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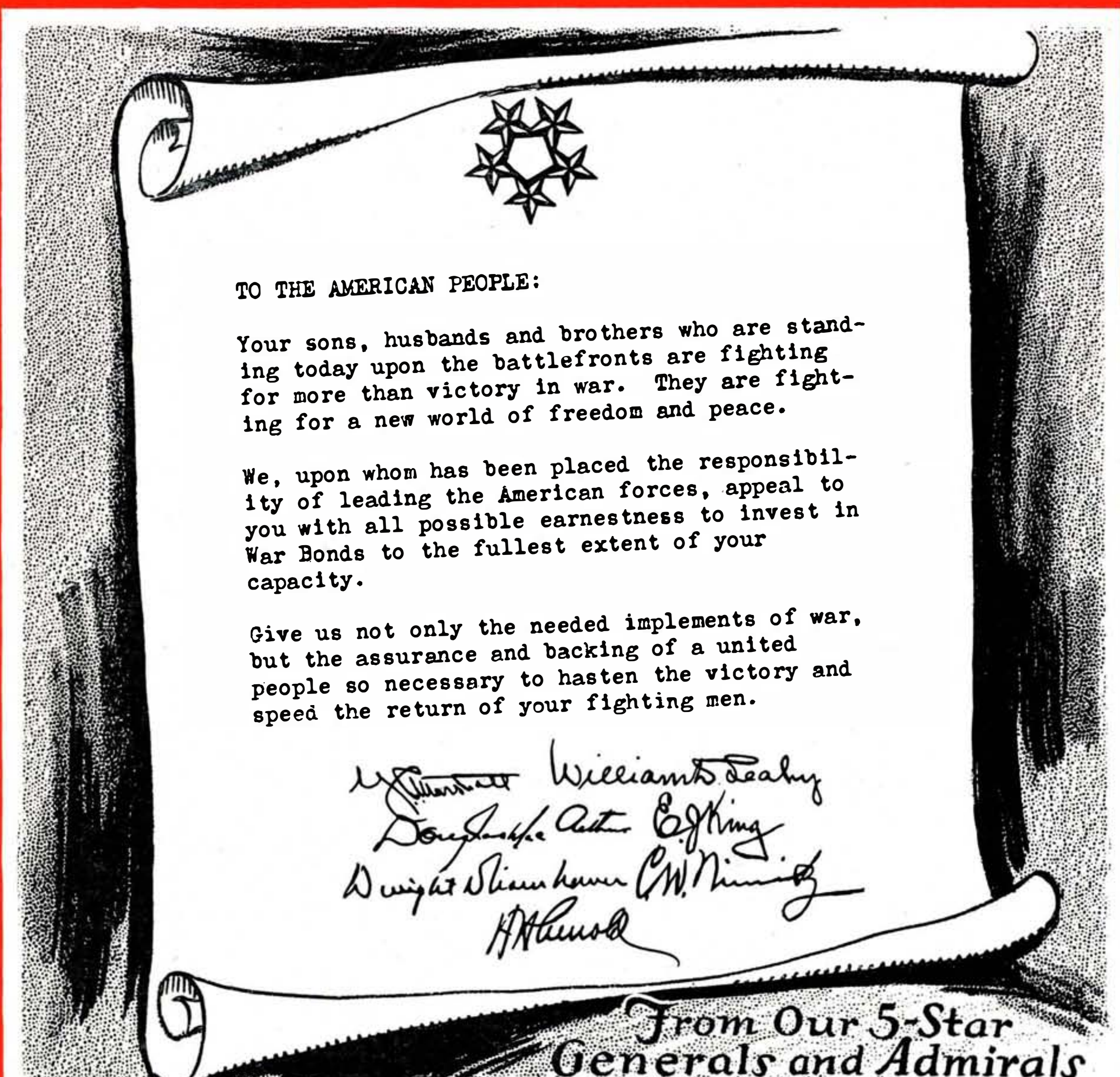

TO THE AMERICAN PEOPLE:

Your sons, husbands and brothers who are standing today upon the battlefronts are fighting for more than victory in war. They are fighting for a new world of freedom and peace.

We, upon whom has been placed the responsibility of leading the American forces, appeal to you with all possible earnestness to invest in War Bonds to the fullest extent of your capacity.

Give us not only the needed implements of war, but the assurance and backing of a united people so necessary to hasten the victory and speed the return of your fighting men.

From Our 5-Star Generals and Admirals

The Story of
AVIATION

Anniversary
Issue
No. 6

Scientific American

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Our Cover: To do our part in stimulating bond sales in the 7th War Loan drive, we are glad to devote our cover this month to carry a message from the 5-star generals and admirals of the United States of America to the readers of Scientific American.

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Previews of the Industrial Horizon

By A. P. Peck

LOWER PLANE COSTS

ONLY a casual stroll along a present-day airplane assembly line is needed to reach the realization that much of the work done is accomplished by hand and that the multitude of parts that go into a single plane must boost the cost tremendously. True enough, aircraft plants of the United States are turning planes out by the thousands, but at a price per unit that would hold little hope for those who foresee the sky of the future filled with private planes bent on pleasure and business alike.

It is one of the axioms of mass production that simplification is necessary to reduce cost and increase the number of any article to be made. However, insistent demands for the planes of war have left little time for engineers to gain the necessary know-how of simplification; they have had to turn out planes regardless of cost in dollars, man-hours, and materials. Even with this immediate urge, they have not entirely disregarded the problems of the future. Probably they do not dream of an airplane in every garage or a landing field in every backyard, but they do know that there is going to be a zooming demand for private planes post-war and that this demand can be met only by planes that can be bought by other than millionaires.

Thus, engineers in at least one large aircraft plant have been turning some of their attention to production processes that will radically reduce costs. As examples of progress made, a stabilizer that formerly involved fabrication of 42 different parts is now made with only ten, and a wing was redesigned so that 21 parts take the place of the 134 formerly required. On this basis it is estimated that airframe costs, once ranging from three to ten dollars or more a pound, can be reduced to less than one dollar a pound, exclusive of engine. Projecting this trend a bit farther, Republic engineers look forward conservatively to comfortable, roomy private planes that will sell, post-war, for about the cost of a medium priced pre-war automobile.

While on this subject of airplane costs, it is interesting to note that recognition is being taken at last of the importance of standardization of plane parts from the servicing angle. So long as planes have individualistic electrical systems, lubrication fittings, fuel connections, propellers, spark plugs, and so on, the servicing problem for private planes and commercial airliners alike will be complicated and costly. But when standardization comes into the picture and makes it possible to service all planes quickly and to replace parts from an airport stockroom that does not have to carry a multitude of parts for which there is a call only once a year, then a long step will have been taken toward making aerial transportation available to the masses.

HEAT BY WIRE

MANY a head is getting gray—or bald—worrying about what will be done post-war with the huge hydroelectric plants that are now supplying needed power for war industries. Out in Oregon, the Bonneville project is a case in point. When war needs end, Bonneville's excess power will have to be absorbed if the whole project is not to become a complete white elephant. To avoid such a disastrous occurrence, plans are well underway to promote electric heating of homes, thus soaking up the excess juice and offering to householders a heating means that promises freedom from smoke and soot, freedom from drafts, and freedom from widely varying winter-time temperatures indoors. Most promising of the many schemes so far considered is the use of more or less conventional radiant heaters recessed into the wall and thermostatically controlled.

But what to do with the power during warm weather? The capacity of the generating plant must be utilized over the entire year if economy is to be realized. Air conditioning in summer, heavy refrigeration that would include quick-freezing equipment for homes and for communities, and electrically powered sprinkler irrigation systems are all part of the picture. Here is one of those cases where, once the initial cost to the householder is written off, the more current he uses the more he will benefit.

TELEVISION PROGRESS

BETTER and better television is seen on the horizon, as exemplified by the large-screen receiver detailed on page 362 of this issue. But, as Scientific American has always held, there is more to practical television, as far as the average man is concerned, than technical perfection. Other factors that must be considered include programming and the question of who will pay the bill. All of the problems are neatly wrapped up in capsule form, with many implications between the lines, by Dr. C. B. Jolliffe, head of RCA Laboratories, who recently said: "Engineers should not be satisfied that their television job is done until they have made it possible to project in the home pictures of adequate size in color [We will be satisfied with *good* black-and-white. *Ed.*] and also for anyone to attend—by television—all major happenings wherever they occur, in the United States or in any other part of the world. These objectives may be accomplished in a few years, or many years may be required."

PHILOSOPHY OF PLENTY

THOSE who would quarrel with the peculiarly American tendency to discard material objects before they have worn out completely and to replace them with other and more improved devices can take a lesson from a recent statement by Alfred P. Sloan, Jr., chairman of General Motors. In these words Mr. Sloan aptly sums up the philosophy of American production and consumption that has made it possible for this country to progress so rapidly, in peace and in war: "Some have the idea that the reason we in this country discard things so readily is because we have so much. The facts are exactly opposite—the reason we have so much is simply because we discard things so readily. We replace the old in return for something that will serve us better."

FOR FUTURE REFERENCE

SOME success has been achieved with solid paints, using no solvent, that are applied in a molten state under steam and air pressure. . . Assistant Secretary of Commerce Burden sees 6300 civilian airports on the horizon, with 400,000 airplanes in use in the United States within ten years after war end. . . At least one automotive engineer crys down the extensive use of aluminum in automobiles as a substitute for steel until the price, now 15 cents a pound, drops to 4½ cents a pound. . . Radio sets and kitchen ranges will probably lead the parade of appliances that will reach the home after the war. . . The steel industry looks with bright eye on the distant horizon, banking on conversion jobs, planned public works, and new bridge construction to keep it going full blast; apparently it has no fear of war-developed materials that might substitute for steel. . . Fluorescent lighting is scheduled for a boom because of its many advantages; authorities foresee that 40 percent of post-war home lighting will involve fluorescent equipment.

Life hangs by such threads

WANTED: Something to keep flyers from freezing. So engineers developed electrically heated goggles, shoes, suits . . . Something dependable to guide pilots in fog and dark. So engineers devised electrically driven gyroscopic instruments. . . . Something automatic to keep engines from overheating or cooling. And now comes an electric control the pilot needn't touch.

Working day and night, G. E.'s research and engineering staff has solved hundreds of such problems. The pictures here show how a few have been met. Through research come better electrical products and processes—in war or peace. *General Electric Company, Schenectady, N. Y.*

Eyelids can freeze shut when you're 7 miles up! Electrically heated goggles, developed by G-E engineers, have fine wires embedded in plastic lenses. With G. E.'s electric blanket as a start, G-E engineers designed electrically heated flying suits, heated gloves and shoes being made in three G-E plants. Toughest problem was to devise heated gloves with thin wires strong enough to stand constant flexing.

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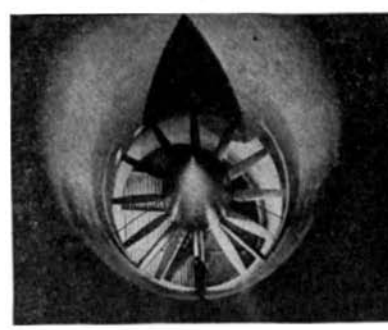


Before it's built, they *know* how it will fly! 18,000 horsepower of G-E motors blow winds faster than a pursuit plane can fly. Testing model planes and parts *up to full size and speed* in wind tunnels like this helps get new airplanes perfected quicker.

Flyers' lives often depend on their instruments. G-E workers use only tweezers to handle these precious parts of electrically driven gyroscopic instruments, dry them with air jets, oil them with hypodermic needles. They've *got* to be accurate.

Making night landings safer. Engineers adapted the G-E "Sealed Beam" auto headlamps into war use—G-E airplane landing lamps 20 times brighter than those on your car. Sealed against dust, dirt and salt water damage, they cut down the peril of high-speed landings.

*

Hear the G-E radio programs: *The G-E All-girl Orchestra*, Sunday 10 p.m. EWT, NBC—*The World Today* news, Monday through Friday 6:45 p.m. EWT, CBS—*The G-E House Party*, Monday through Friday 4:00 p.m. EWT, CBS.

FOR VICTORY—BUY AND HOLD WAR BONDS

GENERAL ELECTRIC

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of June, 1895)

METEOROLOGICAL BALLOONS — "A balloon equipped with self-registering instruments to measure the temperature and pressure of the atmosphere at high altitudes was recently experimented with in Berlin and came down with the instruments in good condition in Bosnia. The instrument showed that the balloon had reached an elevation of 53,872 feet, over 10 miles; the thermometer had fallen to 52 degrees below zero —the lowest it could record."

PROPELLERS — "It is interesting to learn from a paper read at the Institute of Civil Engineers by no less authorities than S. W. Barnaby and Thornycroft, that in their opinion the present speed attained by the screw propeller has in the fastest craft now afloat approached the limit of efficiency. The Marine Engineer says: It will soon be a question, therefore, if this view be correct, not as to the comparative merits of twin and triple screws, but as to the screw in comparison with other methods of propulsion. Here is a vast field for experiment and research."

SUN DAMAGE — "Sunlight can do incalculable damage to chemicals, pharmaceuticals, plush goods, and toilet articles in general, unless special precautions are taken to prevent its injurious action."

CAR CABLES — "The cable system of propelling cars has found favor in New York City . . . The cables come to the power house either entire or in sections in big spools weighing from 40 to 50 tons. The spools are transported by means of gigantic trucks, drawn by long strings of horses; in some cases twenty horses are attached to the truck."

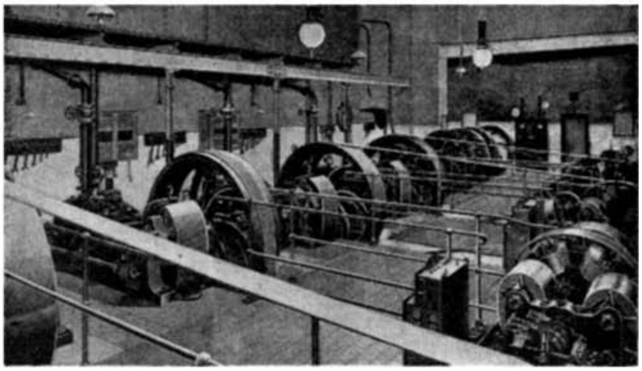
GLASS BRICKS — "Glass bricks, intended to be used in constructing the walls of plant houses and winter gardens, are made out of blown glass, and closed under 500° of heat. They possess internally a hollow of about one-third of their entire contents, which, being filled with rarefied air, acts as a non-conductor of heat. They are joined together with cement."

CANDLES — "The electric candle is in great request in England for the lighting and decoration of dining and other tables. An ingenious device for lighting the candles is provided by placing small pads under the table cloth, and taking the current from them by means of two pin points in the base of the candlestick. The candles, of course, are extinguished on being taken from the table, and are relighted when they are replaced in the proper position."

MOLTEN METAL — "The Cleveland Rolling Mills Company has just inaugurated a novel system of metal transportation. They ship great pots of molten metal from their central blast furnace to their Newburg mills, five miles away. The trip consumes fifteen minutes, and about 500 tons are carried daily over the tracks of the Erie Railroad. At the rolling mills the car is raised on a hoist to the mixer, the ladle is tipped by machinery and the metal poured into the mixer."

FILAMENT TEMPERATURE — "Prof. Weber has lately given the results of a number of experiments made by him to determine the temperatures of filaments in electric incandescent lamps. He has found that the normal temperatures of all species of incandescent lamps is approximately the same, and is comprised between 1,565° and 1,588° C. In the case of some lamps giving a very brilliant light—that is to say, with very thick filaments—the temperature is 40° higher."

GENERATING PLANT — "In connection with the new station, and the extensive alterations recently carried out at Leicester, the Midland Railway Company has put down the largest and most efficient electric plant driven by gas engines. We are enabled to give an illustration of the engine and dynamo room, and also a few particulars of the plant. The motive power consists of four large gas engines and two smaller, and all are made by Crossley Brothers, of Openshaw, Manchester. They are all built on their well-known lines, and are especially fitted for driving dynamos with the necessary steadi-



ness. Each of the four large engines is of 25 nominal horse power, capable of giving off 40 brake horse power as a safe working load with Dowson gas . . . The engines run at two hundred revolutions per minute, and with the means adopted very great steadiness is obtained. The face of the flywheels is slightly rounded, and the dynamos are driven direct from it."

HORSE SHOES — "Among the recent patents is one for an aluminum horseshoe having finely divided particles of hard metal embedded in the wearing face of the shoe. This forms a very light shoe, of considerable durability."

BARGE TOWING — "Canal barges have recently been very successfully towed by electric power on the summit level of the Canal de Bourgogne. This portion of the canal is 3¾ miles long and has been made very narrow to reduce construction expenses. There is no tow path, and hauling is effected on the submerged chain principle. The hauling upon the chain is now done by electric power instead of by steam, as heretofore. A generating house has been fixed at each end of the section, the current being generated by water power."

VOTING MACHINE — "The days of ballot box stuffing and other modes of cheating at elections appear to be numbered. Inventive genius has provided machinery that will not lie and will not allow deception at the polls."

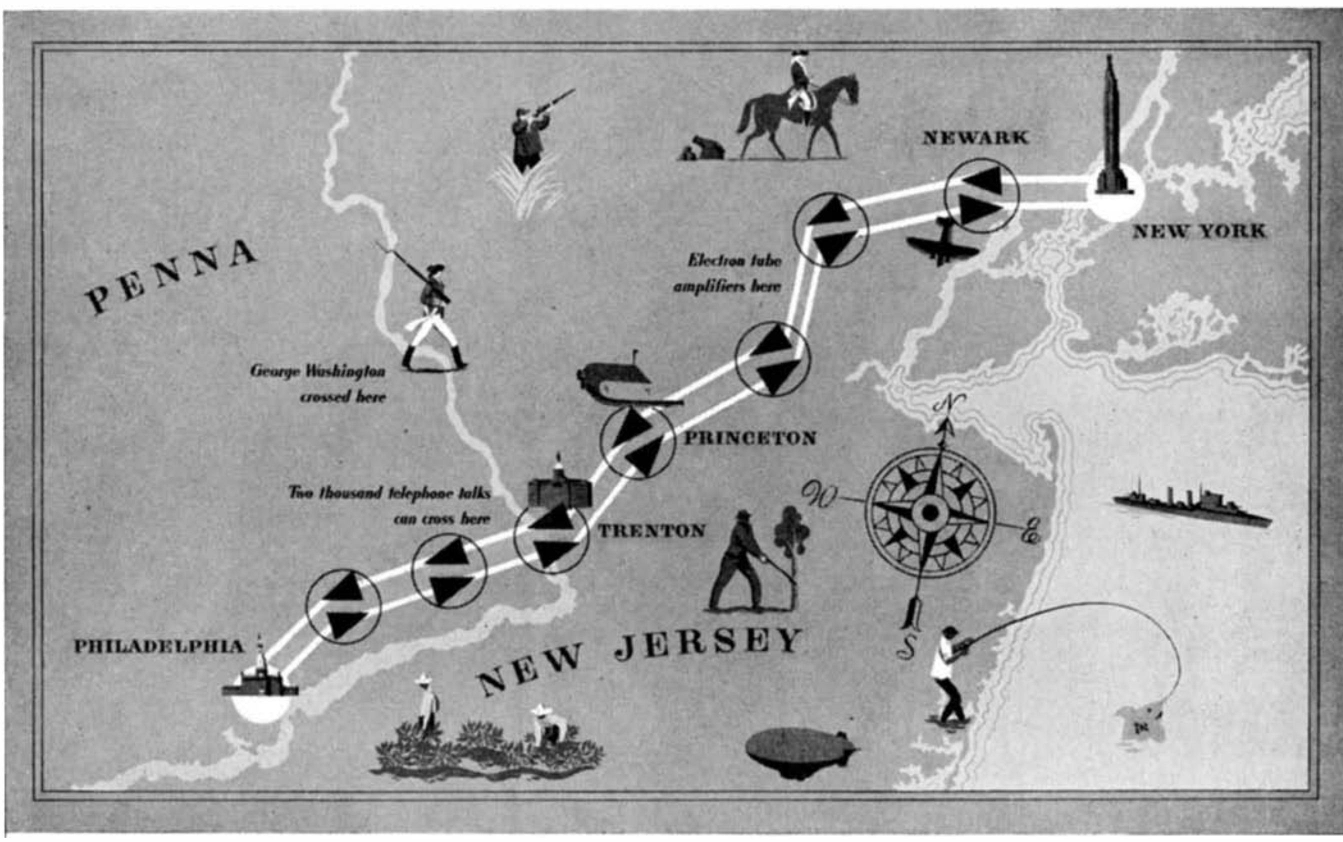
RAIL SPEED — "According to the 'Railroad Gazette,' the time made April 21 last, by the newspaper train from Camden, N. J., to Atlantic City, 58.3 miles, was 45¾ minutes, being an average rate of 76.46 miles per hour."

WATER POWER — "The chief problem in the conversion of water power into electrical power is that of regulating the flow of the water through the turbine wheels . . . One way of doing this was to have a man to regulate the flow by opening or closing the gates. This is, of course, impossible in a plant of any considerable size. Another contrivance employed a ball governor which automatically opened or closed the gates. This was a failure, because of the well known laws of inertia, and had a great tendency to race. Mr. Allan V. Garratt describes a very ingenious regulator whereby the gates were made to open or close, a little before the governor reached its highest or lowest point, thus obviating the chief defect of the older machine."

RUST-PROOFING — "The Gesner method of protecting iron and steel from rusting consists in forming on the surface of the metal treated a double carbide of hydrogen and iron, which is extremely hard and adhesive . . . The coating has a bluish color, and is stated to be so adherent to the metal that a treated bar can be bent through an angle of 45° without disturbing it."

90-MILE LABORATORY

for Telephone and Television



BETWEEN telephone offices in New York and Philadelphia once stretched a strange sort of laboratory. Most of the way it was underground; engineers made their measurements sometimes in manholes. It was a lead-sheathed cable containing two "coaxials" — each of them a wire supported in the center of a flexible copper tube the size of a lead pencil.

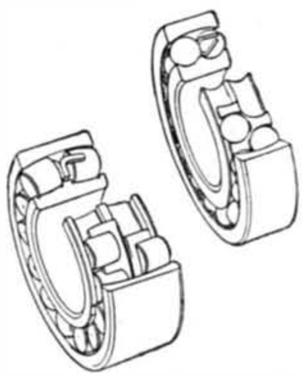
Theory had convinced engineers of Bell Laboratories that a coaxial could carry many more telephone talks than a full-sized voice frequency telephone cable; that it could carry adequately a television program. Experimental lengths were tested; terminal apparatus was designed and tried out. Finally, a full-sized trial was made with a system designed for 480 conversations. It was successful; in one demonstration people talked over a 3800-mile circuit looped back and forth. Now the cable is carrying some of the wartime flood of telephone calls between these two big cities.

This cable made television history also: through it in 1940 were brought spot news pictures of a political convention in Philadelphia to be broadcast from New York. Bell System contributions to television, which began with transmission from Washington to New York in 1927, have been laid aside for war work. When peace returns, a notable expansion of coaxial circuits is planned for both telephone and television in our Bell System work.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for our Armed Forces at war and for continued improvements and economies in telephone service.

● *Built by*
PRATT & WHITNEY



Prelude to a dog fight!

A squadron of these Double Wasps means a squadron of vicious fighters sweeping the skies clear of enemy planes. And as each of these engines is hoisted into the nose of a fighting plane, so are SKF Bearings on its vital parts. As the plane takes off and attacks at speeds of more than 400 m.p.h., the use of SKF's becomes apparent. Then, as never before, the safety, dependability and all-round good performance of SKF Bearings *count*. When an SKF flies, you can depend upon it . . . always.

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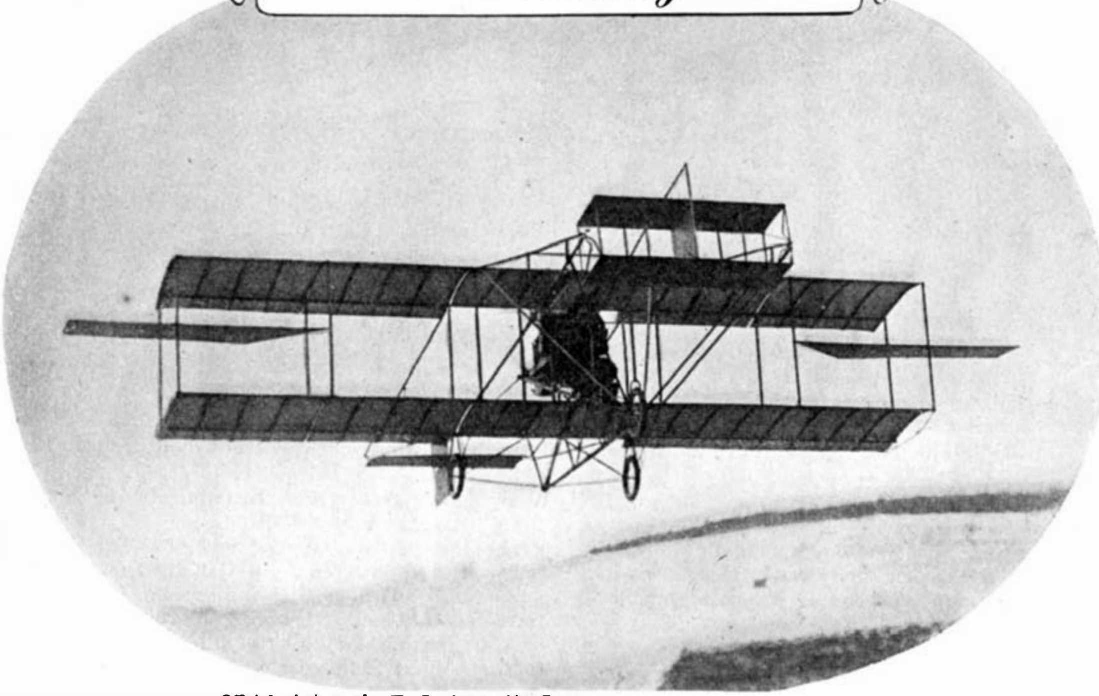


Official photograph, U. S. Army Air Corps
An early Curtiss pusher biplane in flight

Since Man Took Wings

To Fly has been the Persistent Dream of Man Down through the Ages, and in the Present Epoch that Dream has been Completely Fulfilled, but with Greater Consequences of Destruction than of Good. It Remains for Man in the Future to Make Achievement of Flight Entirely Beneficial

By **ALEXANDER KLEMIN**

THE HISTORY of aviation begins with myth and superstition, and ends with a rational application of nature's laws. In an Indian classic, Krishna's enemies build a winged chariot; Egyptian sculpture shows figures of winged men; and from the Greeks humanity inherits the story of Daedalus who made wings, and of his son, Icarus, who fastened them to his shoulders, flew too near the sun, and perished in the sea.

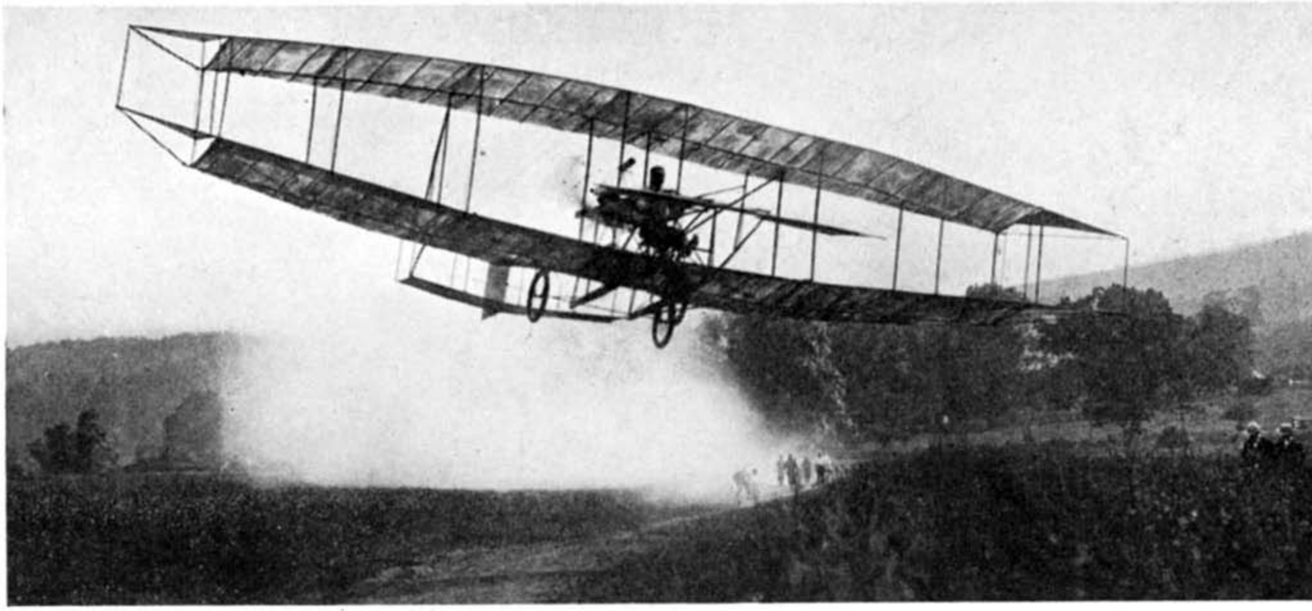
Later, in medieval times, desire sometimes achieved rudimentary attempts at flight. Death punished a Saracen for his boldness at the times of the Crusades, while Oliver, a monk of Malmesbury, England, perished in 1065 in an attempt at gliding.

Friar Roger Bacon made some striking speculations regarding flight in the 13th Century, but the first man who did more than speculate was Leonardo da Vinci (1452 to 1519), who made sketches of ornithopters, flew successful models of helicopters, and attempted an explanation of bird flight in terms of mechanics. One of his famous passages begins: "A bird is an instrument working according to mathematical laws, which instrument it is within the capacity of man to reproduce."

Passing over the centuries of more speculation—some pious, some fantastic—and more attempts at gliding, the human conquest of the air is found to be much closer in the latter half of the 18th Century when Cavendish discovered hydrogen, the light gas, which for so many years was the basis of lighter-than-air flight. It was on June 5, 1783, that the brothers Montgolfier sent up a rudimentary hot-air balloon which reached a height of 6000 feet and landed 7668 feet from its starting point. Only a few months later, on October 15, 1783, Francois Pilâtre de Rozier achieved the honor of being the first human to rise from the earth. While it is to the genius of France that we owe the inception of aerostatics and the parachute, the true beginnings of aviation are due to a number of English pioneers in the first half of the 19th Century.

First there came that great theorist, Sir George Caley, "The Father Of British Aeronautics" who, in a series of remarkable writings, recognized the aeronautical advantages of curved surfaces and the necessity of providing both vertical and horizontal rudders. He also suggested reasonable methods for calculation of propelling power and experimented with a fixed surface glider. His contemporary, Thomas Walker, a portrait painter of Hull, attained almost equal fame through his pamphlet on the "Art of Flying," published in 1810.

After Caley and Walker, men passed from theory to experiment. W. S. Henson, as early as 1940, experimented with



The Curtiss "June Bug" that won the first leg of the Scientific American trophy on July 4, 1908

model gliders and light steam engines. From 1846 to 1848, John Stringfellow worked on a remarkable contrivance, the first engine-driven airplane which actually flew. The model had an eight-foot span, and weighed eight pounds with engine; its design and construction seems reasonable in light of today's knowledge.

FAMOUS NAMES—The latter half of the 19th Century produced equally famous names. Penaud, a Frenchman, in his well-known patent of 1876, anticipated and described almost every feature of the modern airplane. The Germans first took their place in the development of aviation when Otto Lilienthal, with his brother Gustav, undertook to learn the art of the birds by practicing with a man-carrying glider. Lilienthal, in almost 30 years of experimentation, secured glides where the angle of descent was only 1 in 10, and built up a remarkable body of aerodynamic knowledge, particularly in relation to control. His work began in 1867 and ended with a fatal accident in 1896 when he was turning to powered flight.

Lilienthal accomplished much, and the Englishman, Pilcher, followed grandly in his footsteps. Professor Montgomery of California employed gliders launched from balloons and wrote a patent which showed remarkable understanding. Ader claimed actual flight before generals of the French Army in his "Avion" on October 14, 1897, though the official account speaks only of short hops. In the United States, Chanute, a civil engineer, advanced the design of the glider with his trussed biplane, and Sir Hiram Maxim's giant steam-powered airplane almost achieved flight in 1894.

What had these pioneers done? Nothing, in one respect, because they had not flown; almost everything, on the other hand, because they had laid solid foundations for the work of the Wrights.

UNLUCKY LANGLEY—Before the Wright brothers there came the brilliant and painstaking work of S. P. Langley, who began his studies when a middle-aged man with an established reputation as an astronomer. With the aid of a large whirling arm and rubber driven models, Langley did a vast amount of aerodynamic research; his "Memoir on Mechanical Flight," and his "Experiments in Aerodynamics," published in 1891, are classics. Granted a congressional appropriation, and with the help of a young engineer, Charles Manly, he finally constructed the "aerodrome" which he described as "built of steel, weighing complete about 730 pounds, supported by 1040 feet of sustaining surface, having two propellers driven by a gas engine, developing continuously over 50 brake horsepower." The aerodrome was seriously damaged in the launching on December 8, 1903. Manly escaped uninjured, but in the face of public disapproval and the inability to secure further funds, Langley did no more. Some years later, Glenn Curtiss succeeded in flying the aerodrome, but only after important modifications had been made in it.

The fact remains that it was the Wright brothers who first achieved powered flight at Kitty Hawk, North Carolina, on December 17, 1903. The Smithsonian Institution has finally retracted its hostile views on this flight and, once the war is over, the Wright biplane will probably be brought back to the United States from the South Kensington Museum in London, where it has been sheltered all too long.

Since there is a Wright celebration every December 17th, only a brief personal appreciation will be attempted here, drawn partly from personal acquaintance. The Wright brothers learned all they could from Lilienthal and from the English pioneers, frequently consulted Chanute, and carefully studied Langley's writings. It was a mark of greatness that they were willing to learn from others; nevertheless they were not men of little education, as has sometimes been said. Though they never matriculated at a university, and their calling in life was that of bicycle-makers on a modest scale, they were true scientists who carried out their long experiments with a well-defined goal and perfect objectivity.

The Wright brothers' experiments in a small two-foot wind tunnel stand substantially correct to this day, and were followed by the flying of kites and gliders, giving a solid background for building their first powered model. Workers before them had seen parts of the truth; the Wrights saw the truth as a whole, and in one design combined curved wings, control about all three axes, reasonable stability, a correctly designed propeller, and a practical gasoline engine.

