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1943

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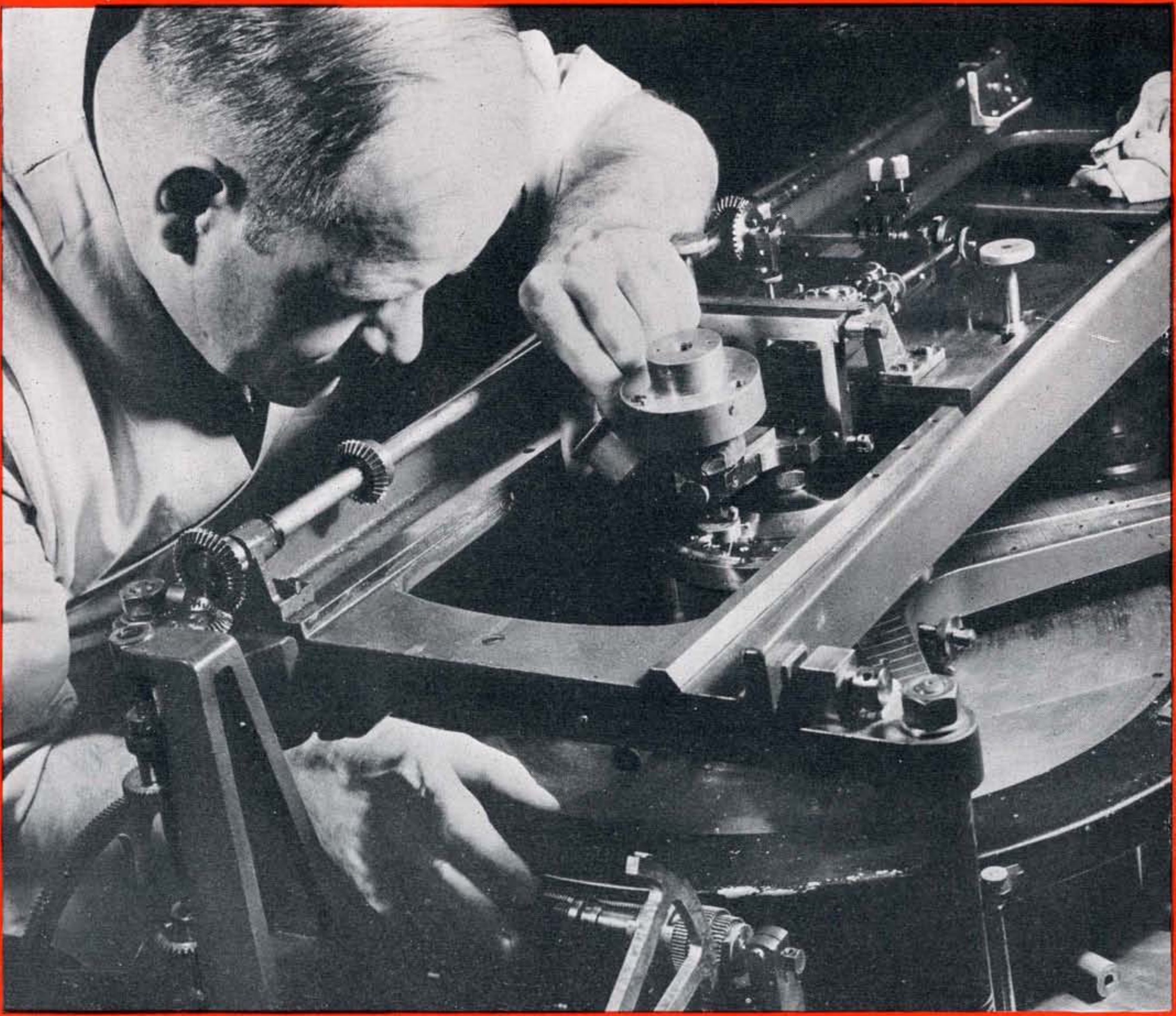
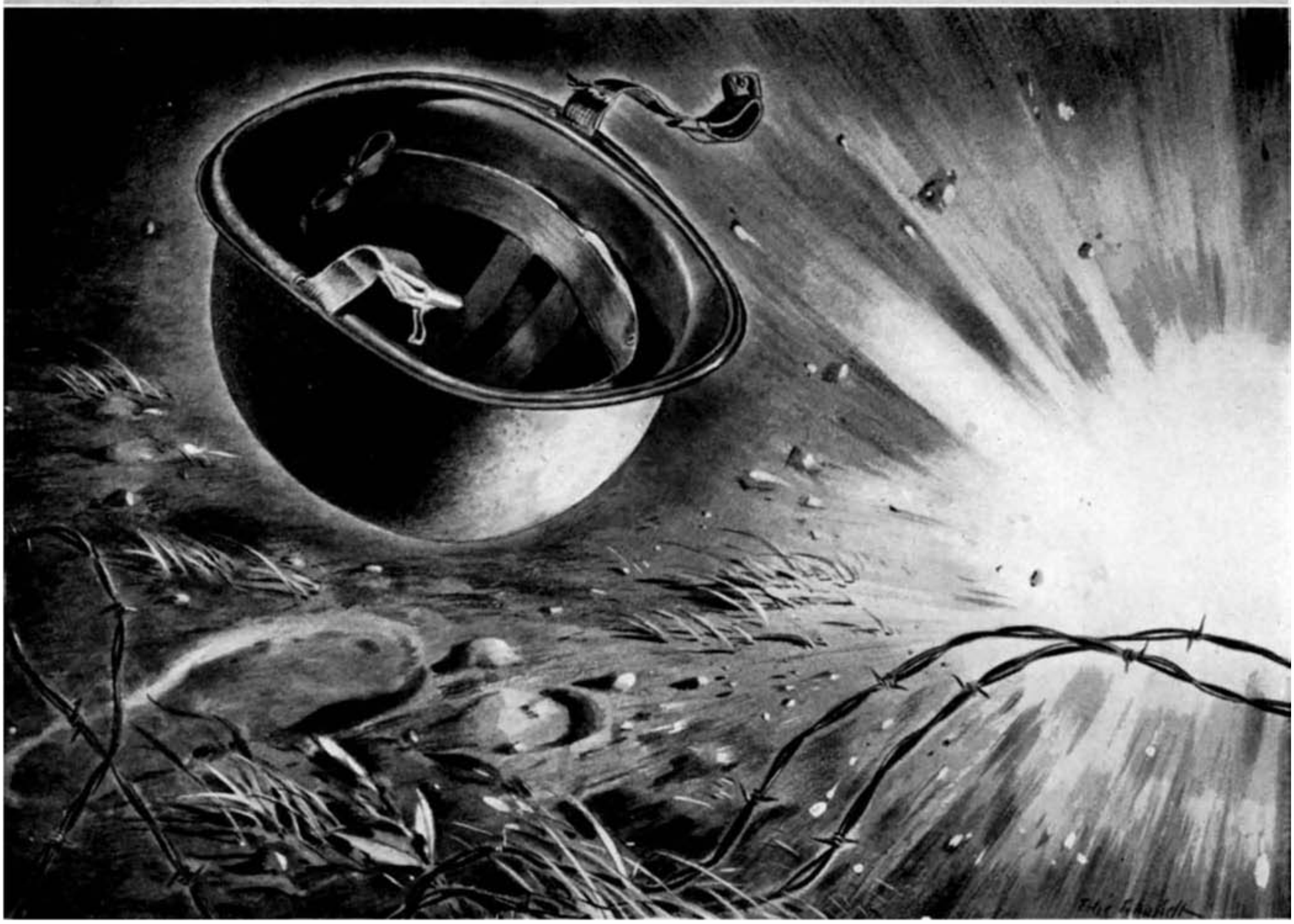
REPORTING THE PROGRESS OF SCIENCE AND INDUSTRY



That Avigation May be Accurate . . . See Page 145

A war can last
one minute too long...



A man can get killed just as dead on the last day, the last hour, the last minute of the war as he can at any other time.

If American troops are delayed in their advance because we at home fail to produce the supplies they need on time, then we are guilty of prolonging the war, lengthening the casualty lists.

The great majority of American industrial workers, owners and managers realize this grim fact. They are working night and day to win the war and win it as quickly as possible. They do not want this war to last "a minute too long" for a son, brother, husband, sweetheart or friend.

The point for all of us to remember is this: Even when the newspapers tell us of new Allied victories on the fighting fronts *we must not slacken our pace on the home front.* We must do all in our power to shorten the war, to save lives.

ETHYL CORPORATION
Chrysler Building, New York City

Our war job is manufacturing Ethyl fluid for improving the antiknock quality of fighting gasolines — *and delivering it on time.* Ethyl workers have been awarded the Army-Navy "E" for "outstanding achievement in producing war equipment."

ETHYL BRAND OF ANTIKNOCK COMPOUND ETHYL CORPORATION TRADE MARK REG. U.S. PAT. OFF.

Scientific American

Founded 1845

CONTENTS • OCTOBER 1943

SHOULD ERRORS creep into the graduations of the scale of an aircraft sextant, they would be multiplied hundreds of times in the calculations of the bomber or transport navigator who used the instrument. Thus the greatest possible precision is maintained in the engraving of these scales. On our front cover this month is shown a skilled worker at the Pioneer Instrument Division, Bendix Aircraft Corporation, setting the ingenious machine that does the engraving which eventually will safeguard lives and planes.

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Previews of the

A. P. Peck

WHEN THE WAR ENDS

So-called "informed circles" in Washington are predicting the end of Germany by next summer at the latest, perhaps by next spring, maybe even by the end of 1943. Then another year of war with Japan and . . . the post-war era. Nothing will be read into such predictions, by the intelligent person, which will in one iota affect our present schedules of production for the military forces. They do, however, bring home forcefully the need for even more intensive thinking on those problems of the post-war world which must be prepared for in advance if they are to be met with any degree of success.

The period of transition from military to civilian production is going to be a painful one. Transition periods almost invariably are painful. Yet the pain—and even more serious consequences—can be reduced to a minimum by the exercise of a degree of foresightedness seasoned with a knowledge of those advances in science and technology which have grown out of war-driven research.

Now, then, is the time to start planning for the future, if it has not already been initiated. So far the Government is not looking with too great favor on such planning by individuals and private industry, although Government itself is doing some of it in a way that many think to be impractical. The fear seems to be that post-war planning will slow up present production. Such fears, for the most part, are groundless or worse. The company which has placed its war-time operations on a sound working basis and has given some of its attention to the future knows that it has a great stake in the peace to come. With this knowledge it will certainly continue to strive for the greatest production which, in turn, will mean the earliest possible end of the war. And when the corner is reached, the companies in this category will be in the strongest positions to face reconversion with a minimum of upheaval within their own organization ranks.

If events follow the path predicted by the "informed circles," war production will probably taper off somewhat after the fall of Germany. No immediate drop is to be foreseen, but the trend will undoubtedly be generally downward in many industries. This will give a period—perhaps the year previously mentioned as being the time required for the finish of Japan—during which some of the post-war plans can start to operate. If they have been polished to a point where they are workable, everyone will benefit. If they are allowed to languish and are put off until needed, they will not be ready for use and many people—employers and employees alike—will suffer.

On post-war planning will industry stand or fall as the guiding force of the American way of life.

SUBSCRIBERS to Scientific American will notice that the present issue was delivered to them without the usual paper wrapping, and with the address on a slip pasted to the front cover. This method of mailing has been necessitated by the current shortage in wrapping paper and will be continued only as long as absolutely necessary. We know that it is not as satisfactory in many respects, but are sure that our subscribers will bear with us until such time as wrapping of mailed issues can be resumed.—*The Editor.*

WHENCE RUBBER IN THE FUTURE?

When considering the problem of whether our future rubber supplies will come from the test tube or the rubber tree, one fact that is often lost in the shuffle is that natural rubber can be produced to special specifications, much as can the product of chemical ingenuity. This, plus the adaptibility of rubber raising to small-scale farming operation, will have a definite effect on the post-war rubber economy. For more details, see page 169.

INDUSTRIAL DERMATITIS

Increasing attention is being given by medical science to skin and other diseases directly attributable to conditions under which industrial workers are employed. Recently, for example, there have been outbreaks of "glue itch" among employees in plywood and laminating plants, causing great amounts of lost time on important war work. This skin trouble has been directly traced to irritating substances in the glue. And the troubles have not been confined to workers using urea-formaldehyde and phenol-formaldehyde adhesives but have also been found among those exposed to the effects of other more common glues to which irritating chemicals have been added.

Such occurrences as those outbreaks of glue itch point definitely to a responsibility which industry has, not only to employees as individuals but to the nation as a whole. Not until the war is over can the production of military goods be relaxed for a moment, except as changes in military operations dictate. Not at any time should employees be exposed to conditions that can effect their health until every precaution has been taken to remedy these conditions, to prevent outbreaks of disease, or to provide adequate treatment for those affected.

Medical science is prepared to cope with problems of these types; with the co-operation of industry much can be accomplished.

SILVER LINING

Coming up rapidly as an industrial metal is silver, yet this important development work has found a number of stumbling blocks in the form of political chicanery, much of which dates back into the early days of silver mining in the United States. In those days, when the uses of silver were limited to coining and decorative activities, the motives of politicians in building the fences which they erected around this precious metal were of little moment to the industrial world.

Today, however, science has shown many new uses for silver, some of them highly important to the war effort, all of them based on jobs which silver can do as well as or better than other materials. In the future, and this will be especially true if the politicians awaken to the facts of life, silver will be widely used in the electrical, chemical, metallurgical, and other industries, following the lines detailed in the article starting on page 151 of this issue.

AIRPLANES OF THE FUTURE

American industry has proved that it can produce airplanes rapidly and in large quantities. These planes are being flown in all kinds of weather in many parts of the globe. On such facts are being built over-optimistic pictures of the future of aircraft as far as the average man is concerned. Planes that he can fly with little more instruction than needed to master the driving of an automobile are entirely possible. They can be made cheap enough to meet his pocketbook. But at low prices they cannot possibly be equipped with the intricate and delicate instruments so necessary for flying under all conceivable conditions. Add to this the terrifying prospect of airways crowded with planes and the over-optimistic pictures will take on a greater shade of reality — and of fewer planes for civilian flying.

This is not to say that there will be no market for private planes in the future. There certainly will be, but from where we sit we can see no immediate prospect of a plane in every back-yard. The future of aviation seems pretty clear at the moment: Huge development of aerial transportation of passengers, mail, express, and cargo (see page 154), handled by competent organizations on well defined airways; and a renewal on an increasingly large scale of the interest in sport flying that was gaining ground rapidly before the war. But planes for every commuter, for week-end trips to the mountains or the seashore, for all the uses to which the family automobile is put, is stretching things a bit too far until a great deal of additional development work is done on fool-proof automatic control of planes and aerial traffic.

FOR GREATEST FLEXIBILITY

In the earliest days of electrical transmission of power, direct current had the field to itself. Then came the development of alternating current, with attendant economy and flexibility. Despite technological progress, however, certain appliances (notably motors) designed for D.C. operation gave better performance for some purposes than did those for A.C. use. And they still do. Nevertheless, A.C. power forged ahead, virtually leaving such appliances to shift for themselves. Now comes a development in the field of electronics to bring to unit motor users all of the advantages of a D.C. machine with the desirable features of A.C. distribution of power. For details see page 166. This industrial adaptation of a principle of electronics is sure to influence machine design in many respects, to bring greater flexibility to electrically driven equipment, to spread the use of unit motors to operations to which they could not heretofore be applied, either because of the lack of a D.C. source or because A.C. motors were not satisfactory.

A PLASTIC OF THE FUTURE

Good news for post-war manufacturers of certain consumer goods comes from the Du Pont Company. Engineers and designers, they say, who never before the war worked with the crystal-clear plastic Lucite have, incidental to war production, developed uses for this material which can be applied on a production basis to the fabrication of such products as furniture, automobiles, refrigerators and other household appliances, display signs, industrial equipment, and so on.

These applications, in addition to uses in commercial air-transport planes, following practices developed for war-time ships, will open broad horizons for clear plastics. As their properties are more thoroughly investigated by the probing finger of restless research, and their mechanical possibilities are tested under even more varied conditions, they will undoubtedly pop up in unexpected places in the home, the factory, and the business office.

JUST AROUND THE CORNER

Some day television will be the basis of a great industry. Many of the technical problems have been solved, in the laboratory and in the field, but there is much more to the whole subject than just this. There are economic problems of tremendous magnitude which must be solved before television will be anything more than an interesting novelty to a few scattered owners of receivers. This situation will hold true until such time as a means is found for paying for the programs. These statements are based on reports from E. F. McDonald, Jr., president of the Zenith Radio Corporation. On the other hand, Ralph R. Beal, Research Director for the Radio Corporation of America, has recently stated that television will be ready for every family's use "immediately after the war."

The difference between "technically ready" television and satisfactory television programs day in and day out is a factor in the whole television situation which must not be overlooked. Science and industry will be ready to produce receivers as soon as they are permitted to do so when peace comes. However, the time when adequate programs will be available seems still to be far off on the horizon.

EARNING WHILE LEARNING

An education plan which might well be applied in other localities and to men as well as to women is now in operation at Shurtleff College. Here girls are given an opportunity to pay for their education by working alternate three-month periods in the plant of the Western Cartridge Company and going to school in the intervening three-month periods. Usual procedure is for the girls to be paired off so that one is working while the other is attending classes. Thus the plant has the uninterrupted services of a productive worker and the college can maintain its classes and teaching staff at maximum efficiency.

MORE ON METALS

In these columns last month we dealt with the possibilities of the light metals in the future and of the steps which the steel industry is taking to hold its own place in various fields. To this discussion should be added further notes in order to round out the picture.

While the light metals — aluminum, magnesium, and their alloys — will find uses in the automobile of the future, steel will undoubtedly remain the predominant motor-car fabricating material, especially in the low-price field. Then, in the manufacture of aircraft, there must be considered the possibilities of steel and plywood combinations and of aluminized steel to meet certain specifications. Today, emphasis in aircraft construction is on high strength combined with light weight, the weight factor influencing such characteristics as maneuverability, gasoline load, ammunitions and bombs carried, and so on. Tomorrow, in the transports and cargo ships, strength will still be needed but there will not be the life-and-death aspects of light weight. Under these conditions, steel will become a much more serious competitor in the airplane field than it is today.

TOMORROW'S FABRICS

One of the fields that rubber, whether synthetic or natural, is going to lose, at least in large part, to other substances, is that of water-proofing. As a result of huge demands by the Army for weather-proof clothing, textile-coating materials made from synthetic resins and similar products of the laboratory have been applied with great success. In many respects these new fabrics are better than the rubberized ones which they replace. They withstand tremendous fluctuations in temperature, resist the effects of gas and oil, and are subject to less deterioration under the direct rays of the sun. Add to these desirable characteristics the fact that these new fabrics can be made lighter in weight and more flexible, and there is seen a future consumer market of sizeable proportion.

KEEPING DOWN THE DUST

Closely linked with problems of industrial diseases, mentioned in a previous paragraph, is the matter of dust in industry. Through the application of recognized methods of dust control (see page 157), many industries are not only reducing the incidence of respiratory troubles among workers, but are, in some cases, recovering valuable materials from process dusts that otherwise would be thrown to the winds.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of October, 1893)

GERM WARFARE — "Experiments have been recently made in Germany to ascertain if rifle bullets can carry infection. . . . Investigations show that if rifle bullets are purposely brought in contact with micro-organisms and then discharged in the usual way they carry the microbes with them into whatever material they subsequently penetrate; the microbes, moreover, suffer no damage and grow as abundantly as ever."

FIREFIGHTING — "The settlement of this country has been followed by fires of unparalleled magnitude, which may be regarded as a natural consequence of the rapid growth of the country. . . . It is a popular belief that every man who is able-bodied is fit to fight fire, but this is erroneous. . . . What we need is a school for fire extinguishment, where systematic training can be given in the science and methods. Such a school would dignify a calling until it reaches the stage of a profession, and would render life and property more secure. The firemen of the United States are, without doubt, the best in the world, but there is still abundant room for improvement."

RAILROADING — "The Chicago flier is not driven by one but by many engineers. . . . In order to cover the 964 miles between the two cites in twenty hours, including nine stops, there are required seven huge engines in relays, driven by seven grimy heroes. A run of less than one hundred and fifty miles is the limit per day for each engine, while three hours of the plunging rush wears out the strongest engineer."

ARGENTINE DEVELOPMENT — "The national government of the Argentine Republic and the provincial government of Buenos Aires have granted concessions to Messrs. Gibson & Co., to construct a port at San Clemente, Cape San Antonio, in the province of Buenos Aires, and railways to connect the port with the existing railway system. . . . The first section of the projected works includes an entrance channel having a depth of 29.5 feet at low water and 34.4 feet at high water. The breadth at low water is to be 311 feet. A mole, 5,578 feet long, will inclose the harbor on the west. Other quays are to be built. There is no special difficulty with the railways, which it is hoped will open up a large and fertile zone of the province."

OIL — "The depth at which oil is found [in recently developed Peruvian oil fields] . . . . is not over 500 feet, whereas in the United States the depth is from 2,000 to 3,000 feet. The distilled product is sold along the coast, while the crude oil has a large sale at Callao for use by the gas companies, for stationary engines, and for the railway locomotives, as a substitute for coal."

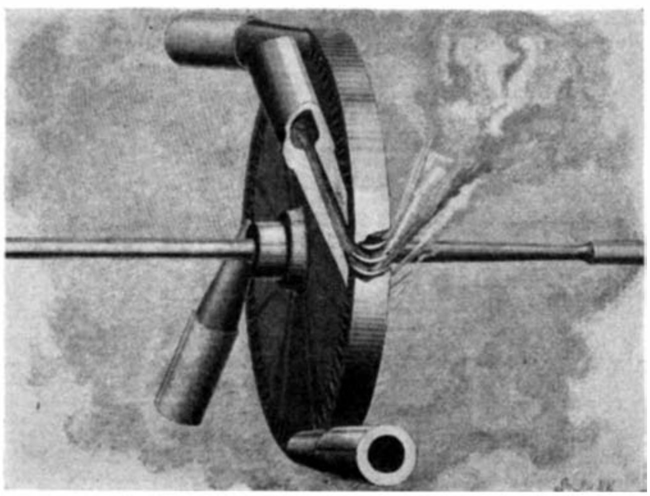
PATENTS — "We regret that not a single member of Congress has brought forward a bill to facilitate, protect, or assist the innocent inventor in securing reasonable rewards for his labors in benefiting the country by discovering new processes and inventions. It seems to us the true policy is to pass laws to foster, encourage and promote the establishment of new industries, not to break down and chastise the authors and inventors thereof."

STEAMSHIP SPEED — "Mr. J. H. Biles, the designer of the Paris and New York, suggests the possibility of 30 knot steamers in the future. Ten knots must be added to the present speeds. Of this Mr. Biles proposes to gain two knots by the use of nickel steel instead of ordinary steel, then three and a half knots by the use of oil instead of coal as a fuel, and the remaining four and a half knots he believes can be secured by such changes in dimensions as will increase the length and draught and by improving the machinery. The length will be about 1,000 ft., and the beam 100 ft., with a draught of 30 ft."

BREAD AND SOAP — "From a communication read to the Association of Belgian Chemists, it seems that Continental bakers are in the habit of mixing soap with their dough to make their bread and pastry nice and light. The quantity of soap used varies greatly. In fancy articles, like waffles and fritters, it is much larger than in bread."

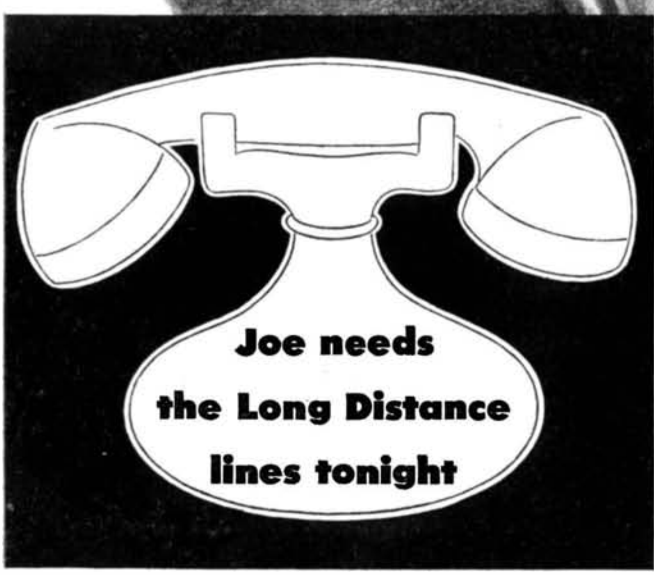
GAS LIGHTS — "The gas used in lighting the Broadway Cable Cars . . . . as well as all cars using the Pintsch system, is made from crude petroleum . . . . from which a very rich gas of over 70 candle power is obtained, and which will stand a very high degree of compression without materially affecting its illuminating qualities."

TURBINE — "De Laval's steam turbine, which forms the subject of our illustration, is in principle exactly similar to the well-known axial jet turbine for water. . . . The steam passes between the blades of the turbine at a constant relative velocity and in a clear jet, without any disposition to further change its pressure or specific gravity. . . . The blades against which the steam strikes are made thin at the edge to reduce the resistance to the flow of steam. In this turbine steam is expanded to the pressure of the surrounding medium before arriving at the blades. This expansion takes place in the nozzle, and is caused by making the sides of the nozzle divergent. As the steam passes through the nozzle its volume is increased in greater proportion than the cross section of the jet, thus causing an increase in velocity. With an initial pressure of seventy-five pounds, and an expansion to the pressure of one atmosphere, the final velocity of the steam is about two thousand six hundred and twenty-five feet per second. . . . Expansion is carried much further in this turbine than in ordinary steam engines."



TORPEDO BOATS — "Considerable interest is being taken in the new torpedo boats which are now being constructed, two at the New York navy yard for the Maine and two others at the Norfolk navy yard for the Texas. The boats are built as light as possible, so that they can be easily hoisted on board the large vessels. . . . The two boats for the Maine will each be fitted with a bow tube for discharging an 18 inch Whitehead torpedo and the two boats for the Texas will each be fitted with a deck training tube for a torpedo of the same size. Each boat will carry a 1-pounder rapid-fire gun."

STOCKINGS — "The enterprise and skill of American silk hosiery manufacturers has, it is represented, very nearly driven the foreign lisle thread stocking out of the market."


Joe needs
the Long Distance
lines tonight

"Quotes . . ."

"IT WOULD be little short of a catastrophe if, in case the war should end tomorrow, the vast onward sweep of our technological war developments should be stopped in mid-air." *Dr. Charles Kenneth Leith, Office of Production Research and Development of the War Production Board.*

" " "

"IN A COUNTRY such as ours, free enterprise supports us all, the government functioning as the referee of the rules prescribed for the conduct of the game of business." Harold Vinton Coes, Vice-President of Ford, Bacon and Davis, Inc.

" " "

"SO FAR as the building industry is concerned, it is now, for the first time, beginning to have the technological skill to build homes within the income-reach of nearly all of the American people. . . The building industry is now on the threshold of a new frontier: Mass production." *Bror Dahlberg, President, The Cellotex Corporation.*

" " "

"THE WAR, if it demonstrates anything, demonstrates that mankind as a whole is morally and politically unfit to apply the knowledge which science has placed at its command." Dr. Willard H. Dow, President and General Manager, The Dow Chemical Company.

" " "

"NO GREAT new engineering principles have come out of the war but many new developments have come from recognized engineering principles." *Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corporation.*

" " "

"THE WHOLE job of war production is geared to the speed of the slowest producer. It is this slow producer who needs our help, for if he is a maker of one part of a weapon, that weapon only gets to the firing line with the speed at which he operates." Alvin E. Dodd, President, American Management Association.

