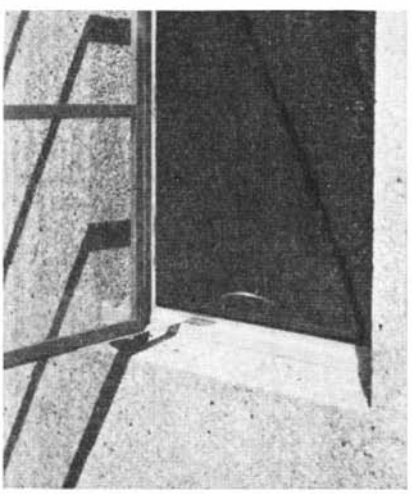
NATIONAL interest in pre-fabricated housing—the newest development in the home building industry—has centered attention on the first house to be built with pre-fabricated walls of Earley mosaic concrete, erected on the Colesville Pike, just north of Washington, D. C.

This house is the work of the studios of John J. Earley. It is built of 32 panels, each nine feet high and varying in width from four to eight feet. The panels are made of two-inch reinforced concrete with a surface of exposed aggregates of red jasperite from Oklahoma, which gives the slabs the appearance of granite and makes them a new triumph of beauty in concrete.

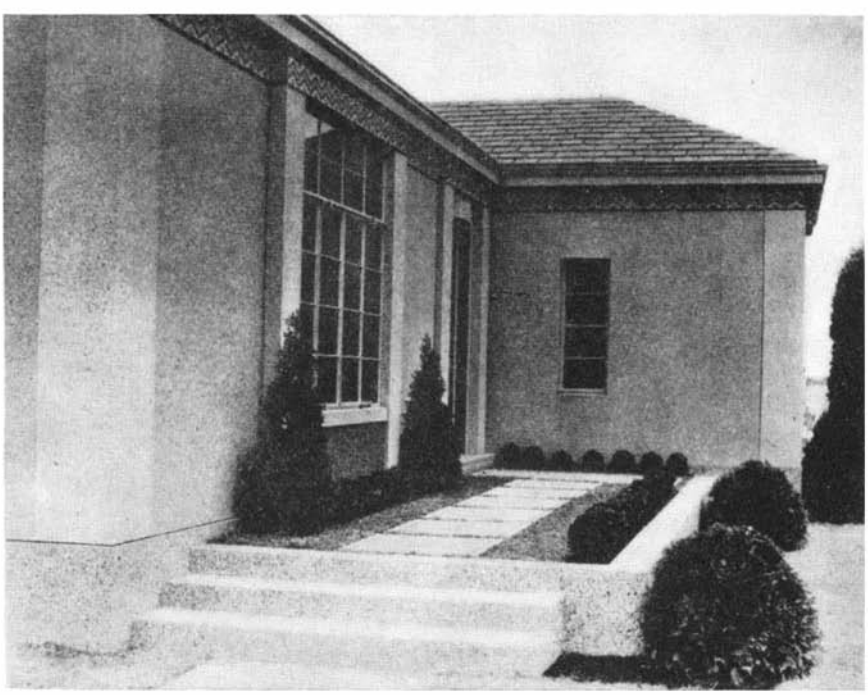
Since the slabs are pre-cast, it is possible to manufacture them under studio conditions and to harden them to a point where they are absorption-proof and water-tight. Window casements are cast into the slabs during the course of pre-fabrication, thereby avoiding the possibility of leakage and assuring proper alignment.

By a patented process, the slabs are made, face downward, in carefully designed molds carved by expert craftsmen to give the castings a perfectly chiseled surface. The mosaic frieze and the other mosaic decorations of the slabs are achieved by putting on the plaster forms of the mold a minute ridge about one-eighth of an inch high to mark the lines between the various colors of the design. The mosaic particles of the colored design, carefully prepared in a mixture of colored stone, and sand crushed from the same stone, together with cement and water, are then placed into their proper position in this design. After the reinforcing mesh has also been put into position, the mold is filled to a depth of two inches with quartz concrete of the same mixture as the colored concrete in the surface.

Only the hardest of stone and stone-like materials are used to form the pre-cast slabs. No pigments are used. The aggregates are



Above: **Steel window casement cast in pre-fabricated concrete slab for the finely textured concrete house shown below. See text on this page**



crushed in the studio, the largest flakes being roughly one-half inch in diameter and the sand particles—crushed from the same material—are graded, as are the larger particles, to a pre-determined formula which requires that this be done with an exactness of 1/1000th of an inch. All dust is eliminated in this process.

