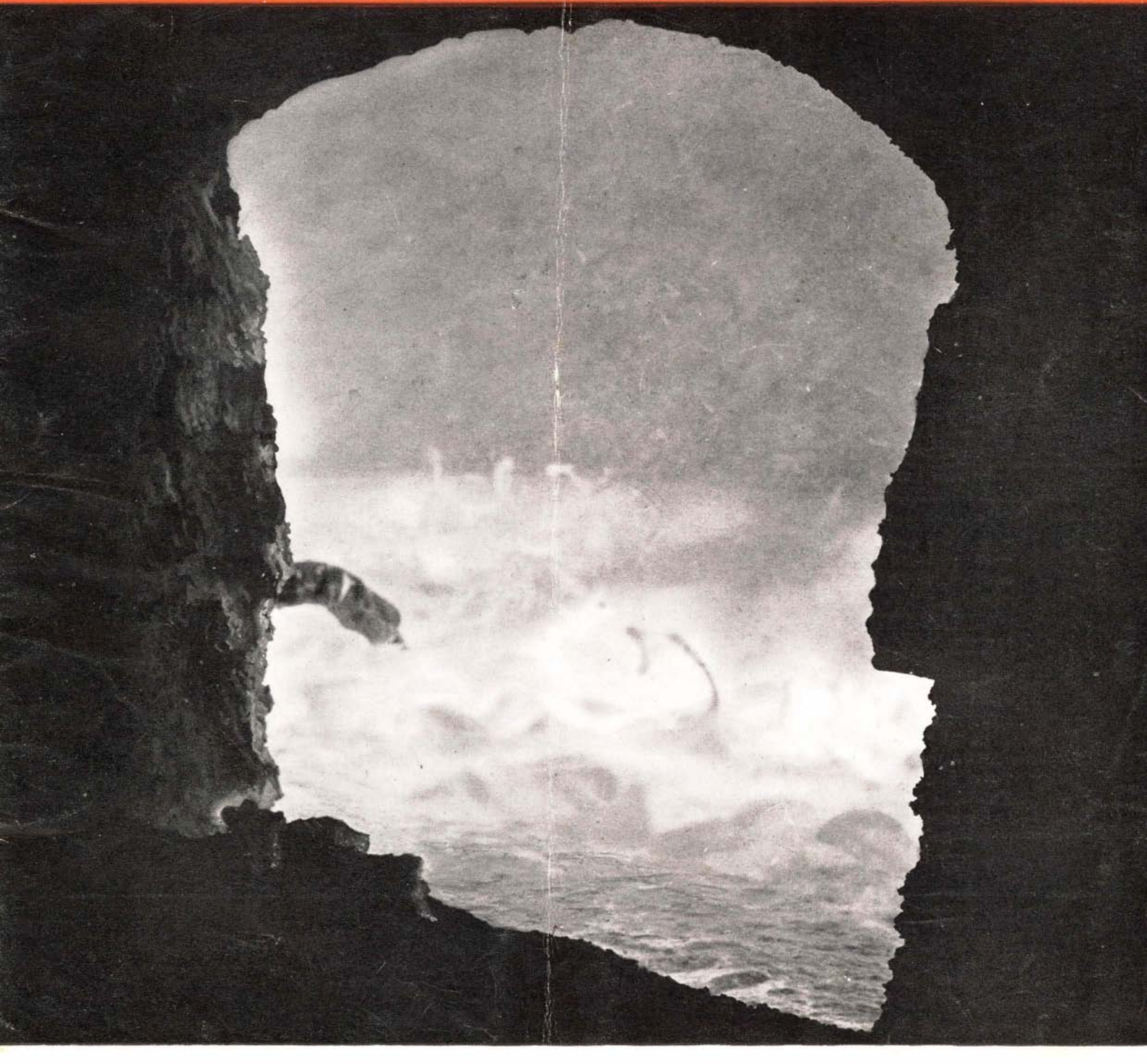
Scientific American

FOUNDED 1845

FEBRUARY
1948

50 cents
a copy

PROGRESS IN INDUSTRY



OXYGEN IN STEELMAKING

© 1948 SCIENTIFIC AMERICAN, INC

VITAL TOOL FOR *Management!*

Use it to *SPREAD* the national debt!

WITH MANAGEMENT BACKING, PAYROLL SAVINGS PLAN CAN HELP BUSINESS AND NATION

In 19,000 companies, the Payroll Savings Plan (for the regular purchase of U. S. Savings Bonds) has made employees more contented in their jobs—has cut down absenteeism—has even reduced accidents!

In addition, of course, the Plan builds financial security for each participant. Each Bond pays $4 at maturity for every $3 invested.

But the Plan has other, far-reaching benefits —to business and to the nation—which are equally important to you.

SPREADING THE NATIONAL DEBT HELPS SECURE YOUR FUTURE

The future of your business is closely dependent upon the future economy of your country. To a major extent, that future depends upon management of the public debt. Distribution of the debt as widely as possible among the people of the nation will result in the greatest good for all. How that works is clearly and briefly described in the brochure shown at the right. Request your copy—*today*—from your State Director of the Treasury Department's Savings Bonds Division.

WHY EXECUTIVE BACKING IS VITAL

Employees still want the benefits of the Payroll Savings Plan. In fact, they *need* the P. S. P., because banks don't sell Bonds on the "installment plan"—which is the way most workers prefer to buy them. But wartime emotional appeals are gone. Human nature being what it is, the success of the Plan in your company is liable to dwindle unless a responsible executive keeps it *advertised.* The *reasons* for promoting it are as important as ever—to you, your company, and your country.

So—today—*check up* on the status of the Payroll Savings Plan in your company. *Act* on your responsibility to see that it is vigorously maintained.

The State Director will gladly help.

"The National Debt and You,"

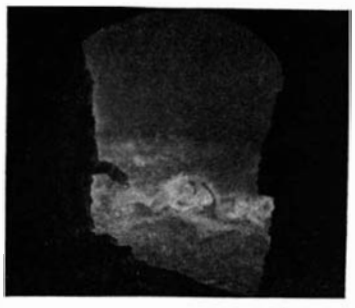
a 12-page pocket-size brochure, expresses the views of W. Randolph Burgess, Vice Chairman of the Board of the National City Bank of New York, and Clarence Francis, Chairman of the Board, General Foods Corporation. Request your copy from the Treasury Department's State Director, Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

Scientific American

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council

© 1948 SCIENTIFIC AMERICAN, INC



ON THE COVER: Oxygen is directed through a jet device (at left of opening) at the molten bath in an open hearth furnace. Uses of oxygen in steel making are discussed in the story beginning on page 53.

EDITORS

ALBERT G. INGALLS

JOHN P. DAVIS

K. M. CANAVAN

NEIL UPTEGROVE

PICTURE CREDITS

Cover — The Linde Air Products Company
52 — The Linde Air Products Company
54 — Air Reduction Company
55, 56 — The Linde Air Products Company
57, 59 — Chemical Engineering
62 — Materials & Methods
63 through 65 — Monsanto Chemical Company
66 through 69 — Westinghouse Electric Corporation
93 — The Blanchard Company and Frank Cooke

ADVERTISING STAFF: F. CLEMENT SCOTT, Eastern Advertising Manager. Western Advertising Representatives, HARLEY L. WARD, INC., 360 North Michigan Ave., Chicago 1, Ill. JOSEPH W. CONROW, 1175 Woodbury Rd., Pasadena 6, Calif.

Subscription Rates:

ONE YEAR—$5

TWO YEARS—$9

THREE YEARS—$12.50

Canada 50¢, foreign $1 per year additional

WHEN you change your address, please notify us immediately, giving your OLD as well as your NEW address. Postal requirements are such that our subscription files are arranged geographically, not alphabetically. Because of this, failure to give your old address may result in delaying receipt of copies.

SCIENTIFIC AMERICAN, February, 1948. Vol. 178. No. 2. Owned and published by Scientific American, Inc., 24 West 40th Street, New York 18, N. Y. Entered at the New York, New York, Post Office as second-class matter June 28, 1879, under act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Scientific American, Inc., 24 West 40th Street, New York 18, N. Y.

Copyright 1948 in the United States and Berne Convention countries by Scientific American, Inc. Reproduction of any article or other work published herein is expressly forbidden without written permission from the owner of copyright. "Scientific American" registered U. S. Patent Office.

Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Files in all large libraries; articles are indexed in all leading indices.

Scientific American

Founded 1845

In This Issue • February 1948

© 1948 SCIENTIFIC AMERICAN, INC

50 Years Ago in . . .

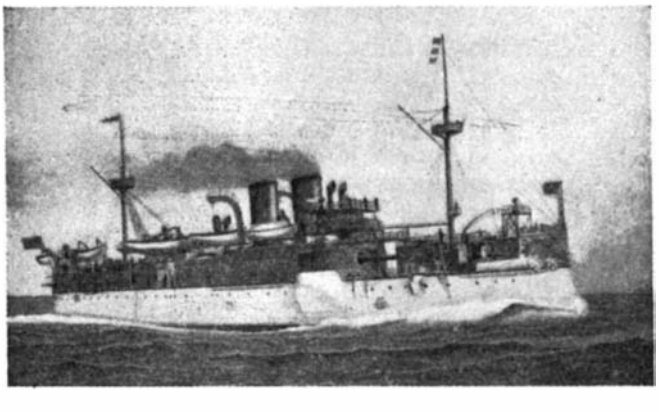
(Condensed from Issues of February, 1898)

LIQUID AIR — The economical liquefaction of air in large quantities has been recently accomplished by Mr. Charles E. Tripler, of New York, after several years of experimental work. Two and a half gallons of the liquid were recently sent from his laboratory to Prof. Barker, of the University of Pennsylvania, and its properties were exhibited in an extremely interesting series of experiments during a lecture delivered by Prof. Barker to his class and a company of invited guests. This was the first public exhibition of the kind in the United States.

VENUS — M. Flammarion, the astronomer, has been discussing the hypothesis of Schiaparelli, recently supported by Mr. Lowell and other observers, to the effect that the planet Venus, by rotating round her axis in the same period as she revolves round the sun, always presents the same face to the sun, as the moon does to the earth for the like reason. Flammarion thinks that the marks on the surface watched by Schiaparelli are effects of atmosphere and sunlight, and not on the body of the planet. He points out that the deep atmosphere of Venus probably absorbs so much of the light from its surface that we are unable to see the latter.

PARIS FORTIFICATIONS — After more than twenty years of discussion, the French Government is submitting to Parliament a scheme for the demolition of the fortifications of Paris from the Seine to the Porte de Flandres, a stretch of about eight miles. It is expected that the Chamber will ratify the proposal, which will be of great service to Paris, in removing a boundary which stands in the way of free extension of the city, while it is no longer of value as a fortification, and, in fact, counted for nothing in the defense of Paris in 1871.

SINKING OF THE MAINE — The great calamity which has befallen the nation in the loss of one of its finest ships, with over two hundred and fifty of its brave and ever popular blue jackets, has brought mingled feelings to the hearts of the American people, feelings in which bewilderment and deep sorrow predominate. The perplexity and anguish which such marine disasters produce are here intensified by the extraordinary coincidences of time and place which render



the loss of the "Maine" suspicious and grimly suggestive. In view of the strained relations existing between the Spanish government and our own, the American people were fully justified in their first exclamation of "Treachery!" when they learned that their warship had been blown up at the dead of night in a Spanish harbor.

CORAL — Prof. Alexander Agassiz has spent several months in the South Sea, mainly devoting his time to the study of coral animals. Both Darwin and Dana held that coral is made, sinks and is replenished on the surface. This they taught continued indefinitely, and this process was called the theory of subsidence. Prof. Agassiz now believes that coral is a comparatively thin crust formed upon a mountain that has been submerged or upon a volcanic pile, and in nearly every case where the borings have been made the coral has been found to be shallow.

CATHODE RAYS — Prof. Lenard, of Heidelberg, who first discovered cathode rays, has received from the French Academy of Sciences its prize of 10,000 francs.

100 Years Ago in . . .

(Condensed from Issues of February, 1848)

POLAR COAL — In his lecture on the Sun, Prof. Nichol alluded to the fact that fields of coal have been discovered in the polar regions of our earth, plainly indicating that that portion of our planet was once lighted and warmed by an agent more powerful than any which now reaches it, and which was capable of sustaining vegetation of a tropical character.

BOILER EXPLOSIONS — Never within our recollection has there been a period marked with so many lamentable steamboat disasters in our country as the past four months. First we heard of the conflagration of the Phoenix on her passage up the Lakes on the 21st of last November, with the loss of 101 lives. The steamer A. N. Johnson, on her first trip last month from Cincinnati to Wheeling, blew up with a tremendous explosion, and God only knows how many perished. One account in the Cincinnati papers stated that "more than one hundred lives were lost," probably nearly two hundred. The Cincinnati Commercial Advertiser stated from a description of one who witnessed the disaster, that there were some saved, who in the delirium of their sufferings begged to be shot, and others called for axes to end their sufferings.

COMPRESSIBILITY — That quality by which a body allows its volume to be diminished, without diminishing its mass, is called compressibility. This effect is produced by bringing the particles which constitute said body closer together, increasing thereby the density and diminishing the pores. All known bodies are capable of having their dimensions reduced by pressure, or percussion, without diminishing their mass. This is a strong proof that all bodies are composed of atoms, the spaces between which may be diminished.

MADE IN ENGLAND — "I have been informed," says a missionary to India, "that some merchants in Birmingham have made a good speculation lately, in manufacturing idols of brass for the India market, for which they have found a ready sale. It was mentioned to me as a fact last year, that two missionaries were embarking for Calcutta on board the same ship which carried several chests filled with idols."

MONSTER ENGINES — The British Great Western Company Railroad, a short time since, placed upon their road, a monster engine, called the "Iron Duke," of thirty-six tons weight. It was found to work so well, that the Company have ordered sixteen more locomotives of about the same gigantic dimensions—a portion of them to be furnished with eight-foot driving wheel.

© 1948 SCIENTIFIC AMERICAN, INC

AN ANNOUNCEMENT TO OUR READERS

It has already been announced on this page that the Scientific American is presently to become a new magazine, under a new ownership and a new board of editors. While the new Scientific American is in preparation, however, the magazine will continue regular publication without major change. The first issue of the new Scientific American will appear in the spring.

Since the first announcement of this change, many readers have written to ask how the new Scientic American will differ from the present magazine. A few of the more significant differences will be described here. Some of them will be physical: The number of pages in the magazine will be considerably increased and its design and typographical style extensively revised. More important, however, will be a massive change in editorial content.

The Scope of the New Magazine

The present Scientific American, as indicated on the cover of this issue, is limited to reporting the progress of industry. The editorial content of the new Scientific American will be limited only by the limitations of science. This principle requires a brief definition of the scope of science.

The classical divisions of science are the physical sciences (e.g., physics, mathematics, astronomy and various departments of geology) and the biological sciences (e.g., zoology, botany, genetics, biochemistry). To these have been added the social sciences, taking in specialties such as anthropology, archaeology, economics and even political science.

Two other classifications of tremendous importance have been added to the traditional divisions of science by practical usage. One is medicine, the methods and functions of which are often separate from the biological sciences. The other is engineering-technology, the art of applying science to the benefit of large numbers of people.

These five major partitions of science outline the scope of the new Scientific American. The Scientific American will publish articles on the physical, biological and social sciences, medicine and engineering-technology. Each of these divisions, furthermore, will be covered in about equal proportion.

Fundamental and Applied Science

The divisions of science provide a bare skeleton for the editorial content of the new Scientific American. How the skeleton will be clothed is largely the business of the editors and scientists working in close collaboration. There are, however, a few important attitudes toward this job which should be mentioned.

In addition to its formal organization, science is divided into two major enterprises. Part of the total effort of science, generally defined as fundamental research, is occupied with investigating the unknown. The rest, under the name of applied science, adapts this knowledge to practical use.

In the past, fundamental and applied science have often been sharply separated. Today, however, the continuous acceleration of scientific progress has largely obliterated this gap. The discoveries of fundamental science proceed almost at once to their applications, often with unpredictable social effects. One of the primary responsibilities of the new Scientific American will be to report such discoveries as they occur, thus preparing the intelligent but uninformed layman for their impact on his daily life.

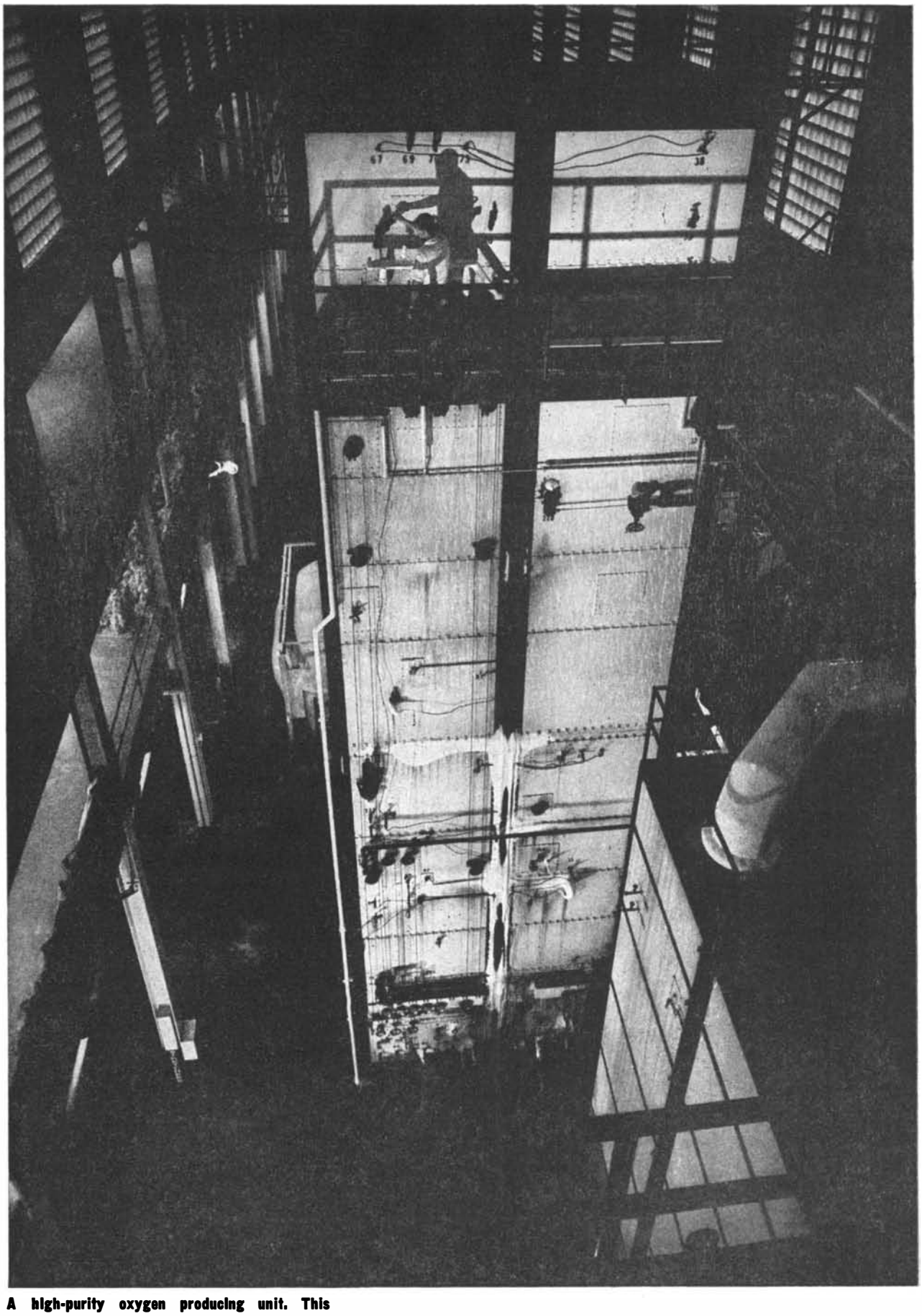
Reporting in Context

Another basic responsibility of the new Scientific American is projected by the fact that the individual projects of science, like all other human activity, are an integral part of a larger whole. The Scientific American therefore must devote a special effort in articles on advances in science to relate this progress to the rest of science. It must furthermore publish articles reviewing whole departments of science, illuminating the interrelationship of their parts.

The present work of science is also related to an historical whole. The Scientific American must place each of its articles in their proper historical perspective. It will also publish articles dealing solely with episodes in the history of science.

These various approaches will provide a considerable variety of writing in the new Scientific American. All of them, however, will be directed to one end. This is that the Scientific American be a faithful reflection of the mind of science.

© 1948 SCIENTIFIC AMERICAN, INC



A high-purity oxygen producing unit. This unit will produce approximately 150,000 cubic feet of 99.5 per cent liquid oxygen per hour

© 1948 SCIENTIFIC AMERICAN, INC

Scientific American
FEBRUARY • 1948

OXYGEN IN STEELMAKING

The Gas Plainly Can Increase Steel Production. What Are The Limitations in Its Practical Application?

By William Mann

IN THE YEAR 1801 the brilliant young Philadelphia chemist, Robert Hare, was trying to make a flame as hot as possible in order to fuse some refractory substances. As a source of fuel he had already used the recently-discovered gas hydrogen in air mixtures, with a certain degree of success. It occurred to him, however, that if only about one-fifth of the atmosphere takes part in an exothermic combustion reaction, as the great Lavoisier had said, it was probably advisable to get the inert four-fifths out of the way. Whatever the fuel, the resultant flame would obviously be hotter if a considerable part of its heat were not wasted in raising the temperature of so much atmospheric baggage which contributed nothing to the reaction. This extraneous material was, of course, nitrogen.

The youthful scientist accordingly obtained a supply of pure oxygen from chemical sources and combined it with hydrogen in a "blowpipe." With this new instrument Robert Hare was able to melt platinum, to the great astonishment of a distinguished visitor to his laboratory at the University of Pennsylvania. This visitor was Dr. Joseph Priestly, who had discovered oxygen some years before. Priestly was astonished partly by the phenomenon, which had baffled prominent European scientists for years, and partly by the fact that the demonstrator was only 20 years old.

$100,000,000 TAKEN FROM THE AIR — The importance of this observation did not pass unnoticed, but for many years not much could be done about it. The fact is that a great many industrial procedures work well enough in their normal bath of 20 per cent oxygen, and industrialists, like the rest of us, are inclined to leave well enough alone. Besides, a great many related developments were needed before pure oxygen could come into full use. Notable among these developments was the making of refractory materials able to withstand the higher temperatures.

The small-scale pure oxygen industry of the 19th Century supplied the modest needs of the oxy-hydrogen flame in soldering platinum, in making laboratory vessels of fused quartz and in the projection apparatus known as the "lime-light." It was rather expensively based on chemical or electrolytic methods of production. Minor amounts were used in chemical industry and in hospitals. But the great increase in the use of the oxy-acetylene torch for welding and cutting metals in the early part of the 20th Century, together with related uses that have recently evolved such as scarfing and heat-hardening of metals, have made the manufacture of compressed oxygen taken from the air a large and important industry. It is said to be now worth over $100,000,000 per annum in the United States alone, with every indication of rapid increase.

Present expectations are that this increase will come from the use of a high-purity (99.5 per cent) or a low-purity product (about 90 to 95 per cent) in the metallurgical and chemical industries. More specifically, it will probably come in those sections of these industries which have operated heretofore with air, the natural 20 per cent oxygen reagent. There are many variable factors involved, economic as well as technical. Although certain scientific advantages seem assured, the details of application are far from definite, and certain new problems have arisen, as we shall presently see. Moreover, it has not yet been definitely determined what degree of purity is best for each phase of oxygen utilization in these

© 1948 SCIENTIFIC AMERICAN, INC

new fields. But much progress has been made and large-scale experiments are continuing in a general atmosphere of optimism that the difficulties that exist will eventually be overcome.

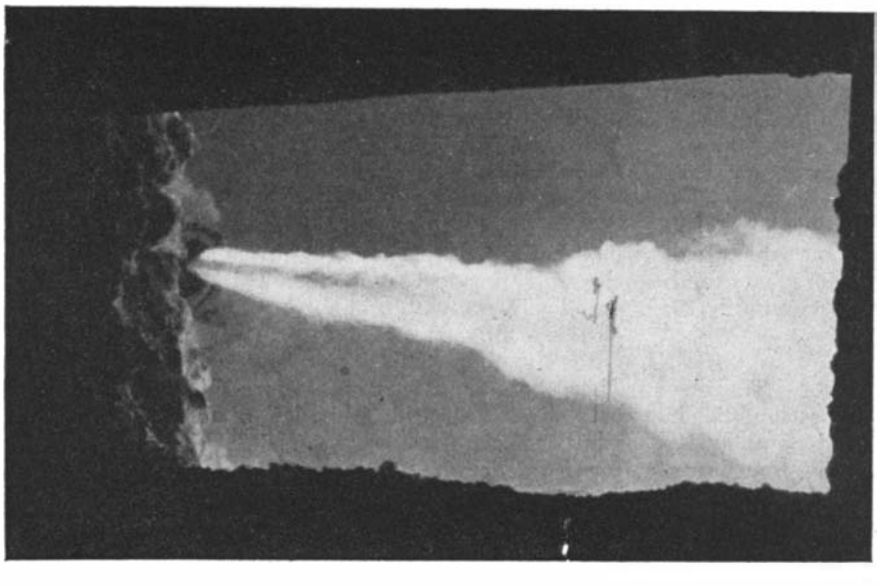
In this paper we are concerned primarily with applications of oxygen to steel-making. It should be mentioned, however, that the non-ferrous metals industry is also conducting experiments in this field and that large-scale applications in the chemical industry are far beyond the pilot plant stage. At Brownsville, Texas, a plant said to be the largest oxygen producer in the world is rapidly being completed for Hydrocarbon Research, Inc. It is scheduled to begin production early in 1948. This plant is designed to produce 48,000,000 cubic feet (some 2000 tons) of 95 per cent oxygen per day. It is planned to use this enormous amount of oxygen in the partial oxidation of 68,000,000 cubic feet of 1000 B.t.u. natural gas by the Fischer-Tropsch method. Theoretically, this will make approximately 2800 barrels of 80-octane gasoline, 1200 barrels of Diesel oil and 150,000 pounds of crude oil daily. An even larger plant is projected by the Stanolind Oil and Gas Company at Tulsa, Oklahoma.

OXYGEN AND STEEL — In the steel industry very pure oxygen (99.5 per cent) has long been used in relatively large amounts for cutting and welding operations and for scarfing of billets. Steel billets must be cleared of adherent foreign matter before rolling, otherwise imperfections will arise in the finished plate or sheet. For these uses high purity is still considered necessary. But oxygen for enriching air in blast furnace operations (from the usual 20 per cent up to 26 or 30) need not be very pure. A purity of 95 or even 90 per cent will do admirably for this purpose. This difference makes production much easier and is said to reduce the cost of the oxygen to about one-tenth. The same reasoning applies to the other branches of the steel industry, to Bessemer converters as well as open hearths. According to published data on Russian experience with Bessemer converters, the duration of a blow is reduced from 15 minutes to one minute by use of oxygen instead of air. In the open hearth, it is definitely known that enrichment with 90 per cent oxygen achieves higher temperatures which shorten the over-all cycle by greatly reducing scrap melting time.

A great deal of study has long been given to the use of oxygen in the steel industry of many nations. In Belgium it was tried in open hearths and blast furnaces over 30 years ago. Considerable data have been reported in recent years from Germany; Russian authorities are talking about converting their entire steel industry to oxygen operations at an estimated cost of $2,000,000. For this large quantity of rubles Professor Peter Kapitza expects to reduce the cost of steel making by 25 to 30 per cent. He is an able man and may very well achieve his purpose. Professor Kapitza has done fundamental work in the field of oxygen liquefaction. His pioneering in connection with the Kapitza low pressure turbine is probably the main source of the remarkable enthusiasm for new applications of oxygen that exists in Russia today, where a technical magazine named *Oxygen* is entirely devoted to discussion of the production and new applications of this element.

ADVANCING WITH CAUTION — Despite a general feeling of confidence in ultimate benefits from oxygen, which seems fully justified, the American steel industry has made no revolutionary changes, but has gone ahead cautiously since the end of the war. With the coöperation of oxygen producers, fundamental exploratory experiments have been conducted to find out how well the use of oxygen pays in the over-all picture of steel production. It has been estimated that if all of the 255 blast furnaces in the United States were to use oxygen enrichment up to 25 per cent (without increasing the volume of the blast), about **900,000 cubic feet of 95 per cent** oxygen per minute would be required. This gives an idea of the size of possible requirements even by this relatively mild enrichment, which is said to have no detrimental effect on refractories.

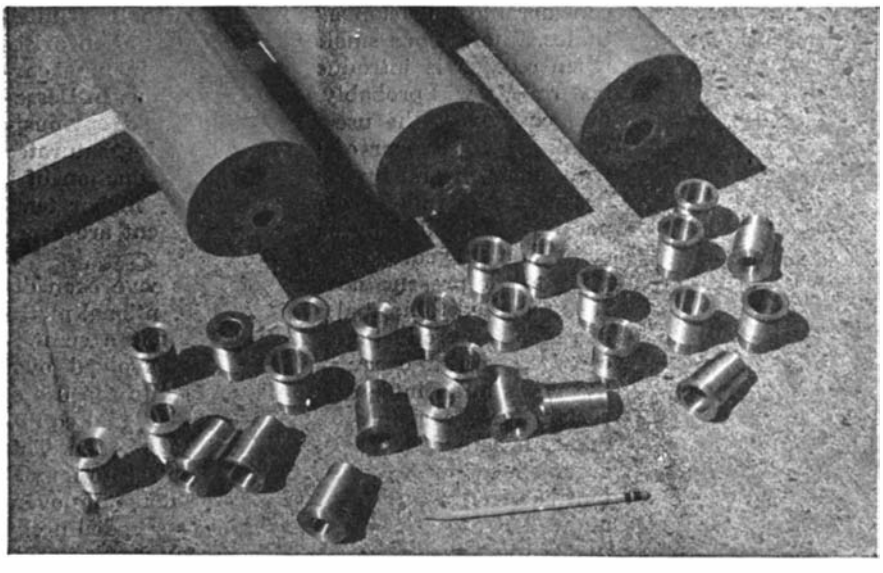
Overlooking for the moment the expensive changes that may be required by new engineering design and improvement in refractories, there are at least



An oxygen-enriched flame being injected into an open hearth furnace. Enriching the flame results in higher temperatures which reduce the over-all cycle by shortening considerably the melting time of the scrap

© 1948 SCIENTIFIC AMERICAN, INC

Right. Assortment of laboratory and field auxiliary and field burners. Laboratory models are distinguished by the absence of connections for water cooling and steam atomizing



Left. Main burners are equipped with removable fuel pipes (upper openings) and interchangeable oxygen nozzles (lower openings). Extra nozzles in front of burners vary in capacities from 15,000 to 70,000 cubic feet per hour

two advantages that may reasonably be expected from use of oxygen in the open hearth furnace. By enriching the combustion air during the charging and melting, this period is shortened; by increasing the temperature of the reacting elements during the refining period these decarburization reactions are also improved and speeded. As a result of extensive tests conducted by the Republic Steel Corporation over a period of months, it has been reported that these advantages actually cut in half the time required to produce a heat of steel. Experiments were conducted in two of Republic's 14 open-hearth furnaces in the Cleveland district plant. Oxygen was applied directly to the bath by impingement on the surface at high velocity with excellent results. The lance method of introducing oxygen into the bath was employed in most of these tests.

The Wheeling Steel Corporation reports that oxygen introduced at high pressure directly into the open hearth bath by means of pipes inserted through the wicket holes has produced heats containing very low carbon and has accomplished savings in time and in fuel. Indications are that the quality of the steel produced is also improved. There is a definite saving of fuel and time, and a marked acceleration in carbon reduction rate. The study of optimum conditions is being continued.

It is a matter of considerable importance in this work that the charging of scrap should always be more rapid than melting in order to prevent damage to the furnace lining. The presence of some cold charge protects the roof and side walls of the furnace. As evidence of the high temperatures reached in this process and of the need for careful standardization of the design and equipment, a pipe inserted 30 inches below the surface of the steel to introduce oxygen will burn up at a rate of over two feet per minute. However, by inserting the lance to the slag-metal interface only, some plants have developed methods of extending its life to periods over an hour. The engineers of The Linde Air Products Company have developed a remarkable water-cooled jet device for this purpose. These have relatively long-lasting changeable nozzles from which a stream of oxygen ranging from 3000 to 70,000 cubic feet per hour can be issued.