" " "

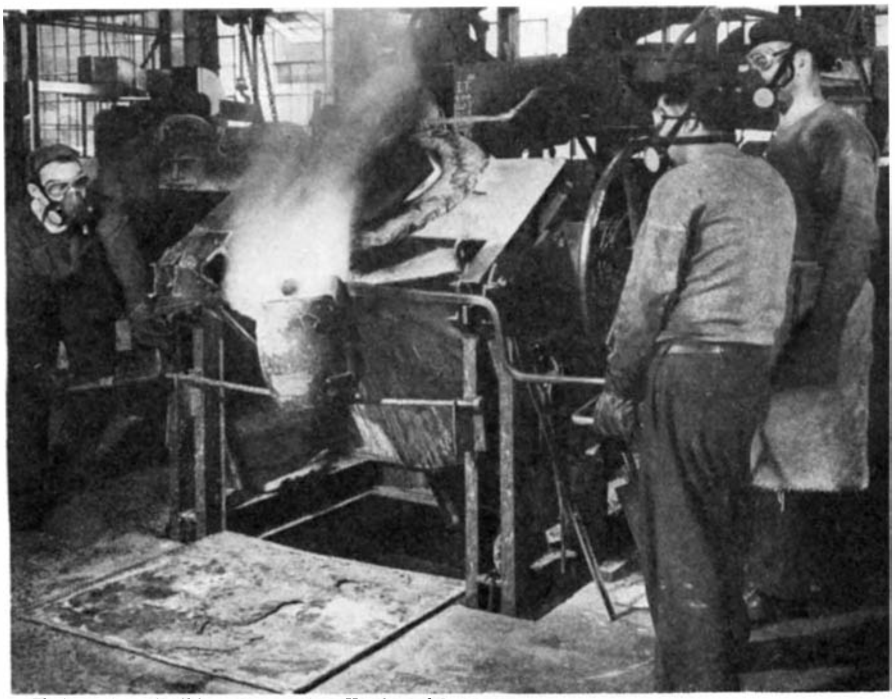
"OUR PSYCHOLOGICAL front should be as powerful, as dynamic, as our economic and military fronts. It can destroy the morale of the enemy, his belief in himself and in his myths. It can win the good will of non-belligerents, so important now and in the post-war world." *Edward L. Bernays, Counsel on Public Relations.*

" " "

"IF SAVING civilization has depended upon the production of war supplies in amounts needed, when needed, then it has been the sprawling giant of American industry, its managers and labor, which saved it." David Hinshaw in "The Home Front."

METALS IN INDUSTRY

Conducted by FRED P. PETERS



Photographs with this article courtesy Handy and Harman

Pouring molten silver into a crucible preparatory to making wire bars

Silver in Peace and War

The Irresistible Technical Force of Silver's Wartime Development As an Industrial Raw Material Has Crashed into an Immovable Political Wall. Full Utilization of this Metal's Post-War Industrial Potentialities Can Come Only With Public Enlightenment on Both Phases

AMERICA'S most misunderstood war material today is silver. The public, which thinks of silver as something used solely for dimes and quarters, tableware and jewelry, sadly underrates it and is completely at sea on "the silver question" as a political issue. Politicians and producers who regard the currency-backing use for silver as its major "market" are blind to its real potentialities. And industrialists who are unaware that silver is a superlative bearing material, a useful ingredient of electrical contacts, and a remarkably ubiquitous jointing metal in war production are doing justice neither to their own operations nor to silver itself.

But, for all its present utility in the manufacture of warplanes, communications equipment, and munitions in general—and despite its promises as a post-war material—silver is at this moment one of our most celebrated political footballs. It is now under WPB control, although a vast hoard of it remains unused in this country, and under a recent order it must be sold to industry *at two widely distant price levels for the same quality material,* depending on the end-use.

Public opinion *could* force a correction of the silver situation. Already the pressure of technical development and industrial demand have broken down a few barriers to employment of the Treasury's silver accumulation for war purposes. But before the full voice of the public can be heard it must "understand" silver—both as an industrial material *and* as a political issue.

To comprehend fully the new position of silver one must examine its status before war needs revealed its industrial adaptability. In 1939 the United States consumed a total of 54 million troy ounces of silver, of which 20 million ounces was used to make silver coins and 34 million ounces went into silverware, photography, and general industrial uses. The significant point is that these general industrial uses accounted then for less than 6 million ounces (about 200 tons). Silver was predominantly employed for either coinage or luxury items—it was a typical glamour metal, with virtually half of its consumption assigned to ornamental uses.

The years of peace had brought something else to American silver—a magnanimous customer who purchased all the silver United States mines could produce, as fast as (even faster than) they mined it and at a price about double that obtainable from any commonsense manufacturer, and who then stored it away in vaults and forbade its use for any productive purpose. This customer was the United States Treasury, which was required by law to pay a high premium for newly-mined domestic silver and store it so that some day the monetary values of the Treasury's silver and gold stocks would be in the ratio of 1 silver to 3 gold. (The ratio is now about 1 to 5).

This premium price was in the neighborhood of 70 cents an ounce (it was fixed in 1939 at 71.11 cents) and foreign silver could be bought by American users in world markets for about 35 cents an ounce. They naturally made no attempt to overbid the Treasury department for American silver when the foreign metal was so much cheaper and, as a consequence, for the eight years prior to 1942 the arts and industries in the United States had been using only silver of foreign origin. In other words, 1939's industrial consumption of 34 million ounces of silver was based entirely on imported metal.

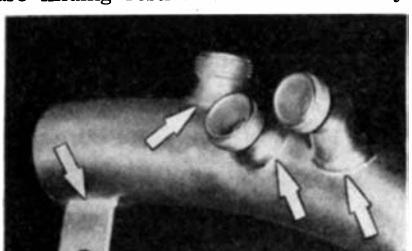
But during all the time the Government's silver-purchase program was apparently becoming more firmly entrenched (to the delight of the "silver state" senators), scientists and engineers were learning things about silver and doing things with it that were ultimately to change the whole situation. The silver producers themselves sponsored research on the properties of and possibilities in silver for industrial use. Pure silver was discovered to have the "slipperiness" expected of a good bearing metal, combined with the corrosion resistance desired for modern aircraft and automotive engine service. Silver-lined containers and silver-clad vessels increased in use for holding certain corrosive chemicals. Powder metallurgy opened up the field for silver in electrical contacts, since by this new technique desirable but otherwise not-producible combinations of silver with nickel, molybdenum, or tungsten could be achieved. And the use of silver brazing ("hard soldering") alloys grew with astonishing rapidity as their advantages of low-temperature but high-strength joints became more widely recognized.

By the time the war struck America, all these trends had reached so far that silver behaved at its impact like any other industrial raw material. The consumption of silver was heavily expanded by virtue of the general expansion of all those industries already using it. At the same time the war created a sudden demand for large amounts of silver as a substitute for critically scarce metals and coatings such as nickel, chromium, and copper.

And, as one might expect, the irresistible technical force crashed into the immovable political wall. The supply of foreign silver was found insufficient for the new industrial demand, and pressure was put on the Government to repeal or modify the silver-purchase laws so that both domestic silver production and treasury stocks not required for currency backing could be used to fulfill the painfully heavy industrial requirements at a reasonable price level.

Domestic silver production (remember: This silver was chiefly *not* used by industry) in 1942 was 54 million ounces. The Treasury stocks not required for currency backing are *over a billion ounces* at this writing. The "silver bloc" in Congress has nonetheless refused to permit the abandonment of the silver-purchase program and legislation so that this hoard might become freely available to industry.

But great gains have been made in recent months and part of both the silver hoard and domestic production are finding restricted use in industry.



Close-up of a few of the silver-brazed joints on an airplane motor ignition shield. Steel brackets and brass tubing and outlets are used

Thousands of tons of Treasury silver stock have been consigned to the Defense Plant Corporation to be substituted for copper and aluminum as bus bars and in other applications where the silver is not consumed or destroyed. Nearly three million ounces of silver were used in the new "silver nickels," thus freeing large amounts of nickel for other uses.

Finally, in July of this year, the controversial Green bill became law, and by its terms and under a subsequent WPB order (1) silver from the Treasury stock may be sold to industry at 71.11 cents an ounce for use only in engine bearings, military insignia, brazing alloys, and solders—under WPB control, and (2) foreign silver, which now costs 45 cents an ounce, may be used for making electrical contacts, photographic materials, miscellaneous high-priority products, and medicines. To carry the extra cost of the high-priced silver, a bearing manufacturer, for example, is now permitted to break his O.P.A. price ceiling on the finished bearing and pass the extra price of his silver on to his customer.

This sketchy political background has been presented in an article on technical developments because the technical and political phases of silver's history in our times have been inextricably woven. The influence on post-war industry of the war-winning applications of silver now to be described can be great or small according to the political handling of silver in the months to come.

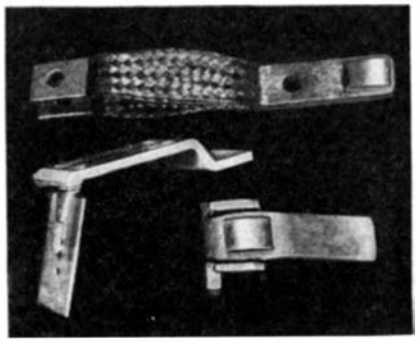
Silver has served the ends of Victory in two ways—as a replacement for tin, copper, and other critical materials and in its own right for mechanical or electrical parts that function best when silver or its alloys are used. Actually, in certain of the "substitute" applications, too, silver alloys are turning out to be superior and will someday present a serious challenge to the metals they now replace—if the price situation permits it.

A typical "for the duration" application of silver is its new use as bus bars in aluminum and magnesium reduction plants. The bus bars are heavy-gage bars of pure metal that conduct the electric current from the power-supply substations to the electrolytic refining cells. They are normally constructed of pure copper or pure aluminum; when silver is employed without redesigning the system the weight of the conductor is heavier than with copper, since the two metals have similar conductivities (silver is slightly higher) on a volume basis, but silver's density is about 18 percent higher.

The silver for this purpose is lent by the Treasury department to the Defense Plant Corporation, who may use it only in Government-owned or operated plants and must return every ounce of it within five years. One of the most recent silver bus-bar installations is at one of the Dow Magnesium Corporation's plants, where 900 tons of it, worth over 18 million dollars at the *Treasury's* price of 71.11 cents per ounce, must be kept constantly under armed guard. One understands immediately why silver for bus bars is an emergency use alone.

The use of silver in the new "silver nickels" will almost certainly end with war's termination. Close to three million ounces of silver have already been consumed in making these new coins. (They contain 56 percent copper, 35 percent silver, and 9 percent manganese and have a "P" mint-mark on one side.) This is a lot of silver but the amount of copper or nickel saved is still only a small portion of the total copper or nickel tonnage.

The standard "nickels" contained 25 percent nickel and 75 copper. Original substitution plans called for a Victory



Typical silver contacts used by industry for a wide variety of services

"nickel" of 50 silver, 50 copper, which would have had about the same color and coining properties as the old nickel. But it was found that this straight silver-copper "nickel" had too high a conductiviy to operate the coin boxes in several types of vending machines, subway turnstiles, telephone pay stations, and so on, and the present composition, containing less silver and some manganese and having electrical resistance and magnetic properties similar to those of the old "nickels," was developed.

Silver is employed in bearings in two ways: In the form of silver-clad or silver-plated steel or silver-base alloys, and as a constituent of lead-base alloys developed to replace bearing metals containing large amounts of tin.

Fine-silver is used in the main bearings and connecting-rod bearings of several types of aircraft engines because of its superior performance and engineering economies. A thickness of about 25 thousandths of an inch of silver or a silver-lead alloy is joined to a steel backing. This combination provides the mechanical strength in thin sections beloved of aircraft designers, plus the embedability (the property of "absorbing" grit instead of being scored by it), corrosion-resistance, and "oiliness" of the silver. The friction properties of pure silver are similar to those of lead, tin, and cadmium, but it has a higher melting point than any of these and—what is especially important in engine-bearing service—unusually good fatigue resistance.

Actually, pure silver is not the "oiliest" bearing metal available, and on ground shafts it has some tendency to "seize." The addition of a few percent of lead, however, seems to improve its bearing qualities considerably, although the bond between silver-lead and steel is weaker than that between fine-silver and steel. Pure silver bearings run ideally against a polished shaft.

Silver bearings in aircraft engines are electroplated, cast, or rolled on to the steel backing. Although the cost of silver bearings might be expected to be high, actually they often cost little more than comparable bearings of other types (especially if the silver coating is produced by electroplating and is therefore very thin), because the cost of the silver in a bearing is only a small proportion of the total material-plus-production cost of the part.

A "substitution" use for silver in the bearings field is its presence as an essential constituent in a class of lead-base babbitt metals being offered in place of conventional tin-base babbitts containing over 85 percent tin. Lead babbitts have widely replaced tin, since tin is relatively much scarcer, and lead babbitts with 2 to 5 percent silver approach the properties of tin-base babbitts more closely than other substitutes that have been proposed or used.

The tin-conservation performance of silver in the solder field can be summarized in the statement that 2½ percent of silver can replace 30 percent of tin. The favorite substitute solder today is one containing 97.5 percent lead and 2.5 percent silver, which replaces lead-tin solders containing more than 30 percent tin. The "substitute" solder, now that the technique of using it has been mastered, is developing a strong

Steel solenoid housings and saddles are cleaned and fluxed, then assembled with a thin strip of silver brazing alloy between them. Heat is then applied, as shown, to melt the alloy and complete the joint

preference in its own right among many users and may be the "standard" solder of commerce in years to come.

The reasons for this are interesting. Although they must be applied at a higher temperature than standard solders (675 to 775 degrees, Fahrenheit, against 450 to 575 degrees) and require more active fluxes, the lead-silver solders can produce stronger joints than lead-tin solders *and are no more costly*. In the words of a recent War Metallurgy Committee report to WPB, "either at present pegged prices or at normal prices under ample supplies of tin and silver, the lead-silver solder is no more expensive in raw material cost than the 60-lead 40-tin solder previously used."

The major uses for solder in normal years were for dip-soldering automobile radiators, for electrical connections, and for soldering tin cans. In wartime the latter use emerged as one of the toughest substitution nuts to crack, but the can-makers have been extremely co-operative. They are now employing the lead-silver solders even on their automatic soldering machinery that was designed for the standard solder's lower application temperature and wider freezing range. (The lead-silver solders go from the liquid to the solid state quite rapidly, without a "pasty" period.) Some can-makers *prefer* the lead-silver solder on can bodies that have been made from the new electrolytic tinplate, because the side-seam strength is higher. This is significant, because the use of electrolytic plate is expected to surpass that of hot-dipped pl te in the post-war period.

The War Metallurgy Committee's investigations lead, finally, to the conclusion that the lead-silver solder for food cans involves no health hazard and is entirely safe even for evaporated milk, so widely used for infant feeding.

Lead-silver solders containing ¼ percent copper have long been used in the electrical field, and solders with 4 to 5 percent silver were and are standard for automotive radiator dip-soldering, in both cases because of their better strength at the elevated operating temperatures encountered.

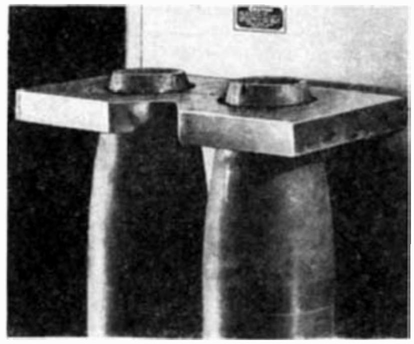
The war has brought a sharp increase in the use of silver in electrical contacts—those small metal parts that permit current to pass in a circuit when pressed together and whose separation leaves the circuit open. Contacts take the form of switch points, flat springs, nibs, screws, and so on. Some contacts are pure metals, some alloys, some bimetallic strips (two layers of different metals) and some pressed from powder to yield a duplex structure.

ENGINEERS are generally agreed that an ideal contact material would be one with the electrical conductivity, heat conductivity, low arc-resistance, resistance to oxidation and workability of silver, and the hardness and low material-transfer during arcing of tungsten. Approaches to this ideal are available in silver-tungsten contacts made by pressing and sintering mixtures of silver powder and tungsten powder to give a finished structure in which the individual properties of the two metals are largely retained.

Similarly, silver-molybdenum contacts made by powder metallurgy are employed where the utmost resistance to oxidation is not required and where molybdenum's aid in correcting the tendency of silver to evaporate at high currents can be utilized.

Considerable attention has recently been paid to laminated or bi-metallic contacts, two-layer contact strips of silver on a copper backing or of sintered silver-nickel, silver-molybdenum or silver-tungsten on copper.

Silver contacts of various types are used in aircraft control devices, communications equipment and switches, circuit breakers, relays, and temperature control systems for a variety of purposes.



Leak-proof joints between steel shell bodies and adapters are rapidly made by induction-brazing with silver alloy, using this heating set-up

The phenomenal expansion in the use of silver brazing in the last decade, and particularly since war production began on a large scale, has reflected a positive interest in this joining method as a faster, less-expensive means of fabrication and not as a substitute. According to Handy and Harman, New York silver bullion dealers, since the start of the war tons of this material have been used where merely ounces were required in peacetime. Millions of silver-brazed joints are now being made every month.

Silver-brazing alloys are basically alloys of silver, copper, and zinc that contain 10 to 50 percent silver and melt at temperatures as low as 1175 degrees, Fahrenheit. The brazed joints are made by bringing the parts to be joined closely together, with a rod, strip, disk, ring, or powder of the brazing alloy at the joint, then heating the joint area to slightly above the melting temperature of the brazing alloy by torch, induction heating, incandescent carbon, or by passing through a furnace or dipping in a hot liquid bath, and cooling. Properly designed silver-brazed joints usually have the strength of the solid metal and give the added advantage of being made at low temperatures. This means either faster production or lower heating costs, or both, and often permits the brazing of parts or tools that cannot be heated to temperatures above 1300 degrees, Fahrenheit, without destroying their useful properties.

A modern airplane has over 400 silver-alloy brazed parts, and every torpedo has several hundred brazed joints. A large ship contains over eight miles of piping that is joined with silver alloy rings. According to one authority the greatest single war use of silver brazing alloys is in the manufacture of bombs and shells. Sections of the 20mm and 40mm guns, the water-jacket of the Bofors guns, and even parts for the latest bombsights are silver-brazed.

A vital contribution of silver brazing to war production is its wide use for repairing hardened high-speed steel tools, which are costly *and time-consuming* to replace with new tools, but

(*Continued on page* 182)

Conducted by ALEXANDER KLEMIN

AIRLINES of the United States, though they have yielded much equipment to the Army, are today carrying more passengers, mail, and express than ever before in purely commercial operation. Growth of such operations has ceased for the time being because no new equipment is obtainable, but in the post-war period we may expect a tremendous increase in airline activities

Tomorrow's Air Transport Planes

There Are Many Reasons Why There Will be Great Increases in Airline Activities After the War. A Preview is Given Here of the Plane Types Which, it Now Appears, Will Carry Passengers and Cargo in Large Volumes and in Safety and Comfort at High Speeds

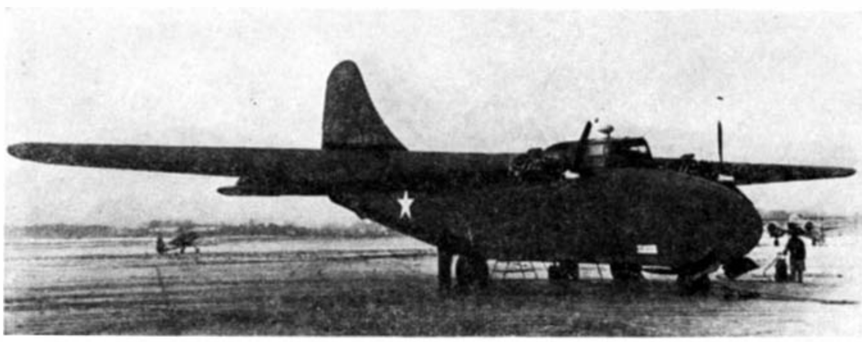
for very definite reasons: War aviation will have broken down all resistance to air travel; flight and ground personnel will be available in large numbers; and war aviation equipment—planes and engines—will be convertible in important numbers and at low prices to the uses of peace.

It is time, therefore, for operators and engineers to speculate on the characteristics of the post-war transport airplane. Timely utterances on the subject have been made by such distinguished men as Charles Froesch, Chief Engineer of Eastern Air Lines, speaking before the Society of Automotive Engineers; Jerome C. Hunsaker, Chairman of the National Advisory Committee for Aeronautics; and W. W. Davies, of United Air Lines, delivering a paper before the American Society of Mechanical Engineers.

Mr. Froesch perhaps gives the most vivid picture of what is being learned in current air-transport operations, particularly in those of a military character. Because war brooks no denial, risks are taken and lessons are learned which peace would not have taught us for many years. Thus, under the drive of war, airplanes have been flown at gross weights far in excess of those for which they were certificated, yet for the most part without disaster. This has led to the conclusion that wings can be loaded to as high as 50 pounds per square foot of wing area—a fantastic figure only a few years ago.

Powerful engines have come, with single units delivering up to 3000 horsepower. The combination of high wing loading, higher power, and greater airplane size has shown that a greater percentage of payload, and higher speeds, can be obtained than those which were available before the war.

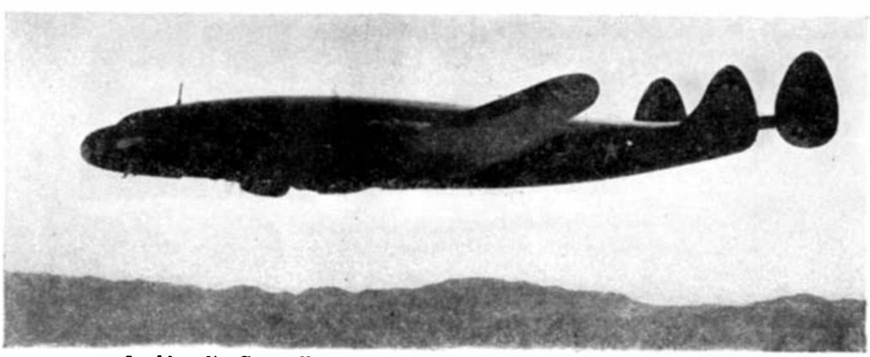
Because the Army and Navy needed high-octane fuels in huge quantities, the oil industry has learned to produce these wonderful fuels on a mass production basis at relatively low cost. Because military transport planes have at times to operate in rough and restricted terrain, the tricycle or nose-wheel landing gear has became an absolute necessity. Because the Army and Navy requires transportation of heavy engines, guns, even tanks, and every known variety of equipment to the farthest corners of the earth, we have learned that air cargo can be anything, that it can be loaded and unloaded quickly and secured in the cargo compartment against the most violent gusts and landings. Because the German army flew gliders into Crete, and the United Nations into Sicily, there is reason to believe that towed gliders will be utilized to some degree in post-war operations. Radar, submarine detection, innumerable war uses of short-wave radio, have given us perfect means for guiding and landing aircraft no matter what darkness or fog may prevail. And, finally, the need for huge numbers of bombers has taught us how to build planes and engines on a scale and at a cost which would have been unbelievable just two or three years ago.



The Curtiss Caravan, built almost entirely of wood

All of the above are lessons of war transportation. There is no ultimate benefit from any war, but war-inspired research can hasten technological advances. Thus Mr. Hunsaker, speaking at the opening of the Goodyear Research Laboratory, gave a picture of war research which will be as valuable to air transport as the more practical lessons of actual operation. The present trend is to use engine cylinders of no greater volume than those available today, where ratio of volume to surface is favorable to cooling. But war experimentation indicates that engines of 24 or even 36 cylinders, and horsepowers of over 3000, are entirely practicable. Both in this country and abroad the combustion gas turbine has been successfully used on land, and we are using a large number of exhaust-driven turbo-superchargers. It now appears that we have alloys which can withstand the excessive temperatures and high speed of the gas turbine. And, if the gas turbine for airplane use should come, it will remove many troubles inherent in the conventional engine such as cooling difficulties, detonation, vibration, and the like. The gas turbine may, however, have poor fuel economy. Propellers can scarcely be improved in efficiency, but, by using counter-rotating propellers, a way will be found to absorb the immense power of any engine. In aerodynamics, the laminar flow wing and the complete enclosure of the power plant will give better performance. These and other achievements of laboratory and experimental factory will coordinate with the advances made by actual experience in giving us greatly improved transport airplanes.

Because stress is placed on advances to come, there is no reason to assume that our present equipment is faulty. On the contrary, we already have splendid transport planes. The Douglas DC-3, almost universally used in commercial operation, is a magnificent ship, as thousands of travelers can testify, even if it is certain to be displaced by



Lockheed's Constellation, faster than any transport built to date better ships in the future. We have only to turn to the pages of our daily papers to see what the four-engined Douglas C-54 Skymaster and the twin-engined Curtiss C-46 Commando are doing so efficiently the world over. They are carrying troops, parachutists, technicians, jeeps, howitzers, supplies, ambulances, engines, spare parts, to our Armies and are pointing the way to greater post-war mastery of passenger and cargo carrying by air. Space will not permit us to deal specifically with all the fine aircraft used in this service; we can only speak of two machines actually produced since the beginning of the War.

One of these, the Curtiss (C-76) Caravan, flown for the first time more than a year after our entry into the War, is noteworthy for two reasons. It is a real air freighter and is built almost entirely of wood and plywood. The Caravan has a wing spread of 108 feet, is 68 feet long, and is powered with two engines of 1200 horsepower each. It is a "high-wing" design, with the fuselage floor near the ground, a level floor because of the tricycle landing gear, and a loading door opening up at the very nose. Thus it embodies some of the basic elements of the cargo airplane which we shall see on many post-war craft. Its construction embodies molded plywood, laminates, and plain lumber. For the moment there is sought the saving of strategic materials and labor, but plywood and plastics may be here to stay in the airliners of tomorrow.

The Caravan has relatively low wing loading, relatively low power for size, and only moderate speed, but it is a freighter. The other war-time achievement to be considered is the Lockheed Constellation, which lies at the other end of the scale; it has heavy wing loading, tremendous power, and a speed considerably higher than that of any transport built to date. And the high speed is combined with long range and large carrying capacity.

Exact specifications of the Constellation cannot be given, but here are some reasonably accurate and striking facts. The Constellation will cross the continent, non-stop, in less than nine hours and fly to Honolulu in twelve. It can carry 55 passengers and a crew of nine, non-stop from Los Angeles to New York in record time. It is powered by four 2000-horsepower Wright Cyclone engines and can reach 16,500 feet with two engines dead. The cabin is supercharged so that an air density of 8000 feet can be maintained while the plane is actually flying at 20,000 to 35,000 feet. The almost circular cross-section of the fuselage facilitates the pressurization. Three large vertical tail surfaces help to give control and stability. Again we see the tricycle landing gear. Built for TWA, the Constellation has been taken over by the Army because of its troop- and supply-carrying potentialities.

Not only shall we have vastly improved transports in the future, but a greater variety of aircraft as well. There will be helicopters for ferrying to the airport and for other auxiliary services. Small planes will serve small communities, possibly with the aid of the cargo pick-up system. The Douglas DC-3 will yield its proud position and become a feeder airplane. There will be planes exclusively devoted to cargo, of moderate speed; feeder line planes; huge, fast, passenger-carrying ships for non-stop operations of over 1000 miles. Announcements have appeared in the press of great six-engined giants of over 200,000 pounds gross weight being built or to be built by Glenn Martin, Harry J. Kaiser, Higgins, and Howard Hughes. Tom Girdler, of Republic Steel, now associated with Consolidated, has stated that his engineers can build a 500-passenger plane that will fly at something like 400 miles an hour.

