ENGINEERING AND SCIENCE

MONTHLY

OCTOBER ★ 1945

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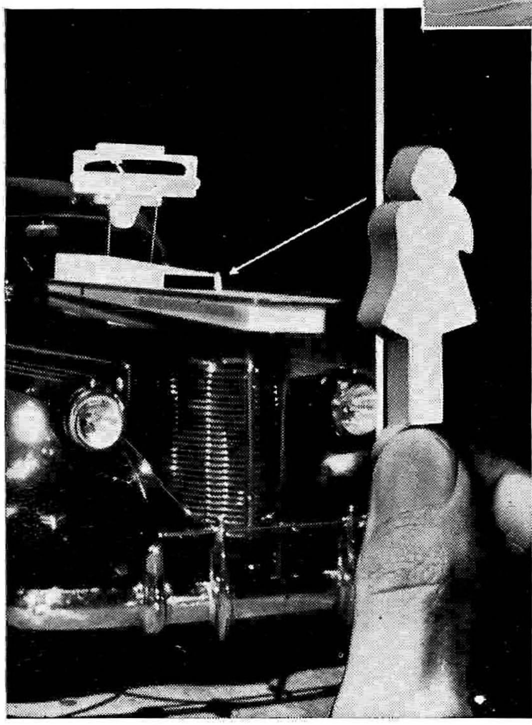
So you'll be safer

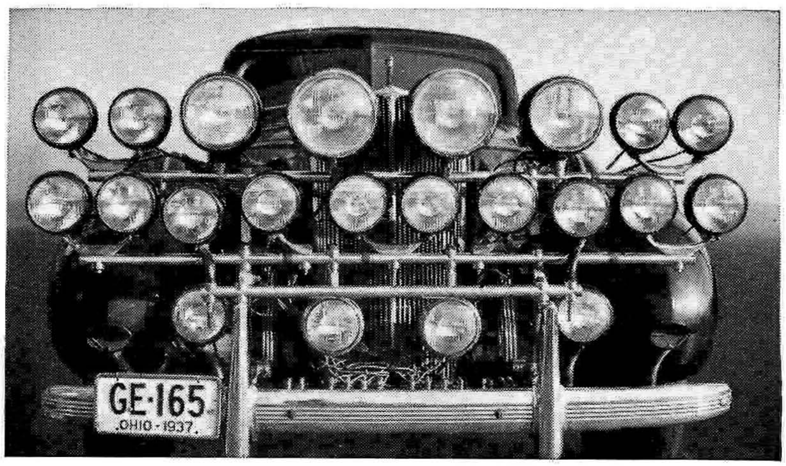
Radar will make travel safer. General Electric scientists are working along these lines. Among many other G-E developments are better street lighting, which reduced night traffic accidents in one city 93 per cent in ten months . . . a tiny gage which prevents accidents to workers around cranes . . . a new hay-drying system that helps prevent farm fires caused by storing wet hay.

Working on developments such as these, G-E engineers and research scientists are helping to make life safer for you. *General Electric Co., Schenectady, N. Y.*

Radar prevents collision. This actual photograph taken on the bridge of the "American Mariner," U. S. Maritime Service Training Ship, shows General Electric's new peacetime radar Electronic Navigator helping plot a safe course. The officer is looking at the G-E Navigator's radar screen, which shows him the position of the ship and the objects around it. On ships or planes, in fog or darkness, radar will warn pilots of unseen hazards.



2-inch doll saves lives. Central character of an ingenious apparatus to test street lighting is a tiny doll that represents the average pedestrian as seen at a distance. The complicated device measures visibility and glare. It was devised by General Electric engineers to help make streets and highways safer for night driving.



Bug-eyed auto was the car used in development of G-E Sealed Beam headlights adopted by the automobile industry. The Sealed Beam headlamps give more and safer light. Tests show that the average G-E Sealed Beam lamp gives 99 per cent as much light near the end of its life as it did when brand new. About 45 lamps of Sealed Beam type have been developed by General Electric for the Army and Navy.

The best investment in the world is in your country's future.

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BY-LINES

J. G. PLEASANTS

J. G. Pleasants received his Ph.D. degree from the California Institute of Technology in 1933. He was employed by The Procter and Gamble Company, in the manufacturing department, and has worked in their factories at Long Beach, Cincinnati, New York and Baltimore. Since 1940 Dr. Pleasants has been western division superintendent, in charge of factories at Kansas City, St. Louis, Dallas, and Long Beach.

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Dr. Washburn received his M.S. degree from Massachusetts Institute of Technology in 1937; his B.S. degree in 1924 and Ph.D. in 1932 having been received from University of California at Berkeley. As vice-president of Consolidated Engineering Corporation since 1937, Dr. Washburn has in the past few years devoted his entire efforts to the development of the mass spectrometer and its associated techniques for use on industrial analytical problems.

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ERNEST C. WATSON

Professor Watson received his Ph.B. degree from Lafayette College, Easton, Pa., in 1914, and was associated with the University of Chicago in the physics department prior to coming to the California Institute of Technology in 1919. Professor Watson is now professor of physics at the Institute.

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Caption for Cover Illustration: Land-marking many modern soap plant sites are the huge spray-drying towers where granulated soaps are made. (See article, Soap in Peace and War, pages 4-8).

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ENGINEERING AND SCIENCE
Monthly

The Truth Shall Make You Free

CONTENTS FOR OCTOBER, 1945

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The Month in Focus

ENGINEERING EDUCATION

THE September issue of the "Journal of Engineering Education" carried a report on "The Future of Mechanical Engineering Education" by Colin Carmichael. While the article is directed to mechanical engineering, it also has a basic application to the whole field of engineering education. This report is particularly timely, since much thought is being given to modifications and possible improvements in the methods of preparing men for the engineering professions. Most engineering colleges were thrown into a changed curriculum by the army and navy training programs. As these programs terminate, each college is faced with a reconversion problem. As long as there is to be reconversion the question in many cases takes the form: What shall the new curriculum be? Shall it remain as it was before the war? This reconversion period may provide an excellent opportunity to clean house and to make a fresh start.

Continuation of accelerated year-round operation has received unanimous opposition. The continued close application of the student in the classroom leads to a tired, restive attitude by both students and faculty, and further, a "soaking period" is not provided. The accelerated program has served its purpose of speeding up training to provide the armed services with trained technical personnel; it should be considered only as a war necessity and now eliminated.

Emphasis on Fundamentals

The report presented by Colin Carmichael is based on the cooperative effort of 12 industrial representatives and 15 academic representatives. The report directs some criticism to a tendency toward overspecialization and indicates the desirability of doing a better job of preparing men in fundamentals by which they may be in a better position to grasp the details of technical procedures upon entering industrial employment. This attitude is in line with that expressed in the Month in Focus in the February, 1945, issue of "Engineering and Science": ". . . the colleges train individuals in fundamentals which serve as the foundation upon which industry must build the training of its employees in the specific skills."

The report states, ". . . it has been suggested that engineering courses should be arranged for two groups of engineers:

"1. Men who will be department foremen, supervisors, directors, sales engineers, etc.

"2. Men who will be designers, consulting engineers, technical experts, researchers, etc."

In recalling undergraduate days, how many engineers could state with any degree of assurance in which group they should have been placed? Probably the majority were not in a position to be as specific in their choice of field as such a grouping would require. Adequate guidance might improve the accuracy of making a selection, in the early stages of engineering training. However, most men cannot be sure until they "get their feet wet" in some important phase of each group. Such a grouping may well be classified still as too much specialization.

Coordination

What is probably needed more than anything else is a marked improvement in coordination of courses and less "pigeonholing." For example, as pointed out in the report, "Physics courses need adjustment to serve more adequately as prerequisites for later courses in mechanics, electricity, engineering materials, etc." In this attempt at better coordination there has been talk of reducing all engineering to four subjects—structures, materials, processes, and circuits—and supplementing these with humanities. As an ideal this may be excellent, but how shall the details be worked out? Undoubtedly even on this basis there will be some tendency toward isolation of certain course material. The success of coordination is entirely dependent upon the coordinating ability of the faculty.

Shop Training

A shift of emphasis can be made toward fundamentals by the elimination of some courses whose purpose it is

(Continued on Page 14)

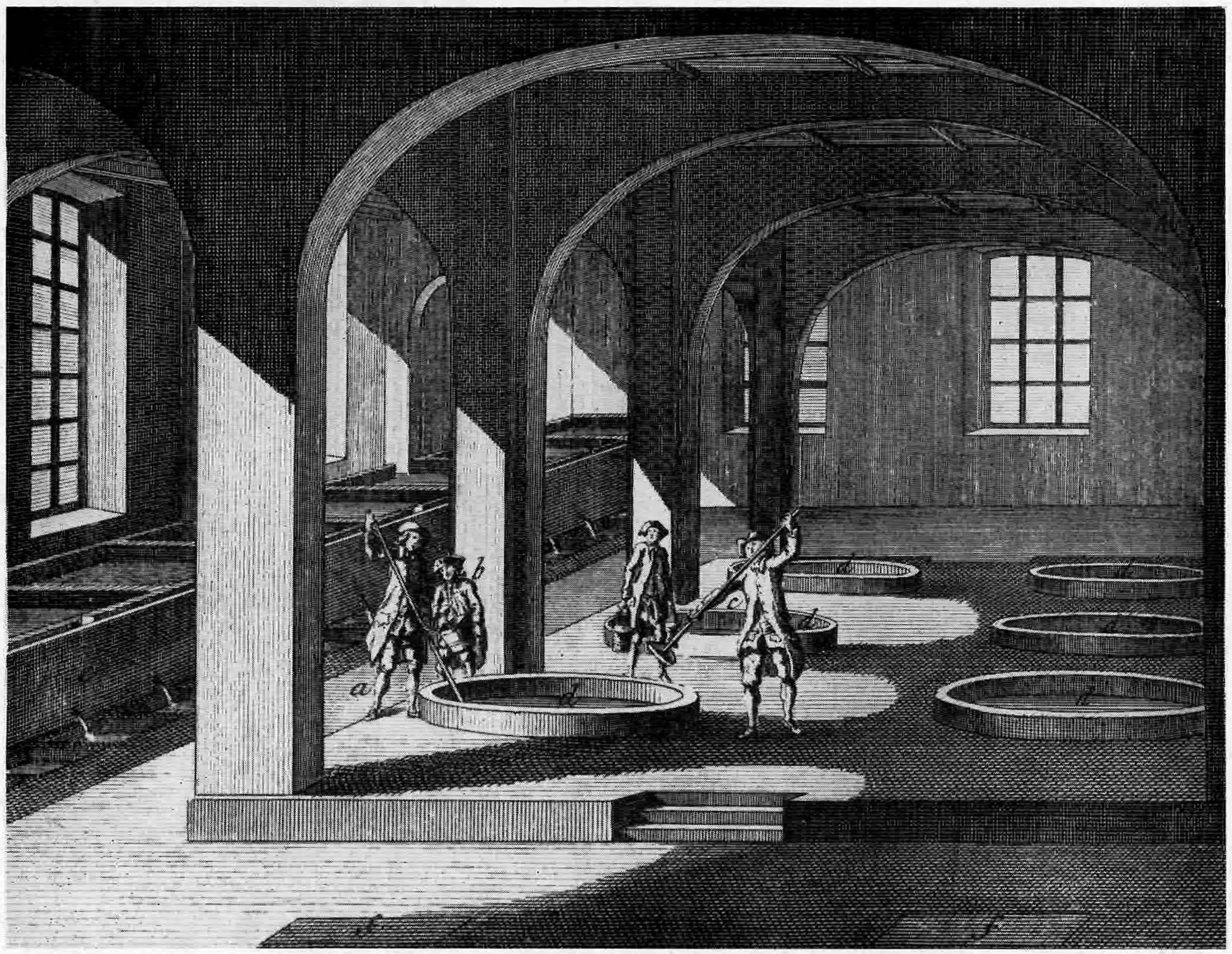


FIG. 1. "Kettle house" of a French soap factory in about 1750. The kettle soap was boiled by open fires underneath these kettles, and the adding of fats and base materials was a "bucket-brigade" operation.