The Steel Company of Canada at its Hamilton, Ontario, furnace found that when oxygen was used increases of 20 to 40 per cent in capacity were possible. Under these conditions, eight to nine hours

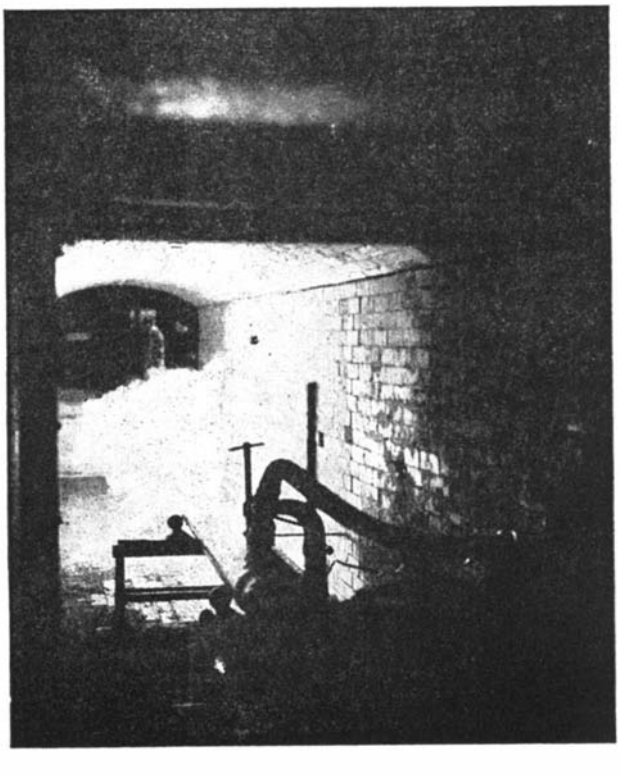
© 1948 SCIENTIFIC AMERICAN, INC

had previously been consumed in charging and melting down. By using 1000 cubic feet of oxygen per minute mixed with the normal air flow, the charging and melting down time can be decreased by as much as one to three hours. Fuel consumption per pound of metal is also decreased (by about 8 per cent), the cycle is significantly shortened, and the control of flame characteristics and distribution is much improved. In one test reported by this plant on a 67-ton open hearth, the carbon content was reduced from 0.58 per cent to 0.09 per cent in 24 minutes. Six thousand cubic feet of oxygen were consumed in this operation.

The commercial producers of oxygen have naturally taken a leading part in this development. For instance, The Linde Air Products Company has coöperated with steel producers in conducting oxygen performance tests in more than 7000 heats in 34 furnace shops, and this work is still being carried on. The results of these experiments confirm the fact that the periods necessary for scrap melt-down and for refining in the open hearth are definitely shortened by significant amounts. Very high purity liquid oxygen was used in these tests, as it was provided at a price which made the tests economically practical. But, anticipating an increase in the use of oxygen of lower purity, Linde has had in operation for over a year a plant capable of producing 200 tons of 90 per cent gaseous oxygen per day. At the present writing, and until the Brownsville plant goes into production, this is probably still the largest single unit ever built.

Linde engineers have developed a number of new burner designs, and the non-consumable device for adding oxygen already mentioned; and to open hearth practice they have contributed to the new idea of direct scrap melt-down with a high velocity jet of oxygen. Air Reduction and the Koppers Company have also actively engaged in this experimental work, notably in coöperation with Bethlehem Steel. And other oxygen producers have done important work too.

This end burner is being tested in a thirty-foot long brick-lined test kiln



OXYGEN AND THE FUTURE OF STEEL — Oxygen plants for use with steel operations are being built in a number of American steel mills. Some are buying delivered oxygen, and a number are leasing or buying mobile units for liquid oxygen production. These developments and the related improvements in engineering design may not require an expense as large as the Russians say they expect to spend for their revolutionary steel developments, but when it comes to revolution we can hardly expect to compete with these experts. Nevertheless, it seems reasonably safe to predict that an oxygen-for-steel industry of considerable importance will develop in the United States. The serious smoke problem that often arises when oxygen is introduced, especially in high carbon ranges, will probably be licked in time. In Bessemer converters the use of oxygen would obviously eliminate the danger of the product being saturated with nitrogen and hydrogen. In the production of a ferro-chrome and ferro-manganese the higher temperatures provided by oxygen enrichment are especially advantageous.

Up to the present most applications have been directly applied to normal ores and conventional methods of steel production. A steel plant is a complicated industrial organism which has evolved over the years in an integrated fashion, tied to the use of certain fuels, certain ores and to conventional equipment all bathed in a sea of 20 per cent oxygen. This organism cannot be expected to adapt itself to important changes in any of these important factors overnight. If one part of the mill's work is speeded up by use of high-purity oxygen, say, it may result in upsetting certain other parts, at least temporarily. For instance, if scrap handling and charging facilities cannot also be speeded up, the accelerated rate of melt-down and refining in the open hearth work mentioned above may be only a nuisance until a new rhythm is established. But once over this hump, which has real economic and technical bases, the benefits of oxygen will probably begin to pay off.

From the standpoint of raw materials, some authorities foresee the time when cheap oxygen will make it feasible to work discarded iron pyrites tailings and poor ores, especially in remote northern or even Arctic areas where fuel is not readily obtainable. As the reaction between iron and oxygen is an exothermic one, practical methods may be worked out to make the ore itself supply at least part of its own fuel, as when a high velocity oxygen stream is applied to pre-heated scrap or to the jet cutting of carbon steel. It is predicted that mobile oxygen units could make it feasible to burn these low-grade ores and cut down coal requirements to a minimum. The supply of high-grade iron ore in this country is reaching an ominously low point. The time may come when such proposals, despite their obvious drawbacks, may seem very attractive and practical. Low-cost oxygen may provide the answer for low-grade ore.

© 1948 SCIENTIFIC AMERICAN, INC

ONE THIRD OF WOOD

Editor's note: The January issue of the Scientific American carried the first instalment of the following article, describing problems in the analysis and utilization of lignin, the second major chemical constituent of wood. Some lignin, Dr. Glesinger pointed out, is burned as fuel in pulp plants or used to make synthetic vanilla. Most of it, however, is flushed into streams as waste. The second instalment of Dr. Glesinger's article explores some of the research which may still make lignin a valuable raw material. Both instalments will appear in *The Coming Age of Wood,* to be published in the spring by Simon and Schuster, New York.

Cellulose and Lignin Are the Main Chemical Constituents of Wood. Cellulose Has a Vast Variety of Uses. Lignin Has Relatively Few. Second of Two Articles Describing Problems and Progress in the Utilization of Lignin

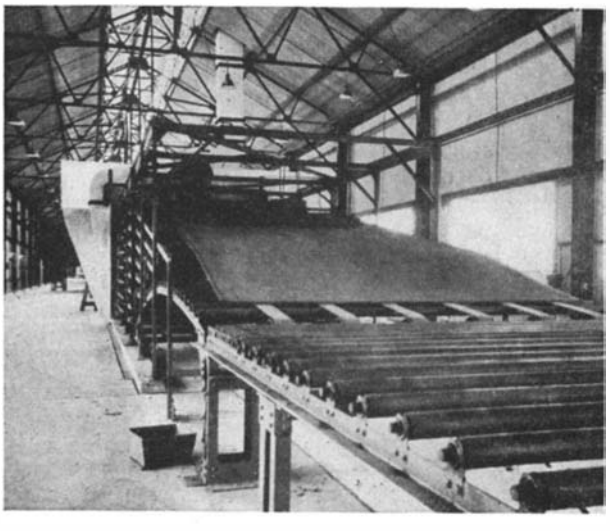
By Dr. Egon Glesinger

Director, Division of Forest Products,
United Nations Food and Agriculture Organization

ONE MAJOR and hopeful line of attack on the problem of finding new uses for lignin is hydrogenation, the process of adding hydrogen atoms to carbon compounds. Achieved by high temperatures and huge pressures, hydrogenation results in profound and diverse changes in the structure, appearance and properties of the chemical raw materials treated. Best known is the hydrogenation of coal, which supplied more than half of Nazi Germany's gasoline and lubricating oils during World War II. In the petroleum industry, hydrogenation is the essence of the various cracking processes used to extend the yield of gasolines from crude oil and to produce the superfuels of aviation.

Lignin hydrogenation has so far been conducted largely in the laboratory pressure bombs of the U. S. Forest Products Laboratory at Madison, Wisconsin. It has produced yellow liquids of high viscosity that look and smell exactly like the basic fractions of crude oil. Fractionation and other chemical treatment of these liquids yield, first of all, a host of mysterious substances of no known immediate use, but apparently great promise: phenols, the parent material for most thermosetting or heat-resistant plastics; volatile as well as heavy lubricating oils; and, finally, most important of all, the hydrocarbon mixture known to the British as petrol, to the Americans as gasoline and to the rest of the world as the precious fluid that drives engines and wins wars.

FUTURE OF HYDROGENATION — As to the future of lignin hydrogenation, *Lab* declares: "These processes have not passed the pilot-stage and, therefore, cost figures for a commercial plant are unknown"— a polite way of saying that the cost of lignin hydrogenation is prohibitive. Yet, this is true of all synthetic processes in the laboratory period of their development. In 1937, I heard no less an authority than Hjalmar Schacht say that it would be madness for Germany to produce Buna rubber if she had any way of getting and paying for natural rubber. At the inception of the United States synthetic rubber program in 1941, the cost per pound of Buna was from thirty to forty cents. Today, its prospective market price of ten to fifteen cents is fully competitive with the prewar average of fifteen cents a pound for crude natural rubber delivered at United States ports.



A sheet of composition board coming out of the processing machine. Lignin is the bonding material which gives the board its strength

Conclusion-jumping on lignin hydrogenation usually begins with an unwarranted comparison of the first meager laboratory results with the high yields and low costs of the hydrogenation of coal and oil. It is also pointed out that the Nazis, despite their mastery of wood chemistry, made no attempt to secure from lignin relief for their war shortages of motor fuel and lubricants. Obviously, the vast and successful experience of coal and oil chemistry sets stern competitive standards for the future of lignin, and the industries that live on these minerals make the most of the situation. But, as long as the exact

© 1948 SCIENTIFIC AMERICAN, INC

nature of lignin remains unknown, all such conclusions are premature.

The chief accomplishment of lignin hydrogenation to date is that it has produced samples of the materials lignin can yield. It has established that lignin is an aromatic compound in the chemist's vocabulary; that its molecule is a "ring" structure in contrast to the linear or fiber-shaped structure of the cellulose molecule. As such it is closely related to the hydrocarbons of coal and oil and responsive to the tricks and devices by which organic chemistry is able to break down and reconstruct these materials into a variety of useful products. The trouble from here on seems to be that lignin is as delicate as a medieval virgin and is adulterated by the most mildly curious glance.

NOT JUST ONE LIGNIN — Apparently, there is not just one lignin, but several lignins. It will probably be found that some are no good at all and that others possess all of the exceptional properties attributed to lignin. This suspicion is supported by the first products of lignin hydrogenation. The thick yellow liquid contains, in addition to oils and resins which have been identified, many mysterious unknown substances. Some will be waste products; others may surprise the world. The unknown qualities in lignin raise the further possibility that hydrogenation may turn out to be an altogether wrong approach. Its exploration, however, may lead to the discovery of new and simpler processes especially adapted to lignin.

There is promise, for example, in a revolutionary new pulping process now under laboratory experiment. Its reagent is an organic solvent, instead of the crude caustics and acids of the sulfite and sulfate industries. The gentler and more precise action of the organic solvent yields two prime products instead of one. Cellulose, the first, comes out as "holocellulose," with the natural cellular structure of the fiber almost intact. Lignin is the second, and it also shows the virtues of organic chemistry. Extracted from solution by means of another organic solvent, ketene, it forms an interesting series of compounds. Basically they are white, as lignin compounds should be, and they exhibit interesting signs of chemical life. There is no justification, again, for predicting costs or even products at this early stage of development, but there is also no doubt that here is something worth public exploration.

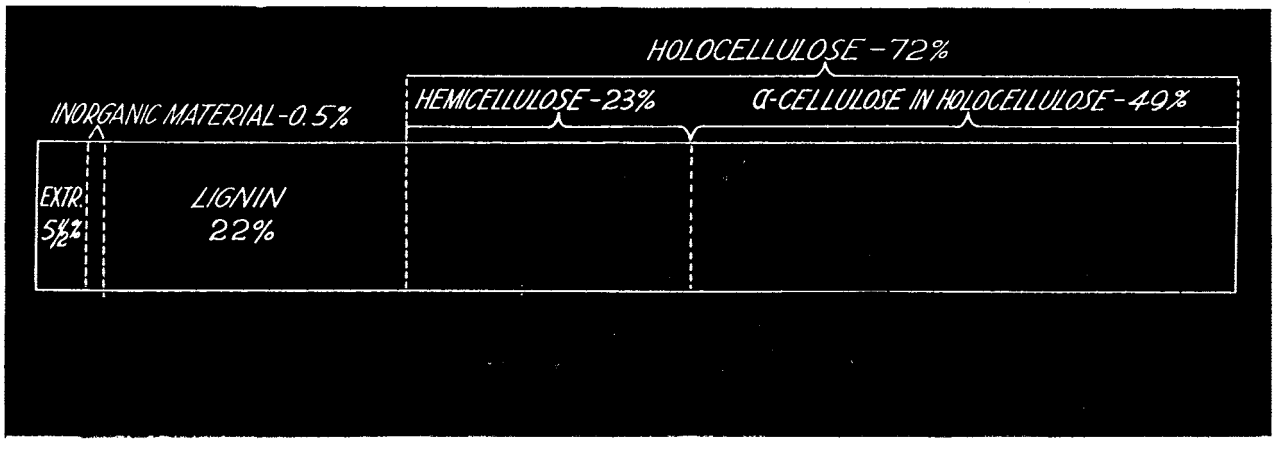
	Gasoline (*Million gals.*)	Alcohol (*Million gals.*)	Pulp (*Million tons*)	Lumber (*Million bd. ft.*)
From 160 million tons of wood converted into fuels	4800	9600		
From 80 million tons of pulpwood	2400	2000	40	
From 80 million tons of logs	1200	2400		40
From 320 million tons of wood	8400	14000	40	40

In sum:	
22,400 million gallons of fuel @ 10¢	2.24 billion dollars
80 million units of pulp and lumber @ $25	2.00 billion dollars
Total	4.24 billion dollars

No matter how it is ultimately processed, lignin has a basic economic advantage because it is a waste material. Even if new and more expensive pulping methods had to be adopted to secure reactive lignin, the major cost of its extraction would always be borne, as in the case of coal tar and producer gas, by other self-supporting products. Since lignin as a raw material will cost next to nothing, a profit of only one cent a pound will be enough to make it a bonanza.

Lignin is justly regarded as the key to the future of wood chemistry. As long as wood chemical industries are unable to process lignin to commercial advantage, their position in coal and oil industries will remain that of the country butcher competing with the Chicago meat packer who exploits everything but the squeal. With the handicap of lignin as a by-product nuisance, it is remarkable that the wood-chemical industries—more correctly, the cellulose-converting industries—have not gone to the wall long ago. It is even more remarkable that wood pulp

A graphic representation of a chemical analysis of wood. Here cellulose is broken down into low-grade hemicellulose and high-grade alpha cellulose



© 1948 SCIENTIFIC AMERICAN, INC

is highly profitable, wood-sugar alcohol is fully competitive and that other products of wood chemistry are making steady progress. The fact that to date lignin is almost a dead loss, however, has seriously hampered wood chemistry and kept its total turnover at about twenty million tons a year.

LIGNIN OPENS THE DOOR — When lignin chemistry becomes a reality, it will immediately increase the annual end-product capacity of wood chemistry by 50 per cent without requiring a single extra ton of wood to the quantities now processed. It will, furthermore, make the entire operation so much more profitable and lead to such substantial reduction in unit cost, that the barriers that have held back wood chemistry will collapse like the walls of Jericho. Soon this industry will find itself processing ten, twenty or fifty times its present wood tonnage and flood the world's markets with inexpensive supplies of many of the things they need.

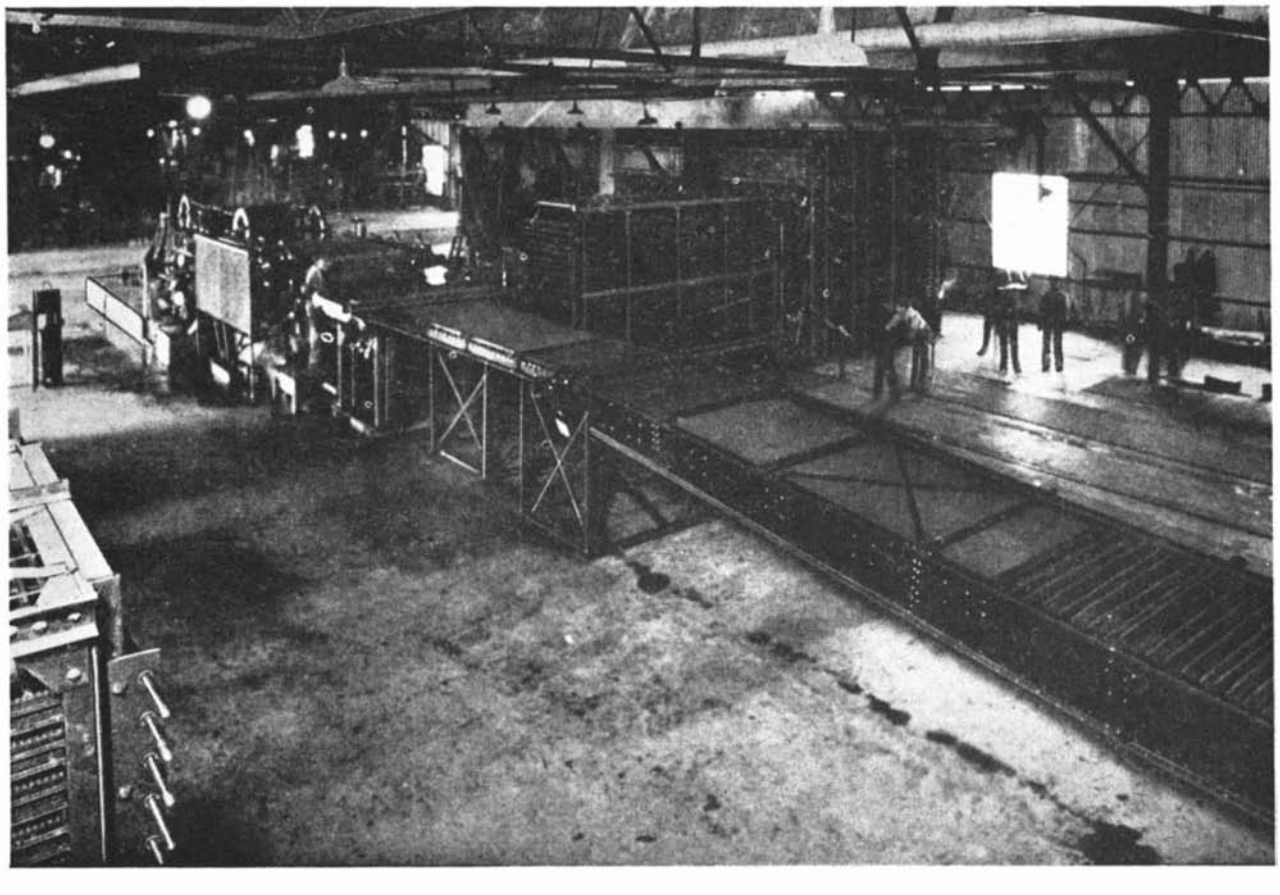
Speculation on the consequences of lignin conversion on an industrial scale provides stimulating mental exercise. Let us make the reasonable assumption that the same ton of wood that yields sixty gallons of alcohol via the Eugene, Oregon, process might produce an additional thirty gallons of lignin-base gasoline. Let us further assume that Europe's forests, not including Russia, could produce annually one ton of wood per acre, of which one half would be diverted to the production of liquid fuel, a quarter to cellulose conversion, and the remaining quarter to lumber. The result, including the waste lignin of the latter two industries, is shown in the accompanying table.

By this calculation, Europe's 320 million acres of forest could produce primary goods worth 4240 million dollars, or three times the value of their present output. They could permanently supply Europe with more motor fuel than the United States consumed in 1937, and revolutionize the economic structure and living standards of the old continent and its 500 million inhabitants.

Applied to the world's 8000 million forest acres, the same assumptions yield truly breath-taking figures. The annual forest harvest could yield, in addition to 2000 million tons of pulp and lumber, more than 400,000 million gallons of motor fuel, or five times the world's prewar production of crude oil. Other lines of calculation give equally impressive results, but it is not my intention and even less within my power to paint a Utopia. The illustrations are useful, however, for projecting the potential significance of lignin not only for the forests but for the entire world.

Gasoline and lubricating oils from lignin are still far away. How far away is best demonstrated by the fact that recent industrial development of lignin has taken an entirely different course. It has led to the rise of a large industry engaged in making a variety of "ligno-cellulose" products—known by their less scientific name of "wood plastics"—in which the natural association of lignin and cellulose is maintained, but modified to meet a wide range of material specifications.

An overhead view of a lignin plastics processing machine. The product, in sheet form, is dense, hard and strong



© 1948 SCIENTIFIC AMERICAN, INC

TUBES IN MANUFACTURING

Tubing Today is Much More Than Pipe. Among Other Things It Is Becoming a Stock as Basic Sheets or Bars

By Edwin Laird Cady

THE ORIGINAL industrial uses for tubing were based on no more than the fact that tubes have holes through their middles. The holes could be used as passages through which liquids or gases could flow or wires be conducted. And when smaller parts needed straight bores the holes avoided drilling and other machining operations.

Within the past few years another consideration has increased the importance of tubing. High alloy steels and some of the other alloys are sluggish in their response to heat treatment. The centers of thick and solid bars may remain soft, fibrous or poor metallurgical structures after the bars are heat treated. Worse still, there can be residual strains between the interiors which do not "take" the heat treatment and the exteriors which do. In tubular shapes, however, there rarely is metal section too thick to respond to heat treatment. Tubes can minimize this problem and sometimes can even eliminate it.

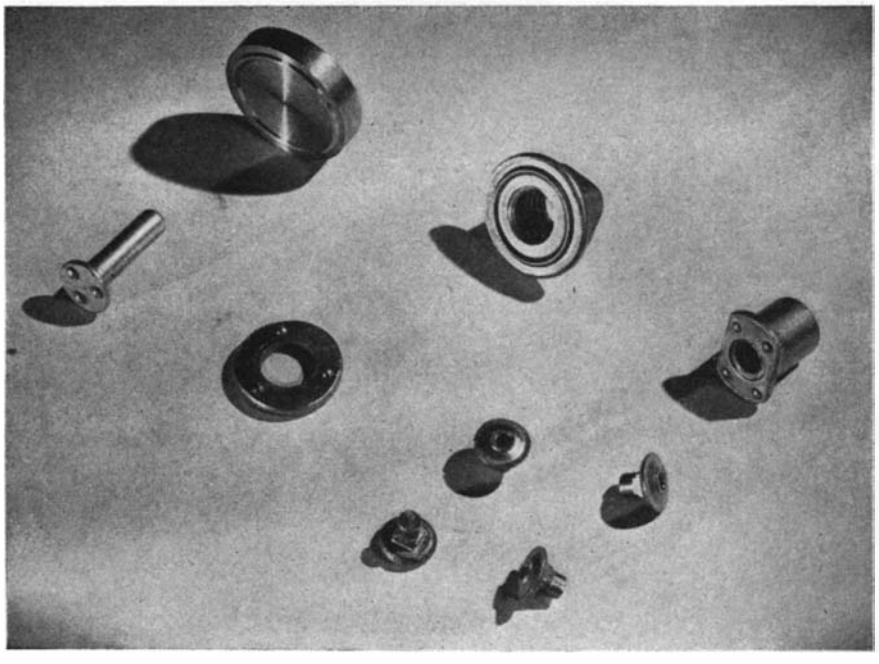
The races of this anti-friction bearing are made from sections of tubing. This permits far greater control of quality

The physical working of metal is another case in point. Tough alloys resist the wroughting processes which do so much to strengthen and refine metallurgical structures. They also tend to confine the results to the exteriors of thick sections. In the manufacture of tubing, however, both interior and exterior of the tube automatically undergo intensive physical wroughting. Either a piercing tool must be forced through the middle of a billet to make the bore of the tube, or wrought flat stock must be bent until the edges meet for welding into tubular shapes. The bore of the tube, then, is at least as thoroughly worked as the exterior, and in most instances is worked even more.

ROCKING PROCESS — The rocking process developed by the Tube Reducing Corporation is an extension of wroughting. Originally this method was intended to solve the problem of making tubes in different sizes. Tube piercing requires highly expensive tools to manufacture tubing of any given outside diameter and wall thickness. Therefore only a few standard sizes of any given alloy were regularly made by any tube mill and were obtainable from stock in reasonable quantities.

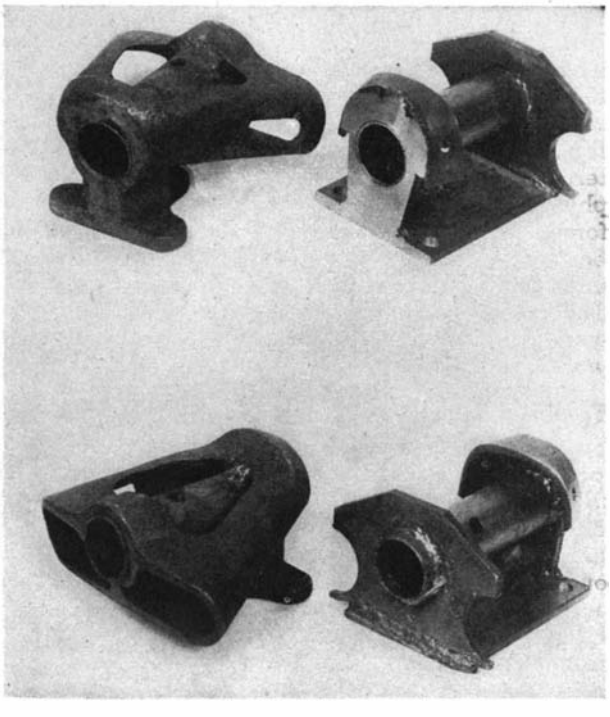
The rocking process uses grooved rockers to squeeze tubes down over mandrels which are smaller than the original tube bores. Reductions in bore of five to one are practical, and even larger ones can be made. The lengths of the tubes are greatly increased, making possible the manufacture of sections as long as thirty six feet for fabrication in automatic screw machines. By this compacting process the strength and grain structure of tubing can be greatly improved. The concentricity can also be held to within 5 per cent of the outside diameters rather than the 10 per cent which applies to the manufacture of many tubular shapes. With this accuracy the makers of machined tubular parts often do no more than machine and grind away the amount of stock which ordinarily would be removed

© 1948 SCIENTIFIC AMERICAN, INC



Right. Such small parts as these are very economically fabricated on automatic screw machines or by means of swaging

Below. Tubular shapes are preferred members of weldments



to eliminate surface imperfections. The finished parts will be to the required accuracies and concentricities.

The makers of anti-friction bearings were among the first to take advantage of the increased range of tube sizes and the refined grains of worked tubing. The steel of which ball bearing races are made is difficult to machine and too expensive to waste as chips from solid bars. For extremely hard service, such as bearings must withstand, tubing also is easier to inspect for flaws.

Metal tubing may be conveniently inspected by X-rays, by xyglo oil techniques and by means of ultrasonics. When tubing is cold drawn or cold worked by the rocking process, nearly all flaws may be detected before a tube is machined into bearing parts. But X-rays or ultrasonics can be used to eliminate the slight chance that there might be flaws which cold working did not reveal.

Tubular shapes are ideal for induction heating because they present smooth exteriors and uniform wall thicknesses to the induction coil so heat can travel rapidly through their wall thicknesses. The salt bath heating of tubing also is rapid because molten salt can bathe interior and exterior of the tube, heating both faces of the metal simultaneously. Radiant gas burners of ceramic types can be applied to tube interiors for rapid heating. Tubes are also easy to heat by resistance because their uniform walls hold a balance between interior temperature and exterior radiation loss.

The ease of heat treating tubes leads to uses which might not be attempted with other forms. Tubes of stainless steel, for example, can easily be heated to the annealing temperature and quenched without spending more than three minutes in the critical range. Automobile makers give the same tubular part one heat treatment to make it stiff and tear-proof for machining, a second for welding, a third for bending after welding and a fourth to impart hardnesses and strength. Sometimes, by induction or salt bath methods, one end of a tubular part is heat treated for machining while the other is simultaneously treated for swaging or other deforming. Such operations would be impossible in other structural shapes.

IDEAL FOR WELDING — Tubular shapes are ideal for any method of welding or brazing. Their bores eliminate the problems of heating and cooling of excess metal. Cylindrical tubes are equally strong in all transverse directions and therefore do not tend

© 1948 SCIENTIFIC AMERICAN, INC

to pull out of shape when cooling. Tubes other than cylindrical are also surprisingly good in this respect. Cylindrical shapes have excellent contours for automatic and uniform transfer and distribution of stresses if residual stresses remain within the welds.

Welding and brazing as methods of manufacturing tubes are advancing rapidly. As practiced by the Republic Steel Company and the National Tube Company the weld is 100 per cent efficient and is under such completely automatic temperature and heat treatment control that there is no threat of carbide precipitation. Cross-crystallized compression welding, wherein the weld zone is metallurgically indistinguishable from the parent metal, has not been widely adapted to tube production but it is capable of producing welded tubes which are as adaptable as pierced tubes to the rocking process. The Bundy process, which makes tubes by continuous fusion joining of spirally wrapped strips, is solving problems of tube stiffness, directional strength, metallurgical control and corrosion resistance, but its products have not been adopted widely enough to estimate its full industrial future.

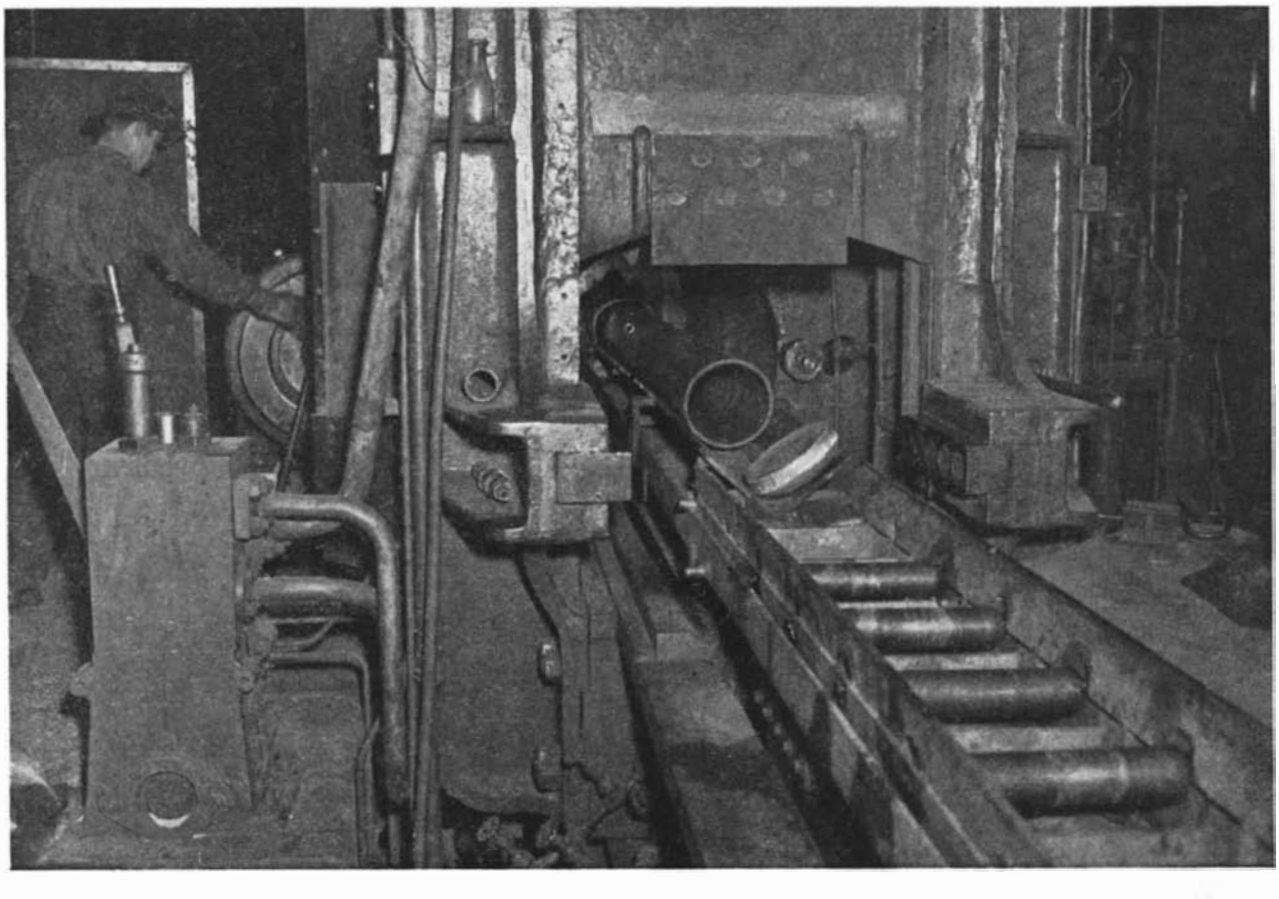
SILVER LININGS — Silver-clad or silver-lined tubes such as those made by the D. E. Makepeace Company begins as solid plates of copper or other base metal overlaid with solid silver plate. The finished tubes actually are extremely deep drawn shapes, good use being made of the high ductility of silver and the fact that silver readily recrystallizes after cold working. Silver solder may also be placed between the silver and base metal, the solder, acting as a wetting agent to promote interface contact, being squeezed out and recovered in the drawing process. Tubing clad with silver and other precious metals by this process is widely used in radar and radio and is improving many of the installations of corrosion-resistant pipes and faucets in chemical plants.