The Constellation just after take-off, showing landing gear

In these columns is presented a table of the characteristics of airplanes to come, drawn from the paper by Mr. Davies; these are less ambitious than the giants just mentioned, but are more likely to be realized soon. From this table we can draw a number of interesting deductions. The biggest airplane for long-range domestic use should carry 100 passengers in day-time service, and be equipped with a total of 12,000 horsepower. For shorter range a 75-passenger plane is likely to be sufficient. Both types will cruise at over 260 miles an hour, and both will have very high wing loadings, with the extraordinary figure of 75 pounds per square foot for the larger craft. The ship listed as No. III will have a freight load of only 14,100 pounds, indicating that Mr. Davies, an experienced airline engineer, does not immediately expect huge cargo loads. But even type IV, the feeder line plane, will be bigger than the DC-3, a sign that transports will constantly grow larger. The small cargo

AIRPLANES TO COME, AS PREDICTED BY W. W. DAVIES

Type	Airplane I Low-Wing-Mono.	Airplane II Low-Wing-Mono.	Airplane III High-Wing-Mono.	Airplane IV High-Wing-Mono.
Takeoff Weight—(Lbs)	126,500	80,000	43,000	32,500
Landing Weight—(Lbs)	110,000	70,000	40,000	30,000
Weight Empty—(Lbs)	76,770	46,405	24,925	19,050
Useful Load/Gross Wgt.	40%	42%	42%	41%
Wing Loading (Lbs/Sq. Ft.)	75.0	57.0	32.3	32.6
Power Loading (Lbs/HP)	10.5	9.3	12.7	13.0
Number Engines	4	4	2	2
BHP/Eng.—Max.—(BHP)	3000	2150	1700	1500
Cruise Speed—(MPH)	266	260	212	210
Range—Max. (Mi.)	2500	1200	750	1300
Span—(Ft.)	141	118	115	100
Length—(Ft.)	118	97	73	69
Number Passengers Day—Max.	100	75	52	None
Number Passengers Night—Max.	56			
Mail or Cargo—Max. (Lb)	4500	3000	14,100	10,410
Type Gear	Tri.	Tri.	Tri.	Tri.
Cabin Superch'g.	Yes	Yes	None	Cockpit and some compartments

or combined cargo and passenger ships will be much slower, with cruising speeds of only 210 miles, and will have lighter wing loadings because they will make use of smaller fields. For passenger ships, the low-wing position is the more attractive because the wing then gives most protection. For cargo planes the high-wing position may work out best because the fuselage is then near the ground for loading and there are no wings to impede the approach of motor trucks.

Mr. Froesch also feels that a 50 to 60 passenger capacity in domestic operation is a practical limit. Beyond a certain size, the utilization factor drops. Power plant installations, he thinks, will be self-contained and interchangeable. Landing gears will be simplified. Since friction brakes on the wheels will no longer be satisfactory on very large planes, aerodynamic braking will be achieved by reversing propellers. To avoid wear of tires, they will be prerotated before landing. Cockpits will be much better lighted, windshields made proof against impact of birds. Fire protection will be much better. Gas tanks will be built in. Pressurization of the cabin will be frequent.

Immediately after the war we can expect a transitional period of some uncertainty. While special transports will certainly be built, there will be a great temptation to utilize war equipment, with some disappointments in regard to accommodations and safety. Airlines will buy cargo planes but not accept cargo-carrying with complete conviction. But eventually the higher speeds and lower direct flying costs of the most modern equipment will fully justify themselves, and the important post-war transport will bring to the airlines a vast amount of traffic—passenger, mail, and cargo—in quantities which it is difficult to overestimate.

A FLYING SCHOOLHOUSE

Provides Systematic Instruction for Heavy Bomber Students

Bessie, the flying schoolhouse for heavy bomber students

THE war has done much to speed up the training of airplane pilots: The Link Trainer and other devices provide the sensation of flying and teach the student how to counteract the effects of gusts without leaving the ground; other devices teach him aerial gunnery and bring home the mistakes he makes in fictitious combats. These devices involve air-driven bellows to provide motion; moving pictures to simulate the horizon, to portray the enemy, and to enable accuracy of fire to be studied.

Another example of these modern instruction methods now appears in the four-engined Boeing bomber, affectionately known as Bessie, which has been arranged as a species of flying schoolhouse. The craft is identical with the Flying Fortresses operating so successfully in many parts of the world, except that its armament has been removed and its fixtures renovated to provide room for classes.

A regular crew of instructors is in charge of the training program and the Schoolhouse flies to various centers. At these centers, advanced heavy bomber students receive systematic instruction. They learn how to secure the highest possible operating efficiency and maximum flight range, by co-ordinating a multiplicity of factors such as fuel mixture, air speed, turbo-supercharger pressure, engine speed, and altitude. The students also learn how to act in difficult circumstances as when, for example, one or more of the engines is crippled in the course of a bombing mission.

The flying classroom, organized by Boeing Aircraft, was originated by Eddie Allen, the famous engineer and pilot who recently perished in a test flight, and is another reason why his memory is so revered in aviation circles.

LATIN-AMERICAN AIRWAYS

Details of the Recent and Continuing Struggle are Available in Book Form

ONE of those rare men whose lives are devoted to public service without thought of financial or political advancement is William A. M. Burden, Special Aviation Assistant to the Secretary of Commerce. Fortunately for American aviation, it is in this field that lie Mr. Burden's vocation and avocation. To the writing of his recently published book, "The Struggle for Airways in Latin America," he has brought well-rounded knowledge and broad experience, which include the writing of a special report for the Coordinator of Inter-American Affairs.

To most of us, aviation in South America means Pan-American Airways; we can scarcely imagine how powerful the Nazis had become in South American aviation, how closely they had come to dominating our Latin neighbors with a fifth column of the air. Between 1920 and 1939 the German and Italian interests, with strong government backing, acquired control of 10,000 miles of air routes in South America, and established strategic airlines linking South America with Europe.

At the opening of World War II, the Germans, in spite of the blockade, expanded their aviation efforts still more. Yet, in the space of one year, our Government and our airways, acting in concert with the South American republics, succeeded in grounding every German and Italian plane.

Mr. Burden begins his book with a fine chapter, geographic and economic, on Latin America, and then describes the period of development when our companies, Pan-American and Pan-American Grace, entered the field and fought their way ahead with postal revenues as their only governmental aid. By 1932 Pan American had established itself splendidly. The keenest period of rivalry came between 1935 and 1939 when the German-owned Condor lines expanded to Argentina and Chile. The story of how the Axis efforts were counteracted, how their services gradually disappeared, and how American airways replaced them, is told quietly and effectively. We can well feel relieved that the task was done well.

But Mr. Burden does not limit his work to episodes. Statistics, charts, and economic analyses make his work scholarly as well as fascinating. Later he discusses potentialities of South America in the air, post-war policies in the air, and maintenance of friendly relations with our South American neighbors, as well as the sound development of our flying operations to the Southern Hemisphere. Possibilities of traffic and national and international legislation are well covered. The photographs are fascinating and include such striking pictures as the catapulting of the Dornier-Wal mail plane from the *Westfalen* and flights over the Andes.

Conducted by EDWIN LAIRD CADY

Taking Dust Out of Industry

Originating Without as Well as Within the Plant, Industrial Dusts Represent Hazards to Production Processes and to Personnel Alike. These Dusts Present Problems that Science Has Answered in Many Ways, Depending on the Individual Factors Involved

DEALING with modern high-speed factories is a corps of dust-controlling technicians whose work grows in industrial importance every day, for dust particles, the tiniest enemies of factories, cause some of the biggest production troubles.

The range of those troubles is amazing: Fine instruments caused to give false readings, light or transparent plastics discolored, lubricants fouled, occupational diseases instigated and promoted, cylinder walls of Diesel engines and air compressors eroded or cracked, short circuits or fires caused in electrical equipment, explosions propagated, and plant "housekeeping" expenses increased—to mention only a few dust troubles.

Dusts may originate within a plant or come from outside. And of the two, the outside dusts are the harder to control, for no one can predict what may be in them.

The managers of one machine shop found that workers in the office as well as the shop were suffering with headaches, asthma, and allergic skin troubles. Dust was one of the causes suspected, but the shop was producing no dust that could have such effects. Slides placed on the office walls over night were used as detectives to find out what went on. In the morning they were found coated with fine flour dust from a nearby cereal plant. The culprit causing the illness was smut and grain rust evacuated from the "cyclone" on the grain mill roof. Strange to say, the workers in the mill itself were pretty well protected, but the cyclone exhaust going down wind was dangerous to a whole neighborhood.

Charging wires and discharge plates of an electrostatic-type air cleaner

Fine dust travels farther than coarse dust; in a 10 mile per hour breeze, fly ash of five-microns size (a micron is one twenty-five thousandth of an inch) discharged from a stack 300 feet high can travel 276 miles before sinking to the ground, while a 60-micron size would travel two miles. The importance of this is that the finer the dust the greater the damage to human lungs, especially if the dust can cause silicosis.

First thought is given to doors and windows. It is impossible to seal these so tightly that dust could not get through. The answer is "plus pressure ventilation"—keeping the air pressure within the room slightly higher than that outside, so that any air leakage will be outward and will blow the dust away.

Some dust will get in anyway, for wind pressure outside the walls can at times become greater than ventilation pressure within. Furthermore, the most efficient ventilating air cleaner known—the electrical "Precipitron"—will not take more than 95 percent of the finest particles out of the incoming ventilation air. Then as much as possible of the dust which escapes all precautions can be trapped by keeping walls and floors just tacky enough so that any dust which strikes them will stay on them. So little dust actually does get in that walls look freshly painted although unwashed for four years after last being decorated, but even this little can do damage; the very finest industrial equipment is kept in specially sealed rooms which still are far from completely dust proof.

The Precipitron is the greatest boon ever given to the dust-control engineer. Before this device came on the market, water sprays were the best air cleaners, but it is impossible to design a spray that will get all of the dust—even air bubbled up through clear water will contain dust within the bubbles. The Precipitron works on an electrostatic principle. Air going through this device flows past wires containing an electrical potential of about 12,000 volts. Dust particles of all sizes, from extremely coarse to the finest that any magnifying glass can make visible, are given positive electrical charges, the charging taking about one hundreth of a second. The air then passes into a collector section containing plates which carry a negative charge of 5000 volts. Since opposite polarities attract, the dust particles are drawn into the field of these plates and out of the air. The cleaned air then passes on to its point of use.

Not all dust control requires as thorough a job as the Precipitron will do. In a steel mill, for example, Precipitrons are used to clean the cooling air which is fed to large motors; for even a little dust in these machines could cause fires or do other expensive damage. But ordinary filtering or water spraying will do a good enough air-cleaning job for the plant in general.

An ideal mill is plotted out into areas for dust control as carefully as for materials handling or for fire control. Needs of each area vary on a scale by which dust concentrations are called hazardous, nuisance, tolerable, or free.

Materials used for some polishing operations produce dusts which might cause silicosis. Following the formula commonly used in mines, any concentration of such dusts which adds up to over 5,000,000 particles per cubic foot of air is in the hazardous class and must be reduced. It is possible to take out more than 98 percent of the weight of

A shot-cleaning machine is sealed dust tight and a cyclone removes the dust as fast as it is produced

dust in the air, and still have a count that is more than twice too high, since the removal of just a few heavy particles will reduce the weight while leaving the count of fine particles almost undisturbed.

Talc polishing compounds can be allowed 10,000,000 particles per cubic foot of air without being hazardous, but the talc has a way of penetrating everywhere, making "housekeeping" problems hard. Therefore, any concentration over the 10,000,000 figure is called "nuisance"—the men hate to work in it anyway—and is reduced.

Concentrations which are neither nuisance nor hazardous are within the tolerance threshold. But the company likes to go still further and reach the "free" point; this latter being subject to no exact definition but covered by the general description that any room is dust free when dusts do not make their presence felt if cleaning of the walls is neglected for a three-week period.

First step in control of dusts originating within the plant is like that which is common to all industry. It is to eliminate each dust at its source. And the first move is to collect the dust as fast as it is produced.

Easiest way to collect dust at the source is to put shrouds, hoods, or complete enclosures over the dust producers and continually evacuate the dust through air suction. This often pays profits. The dust itself may contain valuable brass, copper, aluminum—even the nuisance fly ash from burning pulverized coal is valued as a fine polishing agent. Heat, too, is saved; the heat may be that originally put into the air by the plant heating system, or may be produced by the friction of grinding and other operations, but with outdoor weather averaging around 35 degrees and the indoor temperature 65 degrees, from three to nine tons of coal can be saved per heating season for each 1000 cubic feet of air capacity of the system which picks up the dusty air, cleans, and recirculates it.

COLLECTING the air at the dust source is, however, never completely effective, but every practical bit of ingenuity is used to increase this effectiveness. Nevertheless, there is a limit to the speed at which air can be permitted to enter the evacuator without the suction or draft becoming a nuisance in its own right, and that speed is not always high enough to keep the dust under control.

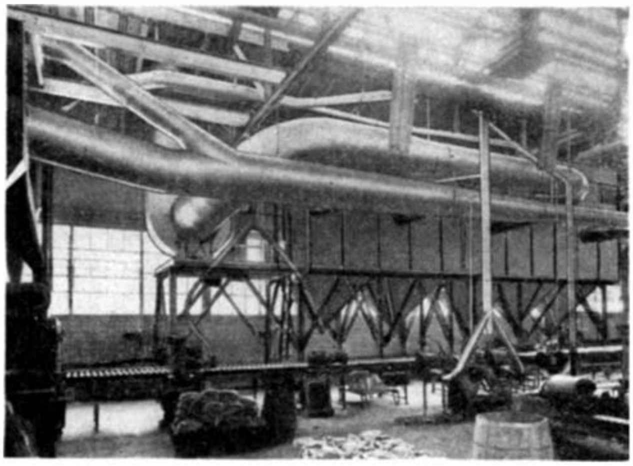
Second step in control is to clean the air of the room itself. This calls for collection ducts, or similar means, leading the fouled air to water sprays, Precipitrons, or other highly effective cleaners. Cleaning is accompanied by control of humidity and temperature—cleanliness, humidity, and temperature being the three main points of air conditioning.

With general air cleaning or air conditioning in use, the control of dust at its source is easier. The air evacuated at the machines is led through ducts to filters, or in some cases through settling chambers, cyclones, baffle type cleaners, and other steps before the filters, and then recirculated in the room.

Filters or high-efficiency cyclones, which will remove 98 percent of dusts by weight, are quite common. They leave the finer particles still entrained in the air, and keeping these down is the function of the more effective cleaners in the air-conditioning systems.

Dust loads on air-conditioning systems are kept down by isolating the worst dust-producing processes in special buildings or rooms. Controlling the dusts from these rooms, and sometimes classifying and saving them as valuable by-products or as materials to be returned to the production line, almost always calls for sequences of dust-removing devices.

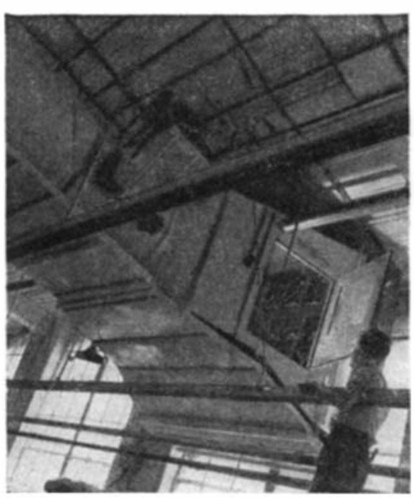
First device in line may be a settling chamber. The effectiveness of such a chamber depends upon the sizes of the particles and their specific gravity. The larger the size and the higher the specific gravity, the faster the particles will settle out of the air and the higher



Bag-type cleaner sections may be individually cleaned

the velocity with which the air may be permitted to move through the chamber, or the shorter may be the distance the air travels in the chamber and consequently the less the floor space occupied by the chamber. A common device is a chamber having a sealed collector trough at the bottom; at regular intervals this trough seals itself off from the chamber so that no fouled air can escape through it, and automatically discharges to a conveyor which returns the collected dusts to the production line. Operation of such a collector may be manual, but often is fully automatic, being controlled by a scale which weighs the collected dusts and actuates a switch which turns on the necessary motors when enough dust has been collected to be handled as a controlled unit of raw materials.

Next in line after the collector chamber may be a low efficiency cyclone. This shares with the collector chamber the advantages of being extremely low in power costs for moving air through it, low in maintenance also, as the air



Cleaning duct in a textile mill

movement is too slow to cause the dusts to do much abrading of its parts, and high in ability to cool off hot dusts whether or not the heat units from them are conserved for plant or process temperature control.

A baffle type cleaner may come after the low efficiency cyclone, or even take its place. In a baffle cleaner the air is caused to take abrupt changes of direction. As the air whirls around the corners between the baffles, centrifugal force causes some dust particles to fly out; dead air pockets also form to let dust settle out. Usually the dust is permitted to fall into collector sections, but in some cases the baffle surfaces are covered with oil or other tacky material which will hold dust that strikes them, and are washed and reoiled as often as necessary.

The drop in air pressure between the intake and the exhaust sides of a baffle cleaner is an index of the amount of adhering dust which is blocking the passages, and therefore of the need to rap or clean the baffles. This drop is easily measured with a water column, the column being a U-shaped tube with one end open to the intake and the other to the exhaust and partly filled with water. The water will be pushed down at the side of higher pressure and will rise correspondingly at the lower pressure end, the amount of rise being an index of the pressure difference—a principle very old in the measuring of stock drafts.

The water column also is commonly used as an index of the need to clean a filter. Many types of filters use dust itself as part of the filter medium; the dirtier the glass fiber or cellulose bats, the finer the dusts which will fail to pass through them. Presuming a filter to be next in line after the cyclone or the baffle cleaner, good management may call for letting the air which reaches the filter be dusty enough so that the filter will retain its effectiveness over long time periods but not so dusty that the filter overloads. The dirtier the filter the greater the pressure drop of air passing through it. The water column measures this drop and tells when the filter is not dirty enough to be at its best or is so dirty that, if a dry type, the bags or bats must be replaced; or, if a wet type, they must be cleaned and re-oiled.

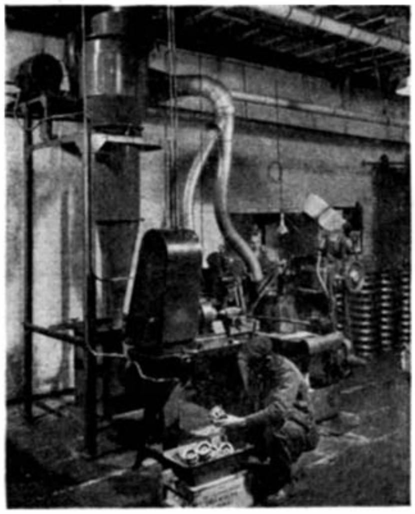
A water column also indicates when the bag type filter needs shaking or rapping, and can indicate the presence of torn bags. This type of filter often is built in sections with many cloth or asbestos bags per section—cotton bags usually being used for air temperatures up to 170 degrees, Fahrenheit, wool up to 220 degrees, Fahrenheit, and asbestos to 450 degrees, Fahrenheit. Individual sections can be shut off for dumping or rapping to clean the bags, the sections being ready for further service when cleaned. When dusts are to be returned to the production line, the bags often dump directly into conveyor sections which are sealed so that the dust in them can travel only to closed containers or process equipment.

High-efficiency cyclones may be used immediately ahead of filters or, by taking out over 95 percent of the weight of dusts, may do such a good job in their own right that no filters are necessary. They differ from low-efficiency cyclones in that they are smaller in diameter and the air in them whirls at much higher velocity, producing greater centrifugal force, and therefore they take out much more of the dust. High efficiency cyclones are likely to have features which add greatly to their effectiveness while reducing maintenance costs.

Last link in a chain of air cleaners may be a water spray or a Precipitron, or both. The spray aids humidity control, the Precipitron does a more thorough cleaning job; selection is by conditions to be met.

Important wrinkle in du t control is elimination of dust producing processes. In one large foundry, the sand coated surfaces of castings had been cleaned by silica sand blasting, setting up a silicosis hazardous condition any time the sand blast machine leaked. Steel shot substituted for the blast sand greatly reduced the problem. A wet cleaning process eliminated the hazard that even the steel shot had left.

With air conditioning so improved, portable air cleaners are being used to take care of casual or temporary problems. The sand blasting of a masonry surface can set up short-lived but dangerous silicosis hazards. Removing of old paint, or welding of machine parts which had been painted, can create fumes and dusts containing dangerous quantities of lead and even of mer-



A cyclone is installed directly at these grinders to collect the dust

cury. Production machines which can temporarily increase their dusts production need temporary amplification of the evacuation through their hoods.

An enemy as elusive as dust needs auxiliary reinforcements as well as regularly established equipment for ideal control.

OIL TEMPERATURE

Must be Controlled for Highest Efficiency in Machinery

MODERN bearings must have exactly the right quantities of lubricant at exactly the right pressures. Let the temperature of the oil in the lubricating system change, and either the oil will become lower in viscosity, leading to more oil being fed at the same pressure, or the same amount of oil will be fed at lower pressure, or if the viscosity becomes higher, then pressure will stay the same but less oil will be fed. In any case the shape and position of the oil wedge in the bearing will be changed, the ability of the oil to scavenge will vary, and the accuracy of the machine as well as the life of the bearing will be reduced.

When cutting oils are controlled in temperature, parts on which they work are kept more accurate and in better alinement, which means more accurate production from the machine and longer life for the tools. Machines need shorter warm-up periods too, for the controlled temperature of the oil brings the work areas to uniform operating temperatures far more quickly than if the heat of operation had to warm up the oil to its ideal working temperature.

In the cleaning of cutting oils, temperature control plays an important part. Hot oils give up their foreign matter in centrifugal type cleaning equipment more readily than cool oils, but some types of foreign matter may settle out of cool oils better than hot. And oils need to be clean if they are to keep tools at their best.

Heat is taken from oil by passing the oil through heat exchangers, sometimes by using large volumes of oil so the oil gets plently of time to cool between passes through the machines, and even by running it through mechanically refrigerated chambers. Often it is economical to flow the oil to a central point where both cleanliness and temperature can be fixed, but the practice of having oil temperature controlling refrigerators or other devices attached to individual machines is a growing one.

GRIND OR NOT

New Figures Aid an Old Argument

DIFFERENCES of methods in the machine shop are largely matters of philosophy, with endless arguments occurring between engineers accordingly. And one of the moot points is whether to obtain fine finishes by machining slowly but nicely, or by hogging the stuff out and then grinding it smooth.

Opinions on this point have bounced all over the machine-tool marts. But the war has given one solid starting point with which to settle old arguments and start new ones. It is that when turning out 20mm anti-aircraft shells on automatic screw machines, grinding can be avoided if the feed is .002 inch per revolution but will be necessary if the feed is .004 inch per revolution, the cutting speed being about 120 surface feet per minute in both cases.

This bit of knowledge still leaves the boys free to argue as to whether it is better to cut twice as much per revolution and then grind, or to get the whole job over with on one machine. but at least they can add some figures to their epithets.

SPOT WELDING

Demands Clean Surfaces for Uniform Results

SPOT welding of aluminum is an art which has grown up from its infancy during the war, but which will long survive the war; spot welding can produce not only sound welds, but consistent ones as well in this "hard to weld" material.

Any spot welding depends for success mainly upon uniformity of electrical resistance of the material to be welded, and the more difficult the welding the more the importance of this quality. Given uniformity of resistance, then such factors as the density of the current, the time period over which the current is applied, the pressure or mechanical shock used, the temperatures of the electrodes, and so on, all can be kept uniform for uniform results.

Aluminum alloy sheets have varied resistance at the points where they are pressed together for welding, due largely to the presence of foreign materials on their surfaces, or to the "chemical" surface effects of contaminants found in the air or in materials to which they have been exposed. One effect of this resistance can be to make the sheets weld more readily to the copper electrodes of the welding machine than to each other.

Cleaning the sheets to get uniformly resistant surfaces involves two problems. The first is that of getting off the foreign matter or soil which may be clinging to them, and the second is to take off the surface layer of aluminum oxide or other "chemical contamination" and expose the clean metal beneath. Thus a uniform resistance is obtained because contact is between uniformly clean parts.

The foreign matter is removed by alkaline cleaners, by petroleum solvents, by vapor degreasing, or by combinations of these methods. A thorough rinse follows; the surface must be "chemically clean" or show no break in the film of water clinging to it after immersion in water.

Modern method of removing the aluminum oxide coating is to immerse the sheet in an acidic cleaner of about 0.5 to 2.0 pH. The cleaners are specially made, and are mixed with water in proportions of four to six ounces per gallon.

Conducted by JAMES M. CROWE

Progress In Proteins

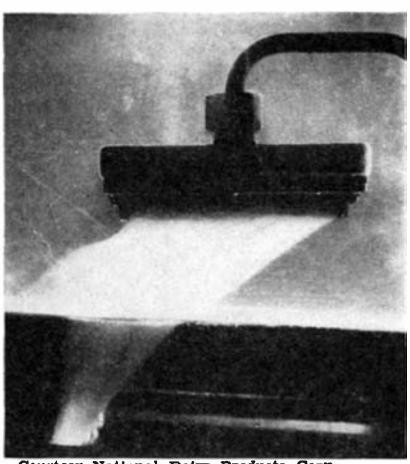
As the Chemists in their Laboratories Learn More and More About the Fundamental Chemistry of Proteins, Industry in the Factory Should be Able to Shift From its Present Fortuitous, Cut-and-Try Methods Toward New Progress and, in Turn, New Industries

Vital to the life of all living cells, protein is also basic to a number of man-made products, some new, some old, but all of importance to the industrial world.

Protoplasm, the essential constituent of all plant and animal cells, consists mainly of water and the complex organic compounds of nitrogen which are called proteins. Since it has been shown that all protein is not chemically identical, however, the plural form of the word, proteins, is used to designate the closely related but different essentials of plant and animal life. From these same groups are now made such prosaic and utilitarian products as buttons and fabrics, glues and paints, and a host of others.

In order to appreciate more fully some of the problems involved in the industrialization of proteins, it is needful to scan briefly what little—and it is little, indeed—has been uncovered by research into the fundamental nature of the proteins.

Animal life is dependent either directly or indirectly on plants for their supply of protein. Plants are able to synthesize or manufacture proteins from simple inorganic nitrogenous substances or in some cases by the utilization of atmospheric nitrogen. Animal organisms are not able to do this and must receive the necessary protein prefabricated in the diet. This does not mean that synthesis of proteins is impossible in animal bodies. Yet the compounds from which animals can manufacture proteins are in themselves complex nitrogenous organic substances—again, proteins.



Courtesy National Dairy Products Corp.
A spinneret through which viscous casein is being converted into fiber

In spite of the great importance and abundance of proteins in both plant and animal life, their chemistry is still largely obscure. One of the main difficulties in the field of research in proteins is the baffling complexity of their molecular structures. Of all the types of molecules found in nature, proteins are undoubtedly the most varied, complex, and largest. In fact, there has never so far been produced any specific and detailed proof of the exact structure of any protein compound.

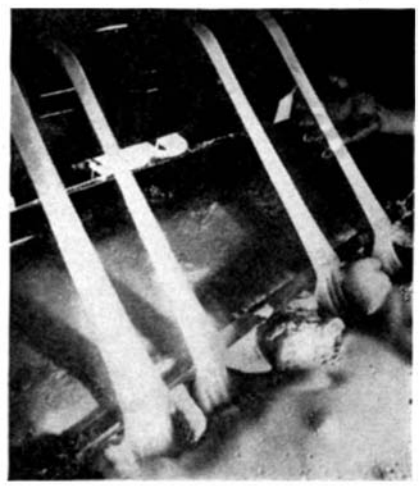
In recent years there has been a revival of interest in the proteins. Their chemical nature has been vigorously attacked with new scientific tools, principally the X-ray, the ultra-centrifuge, and the electron microscope. Much progress has been made but there is still a long, long way to go.