Soap in Peace and War

BY J. G. PLEASANTS

NOWADAYS soap is perhaps the commonest of all household supplies. It is among the cheapest and yet the most necessary. Few things in our daily lives are more familiar than that handy bar of soap on the washstand or the package of granulated soap on the kitchen sink. Most of us accept this everyday article in much the same matter-of-fact way that we accept the very water we use with it. But there are some interesting facts behind that bar of soap and the millions of others like it.

The story of soap's beginnings takes us very far back. It begins with the days of ancient Rome, on Sapo, a sacrificial hill outside the city. Sapo was the poor man's altar ground, where he could make his burnt offerings to the gods. Unlike the well-swept altars in the great Roman Forum, Sapo's crude altars accumulated fat and wood ashes, which, over the years, collected and mixed with the soil and were washed by the rains down to the banks of the river Tiber. Thereupon the river-bank clay was found to have amazing properties—it would loosen the dirt from the clothes scrubbed at the river-bank laundry. So, according to the storytellers, this Sapo clay was the first soap. And by the same token the word, *Sapo*, has become the root of the word for soap in most modern languages—*sapone, savon, jabon*—and likewise forms the base of our word for soapmaking, saponification.

SOAP BECOMES AN INDUSTRY

True or not, the story of Sapo hill gives us a pretty good idea of how thoroughly crude the first soap was. And it was many centuries before anything approaching the substance we call soap was available for general use. The art of soapmaking revived in Italy, Germany, and France during the 13th century; and in 14th-century England there was developed almost a flourishing soap industry. Sometime around 1800 the French discovery that sodium hydroxide could be made from common salt gave the home manufacture of soap a real spurt. It was an improved product, but was nonetheless a harsh, jelly-like stuff that contributed little pleasure to the process of cleansing.

There have been some vast improvements in the ancient business of soapmaking. Today's industrial plants employ complex machines, chemical process equipment, and skilled operators to produce the seemingly simple, commonplace cake of soap. The basic materials, however, except for their quality, have not changed fundamentally since Sapo hill. Soap still comes from the reaction of a fat or an oil with a base. In the modern soap factory this reaction is carried out on a tremendous scale.

THE SOAP INDUSTRY MODERNIZES

Measured against the standards set by industries producing "20th century" developments, such as the automobile, the airplane, radio, etc., the soap industry does not appear to have modernized itself very rapidly. Much of the soap made today is still produced in about the same way that it has been for at least 100 years. Steam may have replaced open fires for heating, and power drives may have replaced manpower, but batch methods are still used to a large extent, much as they were in the last century.

Almost everyone is familiar with the term "soap kettle," and the kettle house was and is the heart of the soap factory. It is the point at which the saponification of fats with sodium hydroxide creates soap and glycerine simultaneously. The kettle house of a sizeable soap factory may contain from 20 to 100 kettles, three stories high, each holding four or five tank cars of material.

The boiling of soap in a kettle is a batch operation. On the average, a week will elapse from the time the kettle is "stocked" until the finished soap is ready to deliver. During this time the kettle goes through a fairly complicated boiling cycle, which usually involves the saponification, several "washes" to remove the glycerine from the soap, another sort of "wash" to remove the excess "strength" (sodium hydroxide) from the soap, and two or three "pitches" to bring the soap into the proper condition for delivery. Each of the boiling operations mentioned is followed by a settling period, and the final "pitch," which is generally called the "finish," is followed by an extended settling period of from one to three, four, or five days, depending on the type of soap. Thus boiling kettle soap is an operation which inherently ties up large quantities of material and a considerable amount of equipment for relatively long periods of time.

When the finished kettle soap is delivered from the kettle house, a great deal of it is further processed by batch methods. Before framing, spray drying, or rolling, for bar soap, granules, or flakes, respectively, the kettle soap is mixed with the proper amounts of builder and perfumes, and this is still done to a large extent in mixers with power-driven agitators. These mixers are called "crutchers" and this term is a hold-over from the days when a man did the mixing or stirring by hand with a stirring pole which looked something like a crutch.

In recent years, however, the old batch methods have been giving way to continuous processing. For example, there are a number of soap factories in this country in which the "kettle soap" is not made in kettles at all, but comes from a continuous soap-making unit, which con-

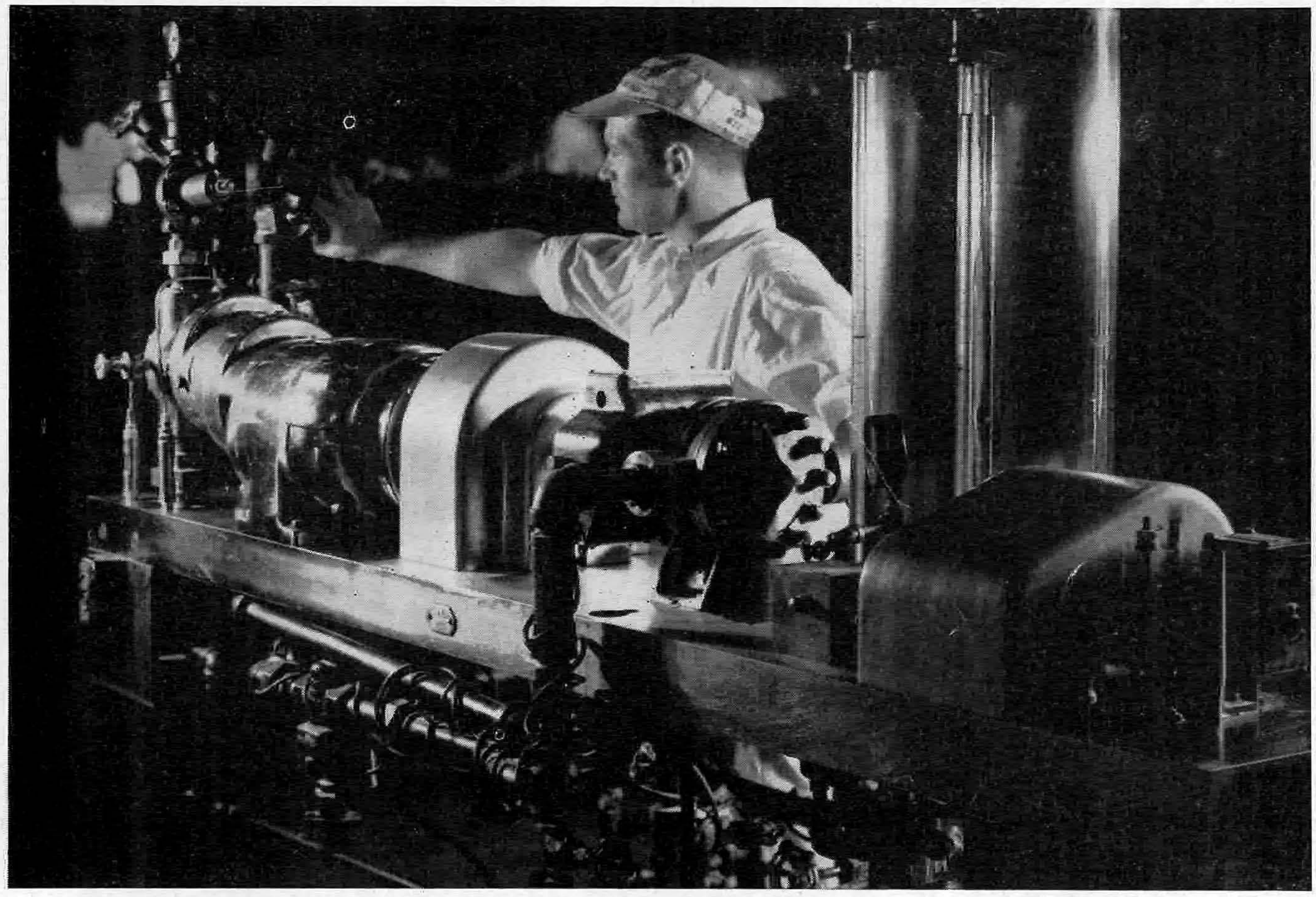
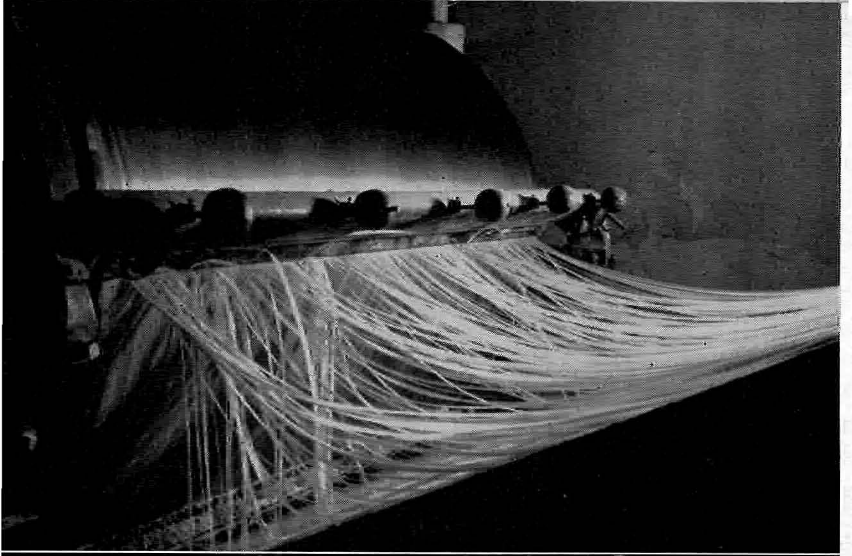


FIG. 2. Automatic machinery and continuous processing equipment are steadily replacing the batch methods of production which have been characteristic of the soap industry for centuries.