MAN COULD FLY—The flight at Kitty Hawk ended all uncertainty as to whether or not man could fly. Now came an era of energetic but poorly guided development, a period of excitement and adventure. The Wright brothers, neglected and held in some suspicion because of their policy of secrecy, persisted in almost unaided effort. Their third model, in 1905, embodied the joy stick for control and flew a distance of 24 miles instead of the record of 852 feet as of 1903. Few followed in their footsteps in the United States, but France gave to aviation history names such as Blériot, Esnault-Pelterie, Ferber, Santos-Dumont, Voisin, Farman, and others.

The United States Army gave the subject of early heavier-than-air flight no acknowledgment. It was only when President Theodore Roosevelt saw a description of the Wright Flyer in an issue of Scientific American in 1907, and asked Secretary of War Taft to look into the matter, that the Chief of the Signal Corps drew up a specification and asked for bids.

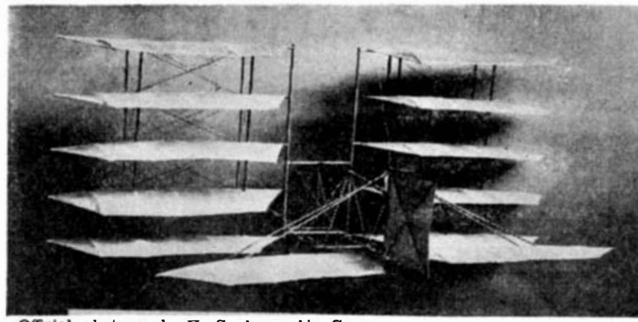
The first American Army officer to lose his life in an airplane was Lieutenant Thomas E. Selfridge, killed at Fort Myer, Virginia, at a test of the Wright model, while Orville Wright, who was piloting, was badly injured. Nevertheless, in 1909, the Wrights received a $25,000 award and a bonus for improving on the minimum speed requirements. With the winning of a suit started in 1910 against the Herring-Curtiss Company, the Wrights established their fortunes on a substantial basis though they never became as wealthy as their genius warranted.

The early days of aviation were wonderful for the pioneers, not always burdened with scientific knowledge but ever willing to take a chance; here was an era of adventure, of barnstorming, of rewards for records which look very modest today. Glenn L. Martin, exhibition pilot and barnstormer, was at the threshold of his career in airplane manufacturing. Glenn H. Curtiss, a bicycle maker like the Wrights, did many things with a few workmen in his shop at Hammondsport, New York. His "June Bug" won the Scientific American trophy on July 4, 1908, for flying two thousand yards over an S-shaped course at a speed of 39 miles an hour. In France, Louis Blériot flew across the English Channel on July 25, 1909, winning a prize offered by the *London Daily Mail.* The Army continued to give grudging acceptance to the airplane, with the Signal Corps still responsible for all aviation activity. In 1910, Lieutenant Ely flew off the deck of an armored cruiser, the U.S.S. *Birmingham,* in Hampton Roads, and two months later alighted on the deck of the U.S.S. *Pennsylvania.*

But these adventurous days had disadvantages. Without development, really practical aircraft could not be achieved, and lack of patronage for the flimsy aircraft available made it difficult to raise needed money. American aviation was virtually at an impasse.

WAR TURNS THE TRICK—World War I changed the situation completely. At the Hague Peace Conference of 1899, it was voted that no aerial vehicle was to take part in warfare, but the Peace Conference of 1907 was less positive, and airplanes were destined to become increasingly important in war. At the outbreak of World War I, France had 1500 airplanes; Germany had 1000; England had a lesser number in keeping with its smaller army, and the United States, true to its general traditions of never preparing for war, had only 50 men and 6 planes in its air force.

The small group of devoted officers within the United States Signal Corps could do little to foster military aviation. Nevertheless, the course of the war provided them with convincing arguments in favor of the use of planes in fighting wars. Thus, during the Battle of Mons, August 23-26, 1914, Sir John French, the British Commander, was able to save his armies by retreat when his few reconnaissance planes, and they alone, warned him that the French forces



Official photograph, U. S. Army Air Corps

A glider built by Octave Chanute, an American, who did considerable gliding experimentation about 1895

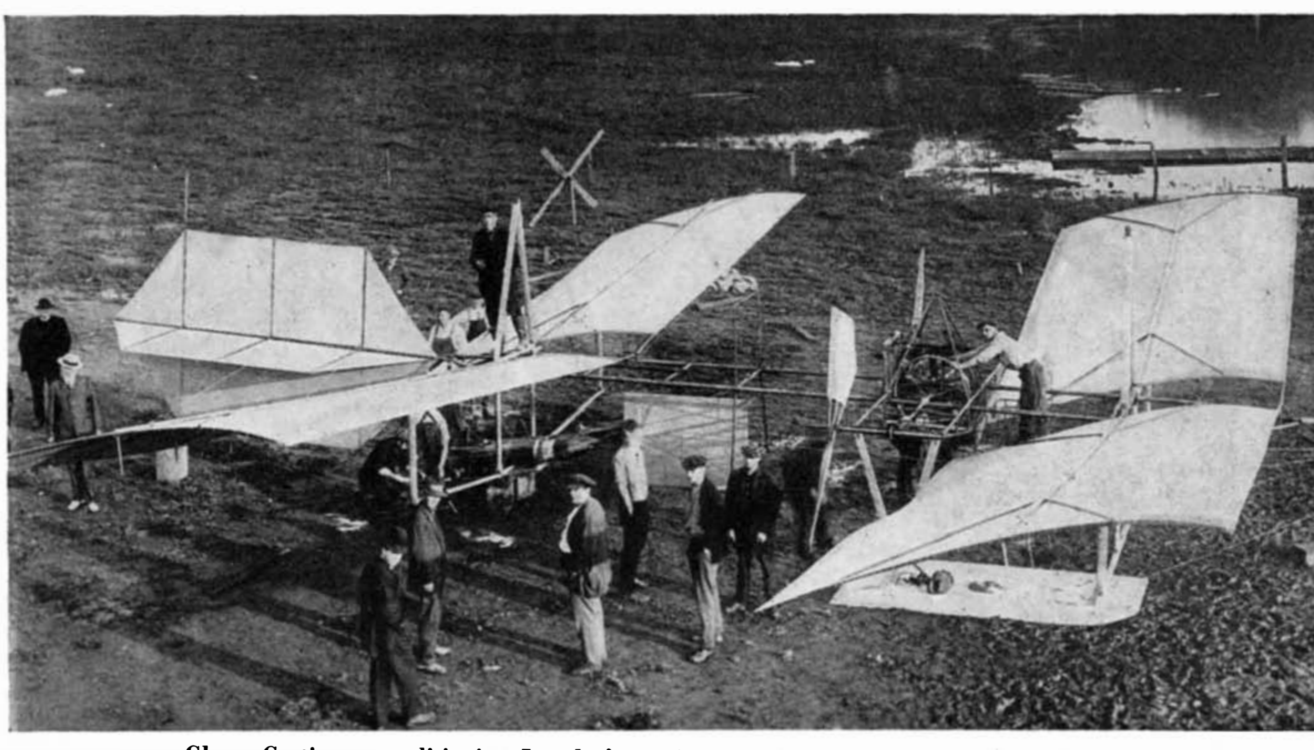
had given way on his right flank. It was then established that the airplane could be a valuable method of military reconnaissance.

World War I was to teach other lessons in the uses of aviation. Aerial photography proved invaluable in securing and conveying information. Aerobatics were limited at the start of the war, and the spin was considered deadly. Beginning with the discovery of the Immelman turn, a whole series of maneuvers were developed for aerial dogfights or for disengaging from the enemy. The power of disciplined formations was soon learned by the Germans, with the noted Von Richthofen squadron playing havoc with the Allies who considered formation attack against a single flier unsportsmanlike.

The war in the air began with an exchange of harmless revolver shots between a French and a German aviator, and the dropping of a sandbag on Paris, asking for its surrender. Early use of fléchettes, small deadly pointed arrows, soon gave way to more deadly explosive bombs. Reconnaissance was first performed at low altitudes because anti-aircraft fire was harmless above 3000 feet; later anti-aircraft guns were made effective at heights of 25,000 feet, which necessitated higher ceilings for combat planes.

The war started with planes of 80 horsepower, with top speeds of 70 miles an hour, and much stability. It ended with combat planes capable of some 150 or more miles an hour, with 400-horsepower Liberty motors installed in the De Havilland two-seater fighters, and with stability giving way to streamlining and maneuverability.

The United States soon abandoned the notion that our air force could be a subsidiary branch of the Signal Corps, and



Glenn Curtiss re-conditioning Langley's original Aerodrome for a test flight in 1914

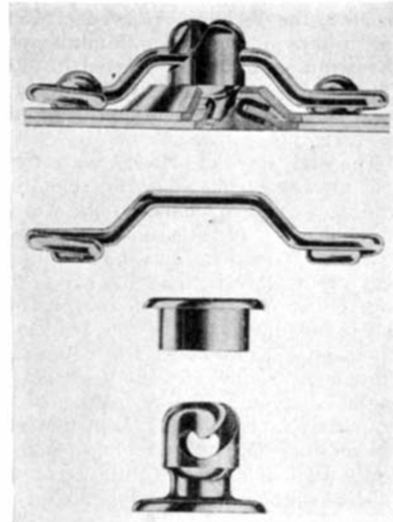
ended the war with 14,330 officers and 124,767 enlisted men in this service. In spite of great mistakes in handling war production, we built 3288 combat airplanes and many more training craft. The Liberty motor, said to have been designed in a few weeks in a Washington hotel, was ready for delivery at the rate of 10,000 a month at the signing of the Armistice.

The American plane manufacturers, who had almost lost hope before 1914, emerged from the war as powerful companies, thanks to early orders from the British and French for Curtiss "Jennies," and from our own forces later. But because Americans could improvise, Congress was encouraged to slash Air Service appropriations to the minimum when peace had come. Congress, neglecting to read the signs of the times, failed to realize that aerial supremacy could, in a war, sway from side to side rapidly, and that such superiority was not a question of heroism, but a matter depending upon which side developed better airplanes.

From 1914 to 1916, the Germans ruled in the skies because their Taube was so superior to the slow British BE 2C's and the 80-horsepower Vosins and Farmans of the French. When the British replaced their earlier craft with the SE 5's equipped with the more powerful Hispano-Suiza engines, and the French developed the fast and maneuverable Nieuports, the advantage passed over to the Allies. Then because Anthony Fokker, the Dutch designer, built a semi-cantilever biplane powered with sturdy and reliable Benz and Mercedes engines, and having wonderful maneuverability, Allied aviators were almost swept from the skies.

The ending of the war brought a shrinkage of the aviation industry. Congress cut air service appropriations drastically. So much surplus material came on the market that a flier could buy a two-place "Jenny" for $50 and a Curtiss OX-5 engine of 90-horsepower for $30. Few military and naval aircraft were built. The brass hats fought Brigadier General William E. Mitchell, who in 1921 sank two old battleships by aerial bombing, and forced him to resign in August, 1926, after a court-martial. In some years not more than a dozen commercial airplanes were built.

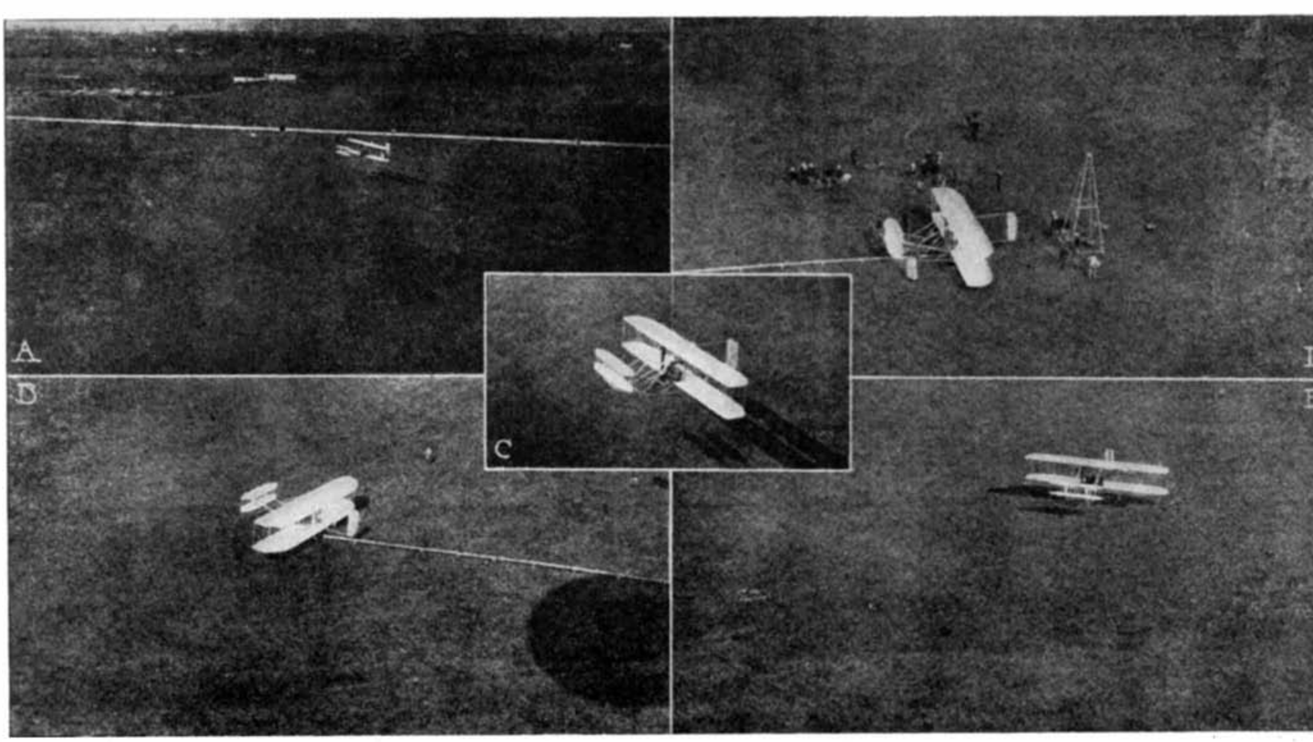
THE MAIL GROWS WINGS—Yet there were signs of the later triumph of civil aviation. Most important of these was the establishment of the United States Air Mail Service. Using roughly converted DH-4's, the Post Office established the first service between New York City and Washington on May 15, 1918. Other large cities were similarly connected, and the years 1920 and 1921 brought the establishment of the transcontinental air mail. On July 1, 1924, a regular night service, over a beacon-lighted airway, came into being between Cheyenne, Wyoming, and Chicago, Illinois. With war equipment and few aids to navigation, the Post Office offered dependable service that was, at the same time, an experimental laboratory for the commercial transport services to come later.



An excellent example of the many accessories that have been developed for airplanes is the Dzus spiral cam fastener. The fastener, used for holding cowls, access doors, and the like, is quick acting and consists of a rotatable stud portion having a spiral cam at the end which engages with a permanently mounted spring

SPANNING OCEANS—Another significant feature of the years after the Armistice was a number of remarkable flight records. These emphasized that the conquest of the air was proceeding rapidly, and they furthered the acceptance of civil aviation by the public. The first great achievement was the transatlantic flight by the Navy's NC-4, a flying boat of some 28,500 pounds gross weight, with Lt. Cmdr. Albert Cushing in charge. The NC-4 took off at Trepassy Bay, Newfoundland, on May 16, 1919, and with stops in the Azores and Portugal arrived in Plymouth, England, on May 31st after a flight of 4514 miles. The flight foreshadowed the time when the Atlantic would be fully mastered. The NC-4 had the benefit of the Navy's whole organization, with supporting vessels to lessen the hazards of the trip, and carried a fairly large crew.

Sir John Alcock and Sir Arthur Whitten-Brown, with no support, showed even greater daring. Flying a Vickers-Vimy biplane powered by two Rolls-Royce engines, they



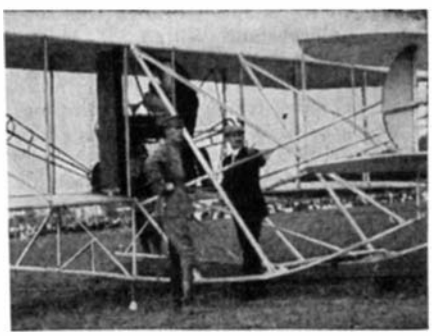
A series of photographs, 1909, showing a Wright biplane taking off and in flight. A starting rail was used

From a string on a strut...

To this...

Instrument panel of a Sperry "flying laboratory" showing the last word in modern flight instrumentation.

IN THE EARLIEST days of aviation, airplanes had no instruments—and a pilot flew "by the seat of his pants."



Sometimes aviators tied a piece of string to a strut. In normal flight it whipped straight back. If the string deflected to one side it indicated that the plane was slipping sidewise. But mostly they flew by the feel of the wind in their faces, and by direct observation of the ground and the horizon.

In 1914, at the beginning of World War I, flight instruments began to appear. One of the first was the Sperry Magnetic Compass for instrument panel mounting—a big improvement over former compasses of the marine type which were placed on the floor of the cockpit.

The Sperry Turn Indicator was introduced in 1918. It was so basic in design that practically every airplane that flies today carries an instrument of that type. A few years later another basic flight instrument appeared on instrument panels—the Sperry Directional Gyro. Being non-magnetic, it eliminated the swaying needle and magnetic error of the usual compass, and is still found among the dozens of amazingly accurate flight instruments on which pilots depend today.

Sperry flight research has grown many times over, and it embraces the new science of electronics in many of its projects. Under the stimulus of wartime demand, new devices have been developed in record-breaking time—and in record-breaking numbers.

Sperry engineers testing intricate flight instruments in a "flying laboratory"

Many of these developments are secret. But it is one of the few compensations of war that many of them will someday be adapted to peacetime use: Radar . . . automatic flying devices . . . new types of compasses such as the Gyrosyn . . . the Attitude Indicator . . . instrument landing systems . . . airport traffic control instruments . . . and many others.

When that time arrives, Sperry's research laboratories will tackle the task of making peacetime flying safer, swifter, more economical, and more comfortable.

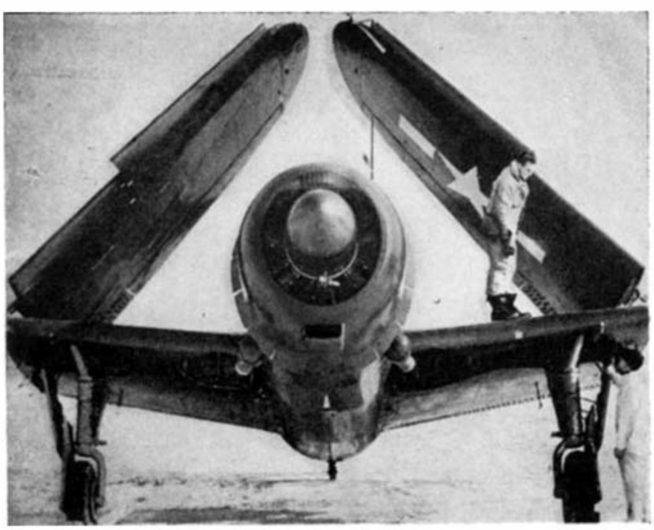
WAR BONDS—TO HAVE AND TO HOLD!

SPERRY
CORPORATION
30 Rockefeller Plaza, New York 20

FORD INSTRUMENT CO., INC.
SPERRY GYROSCOPE CO., INC.
VICKERS INCORPORATED
Waterbury Tool Division, VICKERS INC.

left St. John's, Newfoundland, on June 14, 1919 and arrived at Clifden, Ireland, on June 15, flying 1960 miles in 16 hours and 12 minutes, with fog and clouds imposing blind flying on them for part of the way. In another fine achievement, Lieutenant John A. MacReady, U.S.A., flew non-stop coast-to-coast on May 2-3, 1923, a precursor of transcontinental services to come later. Major Al Williams made a speed record of 266.59 miles an hour on November 4, 1923, in a Curtiss Racer Biplane, which emphasized the tremendous advance in speed that had been achieved since early days. Transatlantic flights from east to west were long unsuccessful because of contrary winds, and casualties in the North Atlantic were frequent.

Then there came the world's most famous flight. Charles Augustus Lindbergh left Mineola, Long Island, on May 20, 1927, and landed at Le Bourget, the Paris airport, on the evening of May 21, 1927, after covering 3605 miles in 33 hours and 39 minutes. He flew alone in the "Spirit of St. Louis," a small monoplane, heavily overloaded with gas. Carrying a few sandwiches and little special equipment, he succeeded because of courage, careful preparation, and an innate flying and navigational ability such as few have. A wave of enthusiasm swept the world when the great news was broadcast. That an American boy had succeeded single-handed, with little help from others, in crossing the wide ocean, renewed faith in the future of aviation, and contributed more to the public support of flying than any other single event. It has sometimes been said that Lindbergh did little for the conquest of the Atlantic compared with the meticulous survey flights of Pan American Airways. True—but morale may count even more than technical preparation. Lindbergh was soon followed by Chamberlain who,

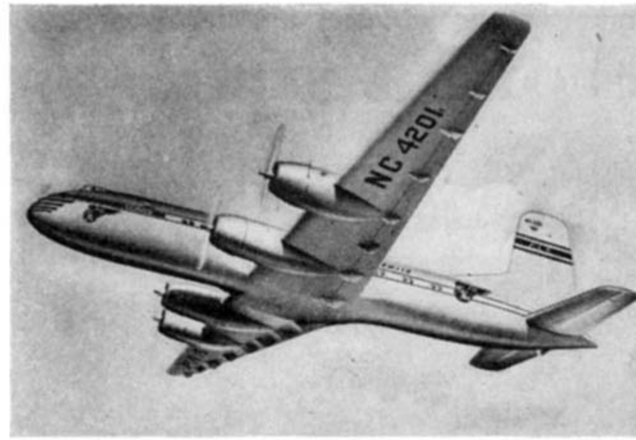


Folding wings, such as on Curtiss Helldivers, have greatly increased aircraft carrier effectiveness

with his passenger Levine, almost reached Berlin from New York; and by Admiral Byrd who reached France after many mishaps.

Meanwhile, it was becoming apparent that air transport in the United States would be on a sounder footing if air mail were placed in the hands of private contractors who could provide passenger facilities and thus lessen the cost of air mail to the nation. Accordingly, February 2, 1925, passage of the Kelly Bill provided for the transference of air-mail operation to private contractors. This meant that the small, poorly organized, struggling air services could grow into well-financed organizations of national importance. There was another helpful factor in the situation. William B. Stout had designed and built, with the support of Henry Ford, the Ford tri-motor. Mr. Ford was so impressed with this excellent ship that he manufactured them on a scale large for that day, and was content to produce them at a substantial loss.

FIRST AIR FREIGHTERS—On April 3, 1925, Ford began an air service out of Detroit to Chicago and Cleveland, carrying his own freight exclusively, but operating with the regularity of a public carrier; and the experience gained with



One of the Douglas super-clippers, on order by Pan-American Airways, that will carry 108 passengers

the tri-motor was to serve others. By 1926, 12 air-mail routes had been awarded under the terms of the Kelly Act, and stronger companies began to emerge such as National Air Transport, capitalized at $10,500,000, with the support of such personalities as Howard E. Coffin of Hudson Automobile; Colonel Paul Henderson, sometime Assistant Postmaster General and "Father of the Night Mail"; Philip Wrigley; William A. Rockefeller; Charles A. Lawrance; and other distinguished men.

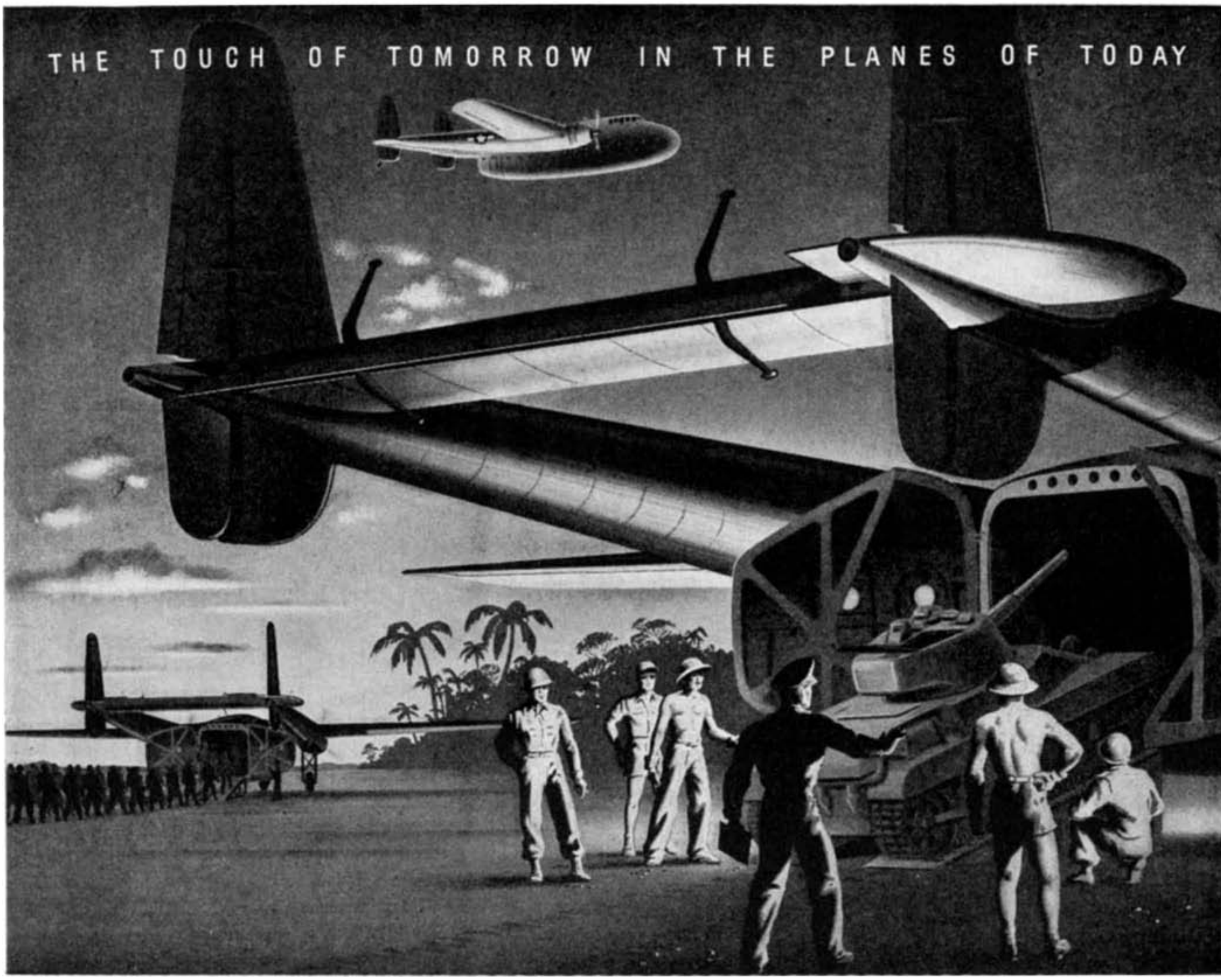
The Air Commerce Act of 1926 became the legislative cornerstone of civil aviation. An Aeronautics branch was set up in the Department of Commerce, and William P. MacCracken, Jr., was appointed Assistant Secretary of Commerce for Aviation. He did excellent work in regulation and in the construction of airways. Later came the organization of such widely known airlines as United, Transcontinental, and American Airways. The airlines grew in the amount of mail and number of passengers carried. They lost money, but their backers were apparently satisfied that they were laying foundations for the future.

Trouble later arose, however, over air-mail contracts allocated in 1930 by Postmaster General Brown. They were canceled in 1934 by Postmaster General Farley on the ground that the fees allowed the companies were excessive. President Roosevelt ordered the Army to carry the mail. But the young Army pilots were unfitted to fly mail planes in all weathers and at night, and many planes and lives were lost. Finally, the President ordered the air mail returned to the same private contractors on a different basis. On August 22-23, 1938, the Civil Aeronautics Act was passed, creating an authority for civil aviation and helping the industry grow still faster in mileage, in passengers carried, in navigational aids, in air traffic control, and in safety. When World War II overtook the United States, the Air Transport Command profited by being able to draw on the skill, experience, and personnel of the airlines to carry supplies and munitions to the far corners of the world.

FLIGHT LABORATORIES—Aviation research deserves as high a place in the annals as air transport, and provides an equally interesting story. Both Langley and the Wrights placed reliance on laboratory methods, and set a tradition of aerodynamic research that has been followed ever since. But just as the United States neglected the airplane in the country of its birth, so America allowed Europe for many years to lead in scientific progress. The first really well-equipped aerodynamic laboratory was that of Eiffel, the builder of the famous tower, who built a wind tunnel in Paris with his own funds and accumulated much aerodynamic information, being most active between the years of 1910 and 1916.

The English did fine work at the National Physical Laboratory, and issued the first reports and memoranda of the British Aeronautical Research Committee in 1909. It was in these early reports that Lord Rayleigh applied the theory of dynamic similarity to the interpretation of model aeronautics.

The Germans, prior to World War I, were concerned greatly with the theory of aerostatics. During the war they converted the vortex theory, established by Lanchester, an



Loads for a Landing on Nippon

Into the spacious hold of the Packet will go lethal cargoes—destination Japan. Guns, light tanks, shells, trucks or paratroopers; material and men for victory in the Pacific will be airborne in the Army's "flying boxcar," the new cargo carrier designed by Fairchild and built by Fairchild and North American Aviation.

The Packet, first airplane produced *specifically* for cargo transport, can carry up to nine tons. Its range, with lighter loads, is more than 3,500 miles.

Forty-two paratroopers with full equipment can be "delivered" through two jump doors in the stern, clear of any obstruction. An ingenious device sends equipment parachuting through special doors in the belly, simultaneously with each paratrooper's jump.

The Packet is loaded with extreme ease. Its fuselage floor is level and at standard truck-floor height. Cargo capacity is 2,312 cubic feet—about 88 per cent of the capacity of a standard railroad boxcar.

This all-metal, twin-engine, flying boxcar possesses characteristics inherent in all Fairchild products, "the touch of tomorrow in the planes of today." With but minor modifications it will become an efficient and profitable carrier of cargo in peacetime commerce, the flying boxcar of the new air age.

BUY U. S. WAR BONDS AND STAMPS

FAIRCHILD ENGINE AND AIRPLANE CORPORATION

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Ranger Aircraft Engines Division, Farmingdale, L. I. • Fairchild Aircraft Division, Hagerstown, Md. • Duramold Division, Jamestown, N. Y.

Subsidiary: Al-Fin Corporation, New York, N. Y. • Affiliate: Stratos Corporation, New York, N. Y.

Englishman, into the Prandtl vortex theory, giving it, however, sounder exposition and application.

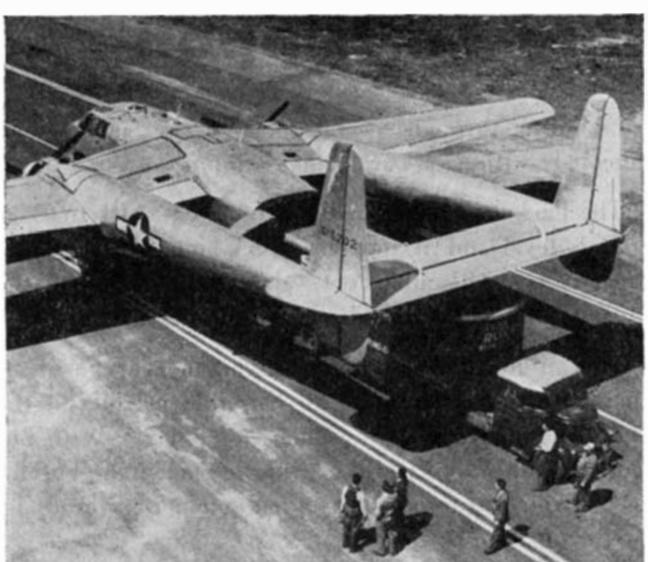
In Russia, Joukowski discovered the theory of the circulation of lift quite early, though Kutta in Germany seems to have made the same discovery independently at about the same time. Prandtl and his associates at Goettingen led in aerodynamics for a good many years until German science deteriorated under the Nazis.

In the United States, a historic date in aerodynamic research was the passing of an Act of Congress on June 30, 1916, by which there was established the National Advisory Committee for Aeronautics. The NACA soon after established a Memorial Laboratory at Langley Field, Virginia, which has remained in the lead ever since, approached but never equalled by the Deutsche Versuchsanstalt fier Luftfahrt near Berlin, the French laboratories at Chalais-Meudon, and Guidonia, the aeronautical research city built by Mussolini near Rome.

Research at Langley Field has been marked by such achievements as the first full-scale wind tunnel, the first compressed-air wind tunnel, the development of the NACA cowl for air-cooled engines, the laminar flow wing, and studies of high-speed compressibility effects. The Army station at McCook Field, Dayton, Ohio, established in 1917, and its successor, Wright Field, have originated little, but have served to point out to industry the requirements of military aviation, and have provided magnificent testing facilities.

During World War II, Wright Field has grown to enormous proportions in personnel, with huge high-speed laboratories, test stands for engines of more than 3000 horsepower, and the most complex equipment for full-flight testing. The Philadelphia Naval Aircraft Factory and the National Bureau of Standards are other government institutions contributing to aviation research. In aeronautical education, the United States has always led. It began on an important scale when Daniel Guggenheim endowed in 1925 the Guggenheim School of Aeronautics at New York University. A few months later the Daniel Guggenheim Fund for the Promotion of Aeronautics was established. Under its auspices there were endowed successively Guggenheim schools or laboratories at the Massachusetts Institute of Technology, the California Institute of Technology, Stanford University, the University of Michigan, and the University of Washington.

INDUSTRY'S CONTRIBUTION—Invention and development of the airplane as well as engines, accessories, and instruments have been a matter of American industry. Never has American genius manifested itself in so many varied and versatile ways as in the promotion of the American aviation industry from its beginning with the Wright biplane to the production of the giant B-29 and the jet-propelled Lockheed "Shooting Star." Manly's 50-horsepower engine has been succeeded by 18-cylinder, two-row, air-cooled giants developing well in excess of 2200 horsepower.



Air-freight operations of the future are foreshadowed in this view of the Army's newest cargo plane, the Fairchild C-82 Packet. Design is such that huge trucks and vans can back right up to the entrance of the cargo hold. Direct loading and unloading are possible because the floor of the hold is level and at truck-bed height. The Packet can carry 2312 cubic feet of cargo weighing nine tons

In this connection, it is interesting to recall a few famous names. Charles L. Lawrance, who began his work in a small loft factory in the early 1920's, is certainly the father of the American air-cooled engine. Elmer Sperry invented the automatic stabilizer now installed on every airliner and bomber. Douglas, who entered aviation as an engineer, has become one of our leading manufacturers; his Douglas DC-3 airliners have been used in greater numbers on the airlines than any other craft. Dr. Sanford Moss is worthy of special praise because his work on superchargers made it easier to build turbo-jets.