Tubes of either pierced or welded construction are being lined with enamels. No tube of less than four inches inside diameter has been found commercially suitable for outright porcelain enameling of the bore. But the rapid advance of special enameling steels which may be welded into tubular shapes, the increased availability of titanium oxide for enamel and the experiments with induction heating for baking the enamel uniformly, may make much smaller porcelain lined tubes available in the near future. And other enamel linings, such as those made by the Interchemical Corporation, are proving highly effective.

Centrifugal casting of tubes as practiced by the U. S. Pipe and Foundry Company is producing cast tubes of qualities suitable for rocking and other cold working. One metal is being cast inside another, such as a soft steel suitable for bearings inside of a hard steel exterior suitable for abrasive wear. The process is under intensive development, with its full potentials not even estimated as yet.

Thus the entire tubing industry is developing rapidly into markets which are established by the fact that tubing, in addition to being a useful conduit, is able to solve thousands of problems of product design and production.

A piece of seamless tubing comes from the extrusion press



© 1948 SCIENTIFIC AMERICAN, INC

THE ARRIVAL OF POLYSTYRENE

By James R. Turnbull
Monsanto Chemical Company

During the War the U. S. Created Capacity To Make Styrene, Key Ingredient of One Kind of Synthetic Rubber. Now Styrene is Built Up To Polystyrene, Presenting Industry With Large Quantities of a Cheap and Versatile Plastic

THE WARTIME development of U. S. capacity to make synthetic rubber made an unexpected contribution to the store of raw materials available for manufacturing processes. During the war this country built plants to produce huge quantities of styrene, a key ingredient of GR-S synthetic rubber. It happens that styrene may also be polymerized into polystyrene, a cheap and versatile thermoplastic.

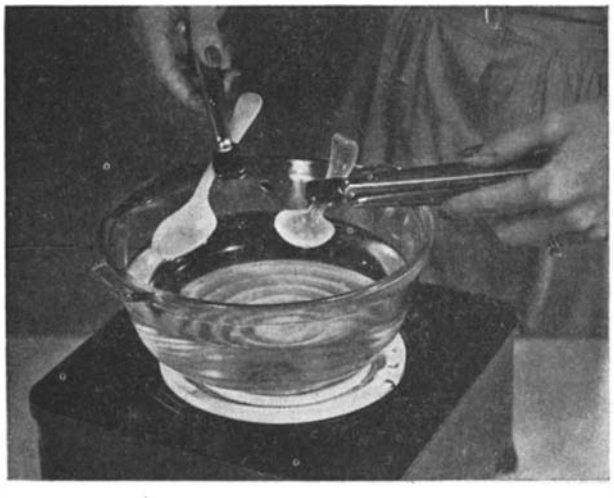
Polystyrene is already on its way to becoming the heavy industry of the plastics field. This year its production in carloads may exceed that of aluminum before the war. From a starting figure of 100,000 pounds in 1937, polystyrene production jumped to 22,000,000 pounds in 1945 and to 55,000,000 pounds in 1946. Experts consider it certain that installed capacity at the end of this year will top 150,000,000 pounds by a wide margin.

The technology of polystyrene, moreover, is constantly advancing. The Plastics Division of Monsanto Chemical Company, for illustration, recently announced a polystyrene variant called Lustrex, which retains its shape after limited immersion in boiling water. With due caution, the company calls it a "scaldable" plastic rather than a "boilable" plastic. Lustrex opens the way to polystyrene's more extensive use in kitchen and dining room accessories, nursery items and surgical instruments.

Earlier, scientists of the same company produced a polystyrene plastic which glows after exposure to light from six to eight hours, doubling the after-glow time of prewar luminescent plastics. This material is now being used to mass-produce such items as house numbers, flashlight handles, switch plates, wall plug plates, door escutcheons and light pulls. A companion plastic is activated by ultra-violet lamps.

The plastics industry thinks so well of polystyrene that several suppliers of plastics materials have made heavy investments in styrene plants purchased from the War Assets Administration. Contracts with RFC's Office of Rubber Reserve, however, still give first call on the production of these plants to the nation's synthetic rubber requirements. One such plant was lost in the recent Texas City disaster, and the wreckage is now being cleared to make way for a new and more efficient plant.

The feeling of Rubber Reserve people is based on something more than a desire to see four good tires on every automobile. Shuddering as they think of the early days after Pearl Harbor, they want to maintain the plants which can guard the country against the emergency caused by the end of natural rubber imports. They also seek a guarantee against high natural rubber prices which might be arranged through price-fixing manipulations of foreign cartels. They reason that there is no better way to nail down these guarantees than to keep the styrene plants in operation.



Both spoons have been dipped into the bowl of scalding water. Spoon of standard polystyrene (right) crazes and distorts. Spoon of improved polystyrene is unchanged

The plastics suppliers, on the other hand, applaud the opportunity to engage in the manufacture of a raw material with polystyrene's market potential and capacity to enrich human life. On the basis of past performance, their faith in the product seems justified. One industry alone, the manufacture of home refrigerators, is expected to consume 8,000,000 pounds of polystyrene this year and 20,000,000 pounds next

© 1948 SCIENTIFIC AMERICAN, INC

year. Comparable amounts will be used by radio, television, toy, novelty and household appliance industries.

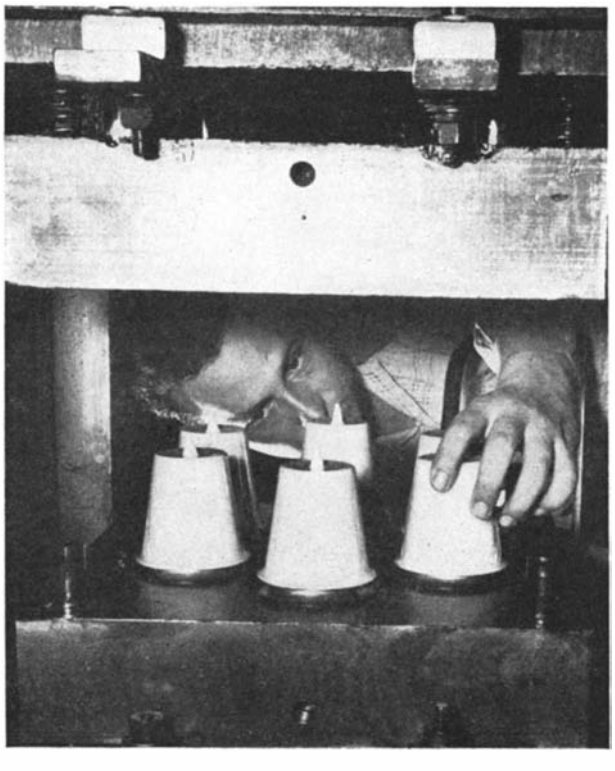
A THIN AND COLORLESS LIQUID — As it comes in tank cars to the makers of plastics raw materials, styrene is a thin and colorless liquid with an odor which suggests escaping gas. It is compounded with butadiene to make synthetic rubber. The plastics manufacturer reacts styrene with itself. The process involves the application of heat, transforming styrene from a liquid to a solid as clear and colorless as water.

Polystyrene is produced largely without hand labor, a factor which helps to account for its low production cost and low selling price. It is brewed inside great kettles, tanks and retorts; even its color can be added by machinery. Generally the first man to see polystyrene molding polymer is the worker who loads it into fifty-pound paper sacks for shipment to injection molding plants.

One important reason for polystyrene's desirability is the fact that it is a thermoplastic. This means it can be used in injection molding machines, the fastest and most economical means of producing objects of plastic. In a 24-hour day the average injection molding machine can produce either 50,000 artificial gems, 25,000 clothes pins, 25,000 thimbles, 20,000 pocket combs, 10,000 compact cases or 5000 clock housings. As a mass production technique, this approaches the ultimate.

Hand labor is again almost entirely absent in injection molding. Raw material is converted to finished material without painting, enameling, die stamping, machining or labeling. When mechanical packaging is employed, the first person to touch a polystyrene item is the buyer. Color is inherent in the plastic material, eliminating the need for painting or enameling. Intricate shapes can be molded to tolerances of one ten-thousandth of an inch, doing away with the need for costly machining operations. The article or its maker can be identified by raised lettering.

Flower pots of polystyrene are rapidly stamped out in a single operation on this injection molding press



A laboratory technician measures the force required to break a sample of polystyrene on a physical testing machine

The injection molding machine is largely responsible for polystyrene's success as a raw plastic. The first injection molding machines were developed in Germany and introduced to this country only 11 years ago. A machine will range in cost from $6000 to $30,000, while the mold required to make any given part will add from $200 to $12,000. The size of the item manufactured is limited by the machine itself. The average injection molding machine is an eight-ounce unit, which means that in one operating cycle it can produce eight one-ounce objects or one eight-ounce object. The molding material is poured into a hopper, whence it goes into a heating chamber to be melted. From there it is squirted under tremendous pressure into the mold cavities which break apart to free the newly-manufactured item.

WANTED AND UNWANTED QUALITIES — Like every other material, polystyrene represents a combination of wanted and unwanted properties. Its chief virtue may be said to be its adaptability to mass production in injection molding machines, a consideration which helps greatly to improve its competitive position in comparison to ceramics, the light metals, other metals and wood. Second in importance is the fact that polystyrene is priced far below competing thermoplastics. When it was introduced in 1939, polystyrene sold at 72 cents a pound. Today's price (in carlot quantities, for crystal molding polymer) is 24½ cents a pound. By comparison, cellulose acetate now sells at 48 to 50 cents a pound, butyrates and ethyl cellulose at 55 to 65 cents a pound, and methacrylates at 85 cents a pound. It should be stated, of course, that each of these lends itself to certain specialized applications more readily than does polystyrene. Yet in hundreds of general applications, polystyrene does as good, if not a better job.

The suppliers of polystyrene have indicated that

© 1948 SCIENTIFIC AMERICAN, INC

increasing manufacturing costs have, for the present, put the hope of a price decrease out of the question. It is known, however, that they are eager to pare polystyrene's selling price to the lowest consistent minimum. No one realizes more keenly that each downward notch will open new markets, bigger volumes and larger profits. At the same time, it is considered likely that polystyrene's competitive threat will inspire suppliers of other materials (*i.e.*, aluminum, magnesium, wood, bronze, glass, ceramics, etc.) to improve their processes and lower their costs. The winner will be the consumer.

Manufacturers of polystyrene say it has much more to recommend it than low price and adaptability to mass production. Another important factor, they state, is its low specific gravity, a property which stretches it 20 to 30 per cent further in many applications than other thermoplastics. Polystyrene's lightness is also an advantage over more conventional materials in itself.

Consider aluminum, for example. Light and ideally suited to markets which polystyrene can never hope to invade, it nevertheless has a specific gravity of 2.7 in comparison to polystyrene's 1.06. Thus on a volume-for-volume basis 1947's projected production of polystyrene will not be far under the aluminum industry's prewar record year of 615,000,000 pounds. Glass has a specific gravity of 2.6, zinc of 7.1, nickel of 8.7, copper of 8.9 and lead of 11.3. Even granting that each of these materials will always have its place in America's economy, it follows that it will always require from 2½ to 8 times as many pounds of them to fill a given cube than will polystyrene.

HIGH TENSILE STRENGTH — High on the list of remaining advantages is polystyrene's high tensile strength, greater than that of lead, zinc, glass and copper, but not quite as high as aluminum. Another factor is its crystal clarity and its large color range; still another is its chemical resistance to acids, alkalis and some solvents. Within certain temperature ranges, polystyrene has excellent electrical insulating properties. It does not lose strength at lower temperatures and it has a high refraction index which gives it sparkle.

The debit side of polystyrene will be mentioned here in its relationship to other thermoplastics only. Its impact resistance is considerably less than that of the cellulosic thermoplastics, giving the latter a pronounced advantage in certain applications (example: gun stocks). It is attacked by aromatic hydrocarbons, including gasoline, which puts it out of the running for some automotive parts. If improperly molded, polystyrene tends to craze and distort to a greater extent than some of its companion materials. It also is less suitable than some other plastics for parts with metal inserts molded in.

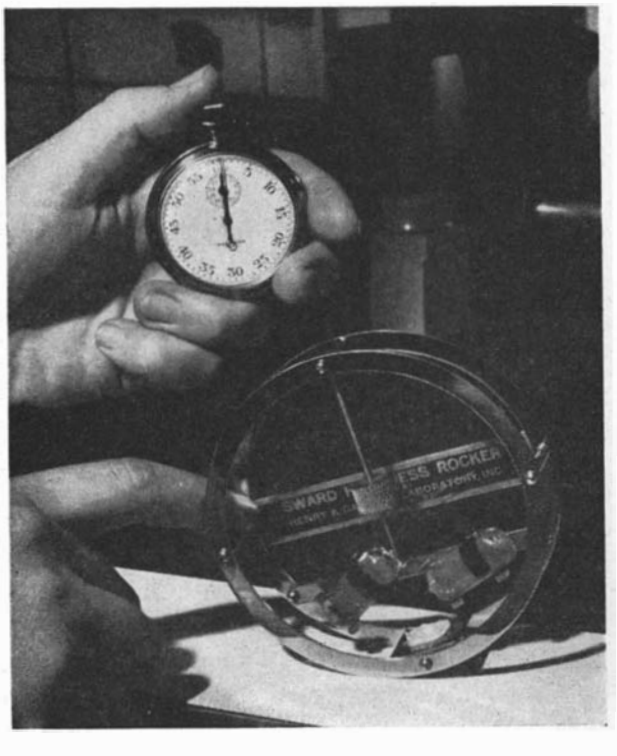
Plastics manufacturers have contended that no material on the market boasts such a wide and diversified range of favorable factors and such a short list of limiting ones. The sales figures and the demand curves back up their statements. It is encouraging to them that research still has some distance to travel in the development of new uses for polystyrene.

In their effort to bring forth new plastics which have new superior properties, plastics researchers are conducting continuous experiments. Many of them are working with styrene monomer. This approach attempts to co-polymerize this low-cost material with some other plastic. As is to be expected, many of these experiments fail, with the development of superior properties being accompanied by inferior properties. On the other hand, some are being crowned with success. It is not beyond the realm of possibility to assume that mating styrene with other materials will create a plastic that can be boiled for hours or one that will have the structural strength of aluminum or another that will take metal inserts readily.

Products made of polystyrene already run a broad gamut. Some items are strictly functional, others are strictly decorative and most of them are a combination of the two. A few samples are refrigerator parts, clothes pins, artificial gems, thimbles, pocket combs, compact cases and clock housings. This list scarcely begins to scratch the surface. The volume uses now include buttons, trays, salad bowls, cutlery handles, measuring cups, tumblers, funnels, bottle closures, cosmetic containers, picture frames, photographic equipment, poker chips, bathroom tile, radio parts, refrigerator parts, adding machine parts, typewriter parts, bathroom fixtures and so on. Telesion lenses and screens have been successfully molded from polystyrene. So have fine-tolerance camera lenses. One molder is preparing to market fog-piercing yellow polystyrene lens which may be slipped over auto headlamps. An auto manufacturer is toying with the idea of molding an entire dashboard of polystyrene. Eighty-ounce battery case halves have already been made for aircraft.

Polystyrene has come a long way in a short time. It seems inevitable that it will go much farther.

Testing the hardness of polystyrene. The hardness is determined by the time required for each bubble to move in the two tubes



© 1948 SCIENTIFIC AMERICAN, INC

THE DOMAIN OF RADIO FREQUENCY HEATING

Another New Technology Has Become One of Industry's Accepted Tools. A Review of Its Principles and Applications

By T. P. Kinn

Westinghouse Electric Corporation

RADIO FREQUENCY heating has been accepted by industry as a new manufacturing tool because it results in better products made faster at less cost. Furthermore, it can sometimes do the impossible.

The evolution of radio frequency heating from its role of laboratory plaything less than a decade ago, can be traced through the many successful installations in industry today. Such varied applications as textile drying, curing and drying of rubber, bonding of wood and plastics, contour hardening, high- and low-temperature brazing, silver soldering, annealing and tin reflowing are but a few of the uses to which this new tool has been adapted, and still current developments represent only a small portion of the demand for this production technique.

The success of radio frequency heating compared to other methods can be computed from the balance sheet of industry itself.

By the use of radio frequency heating one plastic manufacturer shortened the curing time of his products by 91 per cent, cut mold costs by 66 per cent and maintenance costs by 80 per cent. At the same time he was able to increase production 20 per cent, save 12 per cent on materials and get 30 per cent longer life from the molds.

The steam oven method of curing foam rubber sponge mattresses required 30 minutes and each mattress was made in three sections which later had to be cemented together. The double bed mattress, as a single piece, was cured in six minutes by use of radio frequency heating. The quality was improved because of more uniform curing and elimination of the cementing process.

After curing, the rubber had to be washed and dried. Drying with hot air alone required ten hours. By using radio frequency heating for 90 seconds and hot air for one hour, drying time was reduced 90 per cent. Similar results have been achieved in the curing and drying of other rubber products.

One manufacturer required seven men to silver solder an assembly of an angle, five saddles and a tube. Two operators were required to spot weld the five saddles to the angle and five men worked together to silver solder the tube to the saddles. Because gas brazing was so slow, successive brazing would have caused serious warpage. This five minute process was reduced to 10 seconds by brazing the pieces together simultaneously with radio frequency heating. Warpage was avoided by the speed at which the job was handled.

Placing plastics preforms in a dielectric heater. Dielectric heating cuts the cost of molded plastics and improves the quality of the product

TIN-PLATING STEEL — Before the war, steel strip was tin-plated by the hot-dip method . . . a process that required one and a half pounds of tin for each 100 pounds of finished plate. Handled in single sheet form, processing was slow, and as tin became a war-scarce commodity, shortage threatened the entire industry. To conserve available stocks, tin was deposited electrolytically on the steel reducing tin re-

© 1948 SCIENTIFIC AMERICAN, INC

quirements to ½ pound per 100 feet but leaving a coating only .0003 inch thick. The electrolytic coating had to be flowed because the surface was really a succession of steep pinnacles and deep valleys with poor corrosion resistance. Radio frequency heating successfully melted the tin and flowed it evenly on a continuous steel strip moving at the rate of 1000 feet per second. A total of 9600 kilowatts of Westinghouse radio frequency generators—more than twice the wattage of power employed in all radio broadcasting—had been supplied to steel mills for this application at the end of the war.

But the future of this war-born application is even brighter. The steel industry has been having a difficult time supplying the increased demand for tin plating in the post-war era. Since electrolytic plating with radio frequency reflow is a fast process and conserves time, experts estimate that in the next few years 60 per cent of tin plating production will be by this method, with 30 per cent accounted for by the hot-dip process. Currently these production figures are reversed.

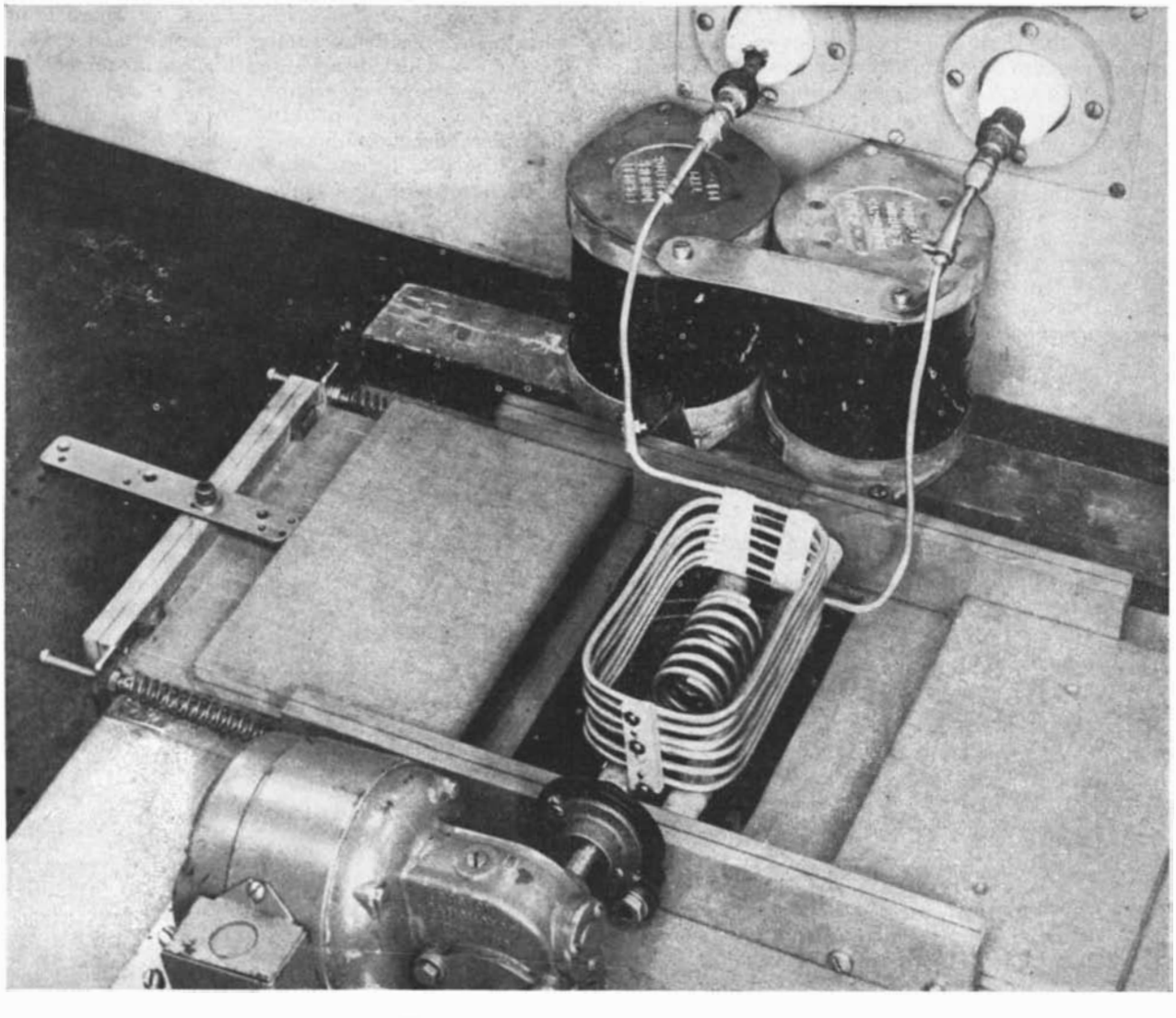
By solving the tin-plating problem successfully, high frequency heating took a long step toward assuring its own future. A decade ago conservative manufacturers looked cautiously at this spectacular process, moved warily where electronics was in use, and under the economic pressure of a receding business cycle were reluctant to discard familiar manufacturing techniques.

How industry's attitude has changed is indicated by a recently completed multi-million dollar plant which is equipped only for the use of high frequency heating to induction-harden gears, shafts and similar machine parts.

Radio or high frequency heating utilizes radio waves similar to those used in short wave broadcasting. In fact, much of the early experimental work was done with regular broadcasting equipment. Two fundamentally distinct methods of applying radio frequency powers are employed: induction, when the workpiece is a material which is a conductor of electricity, and dielectric, when the workpiece is a nonconductor such as rubber, plywood or plastic.

INDUCTION HEATING — Induction heating is based on two familiar and fundamental electrical

Pieces with irregular contours such as the copper-plated coil spring are easily hardened by means of induction heating



© 1948 SCIENTIFIC AMERICAN, INC

phenomena: the principle of induced currents and skin effect. When any electrical conductor is surrounded by a coil carrying an alternating current, corresponding electric currents are induced to flow in the conductor. The induced currents, flowing against the electrical resistance of the conducting material, give off energy in the form of heat, the same type of heat which makes a lamp filament become white hot when current flows through it.

When low frequency alternating current flows through a conductor, or is induced in a workpiece, the current flow is substantially the same at the center of the conductor as at its surface. But as the frequency increases, the current tends to be crowded to the outside of the conductor, so that at a few hundred thousand cycles per second almost all of the current crowds to the surface. This phenomenon is skin effect.

Skin effect is a vitally important characteristic of induction heating because it results in a sharp concentration of heat at the surface of the workpiece. Further, since the depth to which the current can penetrate is determined to a degree by the applied voltage frequency, this depth can be controlled precisely.

The advantage of precise depth control is shown in such applications as shaft hardening, where the bearing surface must be made as hard as possible and the core must remain tough and resilient. To solve this problem, the shaft is properly positioned within the inductor coil of a radio frequency heater and current is passed through it. The surface metal then becomes red hot over the desired area so quickly that the heat has no time to wander off where it might do harm instead of good. When the correct hardening temperature is reached, the power is automatically shut off and the hot surface quenched in water or oil. Shaft hardening and such operations can also be performed by passing the shaft through a coil at a uniform rate of speed, so that the time of passage through the coil is just enough to allow the shaft's surface to reach the correct hardening temperature. The piece is automatically quenched by sprays of water from nozzles just below the inductor coil.

Contour hardening is another case in which induction heating, with its precise depth control, excels. For example, only a gear's surface is made hard by this process—the unheated core still retains the desired toughness and elasticity. Still another application is the hardening of internal bearing surfaces, almost impossible by any other method but extremely easy with induction heating.

In addition to depth control, induction heating allows precise area control, so that localized hardening or brazing without affecting other brazed joints on the workpiece is a simple matter.

OTHER ADVANTAGES — Precise depth and area control are two major advantages of induction heating but there are many others such as:

Increased speed of processing. Heat is generated instantaneously within the material being treated instead of being applied from the outside and then having to soak in by the relatively slow process of conduction. Several pieces can also be treated simultaneously.

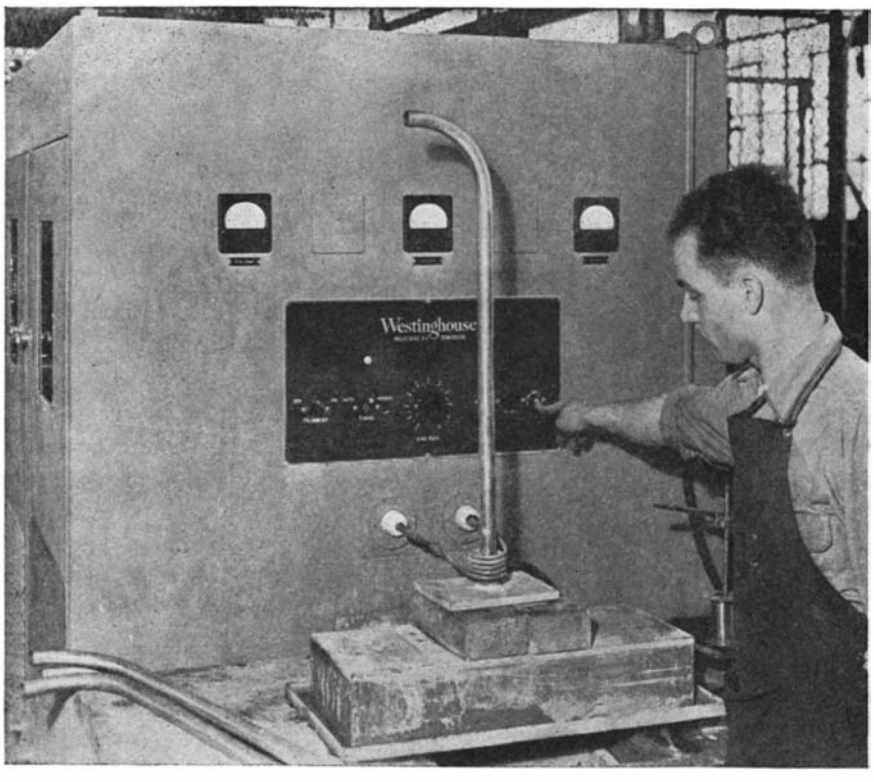
Continuous production-line handling. There is no physical contact between the workpiece and the inductor coil which heats it, an ideal arrangement for the use of conveyor systems.

Improved product quality. Surface hardening may be accomplished without affecting the core structure. There is little distortion, minimum scale formation and high uniformity of results.

Economy. Heat may be applied only where it is needed. Increased speed of processing cuts labor

Dielectric heating rapidly glues these thick slabs of plywood together. Plates of the press serve as electrodes in this operation

© 1948 SCIENTIFIC AMERICAN, INC



Silver brazing a collar to a tube by induction heating to make part of an X-ray machine assembly. Induction heating is as well suited to such small scale operations as it is to large production-line jobs

costs. There are fewer rejects through better quality control.

Simplicity of operation. Automatic controls reduce the heating application to push button operation. Less experienced operators are required than in other heat-treating processes.

Performance of formerly impossible tasks. A braze may be made a fraction of an inch away from a previous one. Contained gases may be boiled out of electronic tube elements just before final evacuation and sealing. Small, irregular parts may be contour hardened.

DIELECTRIC HEATING — Although it got off to a slower start, dielectric heating is now running a close second to induction heating in the radio frequency field. Although generating equipment is almost the same as for induction heating, frequencies of millions of cycles are generally used. The method of applying this very high frequency power is based on the principle of the capacitor, on the broad principle that any pair of conductors separated by an insulating material constitutes a capacitor.

In dielectric heating, the conductors are a pair of metal plates and the piece to be heated, which must be a material which is normally an insulator, is placed between them. When a rapidly alternating voltage is applied to the electrodes, the molecules in the workpiece tend to vibrate because of the rapid change in polarity of the electrical charges within the molecule. The more rapid the reversal, that is, the higher the frequency, the more rapid is the vibration. This molecular motion produces heat. Since the molecular agitation is uniform throughout the dielectric substance, the heat is also uniform, with no overheating at the surface or underheating at the center.

The amount of heat procured by this molecular vibration is proportional to the frequency since this determines the number of vibrations per unit of time; to the square of the applied voltage since this voltage determines the amplitude of the vibrations; and to the "loss factor" used to express the fact that different materials have naturally different rates of heating. Dielectric heating contrasts with induction heating in that the latter assures precise depth and area control, whereas in the dielectric process heat is distributed uniformly throughout the workpiece. Although the methods of heating the workpiece are diametrically opposed, dielectric heating has literally the same advantages as induction heating.

For example, the use of dielectric heating in the rubber and plastics industry showed increased speed of processing, economy, simpler operation and improved product quality. The thickest plywood that could economically be made formerly was about an inch thick. Dielectric heating makes possible plywoods more than a foot thick, a formerly impossible task, and does the job quicker and cheaper in the bargain.

The application of radio frequency heating to industry's problems are being increased daily, abetted by the standardization of power generators, improved equipment and increased experience. Radio frequency heating in action has shown notable results which have increased demand for further application. However, in common with all production tools, radio frequency heating has limitations and these must be carefully considered before it is put into full-scale application. Radio frequency heating should be used when it is impossible to attain the desired objective any other way, when it can do the job much quicker than any other heating method and when it shows marginal improvement over methods now in use.

© 1948 SCIENTIFIC AMERICAN, INC

NUCLEAR PHOTOGRAPHY

The Photographic Plate Has Become the Smallest Laboratory in the World. One Plate Can Record Thousands of Atomic Disintegrations Over Many Weeks. A Team of English Scientists Pioneers In Using This Method For Study of Cosmic Rays

By A. W. Haslett

THE PHOTOGRAPHIC plate is today the smallest laboratory in the world. Its height from floor to roof—the thickness of the sensitive layer—may be no more than one-fiftieth of a millimeter, and the floor space that of the area of the plate. But within this miniature laboratory many of the most interesting and important of atomic disintegrations are now being produced and recorded. There could be no greater contrast to, shall we say, the Hanford atomic energy plant, or to the giant cyclotrons which physicists use to produce fast-moving projectiles with which to attack the atom. The cost of one method can be reckoned in cents and that of the others in millions of dollars.