Because it is important that the concrete should fill even the tiniest and sharpest crevice in the mold, the mixture is made highly plastic. Therefore, the surplus water has to be removed before the concrete is allowed to set.

After the cast has been allowed to harden for twelve hours, it is taken out of the mold and its face brushed with wire brushes to remove the surface cement and expose the aggregates. The surface is then given a bath with weak muriatic acid to reveal the full brilliance of the coloring of the slabs. The casts are then cured for 14 days in a curing chamber which maintains an exact humidity and leaves them with a hard, flintlike surface, and a crushing strength of about 5000 pounds to the square inch—a man-made granite.

The pre-cast panels are then assembled on the concrete foundation of the building and anchored into small structural concrete columns cast in place at each joint. The anchoring is done by an engineering device which keeps the slabs from actual union with the concrete columns, but produces a perfectly water-proof joint and at the same time allows for expansion and contraction.

Colorful Milk Bottles

MILK bottles with the dairy's name or trade mark embossed in bright colors are being adopted rapidly by many of the large dairies. The application of these permanent and attractive colors to glass is a recent development, and represents an interesting application of chemistry.

There are two methods used for colored lettering on glass, called "pyroglazing" and "anigraphing." In the former, the markings are not diminished in brilliance or distinctiveness by washing, exposure to sun, wind, or frost, or rubbing of bottles against each other. They are obtainable in a variety of bright colors such as blue, green, orange, or red. In addition to lending attractiveness to the bottles, especially when filled with milk or cream, they make "pirating" of empty bottles more detectable.

Anigraphing may be likened to lithographing or printing in that any pattern or design that can be transferred to paper can be transferred to glass. The imprint is resistant to ordinary solvents, to washing and cleaning operations, and to ordinary shelf and storage conditions. Anigraphing, like pyroglazing, gives a protective as well as a decorative identity to the container.—*A. E. B.*

Vitaminized Beer

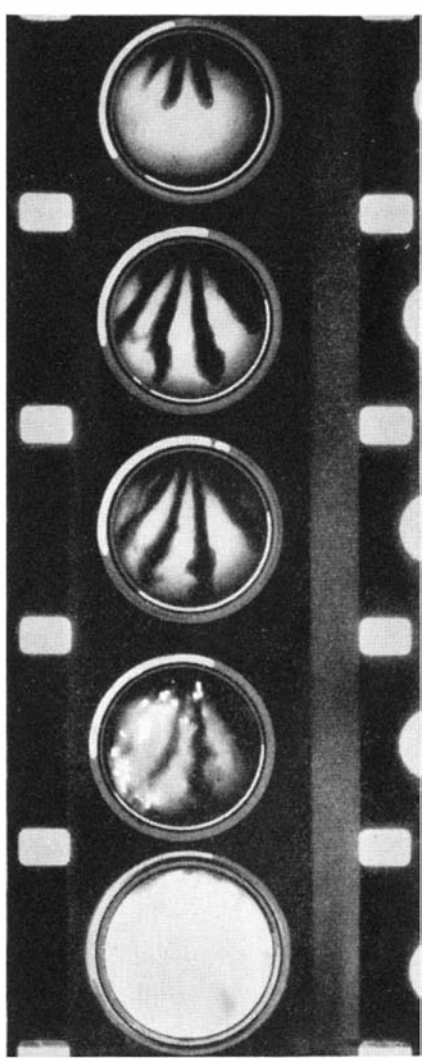
WHEN beer first "came back," a thirsty populace was concerned entirely with its taste and its "kick." But now that the novelty has worn off, enterprising brewers are casting about for new ways of giving their product sales appeal. In view of the current fad for reinforcing various food products with vitamins, it is not surprising to hear of a new process for vitaminizing beer.