Two of the many companies that have contributed to the common advance are Bendix Aviation, with innumerable accessories and instruments to its credit, and Aluminum Corporation of America which did fine work in fostering modern construction in light aluminum alloys.

Thousands of Army pilots received their first training in the sturdy, dependable Fairchild PT-19. More than 10,000 primary trainers of this design were manufactured by Fairchild and four other contractors. Nine other United Nations have used the PT-19 for training. The two-place plane has a top speed of 125 miles an hour and climbs 655 feet a minute

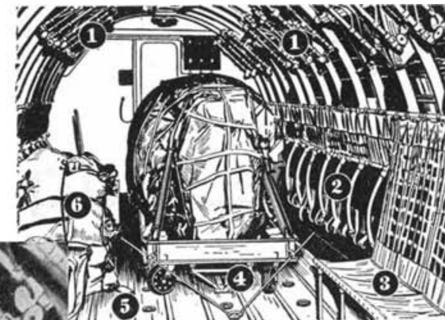
In the field of accessories, there are Fairchild Camera, Dzus Cowl Fasteners, Boots, Elastic Stop Nuts, Cleveland Pneumatic Oleo Shock Struts, and many others.

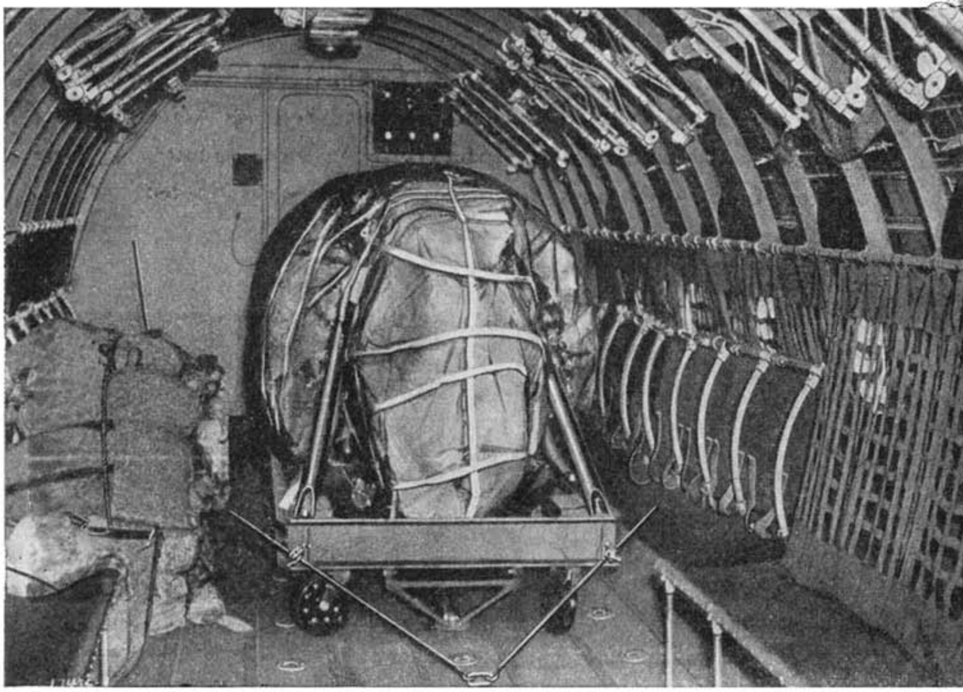
Modern military aviation is an immense subject in itself. From the fléchette of 1915, military destruction from the air has come to the 11-ton volcano bomb; from the revolver and light machine gun of World War I it has developed to the point where the massed rocket guns of a combat airplane are equal in fire power to the broadsides of a light cruiser. Military aviation has not won the war but superiority in air power has been necessary to bring victory in sight. Without it, the United Nations could never beat Germany and Japan.

For the future, it can be said that World War II has given impetus to build faster and larger transports, that jet engines will eventually drive civil aircraft through the air at supersonic speeds, that radar will conquer fog and darkness.

Humanity is truly entering on the Air Age which will push the science of transportation to unforeseen achievements or else bring modern civilization to complete ruin. The alternatives depend on whether the ever-growing power of aviation for good or for evil can be controlled and directed into those channels which will lead to the most effective utilization of its possible benefits.

EVANS SKY PRODUCTS





1 Sky Litter stanchions and supports folded back.

2 Sky Seats folded back.

3 Sky Seat ready for use.

4 Evans Rod-and-hook tie-down equipment in use.

5 Evans Sky Floor with sockets for litter stanchions and rings for Skyloader hooks.

6 Rope tie-down equipment in use with other cargo.

Air Transportation Rides the Beam to a Bright Future

The rapid development of Evans Sky Products in the past few years due to war's demands promises many new ideas in post-war air transportation. For, thanks to the adaptability of Evans Sky Floors and other Sky Products, a transport plane can quickly be changed from a cargo-carrier to a passenger plane, or can be used to carry both cargo and passengers at the same time, depending upon the waiting load.

Airline operators will thus be able to render better service, keep certain types of planes operating profitably and "in the air" more hours per day. And the air-traveling public and shippers of air-cargo of all kinds, shapes and sizes will benefit from more flexible flying service at lower cost.

Evans engineers are planning for even greater future progress in Sky Progress . . . and their services are always available to airplane manufacturers and airline operators. Write for the latest issue of "Sky Loadown"—an informative illustrated publication you'll be sure to find interesting.

In the AAFATC transport plane illustrated two types of Evans cargo tie-down equipment are in use, as well as one Evans wall-seat for passengers . . . and there is still room to drop the Evans litter-stanchions holding four litters each. This elasticity of use so vitally important to transport planes now in the Armed Services can be developed into a much wider variety of applications for peacetime Air Transport.

SKY PRODUCTS DIVISION

EVANS PRODUCTS COMPANY

DETROIT 27, MICHIGAN

Bearing Down On Friction

Certainty of Action Under Varying Conditions, Plus Savings in Power, are Two of the Ways in which Anti-Friction Bearings Are Making for Faster and More Accurate Production in American Industry. To Gain these Great Advantages, Scrupulous Maintenance is Needed

BALL and roller (anti-friction) bearings are making the modern airplane possible just as in their day they made the bicycle and the automobile possible. Army authorities have said that, without anti-friction bearings, feathering of propellers could not be done, the automatic pilot would be impossible, no man would be strong enough to operate the manual controls of a B-29, and the Norden bombsight could not be aimed accurately.

Many of the advantages of anti-friction bearings lie in their abilities to save power. Airplanes soon to fly will have more than 5000 kilowatts of connected electrical power in them. This means more than the amount connected in an average sized factory; more than enough for a small town. Anti-friction bearings can save up to 90 percent of the power that otherwise would be wasted as bearing friction. Without them the hundreds of motors and controls in a plane would have to be made so much larger and heavier for extra power that the increased weight and space problems would be out of all proportion.

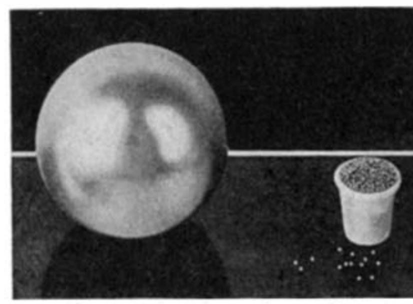
Important as power saving may be, it is not the most important contribution that anti-friction bearings make to airplanes and other machinery. In mounting after mounting the "life and death" factor is the knowledge that "X" amount of power applied to an anti-friction bearing device always will produce "Y" amount of motion or force where it is needed—that the amount of power consumed by the bearings will be the same without regard to load, weather, warming-up period, or anything else.

An engineer measures ten millionths of an inch tolerance in a bearing by the use of a microscopic gage of great power designed for this work

Sureness of action under a given force is a way in which anti-friction bearings add to the controllabilities of machines. Sureness of the positions of the shafts or other members carried by the bearings is another. In really accurate anti-friction bearings a shaft will not get out of position because of bearing wear, or changes in the thicknesses of lubricant films, or expansion of the bearings as a result of the heat of running friction. Gears or any other parts which depend upon their accuracies for much of their strengths can be mounted on anti-friction bearings and if placed in accurate alinements they will stay that way.

SCRUPULOUS CARE NEEDED—The trouble is, while anti-friction bearings are saving all this power and adding all this control, they themselves are helpless unless handled with control. They have to be made by the most controlled methods, installed under the most controlled conditions, maintained (when they need any maintenance at all) by men who never grow careless. That is why, after 50 years of use, anti-friction bearings still are only a fraction of all the bearings used. Where they are needed nothing can take their place; where not needed they often are too exacting in the accuracies and other control measures demanded of their users.

Many a machine shop got its first lessons in accurate assembly-line control when it first installed anti-friction bearings in its products. If kept clean and if mounted in highly accurate parts, the anti-friction bearings would perform flawlessly through astonishingly long service lives. If allowed to get dirty or if mounted with shafts and housings that did not match their own high accuracies, they would fail quickly. For all but slow speeds and light loads, therefore, machinery makers learned how to machine and grind accurately and to run dust-free assembly lines—or else they left anti-friction bearings out of their calculations.



The thimble is filled with the tiniest steel balls in the world, measuring .1063 inch in diameter, developed for the Army's Norden bomb sight. The steel in the larger ball would make 156,660 of the smaller bearings

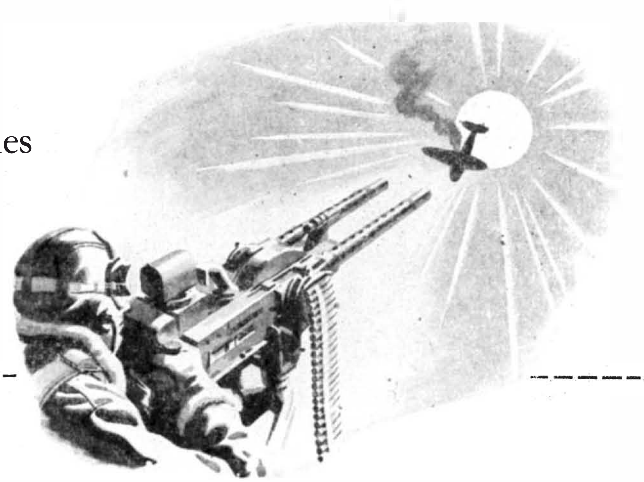
The anti-friction bearings makers learned this same lesson early. Before the turn of this century it was well known that the load- and speed-carrying ability of a ball or roller bearing depends upon control in its making—control of the quality of raw materials, of the accuracies of its parts, of the cleanliness of its assembling and packaging. Inspection operations alone make up more than 50 percent of the costs of manufacturing any good anti-friction bearing.

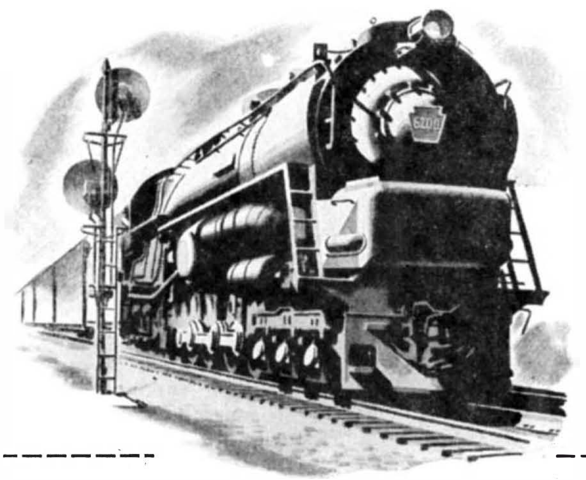
Control brought demands for still higher control. When the machinery makers got used to bearings that would keep heavy loads in accurate alinement on shafts turning at 5000 revolutions per minute, they asked for bearings that would handle heavier loads at 20,000 revolutions per minute. Bearings makers who had been thinking in terms of .0001 inch for both smoothness and accuracies of bearing parts soon had to go to .00001 inch. And so the anti-friction bearings which had been the fathers of accuracy in so many machine shops became the sons of that accuracy in the plants where they were manufactured.

The bearings makers are now working to accuracies—where these accuracies are needed—of ten millionths of an inch as the greatest error permissible on the size of a part and one millionth of an inch on the smooth-

In a bomber a GUNNER uses a new gunsight lamp that permits him to aim *directly into the sun* – blasting enemy planes that otherwise would be invulnerable because of the blinding glare.

. . . the name on the GUNSIGHT LAMP is Westinghouse.



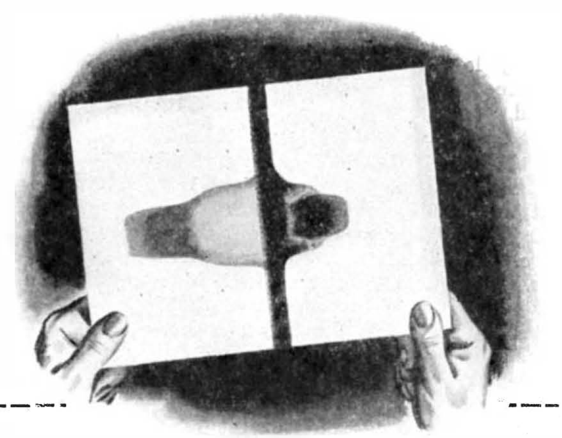


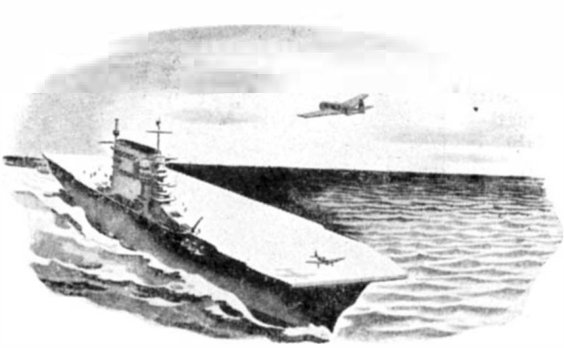
On a railroad an ENGINEER gets smoother operation – and 25% more power – from his steam locomotive because of a revolutionary new steam turbine drive.

. . . the name on the TURBINE DRIVE is Westinghouse.

In an Army arsenal a BALLISTICS EXPERT photographs projectiles, smashing through armor plate, with an x-ray tube that takes a picture in *1/1,000,000th of a second.*

. . . the name on the X-RAY TUBE is Westinghouse.





On a carrier a PLANE DIRECTOR uses a new kind of elevator to hoist planes on deck faster – keeping the deck cleared and getting fighters into the air quicker.

. . . the name on the ELEVATOR is Westinghouse.

Westinghouse

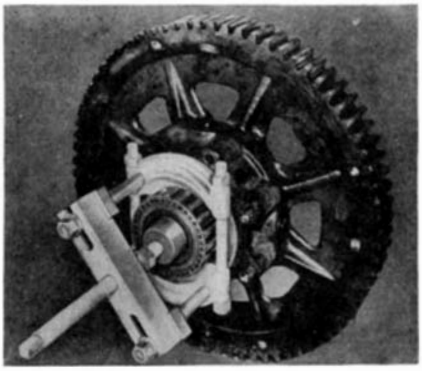
PLANTS IN 25 CITIES OFFICES EVERYWHERE

Tune in: JOHN CHARLES THOMAS–Sunday 2:30 pm. EWT, NBC

TODAY – Westinghouse skill in research and engineering is constantly at work, developing new and better war materials for final Victory.

TOMORROW – This same research and engineering skill will mean more dependable, more efficient industrial equipment and appliances for the home.

ness. And the end is not in sight. Bearings makers are among the most exacting buyers of steels and other materials—companies like SKF and Timken even make their own steels. Bearings makers are quick to buy any inspection instrument or production machine that will increase accuracy. They will



Maintenance work such as pulling a bearing from a shaft must be carefully controlled and perfectly clean

find out how to turn out better and better products, and with every improvement in anti-friction bearings will come improvements in the controllabilities of many kinds of machines.

Fine electrical instruments are examples of what is going on. The classic type of bearing for these is the hard, smooth jewel. And jewel bearings will continue to be used in millions of instruments. But for the hard shock-load conditions or extremely heavy vibrations of war planes something equally low in the amount of power consumed but far less brittle had to be found.

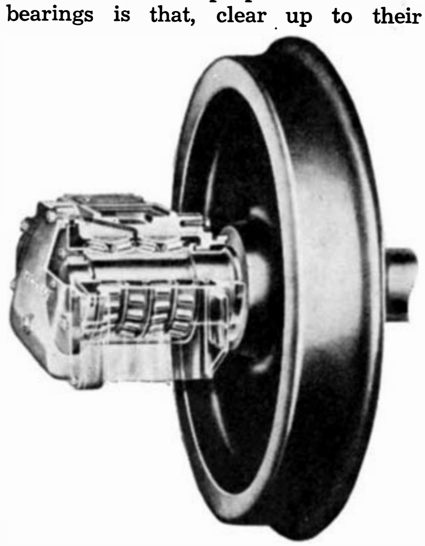
MICROSCOPIC BEARINGS—Special ball bearings filled the bill. They are so tiny that a thimble will hold more than 3000 of the balls which go into them, more than 360 of the completed bearings. Using them, every plane can have row after row of instruments each of which—so far as its bearings are concerned—will perform with complete dependability.

The high production of instrument bearings needed for aircraft means a lot to all other industry. Soon, instruments with these bearings in them will be on looms, on punch presses, in the cabs of locomotives, in all sorts of places where shocks and vibrations had been extremely bad for instruments. The bearings industry knew all along, of course, how to make such tiny bearings, but before the production of planes zoomed as a result of the war, there was no one market with enough demand to pay for learning how to make them at low prices. Now the reasonably priced tiny bearings are here, and they are made to accuracies that make any ordinary "fine watch" look like a lawn mower by comparison. They will be doing things for post-war automobiles, washing machines, and passenger elevators.

Anti-friction bearings are an old story but at the same time an ever new one to the machine-tool industry. Long ago the machine-tool makers started using them to cut down the power demanded. And as machines needed more and more power sources, with sometimes as many as 30 individual electric motors on one machine, the power savings became more and more important. But, as has been the case with so many devices, the certainty of position and of control of parts mounted on them is becoming the real contribution of anti-friction bearings to the metal working arts.

Tungsten carbide tools brought this out many years ago. The speed with which a machine tool does its work often can be multiplied five times or more by the use of tungsten carbide—provided all members of the machine are steady, accurate, and rigid enough to keep fluctuating loads from breaking these tools. Anti-friction bearings, preloaded to take out their initial elasticities, support the spindles with the necessary rigidity.

Even more important, anti-friction bearings permit the electric meters on the machines to tell true stories of how much power is going into the work itself. One of the properties of these bearings is that, clear up to their



Designed especially for railroad use, this Timken bearing fits into existing trucks without requiring change

breaking points, they consume only a little more power under heavy loads than under light ones. Thus when a machine-tool operator glances up at the electric meters on a machine which has anti-friction bearings throughout its power drive he knows that practically all the power registered on those meters is going into the working of the metal. If those meters show too high or too low power readings, he knows that something is wrong and he can shut down his machine or make the necessary adjustments before work is spoiled or harm is done to the tools.

IN STEEL MILLS—Certainty of the amount of power being used at the bearings caused anti-friction bearings to be used in steel and brass rolling mills. With banks of electrical instruments before him, the operator of a mill can tell exactly how much power is being used in work done in the steel itself, can compare this with the temperature of the metal and the exact amount that each pass through each set of rolls is reducing it, and thus know exactly what his machinery is doing. Modern continuous strip mills were impossible before such certainty was obtained. Now, when anti-friction bearings make engineers certain of exactly what positions their rolls will occupy under given amounts of pressure, as well as how much power will be consumed by the bearings, there is no guessing what advances will be made in new accuracies of rolling, new surfaces on steel, new cladding and laminating, new applications of powder metallurgy, and a hundred and one similar improvements.

Certainty of the amount of power used is selling anti-friction bearings to the railroads. Power savings are important, of course, but the railroads got along for a hundred years by putting more power in the locomotive to compensate for any extra demand at the car journals. The one thing they could not do without anti-friction bearings was to be sure that no matter how heavy the load in the car, how high the speed, how rapid the acceleration or deceleration, and—within limits—how cold the weather, the power used at the journals would always be nearly the same as well as extremely low. Anti-friction bearing journals start into motion with only about 2 percent more friction than their running frictions, whereas their predecessors need twice as much power to start as to keep going. This means that the anti-friction bearing train has much greater certainty of starting smoothly. It also places much less starting load on the locomotive. And while the anti-friction bearings will not contribute so much to the braking of the train on a down grade, the engineer always knows exactly how much they will contribute and that it will always be the same amount.

This same exactness of operation is putting anti-friction bearings into remote controlled and automatic controlled machines. An operator in a control tower may flip a switch to turn on a pump miles away from him; he has to be sure how much liquid that

A hypodermic syringe is used to put a drop of oil in these tiny bearings. White gloves, gown, and cap worn by the operator safeguard against dirt

pump will deliver and that this amount is not being changed by variations in the bearing frictions of the pump and its motor. A chemicals process may have hundreds of electrical instruments, each of which is automatically controlling the amounts of power being fed to electric motors; the chemical engineer must be certain that a variation in that power means a similar variation of the work done by the machines and not a variation of the power used by the bearings.

MAINTENANCE PROBLEMS—Such certainty, of course, is not being obtained without a little added trouble. And one of the greatest troubles can be in the maintenance department.

Anti-friction bearings do not always add to maintenance troubles. Many of them have their lubricants sealed in for life; they never have to be oiled and never have to be cleaned as long as the machines they serve last. Many more have so much greater capacities than the loads imposed on them that they will run for years with no more servicing than an occasional addition of clean lubricant.

But when anti-friction bearings do need servicing the maintenance men must pay as much attention to cleanliness and to careful handling as the original installation men—there is none of the carefree abandon with these bearings that so often is found in maintenance departments.

Just as many a machine shop got its first lessons in clean and accurate assembly methods when it first installed anti-friction bearings, many a maintenance shop is being air conditioned so it can keep its windows closed on hot days when it services these bearings. But then, plenty of the highly accurate gears and motors and other devices which use anti-friction bearings need this same cleanliness. And so these bearings, the fathers of control in machine-building methods, are the fathers of control in maintenance.

FLAME SPRAYING

Opens New Engineering Fields for Plastics

THE PROCESS of heating a metal wire in a flame and then, with an air blast, depositing the molten metal on a surface which is to be built up or repaired, has been known since the early 1920's. It was called "metallizing" because nobody ever dreamed that it would be used to apply any other substance than metal.

Now Du Pont announces that polythene, a plastics, can be flame-sprayed like metal.

There is no sign that other plastics makers have paid much attention to such possibilities. But there is no reason why a wide list of thermosetting plastics should not be susceptible to being heated and then sprayed by air blast. The heating temperature does not have to be high enough to melt metal. The plastics does not have to be run directly into flame as is metal. For many a plastics the air for the blast could be preheated to a temperature sufficient to spray the material.

Polythene is an excellent electrical insulator and is tough and resistant to brines, chemicals, and other corrosive agents. It could be flame-sprayed over the contacts of electrical apparatus—the electrician could wire-up his job and then insulate and protect all of the terminals. He could renew damaged insulation while the wiring was "hot" or carrying current.

Plenty of heat spraying of plastics could be done to provide finishes, fill up worn spots, provide special protection against weather or corrosives, and so on.

But one thing is sure. If very many plastics are applied by this method, then a new name or a series of names will have to be coined. "Heat-spraying" could be used as a generic term for the whole process, with "metallizing" remaining for the application of metals and "flame-spraying" applied to anything which is melted directly by the flame.

TORQUEMETER

May be Applied to Obtain Greater Machine Efficiency

MACHINE tools and all kinds of process equipment for paper mills, chemical plants, and oil refineries moved one step farther toward perfection of control when Westinghouse Electric and Manufacturing Company developed its magnetic-coupled torquemeter.

Originally worked out for aircraft engines, this instrument measures the minute amount of twist which occurs in the steel shaft that connects the engine to the propeller. Since the exact amount of twisting which that shaft will do under any given twisting stress or "torque" is known, by measuring this twist the exact amount of power being delivered by the engine also is known.

It is important to machine operators to know the amounts of force being delivered to cutting tools, mixing paddles, and other devices. In machine tools that force is a measure of the kind of work being done on the materials being fabricated. In papers, chemicals, and the like, that same force determines the work done on the materials by the process, and this in turn affects the qualities and properties of the finished products.

The ordinary way to measure the amount of work being done is to read electric meters attached to the motors which drive the machine. But these meters can tell only the total amounts of power that the motors are delivering. Between the motors and the points of work may be shafts, bearings, gears, and other devices, each of which can consume varying amounts of power under varying temperatures, amounts of wear, and other conditions.

The torquemeter would be attached to the final drive shaft as close to the actual point of work as possible. Its invisible magnetic "fingers" in the form of air gaps would pick up variations in the amounts of twist imparted to the shaft and convey these variations to instrument boards or to automatic controls.

Right now the principal use of the torquemeter is to enable the airplane pilot to adjust his engine speed, propeller pitch, and carburetor pressure to get more mileage from each gallon of gas. But, with time, the refinements in the production of aircraft components resulting from the use of these torquemeters in the plants which make parts for planes will result in far greater flight economies.

V-DAY PROBLEM

Raised by Instructions For Storing War Equipment

MANUFACTURERS who have large plants crammed with government-owned machinery and who expect to move this out and put in their own machines at war's end, are staring gloomily at government regulations for the care of the war equipment. The government does not intend that its property shall suffer between shut-down and resale, but expresses little concern about who will perform the labor and pay the bills for protecting it.

Trouble will be plentiful. According to government order P.S. 300-4, if machines are to be stored for more than 90 days in open or closed storage, somebody has to:

Remove all removeable accessories, apply one protection to non-critical surfaces and another to highly finished ones.

Wrap loose parts as prescribed; pack them in boxes which shall be attached to the machine skids.

Drain lubricant systems, clean them, refill with AXS-Grade 2 or with AXS-934 Grade 1 or USA 2-120 protective compounds, depending on whether they originally contained SAE 30, SAE 10, or light spindle oils respectively.

Clean coolant system with fresh coolant, refill with AXS-674 or AXS-394, putting in enough so lubricant can be circulated through entire system. Operate machine under no load long enough to coat entire system. Drain. Save the excess oil or use it for protecting another machine.

Remove grease from internal gears and replace with clean lubricant. Take the oil out of oil-lubricated journal boxes and refill with AXS-934 Grade 1 or 2 as required.

Drain hydraulic systems, refill with AXS-934 Grade 1, operate machine enough to wet all surfaces. Manually remove gums and sludges.

Clean external surfaces with solvent. If they rust, clean again with solvent mixed with protective compound. Then coat 3/64 inch thick with USA 2-121 or USA 2-82 heated and sprayed on.

Follow minute directions for sealing openings, vents, or louvers. Wrap according to exacting specifications. Skid. Then find a place to put the machine while the company's own equipment is moved into the shop.

It looks as if there would be plenty of work for returning service men!

Plastics Aloft

From Practice Bullets to Helicopter Parts, From Structural Materials to Electrical Insulators, Many Kinds of Plastics Are Essential to Aviation Today and Tomorrow. They are Both Utilitarian and Decorative

PERHAPS the most unusual plastics application to be made public recently is the frangible bullet which sluffs away to powder upon contact with the target. Molded of plastics and lead, these bullets are now being used in training Air Force gunners and may in the future serve as practice ammunition for sections of our armed forces.

Until the development of these frangible bullets by the Army Air Forces—in co-operation with the National Defense Research Council; Dr. Paul Gross, Director of Research of Duke University; and research chemists of the Bakelite Corporation—gunners went into battle with a distinct handicap. Whereas navigators, pilots, radio men, and even bombardiers could duplicate in training the performance expected of them over enemy territory, there was no way in which a gunner could safely fire a live bullet at a real plane flown by a live pilot. The best he could do was shoot at targets towed through the sky by a fellow flier.

Now, as a result of the perseverance of Major Cameron Fairchild, who conceived the idea of these frangible bullets, gunners can not only aim but fire at real planes and have the additional benefit of knowing whether or not they were on the target. Early experimental work on the bullet was carried out with a pellet of tempered glass in which the molecular cohesion is such that it disintegrates into a fine powder when the sensitive tip is shattered. The glass bullet proved too costly, however, and the research workers turned to a lead and plastic compound which was found to be hard enough to go through the mechanism of a 30-caliber machine gun, yet fragile enough to crumble into fine powder upon impact with the specially treated duralumin armor employed on the target plane.

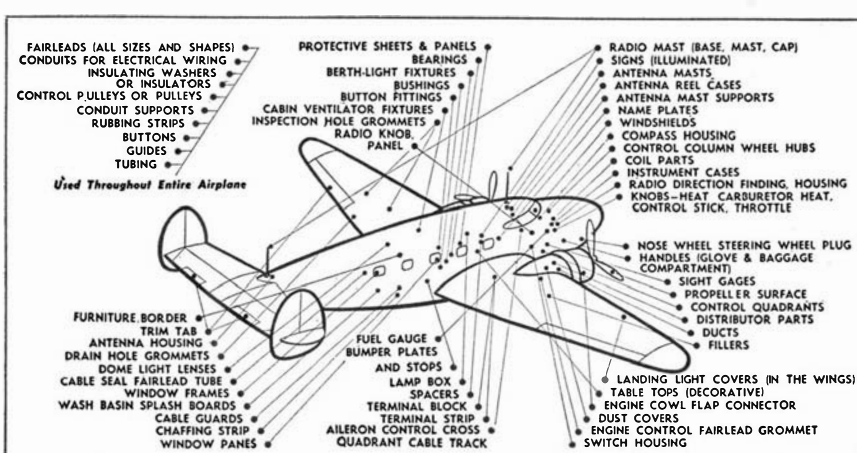
TAKING THEM UP—While this success of plastics in helping to bring down enemy planes is of recent origin, the work which these materials have been doing to get our planes into the air and keep them there dates back to the early days of flying. When search was being made for materials to replace the stick-and-fabric construction of the Wright brothers, one of the first materials tried for wings was a form of plywood. In fact, plywood as a structural element of the fighting plane is a veteran of World War I. The famed crates that reconnoitered over the German lines and fought it out with von Richthofen's Flying Circus relied on glued plywood and fabric.

However, these early laminated woods and plywoods, which used albumin and casein cold-set glues, were susceptible to warpage and fungus growth. When the civilian aircraft industry swung completely over to the all-metal plane, following the success of the Ford tri-motor, the United States armed forces went along, and until the metal shortage became critical with America's entry into World War II, little attention was paid to wood construction.

The early plywood planes had another disadvantage. The veneers were first glued together in a flat press. Then the sheets were wet or steamed and sprung into form. This type of construction had limitations. When the flat-pressed veneers were bent to compound curves they tended to return to their pressed condition, wrinkling and changing shape. These objections to wood construction were, for the most part, removed in the 1930's with the advent of improved hot-press equipment and the commercial availability of thermosetting resin adhesives in both film and liquid form. In fact, after improved forming techniques had been developed in response to a demand for more complicated shapes than could be fashioned from flat sheet, aircraft plywood enjoyed a number of advantages over the lighter metals. Its weight-strength ratio is favorable, and its stiffness outstanding. (The EI, or stiffness value of aluminum is 22; that of birch plywood is 178 and of spruce plywood 416.) In addition, plywood can be molded easily and cheaply into monocoque shapes of extreme complexity, whereas metal fabrication is both more difficult and more costly.

PLASTICS PLANES—In 1938, attention was focused briefly on the aircraft possibilities in the newer molded plywoods when Clark Aircraft Company brought out an experimental plane with a plywood fuselage which had been molded complete in two hours. Representatives from the Army Air Forces who observed the tests of this plane conceded the practicability of plywood parts for light trainer planes but could see little possibilities for the use of the material in combat service. Then came the war. The cry was for planes and more planes, all types of planes.

Among the planes that have rolled from the production lines since the outbreak of hostilities, the Mosquito is noteworthy because it is the first Allied bomber to take advantage of the structural and aerodynamic qualities of resin-bonded plywood. And the Curtiss Caravan was the first of the huge



CHART, COURTESY E. I. DU PONT DE NEMOURS & CO., INC.

No single aircraft employs all the plastics items shown on this chart, but all of these and many more are in use today on passenger, freight, and fighting aircraft

cargo planes to be similarly constructed. To this list can be added trainers and gliders, turned out in swarms to meet the needs of an expanding air program.

Still in the experimental stage is the use of glass cloth laminates as structural materials in our planes. Use of plastics laminates had previously been restricted to non-structural parts such as fairings, fillets, and door, because physical properties were not adequate for primary structures. Developments in the use of high-strength fibers in combination with synthetic resins, however, appeared to open an entirely new field for laminates having adequate strength for primary structures.

From among many different types of fibers, glass fibers were selected as the reinforcing agent because of a strength-weight ratio substantially greater than that of the other materials. Furthermore, glass fiber manufacture can be closely controlled, making possible a uniform laminate. The development of no-pressure, low-temperature thermosetting resins to take the place of high-pressure-type laminating resins which had proved impractical, overcame the final obstacle to the production of plastics laminates possessing adequate strength properties, low moisture absorption, weather resistance, and dimensional stability.

TRANSPARENT ENCLOSURES—Important as is the use of laminated wood and plywood and glass cloth laminates for the structural elements of a plane, these applications represent but a fraction of the service plastics are rendering to the aircraft industry. It is estimated that there is an average of 200 plastics parts in today's fighting ships of the air. Many of these applications are indicated in the accompanying drawing. Although no one plane may have all these parts, all of them—and many others—are essential elements in present-day passenger, freight, or fighting aircraft.

A wealth of transparent enclosures characterizes the modern warplane. Nose sections, cockpit enclosures, gun turrets, observation hatches, blisters, windows, tail empennages—any place in the plane where it is necessary for a man to have clear and unobstructed vision of sky or ground—all are fabricated of acrylic or cellulose acetate sheets. These plastics sections are favored not alone for their optical properties but because they possess other qualities which make them eminently serviceable. They weigh less than half as much as glass, yet are strong enough to withstand the wind pressure encountered by planes travelling at 300 or 400 miles an hour. Their extreme ease of forming is another factor in their favor.

One of the latest developments in this type of application is a shatter-resistant plastics glazing capable of resisting shock-impacts, such as the effects of penetration by machine-gun and cannon fire, or gun-fire concussion. The need for such a material grew out of the increasing use of pressurized cabins in war planes which are often called upon to operate at high altitudes, many in excess of 35,000 feet. Under conditions of pressurized flight the transparent sections are under high stress. Because of this condition there was the constant danger of the glazing shattering if penetrated by enemy gunfire.