On the basis of present theories, speculation as to the molecular architecture of proteins is fascinating but theories must still stand the test of experimental evidence.

For many years it was believed that the isolation of a protein in the chemically pure state was nearly impossible. Recently, however, this situation has changed quite completely. The enzymes pepsin, trypsin, and urease, and the hormone, insulin, have all been isolated and appear to be proteins. One of the most recent and brightest chapters in this search for protein in its chemically pure state is the isolation of the virus of the tobacco mosaic disease. This virus is described as a crystalline protein. The significance of this discovery lies not only in the great advance in the understanding of protein structures but in the fact that it connects proteins with such diseases as measles, yellow fever, the common cold, and several other diseases of both plants and animals.

Although biochemical reactions rank highest in importance in the present-day field of protein chemistry, natural protein products have been used empirically for a long time without realization of the complexities of their chemistry. For example, silk, wool, hair, and leather are all essentially protein products. In the course of the years a great deal of practical knowledge was acquired about the processing and handling of these materials by cut-and-try methods and by accidental discoveries, without much insight into their structure or their chemistry. In more recent years protein products such as casein, gelatin, and albumen have been widely used in industry for paper coating, adhesives, molded buttons and buckles, water paints, plywood and furniture glues, insecticide sprays, wax emulsions, leather dressings, films, plastics, textiles, photographic films, duplication processes, and many other applications.

Outside of the naturally occuring protein fibers such as silk, wool, hair, and leather, probably no single protein has been studied and utilized as extensively as casein, the principal protein of the milk of all mammals. This might have been expected since this constituent of man's earliest food is easily separated in a more or less pure state. In fact, there is mention that early Hebrew texts advised the women to save milk curds for a certain time of the year when an itinerant painter visited the villages and concocted a paint from the milk curds and natural colors to paint the peoples' dwellings. Undoubtedly this was the earliest reference to our so-called cold water or casein paints. It is also said that the craftsmen of ancient China, Egypt, Rome, and Greece used casein glue in fine woodwork. Apparently the art was



Four spinnerets producing Aralac fiber are concealed beneath the foamy mass in this spinning box

carried along in a small way by European wood-workers through the Middle Ages.

In spite of the lack of exact chemical knowledge, the manufacture of casein was started as a real industry in Switzerland and Germany in the early 1800s. Patents on casein sizes and glues began to appear in the United States about 1800, and casein was being used in increasing quantities for coating paper between 1880 and 1890. The need for a strong glue in the manufacture of military aircraft from wood in World War I aroused great interest in the manufacture of casein glues and led to a thriving industry, whose ramifications are now manifold. On one side we have the field of plastics and artificial textiles, and on the other those applications more or less linked with the desirable adhesive properties of casein.

With the increased demand for casein protein in industry, the first crude manufacturing operations were improved to the point where we now have efficient modern processes, which produce large tonnages of high-grade products.

Most casein is obtained from skim milk by precipitation of a protein brought about by the direct addition of hydrochloric or sulfuric acid, or by self-souring as a result of formation of lactic acid by fermentation of the lactose in the milk.

Another method employs rennet for the precipitation of casein. In either process, after the protein is precipitated the whey is removed and the casein is washed with water, ground and dried, and appears as a dry, white, sweet-smelling powder.

THE ACID-PRECIPITATED casein is usually used for adhesive or coating applications, while the rennet casein is preferred for the production of plastics.

The use of casein in plastics can be traced back to the year 1897 when a printer in Hanover conceived the idea of producing a waterproof coating on cardboard. As a result of his collaboration with a chemist who was working on the problem of waterproofing casein, the formaldehyde-casein reaction, on which a great deal of the casein plastics industry is built, was discovered. This reaction was soon used to produce solid plastic masses, and commercial production of casein plastics was started by the Golalith Company of Harbourg. This name, "Golalith" which means "milk-stone" has since been used as a general term for casein plastics.

In spite of a good start, casein plastics have made slow progress in America. One of the main reasons for this is that they are hygroscopic; that is, they absorb water, and this in turn deforms them. Certain other qualities do, however, make casein plastics desirable for small products such as buttons, buckles, beads, and other novelties, and they have enjoyed moderate success in filling these needs.

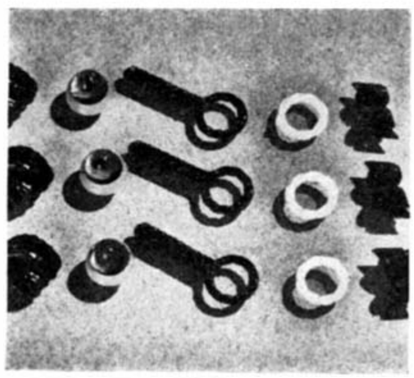
One of the best features of casein plastics is their affinity for a wide range of colors, affording various multi-color effects. Splendid pastel shades and streaked and mottled effects may be obtained that rival the beautiful natural effects of horn, jade, pearl, and so on.

Finished fluffy Aralac fiber ready to be pressed into 450-pound bales

One of the newer uses of casein is in the manufacture of synthetic textile fibers. Before the war started it was reported that a casein fiber called Lanital was in commercial production in Italy. Since that time an American product called Aralac has been put on the market, and is said to have overcome the weakness and brittleness of earlier casein fibers.

Another large field of protein chemistry lies in the production of glues and gelatin from stockyard wastes. The material common to bone, tendons, and skin of animals has been found to be a protein called collagen. This is an insoluble substance consisting mostly of the white fibers of connective tissues.

When this collagen is hydrolyzed, gelatin is obtained. Ordinarily, gelatin is a nearly odorless, transparent amorphous substance, which swells to many times its original volume when immersed in water. Various grades of gelatins and glues depend on the raw materials and processes selected for manufacture.



Courtesy "Modern Plastics"
Ornaments made from casein

Gelatin is used to a great extent in the food industry, in ice cream, marshmallows, desserts, and so on. In industry it is used as an adhesive, as a sizing for paper and textiles, in leather dressings, cold water paints, preparation of colloidal precipitates and emulsions, in matches, hectographs, printing, pharmacy, and photography. These are only a few of its applications to industrial processes. Yet the chemical structure of gelatin is still little understood.

Widespread attention is currently being paid to the soybean both as a farm product and as an industrial raw material. The soybean, while not definable as a protein, has a high protein content. Until the past few years the primary interest in the soybean was from a food standpoint, especially for animals and poultry. Also, the oil extracted from soybeans was soon found to have valuable industrial applications, mainly in the paint and varnish industry and to some extent in the soap industry. The principal use was as a component in the manufacture of butter and lard substitutes and as a salad oil.

It was soon found, however, that the large quantities of meal left from the solvent extraction of oil from soybeans could be considered an almost unlimited raw material for the production of soybean protein. If, for illustration, 10 percent of the 1941 crop of soybeans, estimated at 107 million bushels, was processed for protein, it would supply about a quarter of a billion pounds of protein.

Courtesy Ford Motor Company
Spinning soybean protein fiber

Soybean protein is a comparative new-comer to the industrial field of proteins. It resembles casein more than any other protein and, in fact, in the early attempts to introduce it to industry it was called soybean casein, with the idea of trading on the good name of its already established brother protein. Indications are that soybean protein will find great use in many of the fields already pioneered by other commercial proteins.

RESEARCH work is being carried on both by government and industrial laboratories on the structure of protein molecules, and on the possibility of substitution or modification of their organic groups—possibilities which may result in appreciable changes both in physical and chemical properties. This work, which is being intensively directed toward a study of soybean protein, is expected to make this crop an increasingly important raw-material source for industry; as this source develops, the farmer will profit correspondingly.

Another protein extracted from a farm crop in large quantities is zein, obtained from corn. This is a fine, slightly yellow powder, which has been under investigation for a number of years by the companies manufacturing starch, with the idea of providing a raw material for plastics of the casein type.

Zein has the advantage over casein that the formaldehyde used for curing it can be incorporated directly into the plastic before forming, thus eliminating the lengthy step of curing in a formaldehyde bath which is necessary with a more highly reactive protein such as casein. The zein plastic is tough and has a transverse strength of about 15,000 pounds per square inch.

With zein, water resistance, which is

the weak point in many applications of casein plastics, is said to be better. The largest industrial use of zein, however, appears to be for coating papers, where it improves appearance and provides protection for the surface. Zein is outstanding in its resistance to penetration by greases or oils, and therefore may have a large potential use for making food containers and wrappings, where this property is of importance.

Within the past few months a new field for the production of proteins has opened up with the announcement of the Balls-Tucker processes for obtaining alcohol from wheat. In this process the protein is obtained as a by-product in a very pure state, and some observers say that the by-product protein may become more important than the production of alcohol. This would be a case of a new industrial tail wagging the alcoholic dog. Several food manufacturers, notably soup and bread makers, are considering the use of such proteins to fortify their products and round out their nutritive value.

Many of these recent developments in the production and commercial use of the newer proteins coincide with increased interest and research activity in the fundamental chemical nature of proteins. The work of all groups, including the significant discoveries of the biochemists, indicates a trend of accelerated progress into the secrets of one of nature's greatest and so-far darkest storehouses—one which is likely ultimately to yield new industrial fortunes.

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FLUID CATALYSIS

Operates on a Principle of Industrial Importance

THE FLUID catalytic process which is now being employed to boost the supply of high-octane aviation gasoline represents a new chemical engineering technique which it is predicted will have many industrial applications not only in catalytic operations but also in many other non-catalytic processes outside the petroleum field.

The important operating advantage of the fluid catalytic process is its complete freedom from mechanical means for moving the catalyst or changing the flow of the cracking or regenerating streams.

The way in which this is accomplished is novel and noteworthy. The catalyst is used in a finely pulverized form, almost like talcum powder. This eliminates the requirement of forming the catalyst into lumps which can withstand, without deterioration, the alternating temperatures of the fixed bed type of operation as well as the abrasion of high-velocity gases. Special types of catalysts are thus available which otherwise would be impractical because of physical limitations.

The finely divided catalyst is not actually a "fluid." It is a powder maintained in a fluid, turbulent state, by passing through it at all times a certain minimum percentage of some vapor which may be either air, inert gas, steam, or petroleum vapor. The consistency of the catalyst thus handled might be compared to the sand just at the water's edge at the seashore which flows readily when supported in part by the water.

It is a remarkable fact that a properly pulverized solid mixed with even a small amount of such vapors attains an extraordinary degree of fluidity and can be handled exactly as if it were in fact a fluid. Thus in the fluid catalyst cracking plants the catalyst is circulated in a manner analogous to an airlift used to pump water out of a well, and the means used for this circulation is the petroleum vapor being cracked or the air used for regeneration or removal of coke from the catalyst.

Of particular significance is the fact that the fluid catalytic cracking process makes possible the use of types of catalysts and operating temperatures which would not be possible with other catalytic cracking processes. This permits greater control over the products produced in the cracking operation. These units can, therefore, be converted to work much more effectively in the production of materials from a given amount or type of crude available.

TARTRATES

Recovered from Wine Vats by New American Process

A YOUNG chemist in New York State's grape-growing Finger Lakes region has developed a new process that may help to ease the current difficult situation in the supply of tartaric acid and tartrates which are vitally needed in medicine, food, and industry. Two of these products are widely known as Rochelle salt and tartar emetic.

Consumers and suppliers of tartrates have been on tenterhooks ever since the war began, when supplies of these materials were cut off from the great wine-producing sections of France and Italy. Tartrates and wine go together, because the raw materials for the production of tartrates are formed on the sides and bottoms of vats and casks used in making wine. The crystalline crusts which form on the sides of the vats are known as argols and contain from 50 to 80 percent of potassium acid tartrate and 6 to 12 percent of calcium tartrate. The sediment in the bottom is known as wine lees and contains 20 to 35 percent of potassium acid tartrate and anywhere up to 20 percent of calcium tartrate.

Some refined tartrates are now coming in from Spain and Argentina, but not in sufficient quantities to ease the tight situation. The supply probably could be helped by relaxation of government import regulations which make the importation of argols and wine lees impossible.

Wineries all over the United States have therefore been striving to relieve the strain by recovering their argols and wine lees, a process which in ordinary times would not be economical. One of the obstacles encountered was the obstinacy with which the argols clung to the sides of the vats and casks. It often required one man four days with hammer and chisel and sometimes an electric drill to remove the deposits from one vat.

To speed up this recovery, a young chemist named Ralph Celmer, working with the Taylor Wine Company, developed a process for removing winestone which will do the job in four hours instead of four days. In his method the casks are filled with a one-half percent solution of sodium hydroxide, or caustic soda, at a temperature above 100 degrees, Fahrenheit. This solution removes the winestone, which is subsequently recovered and refined in further operations. In one case the winestone was removed from a 7000 gallon tank in four hours, representing a saving of about 92 man-hours.

Celmer, for his work, has been complimented by the War Production Board, and his process has been made available to other companies in the wine industry.

"WET-STRENGTH" PAPER

Now Commercially Practical for Many Purposes

A SHORT time ago it became necessary to ship potatoes to market in paper bags because of the need for conserving burlap and other packaging materials. When some of the farmers first heard of this idea they were skeptical and quite sure it wouldn't work. But they hadn't yet heard about "wet-strength" papers, whose commercial development and application had been accelerated by the use of a new process and the pressing demands of war.

The new bags soon demonstrated their worth. The result is that "wet-strength" papers are now being used not only for shipping vegetables whose moisture would cause bursting of ordinary paper, but also for wrapping meats and frozen foods and a number of other commodities for overseas shipment; for camouflage strips and nettings; for printing books and pamphlets used by the armed forces and subject to wetting in the field; and for maps, charts, and blueprint papers. It is even possible to make paper towels which can be used, rinsed, dried, and used again.

One of the latest processes in this development of paper having a high strength when wet consists of incorporating an acid solution of a synthetic resin, known as melamine, with the paper pulp in the beater before the sheet is made. The treated pulp is made into a sheet in the customary manner on regular paper-making machines without modification of either the machine or the method of operation. The colloidal resin particles, which have a positive electrical charge, attach themselves to the negatively charged cellulose fibers of the paper and form such a close bond that they cannot be washed free. It is this hold on the fibers that subsequently gives the paper its high strength and resistance to rubbing when wet.

Plastics' Parade

A Systematic Survey of the Growing Group of Synthetic Products Which Are Invading Almost Every Field of Industrial Endeavor. Their Wide Range of Physical and Chemical Characteristics Adapts them to Many Jobs as Substitutes, to Many Others as Original Materials

A. F. CAPRIO
Chief, Patent and Data
Celanese Corporation of America

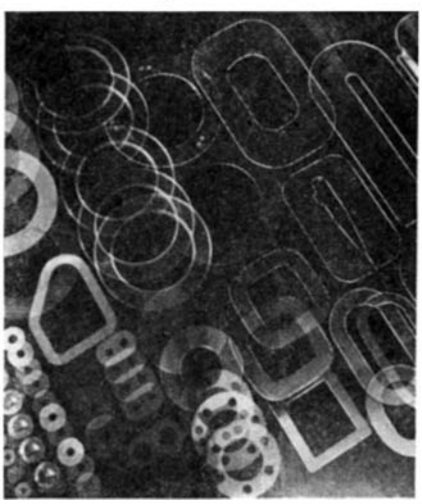
THE PLASTICS industry as it is known today is considered to have started with the invention of Celluloid in 1869 by John Wesley Hyatt, an enterprising printer, who in later years also achieved roller-bearing fame. Celluloid, which is still being manufactured essentially as Hyatt developed it, is looked upon as the world's first synthetic organic plastic. In its development by the Celluloid Company, organized in 1872 in New Jersey, it began almost immediately to play an important role in the drama of industrial progress. Applications multiplied, from the popular collars and cuffs (kept constantly fresh by a damp cloth) to calendars, buttons, piano keys, knife blades, dice, dominoes, and dental plates. Over 25,000 uses have been found for Celluloid.

Remarkable as this growth has been, the significance of the Celluloid invention has been much more far-reaching in scope, because of the immense stimulus it provided for research leading to improvements, particularly in studies to overcome the drawback of high flammability. Numerous attempts were made to retard the burning of Celluloid by the incorporation of fire-retarding agents which liberated water and smothering gases when heated. These, however, while effective for the purpose intended, introduced other undesirable properties.

The development many years ago, by the Celluloid Company, of the plasticizer tricresyl phosphate, now widely known in the trade as Lindol, marked another milestone of far-reaching importance. This non-flammable, odorless, colorless liquid of high boiling point and extremely low volatility found not only a use as a plasticizer in plastics and lacquers, but years later found extensive application as a valuable additive in extreme pressure lubricants and as an air-conditioning medium. More recently it has been in much demand in synthetic-rubber insulations and coatings, a field in which the war department is expediting full capacity production. In the last war, triphenyl phosphate, a homolog of tricresyl phosphate, found extensive use in the coating of airplane fabric wings to render them taut, waterproof, and flameproof.

Thus it is seen how invaluable have been the outgrowths of Celluloid, not to mention the discovery of amyl acetate in 1882 by John Henry Stevens, a co-worker of Hyatt, a discovery which paved the way for the modern lacquer industry. Celluloid research is also credited with the establishment of the highly important synthetic camphor industry in the United States.

The successful development of Celluloid also made possible the motion picture industry. In Newark, New Jersey, the Reverend Hannibal Goodwin was handicapped by the continual breaking of the glass stereopticon slides used to illustrate and popularize his religious lectures. He was aware of the development, at about 1890, by the Celluloid Company, of a continuous, clear flexible film. He conceived the idea of substituting this unbreakable base for the fragile glass. Like Hyatt he went to work in his attic and, despite the annoying disturbances of occasional explosions, he finally succeeded in making and patenting a process of utilizing a spool of film for photographic purposes—the forerunner of the perfected motion picture film of the present.



Grommets, washers, and other forms for use on airplanes are cut or shaped from transparent plastics which are non-corrosive, light in weight, and water- and grease-proof

The flammability of Celluloid also stimulated research abroad. In 1890, Dr. Adolph Spittler, a teacher in Hamburg, Germany, tried to make a "white" blackboard substitute. He added acid to milk and then treated the coagulated mass with formaldehyde to harden it. This marked the discovery of casein plastics, although their manufacture did not begin until 1900, and the commercial development of the industry did not get under way in this country until 1919 when applications were found for buttons, buckles, and novelties. Casein, a protein substance from the animal kingdom, inspired research years later in vegetable protein products, such as soya bean, from which plastics can also be made.

In 1909 Dr. Leo Baekeland, a Belgian chemist, was looking for a substitute for the expensive shellac used in making varnishes and insulating materials. He succeeded in obtaining a hard substance by heating carbolic acid or phenol with a solution of formaldehyde gas in water. Phenol is a by-product of coal tar but it can be synthesized from benzene, C_6H_6. Formaldehyde, having the formula H_2CO, is synthesized from two other well-known gases, carbon monoxide and hydrogen. The new plastic was called Bakelite in honor of its inventor.

Unlike Celluloid, Bakelite is representative of the "thermosetting" type of plastic. It undergoes a chemical change when sufficient heat is applied, as in molding, and the final product is no longer fusible, but hard and set like cement; whereas Celluloid can be softened and remolded like wax or butter without suffering any chemical change. For this reason Celluloid is termed a true "thermoplastic" substance.

BAKELITE soon found application in the electrical field as an insulating material, but since then the uses have been multiplied a thousand fold. Other tar acids besides phenol, such as the cresylic acids, are used in making Bakelite today. Other aldehydes, such as furfural, have also yielded successful commercial products.

Some of the drawbacks of the Bakelite resin have been overcome with the development of cast phenolics in 1928, of which Catalin is an example. This resin is prepared in the form of a viscous syrup which is poured or "cast" into lead or rubber molds and hardened by heating.

Along with the hot molded phenolic plastics in 1909, a third plastic material, known as the cold-molded or bitumen type of plastic, appeared. The raw materials used here are asbestos, asphalts, coal tar, resins, oils, and so on. While considerable industrial importance was claimed during the first 15 years or so, competing with Bakelite, the production of cold-molded products has fallen off considerably because of the commercial appearance of other materials.

Shellac molding compositions were extensively exploited during the beginning of the century, particularly for making phonograph records. Today, shellac of insect origin is restricted in its use in comparison with the broader applications of synthetic resins.

Thus, up to 1925, five basic plastics had been developed; namely, Celluloid, shellac, cold-molded plastics, Bakelite, and casein plastics. Since 1925, the growth has been most remarkable. A new plastic appears almost yearly.

The first revolutionary change of this later-day growth came in 1927 with the appearance of Lumarith. Years earlier, Dr. Camille Dreyfus had developed the use of cellulose acetate non-flammable airplane fabric dopes, which contributed in a major way to the Allied victory in World War I. This cellulose ester is made by treating cotton linters with acetic acid, acetic anhydride, and a catalyst. Its use as a base for non-flammable film had been worked out in 1909, but the utilization in plastics had to await a more economical manufacturing process for making the material.

ANOTHER factor that contributed in a great measure to the success of cellulose acetate was the so-called injection molding process. In this method the cellulose acetate molding material is introduced into a heated cylinder and, when sufficiently heat-softened, it is forced by high pressure through a narrow orifice directly into a chilled mold or die. In a few seconds the die is opened and a number of the molded articles, such as combs, completely finished, are ejected. This combination of Lumarith and injection molding made possible many of the most spectacular results of modern plastics applications, since it meant rapid, economical cycle molding.

Before the advent of molding powder, cellulose acetate plastics had appeared in the form of sheets, rods, and tubes, as well as film manufactured according to the well-established Celluloid methods. Since that time great improvements have been made in simplifying the processing made possible by the greater stability of cellulose acetate under heat and its easy weldability compared with Celluloid.

Extrusion molding, in which the molten material is extruded in continuous lengths through a die opening, is also finding today extensive application for the manufacture of rods, tubes, strips in definite profiles.

In 1930 a transparent packaging material appeared on the market. The first of the rigid transparent materials, it revolutionized packaging in the thirties. This was followed by cellulose acetate foil for wrapping purposes.

Besides cellulose acetate plastics, there appeared at about the same time the urea-formaldehyde plastics of which Beetleware is an example. This is another thermosetting plastic in which urea in place of phenol is reacted with formaldehyde. Urea is a compound of carbon, hydrogen, oxygen, and nitrogen and has the chemical formula $OC(NH_2)_2$. It can be made synthetically from carbon dioxide and ammonia, which in turn is produced from the nitrogen of the air.

The development of urea plastics permitted unlimited color possibilities in the thermosetting type of plastic. The melamine plastics are outgrowths of the development of various urea products.

In the thirties the vinyl ester resins also began to make their appearance under the trade name of Vinylite. Ethylene gas has the formula $CH_2{:}CH_2$. It is known as an unsaturated organic compound and is derived from petroleum. If one hydrogen atom is removed, the residue, $CH_2{:}CH$—, is known as the vinyl group. If this is joined to a chlorine atom the resulting compound is vinyl chloride. If the other hydrogen atom is removed and also replaced by another chlorine, the product is known as vinylidene chloride. If the vinyl group is attached to an "acetate" radical, the compound becomes vinyl acetate.

All these vinyl esters, of which there are a great number, exhibit the property of polymerization. In this the molecules of the same compound combine with each other to form complex, long-chain structures.

The polyvinyl esters, such as vinyl acetate and vinyl chloride, had been known many years before, but their commercial development was slow.

The Family

GROUP	NAMES	OUTSTANDING CHARACTERISTICS	TYPICAL USES
CELLULOSE DERIVATIVES			
Cellulose Nitrate	Celluloid, Pyralin, Nixonoid, Nitron	Thermoplasticity, unlimited color range, ease of fabrication, cementability, toughness, water resistance, flexibility, flammability.	Hammer heads, bag frames, fountain pens, index forms, piano keys, brushes, buckles, novelties and toys, shoe lace tips, spectacle frames, toilet seats, tool and cutlery handles, wood heel covers, pipe line wrappings, films and lacquers, mathematical instruments, tooth brush handles.
Cellulose Acetate	Lumarith, Plastacele, Tenite I, Fibestos, Nixonite	Thermoplasticity (injection, compression and extrusion molded), unlimited color range, ease of fabrication, cementability, high impact strength of molded objects, flexibility, slow burning.	Photographic films, packaging material, transparent rigid containers, airplane cockpit enclosures, automobile accessories, extruded strips, combs and toilet articles, electrical appliances and insulation, lamp shades, telephone bases, spectacle frames, hardware, watch crystals, fountain pens, gas-mask lenses, pressure-sensitive tape backing, nameplates, dopes and lacquers.
Cellulose Acetate Butyrate	Tenite II	Thermoplasticity, compatibility with many plasticizers and resins, low water absorption.	Automobile accessories, fishermen's equipment, spray nozzles, shower heads, gun stocks, gas mask parts, shoes.
Ethyl Cellulose	Ethocel, Lumarith ethyl cellulose, Hercules ethyl cellulose, Nixon ethyl cellulose	Thermoplasticity, compatibility with resins and plasticizers, flexibility and toughness at low temperatures, low flammability, water and alkali resistance, ease of fabrication.	Rubber-like articles, adhesives, cable and wire coatings, hot melt compositions, electrical insulation, trim moldings, ice trays and hose nozzles.
PHENOLICS			
Molded phenol-formaldehyde resins	Bakelite, Durez, Heresite, Durite, Indur, Makalot, Resinox, Textolite	Thermosetting, chemical inertness, heat resistance, water resistance, dimensional stability, limited color range.	Automobile and airplane parts, camera cases, closures, electrical insulation, handles, helmets, plywood laminations, housings, telephone equipment, shell caps and plugs, ammunition fuses, pumps, gears, paneling, abrasive disks.
Cast phenolic resins	Catalin, Marblette, Opalon, Prystal	Colorability, machinability, non-flammability, rigidity.	Costume jewelry, clock cases, radio housings, laminating varnishes, signs, kitchen utensils and handles, drawer pulls, instrument dials.

Glazing material which may be installed with a hammer is composed of a shatter-proof plastic and wire. It is also used where possibility of explosion makes glass dangerous

UREAS			
	Beetle, Plaskon, Uformite, Bakelite urea.	Unlimited pastel colors, absence of odor and taste, thermosetting, hardness, electrical insulation, light diffusion.	Closures, buttons, electrical insulation, tableware, plywood and veneer bonds, housings, baking enamels.
VINYLS			
Polyvinyl Acetate	Gelva, Vinylite A	Clarity, adhesiveness, absence of odor and taste, thermoplasticity, Colorability.	Adhesives, inks, molded articles, coatings.
Polyvinyl Chloride	Koroseal, Vinylite Q	Chemical resistance, water resistance, absence of odor and taste, toughness.	Cable coverings, coated fabrics, tank linings, gaskets.
Vinylidene Chloride	Saran, Velon	Thermoplasticity, high tensile strength, absence of odor and taste, nonflammability, resistance to water and chemicals, ease of machining.	Woven and braided fabrics, house screens, pump parts, pipe lines, couplings, gaskets, valves, battery cases.
Polyvinyl acetate-chloride copolymer	Vinylite V	Chemical resistance, colorability, thermoplasticity, absence of odor and taste, toughness, water resistance.	Coatings, films, sound records, storage batteries, wall board coatings, laminations, shoe parts, suspenders and belts.
Polyvinyl butyral	Butacite, Butvar, Saflex, Vinylite X (butyral)	Adhesiveness, moisture resistance, toughness at winter and summer temperatures, transparency.	Sheet platic for safety glass, army raincoat linings (substitute for rubber), bonding resin, flexble molded and extruded articles, self-sealing fuel tanks, gas-impermeable fabrics.
STYRENE			
	Styron, Lustron, Loalin, Bakelite polystyrene	Thermoplasticity, colorability, lightness, absence of odor and taste, water and chemical resistance, electrical qualities, injection and extrusion molding, low specific gravity.	Bottle closures, radio parts, refrigerator parts, dishes, transparent automotive accessories, edge-lighted instruments, coaxial cable insulation, battery boxes, electrical products.
ACRYLICS			
Methyl Methacrylate	Lucite, Crystallite, Plexiglas	Colorability, edge-lighting effect, dimensional stability, rigidity, transparency, water resistance.	Aircraft and marine enclosures, dentures, dresser sets and tableware, displays, signs, reflectors for highway lighting.
CASEIN			
	Ameroid, Galorn	Colorability, machinability, non-flammablity, hygroscopicity.	Buttons, buckles, game novelties.