Some of the raw materials of brewing contain vitamins, and brewer's yeast is an excellent source of vitamins B and G, but the finished filtered beer contains no significant proportion of any vitamin. Fritz Lux, who describes the process of vitaminizing beer in *Brewers Technical Review*, utilizes the cell sap separated from yeast by supercentrifugalization or by other methods. The inventor of this method says that the cell-free liquid contains 25 to 30 percent of soluble yeast proteins, the vitamins and the enzymes. He proposes the addition of definite proportions of this cell sap to the beer after the main fermentation. The inventor asserts that the vitamins and enzymes mix with the beer and pass through the filter.—*A. E. B.*

Combustion in Diesel Cylinders

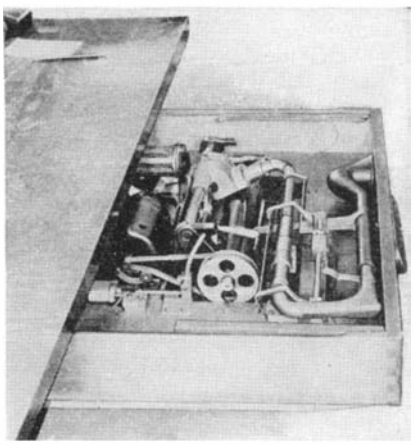
USING special glass windows resisting temperatures up to 3500 degrees, Fahrenheit, aviation research scientists have just discovered how fuel oil burns in a Diesel engine.

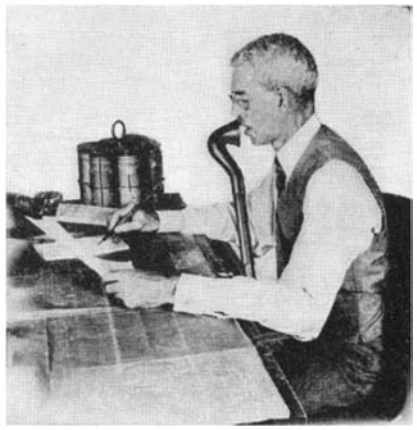
New facts which are expected to advance the possibility of using Diesel engines in aircraft have been found by taking high-speed photographs through these windows. These facts were reported by A. M. Roth-



High-speed photographs show flame propagation in a Diesel cylinder

Below: **A new type of dictation machine is housed in a desk drawer, and,** *right,* **is ready for instant use. It leaves both hands free for making notations or holding papers**





rock of the National Advisory Committee for Aeronautics Laboratories at Langley Field, Virginia, before the meeting of the Institute of the Aeronautical Sciences.

Mr. Rothrock showed motion picture film before the aviation meeting taken at the rate of 2500 frames a second. The film upset theories about how fuel burns in such engines—opinions which have existed since the Diesel engine was first invented.

The characteristic feature of the Diesel engine is that fuel oil is injected into the air of the cylinders which has previously been compressed by the stroke of the piston. Under compression the air temperature rises until it is high enough to ignite the injected oil. No electric spark is necessary. Previously it had been supposed that the oil began to burn as soon as it came in from the fuel jets. Mr. Rothrock's film proves that combustion occurs only after the fuel fills the cylinder.

G. W. Lewis, director of aeronautical research of the N.A.C.A., said that the new technique should speed research in the Diesel engine field. Heretofore, he said, various types of fuel jets—as only one example—were made and inserted in the cylinders. How well they worked could be determined only roughly as long as it was not possible to see or photograph what was going on inside during combustion. With the new windows and high-speed photography, rapid checks on performance can be obtained.—*Science Service.*

Improved Dictation Machine

EVERY executive using a dictation machine has appreciated the difficulty of placing that useful aid so that it is completely handy to the man at a desk, yet out of the way when not in use. If the machine is mounted on a wheeled iron stand, it interferes with opening drawers when dictating, and may interfere with the side chair when callers come. If located on the desk top, it occupies space needed for papers; and the mouthpiece tube is often in the way.

These inconveniences are avoided by the Howarth Dictation Machine. With this machine the dictator sits facing his desk (or the table used with the desk), just as when dictating to a stenographer, with all his papers in front of him. The machine is fitted into the shallow middle drawer, which is of special design, and the mouthpiece tube rises from the front interior of the drawer. The scale and pointer (which show the position of the stylus on the cylinder) are in plain view at the front edge of the desk. Hence the cylinder number, start and stop positions of the stylus, and errata, can be noted as dictation proceeds, either on letters being answered or on a separate pad.

PLATINUM

WORLD consumption of platinum last year was about 200,000 troy ounces compared with 175,000 in the preceding year. The odd thing is that its price has been approximately the same as that of gold because of the governmental decree raising the price of the latter metal.