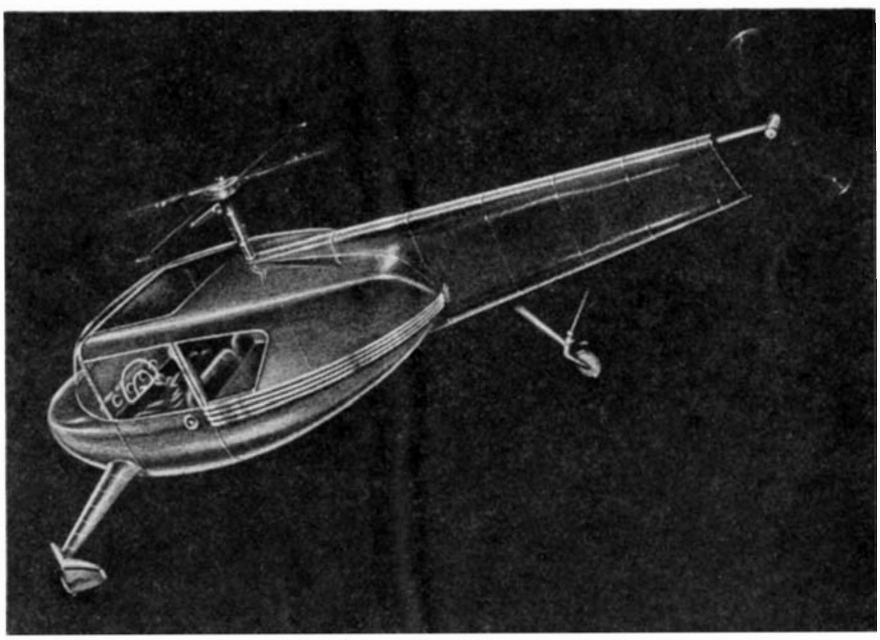
In the absence of a material capable of resisting penetration of gunfire, the next best alternative was one in which bullets make holes of minimum diameter and which has a limited fracture area. Under these conditions the hole may be quickly closed with a temporary transparent patch. The solution proved to be a laminate made up of two layers of methyl methacrylate resin with a layer of polyvinyl butyral resin between them.

NON-STRUCTURAL APPLICATIONS—A variety of plastics materials—molded or laminated plywood, veneer, and cotton fiber impregnated with phenolic resins, among others—have been employed for such non-structural airplane parts as elevators, flaps, ailerons, stabilizers, vertical fins, rudders, tabs, and controls. And then there are the ammunition chutes, ejection hoppers, ammunition boxes, cable guards, and fairings formed from such materials as phenolic canvas-base laminate. There are a number of advantages to the production of these last named parts from plastics rather than metal. The use of laminated phenolic effects a saving in time as compared to that required for the forming of metal, reduces cost, and lessens weight. In addition, plastics fairings have less drag since there is not the surface unevenness which riveted metal parts possess.

A fighting plane without its radio operates under a severe handicap. In this all-important unit of combat equipment, the superior strength, impact resistance, and electrical properties of plastics have been drawn upon by designers of modern planes. The entire radio circuit is studded with molded phenolic plastics as are those of the lighting, control, inter-communication, and motor systems. Circuit breakers, switch boxes, toggle switches, panel boards, sockets, connectors, terminal blocks, switch box covers, meter boxes, terminal boxes, junction boxes—all take advantage of the excellent electrical qualities of this plastics material.

For night flying when the plane's lights must be extinguished, illumination of instrument panels, switches, nameplates, dials, and charts is made possible by laminated plastics with wiped-in fluorescent markings or by fluorescent plastics sheeting.

LOOKING AHEAD—With the war still to be won it is difficult to give any detailed information of the exact part which plastics will play in post-war aviation. Generally speaking, however, we can expect the future commercial cargo aircraft to utilize the light weight, production speed, high strength, and electrical characteristics of plastics in many functional parts. For civilian aircraft will be added low cost, color possibilities, and design for eye appeal.



Post-war helicopter design as envisaged by Dohner and Lippincott

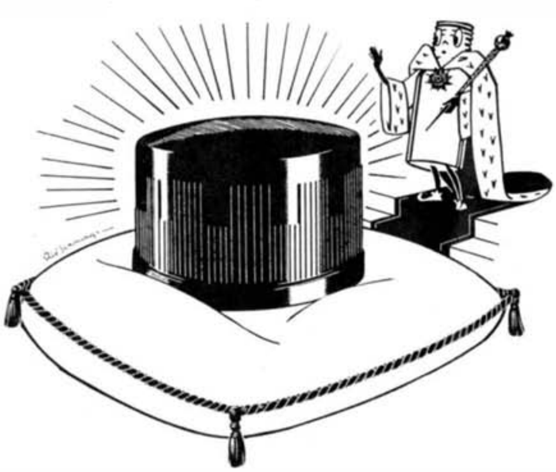
Helicopters, because of their ability to hover over a given point, land on terrain not easily accessible by present transportation standards, and to rise and descend vertically should, in the future, prove valuable for many commercial purposes. However, before any volume in helicopter sales is reached, the manufacturers have three problems to solve. They must make these planes safe to operate. They must make them easy to operate. And they must make them economical to operate.

It is possible that the fuselage of the post-war helicopter, in addition to being constructed of light metals, will feature low-pressure laminates produced from low- or contact-pressure resins reinforced with glass-fiber fabric or other materials. The transparent portion of the planes' bodies will be even more extensive users of plastics. The metal parts that will be employed in helicopter construction will require a protective coating against corrosion and the elements. Even before in-

DUREZ

PHENOLIC RESINS
- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

MOLDING COMPOUNDS



TOPS IN TOPS

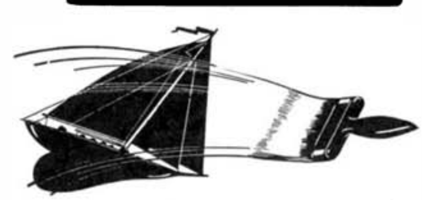
There's a good reason why more closures have been made from Durez than from any other plastic material. In a nutshell, it's because of the unusual versatility of Durez phenolic molding compounds. Such properties as non-bleeding, eye-appealing finish, excellent moldability, and resistance to moisture, chemicals, alkalies, and temperature extremes make Durez phenolics the ideal material for manufacturing closures of all sizes and shapes . . . for all purposes. These same versatile properties also account for the extensive use of Durez phenolics throughout practically all fields of industry where the miraculous progress of wartime research has made their applications almost limitless. To the progressive manufacturer who is thinking ahead . . . planning to market his new products during the post-victory era . . . Durez offers a line of more than 300 versatile phenolic molding compounds from which to select the plastics that fit the job.

INDUSTRIAL RESINS

BREAKING A BRAKING PROBLEM

To be good, a brake lining must possess two qualities to the utmost degree . . . heat resistance and durability. Asbestos fiber bonded with Durez phenolic resin has proved a tremendously successful formula for brake linings because it inexpensively combines the natural heat resistance of asbestos with the durable toughness and heat resistance of Durez resin to form a finished product that meets the highest standards. The wide range of properties inherent in all Durez phenolic resins renders them invaluable to the imaginative design engineer who is in search of a bonding or impregnating resin that is really versatile.

OIL SOLUBLE RESINS

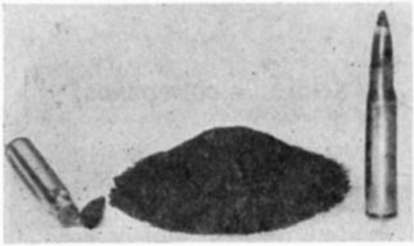


IMPREGNABLE COAT FOR A SEA-GOING BOAT

Such properties as durability, excellent finish, and resistance to marine growth, fresh water, salt water, gasoline, and oil which Durez resins impart to marine paints and varnishes, have made these resins invaluable in producing boot topping, topside, and bright-work finishes for boats of all types. The tremendous progress which Durez laboratory technicians have made in developing resins for protective coatings of every description is reflected in their wide wartime use . . . and in a myriad of new applications designed for post-victory markets.

The past four years of wartime urgencies have advanced plastics' progress by a decade. Many new and unusual applications . . . applications for which plastics have proved better suited than any other material . . . have been developed. The twenty-five years' experience of Durez technicians combined with the natural versatility of Durez phenolics proved invaluable in aiding the successful development of many of these applications. As specialists in the production of these most-versatile-of-all-plastics, Durez' background includes actual working experience in practically all fields of industry. The benefits of this background and the enormous collection of data in our files are available at all times towards helping you select the proper plastic material to fit your job. Durez Plastics & Chemicals, Inc., 526 Walck Road, North Tonawanda, N. Y.

PLASTICS THAT FIT THE JOB



A frangible bullet on the right; on the left, a slug that has been broken to show texture. The pile of powder in the middle was obtained by firing a number of frangible bullets against a target of tough duralumin

corporation in the plane these metals may be well protected by plastics. When metal parts are stamped out, oil and grease are forced into the raw metal to reduce heat and friction. In order to restore the original condition of the metal, the surface must be cleaned prior to assembly. However, it has been found that pre-treatment of the metal with plastics before the stamping operation eliminates these cleaning operations and is faster, cheaper, and more efficient. Vinyl copolymer resins are applied as a coating which is then baked at approximately 300 degrees, Fahrenheit. These resins cling well to the metals to form a protective, flexible coating and, regardless of what happens to the metal during stamping, the coating maintains a continuous protective flexible film.

It is safe to say that the three factors upon which helicopter sales post-war must be predicated—safety, easy operation, and low cost—will be solved. Helicopters will not replace the plane or automobile, they will not be made predominantly of plastics, but they will make good use of these materials and their sales will run into many millions of dollars.

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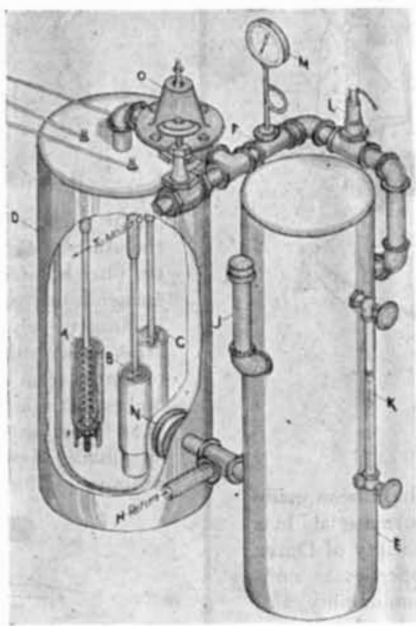
STEAM GENERATOR

Saves Power Costs in Plastics Molding

COMPRESSION molding of plastics gives indications of being strongly influenced by a radical electric steam generator designed for use on individual presses and intended to take the place of a central boiler.

This steam-generator unit was developed by the Vaportron Corporation in co-operation with a number of molders who installed the early models in their plants for testing purposes. Basically the operation of the system is as follows: Water in the steam-generating tank D completes the circuit between the three electrodes A, B, and C, causing a certain amount of current to flow in the system. A maximum flow of current will take place when the electrodes are completely covered but there will be no flow at all when the water level is below the bottom of the electrodes. Passage of current between the electrodes heats the water to the boiling point. The resulting steam passes through a pressure regulator O, and through steam lines which lead to the pressure tank E and to the feed line to the mold platens G. The return line H is used to collect the condensate from the mold and return it to the boiler.

Generating steam in a closed system causes the pressure to rise. When it rises enough to lift the diaphragm valve, the flow of steam is shut off. With the steam supply blocked by the regulator valve O, the pressure in tank E drops until it is less than that in the generating tank D. The higher pressure in D as compared with E causes the water level to drop in D by reason of the fact that pressure in D forces the water out through the lower feed pipe into the tank E. This action equalizes the pressure in the two tanks.



Drawing of the new steam generator designed for use on plastics presses

However, at the same time, the water in the steam generating tank D has dropped to a lower level on the electrodes, reducing the amount of current flowing through the water and, in consequence, the amount of steam that is generated. This sequence of events causes the steam pressure in D to drop still further until it reaches a point at which the regulator valve reopens and allows steam to flow once more through the valve to the mold and to the pressure tank E. This comparative reduction in pressure permits the water to rise on the electrodes so that the amount of current passing through the water is once more increased and the steam pressure again begins to rise. In actual practice, the pressure in the feed line to the mold remains practically steady while the amount of current drawn by this unit fluctuates according to the actual steam demand.

When the final model of this steam-generator unit was tested on a 150-ton press, the average power consumption for the press was seven kilowatts per hour. At an average cost of one cent per kilowatt hour, the cost of power to generate the steam for the 150-ton press was in the neighborhood of seven cents per hour.

It is estimated that a standard boiler installation on a 150-ton press would consume 60 pounds of steam per hour. On the basis of figures supplied by one large utility it is estimated the cost of this steam would be 7½ cents per hour. In addition to power savings, there is the advantage of increased efficiency which is attributed to the use of these new steam units.

OFFICE FURNISHINGS

Employ Many Types of Functional Plastics

AIRCRAFT companies have been among the first to realize that the essence of comfort and convenience lies in the elimination of unnecessary detail. In their application of this belief to the furnishings of offices and terminals, the United Air Lines now employs many types of functional and decorative plastics materials. Examples include Rocoteen for counter facings, Marlite for ticket counter tops, and transparent covers for tops of tables and counters so that time tables and other printed matter can be placed underneath for ready reference.

Inexpensive chromium-gray pyroxylin-coated fabric which replaces the conventional polished walnut is impervious to scratch and cleans easily. The material is reinforced by padding to absorb shock and is held in place by chromium upholstery nails. The Marlite covers on the ticket counters have the advantage of being cigarette proof and stain resistant. Both color and pattern are impregnated in the material, which requires neither waxing nor polishing.

PLUMBING FIXTURES

Can Make Good Use of Plastics

SEVERAL interesting designs for post-war "Dial-Ese" bathroom and kitchen faucets have been worked out by Henry Dreyfuss for the Crane Company. This proposed line uses a plastic dial-type handle on the faucet instead of the conventional pre-war handle. Its operation is based on a new principle which makes it possible for the water to be turned on and off with the same ease that is experienced when a radio or inter-office communication system is shut off or turned on. The new type of faucet is reported to be equally adaptable for use on the kitchen sink, the bathroom lavatory, the bathtub, or the shower.

Plastics may have many more uses in plumbing fixtures. Nozzles of dish-sprays may be of plastics. Or mixing-spout faucet and drain connections may be mounted on a non-staining easy-to-clean plastics panel. But, in all applications, careful consideration should be given to the properties of the material to be used, from the inception of the design to final production.

Motor Vehicles Post-War

Will Aircraft Manufacturers Invade the Automotive Field? Will Motor-Car Makers Produce Airplanes? Where Will the Parts Manufacturers Fit Into the Picture? Investors and Technicians Alike Want Answers to these Questions, Based on Logic and Established Fact and Experience

Despite trends in global military operations, highway transportation in the United States is bound to face harder going before things change for the better for either operators of motor-vehicle fleets or small business men, each with his single truck, bus, or taxicab.

One important segment of the nation's major economic dislocation because of the war has been the violent upset of the vast manufacturing facilities that comprise the automotive industry. No matter when V-E or V-J day may come, the whole automotive industry faces a long period of readjustment and retooling. The problem is basically one of production engineering, but the program probably will be confused by the continuation of Government controls by bureaus and agencies which have set their caps for maintaining their regulatory functions.

Even were the nation not suffering from the philosophy of Government in business, the reconversion of the automotive industry from weapon manufacturing back to peace-time products would be an involved affair. Some 5000 manufacturing companies—many of them small, some of them huge—constitute the automotive industry. A part of these companies sell only a small part of their product to the industry; others sell their entire output to vehicle manufacturers, directly or indirectly.

No one vehicle builder manufactures the whole car, truck, or bus. Some manufacture more of the component parts than do those few companies which are, in effect, designers, assemblers, and distributors of their vehicles. As a result, Chevrolets, Fords, or Plymouths, for example, are in part actually manufactured by thousands of materials and parts suppliers.

MACHINE TOOLS—Preliminary investigation of the machine-tool requirements indicate that between 4000 and 5000 machine tools will be needed to get the pre-Pearl Harbor model cars back into production. Many of the required pieces of manufacturing equipment will take from seven to nine months to build, and our military needs and commitments to Russia and Great Britain have many of the machine-tool building plants jammed with orders. The rehabilitation of the occupied countries of Europe and Asia will require many more machines of the American builders.

A change in existing priorities can help to prevent serious unemployment. Until these thousands of parts plants can get new machinery installed, and until the motor-vehicle plants themselves are supplied with needed tools, production of new cars, trucks, and buses cannot begin.

A large number of cars, trucks, buses, and taxicabs are standing idle today because of the lack of parts for repairs. The Army, for example, has purchased a huge supply of parts for their vehicles. Reason for this apparent over-buying was that the military leaders wanted *all* of their supply depots stocked—not knowing where or when the lightning of combat requirements was going to strike next. The Army and Navy have begun to channel back to the civilian a great deal of surplus material, but the process will be slow.

The Government has a conglomeration of parts produced by vehicle manufacturers and parts makers, plus some slightly used parts, all of which would have to be sorted and segregated to get back to the right car dealers, garages, and fleet owners. Vehicle companies are buying back parts in their original packaging, in some instances, but the process of segregation is slow because of the large number of depots and the few people available for sorting.

A recent survey of opinion among automotive engineers indicates that little of the design advancements developed during the war, or the manufacturing efficiencies developed by the far-flung "arsenal of the democracies," can be transformed into post-war vehicles very rapidly. The fastest way to get vehicles built for civilians after the war would be to modify the pre-war vehicles as little as possible, and to go back to the manufacturing techniques successfully used before the war.

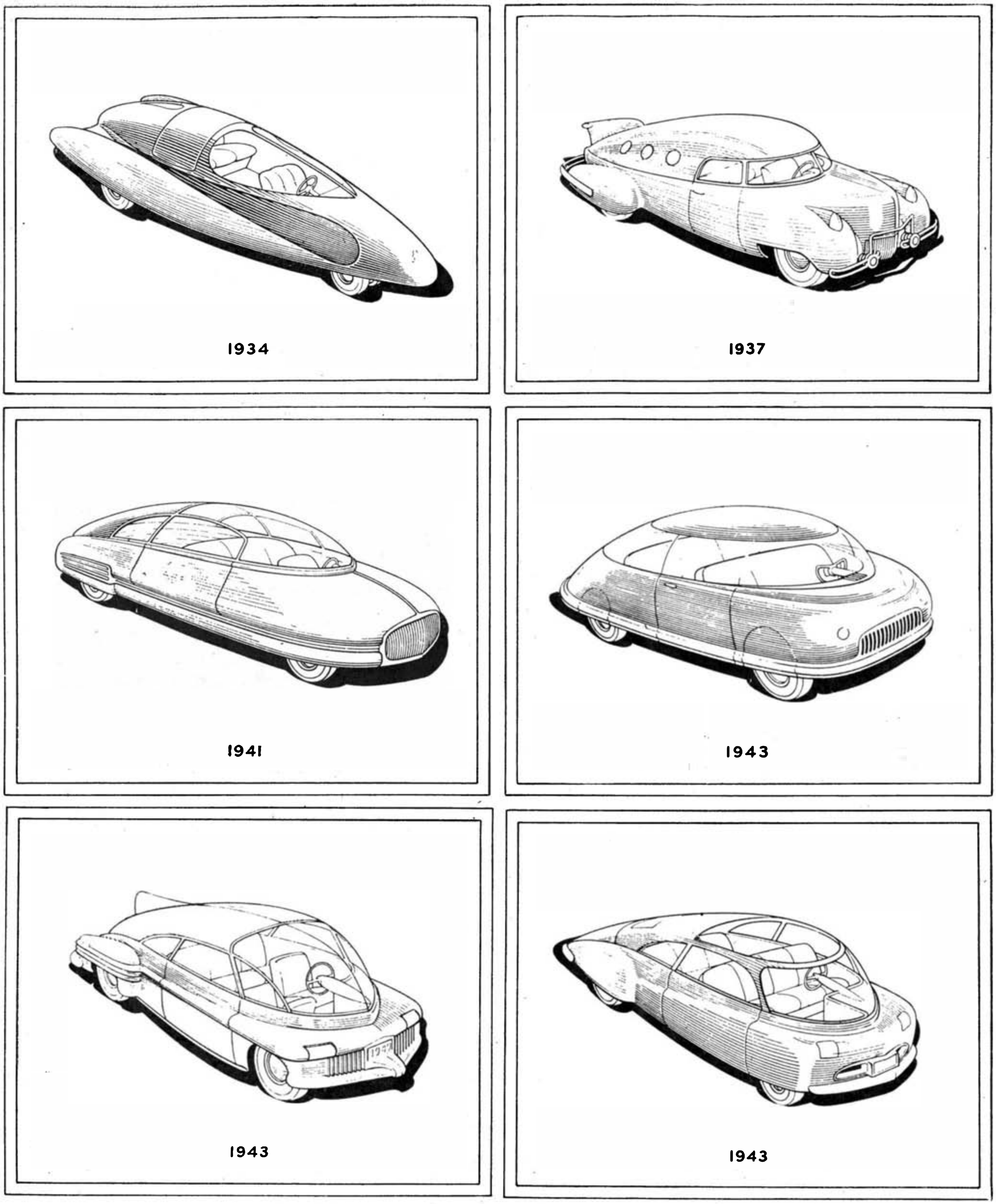
IDEAS DIFFER—Vehicle engineers have investigated aircraft designs carefully to see what ideas could be borrowed. The search has been rather fruitless. Many of these vehicle engineers have been working on the production of aircraft, aircraft engines, and aircraft accessories during the war, but find that the aircraft point of view is not compatible with their own.

For example, in the design of variable-pitch propellers—which might be considered a transmission—provision is made to keep the lubricant flowing through the gears by pumps, and the oil is constantly cleaned. In aircraft-engineering thinking this is necessary to prevent failures and yet permit the lightest possible weight. Failure is prevented in vehicle transmission design by disregarding the weight, making the parts sufficiently sturdy by ample use of material, and flooding the transmission case with lubricant. There it churns until renewed, oblivious, as it rolls along the highway, to stratospheric temperatures and variations in atmospheric pressures alike.

Vehicle engineers liken an aircraft engine to a piece of jewelry because every ounce of weight that can be removed—consistent with the factor of safety—is machined off. Every engine part is designed to take as much stress as possible for the least possible amount of weight of the part. In a car, truck, bus, or taxicab, a few pounds of weight here and there is of no consequence. The result is that an airplane engine cost about $10 per horsepower just prior to the war, whereas the mass-produced car engines cost nearer $1 per horsepower.

Automobile engineers who have been building aircraft engines, which were designed and developed by aircraft engine manufacturers of long experience, marvelled at the Army and Navy requirements for engine testing. This is a complicated task, requiring tear-down and rebuilding, a practice known in the vehicle industry only during the process of developing a new engine. This accounts for most of the high cost-per-horsepower, but the Army and Navy insists that it is one of the reasons our engines are as dependable as they are on all combat missions, in all kinds of weather, and in all sorts of fighting maneuvers.

To achieve the remarkable performance of American aircraft engines, a myriad of minute details have had serious study by design engineers. Each manufacturing operation is carefully supervised, and constant inspection is



A group of sketches of "the car of the future" dating back as far as 1934. It is not uncommon (and this is just as true today as in the past) for engineers to whom such sketches are submitted for consideration to criticise rather than praise. The basic trouble is that artists, striving for effect, are inclined to overlook comfort, leg room, and space for component mechanisms

the inviolate rule. This same costly manufacturing procedure goes on in airframe, wheel, brake, propeller, and other component and accessory manufacturing plants from coast to coast.

The motor vehicle, on the other hand, has been in production many years, and the basic engineering design changes from year to year are relatively few, as compared with transport and particularly with combat aircraft. Thus, similar testing and service experience has been obtained, but over a long period of time and without the excessive premium of cost required in war-necessitated speeding up of airplane manufacture.

AIRCRAFT TO AUTOS—When vehicle production engineers are asked if they fear the "encroachment" of aircraft manufacturers into their field, they usually smile and recount some of the costly steps taken in aeronautical development and manufacture. "They won't stay long unless they learn how to cut manufacturing dollars into pennies," is an expression typical of a number of responses.

However, many of them agree that armament development and manufacture, as well as accelerated aircraft production, has taught many lessons which will later be used in American industry.

Specifically, the Ford Motor Company has announced that it will retire from the aircraft and aircraft engine manufacturing business at war's end. It will be recalled that this company pioneered the mass-production idea in aircraft manufacture with the Ford trimotor, all-metal airplane, many of which are still carrying passengers and freight in South America.

On the other hand, another veteran automobile manufacturing concern, the Packard Motor Car Company, plans to go into the aircraft and marine business, as well as to continue to make cars in the post-war era. Thus the answer to the question that has investors and prospective consumers in a dither is "no and yes." Certainly, if the post-war airplane market is a profitable one, a large number of vehicle accessory companies will participate.

Vehicle engineers discount the aircraft type of engine for cars, trucks, buses, and taxicabs, because to date they are noisy and rough. However, a number of them are studying aircraft brake design with a view to improving these units on vehicles. The vast experience gained on Army landing strips and the limited runways on baby flat-tops and other aircraft carriers, has given brake engineers an unprecedented proving ground, both in respect to the number of service tests and the variety of operating conditions. It is probable, many of them believe, that the vehicle engineers will benefit first from brakes in the post-post-war period.

But, in general, the American motoring public will have to be satisfied with new cars with few modifications until research and development stimulated by the war's engineering effort can be adopted in later models.

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SHOT PEENING

Offers Possibilities of Stress Relief

AMONG the war-born manufacturing techniques which are destined to come into wide peace-time use in the post-war period is shot-peening of highly stressed surfaces. Although considerable work had been done along these lines before the war, shot-peening developments have been rapid to meet the exacting demands of armament manufacture.

There have been two schools of thought about surface finishing in the automotive industry. One has held that honing and lapping working surfaces to a high polish gave the best results. Another group held that this surface finishing was inadvisable, because stresses were set up in the surface of the part which caused premature failure.

Several engineering societies are now working together on standards and specifications of the sizes and quality of shot to be used, and a procedure for its use on various types of parts. Air blasting of the shot against the part is a widely used procedure, but tumbling barrels are sometimes employed. It has been found often that the working surface, although appearing to be rough under a magnifying glass, is improved by the shot-peening.

TRUCKS AND BUSES

Should Be Designed For Greater Utility

VEHICLE operators want safe, unornamented, capable units that feature ease of repairing and maintenance, according to a recent survey of more than 300 leading automotive engineers in charge of commercial vehicle fleets from coast to coast. Specifically, these engineers want the designer of post-war trucks and buses to consider:

Cooling systems which really cool, which will maintain their efficiency, and can be readily serviced; accessibility of critical parts to encourage mechanics to keep them in proper repair; removable powerplants, so the engine can be removed for repair and another be quickly installed to lessen lay-over time of the truck or bus in the garage; better cold-starting characteristics of the engine; more comfort for drivers; and less ornamentation.

BRAKE DRUMS

Salvaged by Spraying to Replace Removed Metal

STRIKING example of the value to industry of coördinated engineering research is the current development of aluminum brake drums stemming from a project of the Society of Automotive Engineers' transportation and maintenance engineering program. To salvage worn brake drums, the Brake Drum Committee recommended hot metal spraying of worn drums, followed by grinding to size. This report resulted from exhaustive tests of various other methods. An aluminum drum, thus sprayed, showed remarkable advantages in test. A large municipal bus line has ordered a number of such drums for actual service tests. Early reports indicate better wearing qualities, longer brake band life, and no brake squealing. Important implication is that unsprung weight could thus be decreased, resulting in more rider comfort.

TRACTORS

Will Find Greater Use On the Farm

MANUFACTURERS expect competition from new entrants into the tractor field soon after the end of the war. Several surveys made recently by farm journals indicate increased interest in farm tractors ranging down in size to small hand cultivators.

Makers of small gasoline engines have been working on expanding the pre-war use of these machines by hooking them up to farm tools as a part of their post-war expansion. More than 280 companies in the United States have been making internal-combustion engines during the war. Some of these expect to be in the tractor business as soon as possible.

STEERING

Will Be Made Easier By Power Developments

POWER steering developments are to be expected if the present trend of labor agitation for greater ease in truck and bus driving continues. A bill, already in the hopper of one state legislature, requires such devices on larger vehicles.

SYNTHETIC TIRES

Have Bright Prospects For the Future

RECENT grueling tests of synthetic automobile tires have cheered automotive engineers, in view of the 1,000,000-ton capacity of synthetic rubbers now in production in the United States. Pre-war use of natural crude rubber by the automotive industry was about 600,000 tons a year.

As fabrication techniques improve under war-time pressures, the prospect of better synthetic tires is bright. Although the synthetic materials are more costly than crude rubber was before the war, improved techniques of manufacture and better control of the consistency of the synthetics may result in competitive prices.

UNDER DISCUSSION

Are a Number of Automotive Developments

A GROUP of automotive engineers, who recently met informally in Cleveland, listed the following developments as being the most important for post-war consideration, in this order:

1. Improved transmissions. In this discussion, the questions of inconvenience in gear shifting and the cost of maintenance of the conventional transmissions were emphasized. Some work, it was reported, has been done on infinitely variable transmissions, but the problem of positive holding is an involved one.
2. Better brakes. Some work was reported on the adoption of aircraft types of brakes, and considerable interest was aroused on the possibility of aluminum drums lined with a hard wearing surface.
3. More adequate ventilation. Most of the engineers felt that no inexpensive way to improve ventilation control could be found without compromising with appearance. Suggestions of slotting the body and fitting adjustable vanes were discounted for this reason.
4. The war has emphasized the need of lower maintenance cost for passenger cars as well as commercial vehicles.

Flying Electronics

Safety and Consistency of Operations are Two of the Factors of Aviation Which Can be Promoted Rapidly Through the Use of Proved Electronic Devices. Plans of the CAA for Post-War Flying Embrace Radio Equipment that Will Give Aid to Both Commercial and Private Pilots

By VIN ZELUFF
Associate Editor, *Electronics*

TO BECOME a full-fledged industry, aviation must be able to provide its own unique method of transportation in almost any kind of weather. Although short delays can be forgiven by the traveling and shipping public, holdups of several days because of limited visibility cannot easily be tolerated for a method of transportation whose essence is speed.

For many years, it was almost impossible for an aircraft pilot to determine the true height of his plane above the ground, or even his location in respect to his destination. These are still problems in some respects, but they have been solved for commercial planes by applications of electronics. Post-war, the private flyer, too, may benefit from the decreased costs of such equipment that will result from techniques learned during military use.

When the weather is such that visibility is limited to a very few feet, flying was far from enjoyable before the days of automatic radio compasses, absolute altimeters, radio ranges, and so on.

Courtesy United Air Lines

Aircraft radio transmitters and receivers receive periodic adjustment

As private flying becomes more popular, accurate radio direction finders will undoubtedly approach a cost near that of good automobile radios. The radio range is available to anyone with a radio receiver, but radio altitude-measuring equipment will not be common on private planes for quite a while, due to its weight and cost.

Radar enables the pilot to contact the ground and to feel his way electronically. He can determine the characteristics of the ground or any object which may be within range of his beam of concentrated radio energy. This type of navigation has been a dream since shortly after the last war, but has become a reality through greatly increased knowledge of microwave technique and of electronic circuit characteristics.

An electronic ice indicator warns a pilot of the formation of ice on wing surfaces, a very serious problem. It can determine the rate at which the ice forms so that a pilot can change his course to one having more suitable weather conditions. The propeller and the carburetor also can use ice detectors. In mass production, a simple ice detector should sell for less than 50 dollars.

HOW MUCH GAS?—Accurate determination of the amount of gasoline in the tanks while in flight is another problem that has been solved by electronic equipment. In very large transports and bombers, the electronic gage has already replaced the simple float-type gage that does not provide accurate readings even during normal flight.

Electronic gas gages are being experimented with that measure the capacitance between a number of plates immersed in the gasoline, the capacitance being a function of the height of the gasoline between the plates. Commercial planes need such an accurate fuel gage, since any excess fuel carried merely because of uncertainties is reflected in higher operating cost to the airline.

Electronic engine controls of the future will take over engine adjustments and leave the pilot with the necessity of controlling only the engine power. The control will make all of the necessary engine adjustments, selecting the optimum operating conditions for the engine horsepower desired. At present, an electronic supercharger developed by Minneapolis-Honeywell controls the boost, or manifold pressure of aircraft engines in military planes. This control maintains a predetermined air pressure at varying altitudes by controlling the setting of the supercharger's waste gate.

An electronic carburetor control

Automatic direction finders are checked for accuracy before installation in an aircraft. The blimp-shaped casing to the left houses the antenna

coupled with the electronic engine knock detector would provide a control which would automatically adjust an engine to the maximum economy consistent with safe engine operating characteristics. This would adjust the fuel supply until one or more of the cylinders were detonating and then enrich the mixture slightly until the knocking ceased. Such control is expected to save as much as 10 percent of the fuel, compared with an engine operated in the conventional manner. In large planes, this saving in fuel alone would soon pay for the cost of the instrument.

AIRPLANE RADIO—Completely automatic radio compasses in which the loop constantly and automatically indicates the direction of the desired radio transmitting station are now available. These units stand up indefinitely under any conditions of operation yet experienced by our armed forces.

The magnetic compass is very limited as a guide, because it can only show direction—it cannot tell a pilot his location. Unlike the magnetic compass, the electronic radio compass is not dependent on only one north pole. Each radio transmitting antenna whose signals can be received by the radio compass becomes in effect a "north pole." When the pilot tunes to a radio station, the radio compass shows the direction to that particular antenna.

The pilot flying through soupy weather uses the radio compass to receive two or more stations and records the angle of each on a map. He draws a line from each at the angle recorded and the point at which the lines cross is the location of the plane. To reduce the plotting time involved still further, the Bendix dual-automatic compass was developed. With this instrument, the pilot can get his bearings from any two stations by merely glancing at the azimuth indicator at any time.

One of the recently revealed secrets of B-29 Super-Fortress raids on Japan is the "air position indicator," an instrument that, for the first time in the history of navigation on the sea or in the air, gives continuous readings of latitude and longitude plus a continuous record of nautical air miles flown. The air position indicator, developed by the Eclipse-Pioneer division of Bendix in co-operation with Army and Navy air forces, automatically makes calculations which ordinarily would require a navigator to work for hours with charts, basic navigational reference books, star-sighting sextants, a chronometer, parallel rules and dividers, and does this accurately even during evasive action when no navigator could follow the maneuvers of the plane and keep his bearings.

POST-WAR ELECTRONICS—The arrangement of electronic aircraft equipment planned by the CAA for post-war use contemplates that one aircraft receiver will be sufficient for minimum navigation and air traffic control requirements. This receiver would receive navigational guidance along the airway using the airway radio ranges, and would respond to the runway localizers of the instrument landing system when instrument approaches are necessary. It would also receive the various voice channels provided for communications along the airways and the simultaneous voice channel on the runway localizers, in addition to the several radio channels used by the control towers for air and ground traffic.

For pilots desiring additional guidance, a second receiver is required for the radio markers along the airways and on the instrument landing system. A third receiver is required for the glide path if the pilot desires to make use of this part of the instrument landing system. A fourth receiver would tune to the visual distance-indicating facilities, and a fifth receiver would be required if automatic direction-finding navigation was to be used.