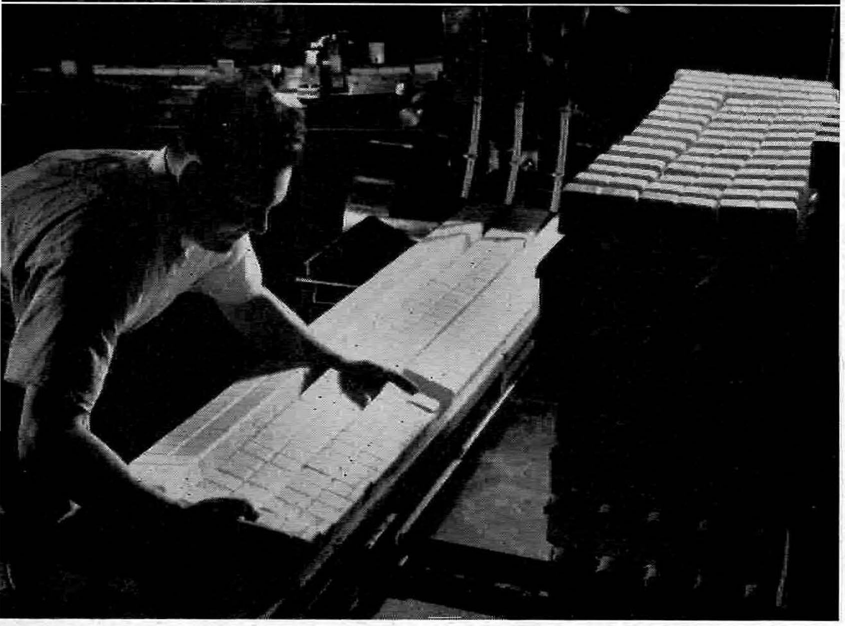


FIG. 3. Soap products are tailored for many specialized uses. Here paper-thin ribbons of soap are feeding off a huge roll into a drying oven on their way to becoming flakes. FIG. 4. Here three conveyor belts are feeding bars to a high-speed stamping machine. A watchful eye for quality is part of the stamp-feeder's job.

sists of an autoclave, in which fat is hydrolyzed into fatty acid and glycerine continuously, and of a continuous saponifying unit, which mixes sodium hydroxide or potassium hydroxide with the fatty acid from the autoclave in just the right proportion to give finished kettle soap. These units operate at high temperatures and pressures and must be made of non-corrosive metal, but one of them will take the place of several of the old soap kettles. One of these continuous units will be delivering finished kettle soap within an hour from the time the fat is started into it, in contrast with the week required for a soap kettle. The advantages of the continuous equipment are better control of product quality, less physical space required, and less material tied up in process.

In addition to the continuous soap-making equipment, the industry is introducing continuous crutching equipment, by means of which the proper amounts of perfume and builder are proportioned into the kettle soap continuously, rather than batchwise.

As in the field of equipment, so also in the type of product offered, the soap industry has only recently shown any very revolutionary progress. It is true that we have bar soaps, both laundry and toilet; flakes, and granules; cold process soaps, pumice soaps, and liquid soaps, castile soaps and medicated soaps; but they have all been nothing but vegetable or animal fats saponified with sodium or potassium hydroxide and mixed with greater or lesser amounts of water softeners, perfumes, glycerine, abrasives, etc. The active wetting and cleansing agent has been the sodium or potassium (in a few cases ammonium) salt of a fatty acid.

Relatively recently, however, some other organic compounds have been found which exhibit wetting and detergent properties. These products are obtained variously by the sulfation of high molecular weight fatty alcohols; the sulfation of monoglycerides; the sulfonation of alkylated benzenes, naphthalenes, and paraffines, and in other ways. Those mentioned are the most common, though there are many more.

These products are known generally as synthetic detergents and have in many cases qualities which make them better than conventional soap products. For instance, some of them make suds equally well in hot or cold or hard or soft water. Most of them do not react with calcium and magnesium salts in hard water, and therefore possess the happy property of not "leaving a ring around the bath tub."

Because of their free-sudsing and complete-rinsing characteristics, synthetic detergents have found a popular outlet in shampoos, and in granules for fine fabrics and for other "quality" washing jobs. It is reported, incidentally, that one of these products has been used very successfully at the Mt. Wilson Observatory for washing the telescope mirrors.

A SOAP FOR EVERY PURPOSE

Almost every industry speaks with pride of the "design" of its products. It may sound surprising to say that each soap product is especially designed for the job it is to do, but that is actually the case. Soaps are tailor-made to handle everything from the delicate jobs of washing infants and fine fabrics to the heavy duty tasks of textile mills and commercial laundries.

Many things are considered in soap "design." The type of washing to be done, the hardness of water in the region, the temperature of the water likely to be used, along with other factors, are all considered in settling on a fat formula, builder content, and the physical form of the soap product.

With respect to physical form, almost everyone can recall the time when bar soap was all there was. People would slice this bar soap into their wash in order to get quicker solution. The soap companies took a hint from this practice and started to do the job for the customer. The original crude rotary knives used to manufacture soap chips have been replaced by modern equipment capable of making endless ribbons of soap less than 0.0005 inches thick. An even greater step in the direction of quick dissolving was made with the development of spray-dried soap granules.

During the past couple of decades, much attention has been given to developing and producing these specialized soap products for many specialized applications. The paper-thin soap flakes and efficient granules tackle their respective household tasks. Industrial soaps are used for cleansing, emulsifying, and lubricating. Pumice soap is the answer for millions of greasy and grimy hands turning out today's tools of war. The scented toilet soaps are made for the luxury bath.

Soap's widest use, of course, is to clean anything that's cleanable. This use alone has taken it far afield from the household washbowls and dishpans. More and more, soap becomes a universal handyman, serving civilization in more ways than civilized mankind generally realizes.

At the outset of World War II many of these varied uses for soap came into sharper focus as their essential value in the war effort became apparent.

THE BIGGEST LAUNDRY PROBLEM IN HISTORY

Wartime or peacetime, the commercial laundry does an important job in maintaining American cleanliness at the world's highest level. But with wartime the job has become more acute because millions of women who stepped from the kitchen into war plants are now saying "send it to the laundry." Added to this demand is a tremendous volume of laundry for the Armed Forces stationed all over the country.

New and knotty washing problems have been occasioned by these conditions. Special soaps and washing formulas have been required of the soap industry. Detergents that cut the grease and grime from millions of work clothes, soaps that protect the synthetic fabrics of wartime—these and many more needs draw on soap's ability to be versatile enough for every need.

But all the laundry isn't on the homefront. From the big Navy laundries on board battleships to the G.I.'s helmet washtub at the front line foxhole, America's fighters are trying hard to maintain their cleanliness standards. But washing conditions are tricky and just any soap won't do—especially in salt water.

Before Pearl Harbor a satisfactory soap for Army-Navy use was being produced from coconut oil. When the South Sea supply of this material was cut off, it meant finding a new formula which would give the Armed Forces a soap that would lather and wash in hard water, cold water, and even salt water. A synthetic detergent stepped into this problem and provided the answer. It is completely indifferent to hard water conditions, and lathers promptly in seawater. It does not react to form insoluble calcium or magnesium soaps; so it rinses thoroughly in hot, cold, or salt water. Thus a combination of soap and synthetic detergent produced an all-purpose salt-water bar soap that meets all washing conditions, from the Aleutians to the tropical jungle.

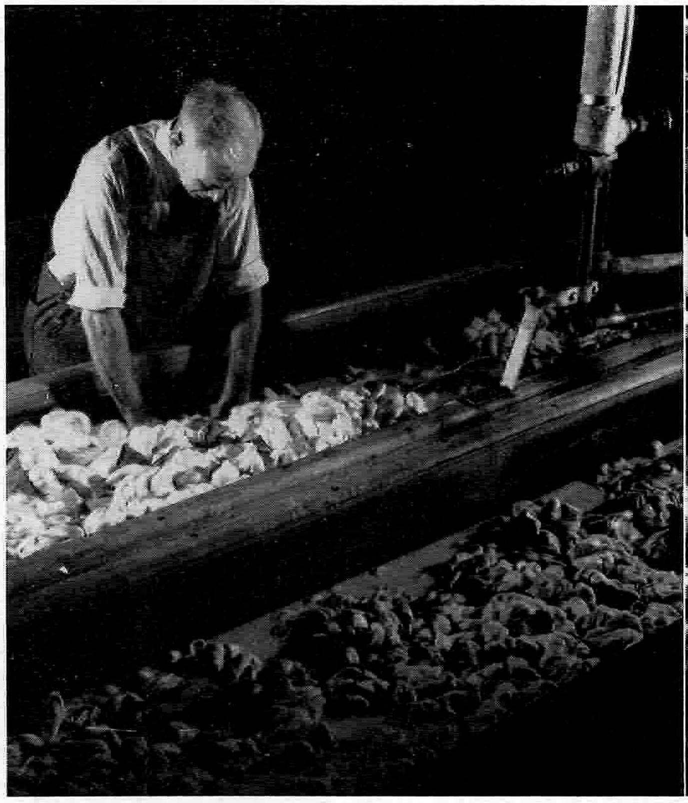
HOMEFRONT HEALTH

National health is always one of soap's busiest jobs, whether during war or peace. Millions of bars of soap go into American homes, factories, hospitals, and institutions each week. Cleanliness is a "must" for health, and America's soap consumption of almost 25 pounds per capita far outstrips the washing habits of any other nation, even by pre-war standards.

There are soap uses for health, however, which have nothing to do with the washing of millions of human beings. One, for example, is the use of special soaps and synthetic detergents for washing fruits and vegetables before they go to market. The delivery of food to America's dinner tables and mess kits means getting it there in a pure, wholesome condition. For certain types of fruits and vegetables, a good soap and water bath is an absolute necessity to insure their reaching the final destination in good condition. Washing helps to reduce spoilage and it removes any dirt, insect spray, or other foreign matter. In the meat-packing industry, too, soap-and-water gets liberal use during the process.

SOAP IN THE TEXTILE INDUSTRY

The textile industry undertook the big job of clothing the fighting forces and supplying blankets, cots, tents, truck coverings, surgical dressings, camouflage fabrics, and rayon and nylon for uses ranging from tire cordage



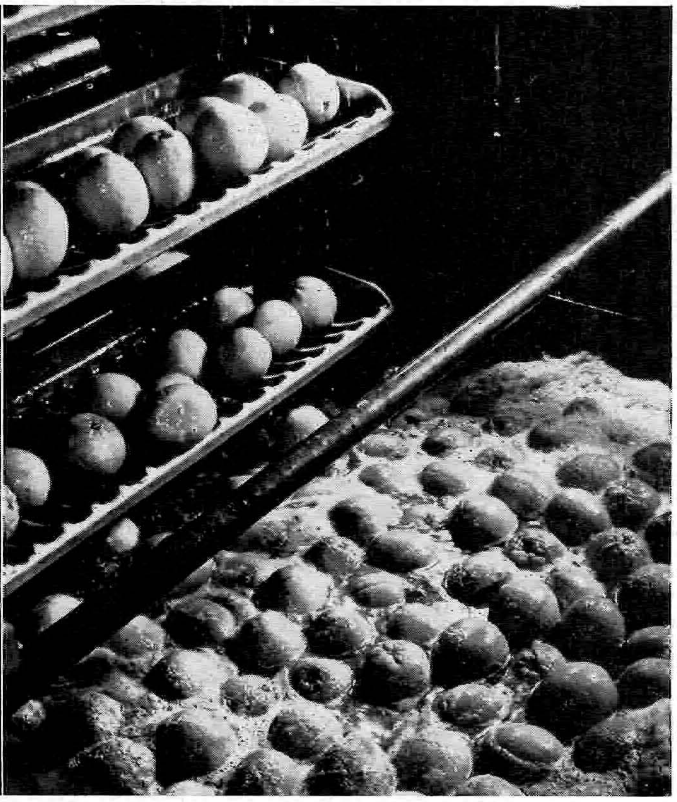


FIG. 5. AT LEFT: Soap has a role in many industrial processes. Here raw silk for parachutes and shroud lines gets a "soaking" bath as an important step in its processing. FIG. 6. AT RIGHT: First step at the packing house in preparing oranges for market is the soap-and-water bath. On the left, a carrier removes oranges from the suds and takes them up to be rinsed with warm and cold showers, then dried by brushes and warm air currents.