New Process for Sulfuric Acid Manufacture

SUCCESSFUL operation of a new plant for making sulfuric acid out of ferrous sulfate has demonstrated the commercial feasibility of reclaiming useful products from a nuisance by-product. The plant in question, built in the middlewest by the Chemical Construction Corporation, is using waste ferrous sulfate in the production of over 100 tons per day of 100 percent equivalent H_2SO_4. A similar plant of equal size is under construction for the same owner in the east. The process appears to be equally applicable for other ferrous sulfate liquors, such as that from steel pickling. It thus opens a field for the possible prevention of stream pollution by pickle liquor from the steel mills.

In operation of the process, says *Chemical and Metallurgical Engineering,* the ferrous sulfate liquor is evaporated to produce a substantially dehydrated material which is then roasted under reducing conditions to yield a strong SO_2 of purity sufficient for use in a vanadium catalyst contact plant. Prior to roasting, as is done in the plant now in operation, green sulfide ores may be mixed with the sulfate to produce additional acid, if this is desired. In addition to SO_2 the roasting yields an iron oxide cinder, part of which is used to neutralize any excess acidity in the feed liquor. Under cer-

tain circumstances the cinder may be used for its iron content in blast furnaces, or it is suitable for the production of pigments.—*A. E. B.*

"Ticket to Mesopotamia, 3000 B. C."

IF you could travel backward through time to any historic age you liked, would you say to the "time-ticket" agent:

"Mesopotamia, please, 3000 B.C.?"

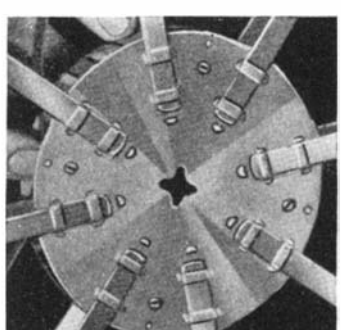
That is where one archeologist, Dr. E. A. Speiser of the University of Pennsylvania, would like to go for a brief change of historic scenery. If the trip could be managed, he could witness one of the major events in human progress—the beginning of the era of history. Evolution of writing was accomplished about 3000 B.C., and learning to write changed life so radically that Dr. Speiser says: "Nothing like it is seen again until we get down to within earshot, so to speak, of our own times."

Digging at sites such as Ur, Tepe Gawra, and Erech in Mesopotamia reveals the sharpness of changes that took place. Despite the impressive succession of generations of prehistoric folk, who left their pottery, their architecture, and their art to show what they were like, the unlettered ancients remain shadowy and anonymous.

But, says Dr. Speiser: "When we learn that the first independent ruler of Ur was a certain Mesannipadda, that the language he spoke was Sumerian, that he made war on the people of Erech, and that he gave costly presents to his wife whom he mentions by name, we realize at once that quiet and anonymity have departed forever and that history is upon us in full sway. It all began the moment the past had broken its silence."—*Science Service.*

An Anti-Bend Movie Film Reel

THE film reel shown in the illustrations is not so much anti-bend as anti-stay-bend. Being of spring band steel, it can be bent freely, but instantly flies back to its original alignment. It can even be jumped on without changing the trueness of its lines. While the spokes are riveted to rims, they slide under steel bands on the hub.



Above: **Close-up of center of new spring steel movie reel.** ***Right:*** **The reel withstands rough treatment**

Clipping film on this reel is made automatic by wells sunk in the hub. When the film is laid over one of the wells and pressed, film perforations catch in prongs and hold securely until the end of the run.

The new reel does away with the bends and twists in ordinary wire or stamped reels—so fatal to the life of the film and to the smooth, uninterrupted run of the show. This model is for 16 mm. film and holds 1600 feet.

Coyotes Move East by Modern Methods

THE coyote, "wild dog of the western plains," seems to be moving east. In keeping with its reputation of resourcefulness, this predator is "moving in" by modern means of travel, the automobile and the express train, according to naturalists in the United States Department of Agriculture.

Tourists in the west often purchase coyote puppies and bring them east. They do not find them dependable pets, however, so there is little grief when an occasional coyote escapes. In a few cases eastern sportsmen have brought in young coyotes and freed them, thinking they were fox puppies. From these small beginnings have developed numerous infestations in some of the eastern states.

Coyotes are now present in New York, Pennsylvania, Tennessee, South Carolina, Georgia, Florida, and Alabama, and may be present in other eastern states. In addition to artificial plantings, coyotes are pushing eastward of their own accord, having been recently reported in parts of lower Michigan and Indiana.