The very-high-frequency electronic instrument landing system perfected by the CAA has now been adopted by the Army, Navy, and most of the nations of the world as their standard. Some 58 of these systems will be in operation by the end of 1946. Eight are now installed and ten are underway at present. In addition, the CAA is installing 50 instrument landing systems for the Army, 35 of which have already been completed.

The localizer unit of the instrument landing system will be operated in the 108 to 112-megacycle band, and will have a simultaneous voice channel for radio communication by the airport traffic control tower with aircraft making instrument approaches. The glide path will operate on six frequencies in the band from 328.6 to 335.4 megacycles.

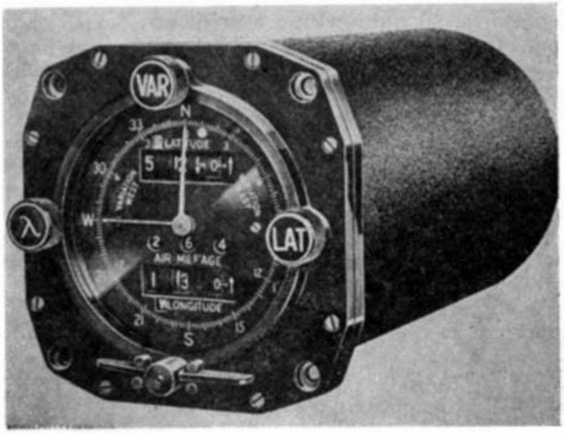
Delayed for two years, because of war necessities, is the conversion of the radio ranges from low frequencies in the 200- to 400-kilocycle band to very high frequencies in the 112- to 118-megacycle band. This range program is now going forward and it is anticipated that over half of the present 37,000 miles of airways will be served by VHF ranges by July, 1946.

Other phases of the CAA's post-war plans for air navigation facilities call for providing a good system of low-frequency, high-powered facilities in the United States to permit long-distance flights by direction-finding upon completion of the VHF range program. These low-frequency, high-powered stations may well take the form of omni-directional range stations, and most certainly will be designated to permit directional guidance without the necessity of the aircraft being equipped with direction-finder receivers.

AIR TRAFFIC CONTROL—Post-war plans envision further that probably two VHF frequencies will be provided for airport traffic control communications with other than those aircraft receiving instructions over the voice channel of the runway localizer. One frequency would be used for aircraft in the air flying locally around the airport, and the other frequency for aircraft on the ground in connection with taxying and parking instructions. It is proposed that all airport traffic control communications, other than those over the voice channel of the localizers, will be conducted in the 118- to 122-megacycle band. The 122- to 132-megacycle band has been set aside mainly for aircraft-to-ground transmission frequencies.

The VHF ranges will guide the pilot along the airways and provide him with weather and traffic-control information. Initially, it is planned that one simultaneous voice channel will be available on all ranges for ground-to-air two-way radio communications. If it is found that one voice channel will not be adequate to provide two-way communications for both traffic control and weather information at a given location, consideration will then be given to the matter of providing an additional channel so that one channel will be available for traffic control transmission and one for weather transmissions, whichever is the more practicable.

One additional device, highly desirable as a monitoring or safeguarding facility in airport traffic control towers, is a "scanning screen" operated on electronic principles which will permit the airport traffic controller to visualize the actual positions of all



Right: Dial of the Bendix air-position indicator that automatically computes latitude and longitude for navigators of the air lanes. Below: Typical aircraft instrument panel with the air-position indicator centrally mounted

aircraft at all times within a predetermined radius of, say, 25 miles from the airport. These screens will permit monitoring the movement of aircraft on the instrument approach system so as to detect any hazardous condition that may possibly develop as a result of a pilot not following instructions or as a result of some failure in aircraft equipment. They also would make it possible for the airport traffic controller to arrange the flow of departing aircraft with more certainty as to the positions of approaching aircraft.

HOW FAR APART?—The CAA also contemplates the use of a cathode-ray tube in the aircraft on which will be displayed indications portraying the vertical separation between the aircraft in which the device is installed and other aircraft in all directions within fixed vertical limits. It operates on the principle of varying the frequency of a low-powered transmitter on board each aircraft by a sealed aneroid capsule, so that changes in altitude will vary the frequency of the aircraft's position-indicating transmitter.

Another approach to the collision warning indicator is through the use of radar technique. This would have an effective range in all directions, rather than just the front hemisphere or a portion of one hemisphere as now used for military purposes.

Ten carloads of radar apparatus loaned by the Army and Navy are being used by a CAA experimental station at Indianapolis to conduct tests of radar aircraft control. Two objectives are perfection of the screening device previously mentioned which will permit the tower controller to visualize the actual positions of all aircraft within a radius of 25 miles, and a collision warning device to be installed on the instrument panel of the plane, which would give constant visual indication of the relative position of other aircraft within a certain radius. With at least 150 plants now making radar equipment, much production know-how in this field will be available for commercial radar equipment when military needs fall off.

DIELECTRIC-HEAT UNITS

Need Shielding to Prevent Causing Radio Interference

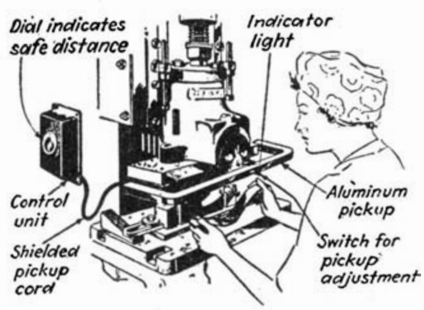
RADIO interference measurements in the vicinity of induction and dielectric electronic heating units reveal that only the dielectric-heating types need to be shielded to prevent interference with radio reception. This means that the induction-heating units so widely used today in industry for quick and localized heating of metals cannot be blamed for mysterious squeals similar to those that created a scientific mystery some years ago until they were traced to diathermy units in hospitals.

As with diathermy units, shielded enclosures are the prescription for the industrial dielectric heating setups used to heat plastics, to dry glue in plywoods, to sterilize food products, and to heat practically any other nonmetallic material. If a single cage will not suffice, a double screen cage with metal weather-stripping sealing the edges of the entrance door is almost certain to squelch any tendencies to broadcast. Where one of these electronic heating units must straddle a conveyor that is carrying work continuously to and from the machine, so that entrances must be open while power is on, metal tunnels at entrance and exit will effectively trap emerging waves. These work on somewhat the same principle as light-trap doors of photographic darkrooms.

FINGER GUARD

Operates by Change in Electrical Capacity

AN ELECTRONIC safety guard for punch presses that eliminates the usual phototube arrangement and permits adjustment of the critical distance at which



Her fingers are protected

the press shuts off, valuable when the press is used for different sizes of materials, has been developed at North American Aviation. The electronic circuit is arranged to operate relays that actuate contacts and solenoid air valves on the press.

Mounted on the press is an aluminum rod that connects to the control unit. When the operator's hands or other parts of the body come near the rod, a change in the electrical capacitance of the circuit takes place which causes it to prevent the operation of the press until the hand is removed from the protected zone. A dial on the control unit permits the circuit to be adjusted to different sensitivities for the proper distance setting.

FOOD AGING

Speeded When Ultra-Violet Lamps Are Used

AN ELECTRONIC guardian for food storage space is the Sterilamp ultra-violet tube, a device which resembles a slenderized fluorescent lamp and kills bacteria and mold either on food surfaces or afloat in air. In a patented process for the rapid tenderization of beef, the temperature in the beef aging room, protected by lamps, is raised from 36 to 60 degrees and the time required for the natural process of ripening is reduced to about one tenth of the time previously required. Without a bactericidal agent, the high temperature, combined with the high humidity necessary to prevent surface drying and accompanying injury to the meat, would result in surface mold and slime, causing serious wastage.

In cheese aging, it is necessary to maintain a relative humidity of 80 percent to reduce dehydration. To speed ripening when using Sterilamps, the temperature is raised to an average of 45-50 degrees—about 15 degrees higher than in unprotected aging rooms. Thus, the lamps permit acceleration of the cheese-ripening process to a fraction of the time previously required and reduce shrinkage by dehydration.

In addition to the bactericidal rays, the Westinghouse lamps produce in the air a small amount of ozone, a colorless gas used commercially for purification of water and foods, particularly in egg and apple storage rooms. Ozone scatters rapidly from the lamps and is circulated throughout the storage space, and acts as an additional weapon to halt mold growth. At the same time, the ozone concentration in food storage and processing rooms properly equipped with the bactericidal lamps never exceeds a few tenths of one part per million of air, which is too low to injure even sensitive foods.

LIGHT MEASUREMENT

Aided by Use of Electron Multiplier Tube

IN THE manufacture of color film, it is necessary to determine the density contribution of each of the three dye layers separately. The insertion of filters in a conventional light-beam system for separate measurements in the green, blue, and red spectral regions reduces the available light so much that conventional photoelectric densitometers used for black-and-white film do not get enough light to excite the phototube. Increasing the size of the lamp used would work for green and blue, but not for red because the ordinary phototube is relatively insensitive to red.

This intriguing photoelectronic problem was solved by the research laboratory of Ansco by the substitution of the electron multiplier phototube for the ordinary type, and addition of a special electronic amplifier working directly from a stack of ten miniature 67½-volt B batteries giving a total of 675 volts.

Electrons emitted from the cathode of the tube under the influence of light bounce in turn from each of nine reflecting plates called dynodes. Each dynode has the characteristic of giving off many more electrons than hit it, so that after nine such electron multiplications the output may be as much as 20,000 times greater than that of an ordinary phototube—enough to actuate the amplifier and meter.

Other applications of this new direct-reading high-sensitivity densitometer include analysis of chemicals, measurement of colors of materials by reflected light, and analysis of the x-ray diffraction patterns and line spectrograms that are now expanding so rapidly in industrial usefulness.

Engines Of The Air

Kerosine Lamps, Exploding Because of Gasoline in the Burning Oil, Paved the Way for the Development of the Gasoline Engine. At First there was a Surplus of Fuel; then Chemists were Hard Put to Produce Enough Efficient Fuel to Meet Demands of Automobiles and Airplanes

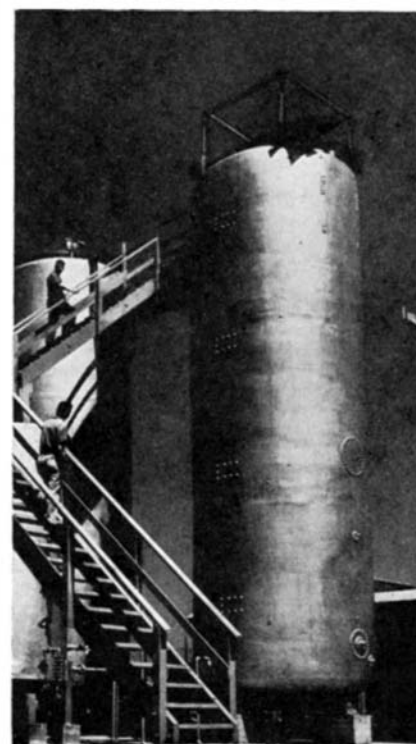
PROPERLY, the chemical story of aviation begins with the explosions of kerosine lamps three quarters of a century ago. From the steps then taken to remove the explosion hazard from kerosine grew the motor-fuel industry of today and upon that depended the development of the internal-combustion engine. Without the internal-combustion engine, aviation as we now know it would be completely impossible. While automobiles could be satisfactorily powered by electricity from storage batteries or by steam engines, the weights entailed per horsepower by either of these prime movers become prohibitive in the air. But the internal-combustion engine was developed primarily for highway travel under the stimulus of the immense quantities of cheap gasoline available in the automobile's early days as a by-product of kerosine production.

The dangerous tendency of lamps to explode was caused by the desire of oil refiners to produce kerosine faster to meet increasing demand. The unfortunate method chosen was to leave some gasoline in the kerosine. As is well known, gasoline vapor, with air, forms mixtures that explode when ignited. That is fine in an engine where the explosion can be harnessed to do work, but in lamps it was disastrous. When the cause of exploding lamps was found, steps were taken to insure that every bit of gasoline was stripped from the kerosine during manufacture.

UNWANTED GASOLINE—This was a hardship for oil refiners who knew no way to dispose profitably of the unwanted gasoline. Later that picture was reversed by the popularity of the gasoline-driven automobile. Although those two events are mentioned together, actual decades of development of internal-combustion engines were needed before there were enough of them to use up the gasoline available.

When the 20th Century arrived, a few carriages in the welcoming procession ran on rubber bicycle tires, but with no horses to pull them. Some drew their power from electric motors run by storage batteries. Others used smelly, noisy gasoline engines. Between the two arose active competition. By that time petroleum refiners were almost overwhelmed by accumulations of excess naphtha, or gasoline, which they had to produce along with coal oil. This surplus fuel gave the gasoline-powered vehicle a distinct advantage in the struggle for survival with its electric rival. Power from gasoline was cheap but by no means as dependable as electricity—or, for that matter, as the steam which some pioneer road vehicles generated by using kerosine as fuel. The outcome of this competition hinged on making gasoline engines dependable.

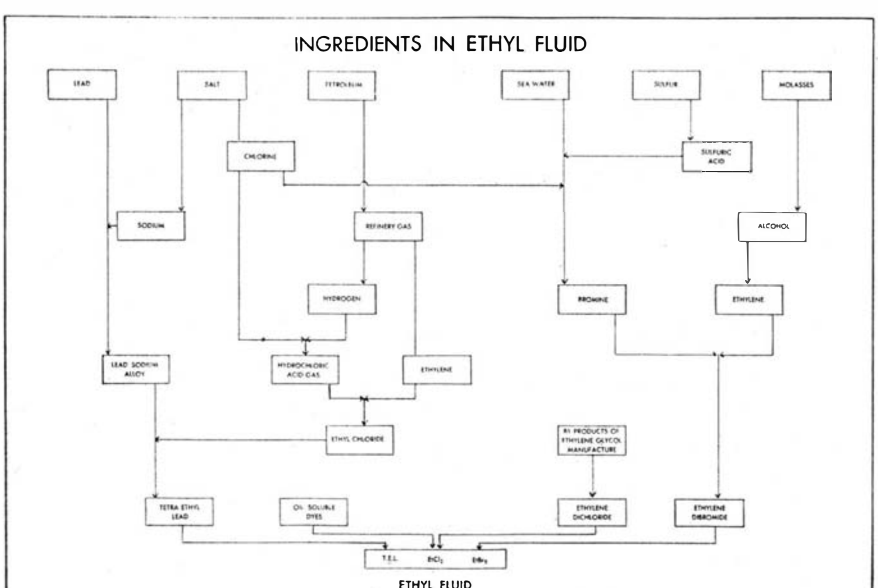
The steps leading to mechanical perfection of internal-combustion engines are not part of this story. However, exploding lamps of the 1860's and the change they forced in petroleum refining were crucial factors in vital modern developments. Without bountiful supplies of gasoline, which refiners had to produce in making kerosine, the essential spur to mechanical development of mobile gasoline engines would have been missing.



Courtesy Standard Oil Company

Storage tank for high-octane fuel

As early as 1903, the Wright brothers flew because gasoline had been a drug on the market 30 years before and on that surplus of gasoline rested the development of the Otto-cycle engine. Automobiles could have developed



with electric or steam power, but not airplanes.

Quite naturally, fuel has had to develop along with engine design. Early engines were built to burn the by-product of kerosine refining and the result was so successful that soon the by-product had far outgrown the need for the original material. Electricity had effectively invaded the field of lighting and was crowding out kerosine. Meanwhile, the growing numbers of automobiles multiplied the demand for gasoline to overwhelming proportions. Indeed, demand seriously threatened to use up all of our petroleum resources.

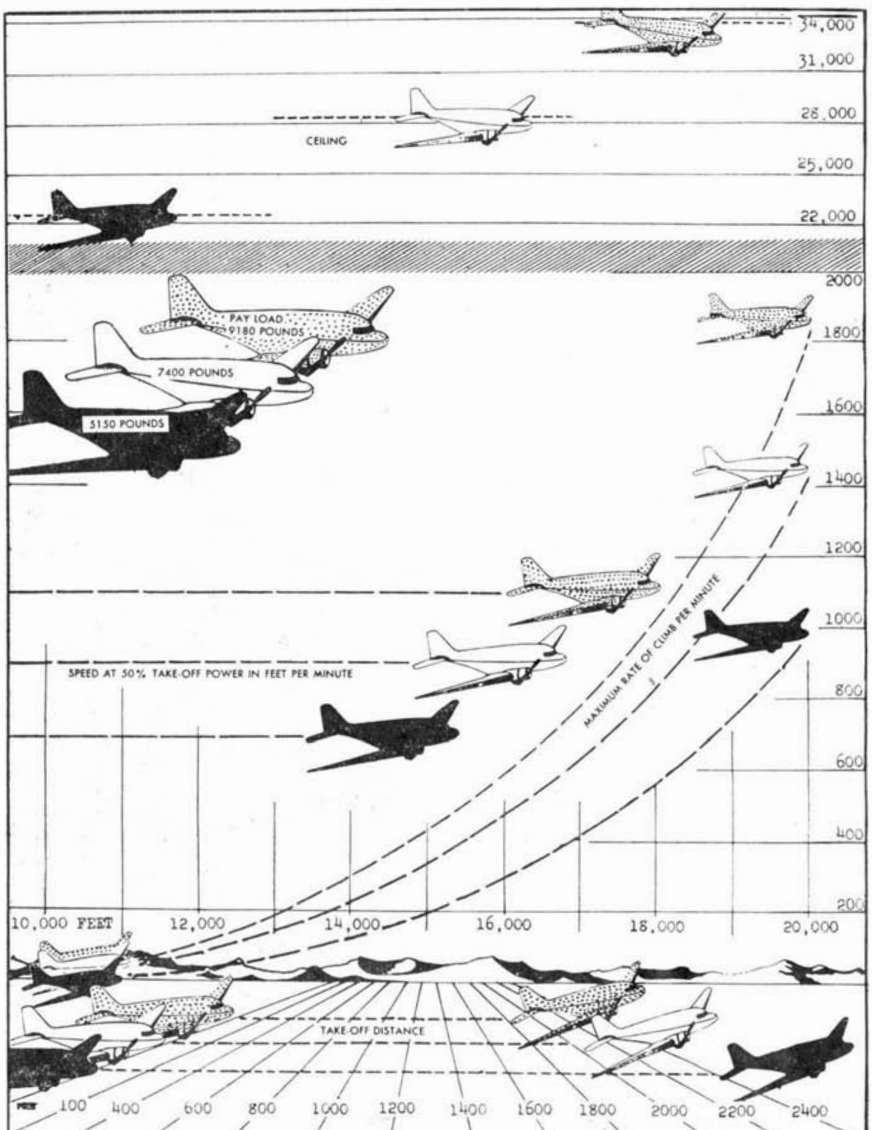
CRACKING—At this juncture the newly developed cracking process offered a solution for the trouble by greatly increasing the amount of gasoline obtained from each barrel of crude oil. That was about 1912, and during the succeeding decades this process in many modifications was utilized throughout the oil refining industry. In effect, gasoline production was doubled without requiring any more crude oil. This was a big jump ahead.

But early gasoline engines wasted large proportions of the gasoline fed to them. They were too inefficient for profitable flight. At the same time, possible depletion of oil sources threatened the automotive industry and spurred it to seek higher efficiency. Theoretically, gasoline engines would produce more power from fuel if the gaseous mixture could be put under greater pressure in its cylinders before ignition. Simply change the stroke of the piston and get more power—simple until one tries to do it. Instead of more power, the modified engine produces less, and at the same time it hammers and knocks as if it would break itself to pieces. The increased pressure changes the nature of the explosion, makes it resemble the sudden blow of dynamite and not the normal, much slower burning of a proper cylinder charge.

Different fuels (gasoline, coal tar benzene, cracked gasoline, and so on) behave differently and tiny amounts of various substances added to fuels change this knocking characteristic. Tetraethyl lead, now almost universally added to motor fuels, proved to be the most potent of these additions. It regulates the rate of burning of the cylinder charge. Even under much higher pressures than those in general use, power is delivered smoothly to the piston at a rate slow enough to allow it to do a maximum of useful work. An actual gain of as much as 80 percent in the output of an engine can be realized by the use of high compression and 100-octane fuel, in contrast to low compression and the 73-octane fuel common on the American market.

Tetraethyl lead gave a tremendous impetus to the development of more efficient engines and at the same time of more effective fuels to use in them. Consistent flight became commonplace because of the increased load-carrying capacity of planes realized through heightened efficiency of power production. Numerous other methods of producing fuels adapted to the re-designed engines also followed the growing demand for them. And that trend continues toward the goal of maximum power from minimum fuel and smaller engines.

By subjecting petroleum fractions—gas oil, particularly—to high temperature and great pressures, carbon molecules can be literally cracked to bits. Many of the resulting particles fall within the desired range for motor fuel, others are too small, and still others come from the process as a sooty deposit of carbon stripped of its essential hydrogen. This thermal cracking, by doubling the yield of gasoline per barrel of crude oil, proved a practicable operation in spite of the considerable wastes accompanying it.

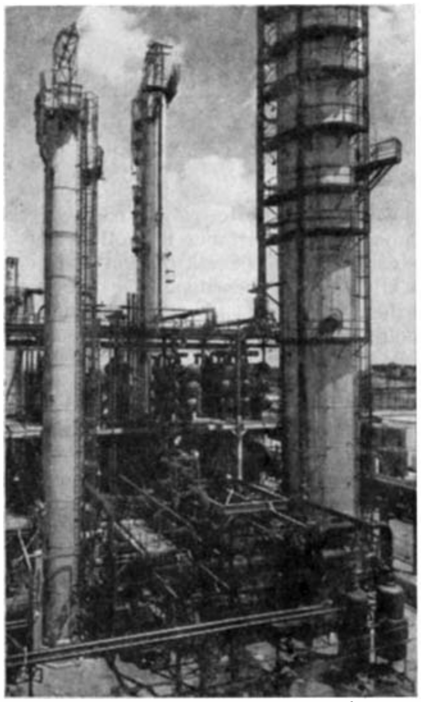


Improvement of fuels has enabled airplanes to carry heavier loads, and to fly higher and faster. The dotted planes on the chart are powered by 100-plus octane gas; the white planes by 100-octane gas; and the black planes by 87-octane gas

CHEMICAL PROMOTERS—One result of thermal cracking is to produce hydrocarbons of the unsaturated or olefin family. These enter with relative ease into chemical reactions, while saturated hydrocarbons are quite inert. Thus it becomes possible to utilize the small molecular fragments produced by cracking to build up larger molecules by chemical means. In spite of their superior chemical reactivity, these olefins react much better and combine more readily in the ways desired if a promoter, or catalyst, is present.

The fragments produced by cracking may subsequently unite among themselves in a variety of new molecular patterns. Certain foreign substances, some natural clays for instance, promote and control these recombinations of fragments and force a larger proportion of them to form desired products. In this way less oil is wasted as gas and more gasoline is produced from the same amount of original oil. Furthermore, the gasoline from catalytic cracking, as this process is called, is better because it has a higher octane number. The gases from the process may be used in making polymer or alkylated gasolines, now prominent as aviation fuel for military and transport services.

This discussion of anti-knock fuels and their characteristics bears directly on the subject of cracking and other methods of enlarging the yield of motor fuel from crude oil. Not only does cracking, both thermal and catalytic, produce more fuel per barrel of crude oil, but at the same time the product has an improved octane number and hence is more valuable. This is vitally significant in view of the general adoption of more efficient high-compression engines in automobiles and airplanes. In the latter, where weight is the vital



Alkylate, an important ingredient of 100-octane aviation gasoline, is produced at this sulfuric acid alkylation unit of the Texas Company

consideration, increased compression and other factors have resulted in weight reduction of engines from 3½ pounds per horsepower at the time of World War I to somewhat less than one pound per horsepower in World War II. That difference is vital to air transport in war and in peace.

FUEL EFFICIENCY—Once a true measure of fuel efficiency was established and types of fuels were classified on that basis, certain conclusions appeared from the classifications. Hydrocarbons whose molecules are straight chains usually knock badly. The greater the branching of the chain, the greater the octane number. Double bonds in some cases raise the octane number, in others depress it. Such observations gave the petroleum industry invaluable guidance in its efforts to improve fuels.

Several important processes based on these considerations are operated on a huge scale. Polymer, alkylated, and hydrogenated gasolines are produced by controlling in various ways the forms taken by the re-uniting fragments of molecules produced in cracking both petroleum and natural gas. Each of these products possesses a high octane number and each can materially raise the octane number of a mixture of which it forms a part. Additions of tetraethyl lead to blended fuels of this kind further raise the octane number so that it is possible to produce commercially on a huge scale fuels as much as 15 to 25 percent more effective in an engine than pure iso-octane, once considered an unreachable fuel goal.

Polymer gasoline is produced from the gases of thermal cracking by causing their molecules to reunite in the presence of a catalyst such as phosphoric acid. The catalyst seems to exercise a directing and promoting function in encouraging the various gaseous molecules to unite in the form of hydrocarbons in the gasoline boiling range. Since hydrocarbons of this type possess high anti-knock values, the resulting motor fuel is especially desirable.

Alkylation also yields highly desired branched hydrocarbons. Its raw material is primarily the butanes and butylenes, hydrocarbons of four carbon atoms, and these are rearranged to form molecules of eight carbon atoms, just the kind needed for aviation fuels with octane numbers of 100 or more. Particularly important about alkylation fuels are their high initial octane numbers and their sensitivity to small additions of tetraethyl lead. Thus, adding small amounts of lead to alkylate gasolines causes a much greater effect than would the same amount of lead added to straight run or thermally cracked gasoline.

Commercial production of iso-octane itself is accomplished by submitting the so-called butane fraction separated from thermal or catalytic cracked gases —the fraction consists largely of the olefins of four carbon atoms—to selective polymerization and subsequently hydrogenating the product. The iso-octane produced possesses an initial octane number of 100 and even better performance can be obtained by addition of tetraethyl lead.

FUEL FROM WASTES—A further important fact about modern chemically made motor fuels is that the raw materials used in their production are to a large extent the gases from the cracking process once burned as fuel. Cracking breaks up large molecules, but polymerization, alkylation, and other catalytic processes reassemble small molecules into larger ones. Not only are important new fuels produced by these processes, but economies in the utilization of crude oil are effected at the same time.

Clearly the purposes of aviation and the conquest of the air have utilized to an essential degree the power of chemistry to alter and improve the fuel of flying engines. The intimate relations between the two sciences of aeronautics and chemistry by no means stop with the fuel supply. The structure of the plane, its metal and plastics parts, its lubrication, and many other elements that contribute to successful and efficient flight owe their origin or perfection to chemical processes of one kind or another. However, when the whole matter is summed up and its elements evaluated, no single development has had anything like the significance of the gasoline-powered, internal-combustion engine. And that owes its practical existence to the explosion of kerosine lamps many decades ago.

STERILE BOTTLES

Indicated by Color-Changing Seals

VISIBLE proof that the contents of a particular bottle have been sterilized after the seal was applied is offered by a new type of cellulose band adapted to seal various types of containers. The band is colored with a dye which changes color when it has been heated to sterilizing temperature. A dark green seal may, in one type now offered, change to orange when it has been heated to a temperature high enough to sterilize the container's contents. Originally proposed as a method of preventing the drawing of blood for transfusions into unsterile bottles, seals of this type are expected to have important usefulness in other ways.

PENICILLIN PRICES

Pushed Down by Rapid Production

LESS than two years ago producers were frantically trying to enlarge their production of penicillin to meet the tremendous demand for this wonder-working substance for the Armed Forces. Now, not only has that goal been exceeded far enough to allow placing penicillin in civilian drug stores and hospitals, but actually production has reached the point where a price war of at least minor proportions is in progress. Improvements in production methods and yields so far effected enable production at far less cost than was originally estimated. This powerful drug, hailed as the most valuable development of modern medicine during the war period, is now available to any physician needing it.

PASS THE ARSENIC

But Be Sure to Try The Fluorine as Well

IF YOU insist on eating arsenic but wish to avoid being fatally poisoned by it, perhaps you can save yourself by taking highly toxic fluorine compounds at the same time. There is no reason why one should wish to take lethal doses of arsenic but, if they should, fluorides may supply an antidote that can be used in certain cases. A report of recent experiments with rats shows that drinking water containing potassium fluoride both before and after the rats took arsenic trioxide mixed with sugar prevented the death of the experimental animals. While the finding is interesting and may shed light on the action of arsenic taken into the human system, the method is hardly to be recommended for first aid since an overdose of fluoride, familiar as ant poison, kills one quite as dead as arsenic does.

Lubricants For Air Power

Airplane Engines, Operating at High Temperatures, Need Strong Oil Films to Protect Moving Parts. Careful Research by the Petroleum Industry Has Produced Lubricants that not only Resist Deterioration under Severe Conditions, but also Carry Away Heat from Pistons

By B. W. STORY and E. A. MARTIN*

LARGELY because of European influence, most of the early airplane engines were lubricated with castor oil, while automotive engines operating on the same principle were running almost exclusively with petroleum oils and with generally better results. These airplane engines were no more difficult to lubricate than some automotive engines of that period and it was soon found that petroleum oils of similar character but of somewhat heavier body were superior to castor oil. While many improvements have been made in airplane engine oils since that time, the supremacy of petroleum lubricants has not yet been seriously challenged.

Early airplanes flew neither high nor far and frequent overhauls were accepted as a matter of course. Within the past ten years, however, these conditions have changed rapidly. Engine output has been stepped up from a few hundred to over two thousand horsepower and operation between overhauls has been lengthened from around 200 to 800 hours or more. The modern airplane may take off at sea level at temperatures ranging from − 40 to + 100 degrees, Fahrenheit, and from either extreme may, within a short time, encounter temperatures as low as − 70 degrees, Fahrenheit, at altitudes of 20,000 feet or more.

High temperature and pressure between moving parts cannot be avoided when internal combustion engines are built to the power output and weight standards of modern aviation. Hence, the lubricating oil must function not only as a lubricant under exceptionally severe conditions but must also serve to carry heat away from pistons and other parts of the engine which otherwise would become too hot for successful operation. Furthermore, as the oil is cooled and recirculated through the engine many times before it is finally consumed, it must continue to perform its various duties with the least possible deterioration. Hence only the most specialized oil can survive.

Petroleum oils are composed almost entirely of hydrocarbons and therefore have certain inherent properties which cannot be changed completely. At elevated temperatures, in the presence of oxygen, they will oxidize to form acidic compounds which then proceed to form what are generally termed sludge—tar and asphalt. At still higher temperatures these oils will crack or break down into smaller compounds and carbon which are quite unfit for lubrication. While petroleum refiners cannot wholly suppress these natural tendencies of hydrocarbons, they can modify them and improve the oil for any given purpose in three ways; (1) crude selection, (2) choice of refining methods, and (3) adding some material to the oil which will impart properties not obtainable from the oil alone. These materials are generally called addition agents or additives and they have a wide variety of uses.

STRONG FILMS—Airplane engines require a fairly heavy bodied oil in order to provide a strong oil film in the hotter zones of the engine. All petroleum oils increase in viscosity as their temperature is lowered and at the lower atmospheric ranges heavy oils have a high resistance to motion where clearances are small, as on cylinder walls and in bearings. Because it is often necessary to start engines in cold weather, it is important to select oils which give the least change of viscosity with temperature. This property of oils has been calibrated to a scale known as "viscosity index" (V. I.) and aviation oils are generally known as high V. I. oils, meaning that their change of viscosity with temperature is comparitively low. As a class, the so-called paraffinic types of oils are good in this respect. The naphthenic or aromatic types are not as good and are consequently less generally used in this field.

All paraffinic oils contain wax which is liquid when warm, but at low temperatures will crystallize and cause the oil to solidify, making it difficult to pump and distribute properly throughout the engine. Most of the wax is removed by suitable refining steps, but generally it is not economical to de-wax heavy oils so that they will flow freely at temperatures low enough for good aviation practice. Fortunately, addition agents have been found which effectively reduce the temperature at which paraffinic oils will flow. Commonly known as "pour depressants," these agents are widely used for this purpose and have saved industry much expense as well as much good oil that otherwise would have been lost through excessive de-waxing. Only small amounts are required and in most cases less than 0.5 percent is sufficient even for heavy lubricants.

Petroleum crudes always contain compounds which are unfit for lubrication of combustion engines and these must be removed as completely as possible. For years it was not commercially feasible to do this in many cases and the production of airplane engine oils was limited to a few crudes, notably of the Pennsylvania type, which

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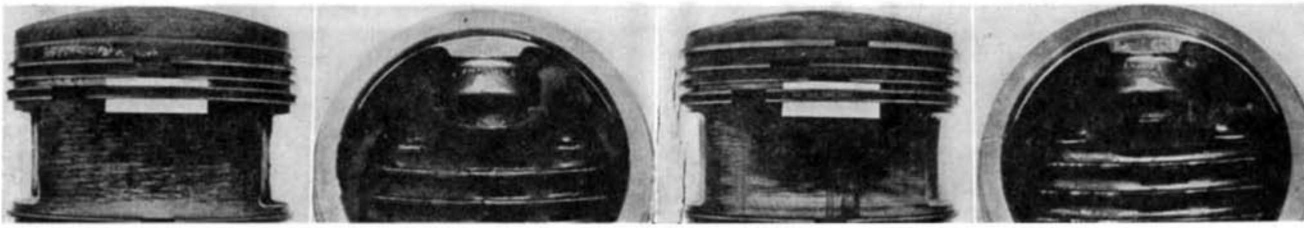


Figure 4: Oil inhibited by an additive is a better lubricant than uninhibited oil. Only 13 hours' operation with straight mineral oil produced the sludge on the piston thrust face and crown in the two pictures on the left, while 30 hours' running with an inhibited oil caused the lesser amount of sludge in the two pictures on the right

were amenable to refining processes then available. With the advent of propane de-asphalting and solvent refining, this situation was changed completely. Superior lubricants can now be made from crudes which only a few years ago were considered hopeless for aviation use.

INHERENT VALUE—Petroleum refining, however, is essentially a subtractive process and relies entirely upon the value of materials which exist in the crude. While excellent lubricants have been and will continue to be made from straight petroleum, there are limits beyond which refining engineers cannot go without the assistance of addition agents. These limits have already been surpassed in the case of lubricants for certain types of gears and high-speed Diesel engines where pure petroleum is admittedly inadequate. As operating conditions become more severe, it seems quite certain that further requirements of airplane engine oils can be met only by the use of additives.

The groundwork of discovering and improving such additives is a job that must be done in the laboratory. To attack a lubrication problem directly through flight tests would in many cases be expensive and hazardous because, as in all research work, failures far outnumber successes. Preliminary tests, therefore, must be made but experience has shown that it is unsafe to depart too far from conditions of actual service because there is danger of obtaining wholly unreliable results. In other words, if the problem involves an airplane engine, such an engine or at least parts of it should be used. It is sometimes permissible to accelerate a test by employing conditions that are abnormally severe but in so doing some correlation with practice should be established.