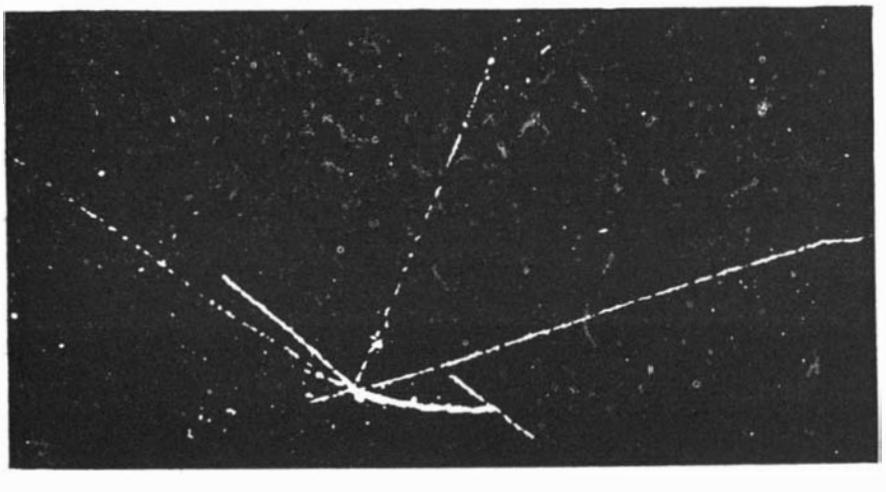
The metaphor that a photographic plate is a laboratory in itself, and not merely a recording instrument, may not immediately be clear. The atomic disintegrations detected by photographic plate, however, are not produced outside the plate and merely recorded. They are produced in the atoms of the sensitive layer of the plate itself.

The fundamental principle of this method is as follows: If an atom disintegrates within the plate, it will produce a number of electrically charged fragments which will scatter from the place where the atom was located. Each fragment will have the same effect on the sensitive layer of the plate as would exposure to light. The tracks of all charged particles originating within the plate are thus automatically preserved until the plate is developed. They then appear as so many trails of metallic silver. These can either be viewed directly beneath the microscope, or projected on a screen and photographed. They can also be photographed through the microscope.

The scientist mainly responsible for the precision and versatility of the photographic method is Dr. C. F. Powell of the H. H. Wills Laboratory of the University of Bristol, England. He has been working on it for about 10 years with Dr. G. P. S. Occhialini. In 1934 Occhialini pioneered with Prof. P. M. S. Blackett in early investigations of the positive electron. Occhialini has worked, in the interval, in both Italy and Brazil. To these two scientists must be added the name of the Ilford Company, which has produced the special plates which they use.

MOST IMPORTANT EXPERIMENT — The most important experiment performed by Powell and Occhialini by the photographic method can be outlined by stating that they have obtained automatic records of an estimated total of 3000 individual disintegrations merely by exposing a set of special plates to cosmic radiation for a few weeks at the Pic du Midi Observatory, high in the Pyrenees. All of the disintegrations have not yet been interpreted. A number of spectacular observations, however, have already been made.

A silver atom, for example, has been observed which is shattered into at least 10 or 12 different fragments, probably the most drastic case of disintegration which has yet been seen. Among other new types of disintegration, five examples have been found attributable to the impact of mesons, a particle which is suspected of playing a most essential



The photographic plate records the disintegration of a heavy nucleus by a cosmic ray particle. One fragment (at the bottom of the plate) comes to the end of its range and splits into two alpha particles which fly off in opposite directions

© 1948 SCIENTIFIC AMERICAN, INC

part in holding the nucleus of the atom together.

It should be possible to manufacture mesons in the laboratory when equipment of sufficiently high electrical energy is available. In the meantime, cosmic radiation, which beats down regularly on the earth from outer space, provides the most violent bombardment to which the nucleus of any atom can be exposed. Disintegrations observed by the photographic emulsion technique are in fact a preview of startling disintegrations which will be observed when new high-energy particle accelerators are built.

Until physicists can surpass the natural intensity of cosmic radiation in the laboratory, however, they must make do with what nature provides. It is in the exploitation of cosmic radiation as a weapon in research that the new technique worked out by Powell is most clearly proving its worth.

The possibility of using a photographic plate as a laboratory was recognized by experimental physicists at an early stage in nuclear research. Plates have been used to a limited extent, for 15 years. They might even have been adopted as standard equipment if another method using the Wilson cloud chamber had not already been established.

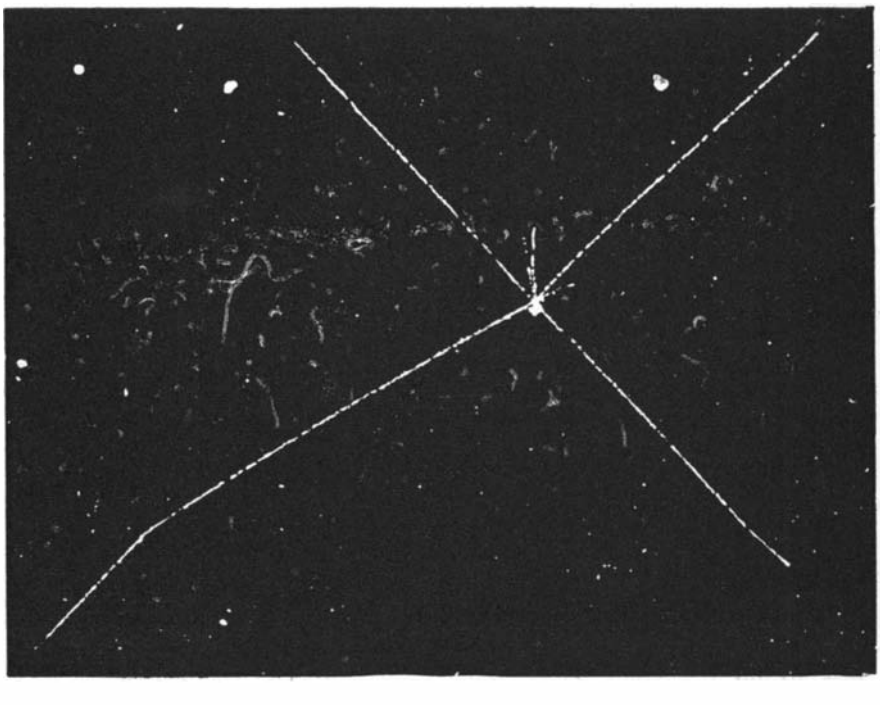
The basis of the cloud chamber method is that the sudden expansion of moist air causes water droplets to collect along the path of any electrically charged particle which passes through the chamber. This makes it possible for the tracks of nuclear particles to be directly observed and photographed, with no uncertainty about the distances they travel. On the other hand, it is necessary that each disintegration or set of tracks in a cloud chamber be separately photographed at the time that it takes place. This means a considerable expenditure in time and control equipment.

EMULSIONS SHRINK — By contrast, the emulsion of a photographic plate is continuously in action and does its own recording. The principal drawback of the plate method, however, is one which appeared an almost insuperable obstacle to accurate measurement. This is that photographic emulsions shrink very appreciably in processing. In the case of the special plates which are now being used, this shrinkage amounts to as much as 43 per cent. Dr. Powell's greatest achievement, accomplished by long and patient investigation, is that he developed a method of measuring photographic particle tracks accurately in spite of this shrinkage.

It was necessary, Dr. Powell found, to confirm that the vertical shrinkage of the emulsion was not only uniform over the central area of the plate but was also constant for all plates of the same type. Of equal importance, since the emulsion was a mixed material, was a direct and experimental comparison between the ranges of particles of different types and speeds passing through air and through a photographic emulsion. Finally, since the emulsion is three-dimensional and the tracks recorded might run in any direction, methods had to be devised of accurately determining the "angle of dip" of individual tracks in relation to the glass surface of the plate. Only in this manner could the range of any track be measured.

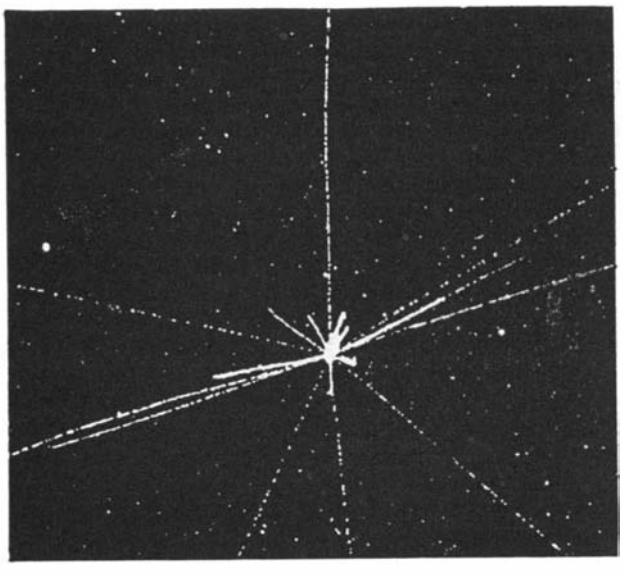
All of these fundamental requirements had been fully met by 1943. The difficulty remained, however, that the number of grains which were exposed—in the usual photographic sense—by the passage of a particle through the emulsion was not great enough to make interpretation of the plates easy. As early as 1939, Dr. Powell had been in touch with the Ilford Company with the hope of their producing special plates in which the number of sensitive grains would be greater than normal.

The first attempts to develop these plates produced no substantial improvement, and at this point the outbreak of World War II prevented any further work. It was not, in fact, until last year that a series of new plates was made with eight times the usual proportion of silver bromide. It was the development



A disintegration is recorded in which four alpha particles of long range are emitted. The tracks of the four particles lie in nearly the same plane

© 1948 SCIENTIFIC AMERICAN, INC



The disintegration of a heavy nucleus into about 20 fragments by a cosmic ray particle

of these plates, following on Dr. Powell's earlier demonstration of the validity of the method, which led to the recent ferment of research activity.

The activity has by no means been confined to Bristol. By the same methods, learned during a visit to the Bristol laboratory, two Paris physicists were recently able to demonstrate the rare splitting of the uranium nucleus into four separate fragments. Similar plates have also been exposed by workers at London's Imperial College of Science and Technology during high altitude aircraft flights. This, of course, makes it possible to obtain plates subjected to intense cosmic radiation.

Other important points in the use of nuclear emulsions are 1) the types of atoms to which the method can be applied and 2) the scale of the photographic effect. The emulsion of a photographic plate normally contains a number of chemical elements: notably silver and bromine and, among others, carbon, nitrogen and oxygen. If nuclear disintegrations were confined to this comparatively small list, even including a number of other elements present only in trace amounts, the method would be limited in its application. Dr. Powell has accordingly developed methods of introducing into the emulsion almost any other chemical element which he may want for his disintegration experiments.

As to scale, the thickness of the sensitive layer in the special plates now being used is either 40 or 20 thousandths of a millimeter. These, therefore, are the longest distances which any track can be followed in a direction at right angles to the surface of the plate. Since the range of particles in the emulsion runs from 10 thousandths of a millimeter to a full millimeter, many tracks can be followed only when they run parallel to the plate surface.

The photographic record of a nuclear disintegration is thus a star-shaped explosion within the plate with the tracks of the resulting particles scattering in a variety of directions. Some leave the plate before their course is completed and others come to rest within the emulsion so their ranges can be measured. Generally speaking, the kind of particle can be deduced from the appearance of its track. The energy of the particle is calculated from its range.

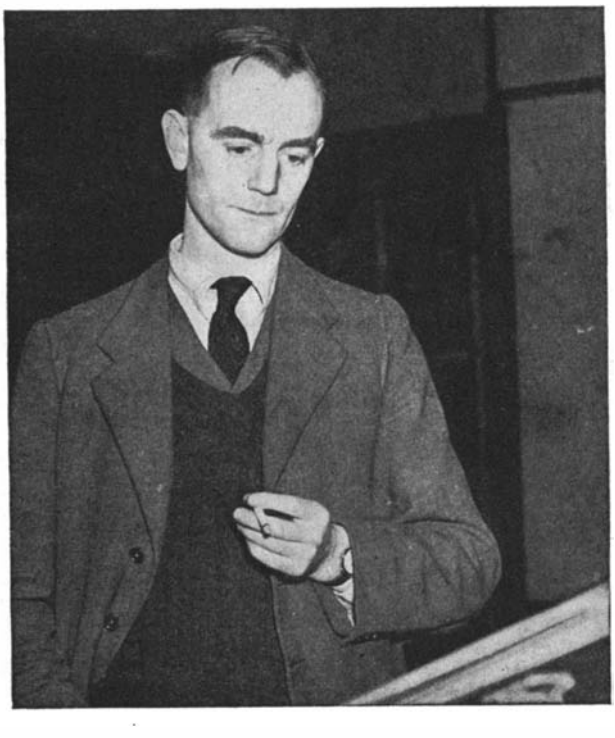
PROJECTION MICROSCOPE — Dr. Occhialini's chief contribution to the Bristol partnership has been to design and construct an ingenious form of projection microscope. This is of great value in the inspection of exposed plates and in the preparation of photomicrographs. These make possible further study and publication of tracks produced by a nuclear disintegration.

Dr. Occhialini has named his device Telepanto, because it may be used to project an image of the plate on a screen at a comfortable distance. It is capable of automatically scanning the complete area of any plate which is put into it for projection. It also varies its focus periodically, so all sections of the plate may be examined in depth as well as in area.

When it is in operation, this automatic scanning device creates the illusion that individual tracks and "stars" which may have been left weeks before in the plate are alive and moving. Apart from its value in speeding up examination, the same equipment can be used with manual control to photograph the projection screen with the microscope focus at different depths. This is necessary to make composite photographs showing tracks which travel in three dimensions in one flat plane.

As a final result of the photographic method of recording nuclear disintegrations, complete visual evidence for any new type of disintegration can be published so other research workers can readily assess it. With the wealth of material which is still to come, this is an essential requirement if confusion in interpreting entirely new atomic transmutations is to be avoided.

Dr. C. F. Powell—nuclear photographer



© 1948 SCIENTIFIC AMERICAN, INC

LUBRICANTS FOR ELECTRIC MOTORS

Motor Life Is Often Shortened by the Wrong Bearing Greases. Functional Tests for Bearing Greases are Therefore Necessary

By H. A. McConville
Works Laboratory, General Electric Company

THE SERVICE life of an electric motor is inseparably bound to the efficiency of the motor-bearing lubricants. And when the tremendous part played by the electric motor in modern industry is considered, the importance of selecting the proper lubricant for a motor's bearings becomes apparent.

All too often, the selection of such lubricants is managed on a completely haphazard, hit-or-miss basis. Almost inevitably, this results in a long series of prematurely worn bearings and expensive replacements, until the proper lubricant is finally stumbled upon.

The systematic determination of a grease that will satisfactorily lubricate the ball and roller bearings in electric motors under a wide range of operating conditions is by no means an easy matter. It can be simplified somewhat, however, if the least desirable greases can be weeded out by suitable chemical and physical tests made in the laboratory. These tests include measurement of consistency; of the dropping point (the temperature at which the grease will lose its stiffness and drop off a thermometer under standard conditions); of the free acid or alkali content; determination of the kind of soap used to thicken the grease; of the tendency to separate oil; and of the amount of dirt present.

But the final answer of whether the grease will be satisfactory in actual service cannot be foretold by such chemical and physical tests. No two persons will interpret these tests alike. A trial run in a test motor of a size large enough to be representative of the worst conditions that might be encountered in industry is a more satisfactory means of evaluation. By testing the grease in a large bearing operating at high speed over a wide range of temperatures, and observing the condition of the grease at the end of the run, it is possible to predict with reasonable accuracy whether the grease will give the required service.

The motor recommended for such a functional test is a 30 horsepower standard induction motor, operating at about 3600 revolutions per minute, and having roller bearings about five inches in diameter at one end, and ball bearings of the same size at the other. It should have pressure grease fittings for the pressure relief system. The motor need not be loaded.

A 500-hour test on a motor of this size and speed will give the equivalent of a year or more of service. The test conditions should be selected so that the required life of the bearings before failure will be about 10 percent of the service life that can be expected from the bearing.

FIRST CLEAN HOUSINGS — In conducting the test, the bearings and housings should first be cleaned thoroughly with some suitable solvent such as carbon tetrachloride. The bearings should then be filled, using a hand-operated pressure gun. The bottom drain plug should be removed and the bearing filled until excess grease comes out the drain hole. The plug should not be replaced for 30 minutes after the maximum temperature at which the motor is to be run is attained. This procedure prevents a building-up of pressure in the housings due to expansion of the grease, with subsequent overheating. The motor is now run for 500 hours, or for whatever time has been agreed upon, and at the end of the test, the greases in either end of the motor should be carefully examined.

If the lubricant has given satisfactory service, the bearings will not have become unduly noisy; the bearings' surfaces will not show noticeable wear; there will be no gumming of the grease; no free oil will be visible in the bottom of the bearing housings; there will be no metal particles in the grease; and the dropping point of the grease will not have lowered by more than a specified amount. Also, the grease should not get more than a specified amount

© 1948 SCIENTIFIC AMERICAN, INC

harder in consistency, as measured by the A.S.T.M.'s penetrometer, than it was before. And its acidity should not increase more than a figure agreed upon.

NEXT A FIELD TRIAL — A grease which meets these requirements is ready to be given a service performance trial in the field in the particular apparatus for which it was intended. It is well to try it out in smaller motors first, and extend it to larger ones later. This field performance is the only true test, as troubles may occur in service which might not have been predicted by any laboratory test.

The test procedure depends somewhat on the test limits set. For ordinary motor applications, a grease should be able to stand about 90 degrees, Centigrade (194 degrees, Fahrenheit), so the temperature on the bearings should be held at that figure. If a grease were to be picked for higher temperature applications, the test temperature could be 100 degrees, Centigrade (212 degrees, Fahrenheit), or even higher.

The speed of 3600 revolutions per minute is again suggested, as many greases will break down in a short time at this speed in the size bearings mentioned, where they may run for months at a speed of 1800 revolutions per minute. These tests, however, will not predict performance in motors operating normally at over 5000 revolutions per minute. A special test motor running at 8000 to 10,000 revolutions per minute is recommended for evaluating greases for these high-speed motors.

It is possible that 500 hours may not be a long enough period, but it should be sufficient for the majority of greases. The test is not planned to run to the final destruction of the bearings, as this is too expensive and time-consuming.

When the grease is examined at the end of the 500-hour period, the term "free oil" does not mean small drops of oil which may be scattered through the grease. But greases that leave a pool of free oil in the bottom of the bearing cup are unsatisfactory. It is believed that the consistency of the grease, measured in tenths of a millimeter, should not be more than 15 points harder than the original unworked consistency at the beginning of the test. The free acid (calculated as oleic acid) should not be over 1.0 percent.

Sometimes, samples of greases submitted for test have been made only on a trial basis in a laboratory, and have not been produced commercially. These may give very good results on the trial run, but the supplier often cannot duplicate them on a large scale. So, if it is known that the grease is only a laboratory sample, a thorough test should be made on the commercial product before giving final approval to the grease.

The greases will not necessarily appear the same in both bearings after the test. The bearing on the pulley end of the motor with the shaft passing through the housing, churns the grease differently from the bearing at the other end, which is enclosed by an end bearing-cap.

Grease in the front end of the motor will usually become much stiffer than that on the pulley end. The best check on changes of consistency of a grease is, therefore, made by testing the hardness of the grease in the front-end housing at the conclusion of the test. There are differences of opinion as to how hard a grease can be, and still lubricate the bearing satisfactorily. A suggested range is about 260 to 300 worked consistency, as scaled by the penetrometer.

VALUE OF TEST — What is the value of this kind of test to industry? The type of physical and chemical tests that can be made in the laboratory cannot distinguish uniformly between good and bad greases. Two greases may have exactly the same formula and many of the same physical properties, and yet one may perform well, and the other poorly. No two people interpret laboratory tests alike. So, the obvious answer is to see what the lubricant is like after it has been run in the type of apparatus in which it is to be used. This test is by no means the final solution. But it is an intermediary step between laboratory tests and long-time life tests in apparatus in the field.

Some examples of what can be expected when the described test method is followed will demonstrate its value. All of the greases in the following tests passed the chemical and physical tests without difficulty.

Grease A. This ball-bearing grease had a worked consistency of 308 and a dropping point of 332 degrees, Fahrenheit. It was run for 18 days in a test motor, during four of which the temperature of the grease in the bearing at the pulley end was 175 degrees, Fahrenheit, and on the front end was 158 degrees. By the end of this period, the grease attained a semi-fluid condition, and most of it leaked out along the shaft on the pulley end and into the windings. The grease left in the bearings was very soft and plastered around the balls.

Conclusion: This grease, thinned down too much under the temperature involved, making it quite unsuitable.

Grease B. A ball-bearing grease of about 318 worked consistency with a dropping point of 275 degrees, Fahrenheit, was run in the motor at room temperature and performed satisfactorily, as most greases will at such a temperature. Then the running temperature was raised to 175 degrees, Fahrenheit, and held there for a few hours. The bearing temperature rose suddenly to 284 degrees and remained at that point for about two hours, at which time the motor was shut down. The grease did not leak out, but remained very soft in the bearing housings. The same thing happened when the test was repeated.

Conclusion: this grease would not stand 175 degrees, Fahrenheit, without breaking down.

Grease C. A ball-bearing grease of 274 worked consistency with a dropping point of 444 degrees, Fahrenheit, this sample was run for three weeks at elevated temperatures—two weeks at 90 degrees, Centigrade, and one at 100 degrees, Centigrade. At the end of that time, judging by its appearance, the grease was in excellent condition and seemed to be operating very satisfactorily. When the motor was cooled to room temperature, the grease was quite stiff, but the consistency at operating temperatures was very good, and the bearing surfaces showed a thin film of grease. This grease looked promising, and was chosen for further field trials.

With these results as evidence, it is obvious that such testing techniques can not only result in extending the service of expensive electric motors, but also can go far to reduce delays in production due to bearing failures.

© 1948 SCIENTIFIC AMERICAN, INC

SCIENTIFIC AMERICAN'S Industrial Digest

COLOR VISION LIMIT

New Estimates Set Human Perception At Over 17,000 Separate Colors

It was recently estimated that wholly unaided eyes can distinguish well over 17,000 separate colors in daylight. Dr. David L. MacAdam, specialist in color vision at Kodak Research Laboratories, who reached that figure, bases his estimate on the 17,000 distinct colors of equal brightness that are detectable when observations are made with precise optical instruments. To this figure he adds the fact that when large pieces of colored paper are viewed with the naked eye, roughly 50 per cent more colors can be distinguished than by the finest optical means.

Under similar conditions some 500 distinct shades of gray—ranging from black to white—can be detected. Dr. MacAdam states that when color is introduced each shade of gray in the middle range of the scale of about 500 shades between black and white is expanded up to 17,000 times. The ultra-fine differences in color studied in the laboratory known as "distinct chromaticities" are the distinguishable features of color when brightness is disregarded.

In arriving at his new figure Dr. MacAdam estimates that there are about 250 distinguishable colors in the spectrum, plus 10,000 distinguishable tints of spectral colors and 7000 additional colors such as purple, which do not resemble any spectral colors.

TELEVISION OBSERVATION

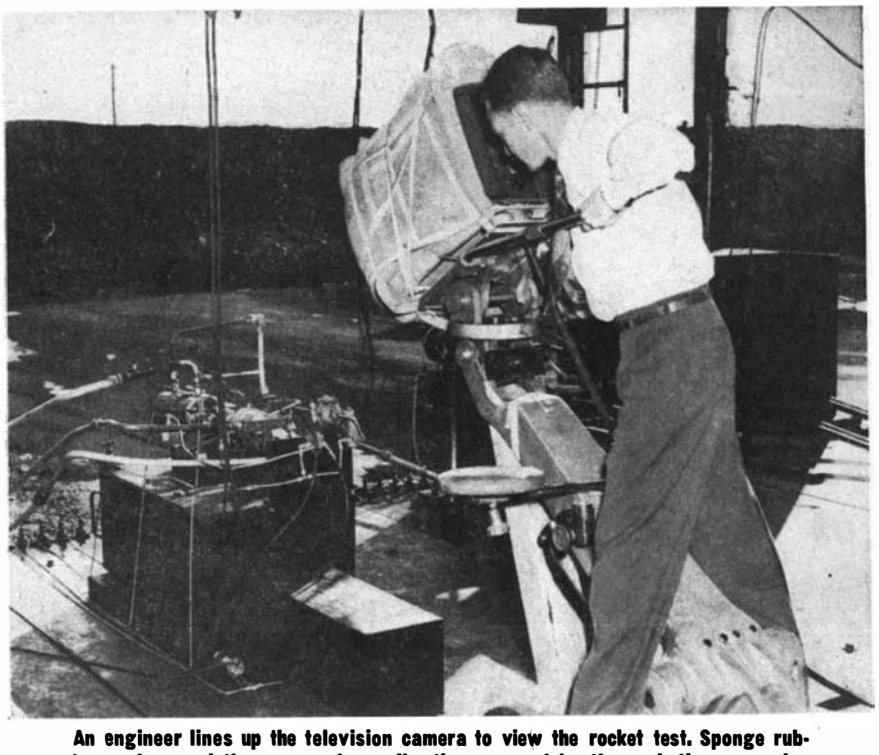
Remote Viewing of Rocket Test Is Safer, More Satisfactory

Television equipment was used for the first time recently in the testing of high-thrust rocket motors in a demonstration for Army, Navy and other government officials at the proving grounds of the Aero Jet Engineering Corporation. A television camera "watched" the rocket motor tests and sent its report to observers in a conference room where they saw the operations on a viewing screen far removed from the test pits.

It is one of those industrial applications where television should be of tremendous value because it will allow "close-up" study difficult and often impossible to obtain with other methods. Limitations of conventional methods of test viewing are manifold, according to Aero Jet engineers. Observation block houses restrict viewing to either the direct method through laminated safety glass which becomes clouded from close-range effects of propellent fumes, or the indirect method using mirrors which in addition to becoming clouded limit the range of vision and often include distortion. Both of these observation systems require apertures through heavy safety walls of the block house thereby weakening the structure. They also limit two or three persons per apertures and obviously require the observers to be present within the hazard area of the test pits.

The television method has many advantages. The whole operation is viewed from a safe distance, picture light intensity and definition are far superior to direct viewing through glass; and shock-proofed cameras can be mounted adjacent to the rocket unit for viewing intimate details. This close-up view provided by the television camera allows the engineers to detect in time to stop the test firing any evidence of fuel leaks or malfunctioning of the system which could result in an explosion and major damage to the rocket motor and its entire test setup. Continual observation of the rocket and exhaust flames during the firing period also enables the test engineers to note any irregularities in mixture ratio.

Commenting on this experiment, C. A. Priest of the General Electric Company—supplier of the television equipment—states that this may pioneer installation of similar television equipments in other hazardous industrial work. Most of the television emphasis to date has been placed in the entertainment phase of the industry. However, there are numerous possibilities for



An engineer lines up the television camera to view the rocket test. Sponge rubber pads guard the camera from vibrations caused by the rocket's concussion

© 1948 SCIENTIFIC AMERICAN, INC

industrial application—for example in salvaging ships in underwater exploration, in places where danger exists from possible explosions, fire, dust or fumes; or where remote supervision is necessary as at dams, vehicular and railroad tunnels, for traffic control and so forth—which will be explored as the art develops.

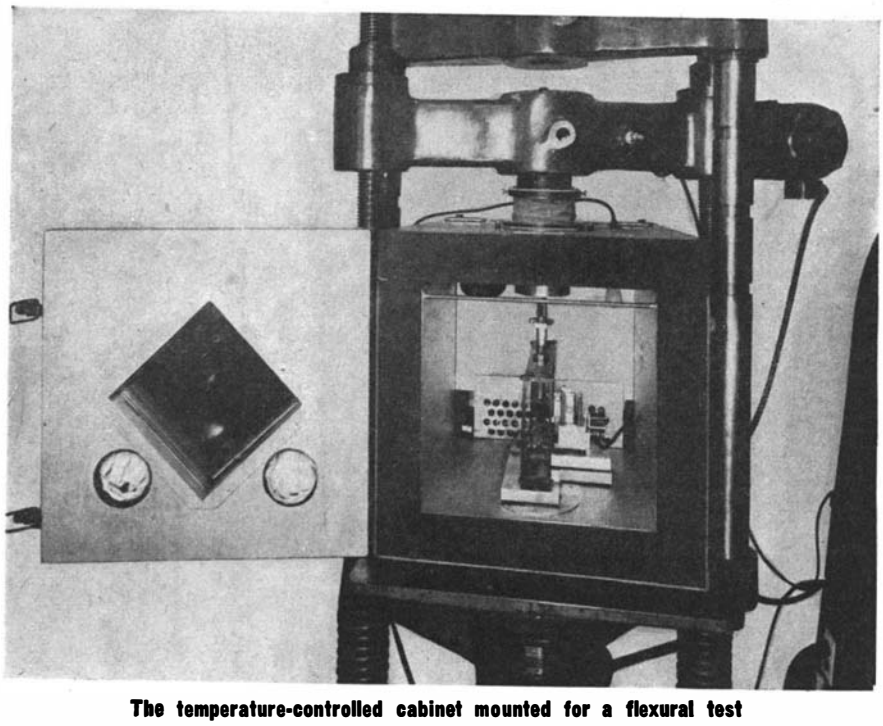
PLASTICS TESTED

In Compression, Tension, Flexure in Temperature-Controlled Cabinet

FOR DETERMINING the physical properties of plastics in tension, compression or flexure over the specification range of temperature of −70 to +170 degrees, Fahrenheit, a new temperature-controlled cabinet has been developed for use on standard Baldwin-Tate-Emery testing machines of 60,000 and 120,000 pounds capacity. The working chamber of the cabinet, approximately 19 inches wide, 18 inches high and 20 inches deep, accommodates Templin type specimen grips of 5000 pounds capacity, a sub-press for compression testing, flexure tool, standard strain followers for either Templin or Microformer type recorders and associated equipment. Standard two-inch gage length tension test specimens, compression specimens two by one half by one half inch, or flexure test specimens up to 16 inches span by two inches wide and two inches thick can be tested in the chamber. The chamber permits a deformation of two inches in the tension and flexure specimens.

Behind the working chamber is a servo unit consisting of a dry ice container, a mixing chamber, fan for air circulation, heater coils and electric temperature control equipment.

The cabinet, which is twenty seven by twenty seven by forty inches overall, is constructed by the Baldwin Locomotive Works of polished stainless steel with four inches of thermal insulation. A hinged door and removable top in two sections give access to the interior of the cabinet. Tests can be observed through a double-glazed plate glass window in the door, and two hand holes with insulated sleeves permit manipulation of apparatus in the chamber during tests without opening the door.



The temperature-controlled cabinet mounted for a flexural test

TREATMENT OF WASTE

By Sedimentation Speeded By Slow Stirring

TREATMENT of a wide variety of industrial wastes may be simplified by a new technique which speeds the settling of sediments and eliminates costly sewer installation, it was reported in a paper presented by A. A. Kalinske and E. G. Kominek of Infilco, Inc., at a meeting of the American Chemical Society.

Although the treatment of wastes varies with the industry, sedimentation, or chemical treatment followed by sedimentation, is employed in most instances, it was explained in the paper, which was read before the Division of Water, Sewage, and Sanitation Chemistry.

In many industries, intermittent discharge of high-temperature waste liquid may raise the temperature of the settling waste several degrees in a few minutes, setting up heat currents which interfere with settling, it was pointed out.

Storage in large basins for extended periods of time can offset this difficulty, but storage facilities are not always available and in any event such storage ties up valuable space. The new technique, employing a stirring device for equalizing the temperature throughout the waste liquid and a trap for removing the sediment, permits continuous treatment of waste by sedimentation, it was asserted. The mixing apparatus, called an accelerator, makes use of the strong hydraulic action of a slow moving rotor, thereby preventing settling from taking place on the bottom of the tank. The settling slurry is constantly pumped from a primary mixing and reaction chamber into a secondary chamber where it settles rapidly and is trapped.