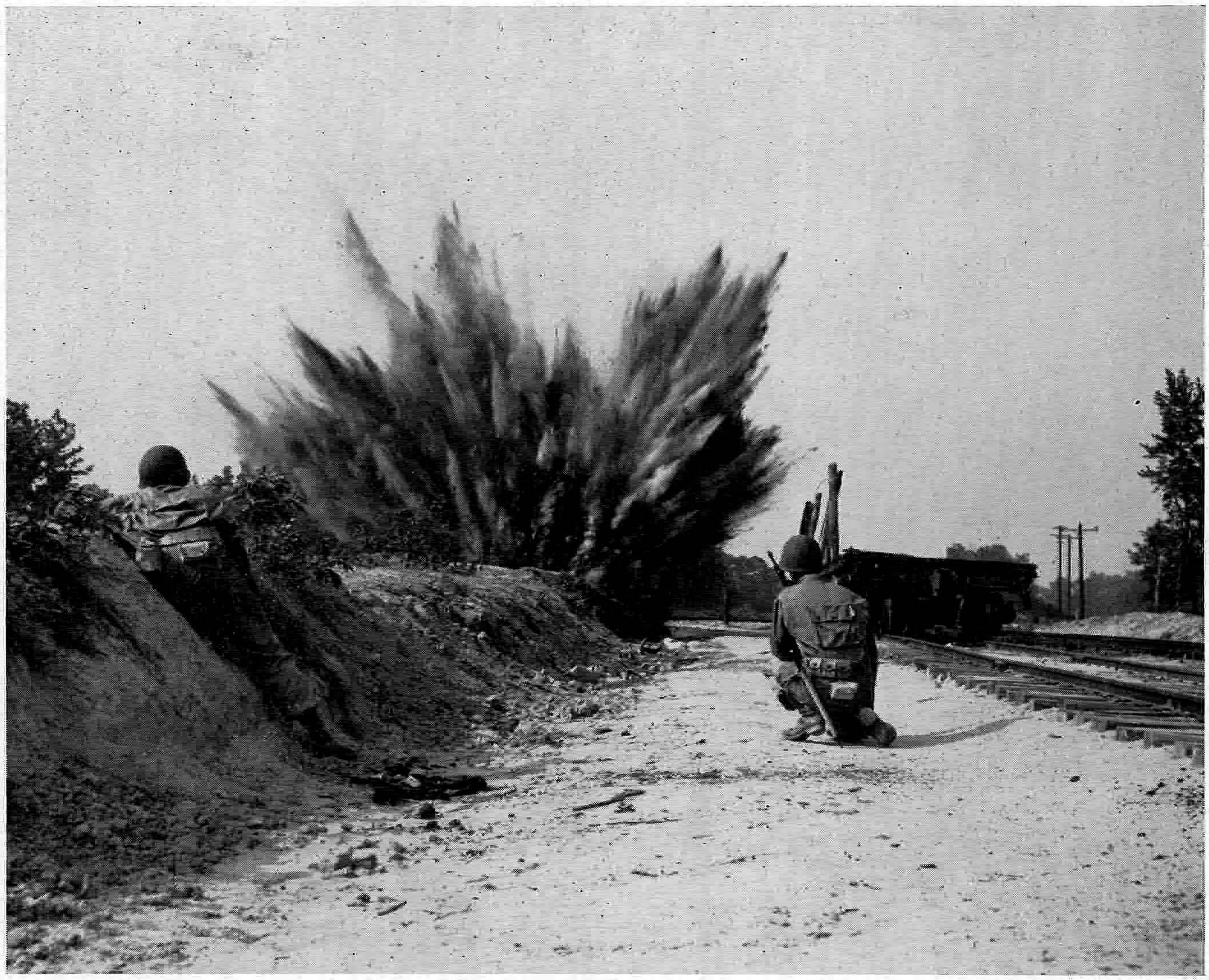


FIG. 7. Glycerine's many uses range from medicines to explosives. Demolition dynamite depends on glycerine; so does the smokeless powder which propels big shells.

to parachutes. In producing all of these things, soap is needed in quantity. Soap scours the raw wool, and a series of baths follows all the way from the carding operations to the finished fabric "fulling" which sizes the cloth with the help of special soap solutions. Cotton, silk, and nylon likewise undergo numerous washing operations on the way to becoming cloth for either war or peacetime needs.

Of course in actual service, all these textiles again meet soap. Cleanliness of clothing is a "must" for civilian and military health. And many fabrics stand longer wear because of periodic washings.

SOAP FOR LEATHER

Soap has a leading role in the leather industry, too. The first step in preparing hides for tanning is the cleansing and soaking. Wetting agents and soap compounds are especially designed for this job so that the hide can be put in a soft flexible condition for removal of hair and tanning.

After the tanning process, it is necessary to lubricate the leather by a "fat-liquor" process. Here special soaps play an important part in giving leather the mellow and pliant qualities so important in good shoes and other leather goods.

Saddle soaps and other lubricating soap solutions are on regular call to keep a wide variety of leather goods, from holsters to factory belting, on the war service list. Periodic washings keep the leather pliant and clean, ready for continued hard wear.

SOAPS FOR COOLANTS AND LUBRICANTS

Soaps and soap solutions have numerous applications as special lubricants and coolants in the metal trades. Modern wire-drawing machines turning out several thousand feet of wire per minute require efficient lubricants at the dies. Soap clings thoroughly and uniformly to the wire surface and can be cleaned off easily after the drawing operation; so it has top-rating for this work.

As hundreds of thousands of automatic machines cut and shape the tools of war, soap solutions are used plentifully in the coolant liquids which lubricate and prevent overheating of the metal being cut or drilled.

Numerous rolling mill operations, notably aluminum, require soap solutions to lubricate exacting jobs. Likewise metal stamping calls for lubricants which wet and cling to the metal surfaces. Soap qualified particularly well to ease the heavy friction of draw-press dies which stamped out, for instance, the millions of cartridge cases needed for victory.

(Continued on Page 14)

THE MASS SPECTROMETER

By HAROLD W. WASHBURN

THE advent of World War II imposed many problems on the petroleum and chemical industries which required more rapid and accurate analyses on their raw, intermediate and final products. The methods used at the beginning of the war were too slow, required too much man power and did not give sufficient information. The contribution of the newer physical instruments in solving these problems is now a matter of record. One of the major problems which had to be successfully solved was the transformation of instruments of the research laboratory type into practical routine instruments which could be operated by the personnel available and under the conditions existing in the industrial routine analytical laboratory.

The newest of the new physical analytical instruments applied to the industry is the mass spectrometer. It is the purpose of this article to describe briefly what the mass spectrometer is and how it works, and to point out the fields in which it has been advantageously employed.

HISTORY

The mass spectrometer was originally designed for accurate determinations of the relative abundance of isotopes. It thus served as a companion instrument to the

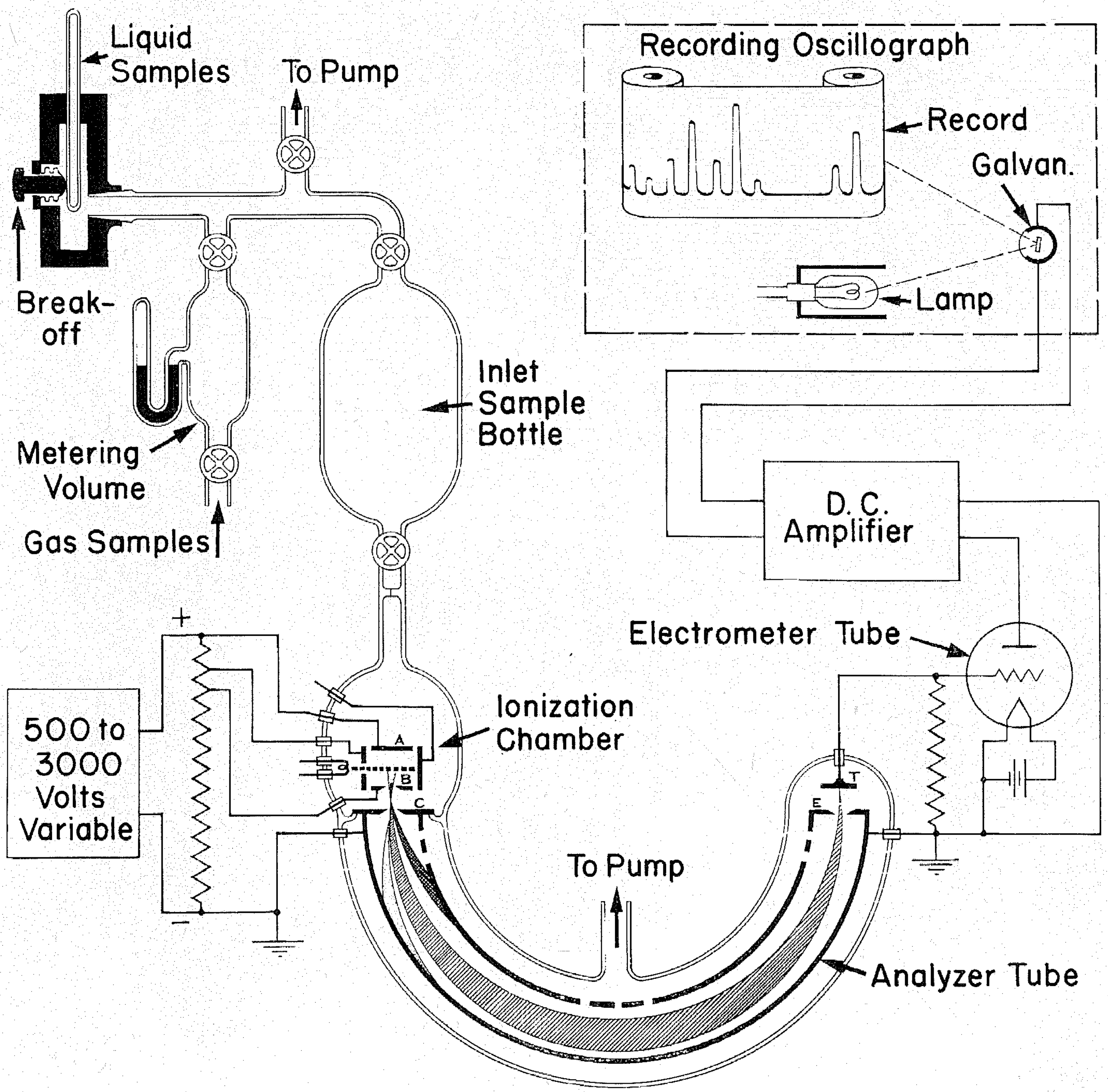


FIG. 1. Diagrammatical sketch of a mass spectrometer and associated apparatus as used for the analysis of gas and liquid mixtures.