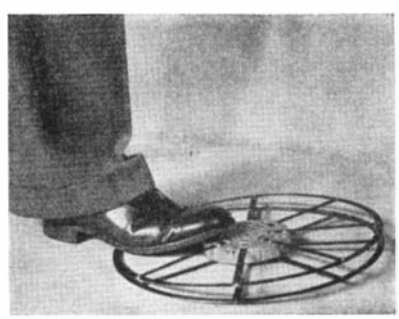
The paid-hunter system is advocated by the Biological Survey as the best method of keeping coyotes under control. The payment of bounties often leads to abuses and deception.

Although coyotes are scavengers and, in addition, destroy many rodents, they are all too likely to find it easier to obtain their living by killing poultry and young pigs, lambs, and even calves. For this reason they may become as much a menace to eastern farmers as they have been to the western rancher.

Cheese Wrapped in Cheese

CHEMISTRY is a versatile science, but it hasn't a cure for everything. Common sense sometimes goes chemistry one better, as illustrated by a new scheme for preventing mold on Swiss cheese. While chemists were studying ways to prevent the deterioration of the cut loaf of Swiss cheese, one of them got the bright idea of wrapping the cheese in cheese.

High-quality Swiss cheese can be made only in "wheels" of 200 pounds or more. Production in smaller sizes causes loss of flavor or suppression of the "eyes" that the



Courtesy The Texaco Star

A fleet of the new streamlined oil trucks described on this page

consumer has learned to demand. However, these large wheels have serious drawbacks. They cannot be cut into sandwich squares without serious loss and one wheel is much too large an order for the usual retail dealer. If he buys a part of a wheel either the cut surface dries out and must be discarded or it develops mold and so causes loss.

Heretofore, the only way to remedy the difficulty has been to process the cheese into bricks by heating and grinding it. Processing works well with some types of cheese but it injures the flavor and removes the eyes of Swiss cheese.

The new method, described by Fred C. Bowman in *Food Industries*, offers a new solution of the difficulty. The standard 200-pound wheel is cut into loaves with the usual wire cutting machine. About 50 pounds of small pieces remain. They are heated and pasteurized, and then molded into blocks of cheese free from holes. They are then cut into sheets ⅛ of an inch thick and are used to veneer the "eyed" bricks. The face of the eyed brick is softened by holding a hot iron near but not against it for a few seconds and then the veneer is pressed upon it and adheres perfectly. All six surfaces of the loaf are covered in this manner, giving a finished loaf that is completely sealed with an impervious layer of pasteurized cheese. It is finally wrapped in tinfoil and parchment paper.—*A. E. B.*

Liquid Copper

LIQUID copper which can be applied to any surface to form a coating of 98.3 percent purity is announced by the Nichols Copper Company. This unique discovery involves pulverizing the metallic copper to such a fine powder that it remains suspended in the liquid vehicle, the composition of the latter being something of a secret. Applied to any surface, "liquid copper" affords complete coverage, the form of the minute particles preventing the appearance of minute gaps in the coating. Two scientists have been at work on this problem for nearly 8 years and after repeated trials, have finally produced the copper in the form required for application and mixing with the vehicle. The maker emphasizes that this new product is not an oxide nor a bronze powder. Tests have shown that it should have a useful life under actual service five to ten years, or longer.—*A. E. B.*

Streamlined Tank Trucks

WE ordinarily think of streamlining as being most effective on vehicles for which extremely high speeds are desirable. Mr. H. W. Kizer, Superintendent of Motor Equipment for The Texas Company, however, believed that streamlining would have many advantages for the company's tank trucks. Six of these have now been built and have proved most satisfactory.

The advantages of the streamline design are economy and ease of operation, greater carrying capacity in relation to size, and increased visibility for the driver—a safety factor well worth considering.

Each truck, although only 26 feet long, has a capacity of 1500 gallons. The engine is mounted in the rear; the clutch, brakes, gear shift, and steering are controlled by air from the driver's compartment.

"Baby Talk" Among Writers

IS it "baby talk" that T. S. Eliot, Gertrude Stein, and other modernists have been giving us in some of their recent writings?

The *Journal of the American Medical Association* interprets the tendency of these writers to link words together by sound rather than by meaning as "essentially infantile."

"One expects the insane to utter every thought that comes into their minds without worrying about continuity or sustained interest," says the medical journal. "Such writing, however, belongs in textbooks of psychiatry rather than in essentially artistic productions of the type intended by James Joyce in 'Ulysses.'"