FINER CASTINGS

Salt-Free Silica Solution Is Used as Precoat

SOLUTIONS which would yield silica particles so fine that the electron microscope alone could measure them long have been the materials for investment precoats which would give precision investment castings their finest smoothnesses. A trouble has been that most of these solutions contained salt which was difficult to remove. Salt-free solutions have finally appeared on the market. Their use is predicted to cause a long stride forward in the precision investment casting art, a stride that will bring the surfaces of castings one step closer to those obtained by machining and grinding.—*E.L.C.*

LEAD-SILICA PIGMENT

Paint Made With One Third The Lead Usually Required

A NEW PIGMENT which will make three times as much paint from the same amount of lead as is now used will help to conserve the nation's inadequate lead supply and to relieve the current shortage of superior house paints.

The reduction in the amount of lead per gallon of paint is not made at the expense of quality, according to F. J. Williams and A. R. Pitrot of the National Lead Company Research Laboratories. They point out

© 1948 SCIENTIFIC AMERICAN, INC

that by making more effective use of the lead present, paints will have the same long life characteristics now exhibited by ready mixed paints containing equivalent quantities of other lead pigments. Exhaustive paint tests have shown that this pigment is the equal from a performance standpoint of the lead pigments now employed.

One hundred pounds of lead will make 6¾ solid gallons of this pigment compared to 2 1/7 solid gallons of white lead. This will mean over three times as much paint from the same amount of lead.

The function of lead pigments in a paint film is to react with the decomposition products of the vehicle, many of which are acidic in nature, converting them to lead compounds which fortify rather than destroy the film. In the course of this film-saving reaction only the surface of the solid pigment particle is consumed, the rest of the particle remaining to perform its normal function of hiding the surface to which the paint was applied.

Only the surface of the lead pigment particle is effective in imparting long life to a paint film. Therefore a pigment with a minimum amount of lead but with this lead content concentrated on the surface was sought. Such a concept was new, and a pigment particle meeting this description had not previously been prepared.

The new pigment is produced by grinding silica sand in the presence of water to an extremely fine particle size. Lead oxide is then added with a small amount of sulfuric acid to convert part of the lead oxide to lead sulfate. This results in an intimate mixture of the ingredients in the water. This mixture is dried and heated in a furnace to a dull red heat for several hours under controlled conditions. The resulting product is such that the individual particles are coated with lead silicate and lead sulfate.

This skin or surface layer is firmly adherent to the underlying silica core and is, in fact, an integral part of the grain. The lead silicate and lead sulfate are available for reaction with the decomposition products in paint films, thus serving as if the entire particle were lead silicate and lead sulfate.

SUPER SHOCK-ABSORBER

Mechanism Compensates for Bumps Before They Can Be Felt

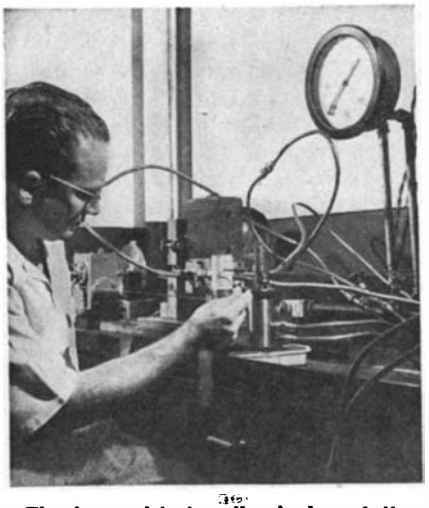
A SHOCK-ABSORBER which promises train and bus travelers far smoother, more comfortable rides is now being road-tested. This new mechanism is designed to:

Eliminate more than 60 percent of the bumps and sway caused by irregularities in tracks or roads;

Enable trains to take curves at more than 25 percent greater speeds without so much as splashing your cup of coffee;

Bring about a 4 to 1 over-all improvement in riding ease of trains and buses and permit increased traffic over present rails and highways.

The new system, developed at Westinghouse Research Laboratories under the direction of Dr. Clinton R. Hanna, is the direct offspring of the tank-gun stabilizer which enabled Allied tank gunners to shoot accurately while speeding over rough ground.



The bump detector, the brains of the shock absorber, is given a final check

"The main difference in the two systems," explains Dr. Hanna, "is that the 'brainwork' in the tank-gun stabilizer was done by a gyroscope, whereas in this vehicle stabilizer it is done jointly by floating weights that feel up-and-down and sideway motion, and a pendulum that senses the pull of centrifugal force and gravity.

"Working together or separately, these two elements can detect and respond to bumps or side-sway in just 0.003 second, thus literally anticipating the movement and correcting for it before it is felt by the train or bus passengers."

The stabilizer automatically moves the car trucks or bus wheels up and down to compensate for bumps in the road surface. Train wheels are moved from side to side to correct for track "weaving." A "tilter" banks the car or bus body as it rounds a curve.

As applied on a railroad car, six hydraulic cylinders and a pair of motor-driven screw-jacks do the "muscular work," Dr. Hanna points out. The cylinders—four for vertical bumps and two for side-sway—are fastened between the wheels and the car body.

"When the car comes to a bump or dip in the tracks," Dr. Hanna says, "the floating weight instantly senses the motion of the body as it begins. This movement opens one valve and closes another, causing oil under high pressure to flow into the proper cylinder. The pumping of oil drives the piston in the cylinder with just enough force in the right direction to counteract the bump and hold the car body virtually motionless. All this takes place in 0.003 second.

"What actually happens is that the wheels are pushed down into the valleys and raised over the peaks of the bumps while the car floats on a cushion of oil in the cylinder. The same type of action moves the wheels right or left to correct for side-sway and the car body moves forward in a straight line."

When the train enters a curve, a similar mechanical brain goes into action, Dr. Hanna explains.

"This is a gyro-controlled pendulum which regulates two electrically-driven screw jacks," he states. "The screw jacks are placed at diagonal ends of the car body. When the car enters a curve at a speed not quite right for the bank of the track, centrifugal force swings the pendulum toward the outside of the curve if the speed is too fast, or gravity pulls it toward the inside of the curve if the speed is too slow. In so doing it closes an electrical contact, sending a signal to the electric motors which operate the two jacks. These jacks immediately tilt the car body to the correct bank angle."

The tilt mechanism can add up to six degrees of additional bank in either direction within two seconds. So precise is its sense of balance that even when going around a curve at theoretical 40 percent overspeed, the tilter can bank the car to within one degree of perfect equilibrium. The permissible speed on curves depends on the design of the locomotive, but even with this limitation the tilter will make possible 25 percent overspeed without passenger discomfort.

Going around a curve even at high speed, the passengers will be able to stroll down the aisles without difficulty. And when the train comes to a standstill on banked curves, the car body will be held perfectly level.

"The big bugaboo of shock-absorber designers always has been the problem of resonance," Dr. Han-

© 1948 SCIENTIFIC AMERICAN, INC

na says. "This means the rhythmic bouncing that occurs when bumps from the road are transmitted through the springs to the car body. A succession of one inch bumps may cause the car to bounce from two to four inches; and if this motion were not restrained, the car would continue to bounce higher and higher.

"The best shock absorbers have been able to limit this bouncing to about three inches. The new stabilizer cuts it to less than one inch—an improvement of some 300 percent. Also, by applying all the hydraulic power of the stabilizer to the wheels and helping them move up and down, the traction power of the car is greatly improved."

Although passenger comfort is the chief aim of the stabilizer, improved train and bus schedules should also result from its use, Dr. Hanna states, adding:

"Much higher speeds will be possible with comfort. This means stepped-up schedules and a greater flow of traffic over present roads."

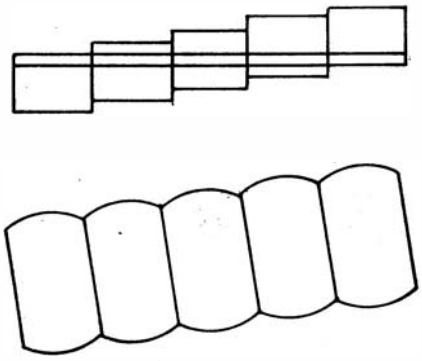
The same equipment used on railroad cars, modified slightly, can be applied to large passenger buses. In the case of buses, the system will be simpler due in part to the omission of lateral sway stabilizers. Buses have no swing link suspension because they do not have to travel along weaving track.

FASTEST MOTION PICTURE CAMERA

Shutterless Instrument Aids in The Study of High-Speed Phenomena

A NEW motion picture camera which achieves the unprecedented speed of 11 million frames per second makes possible such extremely slow motion pictures that a bullet photographed in full flight requires a minute to travel one inch across the screen. This instrument, which was designed by Brian O'Brien and Gordon G. Milne, both of the University of Rochester Institute of Optics, promises to be of great value in the study of many high-speed phenomena.

The revolutionary camera uses no shutter. It achieves its speed through the technique of "image dissection," which consists simply of breaking down the image to be photographed into a series of narrow strips. This dissection is accomplished by a set of small lenses placed side by side in such a manner that a line connecting the centers of the lenses would be slightly inclined from the horizontal. Each lens forms an individual image, with all the images being arranged side by side, descending in step-like order. A metal strip is placed in a truly horizontal position between the lenses and the film so that the images from all the lenses fall upon it. An extremely narrow slit which runs the entire length of the images is cut in this strip and only those portions of the images that fall upon the slit reach the film. The slit passes only the very top of the image from the lens on the lowest level, a small slice just below the top from the next image, and so on, with the very bottom of the image being passed from the highest lens. Since all of the lenses view the same event, the light passing through the slit consists of the dissected elements of the original picture joined end to end.



Lenses (below) are arranged side by side, slightly inclined from the horizontal. Images (above) are formed descending in step-like order. Only that part of each image falling on the horizontal slit is passed on to the film

The film is driven past this line of light in a direction perpendicular to the line, at the comparatively high speed of 400 feet per second. This is accomplished by fixing a strip of film to the inside wall of a shallow drum and then rotating it.

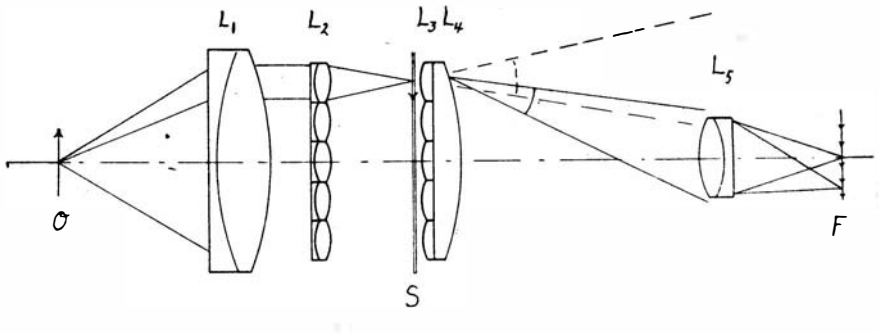
This printer transforms the streak image into a series of rectangular pictures

The narrow line of light from the slit is drawn out into a streak by moving the film, and the variations in photographic density at any place across the film contain all the elements of one complete rectangular picture for the particular instant of the time represented by the position selected along the streak. Since the camera is shutterless, the motion of the film naturally produces a blurring of the image. This blurring is limited to the width of the slit which is less than the resolving power of the film itself. Thus the negative need only be moved the width of the narrow slit to produce a complete new frame of the event.

The negative is reconstructed into a series of rectangular frames by projecting the film strip back through an optical system similar to the one that produced it. This is done by an automatic printer, which produces an ordinary 16-mm motion picture.

Light source for the camera is a new condenser discharge flash lamp with a flash duration of 1/5000 second. This flash is sufficient to illuminate several minutes of continuous performance on the screen.

The negative is enlarged 10 times in the process of printing back to



Optical system of the image dissector, viewed from above. Light from the event to be photographed (O) is received and collimated by lens (L_1). The multi-lens system (L_2) forms multiple images at horizontal slit (S). Image portions passing through the slit continue through the condensing lenses ($L_3 L_4$) and thence to the final photographic objective lens (L_5). The slit image is formed at the film (F)

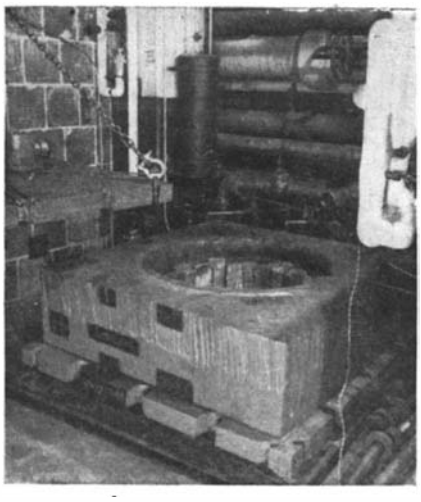
© 1948 SCIENTIFIC AMERICAN, INC

a 16-mm motion picture frame. Thus the film grain imposes a serious limitation on the quality of the pictures.

The camera is not suitable for ordinary pictures. However, while the esthetic value is missing, the device should be an extremely valuable tool for the study of such high-speed phenomena as explosions, electric discharges, pressure waves and high-velocity jets and rockets.

WHIRL PIT TESTING

Spinning Disks at High Speeds Aids Metallurgical Study



In this whirl pit circular steel plates are spun at high speed until they burst

IN AN ARMOR-PLATED "whirl pit" 40 inches in diameter and nine feet deep, circular steel plates are rotated at high speeds until they burst. This is one of the most promising of the new testing methods to provide biaxial stress all the way to fracture, according to Mr. W. Spraragen, Director of the Welding Research Council of the Engineering Foundation. "It makes it possible to test thicker welded and unwelded plates than is possible by other methods," he states.

One of the most valuable uses projected for the rotating disk method will be to test materials and welds at extremes of temperature, and the results should be particularly useful to bridge engineers, shipbuilders, the U. S. Army and Navy and those who use steel at extremely low temperatures.

The project is under the direction of Dr. C. W. MacGregor, professor of applied mechanics at Massachusetts Institute of Technology. All tests so far have been pilot tests with the purpose of perfecting the method and equipment. The disks, which can be tested to a thickness of eight inches, are suspended on a flexible steel drive shaft and rotated in a 30-inch vacuum at speeds up to 35,000 revolutions per minute. The vacuum prevents the generating of heat in the plates as they are rotated and makes it possible, by admitting air, to stop the whirling at any given moment.

The whirl pit itself is made of three heavy pieces of class B armor plate, and is lined with lead pigs to preserve the disks for observation and measurement after fracture. To date, the disks tested have all been 26 inches in diameter but of different thicknesses. For welding tests a small central disk is welded within the outer disk.

As the disks whirl at high speed, the material actually flows from the center toward the edges and thickens the disks at the perimeter. It is expected that future tests will provide interesting information on plastic flow and on distribution of plastic strains.

The program outlined for the future is as follows:

1. Study of plastic flow and strain distributions on disks 26 inches in diameter rotated to partial yielding and to bursting at room temperature; on welded disks, as-welded and stress relieved; and on unwelded disks annealed and as hot rolled.

2. Development of wire strain gage techniques for measurement of brittle fracture conditions at low temperatures, and construction of a refrigeration system for testing disks at low temperature.

3. Low temperature studies on disks of same thickness (three quarter to one inch) unwelded, welded, stress-relieved and as-welded.

RESILIENT TUMBLING PELLETS

Rubber Slugs Squeeze Into Finest Crevices, Quickly Disentangle

PELLETS and slugs for use in tumbling barrels have had the design and materials difficulty that if sharp and pointed enough to get into fine crevices of the tumbled product they tended to entangle and interfere with each other, and if especially shaped to impinge upon special product surface contours they did not always impinge in such positions as to do their work quickly and adequately.

An improvement is found in resilient materials, such as synthetic rubbers, bonded with such abrasives as aluminum oxide. The pellets tend to squeeze into the finest crevices and to follow the most intricate contours, and the resilient release of compression after they have ceased to impinge upon the work surfaces tends to disentangle them and get them out of each other's way. They are resistant to chemicals, therefore may be used in conjunction with solutions which pickle or otherwise improve metallic surfaces while the tumbling proceeds. Therefore tumbling and chemical treating may be done simultaneously.—*E.L.C.*

ULTIMATE LENGTH STANDARD

Basis Is Wave Length of Light From Mercury Isotope

THE BASIS for an ultimate standard of length is the length of a single wave of green light radiated by mercury-198, an isotope not found in a pure state in nature, the National Bureau of Standards announced recently. Measurements based on this wave, which is 21 millionths of an inch long, will make possible length determinations precise to one part in 100 million, and the design of new auxiliary equipment is expected to make possible measurements with a precision of one part in one billion. "Such precision in the measurement of length," according to Dr. E. V. Condon, Director of the National Bureau of Standards, "has never before been attained by man."

While the meter bar kept in a vault at the Bureau of Standards is the legal length standard in the United States, research laboratories for a number of years have been using light waves for special types of length measurements.

The advantages of a light-wave standard over a physical length standard are that it is indestructible and exactly reproducible, and that any laboratory with the necessary auxiliary equipment can have a basic standard on the premises.

The primary criterion in selecting a particular light wave as a standard is that it must be as monochromatic as possible. (By monochromatic is meant that the red, green or other color used is a single wavelength rather than multiple wavelengths extremely close together.) Up to the present the radiation in the red portion of the spectrum of the element cadmium has been used. The cadmium red radiation was adopted provisionally at the 1927 International Conference of Weights and Measures, as a wavelength standard, when 1,553,163.13 wavelengths were defined as equal to one meter.

The fundamental advantage of

© 1948 SCIENTIFIC AMERICAN, INC

mercury-198 over cadmium is that it emits a more nearly perfect monochromatic light. Cadmium consists of six principal isotopes that radiate slightly different waves, a phenomenon analogous to receiving six radio stations on nearly the same frequency. Other advantages of mercury are that it does not need special heating equipment as does cadmium and that the human eye is seven times more sensitive to green light than to red. The heating of cadmium "broadens" the red line and limits the degree of precision.

Actual length measurements made with mercury-198 involve the optical technique of interferometry. Two absolutely flat plates made from either optical glass or quartz are placed at the ends of the length to be measured. The plates are partially silvered so that they both reflect and transmit light. When the light energy from mercury-198 strikes the first plate some of it is reflected back (and is therefore of no further significance) and some of it is transmitted to the area between the two plates. This light starts bouncing back and forth between the plates. With each "bounce," some of the light energy is transmitted through the second plate and from there to the viewing and calibrating instruments.

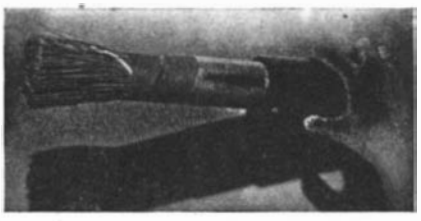
The light energy transmitted through the second plate is seen as a circle at the viewing point so that the end result of a large number of bounces is a series of concentric circles of light. The optical phenomenon that makes measurement possible is the fact that the diameters of the center rings are dependent on the distance between the two plates—or the length of each "bounce." By mathematical calculation the distance between the plates in terms of the length of a single wave of green light from mercury-198 is then determined. Because the unit is so small, and the sharpness of the lines cuts down error due to fuzziness, accuracies heretofore out of reach can be obtained.

TELEPHONE CABLE

Aluminum-Polyethylene Sheath Replaces Traditional Lead

TELEPHONE cable sheath using a thin sheet of aluminum covered with a black, rubber-like polyethylene compound, has been developed by the Bell System. The new cable will supplement the familiar lead-covered type which is now at peak production.

Quantity production of the new cable has begun following extensive



Cutaway view of the cable shows outer covering of polyethylene, the thin corrugated aluminum shield and paper binding next to the pairs of wires

tests of its suitability. The cable, called "Alpeth," is to be used within local exchange areas on pole lines and in underground conduit. It will be made in a variety of sizes, ranging from the smaller cables to those containing hundreds of pairs of wires. The immediate purpose to be served by the new cable will be to step up the delivery of cable to the telephone companies and help meet the continuing heavy demand for telephone service.

BETA-PROPIOLACTONE

New Organic Material Finds Wide Use in Chemical Industry

A DEVELOPMENT of first magnitude in the field of organic chemistry is seen in the successful completion of research work on a new material known as beta-propiolactone which shows promise of becoming as important to the chemical industry as acetylene or chlorine. The new product is described by Doctors T. L. Gresham and J. E. Jansen, research chemists of The B. F. Goodrich Company, as "another fundamental tool in the complex science of manufacturing organic chemicals. Its use as a basic chemical makes possible for the first time the commercial production of whole series of organic chemicals hitherto regarded as laboratory curiosities." Besides making possible the production of an infinite variety of new chemicals, beta-propiolactone promises to open up new and cheaper reaction methods of producing many basic materials already used in the chemical and plastics industries.

Substances which may be made from the new material range from the liquid used in setting permanent waves to materials used in leather processing. Other fields in which it is expected to contribute either better or more economical products include: compounds for preserving fats and oils; thermosetting resin products which can be made tougher and less brittle; plant-growth initiators and mold-growth inhibitors; essential ingredients for certain man-made rubbers; fungicides; selective weed killers; polymerizable esters for plastic products; intermediates for the paint industry; rubber compounding chemicals and solvents, and "polyblends," in which American rubber and plastics are blended. Manufacture of beta-propiolactone is now being carried out on a small scale at the experimental station of B. F. Goodrich Chemical Company. Fundamentally, the method of manufacture of the substance is through the combination of ketene and formaldehyde. The basic raw materials are coal and water, and ethyl alcohol, the latter derivable from grain, petroleum or coal.

HOPPER UNLOADER

Free-Flowing Materials Are Shaken Out of Railroad Cars

LITTLE more than a foundry shakeout on a grand scale, a vibrating mechanism for use on hopper-bottom railroad cars greatly speeds the unloading of free-flowing materials and reduces the manual labor usually required for such operations. The device literally shakes such materials as coal, coke, ore, slag, lime stone, sand and so forth—frozen or unfrozen—out of the car.

This Car Shakeout is placed astraddle the car to be unloaded by means of a five-ton hoist. When it is put into operation, rythmic harmonics are set up within the machine which are transmitted by contact to the car and to its entire contents. Under repeated impulses the material literally dances away from the sides, and out of the car. Average time for unloading a 50-ton car is reported to be less than

The shakeout in position astraddle a hopper car which is to be unloaded

© 1948 SCIENTIFIC AMERICAN, INC

five minutes, and at times as low as 90 seconds have been recorded. It cleans out a car so rapidly that it is possible to unload an entire trainload without uncoupling the locomotive.

An example of the unloading speed possible with this device is seen in a report from a southern power plant. Formerly a crew of 12 men using sledge hammers worked for 40 minutes to unload a car of pulverized coal. Now, with the shakeout, three men do the job in three to five minutes.

The device operates with no danger to the workmen and without any damage to the car.

MIDGET X-RAY TUBE

Dental Tube Has Hooded Target For Greater Output

NO LARGER than a power tube in a home radio set, a new 70,000-volt dental X-ray tube has operated steadily on test for 1000 hours, the equivalent of two decades of normal usage in a dentist's office. One of the smallest X-ray tubes ever offered commercially, the new design minimizes stray radiation which can blur X-ray film. Key departure in the new design is a copper hood surrounding the tube's tungsten target. The X-ray-producing electrons are trapped inside the tube's hooded area, which shields the rest of the tube from bombardment by "backlash" electrons.

Joseph Lempert, the engineer who designed the new tube for the Westinghouse Electric Corporation, explains its mechanism in this manner:

"As the electrons bounce off the target, the resultant X-rays stream through a tiny porthole in the hood, and are beamed onto the film through a window in the glass tube the size of a wrist watch crystal. This window, made of special hard glass which transmits X-rays, is ground down to a uniform thickness of about twenty-thousandths of an inch for all tubes, assuring the radiographer of consistent exposures."

Previously, tube windows had to be made thicker as a protection against unused electrical charges unleashed within the tube. As a result, Mr. Lempert added, more than 10 per cent of the useful X-rays were lost. The unused electrical charges in effect jerked gases out of the glass walls of the tube, limiting its useful life.

Another new precaution against unwanted gases is the use of barium as a "getter" which serves as a sponge to absorb gases which might remain inside the tube after exhausting and sealing.

Small dental X-ray tube is built to operate for 20 years of normal service

The hooded anode was suggested by discovery of such dental tubes among German X-ray equipment seized during the war. The new tube is an improvement on the German design. The hooded anode principle itself had been utilized by Company engineers in 1939 in experimental high voltage X-ray tubes they designed for deep therapy and industrial X-rays.

ACID-RESISTING GLASS

Sandless Material Is Unaffected By Hydrofluoric Acid

GLASS which contains no sand resists the vicious, corrosive attack of hydrofluoric acid and uranium hexafluoride—two chemicals that disintegrate ordinary glass. Developed by scientists of the American Optical Company, the new product was used in experiments with uranium hexafluoride, the essential chemical utilized to separate the fissionable uranium-235 isotope from the more common uranium-238 in connection with development of the atomic bomb.

The new glass, the first ever known to resist the attack of hydrofluoric acid, is expected to simplify the handling of this important acid which is extensively used in scientific experiments and many important industrial operations, particularly oil refining and synthetic rubber manufacture.

Previously the use of hydrofluoric acid presented difficulties because it could be shipped only in lead or wax containers, Dr. Grosse explained, while in the laboratory it had to be processed in platinum or gold retorts which prevented visual observation of chemical reactions.

To determine the acid-resisting property of the new glass during its development, a piece of it was immersed in a bath of hydrofluoric acid for 50 hours. At the end of that time the glass was substantially transparent, and to the naked eye showed no obvious attack.

At the same time a piece of ordinary glass made of sand, lime and soda was immersed in the acid and within a few hours it was converted into a chalky mass.

To obtain hydrofluoric acid resistance, phosphorous pentoxide, rather than sand, was used as major ingredient of the glass, since that acid instantaneously attacks sand with a disintegrating effect.

RUBBER REINFORCING AGENT

New Latex Increases Strength of Natural, Synthetic Rubbers

A NEW LATEX which increases the stiffness, hardness and tear strength of both natural and synthetic rubbers provides valuable reinforcement for the rubber stocks used in such articles as molded toys and sports equipment, fabric coatings, dipped goods and paper impregnates, according to J. A. Weatherford and F. J. Knapp of the chemical products development division of the Goodyear Tire and Rubber Company. Latex compounders have long sought a resin latex which would reinforce the standard rubber latices when incorporated with them. This new material called pliolite latex 190 is a highly stable water dispersion of a high styrene-low butadiene copolymer resin and has been developed to perform this function.

In an investigation to determine the effect of incorporating this pliolite latex 190 in natural rubber latex, neoprene latex type 571, GR-S type III latex and chemigum latex type 200 (a Buna N latex), it was found that the new material increased the stiffness, hardness and tear strength of natural rubber latex without appreciably affecting the other properties. It improved the stiffness, tear strength and hardness of both neoprene latex type 571 and chemigum latex type 200. The stiffness, tear strength and hardness of GR-S type III latex were also improved by the addition of this latex.

Since pliolite latex 190 is an effective reinforcing agent for natural and synthetic rubber latices, it can be used generally for increasing the hardness and rigidity of compounds without losing the inherent toughness and resilience of rubber. Its light color and low specific gravity enable it to be used where darker and heavier reinforcing agents cannot be used.

© 1948 SCIENTIFIC AMERICAN, INC

New Products

COOL GRINDING DEVICE

New Cooling Technique Cuts Wheel Heat Several Hundred Degrees

A NEW method of cooling work on any grinder makes possible both the visibility that is possible with dry grinding and finger-tip control over adequate cooling.

The introduction of coolant directly at the point of contact between wheel and work is the principle of "Cool Grinding." It eliminates the need for splash guards, settling tanks, pump motors and hoses, and floor space formerly occupied by coolant units is not needed. All of this represents a considerable saving in equipment cost plus additional savings in coolant oils since only a small amount of coolant is used. And the mess associated with the conventional coolant systems is eliminated.

The Cool Grinding unit consists of a coolant reservoir mounted on the spindle column, a sight drip valve and a special wheel adapter. The coolant is fed from the reservoir at a rate of from one to four drops a second depending upon the material being ground. The coolant is directed into the front of the special wheel adapter where it enters the arbor hole of the grinding wheel. Since the grinding wheels used in "Cool Grinding" have no lead or ceramic, the coolant enters the wheel at the inside and is thrown by centrifugal force to the outside grinding face of the wheel.

In conventional wet grinding the material at the point of contact between wheel and work is raised to a very high temperature and since the coolant is applied not at point of contact but behind the cut the shock of the sudden cooling often results in surface cracks. With Cool Grinding the coolant is applied at the actual point of grinding. It is reported that actual tests have shown temperatures to be held several hundred degrees below those found in even the best conventional wet grinding systems. And with Cool Grinding, surface cracks can virtually be eliminated.

There are other advantages in using the Cool Grinding system, a development of the DoAll Company. Because the coolant flows through the wheel, it flushes the grinding surface and keeps it clean. This results in longer wheel life and better finishes, especially in softer materials such as copper, bronze, aluminum and so on.

The cool grinding unit consists of a coolant reservoir, a sight drip valve and a special wheel adapter

PORTABLE ARC WELDER

Submerged Arc Welding Machine Is Designed For Small Operations

COMPACT and portable, a new submerged arc welding machine is particularly useful for making welds that are inaccessible for fully automatic welding, making short welds where it is not worthwhile to mechanize the operation, building up deposits of almost any size or shape and depositing metal to repair weld or casting defects. The "Unionmelt" Automatic Flexible Welder as the unit is called, can be used as a primary welding tool in a small welding shop or as a supplementary tool for fully mechanized installations.

The special feature of this machine is that the welding nozzle, at the end of a 20-foot flexible hose, when held in the operator's hands, can be moved from one weld to another without stopping to set up track, carriage or other guiding equipment. The welding nozzle is claimed to be easy to handle and guide along the seam or over the area to be built up.

The flexible hose, connecting the nozzle to the main machine assembly, contains the welding current cable, and two tubes through which the welding rod and the granular material are fed. Bare welding rod of any size up to 5/32 inch in diameter in the standard 25-pound coils can be used in the machine.

Granular welding composition is continuously supplied to the welding nozzle by compressed air from a storage tank included on the main machine assembly. This tank, holding about 75 pounds of the material, provides an adequate supply so that an entire 25-pound coil of welding rod can be fed without interruption and without danger of flash which might occur frequently if a smaller supply were used. The granular material flows by gravity from the welding nozzle and the operator controls the depth of the layer laid down by the height at which he holds the nozzle above the work surface. Included in the main machine assembly, in addition to the tank holding the supply of granular material, are a specially-adapted standard "Unionmelt" welding head, the control unit and a rod reel. This assembly, compactly arranged, is mounted on wheels and can be moved easily anywhere in the shop. All controls are operated from a small portable switch box which the operator can keep with him within easy reach.

The flexible welder, a product of The Linde Air Products Company, has a capacity of 900 amperes, either direct or alternating current, which may be supplied from any welding generator or transformer. Compressed air at about 35 pounds per square inch pressure is required to force the granulated composition through the flexible tube to the nozzle. Only a small amount of compressed air is used, about 110 cubic feet being required for each tank full of welding composition or for each 25 pounds of rod deposited. Simple external connections—compressed air hose, welding cables, and a cable carrying 110-volt current and the contactor and relay operating leads for the control unit—are all that are necessary to make the unit ready for operation.

The portable welding machine in transit

PHOTOELECTRIC CONTROL

Inexpensive Unit Is Versatile And Highly Sensitive

A NEW photoelectric control unit features low cost and versatility. Not only will the unit perform the usual photoelectric switching, controlling and

© 1948 SCIENTIFIC AMERICAN, INC

Control needs no sensitivity adjustment

counting functions, but also it can be adapted for use as a light intensity meter. The device will plug into any standard electrical outlet, and the article to be controlled is plugged into either the normally-on or the normally-off receptacle in the unit's housing.

The internal arrangement of the control unit provides for filters for colored light or infra-red operation. The large (two-inch diameter) light-gathering lens together with the extremely directional optical system (sensitive only to light received from a five-degree arc) makes possible various gaging, controlling and measuring operations with this single unit without the use of a sensitivity adjustment.

As an example of the unusual sensitivity of this control, which is called the Electronic Handyman, it will operate in broad daylight on the light of a small flashlight even though the unit be within 10 degrees of facing directly into the sun. The photoelectric control, a product of John T. O'Connor and Company, will continue to operate over a wide range of voltage shifts, and internal taps may be adjusted for entirely different operating voltages. The unit is equipped with a self-guarding, self-failing circuit.