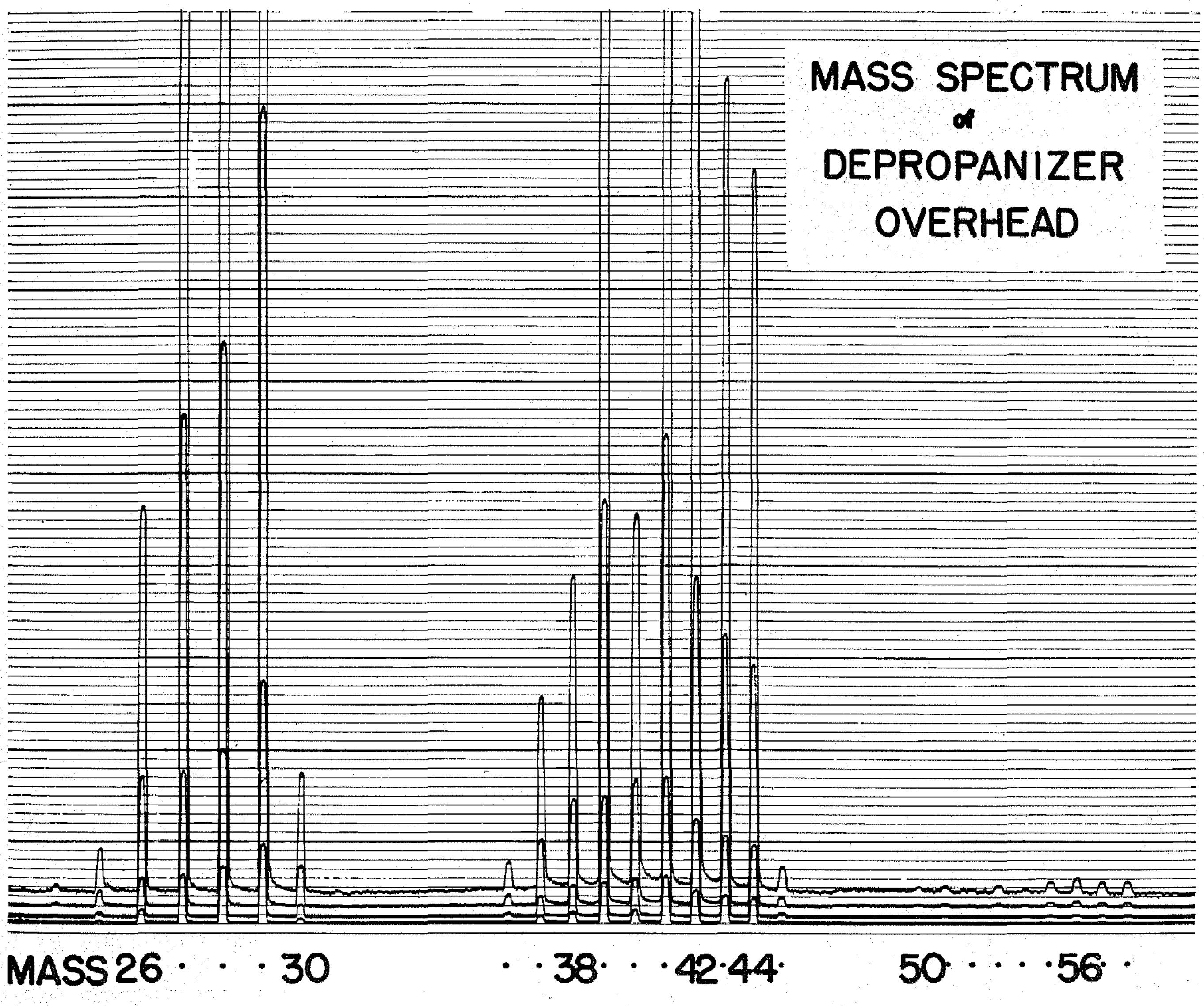


FIG. 2. Automatic record of depropanizer overhead mass spectrum, in which four galvanometers record peaks simultaneously at four sensitivity levels to insure accurate measurement over a large range of magnitudes. This record of a depropanizer overhead shows a 58 peak of 0.9 divisions, which means that the concentration of the key component, iso-butane, is 2.3 per cent.

mass spectrograph, a similar instrument but designed for accurate determination of isotopic mass rather than relative abundance. The data on isotopic mass and relative abundance obtained by these two instruments have been used for some of the most accurate atomic weight determinations available today.

The mass spectrometer is the much simpler instrument of the two, a fact which is partly responsible for its varied use today as an analytical tool. In the 1930's some members of the California Institute of Technology faculty foresaw the possibilities of the mass spectrometer and initiated the development of an instrument for use as a general analytical tool.

In the late 1930's, Dr. Robert A. Millikan, upon learning that Consolidated Engineering Corporation had decided to begin the development of a mass spectrometer which would be capable of analyzing complicated hydrocarbon mixtures, suggested that the California Institute instrument be loaned to Consolidated for preliminary experiments. After four years of intensive research by Consolidated which included the development and the building of two mass spectrometers, an instrument was produced for use in industrial laboratories. Today this instrument is used widely in the petroleum and chemical industries both as a routine control instrument and as a development laboratory analytical tool.

WHAT THE MASS SPECTROMETER DOES

The mass spectrometer is an electronic instrument which obtains data which are called mass spectra. The mass spectrum of a substance may be defined as the relative abundance of ions formed at different masses (molecular weights) by some sort of ionization process. In the type of instrument to be described in this article the ionization process is accomplished by bombarding with electrons the vapor of the substance for which a mass spectrum is to be obtained. The ions thus formed are segregated into a fan of beams by electric and magnetic fields. Each beam in the fan is composed of ions of one mass (molecular weight) only. The relative number of ions in each beam is automatically recorded by sweeping the beams past a target which has connected to it an amplifier and recording oscillograph. These processes are represented schematically in *Fig. 1.* In this diagram, for simplicity, there are shown only three ion beams emerging as a fan from the ionization chamber. In practice these may be from 50 to 100. An automatically recorded mass spectrum of a refinery absorption plant de-propanizer overhead is shown in *Fig. 2.*

The mass spectra obtained in this manner are functions of the types of molecules in the vapors introduced into the instrument. This correlation between the mass spectra and the substances introduced permits the attainment of information from the mass spectra which may be used for obtaining either theoretical information on the properties of the molecules or practical information such as the concentration of each kind of substance present in a mixture.

APPLICATIONS TO INDUSTRIAL PROBLEMS

For purposes of discussion the applications will be divided into three categories:

1. Accurate quantitative analysis of gas or liquid mixtures containing as many as 10 to 20 components. (These analyses can be performed on extremely small samples. For example, if desirable, analyses can be made on samples as small as .001 to .01 cc. of vapor at standard pressure and temperature.)
2. Determination of kinetics and mechanism of chemical reactions.
3. Determination of the chemical processes which occur in metabolism processes.

ANALYSIS OF GAS AND LIQUID MIXTURES[4]

The mass spectrometer method employed for mixture analysis may be called the superposition method. In this method of analysis the energy of the bombarding electrons is made sufficiently high so that a large percentage of the molecules which undergo ionization are in addition broken into fragments. Therefore, if a pure substance is introduced into the mass spectrometer ionization chamber, ions of several different masses will be formed, and it is found that the relative abundance of the ions at these different masses is a function of the structure of the molecules of which the substance is composed. The mass spectrum of a substance may therefore be considered as a fingerprint from which that substance can be recognized.

The commercial mass spectrometer has been developed so that the mixture mass spectrum is a linear superposition of the mass spectra of the components in the mixture. The analysis consists of the unraveling of the composite mixture spectrum into the spectra of the mixture components. The attainment of linear superposition greatly simplifies the determinations of the composition of the mixture from its mass spectrum.

[4]A more complete discussion of this subject by the author may be found in *Industrial and Engineering Chemistry,* Analytical Edition, *17,* p. 74, (February 15, 1945).

Since no exhaustive tests have been made on the types of mixtures which can be successfully analyzed by this method, it is impossible at this time to give a comprehensive outline of the types of mixtures to which this method is adaptable. However, it is possible to state the types of mixtures to which this method has been successfully applied.

One of the major analytical problems in the chemical industry is the analysis for small impurities in intermediate products. The mass spectrometer is particularly well adapted to this type of problem. For example, it is possible to detect as small a quantity as 0.003 per cent diethylbenzene in ethylbenzene, an analysis which is of importance to the synthetic rubber industry. No other analytical method has been successful in performing this analysis.

The mass spectrometer method of analysis, at present, is conceded to be the most satisfactory method for analyzing light hydrocarbon mixtures; for example, mixtures containing hydrogen, carbon monoxide, nitrogen and paraffinic and olefinic hydrocarbons containing one to five carbon atoms can be analyzed without any preliminary fractionation. Mixtures of this type are encountered in many places in the petroleum refinery. One of the output streams from a catalytic cracking unit, for example, contains 15 or more components in this range.

The analysis time for this type of mixture with the mass spectrometer is 30 minutes, instrument time, and one and one-half hours, computing time. This computing time may be reduced to 30 minutes if an electronic computer is available. The complete analysis of this mixture by methods used prior to the advent of the mass spectrometer required about eight hours. The time has, therefore, been reduced to one-eighth the previous time. This increased speed in analysis has permitted refinery operators to maintain closer control of their operation. Hence, there is an improvement both in efficiency and in the quality of the product.

A third type of problem to which the mass spectrometer is just beginning to be applied is the analysis of a mixture containing as many as six isomeric octanes. This permits the analysis of fractionated cuts of alkylates. To date such analyses have been used mainly in

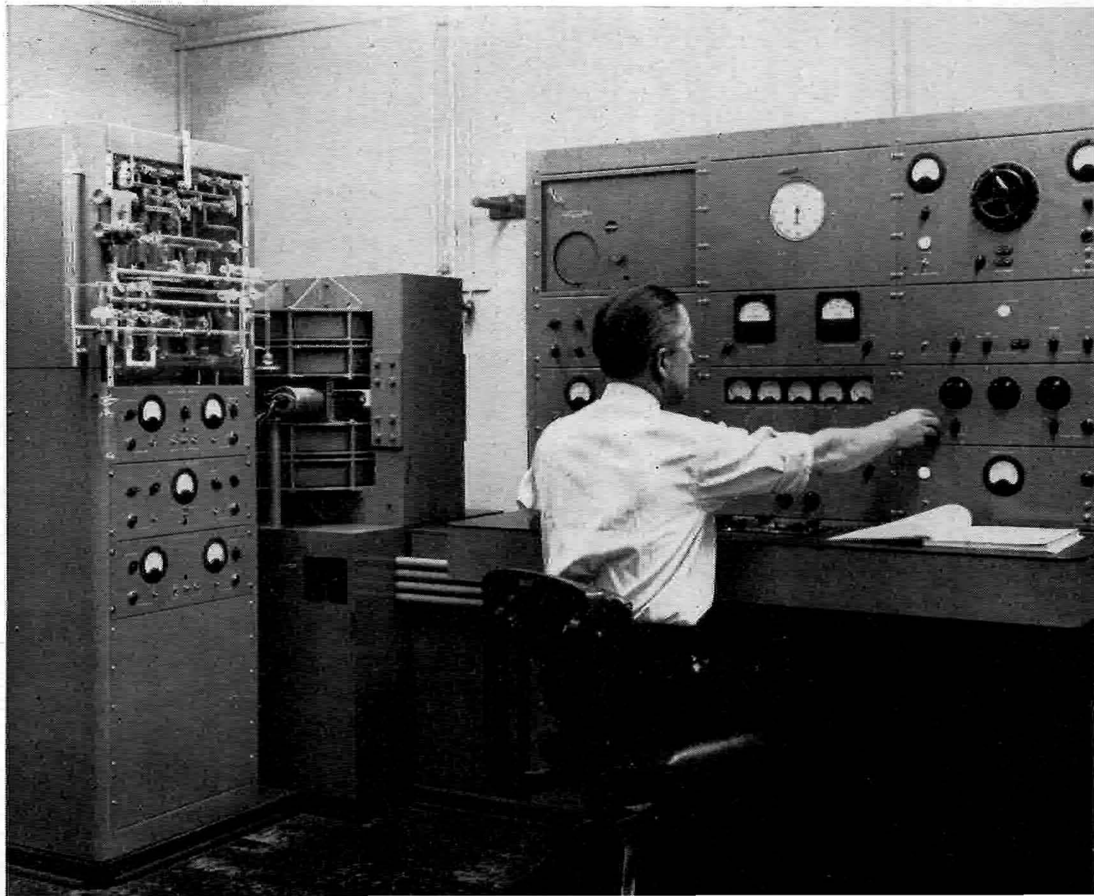


FIG. 3:

Typical mass spectrometer installation in operation.

$$CO_2 + H_2O + h\nu \xrightarrow{\text{chlorophyll}} O_2 + \left(\frac{1}{n}\right) (C.H_2O)n$$

Expt.	Substrate	Time between dissolving $KHCO_3$ + K_2CO_3 & start of O_2 collection (min.)	Time at end of collection (min.)	H_2O	% O^{18} in HCO_3^- $CO_3^=$	O_2
1	0.09M	0		.85	.20	
	$KHCO_3$+	45	110	.85	.41	.84
	0.09M	110	225	.85	.55	.85
	K_2CO_3	225	350	.85	.61	.86
2	0.14M	0		.20		
	$KHCO_3$+	40	110	.20	.50	.20
	0.06M K_2CO_3	110	185	.20	.40	.20
3	0.06M	0		.20	.68	
	$KHCO_3$	10	50	.20		.21
	0.14M K_2CO_3	50	165	.20	.57	.20

FIG. 4. Study of photosynthesis by isotope tracer techniques.

the development laboratory in improving refinery processes. They may, however, prove to be important in control operation in the future, since the alkylate is one of the end products of aviation gasoline manufacture.

Preliminary experiments indicate that the mass spectrometer may be used to analyze mixtures containing oxygenated compounds and chlorinated compounds. Analysis of mixtures containing these compounds is of considerable interest to the chemical industry as well as the petroleum industry, since many intermediate products contain these substances.

In addition to the advantages of speed and additional information which it provides, the mass spectrometer method is unique in permitting the analysis of extremely small samples. Samples of gas as small as one-thousandth of a cubic centimeter can be analyzed. An important application requiring this feature is the analysis of gases in thermionic vacuum tubes.

KINETICS AND MECHANISM OF REACTION

An application of the mass spectrometer to pure research is illustrated by its employment in studies of kinetics and mechanism of reaction. Its application to this field has followed two different attacks: (a) Small samples are withdrawn from the reaction chamber during the reaction and analyzed. (b) Heavy isotope tracer techniques are employed.

The fact that the mass spectrometer is capable of analyzing such extremely small samples makes possible the withdrawal and analysis of samples from a reaction chamber while the reaction is taking place, and thus determining the composition of the mixtures in the chamber without in any way disturbing the reaction. The employment of automatic recording permits the necessary data to be recorded within from two to 10 minutes, depending on the particular analysis which is to be made. Therefore, the sampling procedure may be either intermittent, drawing samples at intervals of two to 10 minutes, or continuous, using a constant flow method with a flow of 10 microliters every two or 10 minutes.

An example of a kinetic study made by this method is given in a publication by Leifer and Urey[1]. In these experiments the authors ran a continuous analysis of the gases withdrawn from the reaction vessel during the thermal decomposition of dimethylether and acetaldehyde.

An advantage of this method of studying the kinetics is its ability to detect and quantitatively determine stable intermediate substances that are formed during the reaction. The publication of Leifer and Urey illustrates this advantage in their quantitative determination of the formation of formaldehyde as a stable intermediate in the thermal decomposition of dimethylether.

The determination of the mechanism of reaction by heavy isotope tracer techniques has been widely used by biochemists. A simple example which illustrates the method is given in an article by Rubin[2]. This article describes simple experiments for determining whether the oxygen liberated by photosynthesis comes from the carbonate ion or from the water. The information in this article may be briefly summarized as follows: The reaction which takes place in photosynthesis can be represented by the equation shown at the top of *Fig. 4.* This equation in no way indicates whether the liberated oxygen comes from the CO_2 or from the H_2O.

Two experiments were performed to determine from which of these two substances the oxygen is liberated. In the first experiment young chlorella cells were suspended in heavy oxygen water containing ordinary potassium bicarbonate. In the second experiment algae

[1]Leifer, E. and Urey, H. C., *J. Am. Chem. Soc., 64,* pp. 994-1001 (1942).
[2]Rubin, S. and Randall, M. F., *J. Am. Chem. Soc., 63,* p. 877 (1941).

(Continued on Page 16)

REPRODUCTIONS OF PRINTS, DRAWINGS AND PAINTINGS OF INTEREST IN THE HISTORY OF SCIENCE AND ENGINEERING

5. The Earliest Print Showing a Steam Locomotive and Train

By E. C. WATSON

THE original of this reproduction is a colored aquatint, eight inches by 12 inches in size, which was first published in 1813 and so is the earliest print of a steam locomotive and train that we have; moreover, the locomotive and train shown was the first to be commercially successful. It appeared in George Walker's *The Costume of Yorkshire* and was designed to show, not the steam train, but what the well-dressed miner of Leeds was wearing. It formed Plate III of a series of costume plates and was entitled "The Collier." The description that accompanied it reads as follows:

> "One of these workmen is here represented as returning from his labours in his usual costume. This dress, which is of white cloth bound with red, may probably be ridiculed as quite inconsistent with his sable occupation; but when the necessity of frequent washing is considered, surely none could have been adopted more conducive to cleanliness and health. The West Riding of Yorkshire, it is well known, abounds in coal, the consumption of which is prodigiously increased by the general use of steam engines. In the back ground of the annexed Plate is a delineation of the steam engine lately invented by Mr. Blenkinsop, agent at the colliery of Charles Brandling, esquire, near Leeds, which conveys about twenty waggons loaded with coals from the pits to Leeds. By two of these machines constantly employed the labour of at least fourteen horses is saved."

The high-pressure steam locomotives designed and built by Richard Trevithick (see Reproduction No. 4 in this series) were not commercially successful as they were too heavy for the tracks on which they were used and too light to provide the traction necessary to haul loads great enough to enable them to compete economically with horses. To meet this difficulty John Blenkinsop (1783-1831), in 1811 patented a rack railway with teeth, cast on one of the rails, which engaged with a cogged driving wheel added to the engine. Toothed rails of this kind were laid in 1812 from the Middleton Colliery to Leeds, a distance of three and one-half miles, and four engines were built by Messrs. Fenton, Murray and Wood in 1812-1813 for use on them. The engines were based on Trevithick's designs, but embodied certain improvements due to Mathew Murray (1765-1826). These were the first commercially successful steam locomotives and they remained in use for 20 years. Details of their construction will be found in the Handbook of the Science Museum, *Land Transport. III. Railway Locomotives and Rolling Stock. Part II—Descriptive Catalogue* (H. M. Stationery Office, London, 1931).

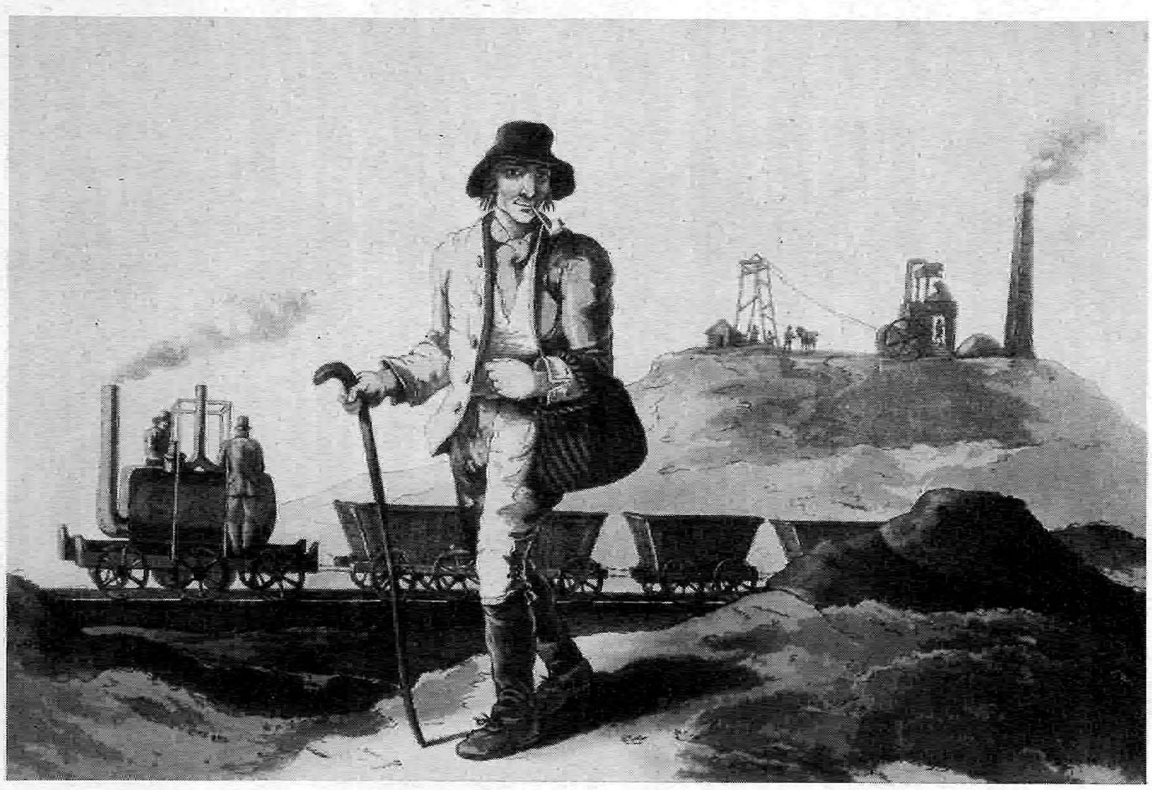


FIG. 1. Blenkinsop's rack railway and the first commercially successful steam locomotive (from an aquatint by R. & D. Havell after G. Walker).

Month in Focus

(*Continued from Page 3*)

to teach techniques rather than fundamental concepts. Some engineering colleges have tried to do this by eliminating shop courses. Such an elimination has not in general proved to be wholly desirable, since it leaves the engineering student without any physical way of securing a feeling for processing operations which are so important in design. The report by Carmichael, however, indicates a unanimous opinion that the engineering college shop course given for the purpose of teaching routine machine operation and skill ". . . has no place in an engineering course." It has been argued that familiarity with processing operations should be derived by the student from industrial experience. This may well be true, but in order that certain academic work may be augmented and made to mean more to the student certain shop operations must be given with emphasis on manufacturing processes. These processes should be closely associated with design and materials. One possibility in shop courses is to shift the burden of this work to the high schools, thus bringing men to the college who have had training in the handling of shop equipment. The engineering college could then carry on from there into those processes which serve to coordinate with design. The difficulty of this procedure lies in the fact that the colleges have no direct control over the high schools. Further thought must be given to this problem.