Man developed reason and intellect in order that he might express himself reasonably and intellectually, the Journal points out in an editorial called "The Psychology of Modernism in Literature."

A poem by T. S. Eliot is offered as an example of the type of writing criticized. It reads:

"If it was to be a surprise
If it was to be a surprise to realize,
If it was to be if it were to be, was it to be.
What was it to be. It was to be, was it to be.
And it was. So it was. As it was. As it is.
As it is as it is. It is and as it is and as it is.
And so on and so on as it was.
Keep it in sight alright."

"Who, one hundred years hence, will quote Eliot or Gertrude Stein as today we quote the writings of Shakespeare, Tennyson, and the Bible?" asks the Journal.—*Science Service.*

Alupak Gaskets

A NEW gasket material of unique properties has been placed on the market under the name of Alupak. The sheets are constructed of alternate layers of thin sheet aluminum and fine wire mesh. An elastic compound binds the sheets together into one flexible piece forming a gasket which,

it is claimed, will hold even on warped and super-heated surfaces, since the gasket actually swells when subjected to heat. This expansion forces a perfect seal on all parts of the flanged surface and fills in all warped or uneven spots.—*A. E. B.*

Tough Glass

DURING the past month or two certain members of a laboratory staff have frequently amused themselves and visitors by tossing glass lenses on a concrete floor. The height of the drop has varied from four to ten feet, and not a single lens has been broken to date. These lenses are not laminated or reinforced by wires or any extraneous mechanical means. They are for optical purposes and, therefore, clear. They can be and have been broken, but it is estimated that the blow required is 13 times as great as that required to break a lens of ordinary optical glass of the same dimensions. Moreover, ordinary glass breaks into relatively large, razor-edged splinters, whereas this glass breaks into less hazardous small pieces with rounded edges.

Peculiarly, this glass is made by violating the traditional "good factory practice" which is considered essential for toughening glass. In ordinary processing, glass is cooled slowly from the molten condition, to minimize the formation of strain. This process is called annealing. But the process used to make these tough lenses reverses the usual procedure. The glass is heated to the softening point, about 1500 degrees, Fahrenheit, and then quickly cooled by means of an air jet, steam jet, or immersion in oil at approximately 400 degrees, Fahrenheit. The result is that the exterior layer of the glass is quickly solidified, while the interior, cooling at a slower rate, contracts and places compressive forces on the exterior. The interior is put under very strong opposite but equal tensions which are revealed by polarized light. Instead of avoiding strains as in the old art, strains are intensified, but their direction controlled to obtain symmetrical stresses. However, this relatively new art is not so novel; those of us who made Prince Rupert drops for amusement employed it.

The utility of toughened glass of this type is apparent for use in industrial goggles, its first commercial application. An ordinary glass lens, though furnishing primary protection to the eye against flying particles of metal, stone, and so on, creates a secondary hazard when it is shattered to form sharp-cutting splinters. Tough glass lenses, on the other hand, resist breakage to a far greater degree, and when broken do no cutting. Glass goggle lenses of this material readily pass twice the shock resistance demanded by United States government specifications GGG-G-501.

These new glasses are not restricted to industrial goggles. They are successfully employed for correcting defective vision, and make the frame, rather than the more expensive lenses, the more delicate portion of eyeglasses. There is but one restriction to the use of such lenses; the minimum dimension must be over three millimeters to retain characteristic features. A thick lens is thus necessary in some extreme cases, but this disadvantage is offset by protection against breakage. Tough glass is also used in various types of bifocal and curved lenses.

The superior physical properties of tough glass deserve further study. Because of this superiority, its use for non-optical industrial purposes is suggested. Its thermal properties in larger sizes should be closely observed, particularly with reference to large and bulky pieces. Naturally, in many of these extended applications, the tough glass will not require the grinding and polishing essential for optical requirements.—Arthur D. Little's *Industrial Bulletin.*

ALLOY WIRE

NEARLY a mile of three quarter inch nichrome ribbon is used in the electrical heating elements of the special annealing kiln of Corning Glass Works in which the disk for the 200-inch telescope is being gradually cooled.

Rubber Lining for Chemical Tanks

GREATER resistance to both acids and alkalis is claimed for a new hard-rubber lining for tanks that has been announced under the designation of MR-10 by the American Hard Rubber Company. The lining possesses a highly glazed surface and is bonded securely to a relatively thin layer of soft rubber which is vulcanized to the steel tank, providing an elastic connection to compensate for thermal changes and protect against shocks. In the installation of this lining, soft rubber fillets are used at all corners.