In the above outline are not included some of the synthetic resins used for protective coatings, known as the alkyds, nor the numerous types of synthetic rubbers, such as Buna, butyl, Neoprene, Thiokol, Vistanex, and so on.

Copolymerization of two or more polymerizable substances, such as vinyl chloride and vinyl acetate, has led to useful products, such as Vinylite. If a part of the acetate radical is hydrolyzed and the resultant product is treated with an aldehyde, the so-called polyvinyl acetals are obtained. When butyric aldehyde is used, for example, the product is known as Butvar or Butacite, which find extensive application in laminated glass and recently as a coating for Army raincoats in place of rubber.

Another vinyl resin, which appeared in 1930 as an opaque molding powder, is styrene, or vinyl benzene. In this, one of the hydrogen atoms of the benzene ring is replaced by a vinyl radical. This product is a crystal-clear thermoplastic with density approaching that of water.

Akin to the vinyls are the acrylic resins, which are forms of vinyl compounds first investigated in Germany in 1901 by Dr. Otto Rohm and prepared industrially in 1931 in this country. Polymerized methyl methacrylate, such as Plexiglass and Lucite, is a product of rather recent origin, although this plastic had been produced commercially in Europe before its appearance in America about seven years ago. The resin has found application in "plastic noses" of bombers, cockpit enclosures, and so on.

Nylon is a rather late addition to the family of thermoplastics. It is made from adipic acid and hexamethylene diamine, both obtained by complex chemical synthesis from coal tar. It has become familiar to us chiefly as a textile material (stockings, bristles, fishing leaders, and so on) but not much specific information is available as to its potentialities in plastcs.

While concentrated studies have been going on in the synthetic resin field, research in the cellulosic field has also continued at an accelerated pace, and so we have the mixed cellulose esters, such as cellulose acetate butyrate, developed in the early thirties. Also developed with the cellulose esters were the so-called cellulose ethers, such as ethyl cellulose.

Thus, progress in the plastics industry continually goes on—new products and new processes are being developed each year, with the result that trade names are increasing, greatly to the confusion of the public. To clarify this picture of names, the accompanying table is offered. Because of the innummerable applications of the various types of plastics it would be impossible to present even a fairly comprehensive list, but the same table furnishes a general idea of the diversity of uses. The varied chemical and physical properties of the many thermoplastic and thermosetting plastics, with their particular advantages, fortunately permit a wide choice of selection and adaptation to specific tasks.

THE DISTRIBUTION of plastics is of necessity under heavy restrictions today. The Chief of the Thermoplastic Unit of the Chemical Division of the W.P.B., Ralph H. Ball, reported late last year that the majority of plastic materials are unavailable in sufficient quantity to meet war and essential civilian need.

While the cellulose plastics have been using cotton linters as the basic raw material, research studies are being expedited to extend the utilization of wood pulp in making plastics. Lignin, a wood product, is being investigated in government and private laboratories as a possible cheap raw material for making plastics in the building industry. Chemists also are at work on other raw materials such as soya bean, zein, and coffee, for making suitable plastics.

Indeed, it is felt that plastics will have attained a position at the end of this war which would have required four or five decades to reach in time of peace. To the layman it will become evident why plastic products, with their lightness, toughness, durability, infinite colorability, permanent finish, pleasant feel, chemical resistance, and fast molding cycles, have taken over many of the jobs of rubber, metals, ceramics, and other strategic materials.

It would startle John Wesley Hyatt today to see the fruits of his famous pioneer invention of the Celluloid billard ball about 75 years ago!

Glass ampoules containing iodine and mercurochrome are now protected by transparent plastic tubes. Thus, when the tube is broken, the fingers are protected from slivers

Conducted by KEITH HENNEY

Motors Do A Better Job

By Means of Electron Tubes, Direct-Current Motors Can be Operated From Alternating-Current Power Lines. The Advantages are Variable Speed Over a Wide Range, Constant Torque at Slow Speeds, Constant Horsepower at High Speeds. Many Industrial Applications Listed

One of the oldest and most prosaic of industrial tools, the electric motor, is about to feel the full effect of the newest and most versatile of industry's tools, the electron tube. By this combination of the old and the new, industry will be provided with a reliable variable-speed drive for increasing the usefulness of machine tools and other vital machinery powered with direct-current motors. No longer will it be necessary to use the motor-generator sets now required where only alternating current power is available, or belts and pulleys to change speed of an A.C. motor, or clutches and other mechanical means of adjusting speed. The elaborate equipment required for these inelegant methods of motor speed control can be released for more useful functions elsewhere, when the full impact of electronics is made effective.

Electric power is distributed to industry in two forms—alternating current and direct current. By the use of alternating current, it is possible to transmit huge quantities of power with only moderate losses in the transmission lines—a feature not possessed by a direct-current power transmission system. This is possible because of the ability to transform alternating current easily from one voltage to another. Since line losses go up with the square of the current transmitted,alternating-current power is transmitted at low current and high voltage.

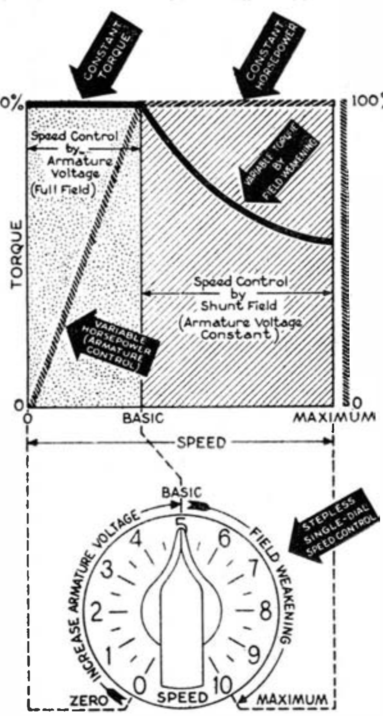
The big objection to the A.C. system comes when it is desired to utilize this power for certain jobs where variable speed motors must be used. Motors running on alternating current are unsuitable for driving lathes, driving conveyor belts, or feeding metal into cutting tools, for the simple reason that they have only a few fixed speeds depending upon the motor construction and the frequency of the current supplied to them. Beyond this speed range, accessory mechanical gear must be employed. What industry desires is the flexibility of the direct-current motor and the efficiency of transmission of the alternating-current system. Electronics now makes this possible.

To overcome the disadvantages of alternating-current power, many industrial plants now buy this power and use it to run an alternating-current motor to which is mechanically connected a direct-current generator. The direct current power thus obtained is used to supply variable-speed direct-current motors. Speed is changed by throwing away or absorbing some of the generated power. The disadvantages of this system are obvious.

Other plants generate their own direct-current power from prime movers, but this is usually uneconomical.

Electron-tube control of motors operated from alternating-current, therefore, not only improves the efficiency of the system where variable-speed drive is essential, but new advantages not evident at first sight are made possible.

For example, an ordinary motor operated from direct current does not fulfill *all* requirements such as extremely wide and stable speed range, good speed regulation, smooth automatic acceleration. The tube-motor combination provides these features plus the advantage that the speed of the motor may be preset so that the forward or reverse speed is obtained merely by pushing the proper button. Then, too, speed may be changed at any time while the motor is running, providing constant torque over the entire armature control speed range and constant horsepower over the field control range, as well as elimination of vibration difficulties sometimes encountered with adjustable-speed drives. This is especially important in providing power for machine tools where vibration might throw the tools out of alignment.



Curves show that motor torque and horsepower vary with motor speed. Drawing coupled with curves shows speed is controlled by single dial

The basic method by which electron tubes are added to a motor is simple. The tubes employed are thyratrons. These are gaseous or mercury-vapor filled rectifiers which convert alternating current into direct current. They differ from ordinary rectifier tubes in that a third element, a grid, is added to the required cathode (supplier of electrons) and anode (receiver of electrons). A rectifier, like any other electron tube, conducts current only when the anode is positive with respect to the cathode. Thus if a load to which power is to be fed is placed in series with a rectifier and a source of alternating-current power, current will flow through the load only on the half cycles of the alternating-current power when the anode is positive. Current, therefore, flows only part of the time but during this half cycle it flows continuously—not for half of a half-cycle nor for a quarter of it but for all of it. The only time the current does not flow is when the anode becomes negative with respect to the cathode, and this occurs on the alternate half cycles when the direction of current flow reverses.

With a grid interposed between cathode and anode, however, the situation is different. Now the portion of the positive half cycle during which current flows through the tube and, therefore, through the load, can be varied by merely changing the voltages on the grid with respect to the anode or the phase of the alternating voltages placed upon grid and anode. Thus a thyratron is a controlled rectifier; by proper circuit arrangement the current through the load may be anything between zero and the maximum passed when the tube conducts throughout the positive half cycle.

The grid inside the tube is connected to a speed control dial in front of the operator. Turning this dial varies the voltage on the grid so that it acts as a faucet, opening to let more power pass through the tube to the motor or closing to reduce the stream of power.

A direct-current motor operated from alternating current by means of a thyratron is supplied with rectified A.C. power. The system consists of a single or polyphase, grid-controlled, thyratron tube rectifier which takes power from the A.C. line and rectifies it into direct-current ouput. The rectified D.C. voltage is supplied to a regular shunt-wound D.C. motor and may be varied from zero to motor rated voltage (or above) for D.C. armature control. Smaller thyratron tubes used in the control apparatus provide rectified D.C. current for the field of the motor. The field voltage is held constant throughout the range of armature voltage and then is reduced to provide greater speed range by field weakening above the base speed of the motor.

Only four pieces of equipment are required for electronic motor control. These are a transformer, the electronic unit, the control (push-button) station, and finally the motor to be controlled.

An anode transformer is used in order to make use of motors of standard voltage. By designing a special motor it would be possible to eliminate this transformer entirely in most cases, but manufacturers (notably General Electric, which has developed the Thy-mo-trol system and Westinghouse the Mot-O-Trol) have felt that the use of a motor of standard design has definite advantages to the user. The speed control dial and the push buttons may be mounted in any convenient location.

The normal speed range by armature control is 20 to 1 below the base speed of the motor, although a much wider range such as 100 to 1 can be obtained. Field current control is used above the base speed for standard motors. This range is normally 2 to 1, with the top speed naturally limited by the characteristics of the motor itself. The electronic circuits automatically regulate the motor speed in order to maintain it essentially constant at any setting regardless of load. Through other smaller control tubes, the D.C. output voltage of the main rectifier tubes is controlled to compensate for speed changes. In a properly adjusted system, the speed over a 10 to 1 range will not vary more than 4 percent from a presetting, with torque varying from no load to full load. Furthermore, the speed will not vary more than 8 percent for any speed within the speed range of 20 to 1. Normal variations in A.C. line voltage have only a small effect on the speed regulation.

In a typical case, the speed will not vary more than plus or minus 1 percent if the line voltage varies as much as plus or minus 5 percent.

When the stop button is pushed, a resistor is automatically connected across the armature. In this way the motor is brought to a quick stop through dynamic braking. The current is interrupted by the thyratron tubes rather than by a magnetic contactor.

TYPICAL INDUSTRIAL APPLICATIONS OF THE ADJUSTABLE-SPEED ELECTRONIC MOTOR DRIVE

Industry	*Application*	*Operating Requirements*
Aviation	General purpose testing, machinery, such as for fuel pumps	Wide speed range; stepless acceleration
Cement	Conveyors	Constant speed for any speed setting
Ceramic	Lathe drives	Adjustable speed
Chemical	Feeders (conveyors or pumps)	Adjustable speed; close speed regulation at any speed
Food	Bottling and packaging machines	Medium speed range; close adjustment
Laundry	Flatwork ironers	Adjustable speed; constant torque
Machine Tools	For all machine tool feeds, such as on lathes, grinders, and milling machines	Wide speed range; good speed regulation; reversing dynamic braking
	Slotters, key seaters and gear cutters	Adjustable speed; good regulation
Glass	Glass drawing	Wide speed; close speed regulation
Materials Handling (all industries)	Feeder conveyors Assembly conveyors	Adjustable speed; high starting torque
Steel Mill	Straightening machines	Adjustable speed; frequent starting; dynamic braking
	Spinning or flanging machine feed	Adjustable speed; high torque at low speeds; braking
	Cold or hot saw feed	Adjustable speed; good regulation
Mining	Ore concentrators	Constant speed for any speed setting
Paper	Wire shakes and rotating filters	Medium speed range; uniform speed
	Rotary cutters, slitters, winders and single intake shaft drive on combining, waxing or paper treating machines	Low threading speed; medium speed range; close regulation at any speed setting; smooth, stepless acceleration
	Reels	Accurate speed setting; wide speed range
	Top roll drive and dandy roll drive	Medium speed range; close regulation
Paper Converting	Bag machines, folders, interfolders, creasing, perforating and embossing machinery	Low threading speed; constant speed at any speed setting; stepless smooth acceleration
	Laminating and coating machines	Wide speed range; stepless acceleration
Power Generation, Heating and Ventilating	Coal Feeders	Adjustable speed; constant torque.
	Stokers	Wide range of speed; close regulation
Printing	Small web-feed rotary printing presses	Inching; dynamic braking; close regulation at any speed; smooth acceleration
Rubber	Small tubing machines	Adjustable speed; good regulation
Textile	Warpers and winding reels	Constant linear speed at any given setting
	Starch mangles, padders, and sanforizers	Wide speed range; close regulation
Woodworking	Lathe feed	Wide speed range; constant torque

Electronic motor control of the type described has the following advantages:

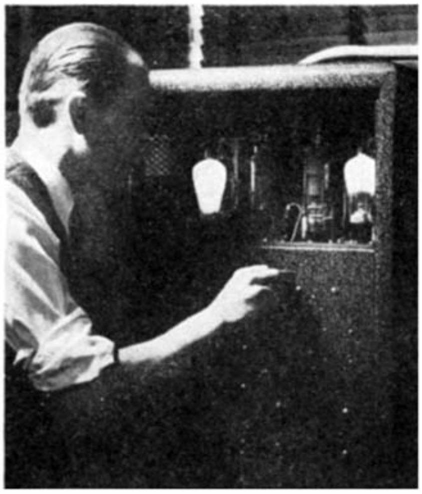
1. All the desirable characteristics of a D.C. motor drive from an A.C. supply.
2. Only one rotating element (the motor), consequently no vibration trouble from auxiliary equipment.
3. Ease of mounting: Control may be mounted in its own cabinet or built into suitable space in machine.
4. Finger tip control: No field rheostats required; speed control in regular push-button station.
5. Adjustable accelerating torque to meet various load requirements. Smooth automatic acceleration.
6. Much wider ranges than normal with stable operation at extremely low speeds and exceptionally good speed regulation under varying load conditions.
7. Preset speeds.

At present, electronic control has been generally adapted to motors of one horsepower and smaller, although the manufacturers have successfully applied the equipment to motors of considerably higher power.

MANY interesting applications have been made, most of them to machine tools because of the present limitations in size. Among the types of machines to which electronic drives have been successfully applied are grinders, milling machines, tool-room lathes, turret lathes, and thread mills. In addition, they have been supplied for automatic welding machines and for various special equipment for testing magnetos, airplane-propeller governors, and instrument tachometers.

A particularly interesting application has been made for driving the headstock on grinders. The wide speed range obtainable and the constant-torque characteristics provided at low speed make it possible to provide the proper speed for every type of grind. In several instances the new control has made possible a simplification in the headstock itself through the elimination of the gears and pulleys formerly required.

One of the earlier applications of this form of motor control was in the field of astronomy, where electronic



Adjusting speed compensation control on cabinet of Westinghouse Mot-O-Trol. Thyratrons are in cabinet

tubes were used in connection with the driving motors for huge telescopes. Since then, the extreme flexibility of electronic motor control has resulted in many other applications in the fields of pure science and research—applications that undoubtedly will eventually result in important new industrial uses as well.

Elevator installations lend themselves naturally to electronic control, particularly in districts where D.C. power is not available. Alternating-current motors cannot economically provide the high starting torques and wide speed ranges required in this application; hence D.C. motors must be used. Where only A.C. is available, the choice lies between providing a D.C. source of power by means of a motor-generator set or small power plant, or using electronic control to run D.C. motors from A.C. lines. The final decision is usually governed by a study of relative costs, with the award going more and more often now to electronics.

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PHOTO-TUBES CONTROL POWER

Automatically Control Flow in Testing Demand Meters

ELECTRIC meters for measuring electrical energy sold to users measure the product of power and time. To test such a meter for accuracy requires measuring two quantities. Since time is easily measured to high accuracy, it is common practice to hold power constant and measure time.

Some types of demand meters may require test periods up to 15 minutes, other types to one hour. When such tests are performed manually, an operator observes the motion of the pointer on a standard wattmeter and by adjusting a rheostat controls a portion of the total test load to correct for the small variations arising from voltage fluctuations, resistor heating, and other causes.

The operator learns by experience that in order to keep the average of the load constant he must try to compensate for the transient variations by briefly applying a greater correction than the deviation, the operator thus mentally averaging the peaks and dips. This is a somewhat tedious operation involving both judgment and eye-strain.

A method of doing this important job automatically by means of photo-tubes has been developed at the Westinghouse Electric and Manufacturing Company, and was recently described in *Electronics.* The apparatus has three parts corresponding to an operator's eye, brain, and hand, according to B. E. Lenahan. The "eye" part consists of a mirror which receives a beam of light from a lamp, also two photo-tubes, and a shutter vane carried on the meter mechanism. The shutter moves in front of the mirror and forms an optical lever to magnify the movement of the meter coil. So long as the coil is in its correct position, indicating the flow of the desired amount of power, the output of the photo-tubes is zero, but when the meter coil moves, the photo-tube output is proportional to the displacement of the meter movement.

The "brain" part of the apparatus consists of a network of resistors and condensers, and the correction mechanism, using amplifier tubes, performs the "hand" operations ordinarily required. Thus the combination of photo-tubes and correction system replaces two operators by one, and increases accuracy.

OIL MIST PRECIPITATED

Electrical Charging Removes Fire Hazard in Shops

HIGHER operating speeds of modern machine tools, causing greater breaking up of coolant oil into mist; increased machine-hours per day which plants now work; increased number of machines in a given space — all these factors increase the oil smoke and mist problem in many machine shops. The effect is to reduce the effective illumination on the work and to create a fire hazard. Several methods of cleaning the air have been devised, and one using the Precipitron electronic tube seems to have particular merit. The Precipitron is a development of Westinghouse engineers by which high voltage precipitates dust and other particles in the air by charging them with electricity. A comparison test between a mechanical air cleaner and a Precipitron, both operating at a rate of 600 cubic feet per minute, showed that the electronic machine was at least seven times as efficient.

OFF-FREQUENCY TUNING

Phenomenon Now Being Usefully Applied

EVERYONE knows that as a radio receiver is tuned away from the desired station, the strength of the signals from that station decreases. No one did much about this electrical phenomenon until a young man in the North woods put it to use in the early days of radio. He noted that the pitch emitted by his simple one-tube receiver varied if he placed a piece of paper between the condenser plates which tuned the set to resonance. This young man was interested in paper manufacture, and he knew that the moisture content of paper was important.

So he devised an electronic system which makes it possible automatically to control the amount of moisture in paper during manufacture It uses, essentially, this off-tuning phenomenon by which a voltage change is noted in an electrical circuit when the circuit is tuned away from resonance.

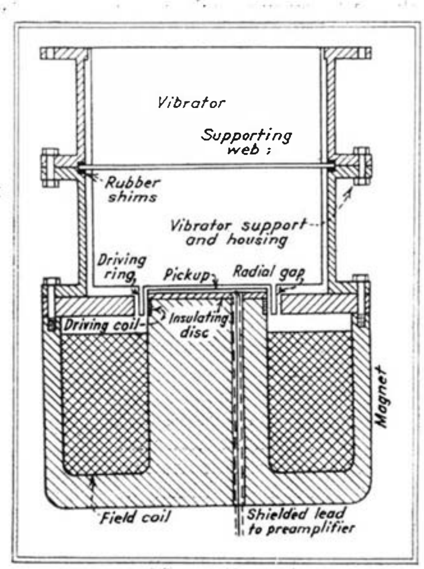
Many other uses have been made of this fact. Recently the United States Bureau of Mines has put the idea to work in a means of studying vibrations of the earth, in measuring and recording the elongation of test specimens being stretched, and in certain metallurgical uses.

AIR CLEANER

Utilizes Ultra-Sonic Waves Electronically Generated

IT HAS been known for some time that high-frequency sound waves will flocculate and remove suspended matter in smoke, fumes, or fog. One of the difficulties of putting this known fact into industrial use has been the problem of generating sufficient energy at frequencies higher than the human ear can hear. In the *Review of Scientific Instruments,* however, Hillary W. St. Clair described a generator which is a step in the right direction.

This producer of ultrasonic waves is built somewhat on the principle of the dynamic loud speaker used in nearly all radio receivers of today. The cone or diaphragm of the loud speaker is replaced by a resonant bar, and current is induced in this bar so that it vibrates at the required resonant frequency. The vibrations of this bar can be imparted to the gas which is to be cleaned.



Cross-section of the new high-frequency sound generator designed for experimental air-cleaning work

Rubber: Natural Or Synthetic?

Possibilities for the Development of Natural Rubber Sources on Small Family-Owned Plantations in the Western Hemisphere Loom as a Challenge to the Synthetic-Rubber Chemist in the Race for Domination of Post-War Markets

DR. EARL N. BRESSMAN

Director, Inter-American Institute of Agricultural Sciences

IN OUR September issue, page 115, was presented an article on the present status of the synthetic rubber industry. We now publish a comprehensive survey of natural rubber, its present and possible future.

It is enlightening to study these two articles side by side. The one on synthetic rubber was, of course, prepared by a chemist; the present article is by a man whose main interest is in natural rubber.

If it, therefore, appears that there are discrepancies in statement between these two reports, it must be remembered that "only time and technology" can answer many of the questions involved. This is particularly true of discussions involving advantages for specific uses of different kinds of synthetic and natural rubbers, and the highly important cost element.—*The Editor.*

SIMULTANEOUSLY today move two great rubber developments of far-reaching importance to the economic future of the Americas. These are the creation in the United States of a synthetic rubber industry and, in the tropical Americas, development of natural rubber production. Which of these two will win out in the long run? The answer holds large meaning for the Americas. Rubber is indissolubly bound up with the economic destinies of the hemisphere. What rubber means to our motor and machine age has been well illustrated in the repercussions from the loss of rubber supplies in the Far East.

Right now the important thing is to get rubber. We must get it from any and every source available, natural and synthetic, as quickly as possible. That is all that matters immediately. Without rubber, the United Nations war machine and the civilian economy of the Americas would be severely handicapped. Lack of rubber can prolong the war. Lack of rubber can cause infinite confusion in civilian life, as we know only too well. Still it is worthwhile to examine now the challenging question: Are we to rely, in the long-range aspects, upon natural or synthetic rubber?

Perhaps the combined answer to this challenging question lies in the test tubes of patient chemists and in the research and experiment stations of the tropical Americas which are producing strains of disease-resistant and higher-yielding rubber trees. In either case, science holds the answer—science in the industrial laboratory and science in agricultural experiment stations. Which will win in the long run? The chemist has produced many fateful changes in our economic life in the last two decades. But probably no single development holds more potent possibilities than the race between the chemist and the agricultural scientist to supply the expanding needs of the Machine Age for rubber and to supply it cheaply and abundantly.

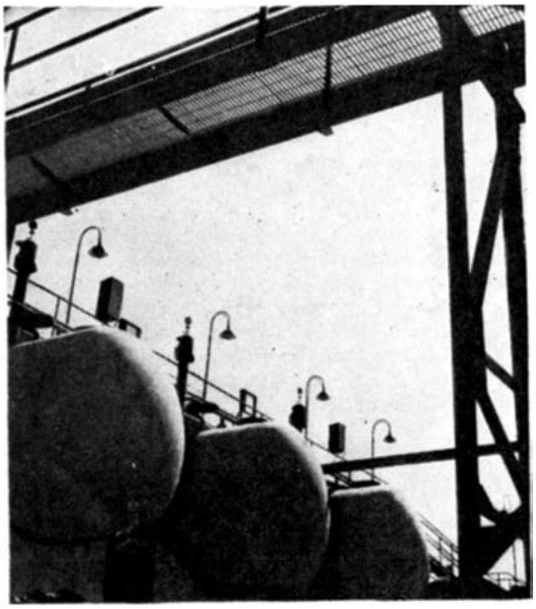
Much of the natural rubber program for immediate war needs is concentrated on efforts to increase quickly the production of wild rubber in the Amazon basin and in Central America. The program also includes large projects for production of rubber from quick-growing plants, such as cryptostegia and guayule. World rubber consumption in the past few decades has increased rapidly. The curve of consumption, both in the United States and outside the United States, seems likely to continue to rise for a long time. Temporarily, in the United States, consumption is limited by need of conserving available supplies for war and for essential civilian use. But probably we are now near the low in war-time rubber consumption. Starting in 1944, the curve of both production and consumption may resume its climb. I believe United States consumption of rubber will expand until it at least doubles consumption during the peak year of 1941. In that year the United States used around 775,000 tons. If I am correct in this assumption, the long-term uptrend in rubber consumption will mean that the United States eventually will require 1,500,000 tons of rubber annually. That means a billion dollar industry. The United States Department of Agriculture, in collaboration with the tropical Americas, is carrying on research for the improvement of plant materials and for commercial stimulation of existing strains resistant to leaf blight as well as of high-yielding strains. In the 100 co-operative nurseries established in the other Americas, nearly 30,000,000 budded trees already have been produced. These are material for the plantation industry. Five experiment stations strategically located are making available scientific research and guidance for development of plantations, small and large. The Institute of Agricultural Sciences is preparing to take an active hand in this program, in collaboration with experiment stations of the other Americas.

Thus we see taking shape the dreams of those who years ago saw the need for growing rubber supplies closer to home. Now the essential plant material, consisting of Hevea rubber trees of high yields and disease-resistant strains from the Orient, developed in the tropical Americas, is available for further expansion of a natural rubber industry in the Americas.

The most important of the co-operative field stations is located at Turrialba, near San Jose, the capital of Costa Rica. This station, started in 1940, is fully equipped and stocked. It possesses ample land for nurseries, clone collections, and other limited plantings. Turrialba was selected as the site because it is ideal for investigation of the most serious pest of the rubber tree in this hemisphere, the South American leaf blight. The volcanic soil is excellent for growing rubber. Moreover, it is well

Seedling rubber trees; a plantation of tomorrow

Above: **Tapping a rubber tree for latex.** *Right:* **The "tree equivalent" of the synthetic-rubber plant—storage tanks for holding butadiene and styrene**



situated to collaborate with the Inter-American Institute of Agricultural Sciences in future research.

The government of Costa Rica has provided a thousand-hectare experiment station, known as "Los Diamantes," near Cuapiles, about 50 miles from Turrialba. This farm is less than 1000 feet above sea level and is representative of the broad northern coastal plain, which is well adapted for rubber growing. It will serve primarily as a propagation garden to supply bud wood to growers in regions infected by the leaf blight.