A further point raised by the Carmichael report deserves mention. This concerns the faculty of engineering colleges. The report states, "Students are not taught by curricula but by men." These men must be forward-thinking, active individuals who maintain adequate contact with industry and research. They must keep abreast of developments and requirements in their field. Industry can assist in making this coordination possible.

This brief discussion is presented in the hope that it will stimulate reflection by engineers, all of whom should be vitally concerned with the preparation of engineers for the future. Now is an excellent time to make improvements, and may we hope that such improvements will be made in the training of young engineers as a result of careful analysis.

Soap in Peace and War

(*Continued from Page 4*)

SYNTHETIC RUBBER CALLS FOR SOAP

More surprising, perhaps, than many other industrial uses, is soap's important role in the production of synthetic rubber. About one hundred million pounds of soap is going annually into this process. During the polymerization process, soap is added to the butadiene and styrene as an emulsifying agent. For example, it takes about 31 pounds of soap to produce the tires for an Army truck, and 100 pounds of soap for the synthetic rubber in a medium tank.

Later on when the finished rubber is ready for molding into tires or other articles, soap still takes a part, this time as a mold lubricant. It is especially fitted for this job because it does not break down at the high temperatures of the process. So in every new or recapped tire, soap has had a role in one form or another.

GLYCERINE—1001 USES

The story of soap cannot be fully told without devoting a generous share of attention to glycerine. Always important for its manifold uses in industry, food, and medicine, glycerine became a vital product in wartime. As a primary ingredient of war's high explosives, glycerine was on urgent and constant call for dynamite, cordite, and smokeless powder. In addition, it ranges from "useful" to "indispensable" in numerous industrial operations.

It is reported that about 93 per cent of America's glycerine production comes directly from the soapmaking process. Kitchen fat collections from millions of American homes have been spurred by the plea for more and more glycerine from the soap kettles. So it is that soap and glycerine go hand-in-hand as products that are tools for both peace and war.

WHERE DOES GLYCERINE COME FROM?

The chemist classifies glycerine as a "trihydric alcohol," or he will designate it simply as $C_3H_5(OH)_3$. Glycerine is a syrupy, sweetish liquid, 26½ per cent heavier than water and hygroscopic to a high degree.

This product is not derived from soap, but is produced in addition to soap during the soap-making process. During saponification, the fat or oil is split into glycerine and fatty acids; the latter react with sodium hydroxide to make soap. The glycerine is recovered and further processed to remove impurities and prepare a pure and concentrated product.

All fats yield glycerine in the soap process; some almost 15 per cent, but the usual average is about 10 per cent. The glycerine losses in kettle-soap boiling, and in evaporation and distillation processing, may run around 10 per cent. It is interesting to note that continuous soap-making equipment, employing high-temperature, high-pressure fat-splitting, enables recovery of as much as 95 per cent of the glycerine resulting from the reaction.

At the beginning of the war, annual United States glycerine production approximated one-quarter billion pounds.

WAR USES OF GLYCERINE

First and foremost war use of glycerine is in the production of explosives. Treatment of a "dynamite" grade of glycerine with nitric and sulphuric acids produces the potent nitroglycerine for dynamite. Glycerine also is used in the U. S. propellant charges of "smokeless" powder, while the British propellant, cordite, employs nitroglycerine directly in combination with pyrocotton.

But just as surely as glycerine packs the power to kill, it also applies its powers to heal. It is used in many antiseptics, drugs, and surgical dressings. It is a base for healing ointments and jellies, and is used in the miraculous sulfa drugs and numerous pharmaceuticals.

Nearly every one of our war machines carries into battle a double coat of armor. Most important is the thick metal plate that wards off enemy blows. And second is the tough glycerine-base paint that protects the surfaces of tanks, ships, jeeps, and planes from sand, rain, mud, ice, and snow. These alkyd-resin paints are really a liquid plastic, and their tough, flexible finish has made them the number one war paint for thousands of battle tools.

On shipboard, the marine compass moves in a glycerine solution. The recoil of big guns on land and sea, the ground impacts of landing bombers and of jolting trucks—these are cushioned by shock absorbers containing glycerine. The hydraulic liquid for plane-wing de-icers likewise calls for a glycerine base.

No wonder America's glycerine-containing kitchen fats were called to war!

GLYCERINE IN INDUSTRY

In versatility, glycerine keeps pace with its companion product, soap. Industry of wide range and variety, for peace and for war, depends on glycerine's important qualities. *X*-ray, V-mail, and movie film, waterproof bonding cements, printing inks, and anti-freeze solutions —all require glycerine in their manufacture. Glycerine's hygroscopic quality makes it an ideal moisture-retaining agent in cigarettes and gives it importance in food processing and preservation.

During the past few years many new applications for glycerine have developed in plastics, cellophane, safety glass and rayon.

SOAP AND THE FUTURE

Americans like to wash. They like themselves, their possessions, and their surroundings to be clean. They like cleanliness in their stores and amusement places, and on their trains, ships, and planes. Therefore, it's easy to prophesy that soap will continue to be used to wash everything that's washable. Soap's unusual applications—from lubricating that sticky drawer in the bureau to performing an important role in synthetic rubber—also are likely to continue to increase.

The Mass Spectrometer

(Continued from Page 12)

were allowed to carry on photosynthesis in ordinary water and heavy oxygen potassium bicarbonate and carbonate.

In these experiments the determination of the excess O^{18} in the water was accomplished by first equillibrating the water with CO_2 and then running the CO_2 through the mass spectrometer. To determine the excess O^{18} in the carbonate ions a precipitate of calcium carbonate was formed and then calcined to liberate CO_2 which was run through the mass spectrometer. The O_2 was run directly through the mass spectrometer.

The results show that when the water contained excess heavy oxygen isotope, the liberated oxygen also contained excess heavy oxygen isotope; but when the carbonates contained the excess heavy oxygen isotope, the liberated oxygen did not contain excess heavy oxygen isotope. The liberated heavy oxygen must, therefore, have come from the water and not from the bicarbonate contained in the water.

CHEMICAL PROCESSES IN METABOLISM

There are many examples in the literature showing the application of the heavy isotope tracer techniques to metabolism studies. The field which seems to be the most fruitful, at this time, is that of intermediary metabolism; that is, the mechanism of the breakdown and synthesis of proteins, fats and carbohydrates and their introconversion, as well as the effects of vitamins and hormones thereon. The usual procedure in this isotope tracer work is to submit a labeled substance to a biological reaction either in an intact animal or in an isolated tissue or extract, and then to isolate the products and determine their heavy isotope content.

Some very interesting articles published by Schoenheimer[3] report the results of experiments in which normal adult rats were fed a labeled amino acid for a period of several days. The amino acid was labeled by synthesizing it with an excess of heavy isotope of nitrogen. At the end of this period the rats were killed and the various parts of the rats analyzed with the aid of a mass spectrometer for the labeled atoms.

There were only two important results. (1) Less than one-third of the nitrogen contained in the amino acids fed the rats was recovered in the excreta, although the total amount of excreted nitrogen was equal to that in the diet. This indicates that the other two-thirds of the labeled nitrogen had been assimilated into the tissues in exchange for normal nitrogen formerly present in the tissues. (2) It was observed that more than half of the nitrogen of the amino acids fed ended up in the body proteins. These two facts showed that the metabolism was much more efficient than previously supposed in incorporating the amino acids fed to the rat into the body protein. In other words, even though the excreted nitrogen was equal to that of the intake, only a small part of this excreted nitrogen passed in effect directly through the rat. Another important conclusion follows from the fact that the nitrogen incorporated in the proteins was

[3]Schoenheimer, R., Ratner, S. and Rittenberg, O., *J. of Bio. Chem.*, *130*, p. 703 (1939).

originally fed in the form of amino acids. This shows that the absorption process is a very extensive succession of chemical reactions and not a simple mixing process. It may be stated here that this information could not have been obtained by any other technique.

These results are very important in that they show the possibilities of this relatively new method of attack in aiding the medical profession to find out many new facts about body chemistry.

CONCLUSION

From this discussion it will be seen that the mass spectrometer is very versatile in its applications. It is expected that in the future it will become of increasing usefulness in the chemical and medical fields, as well as in fundamental physical research.

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3. Schoenheimer, R., Ratner, S. and Rittenberg, O., *J. of Bio. Chem., 130,* p. 703 (1939).
4. Washburn, H. W., Wiley, H. F., Rock, S. M., Berry, C. E., *Indus. and Eng. Chemistry,* Anal. Edition, *17,* p. 74 (February 15, 1945).

C. I. T. NEWS

NOVEMBER MEETING

On November 15 the monthly meeting of the Alumni Association will be held at the Kaiser Steel Plant in Fontana. Dinner will be served cafeteria style at 5:30 P.M., following which a tour of the steel plant has been arranged. Donald R. Warren, of the Donald R. Warren Company, a Tech alumnus, is arranging this meeting. Mr. Warren did considerable design and construction work on the Kaiser plant. This promises to be a very interesting meeting, and a good attendance is expected. Notice of details will be sent in the usual manner.

ERNST MAAG '26 TAKES NEW POSITION

Ernst Maag, past president of the Alumni Association, has accepted a position as chief engineer for Latisteel, Inc., in Los Angeles, effective November 1. Mr. Maag has been with the Department of Building and Safety of Los Angeles County for the past 12 years.

Mr. Maag's affiliation with the County began in 1933 as district structural engineer. Through a series of promotions he became structural research engineer in 1941. Prior to serving with the County Mr. Maag was building inspector for Pasadena from 1926 to 1931, serving under Walter Putnam, head of the department. From 1931 to 1933 Mr. Maag was in charge of the testing laboratory on Morris Dam for the Pasadena Water Department. His new work with Latisteel, Inc., will be chiefly development and testing.

NEW APPOINTMENTS

The Board of Trustees has announced the following appointments to the Institute faculty:

J. R. Oppenheimer, Professor of Physics
Aladar Hollander, Associate Professor of Mechanical Engineering
A. P. Banta, Associate Professor of Sanitary Engineering

PERSONALS

IT WILL be helpful if readers will send personal items concerning themselves and others to the Alumni Office. Great interest has been shown in these columns, but more information is required. Do not hesitate to send in facts about yourself, such as change of position or location, present job, technical accomplishments, etc. Please help.

—Editor.

1925

KENNETH W. RANNEY holds the position of general manager, vegetable dehydrator, Cal-Foods at Santa Ana, Calif. The Cal-Foods Co. is the largest dehydrator of vegetables in southern California serving the Army Quartermaster Corps. Ken, you may remember, contributed generously of his products at the annual Alumni Seminar.

FRANK M. FOSTER is manager of the commercial and industrial sales division, Southern California Gas Co., Los Angeles, Calif.

ROBERT T. DILLON is employed by the G. D. Searle Co. of Chicago, Ill., as a research chemist, and is head of the analytical division.

EDMOND E. WINCKEL is associated with the Shell Oil Co., Inc., Los Angeles, Calif., as a petroleum engineer.

LEROY NEWCOMB is a mechanical engineer for Emsco Derrick and Equipment Co., Los Angeles, Calif.

MICHAEL B. KARELITZ is a staff member in mechanical engineering at the radiation laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

EARL D. STEWART holds the position of director of chemical research for the Schwarz Laboratories, Inc., of New York, N. Y.