The compound used for the lining has been improved in pliability and, on account of the high gloss surface, is easier to clean. Acid resistance is said to be better, permeability less, and the cost no higher.—*A. E. B.*

Why We Can't Drink Sea Water

THE inorganic salt content of sea water is very much higher than that of the blood of man and other terrestrial animals. The salt content of the water of the Atlantic and Pacific oceans is over 3 percent, while that of the blood plasma of man is about 1 percent. Most of the salt in sea water is the ordinary sodium chloride as is the case with the human blood plasma, but in the salt water is proportionately more magnesium sulphate than in the human blood plasma. It is also known that excess salts in the blood are eliminated by the kidneys. This elimination requires the elimination of an increased amount of water, which, in the first instance, is taken from the blood plasma. In the case of a person, therefore, who tries to ease his thirst by drinking sea water, the following things happen:

Because of the higher salt content of the sea water there is an increase of concentration of inorganic salts of the blood. This tends to draw water from the tissues and increase the thirst sensation. At the same time the kidneys are eliminating these excess salts together with a great deal of water from the blood plasma. This further increases thirst. Lastly, the magnesium sulphate in the sea water is not readily absorbed from the intestine, and the presence

of this salt in the intestine holds back a certain amount of the water from absorption. It is therefore clear that endeavoring to stop thirst by taking sea water aggravates the thirst and hastens death. People will therefore live longer and with less discomfort by taking no water at all than by drinking sea water. People can survive longer without water if they abstain from taking food.—*Journal of the American Medical Association.*

An Experiment in Artificial Daylight

ALL-DAY daylight for dark court apartments is an experiment now being tried by the Bowery Savings Bank of New York at a 14-story apartment house.

Regardless of weather conditions, light now streams through the windows of all court apartments, from the tenth floor down, in that building. Formerly some of these apartments were so dark that they required inside artificial illumination even on bright days. Now, according to a statement issued by the real estate department of the bank, tenants can easily read newspapers in corners of the rooms farthest from the windows.

The workings of the plan are simple. Courts have been painted white and in them have been placed batteries of 1000-watt Nova-lux lamps. Light from these lamps strikes the white walls of the court and the rays are deflected through the windows.

"The rays are so diffused," says the bank's statement, "that light coming through the windows has no glare and no resemblance to artificial light. As light pours in, it resembles mild sunshine more than anything else."

The lamps are controlled from a central switch in the basement which, in turn, is controlled by a time clock. When lamps are turned on in the morning, it requires 15 minutes for them to give out maximum illumination and when they go off at night another 15 minutes is required for the gradual step-down.

"We don't wish to awaken tenants in the morning with a sudden flood of light," says the bank's statement. "The step-up and step-down system approximates as closely as possible conditions of daybreak and twilight."

The new system is an experiment. If it works out, the bank believes it may be a first step toward materially improving living conditions in urban communities and may pave the way toward the easier renting of thousands of apartments now facing on courts.

Capturing the Songs of Birds

A REPORT just received by Dr. Roy Chapman Andrews, Director of the American Museum of Natural History, from Albert R. Brand, member of the American Museum-Cornell Ornithological Expedition which started out in mid-February for an extensive tour of the United States to photograph birds and record their songs, reveals that the expedition, now in Louisiana, has covered 15 states, traveled about 3000 miles in the past two months, and recorded some 30 species of birds in Georgia, Florida, and Louisiana. The expedition's next objectives are Texas, Oklahoma, and the Rocky Mountain States. It will probably be on active service in the field all summer.

Leading the expedition is Dr. Arthur A. Allen, Professor of Ornithology at Cornell, whose unusual and beautiful movies of nesting birds are well known to all bird lovers. Paul Kellogg, Instructor of Ornithology at Cornell is in charge of the sound truck, microphones, and recording apparatus; while Dr. George M. Sutton, Curator of the Cornell Museum, and a bird artist of distinction, is making color reproductions of the birds.

Albert R. Brand, Associate in Ornithology at the American Museum, is sponsoring the expedition. Since 1930 Mr. Brand has been collecting the sounds of native birds, and has had a number transferred to phonograph records. These are available to schools, nature study groups, scout troups, and bird students generally, and are great aids in learning the bird songs. Up to 1935 about 115 bird sounds had been recorded on movie film and are in the collection. By the time the expedition returns from the field it is expected that almost 200 species will have been recorded.