Another important co-operative field laboratory is at Belem, Brazil, gateway to the Amazon rubber country. This laboratory is located at the Instituto Agronomico de Horte, operated by the Brazilian Department of Agriculture. Considering its strategic position, the Belem center may have a key role in the development of rubber production in the Amazon basin. Studies will be carried on there in different kinds of Hevea rubber indigenous to the Amazon country. Scientists will collect bud wood and seeds of superior trees. Up-river stations will be established to carry on agronomic research. Improvement in tapping methods and preparation of rubber from wild trees are receiving special attention in view of the need of rubber for war purposes.

In Haiti, a co-operative field station has been established at Marfranc for propagation of planting material. This material will be available for distribution locally and to nearby countries. The leaf blight has not been found in Haiti. Strains of Hevea rubber susceptible to leaf blight will be crossed with resistant selections from the jungles of South America at the Marfranc station.

The co-operative field station at Tela, Honduras, is located at the famous Lancetilla Farm, research station of the United Fruit Company. Two plantations of mature seedling rubber trees planted in 1926 by the United Fruit Company are sources of seed used for root stock production. In addition, some of these mature trees are used in developing techniques for small-scale or family size rubber enterprises.

In Mexico, co-operative projects are under way with the Ministry of Agriculture at the El Palmar experiment station near the city of Tezonapa, state of Vera Cruz. Some 300 acres of mature rubber trees near this station provide ample seeds for production of root stocks and are under investigation for superior clones. Some of the latter, following blight-resistant tests at Turrialba, may prove valuable for commercial planting.

In former times, when there was no competition to force rubber growers to develop special products for specific uses, the latex yield from all types of clones and rubber trees went to make up a conglomerate mass. This yielded a general or all-purpose product which had to serve wherever rubber was required. This all-purpose product, of course, had many shortcomings. In the last three or four years before Java and Sumatra fell to the Japs, the Dutch were beginning to make great strides in developing natural rubber for specific purposes. They had found that latex from different rubber trees, and particularly from different strains, varies greatly in its properties and that it was of value to keep the latex produced from different strains of trees separate for use where best adapted.

Chemists who advocate synthetic rubber on the basis that it has tremendous possibilities in developing products for specific uses, apparently lose sight of the fact that Nature is far ahead of them in the ability to produce different kinds of rubber adapted to specific uses. It is due largely to the fact that producers of natural rubber, particularly in this hemisphere, are not organized, that their product does not receive the wide and favorable publicity accorded synthetic rubber.

As regards price, there is no comparison, at present, between the two products—natural rubber is much the cheaper. Even if the raw material were to cost nothing, it seems illogical to expect that synthetic rubber could be polymerized out of either alcohol or petroleum in a city factory, paying high taxes and wages, overhead, and so on, at a price comparable to that involved in the production of natural rubber, which is an ideal small-family industry. It is to the interest of rubber consumers in this country to see that the rubber of the future comes from a really cheap source. In the future, it should be possible with fully mature plantations of high-yielding trees to produce rubber at 10 cents a pound or less.

RUBBER production is an ideal small-family industry. The Goodyear Rubber Plantations Company, which has carried on experiments with tropical American rubber production since 1935, has emphasized that, in the development of rubber production in this hemisphere, small plantings can play an important role. Although there are some large plantings, like those of Goodyear in Costa Rica and Ford in Brazil, in the future local farmers in those countries will be encouraged to make small plantings of a few acres and to utilize the large plantations and the co-operative experiment stations of the United States Department of Agriculture as sources of planting material.

No tropical crop is more suitable for farm production than is rubber. The mature trees are tapped and the latex is converted into dry rubber, usually smoked sheets, by a simple process which may be carried out with an investment in equipment of as little as $50. The equipment required consists of such materials as discarded oil drums, homemade wooden paddles, and crude smokehouses built with local materials.

The effectiveness of the family-operated farm in rubber production has been amply demonstrated in Haiti in connection with the Haitian-American Agricultural Development Corporation. There the women work on the farms just as men do. Whole families clear and till the land, harvest the crops, and transport them to market. That system is the foundation of the whole Haitian way of living, and any program that would tend to alter it would be doing Haiti a disservice. Small holders are demonstrating that not only can they cultivate rubber, but that they can produce it in competition with large holders to great advantage.

The good wages which rubber production brings the small family unit, providing them with a cash income to

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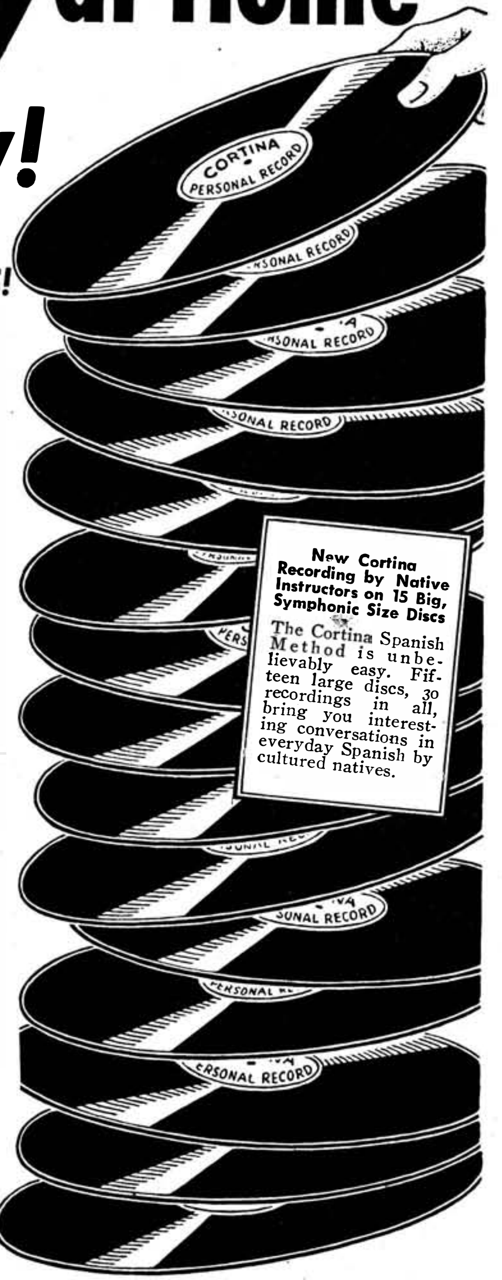

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supplement the living they get off their place, helps to develop contented rural populations. Contented rural populations will undoubtedly mean much more to the future of this hemisphere than some synthetic rubber factories run under high-tariff protection.

Vice President Wallace has said: "Looking ahead to the new time of peace, the motorists of the United States will not only want to have an assured source of rubber, but they will want to get that rubber as cheaply as possible. In the matter of cost, natural rubber from either the Far East or the Western Hemisphere is likely to have a big advantage over synthetic. And, even if synthetic rubber is available in large quantities at a low price, a substantial amount of natural rubber will still be needed for mixing with the synthetic product.

"Few automobile users in the United States realize that the technology of producing rubber from trees is changing almost as rapidly as the technology of producing synthetic rubber. During the last 10 years, high-yielding strains of rubber have been developed. Some of these strains yield two, three, four, and even five times as much as the old-fashioned strains customarily used in the Far East. With modern strains of the Hevea rubber plants, there is every reason to believe that during the period after the war rubber can be profitably laid down in New York City from either South America or the East Indies at less than 10 cents a pound. Therefore, to protect synthetic rubber produced in the United States from destructive competition would require a tariff of at least 10 cents a pound and probably 20 cents."

As previously indicated, natural rubber, under modern conditions, should not cost more than 10 cents a pound to produce and probably will be produced for less.

In this discussion, so far, in referring to the natural product, I have dealt exclusively with Hevea rubber. Hevea is preeminently the most important species for commercial rubber production, but there are other kinds which offer great possibilities, not only from the standpoint of low cost of production under proper conditions but specific qualities. In certain areas in Mexico and Central America conditions are more favorable to the growing of Castilla than Hevea rubber. In those areas, however, as in the West Indies, the Cryptostogin plant, a source of high-quality rubber, appears to offer emergency possibilities. Under ordinary growing conditions it will produce only 400 to 500 pounds of rubber per acre. Under the most favorable conditions, that is, with fertile soil and high rainfall, it is a potential source of more rubber per acre than any other rubber plant known. It is believed possible, with proper horticultural practices, to stimulate its fast-growing young water shoots or branches to yield over a ton of rubber to the acre. At present there are many unknown quantities in the production of Cryptostegia rubber. Good techniques for it can not be worked out until large-scale plantings, which are just being made, are in production.

Just what the chief source of our rubber will be 10 years from now no one can say with certainty. All signs, however, point to natural rubber as the product on which we shall rely mainly in the tremendously expanded industry of the future. Natural rubber has served our needs well in the past and there is every indication that it will continue to do so in an increasingly satisfactory way as time goes on.

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GLASS THAT FLOATS

Foamglas Answers

Many Insulating and Other Problems

Glass, so light in weight that it floats, is the latest development in insulating materials; it is also applicable to life rafts, building blocks, and other uses. Foamglas, as the material is called by Pittsburgh Corning Corporation, is a true glass that has been cellulated by the evolution of internal gas at high temperature into a mass of tiny sealed air chambers, as many as 5,000,000 of them in a cubic foot. Foamglas is impervious to acid atmospheres or solutions and completely vermin-proof, and it can be easily cut into any shape by a cheap saw or knife.

The new product is remarkably light in weight—10 to 11 pounds per cubic foot, as against 156 pounds per cubic foot of ordinary glass. Because it is water-proof and consists of sealed cells, it is buoyant, and therefore especially adaptable for use in various types of floats and life rafts.

Foamglas provides highly effective insulation for cold-storage rooms and for buildings where reduction of heating costs or efficient operation of air-conditioning equipment are desired Dampness has no effect on this new achievement in glass, for, unlike most insulating materials, its conductivity does not increase under such conditions.

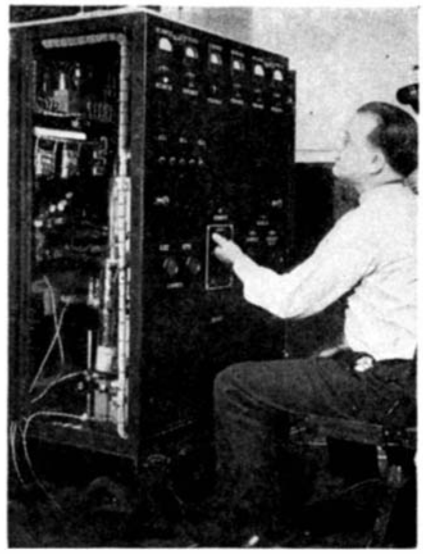
It is likewise excellent insulation for backup in many types of ovens and furnaces, up to a maximum temperature of 1000 degrees, Fahrenheit. Completely non-combustible itself, Foamglas is especially valuable where used as insulation in combination with materials not resistant to fire.

ELECTRONIC "CHEMIST"

Will Speed Production Testing

in Synthetic Rubber Plants

Faster and more accurate than a dozen top-notch chemists, the mass spectrometer will soon accelerate wartime chemical research by freeing hundreds of highly skilled chemists from tedious but important production testing in synthetic rubber plants. The new instrument is a valuable laboratory tool for scientists seeking more powerful gasolines, new plastics, and improved synthetic rubber. An average college student can be taught to operate the spectrometer in a few weeks.



Dr. Hipple and electronic "chemist"

Developed by 32-year-old Dr. John A. Hipple, physicist at the Westinghouse Research Laboratories, the electronic "chemist" swiftly and precisely analyzes many of the complicated gases formed in making butadiene, the principal ingredient of several types of synthetic rubber.

"In 15 minutes," Dr. Hipple explains, "this spectrometer will dissect a complicated gas molecule a twenty-five-millionth of an inch long and can be arranged to produce automatically an autograph that tells the chemist the composition of the gas.

"At present, certain analyses require from 15 hours to three days of painstaking laboratory work by five to ten skilled chemists—others cannot be done at all even by other processes. Results attained by these tedious methods are much less accurate than the molecular 'portrait' that comes out of the spectrometer."

Butadiene molecules, Dr. Hipple explains, are carefully built up from carbon and hydrogen atoms according to definite chemical patterns, much as a tile-setter selects colored blocks to form a design on a floor.

"As the molecule is being put together in a butadiene plant," he says, "its composition must be checked at intervals to make certain that the chemical pattern is being followed.

"Present methods of determining the molecular structure are so slow that a batch of butadiene has often gone through the various treatments of the process before the analysis is completed. If there is an error in the molecular design, the butadiene will make a poor quality synthetic rubber. Sometimes a batch of butadiene has to be reprocessed, causing lost production time."

The spectrometer is housed in a cube-shaped cabinet five feet high. Its key part is a yard-long glass vacuum tube shaped into a quarter-circle. This tube, lined with metal, is fixed between the poles of an electromagnet. "Molecules of the gas being analyzed are given an electrical charge at one end of the tube and are shot toward the other end at a speed of approximately a million feet a second by high voltage electricity," Dr. Hipple explains. "The electromagnet pulls at these speeding molecules so that only those having a certain mass, or weight, travel down the center of the tube, around the bend and through a tiny slit in a metal target at the other end.

"The molecules going through the target are collected on a metal plate where they give up their charges. Then the charges are amplified and counted by electric meters, which indicate how many molecules of a certain weight are in the mixture."

The mass spectrometer requires only a thimbleful of gas for each test. Butadiene plant chemists now have to draw off a bucketful of gas for the involved laboratory procedure of breaking down the mixture by "fractionating" or distilling.

SHIP PROPELLERS

Produced With a Substantial Saving of Critical Brass

ANOTHER indication of the wide-spread advances in metallurgy and foundry practices is found in the replacement by Meehanite Metal of brass in the production of propeller castings. According to Cooper-Bessemer officials, difficult one-piece, three-bladed propeller castings, being produced for United States Coast Guard vessels, have passed rigid inspection and testing, proving that Meehanite Metal has the strength and structural characteristics necessary for this application. Meehanite Metal, with a far higher tensile strength range than ordinary cast iron, has been used with great success by Cooper-Bessemer for several years in the production of engine castings.

Conversion to Meehanite castings is said to have reduced propeller production costs as much as 50 percent, in addition to conserving a substantial tonnage of critical brass which can be used in fabricating other vital war equipment.

MATHEMATICAL DESIGN

Can Replace Slower Mechanical Tests

PRODUCTION of airplanes, tanks, and other armament will be speeded by a unique method, developed in the civil engineering laboratories of Cooper Union, which eliminates the use of models in determining how complicated parts will react to stress.

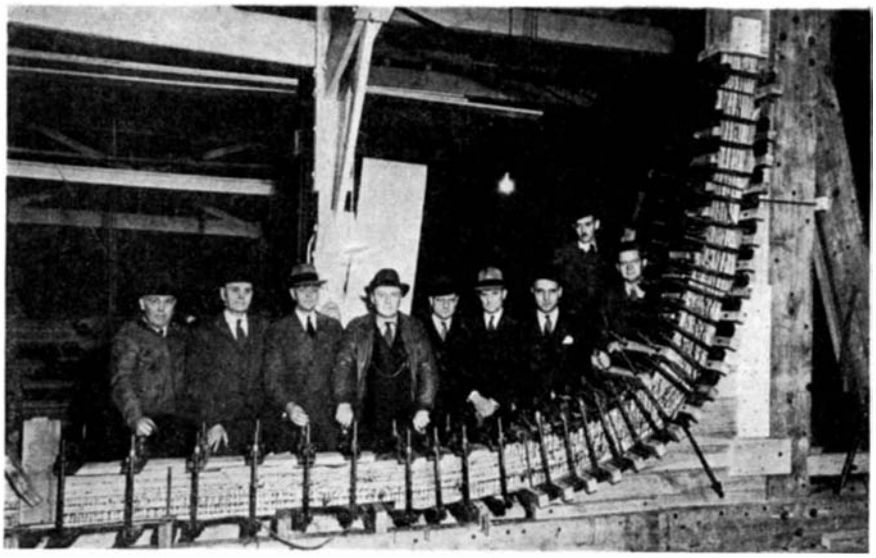
Valuable time and effort in the design of modern complex structures is saved by the new method, which embodies a theoretical approach utilizing mechanics and mathematical formulas, according to Ray C. Brunfield, associate professor of civil engineering at Cooper Union and originator of the method.

"Much equipment now being designed — airplanes, tanks, armament, and many other modern machines — contains portions which are known as indeterminate structures." Professor Brumfield explains. "They are out-of-the-ordinary beams, beams that may be swelled, pinched, curved, or of any other odd construction. The problem is to determine in advance what effect the loads that will be borne by a particular structure will have in inducing stress.

"With so many variable factors involved, the old trial-and error methods of predicting just how much rough treatment the parts of a structure can withstand are time-consuming, tedious, and expensive.

"A refined form of trial and error, the use of models to determine reaction to stress, is widely used throughout industry. Many indeterminate structures are now being designed by means of Bakelite or other plastic models. The models are placed under stress conditions similar to those to which the completed structure will be subjected, and polarized light is passed through the model. The light shows up the effect of the stress conditions.

"Another method used is to make models of plaster of Paris or glass, which break under stress conditions and reveal weaknesses of design. Both methods are entirely adequate for computing stresses, but today speed and efficiency are a prime consideration."



Prior to removing clamps from a new laminated ship's backbone

The Brumfield method of computing stresses is done on paper, by means of mechanics and mathematical analyses "under laws similar to which common types of structures are designed."

"Stress analysis is a very important part of construction," Professor Brumfield points out "Its function is to effect a design so proportioned that the structure will do its job and remain intact in its original form despite the operation of normal stress conditions."

SHIP'S BACKBONE

Now Made of "One Piece" of Laminated Wood

THE IDEAL backbone of a wooden ship — stem, keel, and stern post all in one piece — is now an actuality due to recent progress in wood lamination, using low-temperature phenol glues; shipwrights had never achieved this ideal before, for nature never grew oak trees of the required dimensions and configuration.

Rapid developments in plywood, coupled with research in resin glues, led naturally to the inquiry as to whether lamination wasn't the answer to this problem. Plywood's known strength, greater, weight for weight, than that of steel, led to utilization of laminated woods for trusses in factory and other large construction. But problems of shipbuilding are unique. Stresses and strains are mobile and variable, and no ship can be stronger than its backbone. Laminations must not only be waterproof, but also resistant to the action of salt water.

Experimentation began in 1940, when the Navy recognized the imminent possibility of increased ship construction. With the assistance of technicians of the National Lumber Manufacturers Association, search began for the type of glue that would meet these requirements.

Tried first were phenol resin glues which set at high temperatures, for their effectiveness in marine plywood was known. But laminated wood members use layers much thicker than the thin veneers of plywood, and difficulty was encountered in transmitting the necessary heat through these layers.

Urea resin glues, setting at from 70 to 80 degrees, Fahrenheit, were tried. Frames of two 50-foot vessels were laminated of white oak, and exposed to water for a year. While these glues are considered waterproof, salt-water reaction resulted in delamination and reduced strength at the glue line.

The next experiment resorted to low-temperature phenols, especially those in which alkali accelerators are used. A stem, keel, and horn timber for a heavily constructed ship were built and subjected to salt water. Exposure and laboratory tests both indicate these glues will prove thoroughly satisfactory

To solve the heat problem, a high-frequency electrostatic field was tried to set the glue. While this experiment has had promise of success, new glues, requiring lower temperatures, have been another solution. But the low temperature phenols still require higher temperatures than urea resins, it having been found that phenol glues, set at 200 degrees, holds laminations together with the strength of the wood itself.

This method of creating big pieces by uniting small pieces has several special advantages. The finished product is, in effect, one piece. It is four to eight times as strong as bolted keels. Glued frames are stronger than steam bent frames Proper moisture content can be readily controlled. Prefabrication, reducing labor in the shipyard, is made possible. Because of greater strength, weight can be reduced. For the same reason, materials may not be limited to the use of the traditional white oak.

Lamination makes unnecessary the search for special and rare timbers, thus ending one serious limitation on the number of wooden ships that can be built at one time. As far back as Civil War days, fear was expressed that enough timber suitable for naval construction could not be found. While we are building no more frigates of wood, demands for wooden scouting craft, mine sweepers and various types of combat vessels have reached large proportions, and lamination now seems certain to play an important role in their construction.

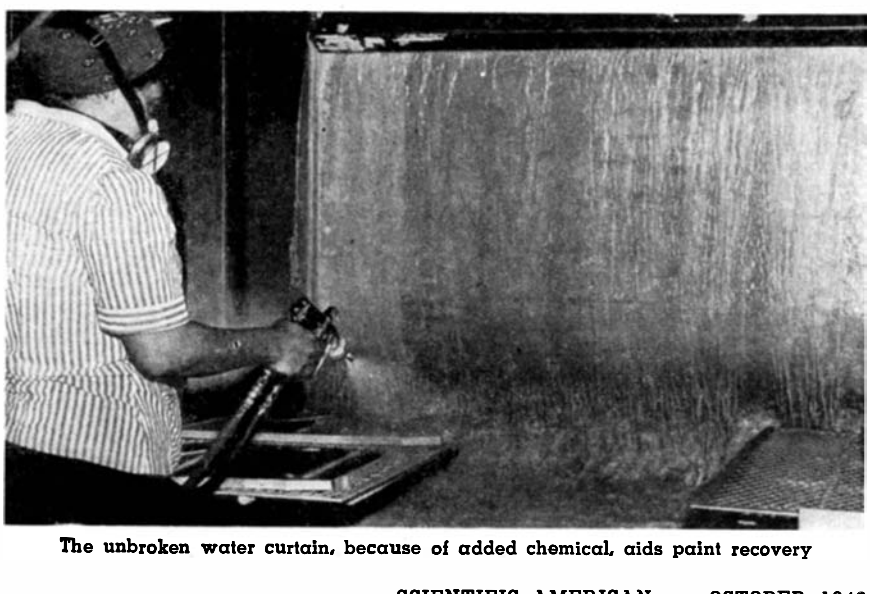
PAINT RECOVERY

Assisted by Additive to Water Curtain Spray

A NEW and important use in the War Production Board's paint recovery program was discovered recently for a chemical compound known as Turco Deflocculator. Paint overspray collected from water wash curtain spray booths which used circulating water treated with Turco Deflocculator lent themselves better to recovery and produced a recovered paint of the highest quality, according to test runs recently made at the Southern California area reclamation factory.

When the deflocculator was originally designed as a chemical treatment for circulating water systems in paint spray booths, its sole purpose was to prevent breaks in the water curtain by emulsifying oil and resinous vehicles and dispersing pigments so that they could not deposit on the metal walls of the spray booth.

Now, without changing the method or directions for using the compound,



The unbroken water curtain, because of added chemical, aids paint recovery the chemical compound serves a double duty. At the same time that the dilute solution of the compound (an initial charge of 1/3 ounce to the gallon of water, with further additions of 1/6 ounce per gallon every four hours) is acting to prevent breaks in the water curtain and maintaining an unbroken sheet, it also serves as a chemical recovery agent. By preventing the formation of scum on the top of tanks, the deflocculator aids in producing a higher quality of sludge which stays smoother and is dispersed easier after reclaiming.

INDUSTRIAL BURNS

Treated With Tannic Acid in New Package

ACCORDING to "Accident Facts" published by the National Safety Council, approximately 4½ percent of the industrial accidents known to the council were accounted for by burns and scalds. V. A. Zimmer, Director of the United States Department of Labor's Division of Labor Standards, has estimated that industrial accidents cost the nation 250,000,000 man days in 1941. This involved millions of workers who were absent from their jobs because of injury or accident in the plant. So, based upon a 4½ percent known estimate or reported accidents from burns, this means that 11,250,000 production days were lost, caused by burns and scalds.

As a means of reducing man-hour loss from industrial burns, The Gebauer Chemical Company has prepared a stable tannic acid solution which is marketed under the name of Gebauer's Tannic Spray. The bottle is unique in that its closure is an automatic device which permits the spraying of the solution directly from the bottle over the affected burn area. The manufacturer makes special emphasis of the fact that the first five minutes are the most important in the treatment of burns and that if first and second degree burns are treated promptly, within a few minutes after they have occurred, with any good, recognized medicament, the probability of blister formation, infection, and other complications is materially reduced.

The manufacturer further claims that this tannic spray solution is stable, antiseptic, and that it forms a tannic film over the area to which it is applied.

INTELLIGENT SELFISHNESS

Has Sound Basis in the Science of Psychiatry

MAN'S INSTINCTS and feelings supply the energy which makes the mind work. There is no other source of his animation and desire to live and thrive. Without the raw instinct of self-preservation, man would be inert, almost as in a stupor, with but a few feeble reflexes left to indicate that life exists. It is energy derived from the baser instincts which enables a man to awake, to dress, to eat, to go to work; it is a crude self-serving feeling, which, when refined by intelligence, causes him to care for his children, to make love, to fight battles, to build cities, to paint pictures, and to compose divine music.

If the instinct to acquire and to desire things were absent, man would be incapable of ambition, would be torpid as to his own welfare, could not provide for his family and would be utterly indifferent as far as pride, self-esteem is concerned. Total accomplishment would be almost nil

This concept becomes clearer when we inspect man's nature from the biologist's point of view. What is the value of basic selfishness or the so-called acquisitive instinct? The answer is obvious — it has an undeniable survival value. The purpose of selfishness is to provide man with energy for survival by acquisition of things which mean material comfort and security for himself and his family.

To the moralists, selfishness is undesirable and is considered to be something opposed to honesty, charity, ambition, and other virtues. To them, it is a base-instinct that is incapable of being refined by intelligence to become something desirable. They do not stop to consider that, like other instincts, selfishness has passed through evolutionary stages. In the primitive savage, it is "raw" and seeks direct satisfaction by simply stealing.

As social life improved, the desire to acquire did not diminish, but man learned, as the child learns, to defer desire, to recognize that the same goal can be achieved by devious strategies, and by socially approved techniques. Thus he attained two advantages; he obtained what he desired and at the same time incurred less hard feeling in his social setting.

Intelligence is, therefore, nothing more than a device whereby one satisfies instinctual desires with social approbation. The criminal who steals is simply stupid; the philanthropist has satisfied the same instinct of selfishness by elaborate intellectualization of this instinct and is therefore a wise and

7 things you should do to keep prices down!

If prices soar, this war will last longer, and we could all go broke when it's over. Uncle Sam is fighting hard to keep prices *down.* But he can't do it alone. It's up to *you* to battle against any and every rising price! To help win the war and keep it from being a hollow victory afterward—you must *keep prices down.* And here's how you can do it:

1. BUY ONLY WHAT YOU NEED

Don't buy a *thing* unless you *cannot* get along without it. Spending can't create more goods. It makes them scarce and prices go up. So make everything you own last longer. "Use it up, wear it out, make it do, or do without."

2. PAY NO MORE THAN CEILING PRICES

If you do pay more, you're party to a black market that boosts prices. And if prices go up through the ceiling, your money will be worth less. Buy rationed goods only with stamps.

3. SUPPORT HIGHER TAXES

It's easier and cheaper to pay for the war as you go. And it's better to pay big taxes *now*—while you have the extra money to do it. Every dollar put into taxes means a dollar less to bid for scarce goods and boost prices.

4. PAY OFF OLD DEBTS

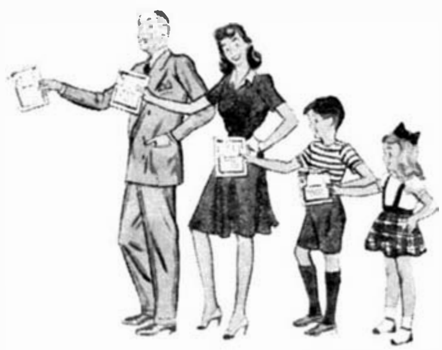
Paid-off debts make you independent now . . . and make your position a whale of a lot safer against the day you may be earning less. So pay off every cent you owe—and avoid making new debts as you'd avoid heiling Hitler!