1927

LIEUTENANT-COMMANDER W. W. AULTMAN, who before the war was a water purification engineer for the Metropolitan Water District of Southern California, is now an executive officer of the 8th Seabee Battalion on Iwo Jima. He was with the invasion forces at Iwo and lived two months in foxholes. Among his responsibilities has been the important one to investigate, design, and construct the water system for the island. The problem was a complicated one because of the high temperatures and chemical properties of the water, on account of the volcanic structure of the island.

HARRY FARRAR has recently returned from an extended business trip in the East, including in his itinerary the Western Electric Co. at Kearny and Jersey City, N. J., and Point Breeze, Md. In New York City he visited the American Telephone and Telegraph and Bell Telephone Laboratories. On July 11 at a New York restaurant the following alumni met with Mr. Farrar: G. P. Wilson '38, Evan Johnson '38, James Davies '36, Harry St. Clair '20, and Robert O. Cox '40. Mr. Farrar also saw Robert Moore '27, George Moore '27, Charles Bidwell '26, Robert Grigg '40, Ralph Blackman '26, Karl Ganslle '29, and Glenn Weaver '34.

RAY E. COPELAND holds the position of manager of sales at the Columbia Steel Co., Los Angeles, Calif.

1931

LIEUTENANT - COMMANDER WALTER L. DICKEY, civil engineer corps, for several years resident engineer at Hunter's Point Naval Drydock, Calif., has been transferred to Davisville, R. I.

JOHN W. DALY is geologist and seismologist for the Honolulu Oil Co. He lives at Lubbock, Tex., is married and has two sons.

FRANK A. NICKELL went to India in the summer of 1944 for geological engineering work connected with the development of dams and other structures related to a huge irrigation project being undertaken by the government in that country.

MYER STEIN is employed at present by the Aviola Radio Corporation, Glendale, Calif. Myer is devoting considerable time to writing "Operation and Maintenance Handbooks for Radar Equipment."

CHARLES K. LEWIS is contract and sales manager of The Glenn L. Martin-Nebraska Company, Omaha, Neb.

1932

CAPTAIN E. C. KEACHIE, U.S.A., is labor and public relations officer, San Francisco, Calif., engineering district.

HOWARD W. FINNEY holds the position of senior accountant for Lybrand, Ross Bros. and Montgomery, Los Angeles, Calif.

OSCAR F. VAN BEVEREN was married in June, 1944, to Mlle. Agnes Toutonghi at the Basilica of Notre Dame in Heliopolis, Egypt.

GEORGE H. BOWEN is a research engineer for the Mission Dry Corp. of Los Angeles, Calif.

1933

MAPLE D. SHAPPELL is working at the Guggenheim Aeronautical Laboratory at the Institute.

LIEUTENANT TED S. MITCHEL is stationed at the naval air redistribution center at Miami, Fla.

1934

H. M. A. RICE is continuing to work on strategic minerals in western Canada for the Canadian Geological Survey.

BOB BROWN is working for International Derrick and Equipment Co., Torrance, Calif.

LIEUTENANT CARROLL C. CRAIG, U.S.N.R., announces the arrival of a son, Thomas Edward, on August 5. The Craigs also have a daughter, Martha, aged two and a half. Lieut. Craig is in the Bureau of Ordnance, Washington, D. C.

1935

MAURICE DONNELLY is still with the Soil Conservation Service in Riverside, Calif. His daughter Louise is now two and a half years of age.

RAYMOND A. PATERSON, after the completion of confidential work with the Submarine Signal Corp., has returned to the United Geophysical Corp., where he now occupies the post of vice-president.

ROBERT P. SHARP is a captain in the Arctic section of the Army Air Forces. Bob has accepted an appointment as associate professor of geology at the University of Minnesota, the appointment to become effective at termination of military services.

ROBERT STANLEY is chief engineer for the Bell Aircraft Corp., Niagara Falls, N. Y.

CHARLES M. BLAIR holds the position of director of research of Tretolite Co., Webster Groves, Mo.

1936

LIEUTENANT G. R. NANCE was based at the Naval Air Station, Pearl Harbor, September, 1941, to March, 1943, then transferred to Johnson Island Naval Station from March until August, 1943. At present he is Bureau of Aeronautics general representative, western district, Los Angeles, Calif.

EDMUND BOYS is with Geophysical Service, Inc., doing contract seismic work for the Standard Oil Co. of California at Bakersfield and surrounding territories.

ROBERT W. WILSON is assistant professor of paleontology at the University of Colorado.

IVAR E. HIGHBERG is associate professor of mathematics and physics, Whitman College, Walla Walla, Wash.

1938

ELBERT F. OSBORN is still at the Geophysical Laboratory, Washington, D.C., and engaged in confidential work. He has purchased a home in Silver Springs, Md.

LIEUTENANT LEROY BRUCE KELLY, U.S.N.R., radar and communications officer, is with the Navy Air Force in the South Pacific area. His wife, Betty, and eight-months-old son, Wally (whom he has never seen), are living in Pasadena, Calif.

1939

WILLIAM R. FRAMPTON and Miss Dorothy Cunningham of Glendale were married last March 3. William has been stationed at Naval Air Station, San Diego, in materials laboratory.

RICHARD R. BRADSHAW announces the birth of a daughter, Linda Maile, last March, in Honolulu. The Bradshaws have been in Honolulu since before the outbreak of war, Mr. Bradshaw being employed in the engineering department at Pearl Harbor Navy Yard.

MAJOR RICHARD H. HOPPER, who has been serving in the South Pacific area, reports he was married in September of last year to Renee Rudd, of Scotch ancestry, in Brisbane. After release from military duty, Dick expects to go back to work with Standard Oil in the East Indies.

1940

SERGEANT KEITH ANDERSON was home recently in southern California on a 30-day furlough. Sergeant Anderson had served overseas nine months and was in a mechanized outfit in Germany when the war ended. At the termination of his furlough, he left for Camp Gruber, Okla., to be assigned to the Pacific area.

1941

ROBERT W. DURRENBERGER has been released from active duty in the Army Air Forces and has begun work to train as a junior executive for the firm of R. S. Bacon Veneer Co., Chicago, Ill.

THEODORE S. GILMAN is a research assistant in the chemistry department at the Institute.

1942

EMERSON L. KUMM has taken a position as electrical engineer with the Nathan B. Smith Manufacturing Co. of South Pasadena, Calif. During the war he was an instrument engineer for the Dow Chemical Co., Styrene Division, Los Angeles, Calif.

1943

MUSTAFA S. AKMAN (Terry) has been working for the Tamarack and Custer Mining Co. of Wallace, Idaho, since his graduation.

BENJAMIN DALEON, after receiving his degree in micropaleontology under Boris Laiming, joined the paleontological staff of the Texas Co. in Los Angeles, where he has become an authority on California Cretaceous foraminifera. Ben is ready to return to the Philippines to aid in the rehabilitation of his country when it calls him.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

of ENGINEERING AND SCIENCE MONTHLY, California Institute of Technology, published monthly at Pasadena, California, for October, 1945.

State of California,
County of Los Angeles, ss.

Before me, a notary public in and for the State and county aforesaid, personally appeared the editor of the ENGINEERING AND SCIENCE MONTHLY, California Institute of Technology, DONALD S. CLARK, who having been duly sworn according to law, deposes and says that he is the editor of the ENGINEERING AND SCIENCE MONTHLY, California Institute of Technology, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation) etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Alumni Association, Inc., 1201 E. California St., Pasadena 4, California; Editor, Donald S. Clark, 1201 E. California St., Pasadena 4, California; Managing Editor, R. C. Colling, 124 West Fourth St., Los Angeles 13, California; Business Management, Colling Publishing Co., 124 West Fourth St., Los Angeles, California.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Alumni Association, Inc., California Institute of Technology, 1201 East California St., Pasadena 4, California; no stock, a non-profit corporation.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is . . . . (This information is required from daily publications only.)

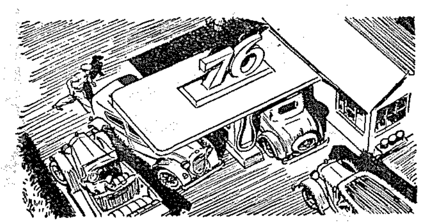
DONALD S. CLARK, Editor.

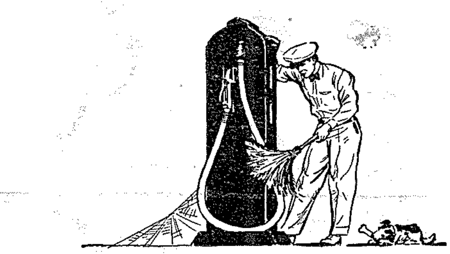
Sworn to and subscribed before me this 26th day of September, 1945.

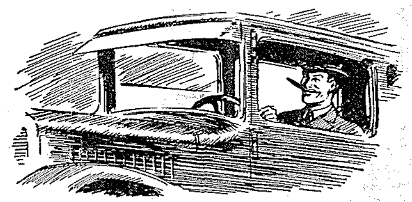
(Seal) Ida A. Ritchie.

(My commission expires April 9, 1949.)

Your sights have been raised some in 13 years



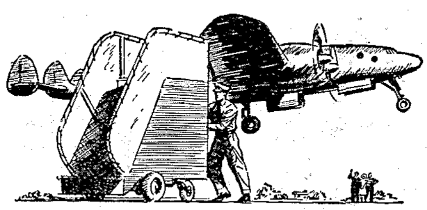


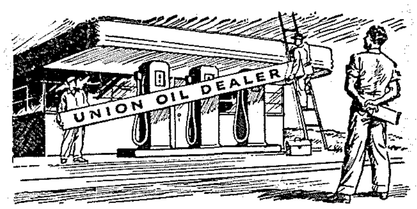


1. In 1932 Union Oil came out with a new gasoline called 76. We made quite a fuss about it. For it was *demonstrably* better than other gasolines on the market—so much better, in fact, that our sales went up by leaps and bounds and new dealers joined us by the hatful.

2. If we were to put out that same gasoline today, only 13 years later, it would *lose* us customers and dealers. For by modern standards it was of a quality a good deal lower than what you're accustomed to now, and you'd recognize the difference instantly. The fact that your sights have been raised so, in only 13 years, is due largely to one thing—*competition.*

3. People were more than satisfied with our 1932 gasoline—in 1932. If no improvements had been introduced you'd *be satisfied with it today.* For you would know of nothing better to compare it with. But competition would not permit us to stand still.





4. For each of us knew that if we could put out a product a little bit better than the rest of the industry we could *get more business.* Consequently, even the company that was in the lead kept constantly searching for improvements. Progress from year to year was gradual—as it always is.

5. But in 13 years that total progress was considerable. Now if the oil business had been a monopoly—private or governmental—it is doubtful if this would have happened. For there simply aren't the *incentives* to better your product when you already control all the trade.

6. So as long as there's still room for improvement in an industry, the only way to guarantee *maximum progress* is to have an economic system that guarantees *maximum incentives.* Our American system with its *free competition* provides these to a degree no other system has ever approached.

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This series, sponsored by the people of Union Oil Company, is dedicated to a discussion of how and why American business functions. We hope you'll feel free to send in any suggestions or criticisms you have to offer. Write: The President, Union Oil Company, Union Oil Bldg., Los Angeles 14, Calif.

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