Figure 1 shows a single cylinder test engine which employs an air cooled cylinder and piston assembly of current aviation design and has an output of 25 horsepower.

Figure 2 shows a test unit which will accommodate large modern cylinders with an output of 125 horsepower and represents an additional step in testing aviation oils. If satisfactory performance is indicated throughout these preliminary tests, the oils are then candidates for trial in actual flight.

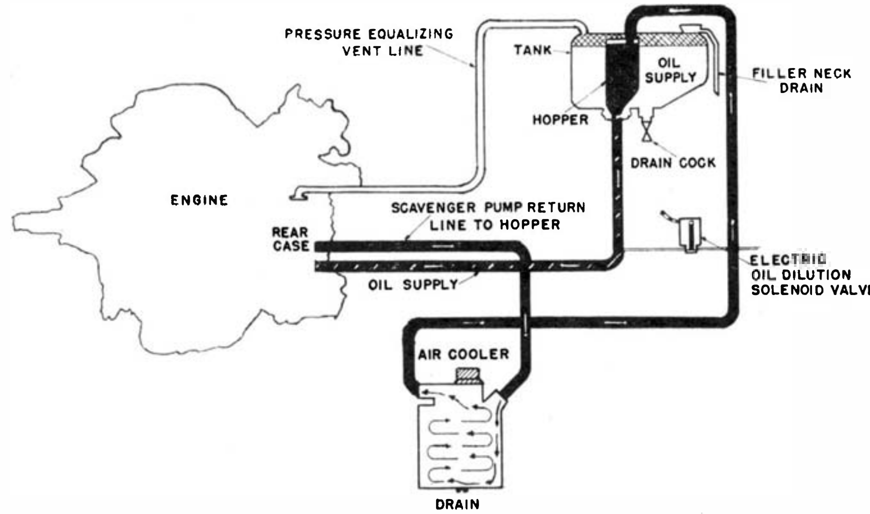


Figure 3: Lubricating system of a modern airplane engine

Figure 3 shows in outline the oiling system for a modern airplane engine. The oil tank, known as a "hopper tank," is actually two tanks with limited communication between them. The oil in active circulation is confined to the smaller interior tank but, as this is consumed, fresh oil flows in from the larger supply tank to replace it. This type of tank tends to prevent contamination of the main oil supply and also is very helpful in starting engines in cold weather. When a cold start is anticipated, a small amount of fuel is added to the oil just before the engine is stopped. This greatly reduces the viscosity of the oil and permits starting on what is practically a light-bodied oil. As the engine warms up, the added fuel evaporates so that, by the time full power for take-off is needed, the lubricating oil has regained most of its original viscosity and lubricating value.

OIL FOR COOLING—Oil from the tank is pumped through channels in the crank shaft and issues as a spray from the ends of the crank bearing. Sufficient oil is pumped to cool the pistons, rods, and other parts; this quantity, of course, is far in excess of that needed for lubrication. The oil is then collected in the crank case, picked up by a scavenging pump which passes it through a cooler, and then back to the tank. A 1000 horsepower engine normally circulates about 15 gallons of oil per minute but the amount in active circulation at any one time is only about five gallons. Oil consumption may amount to about 1.7 gallons per hour, so that the average life of the oil is approximately 500 trips through the engine before it finds its way past the piston rings or is lost elsewhere.

Oil entering the engine through ports in the crank shaft is subject to considerable centrifugal force before it is released at the crank bearing. Any insoluble material is apt to deposit in these ports and interfere with circulation. The most troublesome deposits come from the combustion products which tend to work down past the piston rings and are then picked up by the oil. A lightly refined oil is capable of holding these compounds in suspension fairly well but is also apt to form sludge and give generally poor results in other parts of the engine. More highly refined oils give cleaner engines but are less capable of holding the dense fuel residues in suspension, particularly before they have formed a slight amount of acidity

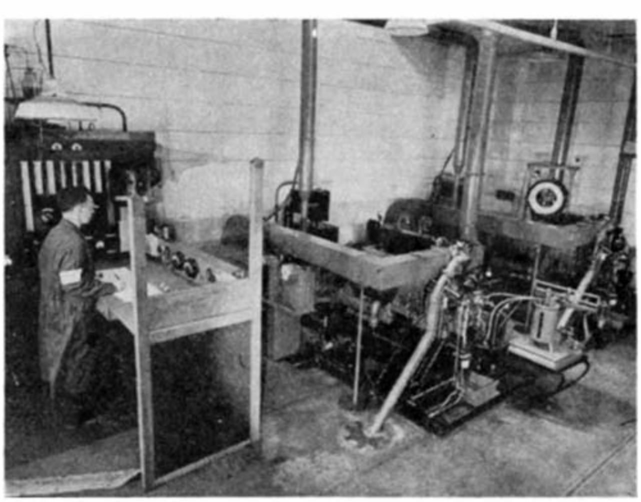


Figure 1: A single cylinder test engine of aviation design is used for preliminary screening of airplane engine oils

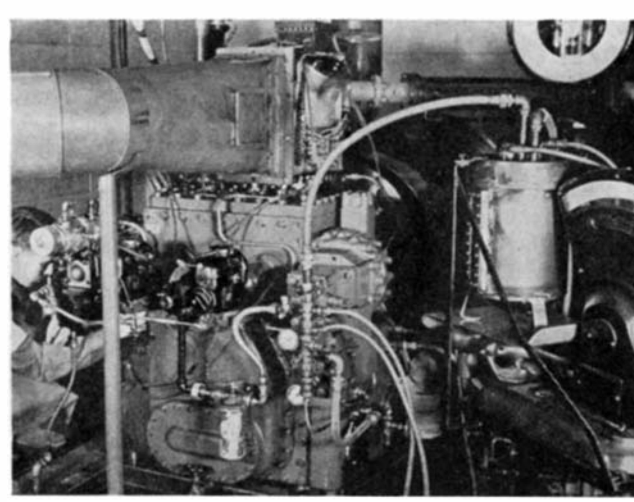


Figure 2: This testing unit with an output of 125 horsepower represents a further step in improving aviation lubricants

through oxidation. It is believed that these acids form soaps which have a detergent effect and prevent excessive deposits.

Considerable work has been done to reduce oxidation of the oil and several additives are effective in this direction. When these are used, the formation of acidity is suppressed and it may be necessary to introduce a detergent as well or choose an oxidation inhibitor with some detergent action in order to keep insoluble contaminants in suspension. It is important that an excessive build-up of acidity does not occur, because it may cause damage to the main connecting rod bearings. These usually contain lead or cadmium, which are both affected by petroleum acids if the concentration becomes too high. However, very effective additives for preventing bearing corrosion have been discovered and this problem is not likely to become difficult to control.

Oil is sprayed from the crank bearing more or less indiscriminately around the crank case to lubricate the pistons, connecting rods, and timing gears. Pistons and piston rings become very hot and are the most troublesome parts of the engine from a lubrication angle. Their reciprocating motion with periods of rest at the top and bottom of each stroke is not conducive to the maintenance of a fluid oil film such as obtains in a journal bearing under constant motion.

DECOMPOSITION—Lubrication at top stroke is especially difficult because hot gases from fuel combustion work in behind the rings, forcing them tightly against the cylinder wall; temperatures are so high that some decomposition of the oil cannot be avoided. If such decomposition leads to tar or dense carbon, it may cause the rings to stick tightly in their grooves, resulting in serious damage. Stuck rings are apt to break and to score cylinder walls and may pass enough hot combustion gases to overheat the piston, causing detonation and possible destruction of the engine. In the reduction of ring sticking and piston deposits, a great deal has already been accomplished by proper selection of crudes and the choice of proper refining methods. It seems probable, however, that further improvement can come only from the use of additives. Many research projects along this line are now under way and promising results are being obtained. The problem is a difficult one, however, and progress has been slow. Additives also help to reduce carbon formation on the underside of piston crowns which can interfere with effective cooling of the pistons. But careful selection is necessary to avoid excessive deposits in the combustion chamber and on exhaust valves.

Figure 4 shows airplane engine pistons operated on high-grade petroleum oil, and the same oil containing a small amount of an additive. A substantial improvement is evident both at the rings and under the piston crown but the better performance of oil containing the additive is even more significant when the difference in running time is taken into account. The test on straight petroleum oil was stopped at 13 hours because the top ring was stuck. This was ascertained by measurement of gas blow-by into the crank case. The additive oil showed no ring sticking at the end of the test period of 30 hours. This test was made exceptionally severe to simulate "take-off" conditions which in practice occur intermittently for only a few minutes while the airplane is leaving the ground. It is the most highly stressed period in airplane operation.

VERSATILITY—There are many other parts in a modern airplane engine where adequate lubrication must be maintained, but oils which suffice for the main and crank bearings, pistons, and rings are usually satisfactory elsewhere. Exception might be made in the case of reduction drive gears which transmit the entire output of the engine and are, therefore, heavily loaded. In some cases it has been found necessary to employ "oiliness" additives to withstand the high tooth pressures. Many agents of this type are known but the majority are of doubtful value for internal combustion engine lubricants because they lack stability at high temperatures or are not compatible with other additives which may be necessary. When dealing with additives, it is important to study not only compatibility of the various additives with each other but also with the oil to which they are added. An oil which gives superior performance without additives is not necessarily the best oil to use with them. This consideration makes the additive problem still more complicated.

In addition to the power plant, a large modern airplane contains a complex hydraulic control system which also must be lubricated. Generally, the same system also includes the mechanical stabilizer and brakes. In contrast to the engine, the control system, except the brakes, operates at low temperature and oxidation is not a factor. The oil must lubricate the pressure pumps, but its outstanding requirements are fluidity at very low temperatures, and it must not cause undue swelling of various synthetic rubber components of the hydraulic system. This requires as a starting point an oil of very low cold test or congealing point, as low as minus 70 or 80 degrees, Fahrenheit. Such oils can be obtained only from relatively light fractions of so-called naphthenic crudes but these oils cause excessive swelling of synthetic rubber. Swelling can largely be corrected by drastic refining by which compounds of an aromatic nature are removed from the oil. The completely saturated components that remain have little effect on synthetic rubbers now in use.

Drastic refining also improves the fluidity of the oil at low temperatures but, as the starting material is a naphthenic type oil, the desired combination of viscosity and fluidity cannot be obtained from the oil alone. Several V.I. improvers have been found which accomplish this but military secrecy prevents a detailed discussion of them.

Synthetic lubricants of non-petroleum origin have appeared from time to time but so far they have found only limited acceptance. Research on such lubricants is still continuing and synthetic oils may, at some future time, become a factor in aviation. When consideration is given to the enormous demand for aviation lubricants, now measured in thousands of barrels a day, the economics of producing such amounts synthetically become staggering. It seems likely, therefore, that petroleum will provide the major supply for some time to come.

The accomplishments of modern aviation have been achieved through the co-operative effort of many minds in many fields of engineering. The petroleum industry has been privileged to contribute to this effort and recognizes its responsibility toward still further accomplishment.

CHEAPER THIOPHENE

Will Have Many Uses In Chemical Industry

UNEXPLORED fields in chemistry—especially in the plastics, pharmaceutical, and dyestuffs industries—are expected to be opened up as a result of an inexpensive method for producing thiophene from petroleum.

Previously priced at $54.00 per pound —too expensive for extensive use—thiophene can now be produced by the Socony-Vacuum Oil Company at a cost estimated to make it commercially attractive. This is expected to have far-reaching results in many phases of industries using chemicals. For example, thiophene may alter the elasticity, brittleness, hardness, and other properties of plastics, the color of dyestuffs, and the physiological effects of medicinals. It is a colorless liquid, heavier than water, boiling at 183 degrees, Fahrenheit. Its odor resembles somewhat that of benzene.

Chemically, thiophene has the empirical formula C_4H_4S and contains 57.1 percent carbon, 4.8 percent hydrogen, and 38.1 percent sulphur. Its structure is agreed to consist of a five-membered ring containing four carbon atoms and one sulphur atom. The ring contains two double bonds between two of the pairs of carbon atoms. One hydrogen atom is connected to each carbon atom.

In its reactions thiophene resembles benzene, although different reaction conditions may be necessary. A large portion of the chemical industry is built around the chemistry of benzene. Dyes, pharmaceuticals, plastics, and a host of other chemical commodities to a large extent are derived from benzene and its compounds. Thiophene, therefore, permits the chemist to prepare many of these products which differ in that they will contain the thiophene ring in place of the conventional six-carbon atom-benzene ring.

Soft Dies . . . Hard Jobs

Developed Originally by the Aircraft Industry to Improve Design Flexibility, Speed Production, and Lower Die Cost for Short-Run Work, the Use of Zinc Alloy Dies for Sheet-Metal Forming has Established Itself as Permanent Tooling and is Invading Other Fields as Well

When harking back to the dim days before war production really started, some awkward or tedious production methods can all too vividly be recalled. In the aircraft industry, for example, mass-production techniques were hardly necessary, with planes usually ordered in lots of one to ten and early delivery seldom a requirement. With such small lots, sheet-metal parts were usually shaped by hand over wooden forms or stamped out on rope drop hammers using low-purity zinc dies and lead-antimony punches.

Today, however, automotive manufacturing methods are applied or even improved upon to meet the high-production requirements of aviation. The advantages of the soft metal die are retained through the use of a specially developed zinc alloy, called Kirksite "A", produced by National Lead Company, which has more durability than straight zinc. More and more aircraft sheet metal forming and blanking has been transferred from drop hammers to punch presses and hydraulic presses. And the soft metal dies have turned out to be such good permanent tooling that other industries are seeking to apply the secret of their successful use.

Some advantages of zinc alloy dies over steel dies are as follows:

The zinc-base dies are much less expensive. Steel dies are competitively uneconomical for relatively short-run work because the combination of their higher cost and the small-lot jobs results in a very high tool-cost per part. Obviously, the shorter the production run the more important becomes the die cost per unit produced, so that cheaper dies are increasingly attractive.

Although the zinc alloy in ingot form costs more than the steel or cast iron in raw-material form, the cost of the finished die is much less for the Kirksite. Labor to make the die, machining costs, and so on are low enough for the zinc-alloy dies to make them cheaper *to produce* than steel or iron dies. What eventually controls the economy of the application is the number of parts to be made with a given die.

The zinc alloy dies can be produced in a matter of hours, as against days for steel dies. This means that production of a part can be started sooner, or that frequent changes in design or experimental production can be accomplished without prohibitive delays. In the reconversion, retooling, and product-experimenting period that lies just ahead, this last may loom as a major factor in smart research-engineering. Also, minor changes can be made directly on the zinc alloy dies with a welding torch, when such changes are indicated by design modifications or for experimental reasons.

The skilled but scarce diemakers required for making steel dies (blanking dies, for example) are not needed in the manufacture of zinc alloy dies, nor is as much critical machining required to finish the cast dies to close dimensional tolerances.

Other advantages of importance are: The accuracy of casting that is possible with zinc alloys, often obviating machining of the cast die; the elimination of die scratches on the work by virtue of the zinc alloy's softness; and the reclamation value of the zinc alloy, for it is almost 100 percent reusable by simply remelting under proper conditions.

Stampings for fuel tanks which can be dropped from airplanes when empty are pressed out of S.A.E. 1010 steel on Kirksite dies by a 1500-ton double-acting press shown in the rear

Two thirds of the weight of this huge die was eliminated by correct coring. It was made for use in the Douglas Aircraft Santa Monica plant

VERSATILITY—The zinc-alloy dies are made either as sand castings, plaster-mold castings, or rolled sheet, depending on the purpose. Most soft alloy stamping, forming, and drawing dies are cast, usually in sand; dies for certain plastics molding operations—a growing use for Kirksite—are cast in plaster molds, as are some stamping dies; dies made from rolled zinc alloy sheets are used for many blanking, forming, and trimming jobs.

The forming machinery on which the

zinc-alloy dies can be and are being used includes rope and air drop hammers, hydraulic presses and brakes, and mechanical presses of toggle, crank, and double-acting types. They are used with or without pressure rings or binders made either of the zinc-alloy die material or of iron. The use of Kirksite "A" dies for punch press operations is one of the most recent developments, of which more later.

Punches used with cast zinc-alloy dies may be made of the zinc alloy itself, of antimonial lead, of cast plastic, of hydrolized woods like Masonite, or of rubber. Often the punch is made by casting the punch material into the cavity of the Kirksite die. Rolled Kirksite dies for blanking are used in conjunction wth steel punches, the clearance between die and punch being *zero*, so that the die will "flow" toward the punch and keep the cutting edge honed and self-healing.

Although care must be taken in the production of sand-cast, zinc-alloy dies to reproduce accurately the dimensions, configuration, and detail of the model, the hand and machine labor required for this is much less than for steel dies and, indeed, less than for any other durable die material. The first step is the production of an accurate pattern. Patterns may be either wood or plaster, the latter being cheaper and more speedily made. The aircraft industry generally uses plaster patterns, which are made from die drawings by the "loft template" method.

The molds in which the dies are cast are of the "open" type—that is, the top of the casting is open to the atmosphere —since the "closed" mold familiar to foundrymen does not produce dies as sound and smooth, especially in heavy sections. Any high-grade molding sand of fine texture may be used, with little or no binder required.

For melting the zinc alloy (it melts at 717 degrees, Fahrenheit) special cast iron kettles or pots are used. Welded steel kettles are attacked rapidly by the zinc alloy and are therefore not used. A protective coating is applied to the iron kettles to provide additional resistance to attack. Kettles are either gas-, oil-, or coke-fired, with gas the most popular. Electric furnaces can be used but generally are not.

RECLAMATION—Melting of new ingot or clean uncontaminated old dies is accomplished without flux and with very low dressing. Borings or finely divided scrap must be fluxed in remelting (with sal ammoniac and zinc chloride) to remove undesirable dirt and oxides.

The most important metallurgical precaution to be observed in melting Kirksite "A" is that contamination by lead and tin must be avoided. One half of 1 percent of lead will reduce the tensile strength 30 percent and the impact strength 75 percent in one year of normal aging, and will also cause the dies to expand 1/8 inch per foot in the same period. More than 1/4 percent iron is also harmful, causing surface defects in use, known as "dural-bug marks."

If the pattern and foundry work are properly done, little fitting is required to match the punch to the die and the pressure ring (when used). No die-polishing is needed if the die is to make steel, stainless steel, or Inconel (nickel-chromium-iron alloy) stampings, as the hard sheets being formed polish the die. Dies for aluminum are either polished, or used to make a few stampings out of sheet steel to smooth the die surfaces before running on aluminum.

For small dies greater accuracy and better surface finish are obtained by casting the Kirksite "A" in plaster molds. Special plasters and mixers are used. Patterns may be of wood, metal, or plaster itself, and a parting compound of some type must be used.

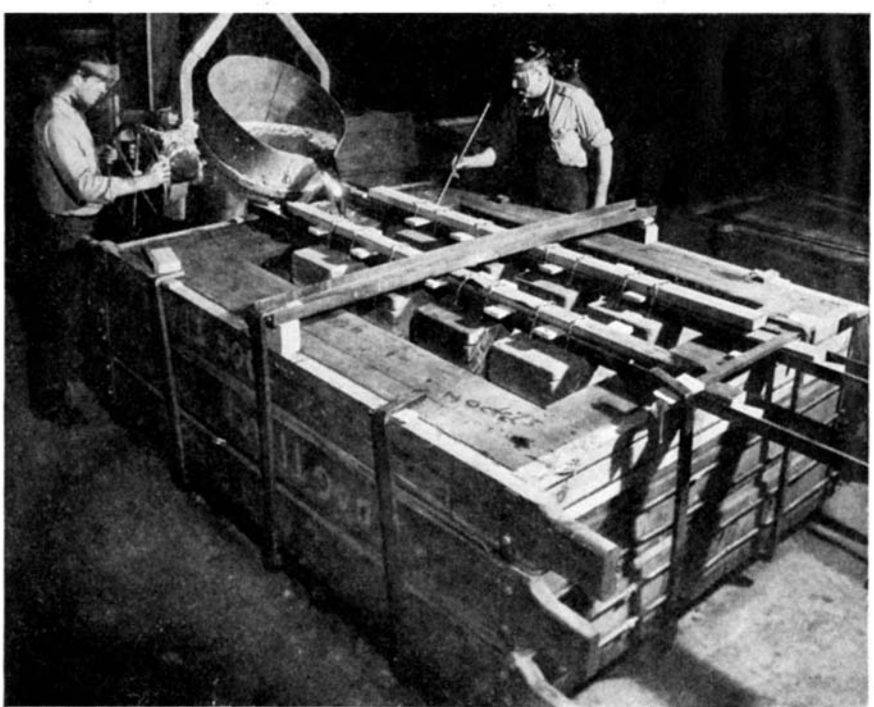
LOW COST—Broadly speaking, the zinc-alloy dies are regarded as low-cost dies useful for moderate production runs. They cannot be expected to replace steel or cast iron dies in all or even most of their established applications. The accompanying table indicates some successful Kirksite "A" applications and the number of parts either involved in the lot or the number made before die failure. These are all of an "extreme" nature, showing either the thickest gages, or the longest runs made with zinc-alloy dies. It has occasionally been found more economical to use up several zinc alloy dies on one job than to employ one steel die for the whole order.

The current trends in the use of Kirksite dies hold much significance for industry in general. Most important perhaps is the growing use of zinc-alloy dies for forming and drawing ordinary steel. This opens up possibilities of using Kirksite in the automobile and general stamping industries. In one case, 25,000 of the jettison or droppable fuel tanks for the P-38's have been stamped on an 800-ton double-acting press out of 0.024-inch steel, using one Kirksite die set.

In another instance, a three-piece zinc alloy die set produced 7500 automotive engine valve cover plates out of 0.078-inch cold rolled steel. The total cost of the die set, including patterns, metal, castings, and machining was only 32 percent of the cost of conventional dies. In addition, the Kirksite die set required 48 man-hours of labor as against 69 man-days for the usual dies.

OPERATION	MATERIAL	GAGE	SHAPE	NO. OF PARTS OR BLANKS
FORMING	Armor plate	1/4 in.	2-ft. spher. radius	several hundred
	Stainless steel	0.091 in.	2.5 in. rect. cup	400
	Stainless steel	0.038 in.	X-exhaust manifold	2800
	Body stock steel	0.089 in.	3-in. draw	1200
	Body stock steel	0.037 in.	3-in. bends	18,000
BLANKING	Stainless steel	up to 0.050 in.	——	100
	Body stock steel	0.062 in.	——	1800
	Duralumin	0.032 in.	——	30,000
	Formica	0.062 in.	——	10,000

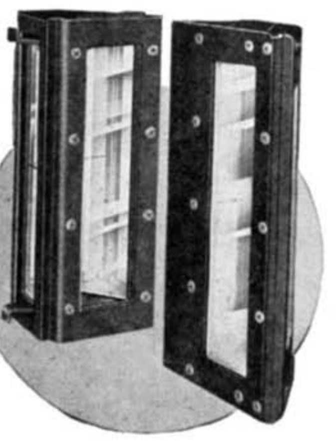
Condensed tabulation of some successful applications of zinc-alloy dies



Courtesy Douglas Aircraft Company

Workmen pour Kirksite to form a male punch for a triple action hydro-press die. This picture shows how a large Kirksite casting is cored in order to reduce weight

TERRIFIC BARGAINS IN WAR SURPLUS LENSES AND PRISMS



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Rugged, strong, originally constructed for U. S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Only plywood body frame is required to finish this exceptional Periscope. First surface mirror is well protected by glass windows. Set weighs 2¾ lbs. Overall length of mount 6⅛", width 2⅛". Would normally retail at $40 to $50.

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TWO SETS (4 Units) .... SPECIAL $5.50 Postpaid

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8 MM. MOVIE PROJECTING LENS SET — Stock #4011-S . . . $1.20 Postpaid. Consists of 2 Achromatic Lenses, diameter 18 mm. and a focal length when combined of one inch.

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90-45-45 degree, 5¾" long, 2⅛" wide, finely ground and polished. Would normally retail from $24 to $30 each.
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(Illustrated booklet on Prisms included FREE)

MICROSCOPE OBJECTIVE LENS SET — Stock #6093-S . . . $2.00 Postpaid. 2 Cemented Achromatic Lenses (color corrected) which may be combined to make a microscope objective lens with a focal length of ½ inch. Use these to make a microscope for micro-photography.

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These are from the Navy's 7 Power Binocular with 2" diameter objective lens.
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An exceptional opportunity to secure a large variety of optical pieces (seconds) in varying stages of processing — from raw optical glass to partially finished. Most pieces have been molded, some finished on one side. Diameters up to at least 3 inches. Good variety of prism blanks included, bulk packed. Refractive indexes from 1.5110 to 1.6490 but not identified. Contains both Crown and Flint glass. Sold "as is" but with our usual guarantee of full satisfaction or money refunded. Excellent for educational uses; for practicing and learning optical grinding and polishing.
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NEW 50 PAGE IDEA BOOK "FUN WITH CHIPPED EDGE LENSES"
Contains wide variety of projects and fully covers the fascinating uses of Lenses and Prisms . . . only **$1.00 Postpaid.**

PERFECT ACHROMATIC (CEMENTED) TELESCOPE OBJECTIVE LENS. Diameter 1¾ inches. Focal length 20 inches.
Stock #6091-S .... Price $5.00 Postpaid

PORRO PRISM SET FROM ARMY'S 6 POWER BINOCULAR
Consists of 2 Porro Prisms to make an erecting system for a Telescope.
Stock #3010-S .... $2.00 Postpaid

MISCELLANEOUS ITEMS

Stock No.	Item	Price
3006-S	Porro Abbe Prism	$ .25 each
3016-S	Pentagon Prism	.75 each
2024-S	10 Pieces Circular Plate Glass (Diam. 31 mm.—for making Filter	.25 each
1004-S	2 Reducing Lenses	1.20
3001-S	Lens Surface Prism	2.00 each
503-S	No. 1 Sable Hair Lettering brush	1.00 Dozen
3021-S	Amici Roof Prism (3rd grade)	.25 each
4009-S	Heat Absorbing Glass 4"x5".	.35 each
4010-S	Heat Absorbing Glass 2"x2".	.10 each
2016-S	17 mm. Diam. Gunsight Reticle	.10 each
2020-S	40 mm. Neg. Lens, Cross Lines	.25 each

Minimum order on above — $1.00

COLOR FILTERS

1 Red and 1 Yellow Filter in following Diam.

20 mm. (seconds)	**40c**	45.5 mm. (seconds)	**90c**
32.5 mm. (seconds)	**70c**	31 mm. (seconds)	**70c**
37 mm. (seconds)	**70c**	29 mm. (perfect)	**$1.00**

Minimum order on above — $1.00

WAR SURPLUS ACHROMATIC LENSES

Stock No.	Dia. in mms.	F.L. in mms.	Comments	Price
6017-S	12	80	Cemented	50c
6019-S	15	41	Cemented	60c
6111-S	16	36	Cemented	75c
6094-S	16	75	Cemented	$1.00
6021-S	18	49	Cemented	60c
6023-S	25	95	Cemented	75c
6066-S	32	132	Uncemented	75c

USES: —Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye-Piece Lenses, Macro-photography, gadgets, optical instruments, etc., etc.

PERFECT MOUNTED ACHROMATIC LENS WITH THREADED MOUNT
Stock #6090-S .... $2.00 Postpaid
Lens has diameter of 1¾ inches; focal length 5½ inches. Excellent Telescope objective or combine two of these to make a 3 inch focal length projecting lens for a 35 mm. Slide Projector.

KELLNER EYE PIECE LENS . . . Focal Length 1¼ inches. Diameter of eye lens 16 mm. Diameter of field lens 25 mm. Comes unmounted but eye achromat already cemented.
Stock #6108-S .... $1.00 Postpaid

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EDMUND SALVAGE COMPANY

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A new development that holds great promise for the economical production of dies for heavy steel stampings is the application of a hardened steel armor over the surface of a cast Kirksite "A" die set. Another method of increasing the hardness and life of the dies (especially in certain areas such as draw edges or for corner re-enforcement when forming heavy steel) is to cast

Courtesy White Motor Company

Used for stamping out engine valve covers, this Kirksite "A" die cost about 30 percent less than a similar steel die, and is reported to be still serviceable after stamping 7500 pieces from .078 inch steel

steel inserts in the die, using well-developed anchoring methods.

A second important development is the increasing use of blanking dies made from rolled Kirksite sheet. Some of the successful applications of this type are definitely in the long-run field and all are considered "permanent tooling" by their users. A few plants even mass-produce the dies, one company in particular having a line-production setup for making Kirksite blanking dies at the rate of 1000 a month.

A third important application that will certainly carry zinc-alloy dies far beyond the confines of aircraft manufacturing is their use for molding plastics and rubber. Kirksite molds for both compression and injection molding are now used in several plants, with mold-life results varying from job to job.

LONG RUNS—For example, one company has produced 600,000 injection-molded plastics telescope rings from a four-cavity die made entirely of zinc alloy except for sprue puller and stripper plate. The parts are molded under 16,000 pounds pressure at 350 degrees, Fahrenheit, and 50,000 pounds clamping pressure.

Another manufacturer made an extensive study of Kirksite dies for high-pressure transfer molding of phenol formaldehyde, urea formaldehyde, and phenol furfural molding compounds and for compression molding of laminated plastics. The zinc alloy molds were found to work satisfactorily; hobbing was more difficult than with steel molds, for the cast Kirksite "A" lacks the ductility of steel, but the Kirksite was much cheaper and has the unique property of not sticking to the molded plastics part.

Other "tooling" uses for this zinc alloy that are not exclusively aeronautical include form blocks for deep drawing on hydraulic presses; stretch press dies; chuck jaws cast in permanent molds, which reduce both time and expense and last indefinitely; anti-chatter pads for milling operations; sand-cast tube-bending dies that save costly machining operations; heated dies for forming magnesium alloy sheet at 300 to 450 degrees, Fahrenheit; jigs and fixtures for assembly purposes.

The aircraft industry therefore must be thanked for having developed a type of low-cost tooling that is certain to be a boon to many other fields after the war. Now considered as full-run or permanent tooling for the stamping requirements of virtually all airplane plants, zinc-alloy dies can be similarly applied in making parts for expensive or custom-made automobiles, housings for oil burners, vending machines, special business machines, metal furniture, certain cooking utensils, lighting fixtures, and so on.

As "temporary tooling," they will also invade many other fields as well. To these they will bring design flexibility because of their low cost and the permissible rapid production of trial dies. Customer reaction to experimental designs can be obtained without building costly steel tools to produce them.

All of which is another way of describing zinc-alloy dies as a highly useful and a flexible adjunct to post-war product planning and reconversion, as well as a promising type of permanent tooling for longer-run work.

SOLDERING CANS

Now Accomplished With Tin-Lead Solder

In soldering the side seams of cans at high speed, a 5 percent tin-lead solder has largely supplanted the silver-lead solders developed for this purpose to save tin a few years ago. Since the 2 percent silver-lead solders quickly picked up about 5 percent tin from the tinned cans, this change in omitting the silver has not materially increased tin consumption for this purpose.

METAL ROLLING

Improved by Development of Two New Processes

Two recent developments now arousing much interest among rolling-mill men also hold considerable potential significance for providing industry with better-quality rolled steel and non-ferrous products than previously available.

The first, the "Unitemper" mill, has received much attention from the tinplate producing companies for temper passing. Instead of conventionally cold working the sheet between pressure rolls, the Unitemper mill continuously stretches the stock beyond its yield point between two sets of gripper rolls.

This process increases roll life and eliminates much of the bearing and rolling friction of pressure rolling. Hence it bids fair to lower operating costs. The sheet produced by the Unitemper mill has a more uniform degree of cold work throughout its section, while the conventional pressure-rolled sheet has a greater degree of cold work in the surface layers.

The second, the Krause mill, has aroused interest in ferrous and nonferrous fields since it reduces a 26-inch wide strip from ½ inch to 0.030 inch in a single pass. This reduction is accomplished by holding the stock in tension with a gripper while four-inch diameter rolls are moved over it by frictional contact between the stock and reciprocating cam plates. Pressure is applied only on the work stroke, and the reduction is made largely through the tension in the strip.

Metal from this mill shows a finer and more even grain structure, and edge cracking in copper has been minimized. The relatively slow delivery speed of 30 feet per minute is offset by the reduction being accomplished in one pass. Developments are in progress toward making the operation continuous by welding the bars end to end.

MORE THE MERRIER

Many Ingredients Blended To Make Fine Steel

The era of "just a few" alloying agents in a material is passing, and the common alloy of the future will have many ingredients, all there for a purpose. Aluminum, magnesium, lead, and zinc alloys are good nonferrous examples and the NE steels are outstanding as a ferrous case-in-point with "impurities" and tiny amounts of such things as boron, zirconium, vanadium, zinc, calcium, titanium, and so on functioning as alloying elements. A little of this and a little of that may not seem as inefficient some day as it once did.

BETTER BELLS

Arise from War-Time Need To Save Scarce Tin

An interesting change in the nature of so-called "aid to navigation" bells, necessitated by war-time shortages, will radically change bell metallurgy post-war. These navigation bells are made by the United States Coast Guard and are used by the navies of all the United Nations. Weighing from 225 to 1000 pounds, the bells were formerly made of a 20 percent tin bronze. To save tin the Coast Guard in 1942 began making bells of silicon bronze containing negligible amounts of tin. Not only did the new composition save 200 pounds of tin per 1000-pound bell, but it also reduced the cost of the bells about 10 cents per pound.

The silicon bronze bells ring in C sharp concert pitch instead of the conventional D of the tin bronze bell metal. One of the most important improvements is an increase in tensile strength from 28,000 pounds per square inch for the old bell metal to 45,000 pounds per square inch for the new. The new bells have not been known to crack, whereas the old bells had a high failure rate.

Better Television

Plastics Mirrors and Lenses Have Overcome Many of the Difficulties of Working Large Glass Surfaces. Combined With High-Voltage Cathode-Ray Tubes, These Plastics Parts Make Possible Post-War Television Receivers that Produce Large Pictures Free from Interference

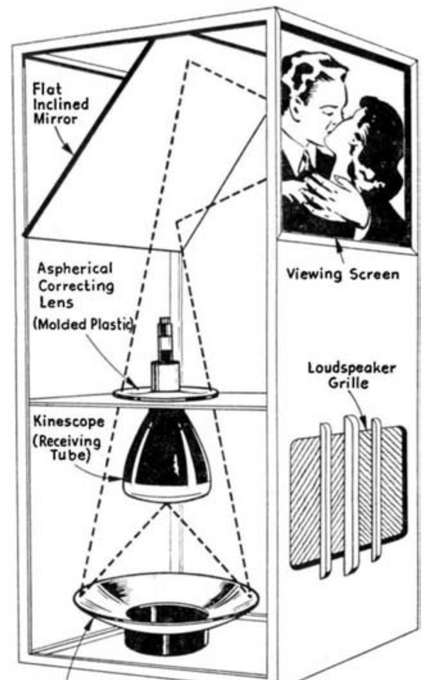
DEVELOPMENT of a television receiver capable of reproducing pictures that are brighter, clearer, and five times larger than were obtainable on pre-war sets has set a standard for what may be expected of this rapidly advancing art in the near future. This new Radio Corporation of America receiver features a new type of screen, 16 by 21 1/3 inches, made of surface-treated plastics.