5. DON'T ASK MORE MONEY

in wages, or in prices for goods you have to sell. That puts prices up for the things all of us buy. We're all in this war together—business men, farmers and workers. Increases come out of everybody's pocket—including *yours.*

6. SAVE FOR THE FUTURE

Money in the savings bank will come in handy for emergencies. And money in life insurance protects your family, protects you in old age. See that you're ready to meet any situation.



7. BUY WAR BONDS

and hold them. Buy as many as you can. Then cut corners to buy more. Bonds put money to work fighting the war instead of letting it shove up prices. They mean safety for you tomorrow. And they'll help keep prices down today.

KEEP PRICES DOWN . . .

Use it up . . . Wear it out . . .
Make it do . . . Or do without.

This advertisement, prepared by the War Advertising Council, is contributed by this magazine in cooperation with the Magazine Publishers of America.

honorable man. He has simply refined a baser instinct into exalted virtues by keeping an ear attuned for social approval. Such dynamic characteristics as ambition, reliability, enterprise, capability, and resourcefulness are nothing more than an intelligent harnessing of the instinct of selfishness.

This process of refining or elaborating a crude instinct to man's ultimate advantage is called sublimation. It signifies an intelligent utilization of instincts, desires, and tendencies, and is the most powerful incentive to work. Give a man an incentive to satisfy a prime instinct and his capacity to perform increases ten fold. No instinct in more propelling in this respect than is selfishness.

Labor without a sublimated selfishness is drudgery. To harness the instinct of selfishness in an intelligent manner produces a capacity to work which defies all the common laws of fatigue. It has little or nothing to do with the physical state A small hunchback who is working with instinctual satisfaction never tires, while the husky athlete who works for the sake of work alone, is listless and flabby at his tasks.

No man works harder and with greater zeal than the proprietor of a shop for the simple reason that he is satisfying the instinct of selfishness in an intelligent and accepted manner. Work is never an end unto itself — it is always a means to an end — to satisfy an innate selfish desire, whether it be to get a new refrigerator or to build a memorial hospital for charity.

The psychiatrist sees no incongruity in the term "intelligent selfishness." The concept has found sound application in industry as demonstrated by the policies of J. F. Lincoln He has been able to show that when the shop worker is allowed to utilize the instinct of selfishness to its fullest, his capacity for satisfying and non-fatiguing work is immeasurably increased. The principle is simple enough; the incentive being a participation in the profits in the form of bonuses and corporation shares.

STEEL CHEMICALS

A Few of the Jobs Being Done by Chemistry

STEEL IS processed by a host of chemicals from the moment explosives blast loose the ore until armor plate, tanks, bridge spans, or other finished products are delivered.

Chemicals to clean, surface-harden, electroplate, pickle, and perform other necessary operations on the metal are being manufactured in record quantities this year to match the unprecedented output of steel, according to E. I. du Pont de Nemours & Company.

Virtually every piece of steel going into ordnance must be thoroughly cleansed of oil, grease, and the like at least once, and usually many times, before it takes final form Both satisfactory inspection and the permanent adhesion of any finish require perfectly clean metal.

Chlorinated compounds — usually known as non-flammable, synthetic dry-cleaning fluids — now clean metal faster and more efficiently than any other known agent, by a method called "solvent degreasing." Oil and grease to the last speck dissolve in these chemicals or their vapors like sugar in water. Many parts vital to military equipment can be cleaned in large volume only by this method. Moreover, the work is done about four times as fast, and requires only about one-quarter the factory space.

The steel gears, bearings, cylinder sleeves, valve stems, and other essential parts of airplanes, guns, tanks, ships, and trucks would quickly break down under the full fury of mechanized warfare had not their surfaces previously been hardened and made wear-resistant by special chemical treatment.

One method for obtaining the required hard metal "case" is to treat steel in a bath containing molten sodium cyanide; another is "nitriding" In the latter, gaseous ammonia is flowed across steel under controlled conditions. Nitrogen in the ammonia combines with the surface layer of metal to form iron nitride—an extremely hard substance. Heat and time of processing determine the thickness of this protective "case."

Two pieces of steel often are joined together with copper by a unique process known as "brazing." Copper heated in the presence of hydrogen—

one of the two components of the chemical ammonia—flows out like oil over glass on the surfaces between the two pieces of steel. When cooled, it hardens and forms a permanent bond.

The heating and cooling of steel during various treatments would cause scaling if done in the air. Therefore, this operation is usually carried out in an atmosphere free of oxygen—for example, nitrogen-hydrogen, or nitrogen alone. "Bright annealing" is the apt name of this process, which assures a smooth, scaleless steel.

HEADBAND MAGNIFIER

Leaves Both Hands Free, Permits Use of Both Eyes

INSPECTORS as well as craftsmen doing high precision work frequently find need for a magnifier yet cannot use one which is fixed in position, or requires use of the hands. For such jobs there is available a Carl Zeiss binocular magnifier attached to a headband as shown in the accompanying illustrations.

Giving a magnification of 2¼ times, a practical power for most industrial purposes, the two lenses provide binocular vision which results in a large and clear field of view with ample depth for most work.

Magnifier leaves both hands free

No focusing adjustment is required and eyeglasses may be worn while using the magnifier. By raising the head slightly the eyes have an unobstructed view.

X-RAY TURNABLE

Makes Possible Pictures from any Angle

AN X-ray machine incorporating a miniature turntable that enables physicians to change the position of a patient at will during delicate operations to remove foreign bodies from the lungs has been developed for the University of Pennsylvania Hospital, according to Westinghouse engineers.

The X-ray machine, called a biplane fluoroscope because it enables examinations to be made in two planes—horizontal and vertical—has been installed

X-ray pictures from any angle

in the Hospital's $200,000 department of radiology, one of the largest in the country. It will be used to locate such foreign bodies in the lungs as coins and safety pins.

"The turntable makes it possible to position a patient so that X-ray pictures can be made from any angle, even vertical, without lifting or turning him bodily," explains C. V. Aggers, Manager of the Westinghouse X-ray Division. "The result is greater safety and comfort for the patient, greater usefulness for the biplane fluoroscope."

Noting that examinations with the biplane device will be conducted in darkness, Mr. Aggers points out that all possible obstructions have been eliminated by design of the mechanism to assure freedom of movement in the examination room. The fluoroscopic assembly suspended from the ceiling and the examination table, riding on miniature trolley tracks across the revolving turntable, constitute the only visible portions of the apparatus. All other parts are concealed behind a wall panel and under the floor.

Aided by the biplane device, a specialist removes the foreign body by means of a small forceps which is passed through a tube in the patient's mouth to the lung.

LAMP FOR LIFE RAFTS
Projects a Beam Visible for 60 Nautical Miles

A MIDGET searchlight only as big as a walnut yet so powerful that it will project a 1500-candlepower beam visible for 60 nautical miles has been designed by Westinghouse engineers to aid the rescue of aviators forced down at sea. The new lamp provides the most powerful beam ever obtained from such a tiny incandescent unit, reports Ralph R. Brady, manager of commercial engineering at Westinghouse.

"Packed with the rubber life rafts with which all ocean-flying military aircraft now are equipped, one of the tiny lamps will be worn by each man of a plane crew forced down at sea," Mr. Brady declares. "The lights fit on a band around the head, like a miner's cap, so the man can have both hands

For use on life rafts

free to hold on during rough weather.

"One half of the lamp bulb is silvered to provide a reflector," he says. "The lamp thus becomes a complete optical package in itself and requires no metal reflector or glass lens. An ordinary six-watt lamp diffuses its light in all directions whereas this lamp projects a beam that belies its size."

Navy specifications called for a lamp that would provide a light beam visible for at least 10 to 12 miles. Westinghouse engineers more than met the requirements by producing a lamp with a theoretical range of 60 nautical miles or about 70 land miles. Water vapor in the air reduces this range somewhat in actual practice, however.

"If burned all night long, one of the sea rescue lamps would last about 10 nights or 100 hours," Mr. Brady points out. The lamp is mounted in a waterproof housing to protect it from damage and contains a single tungsten filament.

METAL SALVAGE

Conducted on Intensive Scale

By Electrical Manufacturer

It's a familiar saying that every part of a pig is used except the squeal. Now this axiom is the catch-word at the Stromberg-Carlson Company, where equal care is taken to make certain that not a bit of the metal used in the manufacture of radio and telephone equipment for the armed forces is wasted.

The firm began an intensive salvage program several months ago and since that time tons of brass, aluminum, bronze, steel, lead, and copper, which, as manufacturing waste were normally thrown away, have been turned back into industry to be processed into useable material.

Large metal pieces such as aluminum, copper, and brass stampings are first sorted according to size and quality and then turned over to nearby metal foundries for re-smelting. Scraps of this type average well over 58,000 pounds a month. Steel borings and stampings net more than 38,000 pounds in a month's time.

From craftsmen's benches, where

delicate electrical apparatus is assembled, come a large supply of usually-wasted solder drippings. This now-valuable metal, which splatters from the workmen's soldering-irons, is sent to a lead works at a monthly rate of 300 pounds.

Even small copper wire ends, snipped off during wiring assembly, are retrieved, along with worn copper tips of soldering-irons, running into more than 250 pounds every month. Discarded braided wire is accumulated, the insulation burned off, and stored for salvage. Tiny, powder-fine metal filings are tediously collected, and packaged for the smelters.

Defective radio tubes, amounting to 125 pounds a month, are turned over to refineries which retrieve the valuable nickel, gold, silver, tungsten, and brass which make up their construction.

CONCRETE CURING

Test Sections Kept in Air-Conditioned Room

SPECIMENS to test durability and strength of all concrete going into the construction of dams, highways, buildings, and sidewalks by the City and County of Denver, Colorado, are cured in a Carrier air-conditioned room at the Materials Laboratory of the Denver city government.

To test concrete's "curing" propensities, the laboratory has constructed a storage room approximately 14 by 18 feet, in which a temperature of 70 degrees, Fahrenheit, and 100 percent relative humidity are maintained the year around with variations of no more than two degrees, Fahrenheit. Walls and roof of the room are fully insulated and all electrical conduits and light fixtures are moisture-proofed.

When the temperature in the curing room rises above 73 degrees, Fahrenheit (maximum permitted by American Society Testing Materials), the refrigerating unit pumps a refrigerant through the air-conditioning coils, thus cooling the air current as it passes into the room. When the minimum temperature (68 degrees) has been reached, the refrigerating unit automatically turns off and heaters turn on. The air current then circulating in the room is warmed. This cycle of alternate heating and cooling may be continuous. However, it has been found that in the

Air conditioned for concrete curing

warm summer weather the heaters can be dormant, and similarly the refrigerating unit can be switched off in cool weather. The humidity is maintained by water being atomized continuously through a small nozzle, thus creating a dense fog. The blower which circulates the warmed or cooled air and also diffuses the water vapor operates almost continuously.

WOODEN-WHEELED TRAILER

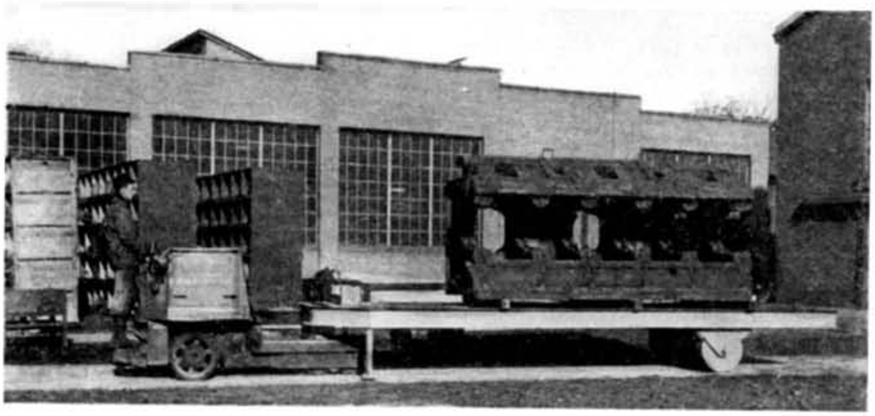
Improvised to Expedite Foundry Production

AN EXAMPLE of ingenuity in meeting today's production schedules was brought to light recently at a plant of The Cooper-Bessemer Corporation.

Faced with a problem of shortage in foundry floor area due to increased output, foundry workmen were cramped for space to store huge engine castings. To relieve this condition, some of the flasks and castings were placed on old flat cars and moved out of the foundry onto rail sidings for the necessary period of gradual cooling. When this expedient failed to solve the problem entirely, low flat platforms were constructed from scrap steel and discarded parts, and two heavy wooden wheels added to permit portability.

Now, castings weighing up to 16 tons are placed on these improvised trailers and moved about at will by simply coupling the trailer to one of the shop's electric-powered utility trucks.

The loaded trailers are usually parked in the yards outside the plant for cooling or for temporary storage. The same method is also used to save time in transporting the castings to and from the chipping and painting department located in a separate building.



Wooden wheels on the trailer solved one plant's storage problem

METALS IN INDUSTRY

(*Continued from page* 153)

which cannot be used if heated, during repair, to temperatures over 1300 degrees, Fahrenheit. Tungsten-carbide and high-speed steel tool tips are also being applied to ordinary steel shanks by silver-brazing, thus saving tons of critical tool alloys by confining their usage just to the tips of the tools.

The use of silver for brazing has grown the fastest of all silver applications during the war and will continue to expand in the post-war period, as will the use of silver-bearings and solders. These are all applications of silver involving more than just replacement of scarce materials—applications in which engineers are discovering that silver and its alloys have superior qualities of their own and can compete economically and technically with the more familiar industrial materials.

Other applications of silver that have post-war as well as wartime importance are its use, especially as a surface layer, for corrosion-resistant chemical process vessels and piping, its use for certain types of food or drug containers, its employment as a surfacing for permanent electrical connections (to defeat oxidation) and its application as a reflecting surface on head lamps, searchlights, flashlights, and so on. One of the largest industrial uses of silver—in photographic emulsions—is an old standby that will grow as photography does.

And, of course, sterling silver, silverplate for tableware (the Army and Navy are today using astonishing amounts of silver-plated steel eating utensils), coinage, and the use of silver for currency-backing will be with us in force as long as we have artistry, esthetics, meals, and governments. But this takes us back to the starting point of this article, which starting-point we suggest that the reader now re-read.

POWDER HARDNESS

Can Now be Measured on Single Metal Grains

QUALITY control of the production of many metals and metal products is exercised through hardness testing. With powder metallurgy parts (made by pressing and sintering metal powders), however, conventional hardness testing has been generally unsatisfactory because of the porosity or the duplex structure of such parts.

Recently devised is a "micro-hardness tester" that is able not only to measure the hardness of microscopic areas of such materials, but also to determine the hardness of individual powder particles. Ordinary hardness testers employ indentors that are considerably larger than individual grains and thus give an average reading of alternate particles and voids rather than the actual hardness of any single particle.

Essentially, the new instrument consists of a diamond penetrator (like that used in the well-known Vickers hardness tester) mounted so that it can be attached to a microscope in place of the objective lens. The microscope has crosshairs in the eyepiece and, by properly alining the diamond, it can be made to touch the sample at a point directly in line with the crosshairs—in other words, right over any selected particle of powder, for example.

The pressure necessary to force the diamond penetrator into the grain of powder is furnished by a carefully calibrated spring. When an indentation has made, the diagonals of the diamond-shaped recess are measured by any one of several standard microscopic means, the indenting force represented by the spring is already known, and from these values a single calculation gives the micro-hardness of the particle.

With this instrument hardness measurements have been made directly on a single tungsten carbide particle for the first time, and the material was found to have a diamond pyramid (Vickers type) hardness number as high as 1850. Previous values, using ordinary instruments, had always been much lower because some of the softer cementing material was unavoidably tested along with the carbide.

Other data provided by the new tester show that annealed sponge-iron powder and annealed electrolytic iron powder have about the same hardness (about 50 diamond pyramid numbers).

The instrument is certain to be widely used to advance both the knowledge of hardness and the science and practice of powder metallurgy.

WELDING PROVED

Wire Production Serves as Accurate Index

An index of the expanding use of welding, aided by the war-effort impetus, is the production of welding wire (for filler-metal rods and electrodes) in 1942. Official data of the American Iron and Steel Institute reveal that 800,400,000 pounds of steel wire for welding was made last year—nearly double the 453,120,000 pounds for 1941 and more than three times the production in 1940.

Almost 13 pounds of welding wire were made in 1942 for each ton of finished steel produced. This compares with about seven pounds in 1941 and less than five pounds in 1938.

CAST DIES

Give Outstanding Performance in Shell Production

The old idea that all "cast iron" is a weak and brittle material has been dispelled by the use of specially-processed, high-strength iron castings for jobs where resistance to impact and other stresses is required.

Outstanding among examples of this is the just-revealed use, especially in Great Britain, of high-strength cast irons of the Meehanite type in the construction of cast-to-shape dies for forging shells and bombs. Some of the service requirements—for example, the horizontal nose-forging of three-inch shells at 2100 degrees, Fahrenheit—are extremely severe, yet the cast dies in the case mentioned have produced more than 6000 shells without failure.

A grade of alloy iron castings containing nickel, chromium, and molybdenum has out-performed forged-and-machined steel dies for this service in a dozen British installations, giving an average die-life of 18,000 shells, compared with an average of 11,000 for the steel dies.

THIN CASE-HARDENING

Accomplished by Use of Ultra-High Frequency Oscillators

Induction heating of metals has made tremendous strides in recent years, and much publicity has been given in recent months to the use of vacuum-tube oscillators with frequencies up to one million cycles for producing hardened cases 5 to 30 thousandths of an inch thin.

However, if the operating frequency is increased from one megacycle to four megacycles, the thickness of the induced-current carrying layer is reduced one half and the heat developed in this area is doubled. By applying frequencies of five to 15 megacycles to small parts, such as end bushings on a 0.63-inch hollow spindle of 0.35 percent carbon steel with 0.12-inch walls, for 7/10 of a second, ultra-thin (one thousandth of an inch), uniform, and very hard (Rockwell C 55) cases are produced.

The operation is self-quenching (no water-quench is required) since the mass of the cold part is relatively so much greater than the thin heated area in contact with it. The very short time at heat also fails to put all carbides in solution and the combination of hard martensite and carbide particles in a low-carbon steel surface may have interesting properties for special services.

GUNSTOCK FORMERS

Now Made of Steel; Last Much Longer

When walnut stocks for rifles are being produced they are made automatically on copying lathes. The roughed-out wooden blank is placed in a lathe with a metal facsimile and is automatically turned to the required shape by cutting tools which are guided by the metal former. Previously, these formers were made of iron and their life was relatively short.

Today, however, Winchester is making these formers of steel, the new formers having a life approximately 10 times that of the older iron type. The development which has made possible this improvement in gun stock manufacture is the Keller automatic die sinking machine. Heretofore no method had been available to shape satisfactorily this harder metal which is also more durable under production conditions as they are today.

New Products

WET-DRY BELT GRINDER

An abrasive belt grinder, recently announced, can be adjusted from vertical to horizontal position while it is running. The belt tension and tracking device can likewise be adjusted while running, by two conveniently located handles.

The Hammond "600" Wet-N-Dri machine illustrated is equipped with tank and pump unit and can also be equipped for water-main connection

Belt grinder which can be adjusted from vertical to horizontal while running

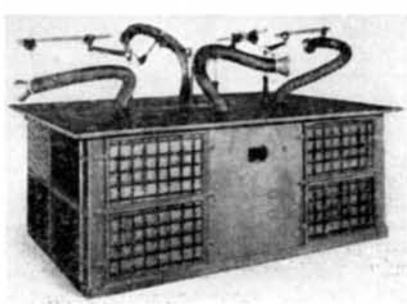
only. Both types are provided with damper or spray control and two nozzles for uniform spraying. Should dry operation be desired at any time on either machine, it is necessary to merely turn off the water, remove drain connection and attach air exhaust system at this point.

Squaring, champfering, forming radii, grinding flat surfaces, rounding, polishing, and removing shaper marks are a few of the many present-day production operations being done on abrasive belt grinders.

DUST COLLECTOR

Designed for use with small portable grinders, a new work bench has been developed by Schmieg Industries which completely solves the dust problem inherent in this type of work.

The bench, as shown in the photograph, has four flexible hooded intakes. A motor-driven blower located under the bench top draws dust through the intakes, and discharges the air through filters. The flexible suction tubes of the intakes makes it possible for the



Flexible hoods for four machines

operator to place the hood in any desired position so that the high-velocity suction may be concentrated at the dust source. Heavy dust particles settle out in a plenum chamber, while fine particles are removed by the replaceable filters.

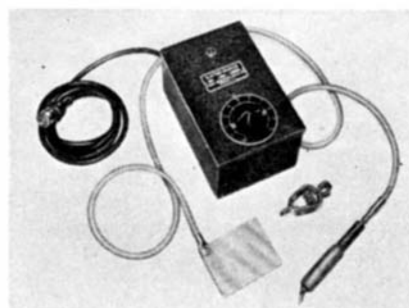
TRAMP-IRON DETECTOR

For general application on belt conveyors carrying non-magnetic materials, a new magnetic control has been developed to detect the presence of tramp iron. When such material, which might damage equipment or otherwise cause trouble, passes into the magnetic field set up by the detector, a relay is actuated to shut down the belt drive motor. When the tramp iron is removed the motor can be restarted. Operation of the magnets in these detector units, made by Dings Magnetic Separator Company, requires a source of constant voltage direct current.

ELECTRICAL MARKER

For placing freehand numbers, symbols, and identifications on soft or hardened steel, alloy steels, other ferrous alloys, wrought iron, and cast iron, a new unit consists of a special transformer with ten voltage stages controlled by a convenient rotary switch, a hand-held marking pencil, a ground plate for use with small work, and a ground clamp for large work. The voltage selection makes it possible to obtain any desired depth of marking, from the faintest line to the heaviest arc required for penetrating through scale or dirt on castings or heat-treated parts.

The marking point is made of a heat-resisting alloy and is threaded into the



Hand held marker for metals

holder at an angle so that it stands vertical to the work when the holder is placed in normal writing position.

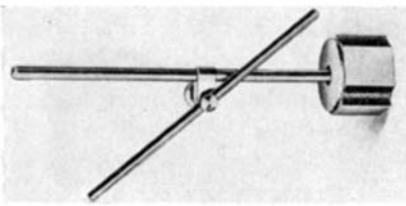
Use of this device, made by the H. P Preis Engraving Machine Company eliminates the necessity for stamping parts before heat-treating them and is represented as a clean, fast, and economical marking method, requiring a minimum of cleaning and surface preparation.

PLASTIC SYPHON

Designed for easy transfer of liquids from carboys, a new plastic syphon tube is equipped with valves which enable the syphon to remain primed as long as any liquid remains in the carboy. The intake section of the tube is filled through a ball valve by the use of a hand operated pump. The discharge end of the syphon is controlled by operating another valve. This unit, called Safety Syphon, is available through the Central Scientific Company.

MAGNETIC ADAPTER

A PERMANENT-MAGNET clamping block that has wide applications in set-up and inspection layouts is shown in the accompanying illustration together with a standard and swivel arm. Known as the Windemere Magnetic Adapter, this unit can be used not only as indicator holder but as a general work-holding block for anchoring parallel angle iron



Magnetic block of many uses

and other work pieces in any given position. The adapter weighs approximately 20 ounces and is furnished with an upright center post either 3/8 or 5/16 of an inch in diameter.

WHEEL ADHESIVE

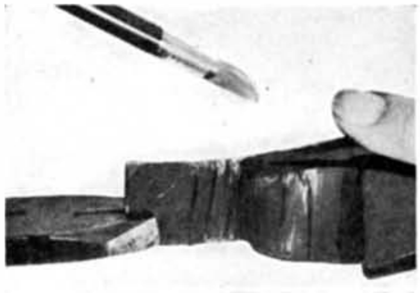
GREAT penetration, high bonding qualities, and long-wearing strength are qualities provided by Stikum, a new polishing wheel adhesive that does away with cooking and mixing operations. The grinding surface obtained with Stikum is reported to be more flexible than with either glue or cement, to resist friction heat, and to wear uniformly to the last grain.

SUPER-STRENGTH BONDING

RUBBER, synthetic rubber, plastics, leather, or wood may now be united to metal or to each other with a bond stronger than the materials themselves, by means of a new process announced by The U. S. Stoneware Company.

Already in use for vital war applications, the new method (known as the Reanite bonding process) holds promise of making possible metal-and-plywood panels to form light weight, fire-proof, water-proof structural assemblies for pre-fabricated housing units, boats, airplane or motor car assemblies, kitchen cabinets, refrigerators, furniture, and so on. Composite metal and plastic parts may be molded; rubber and metal spring assemblies for smooth, soft, quiet, and vibration-free riding are reasonable possibilities arising from this development.

Application of the Reanite process is simple. The surfaces to be joined are brushed, sprayed, or dipped with Reanite. After drying, mild heat and pressure is applied. The joint is said to be unaffected by fresh or salt water, is non-corrosive to metals, and pos-



A strong rubber-to-metal bond

sesses excellent corrosion-resistance in itself, as well as high dielectric strength.

Repeated laboratory and field tests indicate that it requires a direct pull in excess of 30,000 pounds to separate two six inch square pieces of steel bonded with Reanite. On repeated tests of bonds formed between natural rubber, synthetic rubber, plastics, leather, and wood, the materials themselves gave way before the bond.

ACID ETCHING

A NEW portable inspector's acid etching kit for indelibly marking metal production parts consists of an acid-proof housing, a bottle of acid, a bottle of neutralizing liquid, and a set of marking stamps made of an acid-resisting synthetic material.

Within the housing is a stamp pad saturated with the acid. When this housing is tilted to uncover the pad the operator touches the desired stamp to the pad, withdraws it and then allows the cover to close so that acid fumes will not escape. After the stamp is touched to the work to be marked a drop of neutralizing liquid is applied to prevent further etching.

WOOD SEALER

SEALING materials for use in water-proofing wood crates and boxes are now available which not only seal the lumber itself, but cracks and joints as well. These materials, made by the Carbozite Corporation, come in two forms. The surface sealer is a liquid which applies with a spray gun and dries in approximately 30 minutes. It is claimed to seal the natural moisture into lumber, thus preventing drying, shrinking, and warping. The joint sealer is in mastic form and is applied with a trowel or pressure gun. It is claimed that the mastic will bond perfectly with the surface sealer and will remain pliable indefinitely.

BEARING WASHER

IN THE manufacture of many instruments and machines, the utmost care must be exercised to make sure that the bearings are absolutely clean before assembly. Realizing this, the engineers of the Metal Washing Division of American Foundry Equipment Co., working with an important manufacturer of instruments, perfected a simple but highly efficient unit to clean bearings individually without exposing them to room air or handling which would result in rusting from finger smudges.

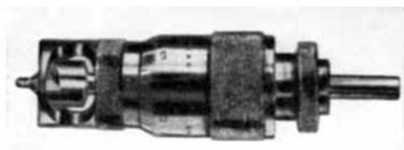
Washing machine, with door open

The bearing washer consists of a solvent container, a fractional horsepower solvent pump, a solvent filter, and the proper bearing adapters. If it is necessary on certain types of work to remove excess solvent from the cleaned bearings, an air hose connection providing clean filtered air can be built into the cleaning unit.

The solution is continuously recirculated and before reaching the nozzle, it passes through a filter to remove all minute dirt particles. All parts of the machine are Parkerized to provide rust protection. An non-breakable plastic door is included to allow the operator to view all operations.