"The expedition," says Mr. Brand in his report, "is getting material valuable to science and of popular interest, without in any way disturbing or molesting the subjects. Not a single bird is being collected. More than a mile of sound film has been taken thus far. These are the first sound records that have ever been obtained of many of the species. A primary objective of the expedition is to secure the sound and to take motion pictures of those species of birds that are becoming scarce."

Cadmium Battles Corrosion

TO combat the extraordinarily severe conditions encountered in the Antarctic, Admiral Richard E. Byrd had a great deal of his steel equipment cadmium plated. This metal is said to provide the greatest protection against rust, corrosion, and fatigue with a minimum thickness. Although not so attractive in appearance as chromium plating, it is finding a rapidly growing field in utilitarian applications where beauty of the finished plated surface is a secondary consideration.

The combination of iron with other metals to produce the high-strength alloy steels required for airplane construction and for quality tools and parts renders the resulting product far more subject to corrosion in most cases than the iron itself. For this reason protection from corrosion becomes extremely important. Cadmium has been found to be the most effective and economical metal to afford this necessary protection.

The aforementioned examples constitute but a few of the many applications of cadmium on similar products. Most new automobiles are furnished with cadmium-plated tools as part of their standard equipment and numerous vital parts of every car are so protected. A glance around a well-equipped service station will disclose entire kits of tools free from rust, protected by cadmium. A visit to a hardware store will reveal quantities of cadmium-plated pliers, wrenches, screw-drivers, screws, bolts, nuts, hinges, locks, and other hardware of many kinds.—*A. E. B.*

CURRENT BULLETIN BRIEFS

BETTER HOMES IN AMERICA GUIDEBOOK. The current drive on housing in the United States makes this 1932 publication especially valuable. It outlines clearly and succinctly the purpose of the Better Homes Movement and how it may be successfully promoted. *Better Homes in America, 101 Park Avenue, New York City.—5 cents.*

PRESERVATION WITH NO-D.K. An excellent treatise on the various methods of preserving wood from decay and termites, by means of a natural wood creosote oil. *Write for Bulletin 635-A, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

PRINTING SHOULD BE INVISIBLE, by Mrs. Beatrice Warde, is an excellent exposition of the fact that the actual typography used in advertising should carry the story but must not of itself detract from the message. *The Marchbanks Press, 114 East 13th Street, New York City.—Gratis.*

HYDRAULIC POWER TRANSMISSION. A résumé of the adaptability of petroleum oils to hydraulic power transmission of various types. Thoroughly illustrated with line drawings and photographs. *Write for Bulletin 635-B, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

PUBLIC EDUCATION IN THE VIRGIN ISLANDS, by Katherine M. Cook, tells how education has been made an integral part of social and economic rehabilitation of the Islands. *Superintendent of Documents, Washington, D. C.—10 cents.*

CHEMISTRY IN THE SERVICE OF SCIENCE, by Dr. A. T. Lincoln. A pithy little report which surveys briefly the whole field of science and what chemistry has contributed to each branch. *Write for Bulletin 635-C, Scientific American, 24 West 40th Street, New York City.— 3 cent stamp.*

AMERICAN TYPE LOCOMOTIVES. A large sheet is available showing the development of the Eight Wheel or American type locomotive from 1867 to 1900. An interesting portrayal of locomotive development. *Railway and Locomotive Historical Society, Inc., Baker Library, Harvard Business School, Boston, Mass.—Gratis.*

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THE INTERNATIONAL LABOUR ORGANISATION MEMBERSHIP OF THE UNITED STATES AND ITS POSSIBILITIES. April 1935 issue of *International Conciliation.* A discussion of the place of the United States in the International Labour Organisation, telling of the benefits which may be brought about to laborers of all countries if harmonious international action can be achieved. *Carnegie Endowment for International Peace, 405 West 117th Street, New York City.—5 cents.*

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INDUSTRIAL DIXIE

(*Continued from page* 289)

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Books SELECTED BY THE EDITORS

(*Continued from page* 284)

press and from speeches of noted men relating to all phases of warfare. In many cases opposing arguments are placed in parallel columns.—$2.15 postpaid.—*F. D. M.*

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By Winifred De Kok, M.C.R.S., L.R.C.P.

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