PROFILING MACHINE

Ends of Pipes, Bars and Tubes Are Rapidly Machined

PROFILING machines for high-production end-machining operations are designed for turning, boring, burring, chamfering, threading, tapping and so forth on the ends of pipe, tubing, bars and similar pieces. These profiling machines, which were announced recently by the Pines Engineering Company, are built for either manual or automatic operation. The automatic types are equipped with hydraulic controls which repeat machining sequence continuously. With the work hydraulically chucked, one or both ends of the work are machined by the action of the rotating heads which hold the cutters and one operator can attend several machines.

Either one or two heads may be employed on these profilers. With two heads, simultaneous machining of both ends of the work is possible, reducing the machining cycle and eliminating the extra handling.

An example of the high rate of production possible with the profilers is seen in the chamfering of both ends of a one-half inch conduit, 10 inches long. Here the rate of 800 to 1000 pieces per hour has been reported. And the same machine is said to be used simultaneously to chamfer both ends of screw machine stock at the rate of 700 to 900 pieces per hour.

When desired, profilers may be equipped with conveyors which carry the work to the machine and transport the finished pieces to a convenient point of storage or to where further processing is performed. Such arrangements are fully automatic, eliminating in-process handling, and reducing the possibility of denting or otherwise marring thin-walled stock.

SMALL DEHUMIDIFYER

Unit Dries Gases For Variety Of Industrial Processes

COMPACT and portable, a new dehumidification unit is capable of drying flows of gas or air up to approximately 100 cubic feet per hour and will adsorb about 5500 grains of moisture before reactivation is necessary. Suitable for use in a broad industrial field, it has varied applications, such as drying compressed air for lacquer spray guns; drying bottled hydrogen to protect molybdenum heating elements; drying refrigeration coils before

The dehumidifyer can dry up to 500 cubic feet of gas per hour and will absorb up to 5,500 grains of moisture before reactivation becomes necessary

installation and dehumidifying drying cabinets. It is also widely used to supply dry air for testing the results of moisture in air on various products or processes. When materials are to be cooled the unit, manufactured by Lectrodryer Corporation, can be used for supplying an atmosphere which will preclude the possibility of moisture condensation.

With this laboratory model dewpoints as low as minus 60 degrees, and lower, are readily obtained. In actual practice, it is claimed, the unit has dried gases to dewpoints well below minus 76 degrees, C.

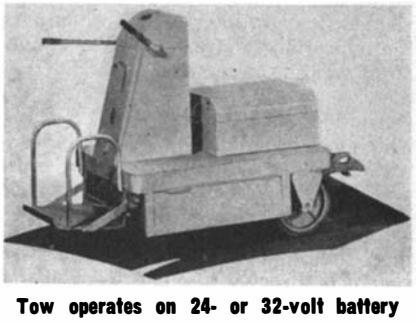
The reactivate the Lectrodryer after it has adsorbed its capacity of moisture it is merely necessary to plug a cord into a 110-volt A.C. or D.C. light socket for two or three hours (the cord and plug are standard equipment). During reactivation a small quantity of air is passed through the dryers and carries off the released moisture.

Although the unit operates on pressures as low as two inches of water, it is built as standard for operation on pressures up to 15 pounds per square inch.

ELECTRIC TOW UNIT

Small Light-Weight Tug Can Pull 10,000 Pounds

LIGHTWEIGHT and inexpensive, a new electric tow unit combines extreme maneuverability and rugged performance with low operating and maintenance cost. Suited for any towing job where maneuverability is a primary factor, the Electric Pony Express Orange Tow Unit, as it is designated, has a turning radius of only 72 inches,



Tow operates on 24- or 32-volt battery

making it possible to turn it into a 62 inch aisle. Moreover, despite the fact that it is capable of hauling 10,000 pounds of trailer loads three to four times faster than walking speed, its remarkably low weight permits its use in elevators, lofts and warehouses whose light construction makes the operation of heavier trucks hazardous. Since it is electrically operated, this new truck is fumeless, odorless and silent. These advantages make its use particularly vital in enclosed spaces such as food and drug warehouses where contamination from carbon monoxide gas and employee health and efficiency are important. Furthermore, the absence of oil drip, with the elimination of such resultant hazards as fire and employee-injuries from slipping, tends to establish better insurance and compensation efficiency records.

The operator of this stand-up tow unit can face in either direction, avoiding considerable time loss when approaching and engaging a trailer train and again when maneuvering that train in the opposite direction away from the congested parking area. Wheel base of the tow, manufactured by the Rocky Mountain Steel Products, Inc., is 30 inches; overall dimension, including hitch is 75 inches. The unit is equipped

© 1948 SCIENTIFIC AMERICAN, INC

with either a 24-volt or a 32-volt battery, depending on the speed desired and the draw bar pull required; a speed of six miles per hour can be attained with the 24-volt battery and eight and one-half miles per hour with the 32-volt battery.

ARGON GAS WELDING UNIT

Hard-To-Weld Metals Are Soundly Joined in Inert Atmosphere

A NEW welding machine capable of welding such "hard to weld" metals as aluminum, magnesium, stainless steels, copper alloys, Fernico and Inconel consists of one compact portable unit. Called the Inert-Arc welder, it is designed so that the electric arc occurs in an atmosphere of argon gas. This feature makes it possible to weld the "difficult" metals by cutting down the amount of oxidation of these metals during welding.

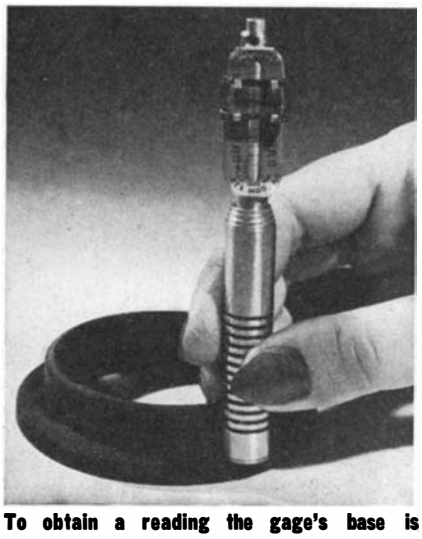
Unlike all other methods of welding these metals, inert atmosphere arc welding is unique in being capable of making clean, sound welds, without the use of corrosive fluxes, according to engineers. Many assemblies can be welded in no other way, because of the impossibility of removing the fluxes after welding by other methods, they said.

Another feature of this machine, which is a product of the General Electric Company, is that it does not cause undue radio interference while it is in operation. A pilot spark circuit, which operates for only a fraction of a second during the starting of the arc, eliminates the likelihood of objectionable interference.

HARDNESS TESTER

Rubber and Similar Materials Checked By Simple Gage

MEASURING hardness of rubber and similar materials, a new device combines simplicity of operation with high accuracy and excellent reproducibility of readings. The gage, known as the Rex Hardness Gage, is roughly the size and shape of a fountain pen. It is operated by pressing the indenter at one end of the gage firmly against the surface to be tested for hardness. The indicator of the gage will hold its reading indefinitely, much the same as a clinical thermometer. The instrument, a development of the United States Rubber Company, reads in the same units as the Shore durometer and meets the requirements of the American Society for Testing Materials. The device contains no gears, cams, levers or pivots to get out of order. It is sturdily constructed and, unless it is abused, need never be calibrated.

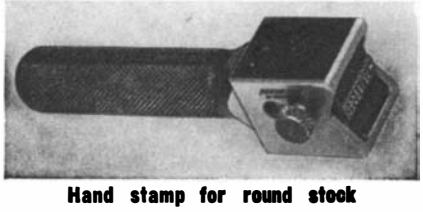


To obtain a reading the gage's base is pressed firmly against the rubber surface

ROUND BAR MARKER

Stamp Centers and Alines Self on Stocks of Various Diameters

A NEW semi-universal, self-centering and self-alining hand stamp is designed for marking various sizes of solid round bar stock with part numbers, serial numbers, heat treatment data and so on. This round bar marker consists of the holder, a V-block guide, a clamping pin and either individual type or a logotype engraved with the desired lettering. The logotype or individual type fits into the grooved slot of the holder, and the V-guide slips over the holder and marking die. Inserting the clamping pin through the slots of the V-guide and the groove in the logotype completes the assembly of the marker. When the stamp is in use, the V-guide slides up or down, automatically centering and alining the stamp on bars of various diameters.



Hand stamp for round stock

This round bar marker, product of New Method Steel Stamps, Inc., is of hardened steel throughout. The handle is knurled and is tempered for long service under severe conditions.

SWEEP GENERATOR

Portable Unit Produces All Signals Needed for FM Servicing

A NEW portable sweep generator designed exclusively for servicing and alinement of frequency-modulation equipment, said to be the first unit of this type, furnishes all the signals needed for the complete alinement of frequency modulated radio receivers. It provides a signal tunable over the 88 to 110 megacycle band, unmodulated or amplitude modulated, for the alinement of R.F., mixer and local oscillator circuits.

Frequency modulation sweep generator

For I.F. alinement, the Sweep Generator, produced by the Radio Corporation of America, provides FM signal tunable from 8.3 to 10.8 megacycles, the sweep-width of which can be varied to suit the requirements of wide-band reception. A buffer amplifier between the oscillator and the output eliminates frequency-pulling with changing load. I.F. stages of FM receivers can be alined with the unit, designated model WR-53A, by using the I.F. sweep action of the instrument. Terminals are provided for obtaining deflection voltages for use with an oscilloscope when employing the visual method of adjustment. A phasing control is included to position the scope pattern properly.

The discriminator circuit of an FM receiver can be efficiently adjusted by the visual method by employing the new sweep generator in conjunction with an oscilloscope. The same method can be employed in the alinement of ratio detector circuits. Harmonics of the I.F. sweep unit can be used to check the overall performance of a receiver under dynamic conditions if desired.

The sweep circuit of this unit consists essentially of an electron-coupled oscillator which is frequency modulated by push-pull reactance tube modulators. This provides wide range low distortion FM consistent with excellent center frequency stability. I.F. output from one microvolt to 0.1 volt can be selected by a suitable combination of "step" and "fine" attenuators on the generator. Attenuation to less than one microvolt can be effected with the use of a switch in the output cable. Direct generation of the sweep frequency without the use of "beats" or harmonics, eliminate spurious output signals.

The new test equipment can be externally modulated by phonograph recordings or by a microphone to demonstrate FM operation.

COIL CEMENT

Adhesive Strengthens and Preserves Radio Coils

CEMENT to bind together and preserve radio coils and to adhere interior antennas has been developed by the Java

© 1948 SCIENTIFIC AMERICAN, INC

Latex and Chemical Corporation. Called No. 26 Coil Cement, this material is claimed to adhere antenna coils permanently to the inside of radio cabinets, even to cabinets of plastic. The cement can also be used to coat any type of radio coil to render it moisture-proof and to impart greater mechanical stability. The adhesive has very high "Q" and excellent insulating qualities.

PROTECTIVE SURFACING

Self-Healing Coating Guards Metal Structures Exposed to Weather

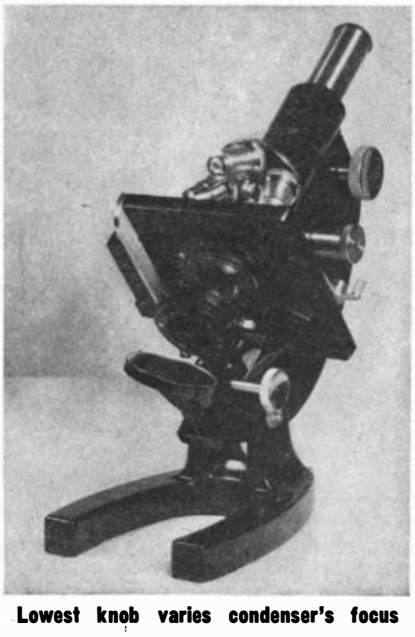
DESIGNED for long-term protection of storage tanks, bridges and similar metal structures which are exposed to weather, a new self-healing coating material forms a tough but pliable film which effectively seals out vapors, moisture, chemical gases and fumes. The surfacing, called Dum Dum for Metal by its manufacturer, the Arco Company, can be used with a minimum of surface preparation on new or uncoated structures or it may be applied over previously coated surfaces (except those having bituminous coatings). If the outer skin of the protective film is bruised or damaged, the inner portions of the film quickly heal the fault. It is claimed that the surfacing will provide effective protection for ten years or more.

VARIABLE FOCUS MICROSCOPE CONDENSER

Full Illumination in Objectives of Various Focal Lengths Possible

SAID to be the first of its kind, a new variable focus condenser for microscopes provides full illumination in objectives having focal lengths of 28mm or more—the intermediate and low-power magnifications. The different objectives are brought into position in the customary manner, and by a slight turn of an adjustment knob, the focal length of the condenser is varied to equal that of the objective, providing full illumination. To achieve this illumination in old-style microscopy would require different condensers for each objective.

This new variable focus condenser cannot be fitted to conventional microscopes, but it will be standard equipment on all new Bausch and Lomb laboratory microscopes.

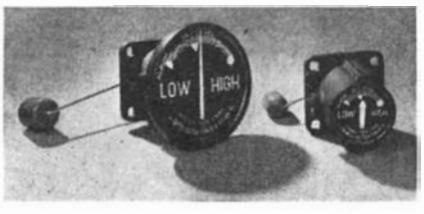


Lowest knob varies condenser's focus

LIQUID LEVEL GAGE

Alnico Magnets Provide Leakproof Coupling of Float to Indicator

DESIGNED to indicate accurately the level of the insulating liquid in transformers, a new liquid level gage utilizes a float inside the transformer tank to transmit the motion of the liquid to a General Electric sintered alnico magnet. This magnet in turn transfers its motion by a powerful magnetic flux to a similar alnico magnet placed on the other side of an aluminum diaphragm and attached to a dial indicator needle.



Two gages equipped with magnetic couplings

The aluminum diaphragm is pressure tight to a minimum of 30 pounds per square inch effecting a permanent seal between the liquid and the gage proper. To effect a seal in the opening where the gage, a product of the Boston Auto Gage Company, is installed, the gage flange is mounted with four studs to the side of the tank, usually below the maximum oil level and is then sealed by a gasket.

METAL ANALYSIS UNIT

Non-Destructive Analysis Made By X-Ray Diffraction

A NEW Geiger-counter fluorescence analysis unit, which utilizes a new X-ray diffraction technique, is said to make possible rapid quantitative metal analysis. The new unit determines quantitatively the purity of metals or the percentages of alloying components, and quantities of metallic elements dispersed in non-metallic carriers.

Essentially, this fluorescence analysis unit consists of an X-ray generator, a rotating indexing holder for four specimens, a special collimating system, a crystal (calcium fluoride or sodium chloride), a goniometer having a scale graduated from 0 to 90 degrees and a Geiger counter. Crystal and Geiger counter are mounted on and positioned by arms which traverse the goniometer arc.

Complete fluorescence analysis unit

The apparatus serves for determinations on elements ranging from atomic numbers 20 to 41 when a rock salt crystal is employed. For elements 42 to 50, a calcium fluoride crystal may be used.

Use of the apparatus is best explained by discussing a typical problem. Suppose it is necessary to determine the cobalt, nickel and chromium content of an unknown alloy. A specimen of the unknown alloy is placed in the four-unit holder along with standardizing specimens containing known percentages of the alloying elements.

Let us assume that the cobalt content of the unknown alloy is to be determined first. From tables of reflection angles in which settings for various metals are listed, we find that for cobalt the Geiger counter should be set at the 36.8-degree mark on the goniometer scale. Next, the sodium chloride crystal position is adjusted to one-half the Geiger counter angle or 18.4 degrees. By rotating the specimen holder, readings are taken first on one or more of the cobalt standardizing samples and then on the unknown. By comparing the readings and referring to a calibration chart the percentage of cobalt may be determined.

The technique employed with the new Fluorescence Analysis Unit, produced by North American Philips Company, Inc., makes available an entirely new approach to many of industry's problems of metal analysis and control. The X-ray method permits analyses to be made without destroying the specimens used for the purpose. This method also permits a rapid determination of the percentage of a component present in large or small proportions.

CALKING GUN

Inexpensive Applicator Is Easily Operated

SIMPLICITY of action and low cost are features of a new calking gun produced by the Gibson-Homans Company. This trigger-operated calking gun will accept any spouted calking cartridge. It has no parts to be

© 1948 SCIENTIFIC AMERICAN, INC

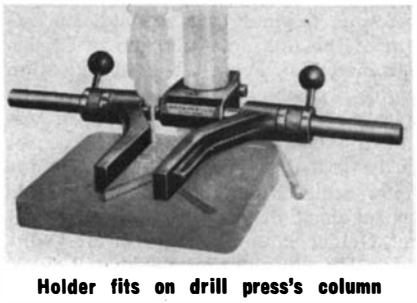
screwed on or off, no gun caps, nozzles, washers or bolts, and it need not be cleaned. Known as the Handicalk, the gun is constructed throughout of steel.

To operate the gun, the base of a cartridge is placed in the metal recess formed as part of the gun's handle. The front end of the gun is then snapped down over the neck of the spout. Thus a firm grip is held over the entire metal shoulder in which the spout is seated. The entire unit weighs less than 14 ounces.

WORK HOLDER

Tool Promotes Safety, Accuracy In Drill Press Operations

CLAMPING easily on the column of any small standard drill press, a new work holder instantly and firmly secures the work piece with a quarter turn of a single lever. In many instances the tool can substitute for simple drill jigs, thus simplifying tooling and cutting costs. In addition, by replacing makeshift devices such as bolts and C-clamps, the device promotes safety and tends to increase accuracy. The work holder, a product of the Universal Vise and Tool Company, has clamping arms that can be



Holder fits on drill press's column

quickly adjusted along the length of the cross arm to encompass the full width of the drill press table, and they may be swung back to clear a drill jig or machine vise if necessary. Work holders of standard sizes are adaptable to drill presses with columns 1⅝, 2¼, 2¾, 3, 3½, 3¾ or 4 inches in diameter.

CARBON MONOXIDE TESTER

Color of Gel Indicates Percentage Of Gas Concentration

UTILIZING indicator tubes developed by the National Bureau of Standards, a new instrument is designed to determine the presence of carbon monoxide concentrations in air, and employs the most advanced colorimetric method of carbon monoxide detection. Simple in operation and requiring no special training to use, this carbon monoxide tester is capable of indicating the presence of carbon monoxide from 0.001 to 0.10 per cent by volume in air. The nucleus of the instrument is a detector tube containing a yellow silica gel, impregnated with a complex silico-molybdate compound and catalyzed by means of palladium sulfate. In use, the sealed ends of the tube are broken in the convenient tube-breaker and the tube inserted into the instrument tube-holder. A sample of the air is aspirated through the tube by squeezing the bulb of the instrument.

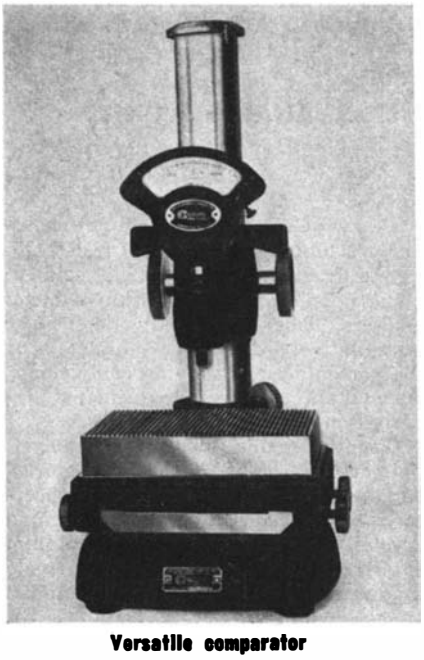
If the air sample contains carbon monoxide when it is drawn through the tube, the yellow indicating chemical turns varying shades of green, directly proportional to the carbon monoxide concentration; the degree of discoloration of the gel is then compared with the instrument's integral revolving color scale for quick and easy reading.

The carbon monoxide tester, produced by the Mine Safety Appliances Company, is adaptable to surveys of industrial atmospheres, mine ventilation currents, garages, bus terminals, the interior of aircraft, passenger cars, blast furnace and open hearth operations, public utility mains and conduits, artificial gas plants, and wherever the accurate determination of low concentrations of carbon monoxide is desired.

COMPARATOR GAGE

Interchangeable Tables Enable Wide Range of Applications

PROVISIONS for five interchangeable tables and the use of standard indicators are features of a new comparator developed by the Standard Gage Company. This comparator is suited to a wide range of production and inspection measuring jobs, and it affords a simple and effective means of checking plug gages. Any AGD dial indicator of the No. 2 or No. 3 size having standard lug-type back can be used. Thus, an indicator having graduations appropriate to the accuracy desired may be mounted on the comparator. Raising, lowering and approximate positioning



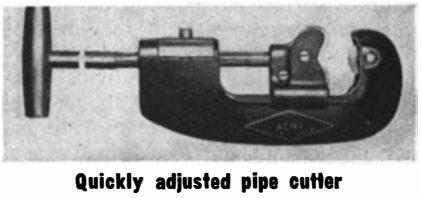
Versatile comparator

of the indicator support arm are facilitated by a rack on the rear of the column. Fine adjustment for setting the comparator to a standard is effected by a wing handle. Pressure of the contact point on the work piece can be regulated by means of a knurled bushing and a reed mechanism within the head prevents side thrust from reaching the indicator and thus adversely affecting accuracy.

PIPE CUTTER

Thread Release Permits Fast Adjustment to Work

A NEW PIPE cutter features a push-button release and lock which enables the operator to adjust the tool rapidly for work on any pipe size from one-quarter to two inches. The pull-open-push-close action saves hours of accumulated work-time. This tool, called the Manville-Acme pipe cutter, carries



Quickly adjusted pipe cutter

a unique engagement which locks or rides over a seven-degree undercut buttress thread on the handle. The pins and rollers of the cutter, which is distributed by A. D. McBurney, are of hardened steel. The housing is ruggedly constructed for long life under rough service conditions.

HUMIDITY INDICATOR

Built-In Slide Rule Eliminates The Use of Tables

DESIGNED for use in industry and laboratory, a new quick-reading all-metal Humidity Indicator provides readings of relative humidity accurate within ± 1 per cent for general conditions. The instrument, product of the Weston Electrical Instrument Corporation, is of wet and dry bulb type, featuring all-metal Weston laboratory thermometers, self-supporting wet-bulb wick covering the thermal element, sturdy all-metal construction and a simplified slide rule calculator giving relative humidity reading directly, thus eliminating the need for tables or psychrometric charts. The unit is light and well balanced, and can be swung if desired to create air movement. The only maintenance necessary is to change the wick occasionally and replenish the water in the reservoir, which is a heavy-walled, large-capacity jar, covered to reduce undue evaporation.

The slide rule calculator, located on the face of the instrument directly beneath the two dial-face thermometers, indicates relative humidity from 10 to

© 1948 SCIENTIFIC AMERICAN, INC

Indicator is accurate to ±1 per cent

100 per cent. With one movement of the slide the proper setting is made according to the readings of the two thermometers, and the per cent humidity is shown immediately on the upper scale. The instrument requires no calibration.

DISTRIBUTION TRANSFORMERS

New Fabricating Techniques Result In Smaller, Lighter Units

DISTRIBUTION transformers, smaller, lighter and more compact than conventional models, have an internal assembly patterned upon time-proved basic electrical design in addition to new light-weight construction techniques made possible by the use of preferred orientation electrical core steel. The new design is said to achieve a 17 to 46 per cent savings in weight with corresponding reduction in size. The transformers are engineered to meet all the recommendations included in the revised second report of the E.E.I.-NEMA Joint Committee on the standardization of distribution transformers from 1½ to 100 kilovolt-amperes, 2,400 through 15,000 volt classes. They represent the latest development in the electrical field as well as the latest advancements in metal fabrication and welding.

Features of the new units include spray Bonderized steel tanks with machine welded seams to insure permanent protection against leaks; high-voltage pockets fabricated from a single piece of special deep-drawing steel permanently welded to the tank wall; recessed tank bottoms to provide additional protection against rusting and mechanical damages in handling; and low-voltage bushings mounted with a gasketed joint which is held in compression by a pressed steel gasket ring. This ring can be easily removed at installation for replacement of low-voltage bushings, if necessary, without opening the transformer.

Other features include standard flat-slotted lugs on internal low-voltage leads which allow quick change from series to parallel or vice versa; the use of preferred orientation electrical steel for efficient core construction; and redesign to reduce copper-to-oil temperature gradients to a minimum, resulting in better short-time over-load characteristics.

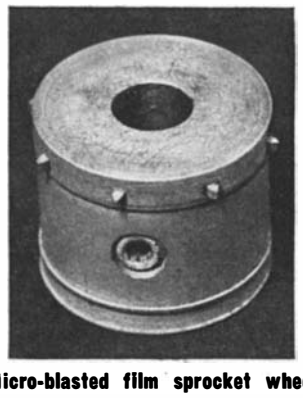
The transformers are given three coats of high-quality paint for protection against severe weather conditions, salt and corrosive acid atmosphere.

MICRO-BLASTED FINISH

Presents Smooth Surface Despite Grained Appearance

SMOOTHER than polished metal, long wearing, and highly resistant to scratches is a micro-blasted finish being used on the film sprocket wheels in a sound motion picture projector.

Faced with the problem of obtaining a surface finish on the film driving wheels of the projector that would not mar or scratch the film surface, engineers of Natco, Inc., finally tried micro-blasting and obtained the desired results. The finish obtained by this process presents a grained appearance but actually offers less friction and causes less wear on the film than would a polished or plated surface. The micro-blasted finish also is more resistant to scratching than are plated surfaces.



Micro-blasted film sprocket wheel

By micro-blasting the wheels, it was found that all burrs and irregularities were removed.

Micro-blasting is similar to the familiar sand-blast treatment but instead of coarse, gritty particles, microscopic particles are hurled by high air pressure against the surface being treated. The enormous force of these tiny particles soon removes all burrs and irregularities from the metal and gives an extremely fine grained surface.

MASONRY PRESERVATIVE

Water Repellent Moisture-Proofs Concrete, Bricks or Tile

A COLORLESS masonry water repellent that penetrates into cement blocks, tile, brick, concrete, stucco and so forth, gives long-lasting protection against moisture. This material, called Rainchek, will not evaporate or wash away from the treated surface, according to the manufacturer, the Protection Products Manufacturing Company. The material guards against water seepage—the direct result of normal moisture in the ground working its way through the basement walls and through basement floors. It protects outside walls from becoming discolored due to ground moisture or rain saturation, and helps prevent masonry disintegration that comes from moisture accumulation and freezing under the surface.

The passage of moisture through masonry usually leaves a deposit of alkaline salts on the surface causing large white stains. This "efflorescence," as the stains are called, is effectively controlled by Rainchek, the manufacturer reports.

SHEET METAL NOTCHER

Precision Shearing Without The Use of Dies

STURDILY constructed, a new flexible precision shearing unit will cut notches rapidly and accurately in sheet materials, thereby eliminating dies for this specialized application. A 90-degree notch of any size within the capacity of this "Notcher" can be cut in one operation either at the corner or in any position along the edge of a sheet. It is also possible to shear angles both smaller and greater than 90 degrees, and many straight shearing operations can be performed with this convenient unit.

A flexible gaging arrangement built into the Notcher allows a notch of any dimensions desired to be exactly located, providing precision in all duplicated parts. The cam of this tool is equipped with roller bearings, and the shearing pressure is distributed evenly on both shear blades. A clean cut free from rough edges and burrs is assured.

Notcher makes a clean, burr-free cut

The cutting range of this Di-Acro Notcher, a product of O'Neil-Irwin Manufacturing Company, extends from the lightest plastics, fibers, mica, leather and rubber to heavy gages of aluminum, cobalt steel, chrome molybdenum, leaded brass and stainless steel. The material capacity is 16 gage steel plate, and the greatest possible 90-degree notch is six by six inches.

© 1948 SCIENTIFIC AMERICAN, INC

CURRENT BULLETIN BRIEFS

Conducted by K. M. CANAVAN

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

HEAT FOR METALS is a 32-page ready-reference booklet which includes information on the latest developments in heating equipment for steel mills; history of the development of gas chemistry and heat treatment; prepared gas atmospheres and heating equipment applications to processing such as gas carburizing, carbon restoration, atmosphere hardening, gas normalizing and annealing, gas cyaniding, gas quenching, gas malleableizing and atmosphere heating for forging. *Surface Combustion Corporation, Technical News Bureau, Toledo 1, Ohio.—Gratis. Request this booklet on your business letterhead.*

GRINDING WHEEL DRESSERS. This 18-page booklet describes the Carboloy line of diamond impregnated cemented carbide grinding wheel dressers. Because of the use of a number of small diamonds securely held together in a matrix of hard carbide metal, it is claimed that a less expensive dresser gives faster and more accurate truing. Three standard nib sizes are available from stock. Request Booklet DR-480. *Carboloy, Inc., Detroit 32, Michigan.—Gratis.*

SHADOGRAPH SCALES is a four-page brochure describing and illustrating six types of scales which feature the substitution of light projection indication for mechanical reading. Specifications, capacities and sensitivities are given for each model. *The Exact Weight Scale Company, Columbus 12, Ohio.—Gratis.*

THE GUIDEBOOK TO RIFLE MARKSMANSHIP. This 48-page booklet, prepared by The National Rifle Association of America, was originally prepared as a course of pre-induction training for men about to enter the armed service. Presenting an authoritative series of fundamental lessons in the use of small arms, whether .22 or large caliber, this booklet is now aimed at promoting the popularity of this all-year-round sport. *O. F. Mossberg and Sons, Inc., 131 St. John Street, P. O. Box 1302, New Haven 5, Connecticut.—Gratis.*

CUTTING FLUIDS FOR BETTER MACHINING. Completely revised, this 72-page pocket-size catalog contains data on the application of oils for cutting, grinding, drawing, quenching and tempering, and all other phases of metalworking and industrial lubrication. In addition, useful sections on metal cutting mechanisms, the selection of cutting fluids, rules for prolonging tool life, handy tables of standard steel specifications, independent research committee data and marking system chart for grinding wheels are included. *D. A. Stuart Oil Company, 2729-39 South Troy Street, Chicago 23, Illinois.—Gratis.*

PLASTILE PLASTIC FLOORING. A laminated vinyl floor tile is described in this four-page folder. Available in 20 color combinations, this plastic flooring can be layed with ordinary linoleum cement. *The United States Stoneware Company, Akron 9, Ohio.—Gratis.*

M.S.A. PORTABLE WELDING FUME EXHAUSTER is a two-page bulletin describing how this exhauster can be used where stationary ventilating systems are unavailable or impractical, or where operations are performed in cramped quarters, or where the welder must move from place to place in enclosed areas. Request Bulletin CU-1. *Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh 8, Pennsylvania.—Gratis.*

ROTARY KILNS. This 32-page bulletin describes and illustrates rotary kilns for cement, lime and chemical plants. Special construction features of this company's kilns and associated equipment are included. Request Bulletin 07B6368. *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin.—Gratis.*

BROADCAST OPERATOR'S HANDBOOK. In 288 pages this handbook presents facts that can serve as a general set of rules for good operating practice. This handbook is divided into these six parts: Operating in the Control Room and Studio; Operating the Master Control; Operating Outside the Studio; Operating the Transmitter; We're Off the Air; and Technically Speaking. *John F. Rider Publisher, Inc., 404 Fourth Avenue, New York 16, New York.—$3.30.*

PRINTED CIRCUIT TECHNIQUES, by Drs. Cledo Brunetti and R. W. Curtis, is a 43-page booklet based on performance and application details as well as precautions and limitations. A section on comparative performance of printed circuit elements is included, as well as a bibliography covering processes, patents, applications and other relevant matters. *Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.—25 cents.*

BALL BEARING OVERHEAD CONVEYOR TROLLEY. Sub-titled "An engineered trolley for overhead conveyors, simple and rugged in design," this eight-page folder describes this trolley equipment which can be used on this company's own conveyors or purchased separately. This folder gives dimensions, weights, trolley ratings, allowable chain pulls, list prices and other data. Request Folder 2241. *Link-Belt Company, 2410 West 18th Street, Chicago 8, Illinois.—Gratis.*

With DI-ACRO BENDERS....

The DI-ACRO Bender makes perfectly centered eyes from rod or strip stock at high hourly production rates. Both eye and centering bend are formed with one operation. Any size eye may be formed within capacity of bender and ductile limits of material.

DI-ACRO Precision Bending is accurate to .001" for duplicated parts. DI-ACRO Benders bend angle, channel, rod, tubing, wire, moulding, strip, stock, etc. Machines are easily adjustable for simple, compound and reverse bends of varying radii.

Pronounced "DIE-ACK-RO"

A CENTERED EYE IN 1 OPERATION

Precision CENTERED EYE Bending

Send for Catalog "DIE-LESS" DUPLICATING showing many kinds of "die-less" duplicating produced with DI-ACRO Benders, Brakes, Shears, Notchers, Rod Parters, Punches.