Console models, containing projection-type television, FM, and standard broadcast receiving facilities, will cost approximately $395 when they can be put into production. RCA Victor will also have several models equipped with direct viewing picture tubes, and at least one table model priced at about $150.

TECHNICAL ADVANCES—The large-screen television receiver was made possible by four pre-war technical developments: (1) A reflective optical system which collects from the image on the receiving tube and projects upon the viewing screen about six times as much light as could be delivered from tube to screen by a conventional *F*/2 movie projection lens, without loss in image quality. (2) A built-in translucent plastics viewing screen with molded surfaces designed for even distribution of light over the area of the screen and distribution of transmitted light within the normal viewing angle. (3) An automatic frequency control system which virtually eliminates picture distortion caused by interference from automobile ignition and other noise impulses. (4) A new high-voltage type of cathode-ray tube which produces a brilliant initial image.

MIRROR AND LENS—The optical system, which was developed by RCA Laboratories engineers before the war, consists primarily of a spherical front surface mirror and an aspherical correcting lens. The mirror may be visualized as a shallow bowl, with its reflective coating on the concave surface facing the light source. The lens is flat on one side, with the opposite surface rising slightly at the center and at the edges, but depressed in the intermediate area.

The system is mounted with the image end of the receiving tube facing downward through an opening in the center of the lens and facing the center of the mirror. Images appearing on the face of the tube are picked up by the mirror and reflected through the aspherical lens to the back of the viewing screen.



Simplified diagram of a large-screen television receiver for the home. The broken lines trace the path of light from a single picture element on the face of the cathode-ray tube to a corresponding point on the screen

Latest design in large-screen home television receiving equipment

The great light-gathering power of this optical system makes it possible to transfer to the viewing screen a large percentage of the light produced on the face of the tube, whereas the efficiency of a conventional projection lens in such an application is extremely low. The function of the aspherical lens is to bring the light reflected by the mirror to a sharp focus on the screen. A major obstacle to the development of the system was the time and cost involved in making aspherical lenses from glass. The problem was solved by devising methods and equipment for molding the lenses from a transparent plastics material.

THE VIEWING SCREEN—Two different optical problems have been overcome by special features of the new translucent viewing screen. One was a tendency which the screen would normally have to develop a "hot spot," resulting in a glare in the center and insufficient light in other parts of the image. The other was the need for distributing a major portion of the transmitted light to the area which the spectators would occupy in relation to the receiver. Solutions were found in a combination of principles which have been incorporated in the molded design of the screen.

PICTURE CONTROL—Automatic frequency control discriminates between the transmitted synchronizing impulse and any stray noise impulse, which otherwise might trigger the controlling picture sawtooth wave voltage prematurely. This discrimination is achieved by fixing a time interval for the former and shutting out impulses which do not arrive on schedule.

Without some such control, noise interference could throw the scanning beam in the receiver out of synchronization with the one in the transmitter, causing the former to "black out" and return on some lines of the picture before they were completed. "Tear outs" and ragged edge effects would result. Preventing this form of distortion, the new system regulates reception in somewhat the same way that a fly-wheel regulates machinery.

NEW TUBES—The high-voltage cathode-ray tube used in the large-screen home television receiver is substantially smaller and lighter in weight than pre-war direct-viewing picture tubes. This means smaller, lighter, and less costly home receivers, and may mean lower tube replacement costs.

Designed to operate at a rated voltage of 27,000 volts—nearly four times the voltage used in pre-war picture tubes—the new tubes produce a much brighter initial image. This high initial brilliance, in conjunction with the efficiency of the optical system, makes it possible to obtain from a tube with a face diameter of only five inches a bright, clear image on a screen that is more than five times as large as could be produced on a pre-war direct-viewing tube with a face diameter of 12 inches.

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SHOP PRACTICE

Can Reduce Unit Cost of Production

WITH post-war industrial competition certain to change the emphasis from production at almost any cost to a peace-time policy of profits through production economies instead of higher prices, future factory management will require every effort to reduce unit costs, Professor George W. Barnwell told the Metropolitan Section of The American Society of Mechanical Engineers recently. Mr. Barnwell is professor of production practice and director of shops at Stevens Institute of Technology.

"After the war and the rush to buy many things which we have had to do without for the past several years, manufacturers are going to find themselves up against the old competition that is ever present in our way of life," the speaker declared.

Under these circumstances, the manufacturer has three possible solutions, he continued: To lift selling prices while maintaining present volume; to increase volume at the same selling prices and, most desirable of the three, to cut the unit cost of production.

"The cost of producing many products actually has been reduced by a change of material, design, or method of processing, even in the war period," Professor Barnwell said. "Huge expenditures for plant, equipment, special tools, jigs, and fixtures, and the like have resulted in lower net cost per unit of output, but there are, in addition, other points at which an attack may be made on this problem in order to cope with the difficulties of post-war competition."

Such efforts at reducing unit costs, the speaker continued, may well stem from the machine shop itself, where proper shop organization will be found to be the starting point of all efficiency.

"As a means to this end, it is well to assign authority and responsibility to workers in equal amounts, since a matter that is anybody's business usually develops into a matter which is nobody's business," Professor Barnwell said.

Additional vital elements in shop practice to assure the lowest possible unit costs, the speaker said, include the following: Coördination of the engineering or design department with the shop production department; proper selection of equipment and small tools on a "use cost" basis rather than a first cost basis; control of materials and tools by such means as determining minimum amounts needed and minimum economical amounts to be ordered; provision for adequate inventories and for tool repairs; consideration of problems of shop layout with recognition of the economy of short moves, importance of wide aisles, and a layout emphasizing the relative cost importance of product and process.

BATTLE RATIONS

Now Being Wrapped In Laminated Paper

K RATION meals for GIs at the battlefronts are now being wrapped in a special heat-sealed moisture-proof material. Heretofore the heavy cardboard box containing K rations was given a protective coating by dipping it in wax, but the Army's Quartermaster Department found the wax often cracked in shipment and so they ordered new specifications.

The new wrapping material, made of two thicknesses of waxed paper laminated over an inner layer of foil, was developed by the Marathon Paper Company. The Package Machinery Company has re-designed parts of its standard wrapping machine to handle the material. Six of these machines will go to the American Chicle Company, and three to the Cracker Jack Company. Each will have an expected capacity of 80 K ration cartons per minute.

TURBO-ELECTRIC POWER

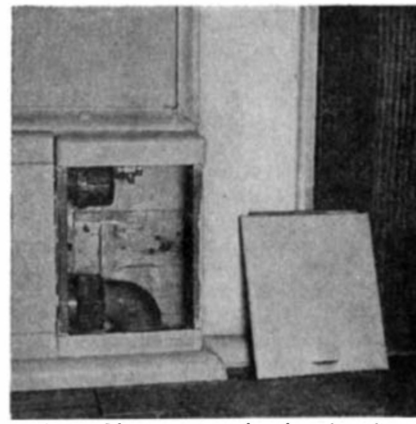
Will Drive New Coal-Fired Locomotives

THREE coal-burning locomotives designed to use in combination the best features of steam, turbine, and electric drive are planned for future construction. Each of these new locomotives will combine in a single self-contained independent unit the advantages of speed, continuous power, and smoothness of operation that, with other types of fuel and comparable horsepower, have heretofore been achieved only in multiple units—two or more complete engines connected together.

This new kind of locomotive will convert the heat energy of coal and steam into 6000 horsepower, delivered from a turbine to generators for the electric motors which drive the wheels. It will be capable of running more than 100 miles an hour under full load, with high sustained speeds on grades.

The basic designs for the new motive power have been completed by the Baldwin Locomotive Works in collaboration with engineers of the Chesapeake and Ohio Railroad, for which the engines will be constructed. The steam turbine and electrical equipment required by the railroad as integral features have been designed and will be built by Westinghouse. In horsepower per self-contained power unit this turbine-electric locomotive is expected to surpass by two to three times the most powerful Diesel locomotive yet built.

The cab will be near the front end of the locomotive, giving the engineer a protected location with excellent forward vision. The coal supply will be carried at the head end of the locomotive instead of in the tender, as at present. The boiler will take up the center section behind the engineer's cab. The steam turbine and electric generators will be placed at the rear and will feed 4000 kilowatts of electricity—enough for all of the electric power needs of a town of 5000 population—through motors mounted on each of the driving wheels.



Left: The cast-iron baseboard radiates heat. Above: Cover removed to show pipe connections and vent valve

BASEBOARD HEATERS

Keep Temperature Steadier Than Older Methods

INVISIBLE home heating, with neither conventional radiators nor registers in a room and known as the "radiant baseboard," has several advantages over conventional heating arrangements. Room warmth comes from a hollow cast-iron baseboard supplied with hot water from a regular home heating boiler. Radiant baseboards replaced wooden baseboards along the bottom of outside walls in rooms of the research home of the Institute of Boiler and Radiator Manufacturers during the severe past winter and proved completely successful.

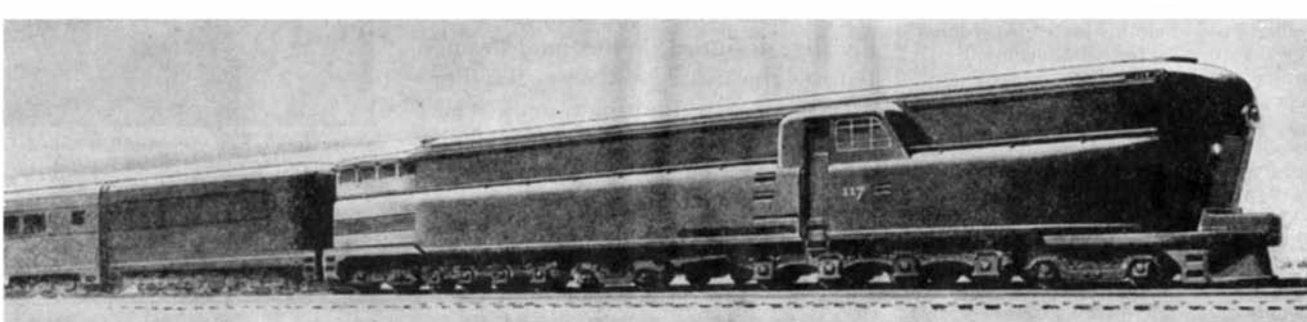
The radiant baseboards are painted to match woodwork of the room and are hard to distinguish from the trim which they replaced. Pipe connections from the boiler are concealed in boxes at the ends of the baseboards. Installation is a relatively simple job.

The baseboard in the research home, located at the University of Illinois, is slightly over six inches high and less than two inches wide, though appearing thinner because of molding at top and bottom. Future installations may be recessed into the wall and extend into the room no more than an average wooden baseboard.

As a heat source the radiant baseboard is completely inconspicuous, and does not in any way interfere with furniture arrangement or room use, as radiators or registers sometimes do. It is as easy to keep clean as any conventional baseboard.

By spreading its warmth in the coolest part of the room—the bottom of the outside wall—and providing a room-long source of heat, the radiant baseboard provides the most uniform floor-to-ceiling home temperatures ever achieved.

In previous years, with conventional radiators as heat sources, the floor-to-ceiling temperature difference in the research home was five degrees in zero



Many advantages, including smoothness of operation, are claimed for steam turbo-electric locomotives weather. This past winter, with baseboard heat, the difference was never more than three degrees, even when the mercury outdoors dropped to subzero levels. How effectively the radiant baseboard concentrates heat in the lower part of the room is shown by the fact that, with the new heat distribution system, temperatures in the research home are uniform from the five-foot level to the eight-foot ceiling—the area which ordinarily is increasingly the hottest in a room.

CRITICAL METALS

Post-War Production Here is Urged for National Safety

Continued production in the post-war period of certain metals vital to national safety, even though their importation would be cheaper, is urged by Dr. William H. Waggaman, mineral technologist of the United States Bureau of Mines.

Richly endowed in most minerals, this country nevertheless lacks some, and has only medium or low-grade deposits of others, such as manganese, chromium, and tungsten. These deposits, more expensive to mine, are being worked under war emergency conditions, Dr. Waggaman says in "Chemical and Engineering News," American Chemical Society publication.

After the war, he points out, it would be cheaper to import ores of higher grade which other countries can produce at less cost, and shut down many American mines and processing plants producing these highly important minerals. But "through extensive explorations we have established substantial reserves of certain low-grade domestic ores; by intensive research investigations we have learned how they may be concentrated or the desired ingredients extracted at a cost that offsets, in part at least, the advantages heretofore offered by higher-grade ores from foreign sources; men have been trained to mine, mill, and process these domestic raw materials, and continued research and improved techniques should lower production costs still further.

"It seems logical therefore to continue to utilize these resources to provide jobs for our people and maximum insurance against a catastrophe such as now engulfs so many nations unprepared for war. Certainly, no policy that jeopardizes this nation's security is either economical or wise."

JET TURBINES

Have Extremely Low Oil Consumption Ratings

How to heat, not cool, lubricating oil used in the jet-plane power plant developed by General Electric engineers was one of the problems solved by them in their work.

Heating was necessary because there is only one major moving part in the unit. This rotates without appreciable vibration and hence can be supported on anti-friction bearings.

As a result, heat rejection to the oil is very low. An oil heating system with thermostat control was devised to maintain the oil at proper temperature under varying degrees of cold at high altitudes.

Oil consumption is negligible, and the amount of lubricating oil required by the jet-propulsion gas turbines is, therefore, small—being 15 percent less than that required in other aircraft power-plants. The entire lubricating system is integral with the gas-turbine engine, and no complex cooling mechanisms, oil coolers, or large oil tanks are involved.

Likewise, cooling the gas-turbine engine itself is a simple matter, and is provided for as an integral part of the design. Moreover, air required for cooling the unit is as little as 2 percent of the sum total taken in for operation.

Engineers who have worked on the jet turbines point out that inherent simplicity features such as these greatly facilitate production and operation. The power plant is a "packaged" unit which is installed easily. Inasmuch as it operates without appreciable vibration it can be tied right to the airframe. Operation-wise, relatively few gages and instruments face the pilot in the cockpit, and there are no propeller or fuel mixture controls.

The gas turbine engines will burn kerosine, automobile gasoline, or aviation high-test without any major changes being required. Since combustion is continuous, expensive high-octane fuels are not needed, and cheaper fuels are preferred.

New Products and Processes

COOLANT COOLING

Packaged Unit Speeds Production

A DEVELOPMENT brought about by the demand for maximum production from machine tools is the perfection of a system for controlling the temperature of coolants and cutting oils. Increased speed of operation plus the war-time use of new alloys and cutting tools, has created new production problems. By application of uniform temperature control, marked results have been shown on many machines.

Cutting oils which flow over the work of machine tools are used for lubrication, cooling, and for carrying away cuttings. Under present high-speed operating conditions, those cutting oils which lack sufficient cooling properties cause variations in the size, shape, and location tolerances of the work piece and of the machine itself. These variations, in a number of cases, cause shorter tool life and necessitate frequent machine adjustment to hold location and tolerances.

Now Chrysler Airtemp engineers, through their "packaged" cooling units, have developed a system of controlling the variables caused by coolants and cutting oils, making it possible to produce a uniform temperature condition. This condition, once established, can be maintained throughout the year.

PRINTING PLATES

Made of Plastics Are Light and Durable

PLASTICS printing plates have greatly increased the scope of the United States' use of pictures and the printed word in this war. Greater ease in handling the lighter weight plates has resulted in wider and speedier circulation of words and pictures overseas than would otherwise be practical. Magazines are printed from plastic plates; books are published from them; and pictures are reproduced from them.

Today, for example, the *New York Times, Chicago Tribune, Newsweek,* and *Time* use plates made of "Vinylite" plastics in printing their foreign editions overseas. The Picture Division of the Office of War Information sends to outposts all over the world 22,657 plastic plates a month for reproduction abroad. The plates are sent abroad by air mail which, if the process depended on the use of regular stereotype or electrotype metal plates, would hardly be practical because of the weight and bulk involved. Also, in some foreign locations there are no facilities for making plates from stereotype mats.

The plastics plates weigh only one-eighth as much as electrotypes of the same size. They retain detail, can be used curved or flat, are virtually unaffected by extremes of climate, are durable and machinable, and can be produced speedily without sacrifice of legible impression. Moreover, they can be produced economically in quantity.

Fidelity of reproduction of the plastics plates is the highest yet obtained by the printing industry, and the hardness and durability of the printing surface permit runs comparable with the number of impressions obtainable from the average copper electrotype. Runs of 250,000 to 350,000 are being achieved. Plastics printing plates are easily stored, are not subject to attack by moisture, and are virtually immune to weak acids, alkalies, and other organic and inorganic chemicals.

PORCELAIN ENAMEL

Sprayed Successfully By New Process

ELECTROSTATIC spraying for use in porcelain enameling has been established as a practical technique as the result of recent experimentation. The technical data accumulated at the Pemco Corporation Research Division definitely prove that electrostatic spraying is satisfactory in porcelain enameling and that when it is properly used a uniformly coated product with a minimum of overspraying can be obtained.

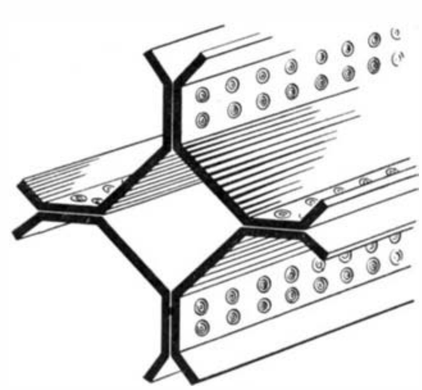
The process consists of charging the spray particles in an electric field and the attraction of these particles to the object to be coated. It is not entirely dissimilar theoretically from electro-plating, with the difference that, in electro-plating, the metallic particles are suspended in a water medium. In the electrostatic process, the spray particles are suspended in air. In the use of this process the object to be coated is grounded and is surrounded by an electrical field that imparts a negative charge to the atomized particles entering the field. The particles so charged migrate in the field toward the object which bears a positive charge. The field is created by a specially designed rectifier and transformer which produces a voltage of approximately 95,000 volts with a current average not exceeding 5 milli-amperes.

WELDER

Operates on Power From Storage Batteries

DESIGNED for use in plants having only a limited amount of power available, a new storage-battery welder is coupled direct to the 220-volt shop wiring system through a battery charger which has a maximum 3-phase draw of only 26.7 kilovolt-amperes.

The welder itself is of the rocker-arm type, with batteries located in the base of the machine in place of the conventional transformer. The air-actuated contactor-controller which operates on the carbon-pile principle is also located in the base of the machine. With this type of contactor, it is the actual welding current rather than the primary current which is interrupted. The amount of current is controlled by the pressure between the two carbon disks in the contactor-



Above: Sketch of a structural section of a type being produced in large numbers on the battery-operated welding machine shown in photo below

controller. (The greater the pressure the less resistance and the greater the current.) When the pressure is removed, current stops flowing, permitting opening of the contactor by separating the carbon disks without arcing, despite the fact that welding current is around 20,000 amperes.

An unusual feature is that no compensation is required for induction losses from the first to the last weld in the assembly. Since direct current is used for welding, the amount of stock in the throat of the welder has little effect on welding current, there being no induction losses to all practical purposes.

Although in continuous operation, the 12 battery cells are kept charged by the automatic charger with its peak draw of 80 amperes, three phase. Service requirements consist mainly of adding water to the battery about once every three weeks, and occasional point dressing.

ABUNDANT SILICON

Being Put to Many Uses By Industrial Research

SIGNIFICANT industrial developments are promised by silicon, the most plentiful metallic element in the earth's crust, according to Dr. Eugene G. Rochow of the research laboratory of General Electric Company. Research in this new and unexploited field has produced some entirely unexpected and surprising results, Dr. Rochow says. Resins, varnishes, oils, and other materials have been made from silicones and their uses now include ceramic insulators to protect aircraft radios in humid atmospheres. [For other reports on silicones, see pages 66 and 114, February 1945 issue.—*Ed.*]

"Though silicon is three times as abundant as aluminum and six times as abundant as iron, the only compounds of silicon which have heretofore been important are those natural forms of silica and the silicate minerals which are used in the building arts and in ceramic technology," Dr. Rochow explains.

"Many synthetic or man-made compounds of silicon, some volatile, some soluble, some flexible and plastic, have long been known but have been confined to the laboratory as expensive curiosities. Only recently have chemists begun to explore the commercial possibilities of these synthetic organo-silicon compounds, with such surprising results that they now seem certain to become important to our daily lives.

"These organo-silicon oxides are known as silicones because they were first considered analogous to certain organic compounds called ketones. They are more properly thought of as organic-substituted sand or quartz, inheriting some of the characteristics of their inorganic and organic parentage. From these silicone structures, there have been made a number of materials, such as resins, varnishes, and oils, all heat-resistant polymers in the same way that silicon itself is polymeric and heat-resistant.

"From the troublesome 'glue-like' silicone polymers observed in the past, chemists have developed several new and different organo-silicon resins to meet many needs of the electrical industry. As is often the case, research in so new and unexploited a field has produced some entirely unexpected and surprising results. For example, it was found that the action of various organo-silicon halides on glass, paper, and cotton surfaces would render these surfaces water repellent to a high degree. Mere exposure of the surfaces to the vapor of methyl chlorosilanes suffices to impart a water-repellent film which withstands washing, dry-cleaning, and even considerable abrasion.

"Many ceramic insulators in aircraft radios are now being treated with this General Electric Dri-Film so that when moisture condenses on the insulators it will not spread and short-circuit the terminals, thereby keeping the radio operative during a rapid dive into humid atmosphere. The many uses to which such an unusual process may be put will become apparent after the war is over.

"In the course of further research on organo-silicon materials, it was found possible to make silicone oils which not only had the stability at high temperature which is characteristic of silicones, but also remained fluid at very low temperatures. In fact, the change of viscosity with temperature is so much less than that of ordinary petroleum oils that a single silicone oil often will suffice for operation of equipment from —50 to +400 degrees, Fahrenheit. These silicone oils do not swell natural rubber nor corrode metals.

"It seems probable that the organosilicon polymers will find use in the future not as direct competitors of the many present-day plastics, but rather in many applications where no present-day material will do, and where full use is made of the outstanding thermal durability of the siloxane network. From this viewpoint, the silicones are rightly placed as a new group of materials intermediate in properties and uses between the organic plastics on the one hand, and glass and the ceramic materials on the other."

CEMENTED CARBIDE

Makes Long-Wearing Dies For Deep-Drawing Metal

Good results in the production of cases for radio tubes are being obtained with deep drawing dies of cemented carbide. Here, on an operation where 100,000 pieces per die give profitable performance, some of the carbide dies have turned out as many as 750,000 pieces—400 percent more than was calculated before they were installed.

The material being drawn is tin plated sheet steel, .011 to .012 inch thick. Disks 2-9/16 inches in diameter are blanked and cupped in two operations. The first cup is 1-5/32 inch outside diameter and 1-1/8 inch high. The second draw is .795 inch in diameter and the draw angle is not blended but is cut 60 degrees. The cup is then finish drawn at size .795 by 1-11/16 inch high and with a .010 inch wall.

Some of the Carboloy cemented carbide dies for the first draw have run as high as 750,000 pieces. One of the second-draw dies has, to date, exceeded 100,000 draws and is still turning out excellent grade work.

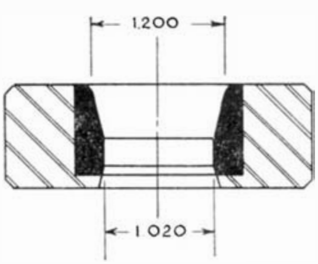


FIG 1. DRAW DIE

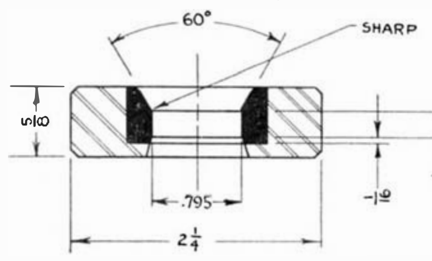


FIG 2. DRAW & PINCH TRIM DIE

Sections of the two cemented carbide dies used in the cupping operation described

TWO-WAY RADIO

Speeds Up Possible Rescue at Sea

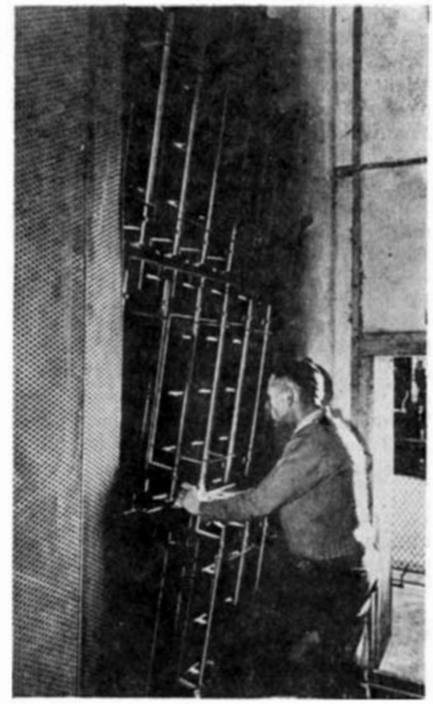
Capable of operating over distances of 1000 miles or more, new lifeboat radio equipment that automatically transmits SOS and radio direction finder signals, is designed to meet the demand for more dependable communication between victims of maritime disasters and rescue forces, and is reported to be far advanced over all previous lifeboat radio equipment. Its hand-driven power generator, which replaces storage batteries, and its two-way radio-telegraph and radio-telephone facilities, are combined in a single water-proof housing.

A 300-foot antenna, carried aloft by either a kite or a balloon, is largely responsible for the greater operating distances of the new unit, a product of Radiomarine Corporation of America. A kite, a collapsed balloon in a hermetically sealed container, and a small canister of helium are standard parts of the equipment. Weather and wind conditions determine the use of either the balloon or the kite. The balloon is designed to remain aloft for a week or more.

Intended for semi-permanent installation in the lifeboat, the new apparatus may be easily transferred from one boat to another. The transmitter, which may be used for either voice or code communication, delivers five watts of power to the antenna on frequencies of 500 and 8280 kilocycles. Operating on the former frequency, distances from 50 to 200 miles can be covered; the high frequency signals will reach points 1000 miles or more distant.

In addition to conventional voice and code methods the unit is automatic in operation. The cranking of the hand-generator causes a keying device to transmit groups of SOS signals to summon aid and "long dash" signals for radio direction finder bearings. The same keying mechanism switches the transmitter frequency from 500 to 8280 kilocycles as the power is generated, thus assuring automatic transmission on both frequencies.

When two-way communication is needed, the radio receiver can be brought into action. This receiver is pre-tuned to the international distress frequency (500 kilocycles). It also can be tuned to sweep the short-wave band from 8100 to 8600 kilocycles. Once communication with ships or shore stations has been established, the two-way feature permits the drifting seamen to give information that will expedite rescue operations.



Electrostatic air cleaning units installed in a bearing plant to remove all dirt, dust, and smoke from the air

AIR CONDITIONING

Aids Precision in Bearing Manufacture

To protect high precision accuracy in vital bearing plants, air conditioning equipment with a capacity of 12,000,000 cooling units or 2000 tons of refrigeration is being used by a bearing manufacturer. Installed by York Corporation engineers in the SKF plants, the air conditioning is vital in safeguarding production of tons of bearings a day ranging in size from the diameter of a dime to six feet. A total of 550,000 cubic feet of cool, filtered air a minute is circulated through the plants by means of a chilled water system and electrostatic air cleaners.

Air conditioning in these plants is aimed at improved production and a reduction of spoiled parts.

The smallest of several thousand different bearings made are ground to a surface finish accurate to one millionth of an inch, about the same thickness as the film of moisture left by breathing on a mirror. Even a microscopic bit of moisture, such as perspiration on the hand, will attack the surface of a bearing and eat into its finish in time. Once in contact with the polished steel, it cannot be easily removed and the corrosion will continue until the bearing is repolished.

To guard against this, before air conditioning was installed, the bearings carried a coating of oil to protect them during handling. But this protection in itself created another hazard. The customary dust, grinding grit, and haze in factory air collected more easily on the heavier oiled surface and threatened to cause destructive abrasion on the bearings when they were put in use in high speed operations, occasionally as fast as 50,000 revolutions per minute. In addition infinitesimal quantities of grit and dust on the bearings made size gradings complicated.

Now the manufacturing, assembly, and inspection areas are kept at a constant temperature of approximately 80 degrees and a humidity of 45 percent. Electrostatic air cleaners in the critical assembly and inspection operations filter out nearly 100 percent of all smoke, haze, and dust particles, delivering an atmosphere equivalent in purity to that found only at extremely high altitudes of the world.

SLIDE RULE

Tells Cutting Speeds Quickly and Easily

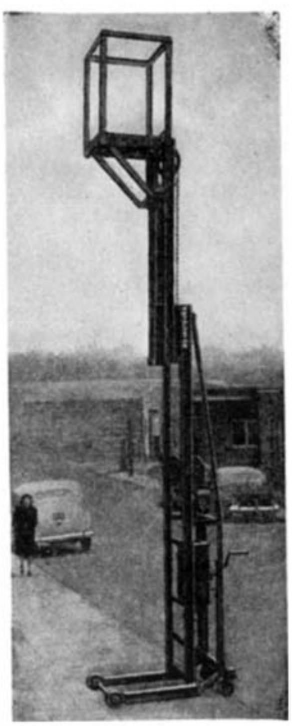
A VEST-POCKET plastics slide rule that instantly determines the correct speed for all metal cutting operations is now being manufactured. Simple operation enables machinists and supervisors to select most efficient cutting speeds for both high speed and carbide machining operations. Readings from 10 to 1000 feet per minute can be obtained. Handy size permits on-the-spot check of actual machining conditions. It is made by the Grove Calculator Company.

TELESCOPIC ELEVATOR

Has Hinged Section For Convenience

A PORTABLE elevator is being manufactured for convenient servicing of ceilings, sky-lights, overhead lighting fixtures, overhead heaters, and, in fact, all overhead repair work and cleaning at a height up to 24 feet.

The design combines the Revolvator telescopic principle with that of the



Overhead repair work simplified

hinge, as follows: Starting with the machine collapsed to a height of seven feet, the middle portion of the frame is turned up to an upright position on hinges. The upper section, with the platform at the top, is then raised by hand crank to the full height or any lesser height desired. This design permits the machine to be wheeled to the working position under low doorways or other obstructions.

Although of lightweight structural steel, the machine is so designed as to

be extremely rigid, with a liberal factor of safety permitting one or two men with tools to work on the raised platform without danger. The machine contains other safety features, including machine cut gears, wide spread auto-type steering, independent floor lock, self closing brake, and a device which holds the platform stationary in the event of breakage of the cable that actuates the elevator.

SURFACE GRINDER

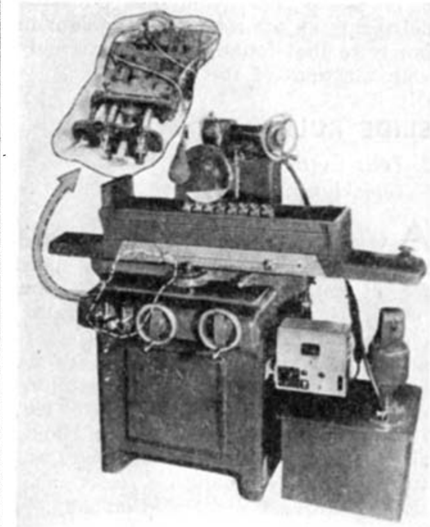
Has Hydraulically Operated Multiple Control Valve

THE CONSTANT research necessary to provide modern machine tools for American industry has led to the development of a new innovation in hydraulic valves. This new "five-in-one" hydraulic control valve has been incorporated in the DoAll G-10 surface grinder and provides increased speed, efficiency, simplicity of operation, and greater accuracies. This new machine tool, illustrated on the following page, will grind a surface with precision to six micro-inches.

To understand the function of this new valve, the requirements of an efficient surface grinder must be considered. The G-10 DoAll has a variable table travel of 0 to 50 feet per minute with a cushioned reversing action operated by a pilot valve to give smooth, long life performance. To accomplish this, a table control valve and a table reversing valve are necessary.

The crossfeed action (indexing at the end of the table travel) is actuated by

The Editors Recommend



Control valve (inset) insures precision

a hydraulic cylinder and can be controlled in infinite settings from .004 to .200, depending on the work being done. The crossfeed or traverse action, in addition to hydraulic operation, is also actuated by an accurate screw located in the center of the cross travel ways and can be held to split "tenths of a thousandth" for close tolerances on form and tool grinding.

INDUCTION HEATER

Designed for Metal Working, Has Automatic Timers

DEVELOPMENT of a new electronic induction heater for brazing, soldering, annealing, hardening, and pre-forge heating applications in the rapidly expanding induction-heating field has just been announced by the Allis-Chalmers Manufacturing Company.

With a low-loss coupling arrangement, the new electronic generator can be adapted to a wide variety of metal-working applications without the use of radio-frequency transformers. Predetermined automatic timing controls each unit operation, assuring uniform production quality. The operator pushes the start button and when the operation is completed, the unit automatically shuts off.

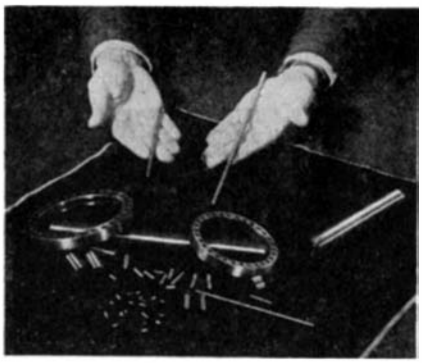
Other features of this electronic heater include a current limiting cir-

Simplified control and safety devices are features of this induction heater cuit for protecting the oscillator filament and prolonging tube life; a three-phase rectifier on larger size units to obtain maximum power and prevent unbalance of the power line; and safety devices for full protection of operator and unit.

THREAD GRINDER

Jumps Production While Cutting Costs

By forming the roots of a screw thread so that they come closer to fitting both American and British standards, a new centerless thread grinder may help to solve an international problem that has long been troubling industrialists and mechanical engineers of both nations. It is estimated that lack of unification of screw threads has already added 100 million dollars to war costs.



Typical threaded parts produced by a new centerless thread grinding unit

In addition to cutting production and replacement costs, the new thread grinder is said to step up production output as much as four to ten times the present rate.