COUNTERSINK STOP

BASED on the principle successfully used in engine valve-spring design, a split keeper which gives positive set to the retainer collar on bearings is now incorporated in micrometer stop countersinks manufactured by Aero Tool Company. With this positve locking feature, no amount of vibration will loosen the bearing retainer and cause damage to the tool or material, it is said.



New micrometer countersink stop

The keeper insert works on the slotted, taper shaft principle. All force is directed toward the shaft center under constant, even pressure.

Lightning-quick service is now possible with this added feature. The unit may be immediately disassembled by hand. No tools are required. On-the-job oiling and other required servicing becomes a matter of moments, thereby speeding operations.

WATERPROOF CLOTH

AN EXTREMELY thin, invisible, yet waterproof coating for such materials as cloth, paper, and ceramics may be obtained through the use of a new liquid known as Dri-Film. This liquid vaporizes at a temperature somewhat below that of boiling water and the vapor is used to form the waterproof coating. Application of the vapor is made in a closed cabinet.

GLOSS MEASUREMENT

DESIGNED for measuring specular gloss of paints and varnishes, ceramics, paper, and machined or polished surfaces, a new photoelectric Glossmeter is particularly suited to register changes in specular gloss as a result of age, wear, abrasion, exposure to moisture, heat, light vapors, or sprays.

The Glossmeter comprises the instrument proper and the search unit which is connected to it by a flexible cable. The search unit may be placed on the sample to be tested, or the unit may be positioned with the opening pointing upwards so that the sample is placed on top of it. The search unit may, furthermore, be turned with the opening sideways for convenient measurement of vertical surfaces. The samples can be of any size and may be measured in rapid succession. The instrument is portable and will be found valuable in the laboratory as well as in production control, in the field, and in test fence work.

Glossmeter search unit is at right

The operation of the instrument is simple and convenient, and requires no training on the part of the user. The search unit is first standardized to give a reading of 92.5 for polished black glass. Then the search unit is placed on the sample, and the needle indicates directly the gloss in terms of an ideal, completely reflecting mirror as 1000.

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.)

INDUSTRIAL AIR POWER is a 24-page comprehensive pamphlet describing and illustrating a large number of air operated devices now in use by American industry. *Mead Specialties Company, 15 South Market Street, Chicago 6, Illinois.—Gratis.*

CAN GLASS HELP YOU FILL WAR CONTRACTS? is a 16-page illustrated pamphlet describing some of the war activities of a glass manufacturer, with emphasis on those characteristics which make glass adaptable to a wide range of applications. *Libbey Glass Company, Toledo, Ohio.—Gratis.*

HOW TO TAKE CARE OF YOUR CLOTHES is a 30-page pamphlet which tells of the importance of the proper selection of clothing material and how best to prolong the life of such materials. *Dan River Mills, 40 Worth Street, New York 13, New York.—Gratis.*

AIR EXPRESS WALL CHART is an 11½ by 26 inch chart which gives specific information on shipping by air express — what can be shipped, how to secure priorities, weight and size limitations, and so on. *Railway Express Agency, Inc., 230 Park Avenue, New York, New York.—Gratis.*

TESTS OF RIVETED AND WELDED JOINTS IN LOW-ALLOY STRUCTURAL STEELS, by Wilson, Bruckner and McCrackin, Jr., is a 76-page bulletin reporting results of a recent investigation in this field. Bulletin Series No. 337, *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—80 cents.*

WELDING POSITIONER is a 4-page folder describing and illustrating specialized equipment for speeding up welding operations. *Lyon-Raymond Corporation, 1207 Madison Street, Greene, New York.—Gratis.*

MEETING TODAY'S EMERGENCY is a 2-page circular describing modern designs in completely flexible wood partitions for office and industrial use. *Martin-Parry Corporation, York, Pennsylvania.—Gratis.*

CEMENTED CARBIDE DIE MANUAL is a 32-page booklet covering standard and special dies for drawing wire, bar, tubing, and sheet metal. *Carboloy Company, Inc., Detroit, Michigan.—Gratis.*

EBONOL is an 8-page pamphlet describing in detail a simple procedure for direct low-temperature blackening of various metals. The finishes are produced in the form of stable, adherent, hard oxides. Also available are four pamphlets giving operating instructions for the above processes. *The Enthone Company, 442 Elm Street, New Haven, Connecticut.—Gratis.*

CARE AND CONSERVATION OF BRUSHES is a booklet which gives reasons why proper care of paint, varnish, and lacquer brushes is imperative, together with suggestions for such care. *The Osborn Manufacturing Company, 5401 Hamilton Avenue, Cleveland, Ohio.—Gratis.*

PRIMER OF ELECTRONICS is a 4-page simplified introduction to the electron and to the principles which govern its use. *General Electric Company, Electronics Dept., 1 River Road, Schenectady, New York.—Gratis.*

VULCAN SERVICE TO YOU IN THE POST-WAR ECONOMY is a 24-page plastic bound booklet describing tool and machine design services which are available through an organization that is conscious of the needs of tomorrow as well as of today. *The Vulcan Tool Company, 213 North Beckel Street, Dayton, Ohio.—Gratis.*

HOW TO USE DIAGRAMS IN RADIO SERVICING, by M. N. Beitman, is a small booklet intended to aid radio students and beginner service men. *Supreme Publications, 328 South Jefferson Street, Chicago, Illinois.—10 cents.*

INDUSTRIAL HEAD AND EYE PROTECTION is a 48-page catalog concerned with a wide range of goggles, respirators, various types of masks, face shields, machine guards, and so on. *Chicago Eye Shield Company, 2333 Warren Boulevard, Chicago, Illinois.—Gratis.*

FLOODS OF MARCH 1938 IN SOUTHERN CALIFORNIA (Geological Survey Water Supply Paper 844) is a 399-page, illustrated, paper-covered, technical-scientific study of this great flood and, because of its source, it should be authentic and dependable. *Superintendent of Documents, Washington, D. C.—$1.25.*

HOW TO TEACH FIRE FIGHTING is a 16-page illustrated pamphlet which shows how to set up fire fighting demonstrations, how to conduct them, and what their value can be to industry. *Walter Kidde and Company, Inc., Belleville, New Jersey.—Gratis.*

HAND TOOLS is a 52-page illustrated booklet that gives simplified, down-to-earth hints on the use of all the common hand tools ranging from files and hammers to wrenches and vises. *General Motors Corporation, Broadway at 57th Street, New York, New York.—Gratis.*

NEW MAGIC IN WOOD is a 32-page booklet that illustrates and describes many of the things which industry is doing today, using wood as a basic raw material. *American Forest Products Industries, Inc., 16 East 48th Street, New York, New York.—Gratis.*

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"

BEATS any prism binocular, is the testimonial which Dr. Henry Paul, 119 North Broad Street, Norwich, N. Y., gives concerning the "richest-field" telescope, or "RFT", after making the one shown in Figure 1.

The richest-field telescope is a stubby, compact instrument usually used without a mounting—simply held in the arms—and it is designed to give magnificent views of the myriad Milky Way stars. No specialized type of telescope has equalled it in popularity since its descriptive data were published in "Amateur Telescope Making — Advanced" in 1937.

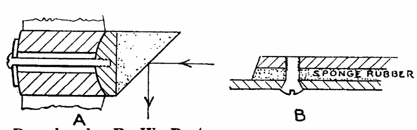
Paul says he weighed all factors and chose a 5" mirror aperture, with focal ratio 4, which hooks up just right in a 6" Micarta tube to give optimum portability, size, and so on. The 5" mirror was cut from a 6" Pyrex disk. The field of view covered is better than 2° in diameter. When the telescope is rested on the knee the eyepiece comes to just the right height for the eye.

Figure 1: **Paul's RFT, arm-held type**

Figure 2 shows detail of the diagonal support, which is easy to adjust. The two curves' locus is at center of the diagonal. The latter is an aluminized solid piece of Pyrex. The other sketch in Figure 2 shows how all adjustments for mirror and eyepiece are afforded: screws passing through sponge rubber.

After taking this telescope with him to the country and using it several nights, Paul writes, "The Milky Way was a bright ribbon all the way from horizon to horizon. I really got more of a thrill from the RFT than from my big telescopes. No complication: Just sit in a chair with a blanket around you and look to your heart's content."

ANOTHER satisfied "customer" for the richest-field telescope is Charles E. Kratz, 3512 Dennlyn St., Baltimore, Md., whose 4" RFT of 16½" f.l. is shown in Figure 3. "I have had a big kick from the RFT," he writes, "and was surprised to discover how much can be seen with low powers."



Drawing by R. W. Porter

Figure 2: **Adjustments. Paul**

Kratz made the hex tube of ¼" mahogany, using hand tools, and glued it up.

The telescope sets on a home-made tripod, the head having three pieces of wood each set in so that the grain runs in the direction of the legs, with ⅛" mahogany glued on top and bottom.

The RFT has become so widely established as a telescope type since it was presented in "A.T.M.A." that the initials RFT have now become a word just as they stand, without periods.

MACHINE for grinding and polishing, shown in Figure 4 and made by Robert W. Coulter, 812 Sixteenth Street, N. E. Masillon, Ohio, "works like a charm," he states "with almost unlimited variations of stroke, and requires but little attention while operating." It is a modification of the Hindle type and was built on an old library table of heavy oak.

"Speed reduction was accomplished entirely with V-belts and pulleys. Speeds are: Drive 27; sidethrow, 5 1/2"; turntable 1 1/3"."

The machine as shown worked well on a 6" mirror but when a larger mirror was tried there proved to be whip due to the high extension of the vertical end shafts. When the shafts were shortened, after this photograph was taken, the whip no longer occured.

ABSTRACT of a correspondence file. Subject: Outsized mosaic tool for grinding mirror.

February 24, 1943. Coulter (the man named above) to this department. "I am contemplating a 12½" short focus mirror, and would like to make a tool of small glass caster cups mounted on a full-sized circular base, its surface shaped to convex spherical curvature roughly approximating desired sagitta for finished mirror. I propose to use one central cup surrounded by a ring of smaller cups, and this by a ring of larger ones—combinations of sizes and numbers that happen to suit my size of tool. Doubt has arisen, however, whether such a tool would produce a regular sphere on the mirror, or whether zones would result. What do you think?"

Reply, March 1, 1943: "Theoretically it won't work. This tool amounts to a tool made of annular, concentric rings. Stroking should minimize the effect but not get rid of it all. This is *theory* but theory often proves wrong. Theoretically, the Germans had the English licked. So try it, if you are willing to gamble, and after making the experiment please tell us the outcome."

Side comment by Cyril G. Wates, Edmonton, Alberta, to whom inquiry was shown: "What's the idea? Why not, instead, make a solid glass lap, bust it on a hydrant, and then glue it together again? In other words, why make such a lap at all? And what a job it would be to bring the irregular glass cups into contact!"

Reply by Coulter, on seeing above comment: "It's much cheaper than a solid tool, easier also to form the curve with a built-up tool than to work a solid tool to curve, and saves time. Built-up tool also reduces suction when fine-grinding. (While working on a 12½" mirror a long-winded telephone interruption once led to my mirror and tool being welded together, and bad chips resulted from forcible separating.) But I suppose the underlying reason for the venture is to indulge a pet passion for oversized tools. [And it's always fun to try something different.—*Ed.*] Moreover, I like to be able to use long strokes throughout fine grinding—it goes much quicker and the mirror has to come to a sphere, since the two surfaces are always in contact. Hence I propose an 18" tool for use with the 12½" mirror."

Final report by Coulter, June 22, 1943: "Caster cup tool seems OK. Shadow test of mirror showed evenly spaced, concentric zones—a target without a bull'seye—and turned up edge But these reduced readily with local

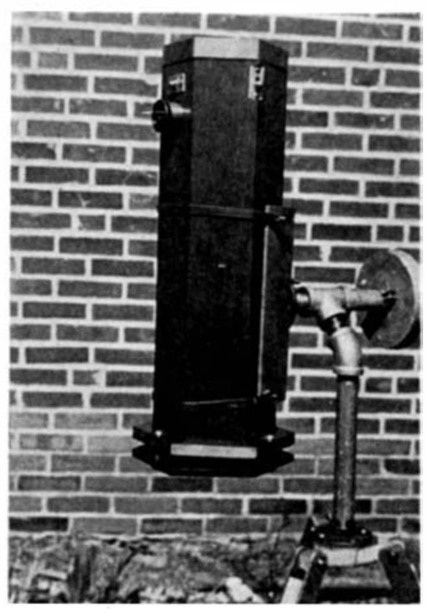


Figure 3: **RFT, tripod type. Kratz**

treatment by third finger dabbed in rouge. There also wasn't so much suction as with a solid tool. But Wates was right about establishing contact on a curved surface; it proved unsuccessful, so the tool was made flat, and it worked OK."

A READER of this department inquires: "Can a telescope mirror be made of cast aluminum? If so, where can I obtain aluminum blanks?" The answer is no, but the exact reasons make an informative discussion.

When an optical surface of glass is aluminized, the evaporated molecules, being in a high vacuum, travel, without bumping into other molecules, from the hot metal source to the mirror's cold surface and are deposited in a non-crystalline metallic film having the same degree of polish as that of the glass. As soon as air is admitted, the metallic aluminum begins to oxidize and, according to Strong (*Astrophysical Journal*, June 1936, pages 401-423), this oxide continues to thicken for about 60 days. It is transparent and is either corundum (Al_2O_3) or bauxite ($Al_2O_3.2H_2O$). Dr. J. A. Anderson states in a private communication that "the layer of aluminum, approximately 1/250,000" in thickness, is made up of 250 molecular layers. Of these," he continues, "I would guess that within the first month's exposure to air about 20 to 40 layers will have turned into aluminum oxide. The light rays pass through the transparent oxide layer and enter part way into the metal, then turn around and go back again."

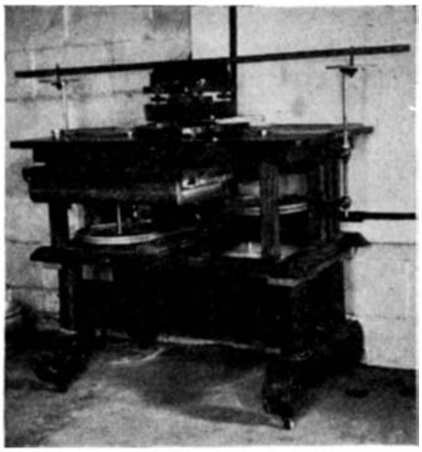


Figure 4: **Coulter's machine**

The above was shown to Dr. John Strong, who commented as follows: "If the thickness of one layer of aluminum is 4 angstrom units, or about 4 x 10^{-4} μ, then 250 layers are about 0.1 μ (or 0.2 wavelengths of green light). The oxide coat is about 100 angstrom units in thickness."

An angstrom unit is a ten billionth of a meter. The Greek letter "μ" (mu) designates one micron, or 10,000 angstrom units A micron comes pretty close to 1/25,000 inch and a wavelength of green light is roughly 1/50,000 inch.

Hence the coat of aluminum, as originally laid down, is about 1/250,000" thick. After some 60 days about the outer 60/250, say ¼, of its thickness has turned into oxide of aluminum.

The actual mirror is therefore metallic the same as a silvered mirror, but we still haven't answered the question why all this couldn't be as easily—more easily, it might seem—accomplished simply by letting a disk of plain cast aluminum oxidize in the air in the ordinary manner (the thought in the question which opens this note—a question which others have asked.

Fred B. Ferson, a Biloxi, Mississippi, amateur telescope maker who has inquired into metals and casting metals (see his chapter on molding and casting, in "A.T.M.A."), states it thus: "Aluminum is a metal which absorbs gases readily, and is hard to prevent from taking up impurities when it is cast. Also in castings it cools into crystalline structure, the crystals coarse and full of holes—possibly from absorbed gases driven off."

J. H. White, 20 Burchfield Avenue, Cranford, N. J., a metallurgist and amateur telescope maker who built his own aluminizing equipment, when asked for his comment, added: "Under the microscope the surface of an aluminum sheet, and still more an aluminum casting, shows a great many holes. These are gas holes. There also are black specks which are hard and brittle and are aluminum oxide which it has been impossible to remove from the melt. Even the best aluminum made by the Hoopes process, which has a purity of 99.983 percent, shows these spots. When the sheet is rolled the surface is smeared over and this covers up most of these defects. If a mirror were made of cast aluminum the crystalline structure of the metal, also the oxide particles, would show, and probably would fall out of the surface and leave holes."

Sometimes in popular writing (and some that isn't) it has been said that the oxide coating on an aluminized mirror is sapphire. This isn't literally true, though as a figure of speech it is a relative of the truth. The coating is aluminum oxide, Al_2O_3. If a given specimen of Al_2O_3 is a crystalline mineral it is properly corundum. Corundum has hexagonal crystals and its hardness is exceeded in nature only by that of the diamond; which, however, is very much harder. If black, due to iron impurity, the corundum is emery. It may also be gray, blue, yellow, red, brown, or colorless. If any of the last named crystals are clear and perfect—which is relatively very rare—the corundum is of gem quality. If blue, then it is sapphire; if red, ruby; if colorless, oriental white sapphire. That the coating on an aluminized mirror is protected by aluminum oxide is, therefore, the most nearly romantic (though not romantic at all) claim that can be made, for it isn't a gem and it isn't even crystalline.

Commenting on the above, Dr. Anderson notes an interesting analogy with quartz and fused quartz, the latter being the correct term for a "quartz" (often so-called) mirror: Quartz is a natural, crystalline mineral. Fused quartz is not crystalline, and neither, therefore, is a fused quartz mirror disk properly called quartz.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation 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.

Conducted by JOHN P. CANDIA

AMERICA'S GREATEST INVENTORS

By John C. Patterson

BIOGRAPHICAL sketches of 18 American inventors, living and dead, selected by a distinguished committee of scientists and industrialists as America's greatest inventors. These men have had tremendous influence on industry; an understanding of their trials and tribulations leads toward a better understand of industrial operations in general. (240 pages, 5½ by 8½ inches, a few drawings.)—$2.10 postpaid.—*A.P.P.*

FUNDAMENTALS OF ELECTRICITY

By A Staff of Electrical Experts

THE War Department's recommended outline has been followed in the preparation of this text book in the basics of electricity. Although designed to supply men about to enter military service with a foundation for further training, the text will serve a similar purpose for anyone desirous of acquiring such knowledge. (388 pages, 6 by 8½ inches, a large number of drawings and photographs, plus a dictionary of electrical terms.)—$2.10 postpaid.—*J.P.C.*

MAPS AND SURVEY

By Arthur R. Hinks

DETAILS of how maps are made, covering early maps, the modern map, British official maps (the book is British), international maps, maps of Europe, other foreign maps, charts and atlases; also exploratory, trigonmetrical, property, geodetic, and photographic surveys; and survey instruments. (301 pages, 5½ by 8½ inches, 28 plates.)—$3.85 postpaid.—*A.G.I.*

SMOKE STREAMS

By Charles Townsend Ludington

MOST Americans understand mechanical appliances and movements easily and instinctively; the motion of water and waves with almost equal readiness. But while the air is all-pervading, it is invisible and mysterious and we cannot visualize its flow past airplane wing, yacht sail, or roof top. Mr. Ludington and an associate, Roger Griswold, working in the quiet of the country, burned dried leaves or wood, created a small, inexpensive, home-made tunnel by drawing smoke with a blower past the aerodynamic body to be investigated. The book, an outcome of these experiments in visualization, presents fascinating pictures. There pass in review flow pictures of airfoils, cylinders, roofs, flaps, slots, tips of wings, and dozens of other phenomena. Coupled with the pictures, there is a simple, readable, elementary, but accurate explanation of the phenomena. The whole is fascinating and instructive for laymen and professional. (144 pages)—$2.85 postpaid.—*A.K.*

WHY MEN CAN FLY

By M. K. Chapin

THE answer to the implied question in the title of this volume is: Because he thinks. However, thinking alone can never result directly in flight. It is the product of human thought translated into aero-dynamics that has made possible aviation as we know it today. These thought processes are logically and simply traced in the pages of this volume which brings the reader up to date in aviation—and into the future—with a minimum of study. Not a text book, but an easily read exposition on the subject. (388 pages, 6 by 9 inches, a number of drawings.)—$2.60 postpaid.—*A.P.P.*

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By Edward Podolsky, M.D.

WHAT the layman should know about cancer: How it is detected; treatments; food and cancer; cancer research. (179 pages, 5 by 7¼ inches, 2 illustrations.)—$1.85 postpaid.—*A.G.I.*

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By H. T. U. Smith

AERIAL photography has far greater applications than those pertaining to military matters. It is of value in economic geology, in many engineering fiellds, in forestry and agriculture, in city planning, and in archeology. With a special eye toward these uses, the text of the present book is built up through the taking and study of aerial photographs to various methods of interpretation. (372 pages, 6½ by 9½ inches, 62 photographic plates and over 50 drawings.)—$3.85 postpaid.—*A.P.P.*

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By A. J. Eardley

PRACTICAL guide for geological students and others having some technical background. All applications of aerial photography are carefully considered and the military importance is also stressed but the emphasis is mainly on structural geology. (203 pages, 6 by 9 inches, 92 illustrations.)—$2.85 postpaid.—*A.G.I.*

AERODYNAMICS FOR MODEL AIRCRAFT

By Avrum Zier

WHAT makes airplanes fly is the general theme of this book, presented in non-technical language. Many of the data are based on wind tunnel tests with model planes. (260 pages, 6 by 9 inches, 107 drawings.)——$3.10 postpaid. —*J.P.C.*

THE AIRPLANE AND ITS COMPONENTS

By W. R. Sears

AN INTRODUCTION to the field of aeronautical engineering prepared for students or other persons having some technical knowledge; technical terms are, therefore, employed with little or no definition. Parts of the airplane are considered and discussed in relation to their relative importance to airplane design, rather than by part sequence or general availability. Not a popular book, but rather one which requires concentrated study. (75 pages, 6½ by 9½ inches, a number of drawings and photographs.)—$1.35 postpaid.—*A.P.P.*

UNLOCKING ADVENTURE

By Charles Courtney

IN THIS autobiography of a world-famous locksmith, the safes of Kaiser Wilhelm, locks in the Kremlin, chests containing the crown jewels of the Romanoffs, and safes of wrecked ships are factors in but a few of the adventures of the world's highest paid legal Jimmy Valentine. (335 pages, 5¾ by 8½ inches, illustrated.)—$2.60 postpaid.—*K.M.C.*

WESTWARD FROM VINLAND

By Hjalmar R. Holand

COMPLETE account of the much-debated Kensington Stone found in Minnesota and inscribed in 1362 by Norsemen who were trying to circumnavigate Vinland by way of Hudson Bay. Today a majority of quoted authorities favor the validity of the author's long-fought-for claims. In addition to the Stone's inscription, three attested 14th Century Norse battle-axes

The Editors Recommend

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Here's *one* Nazi broadcast that's the Gospel Truth!

U.S. TANK IS BEST, SAY NAZI EXPERTS

Germany Will Doubtless Copy Gyroscopic Feature of General Sherman Tank, Berlin Radio Declares

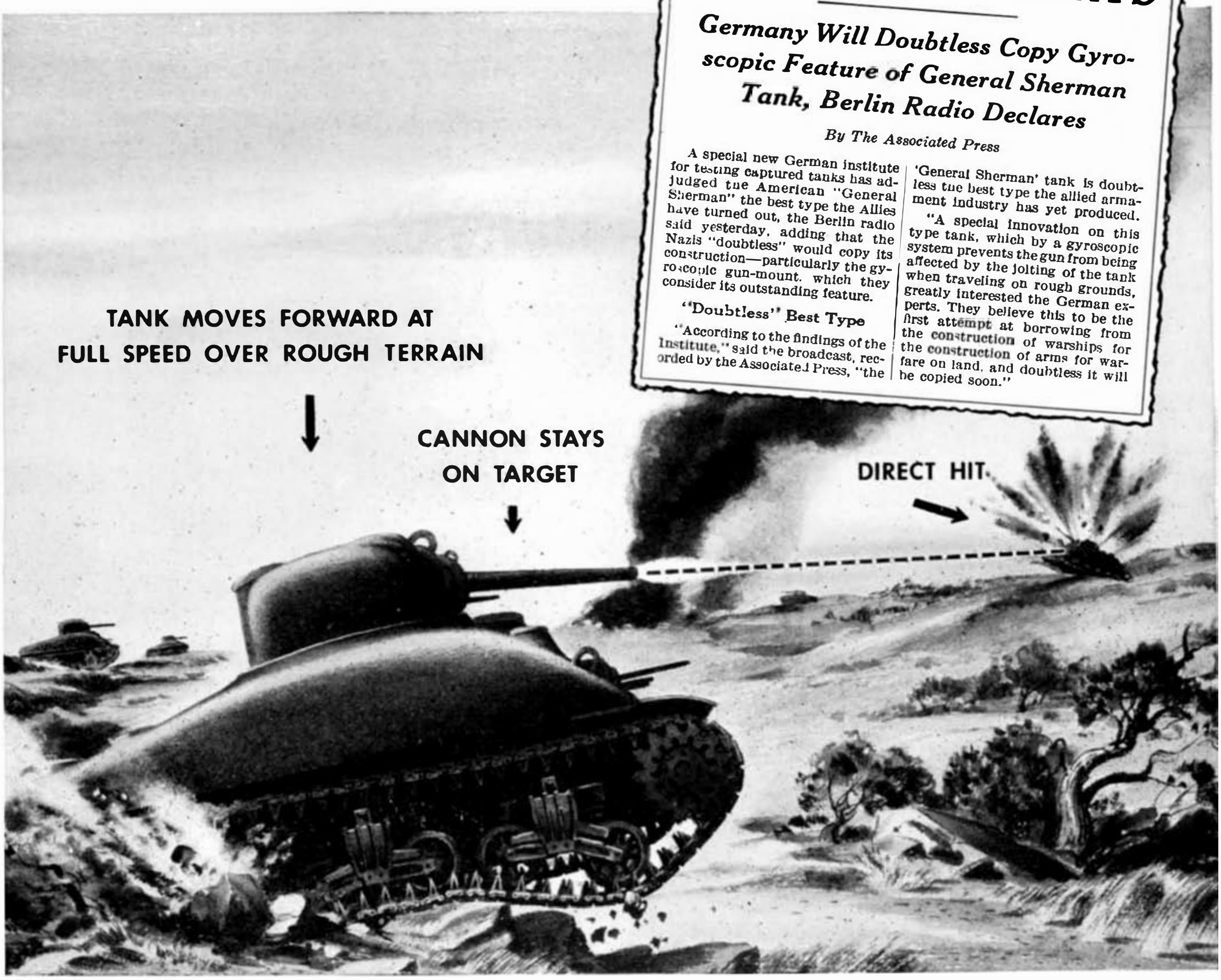
By The Associated Press

A special new German institute for testing captured tanks has adjudged the American "General Sherman" the best type the Allies have turned out, the Berlin radio said yesterday, adding that the Nazis "doubtless" would copy its construction—particularly the gyroscopic gun-mount, which they consider its outstanding feature.

"Doubtless" Best Type

"According to the findings of the Institute," said the broadcast, recorded by the Associated Press, "the 'General Sherman' tank is doubtless the best type the allied armament industry has yet produced.

"A special innovation on this type tank, which by a gyroscopic system prevents the gun from being affected by the jolting of the tank when traveling on rough grounds, greatly interested the German experts. They believe this to be the first attempt at borrowing from the construction of warships for the construction of arms for warfare on land, and doubtless it will be copied soon."



When the German radio paid glowing tribute to the General Sherman tank—for once it was telling the truth.

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For us, tank battles are no longer stop-and-go affairs, with every stop offering the enemy a "sitting pigeon." American tanks are now more than 500% deadlier than ever before.

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