O'NEIL-IRWIN MFG. CO.
347 EIGHTH AVENUE
LAKE CITY, MINNESOTA

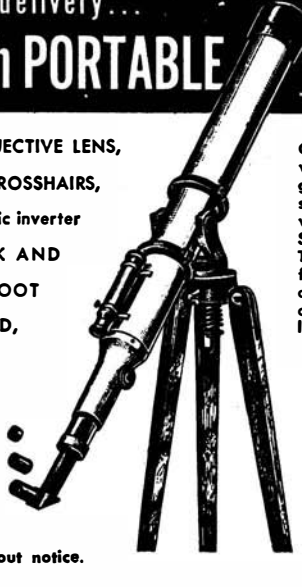
Immediate delivery...
3 and 4 inch PORTABLE REFRACTORS

FIRST QUALITY DOUBLE OBJECTIVE LENS, LOW POWER FINDER with CROSSHAIRS, STAR DIAGONAL (or prismatic inverter for terrestial work), RACK AND PINION FOCUSING, 5 FOOT HARD MAPLE TRIPOD, ALUMINUM TUBE

3 INCH COMPLETE WITH 45, 90, 180 POWER EYEPIECES
$325

4 INCH COMPLETE WITH 60, 120, 240 POWER EYEPIECES
$435

Prices subject to change without notice.



Objective lenses are precision ground of the very highest quality crown and flint optical glass, and corrected for chromatic and spherical aberrations. Both instruments reveal details as found on Mars, Jupiter, and Saturn with unusual richness and brilliance. These and other portable reflecting and refracting types are available immediately; descriptive folders sent on request. Inquiries on permanently mounted instruments for college and private observatories are invited.

Tinsley laboratories
2526 GROVE
BERKELEY
CALIFORNIA
FOLDER SENT ON REQUEST

© 1948 SCIENTIFIC AMERICAN, INC

Books

THE BOOK DEPARTMENT of Scientific American is conducted, with the cooperation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S. All remittances are to be made in U. S. funds. Prices given are subject to change without notice.

ASTRONOMY—REVISED EDITION

By Skilling and Richardson

FROM the several extant treatises on elementary, non-mathematical, descriptive astronomy the editors, since its first publication in 1939, have usually selected this one to recommend to lone wolf readers because it is written in a more direct, homespun style of approach than others. Now it has been revised and enlarged by 113 pages plus four azure sky charts. Comparison of the two editions reveals no mere nominal revision but much entire rewriting. Facilitating this, the text has been re-set. It is up to date as of 1947, July 6, and it still is the editor's selection for the lone wolf reader. It gives a well-rounded coverage of the modern science of astronomy. Authors are professional astronomers, one as a teacher, the other at the Mt. Wilson Observatory. (692 pages, 5½ by 8¼ inches, 309 illustrations, 4 charts.—$4.85 postpaid.—*A.G.I.*

MECHANICAL DRAWING

By Fred Nicholson

THIS excellent text on mechanical drawing is the result of the author's (the head of the Academic Division of the Henry Ford Trade School) twenty years of experience in this field. The subject matter is presented in logical sequence, and the methods of teaching and the problems for practice are designed to bring the drafting room of industry into the high school classroom. With this book the transition from one to the other should not be difficult. (211 pages, 7½ by 10 inches, profusely illustrated.)—$2.10 postpaid.—*N.H.U.*

EXPERIMENTAL CASTING PLASTICS

By Thomas A. Dickinson

A FINE presentation of the results of important research. The book is devoted to formulas and simple new methods of making rigid or flexible patterns, molds and casts—from plastics or for use with plastics. The processes are simple and economical enough to be used in any workshop, large or small, and the data should be of equal value to the home craftsman and the factory engineer. While it comprises only 32 pages, it is set in small and closely-spaced type and provides a wealth of ideas. Sources of materials and equipment are given for the convenience of those who would like to experiment further. (32 pages.) —$2.10 postpaid.—*A.K.*

POWDER METALLURGY

By H. H. Hausner

THE MINDS in industry that are about the hardest to shunt toward new knowledge are those of metallurgists and their employers. This phenomenon of resistance to the new doubtless explains the laggardness of powder metallurgy. So far there has been in this field some pragmatic technology, but little science. Dr. Hausner (Rutgers research associate) briefly, too briefly, describes the technology, and makes a stark attempt to advance the science. He found that the American Society for Metals has finally compiled a glossary of 90-odd powder-metal terms, which he reproduces. In hope, presumably, of stimulating theoretical thinking in behalf of this growing fraction of metals industries he gives over a full half of this book to bibliography. (307 pages, 5¾ by 8¾ inches, graphs and tables.)—$7.10 postpaid.—*M.W.*

PRINCIPLES OF MICROPALEONTOLOGY

By Martin F. Glaessner

DURING the past few years the petroleum industry has become increasingly conscious of the importance of micropaleontology. And with this increasing realization has come a proportional increase in the demand for trained micropaleontologists. One of chief obstacles in the training of these specialists, however, has been the lack of adequate texts on the subject. This book, written by the chief paleontologist for the Australasian Petroleum Company, is designed to fill this need. Part I of this book reviews the main types of microfossils and the methods applied to their study. Part II is devoted to a discussion of the fossil representatives of the foraminifera. Part III deals with the historical se-

INVENTORS

Learn how to protect your invention. The U. S. Patent Office advises the inventor, unless he is familiar with such matters, to engage a competent registered patent attorney or agent to represent him. We maintain a staff of registered patent attorneys ready to serve you in the handling of your patent matters.

Special booklet "Patent Guide for the Inventor" containing detailed information concerning patent protection and procedure with "Record of Invention" form will be forwarded upon request—without obligation.

CLARENCE A. O'BRIEN & HARVEY JACOBSON

Registered Patent Attorneys

85-A District National Bldg., Washington 5, D.C.

Please send me copy of "Patent Guide for the Inventor" and also "Record of Invention" form. This request does not obligate me.

Name_____

Address_____

City_____ State_____

LAW STUDY AT HOME for Personal Success and LARGER EARNINGS. 39 years expert instruction—over 108,000 students enrolled. LL.B. Degree awarded. All text material furnished. Easy payment plan. G.I. Approved. Send for FREE BOOK—"Law and Executive Guidance."

AMERICAN EXTENSION SCHOOL OF LAW
Dept. 86-SA, 646 N. Michigan Ave., Chicago 11, Ill.

Please Mention
SCIENTIFIC AMERICAN
When Writing to Advertisers

Learn to SPEAK SPANISH
FRENCH GERMAN ITALIAN
Famous Cortina Method Makes It EASY

Count Cortina

IG OPPORTUNITIES await Americans who speak SPANISH. Learn as a child learns — "by listening" to these new CORTINA recordings. The CORTINAPHONE METHOD, famous for 65 years, teaches you to speak SPANISH as a NATIVE speaks! Right at home, relaxed and at ease.

Listen to this Record!

VETERANS When writing for free book — mention that you are a *veteran.*

Sent On 5 Days' Approval
Write *today* for our amazing free book, "The Cortina Short-Cut." State language interested in.
CORTINA ACADEMY
Dept. 152, 105 West 40th St.
New York 18, N. Y.
FREE BOOK

DIAMONDS....
Economical Tools of Industry

Many production processes can use diamonds with profit — but only when they are properly utilized to obtain maximum results. Now you can obtain, in one volume, complete and concise information on industrial diamonds and their uses in hardness testing, wheel dressing, cutting metallic and non-metallic materials, machining glass, rock drilling, and wire drawing. All of this, and more, in

DIAMOND TOOLS
By Paul Grodzinski
Technical consultant, Industrial Diamond Review, London
$4.60 postpaid
Order from
SCIENTIFIC AMERICAN
24 West 40th Street, New York 18, N. Y.

© 1948 SCIENTIFIC AMERICAN, INC

Today, war worries have been succeeded by an atomic turmoil. Far-reaching changes have always followed wars—and the man who has kept pace always comes out on top.

Come what may, one need is never completely filled—the need for competent executives to direct business and industry. In tumultuous times like those of today, this demand multiplies. Right now, the outlook for ambitious men is brighter than ever before—if they have the training to take advantage of opportunities.

The training needed is not narrowly specialized, but goes broad and deep, probing the basic principles that underly *all* business. It provides the knowledge that enables men to direct the activities of others not in one department or one kind of business, but in *any* business. It supplies the "know how" that enables top executives to manage *any* business.

How to get such executive training

Training of this kind is provided by the Modern Business Course and Service of the Alexander Hamilton Institute. The Course covers the four major functions of business—Production, Marketing, Finance and Accounting. It turns out not accountants, or salesmen or production men, but *executives!*

Takes months instead of years

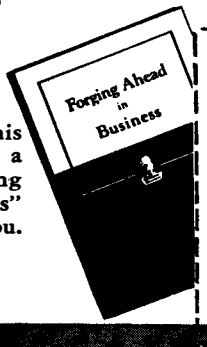
This knowledge takes years to acquire by ordinary methods. Through Institute training, the process is concentrated and thus finished in a matter of months. It does not interfere with a man's present position, being taken at home, during spare hours. More than 430,000 men have subscribed; many call it "a turning point in their lives."

Many prominent contributors

One reason why the Institute Course is so basic, thorough and scientific is found in its list of prominent contributors. Among them are such men as Thomas J. Watson, President, International Business Machines Corp.; Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.; Clifton Slusser, Vice President, Goodyear Tire & Rubber Co., and Herman Steinkraus, President, Bridgeport Brass Company.

"Forging Ahead in Business"—FREE!

You can read the Institute's stimulating story in the 64-page booklet "Forging Ahead in Business." Convenient, time-saving, it is offered without cost or obligation. Simply fill in and mail the coupon!



Fill in and mail this coupon today, and a *free* copy of "Forging Ahead in Business" will be mailed to you.

ALEXANDER HAMILTON INSTITUTE
Dept. 35, 71 West 23rd St.
New York 10, N. Y.
In Canada: 54 Wellington Street, West, Toronto 1, Ont.
Please mail me, without cost, a copy of the 64-page book—"FORGING AHEAD IN BUSINESS."
Name .....
Firm Name .....
Business Address .....
Position .....
Home Address .....

Alexander Hamilton Institute

quence of microfaunas, the methods used in their detailed stratigraphic analysis and examples of the application of microfaunal studies to problems of economic geology. (296 pages, 6 by 10 inches, illustrated.)—$6.10 postpaid.—*N.H.U.*

THE YEARS AFTER 50

By Wingate M. Johnson, M.D.

SOUND, solid, sane, sensible, safe advice for oldsters, covering, chapter by chapter, bugaboos; blood pressure; lung troubles; heart ills; digestive ills; dietary fads; rheumatism and arthritis; glands; mental changes; exercise and recreation; preparing for old age and dying. The author is a long-experienced practicing doctor. His book represents modern majority medical opinion without leanings toward the radical. Much of it is reassuring, tending to diminish apprehensions. It is not a home medication book, beyond the fact that good advice is home medication. (153 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*A.G.I.*

MODERN DEVELOPMENT OF CHEMOTHERAPHY

By E. Havinga, H. W. Julius, H. Veldstra, and K. C. Winkler

THE researches described in the present paper-bound volúme have to do with the development of the sulfonamides as it has progressed in Dutch laboratories tackling problems arising in this connection from several different points of view. A brief concluding chapter relates to Dutch investigations of antibiotic substances that might be isolated from the products of metabolism of micro-organisms. (175 pages, 5¾ by 8 inches.)—$3.60 postpaid.—*D.H.K.*

STEEL CASTINGS

By Eric N. Simons

ALTHOUGH based on British practice, this book is so clearly and simply written that American users of steel castings will overlook minor discrepancies. Because of the non-technical style of presentation, the text will appeal to students, beginners, users of steel castings, salesmen, and so on, who need an overall knowledge of the raw materials, methods of production, testing procedures, and the like. (208 pages, 5 by 8 inches, well illustrated.)—$5.10 postpaid.—*A.P.P.*

PICTORIAL CONTINUITY

By Arthur L. Gaskill and David A. Englander

SUBTITLED "How to Shoot a Movie Story," this book presents the vital fundamental principles of camera continuity. In plain and simple language it tells the amateur cameraman how to make a coherent motion picture with even the most modest equipment. Both Gaskill, a former newsreel cameraman

© 1948 SCIENTIFIC AMERICAN, INC

and wartime head of the School Division of the Signal Corps Photographic Division, and Englander, newspaper man who served as a combat photographic officer during the war, are highly qualified to write on this subject, and their book should be of great value and interest to the vast army of home movie addicts. (149 pages, 5½ by 8 inches, illustrated.)—$3.10 postpaid. —*N.H.U.*

SEQUENTIAL ANALYSIS

By Abraham Wald

IN THE large scale production of manufacturers and in the gross behaviors of populations it is practically impossible to scrutinize each piece or person. Random sampling becomes necessary. It can supply satisfactory statistical inferences. One efficient method of reaching such inference, and decision, is sequential analysis. Its characteristic feature is that the number of sampling observations need not be determined in advance. A particular method of sequential analysis, which Professor Wald (of Columbia University) devised to facilitate the production of good wartime materiel, is the sequential probability ratio test. This test, he asserts, "frequently results in a saving of about 50 per cent in the number of observations over the most efficient test procedures based on a fixed number of observations." Higher mathematics is useful in reaching the statistical inferences most efficiently, but is not necessary for understanding this significant new statistical technique. (212 pages, 6 by 9¼ inches.)—$4.10 postpaid.—*M.W.*

SUNSPOTS IN ACTION

By Harlan True Stetson

COINCIDING with the maximum of the 11.2-year sunspot cycle this book brings up to date a round-up of our knowledge of a fascinating corner of science. Sunspots and radio; sunspots, earth's magnetism and northern lights; radio and the moon; radio, solar eclipses and cosmic effects; sunspots their nature, origin and prediction; effects on weather, life, and the economic cycle; cosmic terrestrial research—these are the main subjects discussed with their numerous appertaining theories in this work, mainly one of pure science, in which the author, long a master science expositor and leading researcher in this special field, instead of skipping technicalities, explains them in plain language as he writes. (252 pages, 5½ by 8¼ inches, 50 illustrations.)—$3.60 postpaid.—*A.G.I.*

THE FUTURE OF TELEVISION
Revised Edition

By Orrin E. Dunlap, Jr.

SOME of the past, present and future problems of television are here discussed, along with this industry's possible impact on the home, the theater, on music, news, sports, radio and so forth. Revisions in this new edition

The Editors Recommend

Best Sellers in Science and Technology

PHOTOGRAPHIC GIANTS OF PALOMAR — ***By J. S. Fassero and R. W. Porter.*** Twenty full-page drawings of the 200-inch telescope by Porter showing the big telescope and such details as observers coop, the 36- by 51-inch elliptical coude mirror and its crane and R.A. drive and computer. Also eight full-page astronomical photos. Detailed explanations face each illustration. • **$1.60**

GUIDE TO THE LITERATURE OF MATHEMATICS AND PHYSICS — ***By Nathan Greer Parke III.*** A guide for self-directed education in both mathematics and physics. The major part is a classified list of books in each sub-class of both subjects and in related engineering subjects. **$5.10**

HIGH FREQUENCY INDUCTION HEATING — ***By Frank W. Curtis.*** Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$3.10**

MUSICAL ACOUSTICS — ***By Charles Culver.*** Textbook for college students majoring in music, and essentially physics throughout. Covers all important phases of acoustics of music. **$3.10**

PLASTICS — ***By J. H. DuBois.*** Third edition, again revised and enlarged, with two four-color plates. This is an important book on the whole general subject of plastics, plus much brand new material on synthetic rubber, manufacturing processes and plastics moldings. **$5.10**

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — ***By Norton and Inglis.*** Tenth edition of a standard work, with main charts redrawn for epoch of 1950. Standby for amateurs past the cradle roll. **$5.35**

THE MEANING OF RELATIVITY — ***By Albert Einstein.*** Second edition with added chapter describing advances since publication of first edition some 25 years ago. Requires knowledge of advanced mathematics and physics; not a popular exposition. **$2.10**

THE SCIENTISTS SPEAK — ***Edited by Warren Weaver.*** A review of recent advances in all of the sciences and a wide-ranging discussion of the meaning of science in the modern world. This book brings together the 79 "science talks" by 81 distinguished scientists which were broadcast at the intermission of the New York Philharmonic Symphony Sunday afternoon concerts in the 1945-46 and 1946-47 seasons. **$3.85**

RADIANT HEATING — ***By T. Napier Adlam.*** Complete information for engineers, architects and contractors on design, installation and control of hot water, steam, warm air and electric radiant heating systems. **$6.10**

SOILLESS GROWTH OF PLANTS — ***By Carleton Ellis and M. W. Swaney. Second edition revised and enlarged by Tom Eastwood.*** A practical "how-to-do-it" book for those who want to make money out of soilless farming. **$4.85**

MACHINERY'S HANDBOOK — ***13th Edition.*** "Bible of the mechanical industry." 1911 pages of latest standards, data and information required daily in shop and drafting room. **$7.10**

PROCEDURES IN EXPERIMENTAL PHYSICS— ***By John Strong, Ph.D.*** A wealth of useful data of a practical kind for the constructor, experimenter and skilled craftsman. **$7.45**

EXPERIMENTAL SPECTROSCOPY — ***By Ralph A. Sawyer.*** Covers theory and types of spectroscopes and spectographs, mounting and use of gratings, determination of wavelengths, infra-red spectroscopy, spectrochemical analysis and so on. Somewhat elementary, but requires knowledge of physics and some physical optics. **$5.10**

TIME, KNOWLEDGE, AND THE NEBULAE — ***By Martin Johnson.*** Discourse on physical notions of time and limitations of profitable contact between physics and philosophy, analysis of Lorenz-Einstein interlocking of time and space observations, and similar physical aspects of time. **$2.85**

HEAT PUMPS — ***By Sporn, Ambrose and Baumeister.*** Presents the basic facts on the design, operation, installation and maintenance of heat pumps for either heating or cooling in domestic and industrial applications. **$3.85**

PRINCIPLES OF PHYSICS, VOL. III—OPTICS — ***By Francis Weston Sears.*** One of the most modern works on physical optics available today. At college level, it covers the subject with emphasis on physical principles rather than practical applications. **$5.10**

IF YOU MUST GAMBLE—***By Maurice Lenihan.*** Statistical safety, as practiced by insurance companies, applied to bridge, dice, roulette, horses and so on. No guarantee of successful "systems" but sound advice lightly handled. **$2.10**

LUMBER — **Manufacture, Conditioning, Grading, Distribution and Use** — ***By Nelson C. Brown.*** A complete analysis of manufacturing techniques, conditioning, grading and so on, with stress on efficient and economical production. **$4.35**

FUNDAMENTALS OF OPTICAL ENGINEERING — ***By Donald H. Jacobs.*** This work starts out at the very beginning, is mainly non-mathematical, and is probably the best suited of all existing books as an introduction to optical design. Author is a physicist at Bureau of Standards. **$5.60**

THE HOME FREEZER HANDBOOK—***By Gerald J. Stout.*** Detailed instructions for building and operating home freezers, large and small, that are low in first cost and economical to run. Section on preparation of foods for freezing. **$4.10**

YOUR HOME AND HOW TO BUILD IT YOURSELF — ***By Wayne C. Leckey.*** A comprehensive volume covering the entire process of house building from the preliminary layout through excavation and masonry to framing, sheathing, plumbing, wiring and the thousand and one little details that go into house construction. **$3.10**

AN OIL BURNER HANDBOOK—***By L J. Whelan.*** How oil burners work, how to get the greatest efficiency from them, how to conserve fuel and what to do about troubles, are all told here in simple, understandable language—for home owners or technicians. **$2.50**

(The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. All prices subject to change without notice. Books listed are offered for retail sale only, not to the trade.)

For Sale by: **February, 1948**

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $..... for which please forward at once the following books:

Book .....**Author** .....

Book .....**Author** .....

Name .....

Address .....

Write us for information on books of any subject. We can supply any book in print

© 1948 SCIENTIFIC AMERICAN, INC

INVENTORS

PATENT LAWS ENCOURAGE the development of inventions. The Rules of Practice of the U. S. Patent Office advises — unless an inventor is familiar with such matters — that he employ a competent registered attorney or registered agent, as the value of patents depends largely upon the skillful preparation of the specifications and claims. Write for further particulars as to patent protection and procedure and "Invention Record" form at once. No obligation.

McMORROW, BERMAN & DAVIDSON
Registered Patent Attorneys
1757 Victor Building, Washington 1, D.C.

KEEP ALL MACHINES UNDER CONTROL WITH VEEDER-ROOT COUNTING DEVICES

VEEDER-ROOT INC. HARTFORD 2, CONN.

TECHNICAL & SCIENTIFIC CATALOG FREE

Professional Engineers - Research - Testing - Development - Technical Publications and Reports

Concise Chemical & Technical Dictionary — Bennett, H. $10.00
Powder Metallurgy — Henry H. Haussner $7.00
Air Conditioning — Herbert & Harold Herkimer, M. E. $12.00

ENGINEERS' BOOK SERVICE,
19 W. 44th St., NEW YORK CITY 18

For Scientific and Technical Books, Use our BOOK DEPARTMENT SCIENTIFIC AMERICAN
24 West 40th Street, New York 18, N. Y.

HAVE YOU A CAMERA?
Improve your hobby of photography and learn how to make better pictures. Write today for our latest book catalog, and sample copy of American Photography, containing articles and pictures by the world's foremost writers and photographers. Camera House, 604, 353 Newbury St., Boston 15, Mass.

15,000 FORMULAS 1077 PAGES

HOPKINS' "CYCLOPEDIA OF FORMULAS"

Thousands of copies of this acknowledged leader among books of formulas are being used daily.

$6.00 postpaid (Domestic)
$6.50 postpaid (Foreign)

Order from

SCIENTIFIC AMERICAN
24 West 40th Street, New York 18, N. Y.

bring it abreast of recent changes in the field, and include extensive additions to the historical appendix, a chronological listing of the steps in the advance of television. An interesting, if often over-enthusiastic book. (194 pages, 5½ by 8½ inches, illustrated.)—$3.10 postpaid.—*N.H.U.*

FOOD PRODUCTS

By Saul Blumenthal

A BOOK full of practical, factory-tested formulas for making hundreds of commercial food products. Includes special chapters on dehydration, freezing, food plant sanitation, and the compositions of foods. Written for the canning, flavoring, beverage, confectionery, essence, condiment, dairy, meat, fish, and allied industries. This book wastes no words; it is intended to be understood and acted upon. (986 pages, 6 by 9 inches, unillustrated.)—$12.15 postpaid.—*E.L.C.*

WHEN THE EARTH QUAKES

By James B. Macelwane, S.J.

EARTHQUAKES, their causes, kinds and field study; sea quakes and the waves they cause; seismographic; seismographic instruments in wide variety; interpretation of seismograms; earthquake engineering; microseisms—these and other aspects of earthquake science are treated in a popular yet far from superficial manner in this book by a noted scientist. Its reader would have a right to feel himself as well informed on earthquake science as is possible short of study of the really abstruse mathematical treatises. (288 pages, 6 by 9 inches, 251 illustrations.)—$5.10 postpaid.—*A.G.I.*

THE SAILING SHIP

By Romola and R. C. Anderson

SIX THOUSAND years of history of the sailing ship, dealing with the evolution of hull and rig types through Phoenecian, Greek, Roman, Viking, medieval, 16th and 17th Century and modern periods. A most satisfying characteristic of this little book is this: The text discusses the exact illustrations chosen, instead of illustrations more or less relevant—often less—being hunted up and dragged in by the ears to brighten up a text already written. This doubles the value to the reader and shows conscientious preparation. (212 pages, 5½ by 8 inches, 134 illustrations.) — $3.60 postpaid.—*A.G.I.*

Because of increased production costs of books, publishers' retail prices today are subject to constant change. It may be necessary, therefore, for our Book Department to advise book purchasers of increased costs, even when orders sent are based on current quotations. *The Editor*

BEGINNER'S TELESCOPE

Needn't be a Crude One Nor Its Maker a Genius

AMATEURS who make their own telescopes go about it approximately thus:

They get a prepared kit of materials and make the main optical part, the concave mirror, first. They buy an eyepiece and prism and mount these three in a home-made mechanism of which the one shown is typical. Made mainly of wood, it suffers in no way for that, costs little, requires only average skill to build and is both artistically and mechanically attractive.

First thing the interested reader asks, and naturally, is: "What about that concave mirror? For that scares me a little, as I've been reading how it took the experts 11 years to finish the big one in California." That one did, since the genius increases as the cube of the diameter, but a 6" one—can you tinker an alarm clock?

The mirror-making kit contains a 6" glass blank and another of same diameter to grind the first one against; abrasive grains for the grinding; pitch and rouge for the polishing. You push one disk over the other by half-hour spells during a dozen spare evenings.

This sounds stupid and monotonous. It would be but for the leavening, for there is a simple testing set-up that measures millionths of an inch with light rays and this constant testing is

Typical homemade telescope

the leavening: throughout, you watch exactly what you are accomplishing. Thus you don't need to wait till the end to detect your mistakes but can catch them as they develop and improvise stratagems. Some claim they get as much fun out of the mirror making as out of the telescope later.

Next, you send the completed mirror away to be coated with aluminum in a vacuum—for silvering is obsolescent. Then you make a mounting.

The mounting shown was made by Theodore Van Abbema, Chicago, is very simple, efficient, inexpensive. He kept track: $24.50. Did he count his time? Do folks count their time playing bridge? It is a fact—some say a scandal—that many builders don't half use their telescopes. Too busy making more of them. Bigger ones and different, specialized types.

© 1948 SCIENTIFIC AMERICAN, INC

Telescoptics

A Monthly Department for the Amateur Telescope Maker

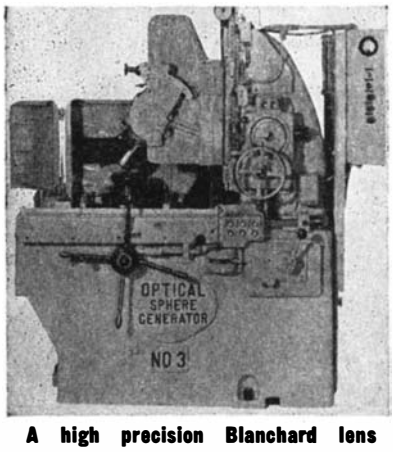
Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

UNCOMMON optical grinding and polishing materials such as boron carbide, sapphire dust, titanium oxide, diamond dust, together with uncommon facts about some common abrasives, are the subject of a systematic survey by John M. Holeman, 305 Thayer Drive, Richland, Wash. He writes:

Today, many other substances than glass are being optically worked. To name a few: metals, especially hard ones that do not tarnish; crystals; transparent salts and plastics, each of which seems to be best worked with some particular combination of abrasives and laps.

There is a trend toward harder and harder abrasives because they lessen the time of working and thereby lower the cost of the finished product. The makers of diamond tools advertise:



A high precision Blanchard lens generator. Used for shaping lenses

"Diamond is the cheapest abrasive you can use." In many cases this turns out to be true. A dollar's worth of diamond will remove more glass than a dollar's worth of any other abrasive, and with the expenditure of less effort.

The arbitrary Mohs scale of hardness used by mineralogists is very deceptive. Diamond on this scale is 10, sapphire 9, topaz 8, quartz 7, feldspar 6, apatite 5, fluorite 4 and so on. These indicate the relative hardness of the minerals but not their abrasive power and not the breadth of the steps in hardness between the various degrees. One might be led to believe that each degree of hardness represented by a number meant a uniform increase in hardness and abrasive durability. Experience shows that this is far from true. Actually, the steps from fluorite 4 to feldspar 6 are very close but from topaz 8 to diamond 10 much greater. The hardness numbers do not reveal this disparity.

In the discussions that follow there will be no attempt at completeness nor will all the means of using any particular abrasive be indicated. The information offered represents the experience of only one amateur.

Sand: This, the cheapest abrasive to buy, is still used where nothing else is available or where cost is paramount. Plate glass is ground flat with sand. During the War when better abrasives were under priority some amateurs used sand. TNs stranded on Pacific islands used sand. Pure sand is quartz and has a hardness of 7. This is greater than that of glass, which varies from 5½ for soft crowns to 6 for hard flints. Sand may be crushed, sieved, washed and levigated and has been used to produce excellent work on both metal and glass. In the form of a sand blast it is the quickest means of removing glass, and blown through suitable rubber stencils it can be used for chanelling glass tools and will perform glass removing operations that would be very difficult by any other means.

Crushed steel: This inexpensive by-product of the steel mills (see "A.T.M.") is available only in coarse sizes, but is useful for bringing a large piece of glass to shape. It cuts Pyrex readily.

Emery: A form of corundum (not Carborundum) which came originally from natural sources, but in this country practically all of it that is used as an abrasive is manufactured, permitting better control of the purity and uniformity. Chemically, emery is the same as sapphire, both being aluminum oxide, and has a hardness of 9.

Emery is available in all grades from very coarse to extremely fine and in some countries is used in the coarse sizes almost to the exclusion of silicon carbide, Carbo, for example. It is generally believed that the pits and scratches left by emery are different from those left by Carbo and are easier to polish out. Consequently emery is almost universally used as a final abrasive. Similarly, because it seems to chip sharp edges less, it is often used for the fine grinding stages of roof prisms and other sharp-edged elements, this being a case where the fastest abrasive is not always the best.

Manufactured emery is a clean white powder easy to refine and levigate. In many plants used emery is saved, washed, and re-levigated to produce finer grades. The best description of this process, which is more or less applicable to refining all abrasives, is found in Dévé's "Optical Workshop Principles."

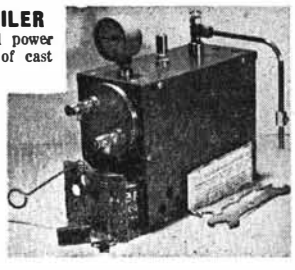
Silicon Carbide: Chemically, Carborundum, usually shortened to "Carbo," and Crystolon, are silicon carbide and have a hardness greater than 9. In coarse grades, at least, these remove

ROSS' BUYS

STEAM ENGINE

Miniature Steam Engine completely assembled ready for steam. Strongly made of bronze, brass and iron. A practical working model that performs and operates like a real steam engine. Made to exact scale. Educational, instructive, entertaining and decorative. For students, experimenters, display. Can be employed as aerating pump for tropical fish tank. Many other uses. Specifications: Bore 9/16"; Stroke 11/16"; length of base 6"; height 3"; weight 2 pounds. Finished in red enamel with brass trim. With 15 lbs. pressure engine delivers almost ¼ H.P.
Price $17.50

STEAM BOILER



Miniature real power Steam Boiler of cast bronze end plates silver soldered to brass tubing. Tested to withstand 300 lbs. pressure. Safe! Enclosed in sheet iron housing. Uses one or two "Sterno" cans for heat. Dimensions 8"x8"x3½". Weight 4 pounds. Fittings include safety valve, pressure gauge, throttle; connecting steam pipe of copper with oil vent; wrenches. Natural rolled iron, bronze, brass and enamel finish. One pint water will run 2 hours, giving steady volume of steam at 15 lbs. pressure.
Price $22.50

PRISM BINOCULARS 8 x 25

The finest glass obtainable today. Sharp, clear, brilliant image. Ideal for all year round day and night use. Satin black finish in leather case with safety straps.
$48.80 all taxes paid. Postpaid.

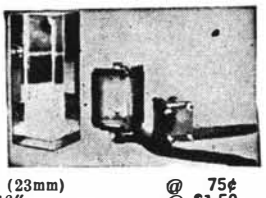
MICROSCOPES

Used. Guaranteed in excellent optical and mechanical condition. Ready to use. Standard size Bausch & Lomb, Spencer, Leitz, etc.:
2 Objectives, 2 Oculars, powers 60x, 100x, 270x and 450x @ $65.00 net. Above plus oil-immersion lens giving added 600x and 1000x and also including Abbe condenser @ $125.00 net. Express Collect.

VARIABLE DENSITY FILTER

Genuine Polaroid variable density device. 2-⅞" diameter. Complete new stock.
Postpaid $2.35

PRISMS



Water - white crown glass of excellent quality. Government inspected and accepted. No chips or roughs. 45-90-45 degrees in mounts.
Sizes:
⅞" x ⅞" (23mm) @ 75¢
1⅝" x 1-3/16" @ $1.50
Back silvered unmounted, size:
4" (102mm) x 1½" (38mm) @ $3.00

Include Postage — Remit with Order

Send 20¢ for Up-to-minute Catalog

HARRY ROSS
MICROSCOPES
Scientific and Laboratory Apparatus
70 West Broadway, New York 7, N. Y.