Key to lowered costs and faster production is the centerless principle by which the machine operates. This makes it possible to feed the parts to be threaded continuously through the machine. Up to now, this process has been intermittent. Screws and other threaded parts are turned out with extreme accuracy, according to the Landis Tool Company, makers of the machine. Nearly 100 percent of the production output meets the Class Three fit standard set up for precision work in the aircraft industry. The machine is easily adjusted and operated. One of its advantages is that it will cut hardened steel as easily as softer steel, thus eliminating the distortion and discolorations caused by heat treating the part after machining.

ENGINE IDEAS

To Increase Efficiency and Use Low-Grade Fuels

Direct injection of gasoline into motor-vehicle engines, with injectors to replace carburetors, and the use of a new water-alcohol device with present carburetors for truck and bus engines, are two post-war ideas suggested to improve motor vehicle efficiency.

A 50-50 alcohol-water injection mixture appears to be the most economical fluid for best results. The alcohol content used may be a blend of various alcohols for denaturing purposes and to gain the best properties of each type. It is probable that the beneficial effects of alcohol-water injection are due both to cooling and to chemical action. Best gains are realized when fuel of approximately 12 octane number lower than the engine requirement is used, according to A. T. Colwell, vice president of Thompson Products, Inc.

Gasoline injection equipment for an otherwise conventional four-stroke-cycle automotive engine is described by Harry O. Hill, of the American Bosch Corporation, as a multi-cylinder injection pump having one pumping unit for each cylinder of the engine, driven at half speed from a train of gears at the forward end of the engine. An injection tubing from each pumping unit would lead to a spray nozzle located either directly in the engine cylinder head or in the intake manifold pointing directly at the air intake valve of the engine. A master control for regulating the amount of fuel delivered by the pump so as to maintain under all conditions the proper fuel-air ratio would be mounted on the injection pump and have a tube leading to the intake manifold, or alternatively might be mounted on the intake manifold and have a mechanical linkage of some sort to the capacity control lever of the pump. In either event the master control would derive its virtue from a pressure-sensitive element responsive at all times to the intake manifold absolute pressure. It would thus utilize the engine itself as an air meter and would proportion the fuel delivery accordingly. The intake manifold would be of extra-large capacity and would contain a throttle valve for the regulation of air to the engine. There would be no carburetor or other mixing device.

Among the advantages of this equipment would be improved volumetric efficiency, Mr. Hill said. Application of gasoline-injection equipment permits the use of large intake manifolds by eliminating gasoline mixtures from the induction system and making unnecessary any reduction in manifold flow area to insure adequate mixture velocities at low engine speeds, thus avoiding the customary compromise between good idling and maximum power.

CHAIN SAW

Cuts Trees Quickly, Saving Labor and Lumber

A LIGHTWEIGHT gasoline engine timber chain saw is expected to aid in lessening the manpower problem in the timber industry and speed the output of lumber needed for war and post-war urgencies. Among the advantages of the tool, manufactured by the Mall Tool Company, is an automatic centrifugal type, stall-proof clutch. If the saw is forced too hard, or pinched, the engine will not stop. When the difficulty is corrected, the operator can continue to saw by simply operating the throttle.

Gasoline powers this chain saw

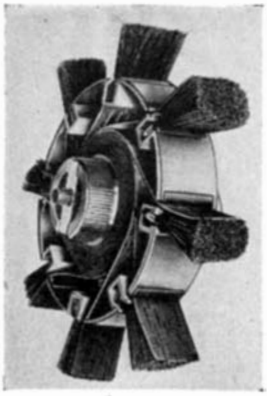
The saw is available in 24, 36, 48, 60, and 72 inch capacities. By cutting felling costs and enabling closer cutting to the stump, the saw saves timber and enables the lumberman to make greater profits. It is less fatiguing to the operators than hand sawing. Adjustment of a simple index lever permits horizontal or vertical cutting. The saw is many times faster than hand sawing and is quickly and easily serviced in the field. Another advantage is the fact that it can be quickly and easily moved over rough ground with little loss of time.

SANDER

Makes Use of Bristles to Back-Up the Abrasive

RECENTLY announced is a new, brush-backed sanding wheel which sands, deburrs, and finishes wood, metals, plastics, rubber products, and many types of special materials. The outstanding feature of this sanding device is its adaptability to jobs that were formerly done only by hand.

The device consists of a central



Eight abrasive strips extend through the housing of this sander and are pressed against the work by bristles

magazine which houses the strip abrasive. Eight of these strips extend through the housing and are held against the work by tough bristles. The bristles "cushion" the abrasive, making it possible to get in and around corners, hollow and fluted surfaces, and small openings.

Overall diameter of the Sand-O-Flex (including brushes) is approximately eight inches. Weight fully loaded is about 2¾ pounds. Normal loading contains 20 feet of abrasive and reloading is done simply by unscrewing a serrated nut and removing the cover. A wide range of abrasives of various grits and grades are supplied for use with the sander. These cartridges, plus the quick-changing feature, permit the same tool to be used in all operations from rough stage to polished surface.

DUST COLLECTOR

Made Specially For Laboratories

A SELF-CONTAINED combination dust collector and bench designed for collecting both wet and dry dust, dirt, lint, pumice, and so on, in dental and similar laboratory work is now available. Requiring no installation other than merely locating and plugging in the cord to the nearest electric light outlet, Lab-Bench dust collector not only eliminates time usually needed for cutting and fitting for installation, but has an

Filters and fan of this self-contained dust collector are in base

unusual amount of storage space for the collected dust and dirt.

The design permits all the material to be separated out of the air stream before the latter enters the fan. Hence, any type of material can be handled without wear to the fan blades.

A self-shaking feature of the bag type filter also eliminates maintenance, and renewal of the filter element does not have to be made except at most infrequent intervals.

Recovery of precious metals such as gold and silver is easily made when the collected dust and dirt is removed from the bottom of the collector. Precious metals that have become lodged on its surface or imbedded in the filter can be recovered simply by burning the filter which is inexpensive.

VAPORIZER

Produces Steam Quickly, Shuts Off When Dry

HOLDING a full half gallon of water, a new Spartan vaporizer discharges a "dry steam" type of vapor less than one minute after connection to an electrical outlet—even though extremely cold water has been used.

Entirely automatic in action, the unit does not require the addition of any

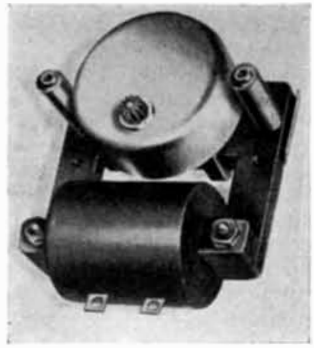
Quick-acting vaporizer

extra ingredient, such as salt, to enhance fast starting, and it shuts off as soon as the water chamber is empty. A special compartment is provided for the medicant. The main body, handle, and several parts are molded of a special Durez plastics which resists heat, water, and chemicals, is easy to clean and to keep clean, and is self-insulating. The cover is of smoothly finished aluminum. The complete unit is only 5 inches high, 5½ inches wide, and 7¾ inches long, and weighs approximately two pounds when empty. While the vaporizer is designed primarily for relief of bronchial ailments, its capacity suggests its use as a humidifier for offices and sleeping rooms where humidity is too low.

TIMING MOTOR

Shaft Rotates Once an Hour For Use in Control Devices

WITH a terminal shaft speed of one revolution per hour a timing and control motor has been developed to meet control manufacturers' demands for a slow speed, totally enclosed motor for use in timers, thermostats, oil



Slow speed for controls

burner and coal stoker controls, and other apparatus in which minimum space and slow speeds are necessary. This new motor, a product of the Warren Telechron Company, has an input rating of two watts and can be furnished in other speeds up to and including six revolutions per hour. A special oil gland has been built into the terminal shaft bearing, thereby extending its life greatly under industrial and domestic operating conditions. The terminal shaft is concentric with the outer case of the motor.

HELPFUL DOLLY

Designed for Handling Long Objects

HANDLING and transportation of large unit loads of landing mat strips by electric industrial trucks created difficulties arising from the ungainly dimensions of the material. Factory aisles were not wide enough to permit carrying the strips crosswise of the platform, and the standard truck platform was not long enough to permit carrying them lengthwise and have a well balanced load. A satisfactory solution was obtained by constructing an auxiliary dolly mounted on casters. It can be moved about manually to a limited degree and can also be transported rapidly between various operating departments by electric truck.

The dolly was made by welding

Long loads easily handled

flame-cut parts of standard flat rolled shapes. A steel fitting bolted to the forward end of an Elwell-Parker power truck platform provides for a pin connection between the base frame and the truck. The truck lifts only one end of the dolly and can either push or pull the load through narrow aisles and around corners with ease and safety.

This arrangement for handling loads of long pieces has the advantage that the truck can be made quickly available for handling other types of loads on skids in the same plant. It can easily be modified to accommodate other types of material in long lengths such as tubes, bars, small trusses, and the like.

INDENTING MACHINE

Rapidly Produces Straight-Line Impressions

An indenting machine that marks straight-line impressions on metal parts at a high rate of production has been given the trade name Gottscho Indenta #10. The moving parts consist mainly of a sector of a round steel die,

High-speed metal marker

which makes a half turn and stamps an imprint into the metal part. The die then returns to its starting position, the marked part is removed, and a new one put in its place.

The actual marking occurs in a fraction of a second, so that production is dependent on handling. If parts may be smoothly conveyed to and from the machine, production may be higher than 1200 per hour, according to the manufacturer. A friction clutch prevents jamming.

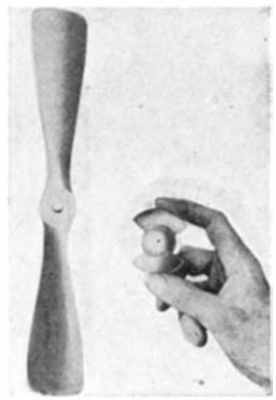
FANS

Designed for General Industrial Applications

Two new axial flow fan units, one 60 inches in size and the other two inches, have been announced by Dynamic Air Engineering, Inc. The 60-inch low-pressure propeller, driven with a 10-

horsepower, 1150-revolutions-per-minute motor, delivers approximately 60,000 cubic feet of free air a minute. Wide general industrial use is expected, particularly where space, economy, and efficiency is important in air movement.

The midget two-inch propeller has been developed for a complete fan unit.



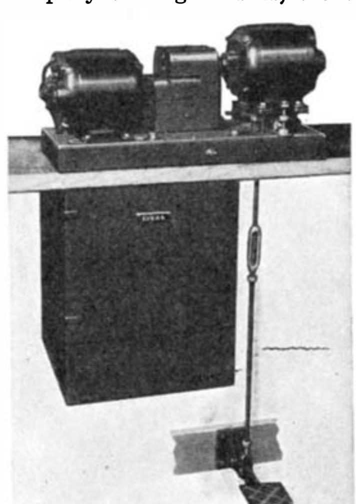
Economy of space and power in industrial uses are predicted for these axial flow fan units

It will be powered by a tiny motor of approximately one two-thousandth horsepower and will deliver 30 cubic feet of air per minute. It was originally engineered for the cooling of modulators in airborne electronic equipment.

WIRE STRIPPER

Has Two Brushes Driven by Separate Motors

An inexpensive wire stripper for cleaning cotton and enamel, silk and enamel, string asbestos, and similar types of light insulation has two wire cleaning brushes positively driven, mounted directly on the end of separate motor shafts. Stripping is done by simply inserting the wire in the opening and pressing the foot pedal. Between the two rapidly turning brushes, the wire



Insulation stripped from wire by the brushes is collected in the cabinet

is quickly cleaned. Where desirable, the distance between the brushes may be set to the diameter of wire, thus eliminating the foot pedal action. The brushes are made in sections of special steel wire ground to size. The machine is a product of the Commutator Dresser Company.

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.)

ARRIVED O. K. is a well illustrated booklet which shows, step-by-step, the methods of sealing fiberboard and V-board shipping containers and waterproof case liners for export shipments. The adhesives used are made to meet government specifications to withstand rough treatment, extremes in temperature, and high humidity. *Minnesota Mining and Manufacturing Company, Saint Paul 6, Minnesota.—Gratis.*

NEVILLE RESINS AND PLASTICIZERS is an 82-page booklet presenting new information on applications, detailed specifications, properties, and other characteristics of a number of these products. A preview of new resins, solvents, and pure chemicals, some available in sample form only, are described. *The Neville Company, Neville Island, Pittsburgh 25, Pennsylvania—Gratis.*

THE CONSULTING CHEMIST AND YOUR BUSINESS is a brochure outlining the type of business enterprise which finds use for the services of consulting chemists and describing some of the branches of service offered, including research in rubber and plastics, organic synthesis, physical testing, chemical engineering, and calibration service. *Foster D. Snell, Inc., 305 Washington Street, Brooklyn 1, New York.—Gratis.*

MANUAL ON FLEXIBLE METAL HOSE USE is an illustrated catalog dealing with a complete line of hose construction, flange and coupling types, vibration absorbers, laundry and platen press units, and other specialties. *Packless Metal Products Corporation, New Rochelle, New York.—Gratis.*

ADHESIVES, COATINGS, PRIMERS, AND SEALING COMPOUNDS is a 56-page catalog dealing with the vulcanizing and non-vulcanizing types of cements made from rubber and other materials. General information and rules of application on each type are given and questionnaire pages with space for information on adhesive data inquiries are featured. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

COLLET CATALOG No. 45 is a 20-page pamphlet that illustrates and gives complete specifications and prices of a complete line of collets and stock pushers, including new models. *The Sheffer Collet Company, Traverse City, Michigan.—Gratis.*

CAN ELECTRONICS IMPROVE YOUR PRODUCT? is a 32-page booklet designed to help executives seeking sources for electronic features to be incorporated into mass-production products. This booklet provides practical information regarding the firm's facilities and capacity for the production of electronic sub-assemblies and parts. *Operadio Manufacturing Company, St. Charles, Illinois.—Gratis. Request this booklet on your business letterhead.*

GROUND THREAD CUTTING TOOLS AND HOBS is a four-page bulletin containing descriptions and instructions to customers on the ordering and selection of hobs, taps, cutters, and leaders. Operational details of the U-6 automatic thread milling machine are given. Data on special gages, jigs, and fixtures are also included. *Universal Engineering Corporation, Cedar Rapids, Iowa.—Gratis.*

AS MANY AS 500 IN ONE PLANT is a six-page catalog containing well illustrated descriptions of three models of transmissions for motorizing various cone driven machine tools. Among the installations pictured are lathes, shapers, milling machines, automatic slotters, and vertical and horizontal boring mills. *Western Manufacturing Company, 3400 Scotten Avenue, Detroit 10, Michigan.—Gratis.*

WHITE POTENTIOMETERS AND ACCESSORIES is a 12-page catalog based on information that is valuable to those confronted with educational or research problems involving precise measurement of temperature or temperature difference. Both the single and double potentiometer are described. *Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pennsylvania.—Gratis.*

THE WORLD SYSTEM OF DECIMAL WEIGHTS, MEASURES, GRADUATION, AND TIME, by Hamar, is a 69-page lithographed booklet which describes a measuring system for universal use which places weights, measures, graduation of the earth, and division of time on a common decimal basis. The conception is ingenious, but any realization of it is far in the future. Paper covers. *Universal Unit Systems, Inc., 60 East 42nd Street, New York 17, New York.—$1.25.*

A PRACTICAL GUIDE TO THE USE OF THE OPTONIC COLOR SYSTEM is a 12-page color selection guide based on 18 short and simple rules for the selection on a scientific basis of paint colors for industrial, commercial, and institutional interiors. *The Arco Company, 7301 Bessemer Avenue, Cleveland 4, Ohio.—Gratis. Request this booklet on your business letterhead.*

KNO-DRAFT ADJUSTABLE AIR DIFFUSERS is a 76-page loose-leaf binder containing sketches, charts, instructive text, and dimension prints to help simplify the selection and application of air diffusers. Data on selection, application, location, assembly, erection, adjustment, and testing are given, together with information on accessory equipment. *W. B. Connor Engineering Corporation, Department D, 116 East 32nd Street, New York 16, N. Y.—Gratis.*

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. All remittances are to be made in U. S. funds. Prices given are subject to change without notice.

TO MAKE CERTAIN that books ordered by or for men in the Army, located in the United States, or men in the Navy, Marines, or Coast Guard, located anywhere, will be delivered, insurance fees should be sent with orders, as follows: To $5 in value, 3¢ additional; from $5 to $25, 10¢; from $25 to $50, 15¢.

POT LUCK

By Roland Clark

THIS is a most attractive book of interesting gunning stories by the well known writer, etcher, and painter, Roland Clark. It is profusely illustrated by the author himself. Mr. Clark has hunted all his life and we heartily agree with Mr. Holmar who wrote the introduction to this charming book when he says of Mr. Clark: "As a teller of tales that grip the hearts of men who go out in the early dawn and cast their decoys on rosy waters, or tramp the frosty uplands, he is hard to surpass." (101 pages, 6 by 9½ inches, 6 colored illustrations, reproductions of sketches and etchings as additional art work.)—$3.60 postpaid. *—O.D.M.*

AERODYNAMICS

By L. R. Parkinson

IF YOUR vocation or avocation requires or suggests that you should have a fundamental knowledge of the abstruse science of aerodynamics, you can acquire such knowledge quite painlessly from the pages of this well written little book. With a minimum of mathematics, it deals briefly yet succinctly with physical properties of the atmosphere, effects of air streams, lift and drag, air foils, lift increasing devices, propellers, and wind tunnels, together with other pertinent phases of the subject. Elementary phases occupy a large part of the text, but advanced parts are not ignored. A number of reference tables supplement the text. (112 pages, 6 by 9 inches, 73 photographs and drawings.)—$2.35 postpaid.*—A.P.P.*

COLLEGE PHYSICS

By Mendenhall, Eve, Keys, Sutton

FOR ADULT readers, whether in college or not, an elementary college textbook of physics makes an excellent reference and study book and this is one of numerous texts which rate high. It is rather longer and better illustrated than most. It is less mathematical than some and the mathematics is limited to simple algebra and a little trigonometry. The whole field of classical and modern physics is covered in a rounded way and the treatment is rather detailed. No amount of home study of physics will fulfill the lack of a teacher and experiments but application will go a long way in that direction. (693 pages, 5¾ by 9 inches, 597 illustrations.)—$4.10 postpaid.*—A.G.I.*

FORMALDEHYDE

By J. Frederick Walker

REPORTED to be the first serious attempt to sift and analyze the literature on the subject of formaldehyde, this technical treatise presents the essential facts, evaluated and reviewed by a technician with a background of years of experience in the field. This volume will be a standard reference for a long time to come. (397 pages, 6 by 9½ inches, 28 illustrations, 31 tables, comprehensive reference lists.)—$5.60 postpaid.*—A.P.P.*

PRINCIPLES OF PHYSICAL GEOLOGY

By Arthur Holmes

AN EXCELLENT and thoroughly up-to-date treatise on physical geology, written primarily for students and teachers as a serious textbook, this volume may be broadly defined as the interpretation and description of the physical appearance of nature. Titles of some of the chapters of this beautifully illustrated work are particularly enticing, as for example: The Changing Face Of The Earth, Rocks As Pages of Earth History, and the like. Part I deals with a general survey. Part II is entitled "External Processes and Their Effects." Part III is entitled "Internal Processes and Their Effects," and goes into earthquakes, earth tremors, and volcanic activity. (532 pages, 95 plates, 262 illustrations.)—$4.10 postpaid.*—A.K.*

THE FIRE SERVICE TODAY

By Frank Eyre and E. C. R. Hadfield

IN THE language of the firehouse, amateur enthusiasts of the ancient, hazardous, and honorable trade of firefighting are "buffs." This account of the

British Fire Service that struggled to extinguish the myriad fires of the London blitz is a book for them. Professional firemen also should find it of great interest. In addition to a brief and entertaining history of firefighting in England and a description of the variety of equipment used today, the book contains an illuminating account of how fires should be fought. This is the best part of it for the American reader. There is a lot more to putting out a fire than squirting water at it and smashing windows, and the more the fireman knows of his trade, the greater his chances of dying of old age. (148 pages, 5½ by 8½ inches, many illustrations and index.)—$2.10 postpaid.—*J.C.*

THE RADIO AMATEUR'S HANDBOOK

1945 Edition

Latest edition of this yearly publication, the twenty-second, is rated as the most widely used radio training text in existence. This edition contains material on the older, familiar phases of radio theory, plus information on the more advanced techniques of the future. (512 pages of text, 200 pages of advertising, 6½ by 9½ inches, comprehensive index, paper covers.)—$1.00 postpaid.—*A.P.P.*

DEMOCRACY UNDER PRESSURE

By Stuart Chase

Those tightly organized minorities whose purpose it is to obtain special privileges at the expense of the public are exerting pressures that are pushing our democratic government out of alinement and causing it to function with impaired efficiency, according to author Chase. These groups are carving the national economy into segregated chunks which they regard as their own meat, not to be shared with others. The greediness of these "Me First" boys, Mr. Chase says, threatens the creation of the happy, prosperous, and free America that our fighting men and civilians want to build when the war is over. But the author is not content with only describing the evil—he has a number of cogent proposals for curbing the pressure groups and lobbies. A stimulating and informative book. (142 pages, 5½ by 8 inches.)—$1.10 postpaid.—*J.C.*

THROUGH ENGINEERING EYES

By Allan R. Cullimore

Engineers and all who are interested in engineering will enjoy this collection of selections from the literature of the world dealing with the inventiveness of men. The book begins with Homer's account of Vulcan's forging of armor for Achilles to wear in avenging the death of his friend, Patroclus, and ends with a selection from Michael Pupin's autobiography. In between, the chosen pieces represent a wide range of writers all in some way, factual or fanciful, having to do with engineering and science. At a time when the narrowness of technical training is giving educators some concern, a book such as this is especially valuable. Reading it, the engineer and the student in the technical school will obtain a whiff of the rich cultural history of humanity, and begin to sense that there is more to science than technical information. (166 pages, 5½ by 8 inches.)—$1.10 postpaid.—*J.C.*

MASTERS OF MASS PRODUCTION

By Christy Borth

In smoothly flowing text, amply seasoned with pertinent facts but unfortunately lacking a bibliography, the author has put together the running story of that particular phase of American industry which has made the United States pre-eminent in production. After dipping briefly into the story of the contributions which such men as Paul Revere and Eli Whitney made to our nation's greatness, Mr. Borth buckles down to the story of automobile manufacture, which, in truth, reflects the perfection of the art of mass production. Those giants of this industry—Knudson, Ford, Herrington, and dozens of others—naturally occupy a large part of the volume. And, of course, due recognition is given to the tremendous part which mass production played and is still playing in World War II. Altogether, this story is one to make Americans proud of American ingenuity. (290 pages, 6 by 9 inches, a number of illustrations.)—$1.60 postpaid.—*A.P.P.*

ROCKET RESEARCH

By Constantin Paul Lent

Historical aspects of rocket research occupy about 40 percent of this compact little book. Then is presented a concise chapter on rocket theory, followed by chapters dealing with practical applications, hints to experimenters, and a resume of the potential advantages of jet propulsion. Many of the drawings give specific details of various types of rocket and jet propulsion motors. Listed in an appendix are the numbers of some American and British patents on rockets, and a roster of rocket societies. (120 pages, 6 by 9 inches, over 100 illustrations.)—$5.10 postpaid.—*A.P.P.*

SEEING THE INVISIBLE

By Gessner G. Hawley

An up-to-date, popular, not a highly technical, account of the electron microscope and it remarkable findings in the world that has been too minute to descry under the best optical microscopes. This book starts at the beginning and explains the instrument and it findings as it goes, so that the average reader could carry away a clear, rounded, even if not profound, concept of the subject such as a physicist might demand. Included are some of the newer micrographs which have revealed unsuspected details. (195 pages, 4½ by 7 inches, 71 illustrations.)—$2.60 postpaid.—*A.G.I.*

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"

CONCRETE, offered as a material for telescope making by Russell W. Porter in "A.T.M." (chapter on mounting design, Figure 7, "Porter's Folly"), has not yet met with general favor, perhaps because there is a feeling that concrete is crude. Frederick H. Minard, 834 Thayer Ave., Los Angeles, California, with Edward A. Carson of Los Angeles, has now constructed "Porter's Folly" of concrete in 10″ *f*/10 size, (Figure 1). The conical polar axis is made of 16-gage steel attached to a 27″ flywheel and poured full of concrete. That part alone, with the concrete-filled, 16-gage steel fork, weighs 1250 pounds.

Asked to particularize, Minard (Figure 2) writes:

"After carefully studying the two volumes on amateur telescope making we decided that 'Porter's Folly' was not at all, as he nicknamed it, a folly but a feasible idea. So we set to work and it took us the better part of a year to complete the entire installation. Edward A. Carson was associated with me; in fact, the telescope was constructed and installed at his estate in Bel-Air, this city. The results proved the soundness of Mr. Porter's idea and it is a most satisfactory instrument in every way.

"Upon viewing the instrument it would never be suspected that the main elements were constructed of concrete. The basal block, containing three adjusting screws on the bottom, is a plain concrete block, poured in the usual way in a wooden form. The latter was removed and it remains a concrete block, but it is all below the observatory floor level and is not visible. It is covered by removable floor sections.

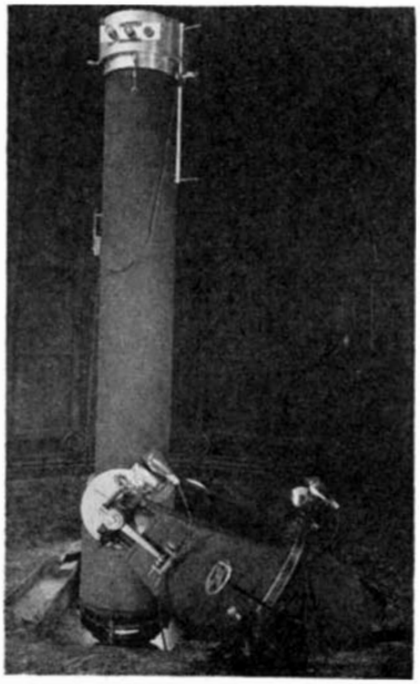


Figure 1: Porter's Folly

"Now comes the disguise of the visible polar axis—the right ascension circle is a flywheel, 27″ in diameter, into the hub of which is fitted a long 2″ shaft, trued in a big lathe. On the lower part of the shaft is welded a 16-gage steel disk about 12″ in diameter. Then a 16-gage truncated steel cone was rolled and welded on to this assembly, the large end fitting inside the rim of the flywheel and the smaller end on the 12″ disk.

"Into this assembly were placed the long rods which hold the declination bearings and around these rods were placed shaped 16-gage steel forms and these forms make the outline of the yoke, which shows in the photograph.

"Having this concrete-metal structure all set and trued up, the entire layout was stood up with the small disk end down and the entire form was filled with concrete.

"The only concrete surface that shows is in the center of the flywheel around the hub top and, as this is painted black, no one would suspect there is any concrete in the construction. Not even a trace of a crack has ever appeared on this small exposure. In fact, the entire polar axis looks as though it were turned out of steel.

"One can kick the polar axis to the extent of almost breaking a toe and there is no vibration of the telescope tube.

"The telescope driving mechanism is located at the lower end of the polar axis, entirely below the floor level, in a concrete vault. Consequently, the observer is always in a comfortable observing position and even at the meridian has only to mount two steps above the floor level.

"The weights are: Tube (16-gage rolled steel), 55 pounds; mirror and cell, 29 pounds; lead counterweight ring, just above cell, 350 pounds; tube bearing ring with trunnions (one-piece aluminum), 26 pounds; upper end ring with flange and revolving head (aluminum), 26 pounds; revolving cone, steel-jacketed concrete, 1250 pounds; concrete three-point bearing block, 1500 pounds. Total, 3226 pounds.

"It is a very stable telescope and free from vibration, yet the part showing above the floor does not look massive.

"The observatory is fitted with flanged wheels on the bottom of the dome and the entire dome revolves on a 20-pound circular rail on a concrete foundation. The observer can easily push it by hand. The floor of the observatory is of concrete on which is laid heavy linoleum."

Porter, who went to see this telescope and its handsome and practical dome, reports: "'Porter's Folly' is at last vindicated. It's a mighty good job and it works. Steady as the Rock of Gibraltar. A concrete telescope mounting!"

True, this telescope is largely concrete but it still is not quite a concrete mounting unashamed. Yet, though so much of the concrete work we see here and there looks ratty, it remains nevertheless possible to do concrete work that looks finished and refined. To accomplish this let the worker forget most of the working technique he has picked up from sundry laborers, foremen, and contractors. Let him then obtain scientific instructions from a sound source (for example, the Portland Cement Association, 347 Madison Ave., New York) and carefully study those instructions and the principles behind them. And then let him follow them to an extent that seems fussy, taking special pains to obtain low water content, to ram the placed "mix" well and cure it really adequately.

Figure 2: Minard and dome

Such work should be free from the cracks and spalls and other flaws so commonly seen in concrete.

SOME seeds gestate a long time before sprouting. The short chapter on "Dealing with Spider Diffraction," in "A.T.M.A.," reached notice in 1941 in the July-August number of *The Journal of the Royal Astronomical Society of Canada* (198 College St., Toronto, Ont.) in an article by C. H. Werenskiold, from which the following is quoted:

"This method consists in placing, in the open end of the telescope, a diaphragm having four elliptical openings, in such a manner as to cover or hide the four straight arms of the spider and in effect provide them with a curved outline. A modified procedure is also described in which the spider arms are covered with small plates or screens of curved outline. The spikes or cross-bars in the star images were eliminated in both cases.

"The use of diaphragms or screens naturally causes a certain loss of light, and it has occurred to the writer that this loss can be reduced to a minimum by curving the spider arms themselves, which would render the use of diaphragms or screens unnecessary.

"Several methods for accomplishing this are possible, of course, such as suggested in Figure 3, at 1, 2, and 3, and where *E* indicates the position of the eyepiece and *P* that of the assembly supporting the prism or diagonal.

"Up to recently the writer has employed the 'straight' spider construction of 4, made from brass strip approximately 1" x 1/16", in an 8½" reflector, and no substantial mechanical weakness or vibration due to the omission of the fourth spider arms has been noted. The star images with this spider naturally exhibited the usual spikes. In considering the various possible curved spider designs, the one shown in 1 appeared most attractive from a mechanical standpoint, since its arch-like design offered strength and stability, together with a reduction of the number of spider arms to two. A curved spider of this type, made from brass strip approximately 1" x 3/32", was substituted for the straight spider formerly employed and has been found both mechanically satisfactory and effective in eliminating the spikes from the star images.

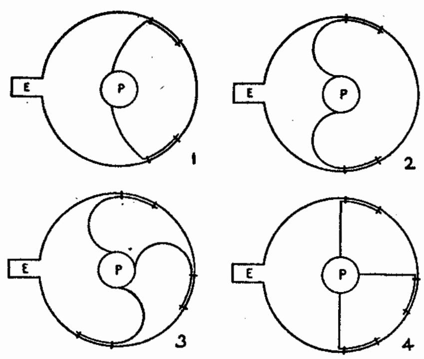


Figure 3: Four spider types

"Furthermore, the definition obtained in the observation of planets, such as Jupiter and Saturn, appeared to be considerably improved. This is readily understood when we consider that the bright disk of a planet as seen in a telescope constitutes a pattern composed of smaller light elements. Each of these, depending on its individual brightness, gives rise to more or less luminous cross-lines or spikes when a straight spider is employed, with the total result that the image of the planet is accompanied by a hazy, more or less noticeable, cross-band of light, approximately as wide as the diameter of the planet and oriented in the manner of the usual star spikes. It seems obvious that the definition would suffer under such circumstances, the fine detail originally rendered by the mirror being again partly obliterated by the superimposed cross-band of light. Since no such cross-band is formed when a curved spider is used, the definition is improved accordingly.

"As to the practical construction of the spider 1, it was found desirable to prepare an exact drawing beforehand and to calculate geometrically the overall length of the spider to determine the exact position of the bends adjoining the telescope tube. In order to obtain satisfactory results, one must make certain that each spider arm is curved continuously without any straight sections. As the work progresses, the shape of the spider should therefore be compared carefully with the drawing. A liberal additional length of strip was allowed for fastening the spider to the telescope tube with short bolts. The holes for the bolts were elongated lengthwise of the strip, and the corresponding holes in the tube were elongated at right angles to this; that is, lengthwise of the tube, to the extent required for adjusting the spider to its correct position.

"The more strongly curved forms shown in 2 and 3 may have certain advantages in construction, such as lessened danger of straight sections, but whether these modifications are otherwise practical has not been investigated.

The same subject is discussed in mimeographed Mailing 20, of the "Astronomical Information Sheets" (a service for placing information on new comets, novae, occultations, and so on into amateur astronomers' hands quickly: 20 mailings, a dollar, G. B. Blair, Dept. of Physics, University of Nevada, Reno, Nevada, Editor) by Clarence W. Parham Sr., 2354 Woolsey St., Berkley, California, who has had excellent results with the streamlined spider in his 6" reflector and will be glad to answer any questions proposed by interested amateurs. He made his spider of a single strip of 3/32" x 1¼" brass bent as in 2. Where sharp bends were needed at the ends, the strip was grooved with a hacksaw, then bent, and the groove filled with solder.

In Mailing 44 of the same "Information Sheets," Carl E. Wells, 419 Oak St., Roseville, California, states: "Mr. Franklin B. Wright, 155 Bret Harte Road, Berkeley, drew my attention to the fact that this spider must be curved in multiples of half circles—that is, one half circle, one circle, one and one half circle, and so on. Also, your prism holder should present a full circle to the light rays. A square prism holder will destroy the effect you are trying to get with the streamlined spider."

TO THOSE who are designing Maksutov telescopes, the following, from the author of the articles in the October and December numbers, should be of interest. "I wish you would kick me good and hard, as there is an error in the December article, page 285, first column, at bottom. The figure .122 should instead be half that, or .061," and the other figures mentioned in relation to it are wrong to the same extent. I picked up the figure for a diameter instead of an aperture radius. My apologies to all and sundry."

The Maks are still delayed because those who had nearly finished them suddenly took war production contracts.

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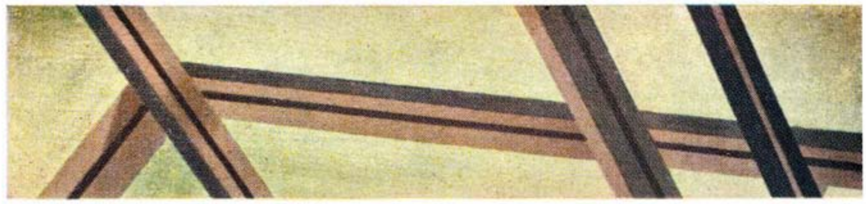

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