© 1948 SCIENTIFIC AMERICAN, INC

LENSES 500,000 OF THEM

Send 3 cent stamp for "BARGAIN" List. Let's Go!

AVAILABLE NOW!

U. S. ARMY and NAVY SURPLUS

HOBBYIST LENS SET
Magnifiers, reducing lenses, positives, negatives, etc. 10 piece lens set **$1.00**

ACHROMATIC TELESCOPE OBJECTIVE 3" (76m/m) dia., 15" (381m/m) F.L. Magnesium-fluoride coated and cemented. Mounted in aluminum cell O.D. 3⅝". **Postpaid ea. $20.00**

ACHROMATIC TELESCOPE OBJECTIVE 1⅞" (48 mm) diameter, 23⅝" (600 mm) focal length, unmounted **Postpaid ea. $9.75**

5 POWER TANK ARTILLERY TELESCOPE (M-71) Brand New. Coated optics. Completely assembled. Value $345.00 **ea. $29.50**

OPTICAL LENS BENCH, a necessity for designing your own telescopes or optical instruments. Complete bench with four lens holders. **Postpaid $8.50**

MOUNTED KELLNER EYEPIECE E.F.L., 1½" O.D. of brass mount 1 17/32", clear aperture of field lens 1½", eye lens 13/16". **Postpaid $2.65**

ACHROMATIC OBJECTIVE. Perfect. Coated and cemented 44m/m Dia. 7½" F.L.
Unmounted **ea. $2.50** Mounted **ea. $3.50**

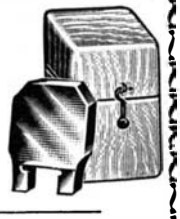
KELLNER EYEPIECE
ACHROMATIC

Mounted eyepiece has 2 perfect magnesium-fluoride coated achromatic lenses 29mm in dia. Designed in order to give good eye relief, 1¼" E.F.L. (8X).
Outside dia. of cell 40m/m $4.50
Cell to fit 1¼" tube (illustrated) 4.50

WIDE ANGLE EYEPIECE

All coated optics, mounted in focussing cell, 2" clear aperture, 1½" E.F.L. 3 Achro. lenses. Value $125.00 **Perfect ea. $9.50**

ALUMINIZED MIRROR



First surface aluminized mirror. Polished to ¼ wave length of flatness. Packed in individual wooden boxes. Every mirror in sealed government inspected box. Mfgd. by Bausch & Lomb. Highest astronomical quality. Size 2½" X 3" X ½" thick.
Postpaid....$3.00

ACHROMATIC LENSES, cemented

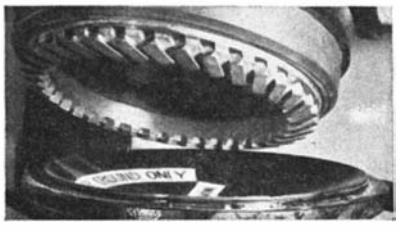
12 mm Dia.	80 mm F.L.		ea.	$ .50
14 mm Dia.	60 mm F.L.	coated	ea.	1.25
18 mm Dia.	102 mm F.L.		ea.	1.25
23 mm Dia.	162 mm F.L.	coated	ea.	1.25
23 mm Dia.	184 mm F.L.	coated	ea.	1.35
25 mm Dia.	122 mm F.L.	coated	ea.	1.25
26 mm Dia.	104 mm F.L.	coated	ea.	1.25
29 mm Dia.	54 mm F.L.	coated	ea.	1.25
31 mm Dia.	124 mm F.L.	coated	ea.	1.50
31 mm Dia.	172 mm F.L.	coated	ea.	1.25
32 mm Dia.	132 mm F.L.		ea.	1.50
34 mm Dia.	65 mm F.L.	coated	ea.	1.50
38 mm Dia.	130 mm F.L.		ea.	1.50
38 mm Dia.	240 mm F.L.		ea.	2.50
52 mm Dia.	224 mm F.L.		ea.	3.25
58 mm Dia.	215 mm F.L.		ea.	4.50
PENTA PRISM	19m/m Face		ea.	1.00
PENTA PRISM	40m/m Face		ea.	5.00
90° AMICI PRISM	21m/m Face		ea.	2.00
RIGHT ANGLE PRISM	23m/m Face		ea.	1.25
RIGHT ANGLE PRISM	30m/m Face		ea.	1.75
RIGHT ANGLE PRISM	38m/m Face		ea.	1.75
RIGHT ANGLE PRISM	47m/m Face		ea.	3.00
RIGHT ANGLE PRISM	62m/m Face		ea.	6.00
CROSSLINE RETICLE	23m/m Dia.		ea.	.50
DOVE PRISM	49m/m long		ea.	.75
115° AMICI PRISM	10m/m Face		ea.	1.25
GIANT RIGHT ANGLE PRISM	41m/m X 57m/m Face (flint glass)		ea.	3.00
GIANT PORRO PRISM	(grooved) 41m/m Aperture		ea.	3.25

Send 3 cent stamp for "BARGAIN" List

A. JAEGERS
123-26A Rockaway Blvd.
SO. OZONE PARK 20, N. Y.

glass much faster than the same grade of emery—which, as we have seen, is only a fraction of a hardness degree less hard. Silicon carbide is today available in grades from very coarse to 600 grit. No. 1000 Carbo, used in wartime, has been discontinued. The price, like that of any abrasive, varies with the fineness and is less per pound than fine grades which are more difficult to produce. In any case, it is considered an extremely cheap, hard abrasive. Silicon carbide is used to cut quartz and metals as well as glass and, in the form of inexpensive resin- or rubber-bonded thin disks, is used to saw glass and other materials.

Boron Carbide: Sold as "Norbide," this has hardness 9½ and is therefore much harder than silicon carbide; it is



Cutter: diamonds in sintered metal

the hardest material known excepting the diamond. Commercially it is available in at least two grades, 100 and 400 grit, from the Norton Co., Worcester, Mass., and it represents the ultimate in loose abrasives at present. Though it is only a fraction of a hardness degree higher than silicon carbide and emery, it breaks down much less rapidly and can be used to rough out a 6" Pyrex mirror in half an hour when properly applied. This material is also useful to charge biscuit cutters and wire saws for cutting glass and harder substances.

In 1947 boron carbide cost 50 times as much as silicon carbide, but the price will probably decrease. In appearance it resembles silicon carbide, being black and yet crystalline, but when broken down and wet it forms a dirty black slurry that is much more difficult to clean up than other abrasives. Metal tools that have become embedded with it are difficult to clean and will continue to scratch for a long time due to the difficulty of breaking down the very hard grains. This is one worker's experience. Another says almost the opposite. Because boron carbide grains are blocky in shape they will not charge metal tools as readily as do the sharper abrasives; in fact, when it is actually desired to cause a metal tool to take and hold a charge of it, cast iron having plenty of voids should be selected. [The Bill of Rights of the United States Constitution guarantees the freedom of workers who may wish to choose sides in this little dispute, and an account of their findings will be welcome.—*Ed.*]

Sapphire Dust: This is a by-product of the artificial sapphire industry which during the war made millions of jewel bearings for instruments. Sapphire crystals are grown to large size, then sawed up to make bearings, all the sawings

ALNICO FIELD MOTOR

This is perhaps the **WORLD'S SMALLEST MOTOR**

1" x 1⅛" x 2" made for 27 Volts DC runs on 4 Flashlight batteries REVERSIBLE DRIVE it as a generator! **$3.50**

• • •

At last: a synchronous Alnico Field reversible D C Motor which will run over ONE WEEK on a 6 volt flashlight battery. Geared down to ½ rev. per minute. Mounted with two G.E. Switchettes and a relay. Fuse holder and extra fuse, two Bristol wrenches to change timing cams, two 220 ohm resistors furnished to run on 12 or 24 volts.

$5.50 postpaid

BLAN, 64-N Dey Street, New York 7, N. Y.

When you write to advertisers
• The Editor will appreciate it if you will mention that you saw it in **SCIENTIFIC AMERICAN**

ARMY AUCTION BARGAINS

Antique oil cup	$ .25	each
Krag rear sight, new	1.00	"
Shot gun nipples	.25	"
Rev. holster, black cal. 38	.45	"
Mauser '98 book	.45	"
Angular bayonet cal. 45	.90	"
Lead ladle, 6½ inch	1.80	"
Flint pistol barrel, 6 inch	.75	"
Sharps carbine barrel 50/70	4.00	"
Springfield carbine barrel 50/70	.60	"
Flints, assorted, dozen	1.00	"

Prices do not include postage.

Articles shown in special circular for 3¢ stamp. 1945 catalog, 308 pages, over 2,000 illustrations of guns, pistols, sabers, helmets, medals, buttons, etc., mailed in U. S. for one dollar.

FRANCIS BANNERMAN SONS
501 Broadway New York 12, N. Y.

Yes, it is safe to say that perhaps 8 out of 10 families in your neighborhood read at least two or three popular magazines.

This magazine plans to establish in every community a service for handling NEW ONE YEAR subscriptions for SCIENTIFIC AMERICAN. This service, operated independently by a reliable resident, will include also the handling of new and renewal subscriptions for all other publications. It will be welcomed by magazine readers as a dependable local source through which they may obtain their magazines.

Perhaps you can qualify for one of these appointments. A neighborhood magazine subscription service need not interfere with any full-time work you are engaged in, although many have developed into profitable full-time enterprises.

You can obtain full particulars without cost or obligation by writing to

INDEPENDENT AGENCY DIVISION
Room 1201, 250 Park Avenue
New York 17, N.Y.

© 1948 SCIENTIFIC AMERICAN, INC

EYE PIECE BARGAINS

EYE PIECE—KELLNER'S, brand new, E.F.L. 27mm. (1-1/16 inch). Coated optics. Focusing mount with plus & minus 4 diopter scale. Clear aperture eye lens 19/32 inch. 1¼ inch O.D. across threads at objective end. This is a beautiful job you will be proud of in both appearance and performance.
Stock # 24 .....$6.50 ea.

ACHROMATIC ERECTING LENS SYSTEM, six elements, coated and mounted in 1¼ inch dia. by 1⅜ inch long aluminum mount. This is a really high grade erector made by the same company and for the same instrument as our #100 A&B objectives.
Stock # 101 .....$5.00 ea.

EYE PIECE E.F.L. one inch, removable reticle, coated lenses, field lens is an achromat, 1-1/16" dia. threaded mount. Clear aperture eye lens 15/16 inches. This eye piece was made for M-12 panoramic telescope.
Stock # 20 .....$3.75 ea.

EYE PIECE—Large, from aircraft sighting station. In 2⅞ inch dia. threaded aluminum mount with locking ring. E.F.L. approx. 2 inches. Coated optics, clear aperture eye lens over 1¾ inches.
Stock # 22 .....$5.00 each.

Lenses only for above
Stock # 22-B .....$3.00 set

Please use Stock No. when ordering

F. W. Ballantyne
P. O. Box 382
Point Pleasant, New York

MECHANICS • HOME STUDY

Step up your own skill with facts & figures of your trade. Audels Mechanics Guides contain Practical Inside Trade Information in handy form. Fully illustrated. Easy to Understand. Highly Endorsed. Check book you want for 7 days' Free Examination. Send no Money. Nothing to pay postman. ☐Carpentry $6 • ☐Auto $4 • ☐ Oil Burners $1 ☐Sheet Metal $1 • ☐Welding $1 • ☐ Refrigeration $4 ☐Plumbing $6 • ☐Masonry $6 • ☐Painting $2 • ☐Radio $4 ☐Electricity $4 • ☐Mathematics $2 • ☐Steam Engineers $4 ☐Machinist $4 • ☐Blueprint $2 • ☐Diesel $2 • ☐Drawing $2. If satisfied you pay only $1 a month until price is paid.
AUDEL, Publishers, 49 W. 23 St., New York 10, N. Y.

For Scientific and Technical Books
Try our Book Department
SCIENTIFIC AMERICAN

INVENTORS

If you consider your invention to be something of importance, you may take steps to protect it with a United States Patent.

PATENT PROTECTION

A U. S. Patent gives you the right to exclude others from making, using and selling your invention as claimed. Detailed information and steps to take to secure Patent Protection will be mailed to you promptly without obligation.

VICTOR J. EVANS & CO.
Merlin M. Evans
REGISTERED PATENT ATTORNEY
326-B Merlin Building Washington 6, D. C.

becoming waste. The Linde Air Products Company, East Chicago, Indiana, has several grades at surprisingly low prices. A half pound of No. A5175 "Polishing Powder" cost $5 in 1946. It has a grain size comparable to very fine emery. Though chemically it is the same as emery and, like it, has a hardness of 9, it is a very different abrasive. It cuts and polishes glass, Pyrex, quartz, sapphire, and metals more readily and to a higher polish. Used on glass laps it will put the sharpest possible edge on microtome and other knife blades. Used on hard laps it grinds and polishes (though not optically) stainless steel, Stellite, and many other difficult metals. Used on pitch or felt it polishes quartz and harder materials in a fraction of the usual time, though for best finish a final treatment with rouge should be added. This snow white powder is clean to handle and, of course, can be levigated like emery or diluted with talc to reduce its cutting speed.

Diamond: During the war greatly improved techniques for using diamond were developed. Previously, rotary diamond saws were made by rolling or pressing diamond chips into slots or nicks in the edge of a copper disk. Such saws cut well until they snagged a sharp edge and the diamonds were dislodged and lost. Further, the soft copper blade was so flexible that it was difficult to make an oblique cut and the saw wandered off on a crooked path. Most postwar saws are made of steel with the diamonds brazed on, so that it is practically impossible to remove them. Such saws last almost indefinitely. A 10" blade costs about $6. They will cut glass, quartz, rocks, firebrick, hardened steel or any hard substance. In a recent demonstration with portable equipment, an 8" thick concrete highway was thus sawed in two in 30 minutes at much less cost than the job could have been done with air hammers.

Another development of the diamond saw is the hole saw or biscuit cutter used for making large holes in glass and other hard materials. Such hole cutters are now available so cheaply that it hardly pays to make one. They cut faster, cooler and with less danger of chipping than the usual cutter charged with loose abrasives. When they are properly operated the hole produced has a beautiful finish with only extremely fine chips on the exit side, and the removed plug looks as if it had been turned and fine ground.

A recent development is a diamond boring tool made by Felkin Tool Company, Torrance, Calif., which forces lubricant (usually water) under its cutting edge through a stationary water connection on its rotating shank. Such a saw cuts ten times as fast as the familiar diamond hole saw and I have seen an operator cut sixty 1" diameter holes in thick glass in less than two hours.

Besides saws and hole saws, diamond milling cutters and lathe tools are available. The former are metal cylinders with the surface covered with brazed-on diamond chips. They can be used either on a milling machine or a surface grinder. It is amazing to see such a

WAR BARGAINS

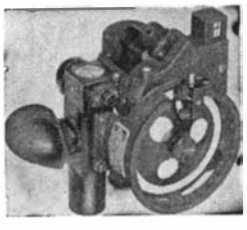
ASSEMBLE YOUR OWN BINOCULARS
Save More Than ½ Regular Cost

GOVT'S 7 x 50 BINOCULARS

Complete Optics, new and ready for assembly. We supply full instructions. Limit—1 Set of Metal Parts and 1 Set of Optics to a customer.
METAL PARTS — Set includes all Metal Parts—completely finished—for assembly of 7 x 50 Binoculars. No machining required. Bodies have been factory hinged and covered. A sturdy Binocular Carrying Case is optional with each set of Metal Parts.
Stock #842-S $39.40
Postpaid, plus $4.80 for Case .....Total $44.20
OPTICS — Set includes all Lenses and Prisms you need for assembling 7 x 50 Binoculars. These are in excellent condition — perfect or near-perfect — and have new low reflection coating.
Stock #5102-S — 7 x 50 Optics .....$25.00 Postpaid
NOTICE! If you buy both Binocular Optics and Binocular Metal Parts, add 20% Federal Excise Tax to above prices.

ARMY'S 6 X 30 BINOCULARS
COMPLETE OPTICS & METAL PARTS—Model M-13A1, 6 X 30 Binoculars (Waterproof Model). Everything you need—ready for assembly. When finished will look like a regular factory job costing $102 to $120. The Optics are new, in perfect or near-perfect condition. Have new low reflection coating. Metal Parts are new and perfect, all completely finished. No machining required. Bodies factory hinged and covered. Complete assembly instructions included.
Stock # 830-S .....$40.00 Postpaid plus $8.00 tax—Total—$48.00

SENSATIONAL BARGAIN BUBBLE SEXTANT



These Army Air Forces Bubble Sextants cost the Govt. about $125.00 each. A real bargain at our price of $12.50! Included with Bubble Sextant shipment is wooden Carrying Case, 5 spare waxed paper discs, flashlight with rheostat for night use (uses ordinary flashlight cells — not furnished), aux. 2-power Galilean Telescope, Allen wrench, 1 spare marking point. Wartime used, but where necessary completely repaired, collimated and put in good working order. If not satisfied that Sextant is exactly as represented, return within 10 days and money will be refunded. Full directions for use accompany each shipment.
Stock # 924-S .....$12.50 Postpaid
Same SEXTANT as above, but **BRAND NEW** and with Automatic Electric Averaging Device and Illuminated Averaging Disc for night-time use. Govt. cost $217. Though brand new, we have re-checked Bubble and Collimation and guarantee perfect working order.
Stock # 933-S .....$22.50 Postpaid
35 MM KODACHROME PROJECTING LENS SET — Consists of 2 Achromatic Lenses for projecting, plus 2 Condensing Lenses and piece of Heat Absorbing Glass with directions.
Stock #4029-S .....$3.10 Postpaid
AIR FORCES GUN SIGHT — With Polarizing Variable Density Attachment. (Polarizing attachment alone is worth many times the price of the entire unit.)
Stock #908-S .....$5.00 Postpaid
Same Unit Without Polarizing Attachment
Stock #916-S .....$2.50 Postpaid

$15.00 BUYS A $500.00 TELESCOPE WITH BIG 3" OBJECTIVE

3 power instrument, brand new, with plastic Optics and fixed focus, 23" long. Objective Lens has F.L. of 14.9". Wt. 31 lbs. Wide field of view.
Stock #929-S .....$15.00 f.o.b. Chicago, Ill.
(Shipping Wt. about 70 lbs.)

MOUNTED PROJECTING LENS SYSTEM
F.L. 91.44 mm. (just right for 35 mm. Projectors). Speed of F 1.9. Outside dia. of mount at one end 60 mm. Length of mount 65 mm.
Stock #4033-S .....$3.00 Postpaid
THREADED OUTSIDE MOUNT FOR FOCUSING ABOVE SYSTEM. (NOT ILLUS.)
Stock #715-S .....$1.50 Postpaid
CONDENSING LENSES — Seconds, but suitable for Enlargers and Spotlights.
Stock #1061-S, 6½" dia., 9" F.L. ....$2.50 Postpaid
Stock #1082-S, 4½" dia., 5½" F.L. ....70¢ Postpaid

We Have Literally Millions of WAR SURPLUS LENSES AND PRISMS FOR SALE AT BARGAIN PRICES. Write for Catalog "S" — SENT FREE!
Satisfaction Guaranteed.
Order by Stock No.

EDMUND SALVAGE CO.
P. O. AUDUBON, NEW JERSEY

© 1948 SCIENTIFIC AMERICAN, INC

ASTRONOMICAL OBJECTIVES, OCULARS PRISMS, FLATS

Instruments Designed to Your Specifications

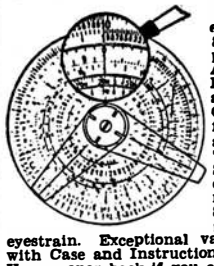
Write for Descriptions and Price List

BRANDON SCIENTIFIC DEVELOPMENT

A New York Corporation

P. O. Box 85 Malverne, New York

THE BINARY SLIDE RULE



equals a 20 Inch Straight Slide Rule in precision. Has C, CI, A, K, Log, LL1, LL2, LL3, LL4, Binary, Add and Subtract Scales. Gives Trig. Functions from 0 to 90 degrees and reads to 1 Minute. The Engine - divided Scales are on white enameled metal. Permanently accurate. Dia. 8¼". Large figures and graduations eliminate eyestrain. Exceptional value and utility. Price, with Case and Instructions, $7.25. Circulars free. Your money back if you are not entirely satisfied.

Gilson Slide Rule Co., Box 993, Stuart, Fla.

Slide Rule Makers since 1915.

PATENTS AND TRADE MARKS

C. A. SNOW & CO.

REGISTERED PATENT ATTORNEYS

WRITE FOR INFORMATION TO

490 SNOW BUILDING, WASHINGTON 1, D. C.

ALUMINIZING

SURFACE HARDENED COATINGS

Get The Best

6"	— $2.50	14"	— $14.00
8"	— 3.50	16"	— 18.00
10"	— 5.00	18"	— 21.00
12½"	— 8.00	20"	— 24.00
	24" — $30.00		

LEROY M. E. CLAUSING

5507-5509 Lincoln Ave. Chicago 25, Ill.

COMPLETE HIGH GRADE KITS OUR SPECIALTY

Each kit has two glass discs (correct thickness), tempered pitch, 8 assorted abrasives including rouge (fewer may not give perfect optical surface), instructions, FREE ALUMINIZED DIAGONAL, etc.

4" Kit.....$4.00	Pyrex kit, $5.50
6" Kit..... 5.50	Pyrex kit, 7.50
8" Kit.....10.00	Pyrex kit, 11.50
10" Kit.....15.00	Pyrex kit, 22.00
12" Kit.....21.00	Pyrex kit, 35.00

PRISMS 15/16" $2.50, 1¼" $3.75, 2" $7.50

Pyrex speculums made to order. Your mirror tested free. We do polishing and parabolizing.

ALUMINIZING

A harder and brighter aluminum coating that is uniform and produces a lasting and superior reflecting surface. Guaranteed not to peel or blister.

6"	$2.50
8"	$3.50
10"	$5.00
Equatorial Mountings (Ball-Bearing)	$87.50

Mirrors for Cameras, Range Finders and other optical instruments.

Write for FREE PRICE LIST

THE PRECISION OPTICAL CO.

1001 East 163rd Street, N. Y. 59, N. Y.

cutter smoothing off the top of a line of glass prism pressings on power feed at the rate of several feet a minute. Diamond lathe tools can be used to turn glass disks round or to shape lenses. The deep curve of a Schmidt mirror, for example, can be quickly cut out with such a tool. In fact, if diamond cutters are used, it is possible to work glass very much like metal and on the same machine tools.

Probably the most advanced development of this kind is the lens generator which makes precision lenses from glass blanks without the use of laps or loose abrasive. The blank is clamped in a holder and a diamond cutter adjusted by a graduated wheel runs over the surface at the desired curvature. The resulting lens is of good quality and even has a fair polish. A simple adjustment of the dial allows a different radius to be cut.

Diamond drills for small holes consist of a single properly shaped diamond fastened to the end of a steel shaft. Such drills are mass produced in the size, about 0.05" diameter, that is used for drilling mounting holes in spectacle lenses, and can be made to order in other sizes. The selection of the stone, with the mounting and shaping of the point, are a job for the expert and may be considered reasonable at $35 for the size described. Small holes can be drilled in hard materials, using a vibrating hardened steel wire and diamond dust, by a process that is exactly the same as star drilling in concrete. The National Bureau of Standards, Washington, D. C., has recently developed some very superior chemical and electrical methods for drilling extremely small holes in diamonds which would probably be applicable to other hard materials also.

Diamond is too expensive to use loose like silicon carbide and emery. Instead, a tool or lap is made and charged with diamond powder or chips. Lapidaries, in smoothing and polishing gems, spread a small amount of diamond dust in oil vehicle on a smooth soft iron or copper lap; then, with the lap rotating at low speed, they press down on the surface with a small hardened roller, which forces the abrasive into the soft metal. The cutting action of such a charged lap is a combination of grinding and polishing. It is like grinding, in that relatively large particles of abrasive are used and consequently there is rapid removal of material, and it is like polishing, in that the abrasive particles are fixed in a comparatively soft lap and are not free to roll. The result is that a diamond lap cuts rapidly but leaves a semipolished surface covered with scratches caused by the larger particles. The spaces between the scratches are pretty well polished and this is very convenient in working glass, as the surface always has a good enough finish to give a reflection for test purposes.

Next month, more about diamond abrasives; how to make diamond laps; data on titanium oxide; and Barnesite, its composition, how it should be applied, where it may be obtained. Also garnet fines as a finishing "emery."

REFLECTING TELESCOPE KITS OUR SPECIALTY

PARABOLIC PYREX MIRRORS made to Order, correctly figured, polished, and parabolized. Precise workmanship guaranteed. Prices on request.

WE DO POLISHING, PARABOLIZING, AND ALUMINIZING

Send for FREE ILLUSTRATED CATALOGUE

M. CHALFIN OPTICAL COMPANY

G. P. O. Box 207, New York, N. Y.

TELESCOPE MAKERS

Quality materials of the RIGHT kind. 6" Kit:—Glass, abrasives, pitch rouge and instructions $6.00

HOBBYGRAFS—INFORMATION—INSPECTION

Hobbygraf 15-Diagonals and Supports . . . 30¢

We offer you the benefit of our 26 years of experience at this hobby. Free price list.

John M. Pierce, 11 Harvard St., Springfield, Vt.

RAMSDEN EYEPIECES

¼"-⅜"-½"-1" E.F.L. standard 1¼" O.D. each $5.10 — immediate delivery

EQUATORIAL MOUNTINGS

Combination Eyepiece and Prism Holder

Mirror cells with ring for tube

Prisms highest quality

Prices and catalog on request.

C. C. YOUNG

25 Richard Road East Hartford 8, Conn.

TELESCOPES BINOCULARS MICROSCOPES

ALL LEADING MAKES

CATALOG OF BIG VALUES FREE ON REQUEST

BROWNSCOPE CO. Dept. 2K, 24 W. 45th St. New York 19, N. Y.

Make Your Own

TELESCOPE

EXTENSIVE, practical instructions for making excellent telescopes capable of serious astronomical work, including the glass mirrors and at a cost of less than $25 for materials, are presented in

AMATEUR TELESCOPE MAKING

(500 pages, 316 illustrations)

$5.00 postpaid, domestic; foreign $5.25

AFTER you have made your telescope, there will be other optical apparatus that you will want to make. Then the book you will need is

AMATEUR TELESCOPE MAKING—ADVANCED

(650 pages, 361 illustrations)

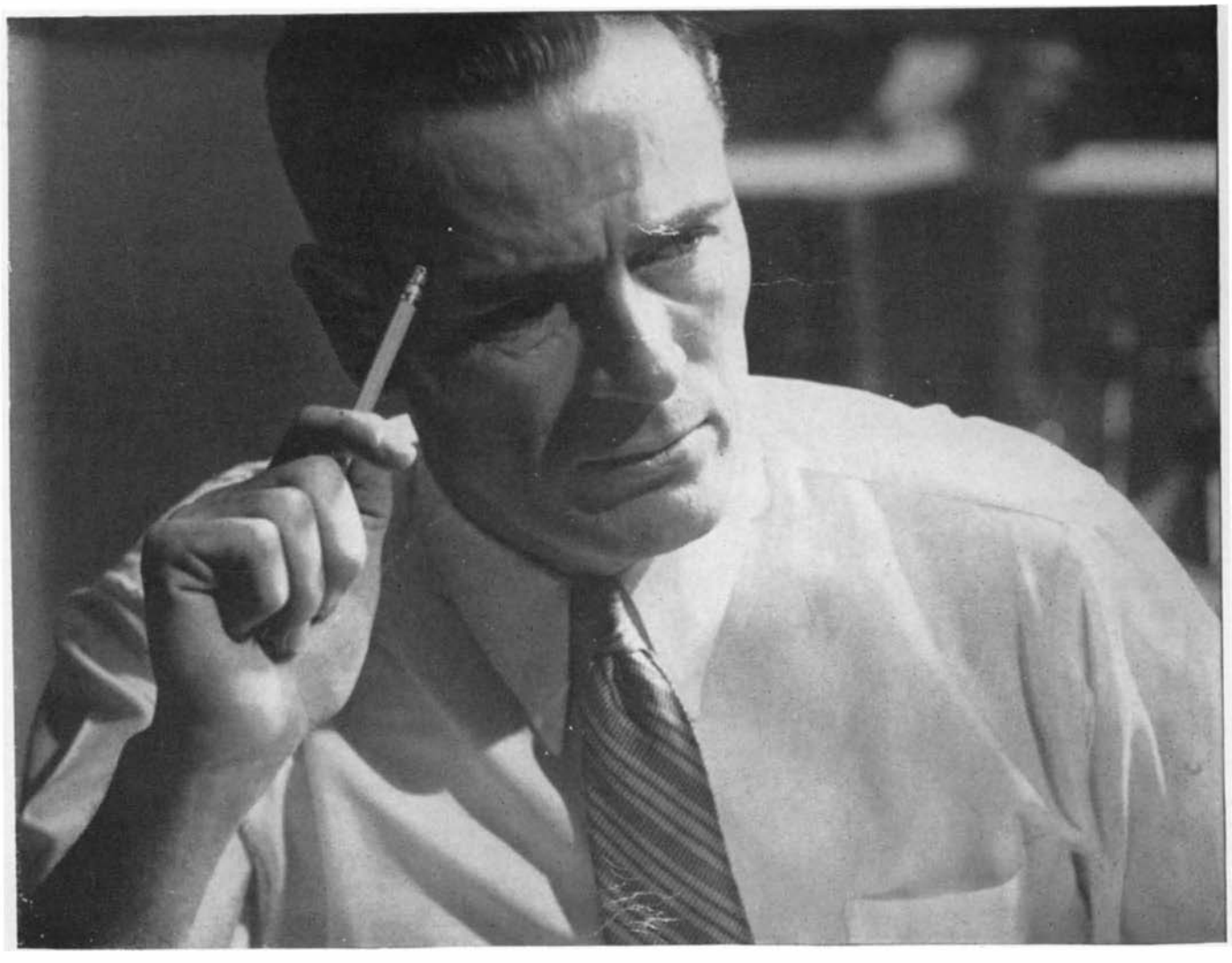
$6.00 postpaid, domestic; foreign $6.35

Ask for detailed information on these two practical books on an important scientific hobby. A postal card will do.

SCIENTIFIC AMERICAN

24 West 40th Street, N. Y. 18, N. Y.

© 1948 SCIENTIFIC AMERICAN, INC



When does a man start slipping?

The moment comes to every man.

The moment when he realizes that he isn't the man he used to be . . .

That the days of his peak earning power are over . . .

That some day not so very far away some younger man will step into his shoes.

When does this time come?

It varies with many things.

But of one thing you can be sure. It will come to you as surely as green apples get ripe– and fall off the tree.

Is this something to worry about? Well, yes. But . . . constructively. For that kind of worrying can lead you to save money systematically.

What's the best way to do this? By buying U. S. Savings Bonds . . . *automatically*. Through the Payroll Savings Plan. Or through the Bond-A-Month Plan at your checking account bank.

Either method is an almost foolproof system of saving. It's automatic. You don't put it off. There's no "I'll start saving next month"—no "Let's bust the piggy bank."

And you get back four dollars, at maturity, for every three invested.

So why not take this one step now that will make your future so much brighter?

Get on the Payroll Savings Plan—or the Bond-A-Month Plan—today.

Sure saving because it's automatic—U.S. Savings Bonds

Contributed by this magazine in co-operation with the Magazine Publishers of America as a public service.

© 1948 SCIENTIFIC AMERICAN, INC

Ever wish you were Aladdin?

You remember him . . .

He was the lucky fellow who found a magic lamp. It gave him everything he wished for—from diamond-crusted palaces to a sultan's daughter as his bride.

You've probably wished a lot of times for a miracle like this to happen to you. Maybe not for out-of-this-world treasures, but for something that will take care of the things that are bound to come up.

Like medical expenses, or college for the kids. Or maybe just for the nice, safe feeling it gives you to have some extra money put aside for the future.

Though no magic is involved, there is a way to give you this security. The Payroll Savings Plan. Or, if you're not eligible for the Payroll Plan but have a checking account, the new Bond-a-Month Plan.

Either way, it's almost unbelievable how quickly your money accumulates.

Where else can you get such a *safe*, generous return on your money ($4 for every $3)? It's so simple—so easy, you hardly miss the money that you're saving.

And don't forget—at the same time, you're *making more!*

Next to a magic lamp, there's no better way than this to make sure your future is secure.

Save the easy, automatic way . . . with U.S. Savings Bonds

Contributed by this magazine
in co-operation with the Magazine Publishers of America as a public service.

© 1948 SCIENTIFIC AMERICAN, INC