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SEPTEMBER 194[illegible]
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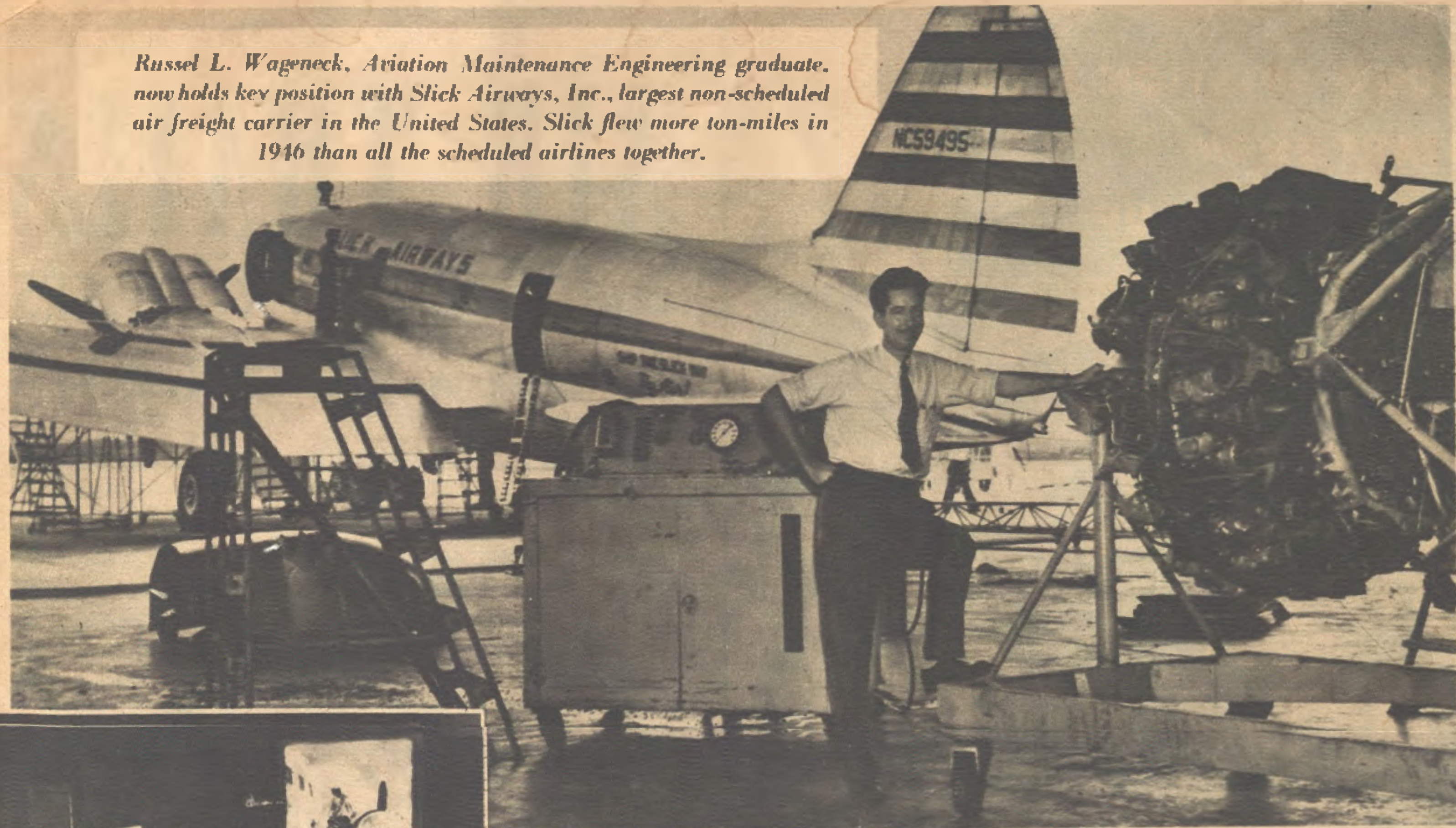

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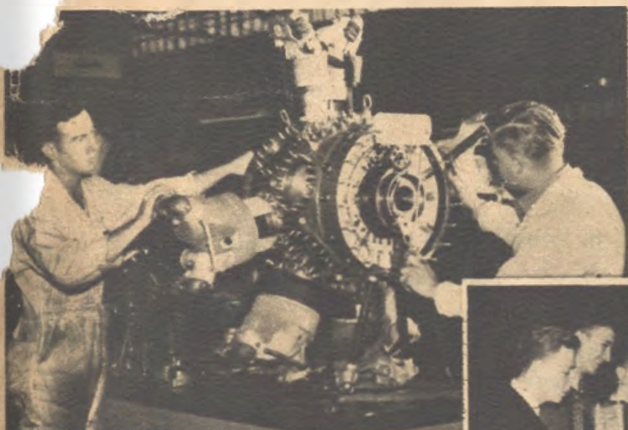

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AIR TRAILS
and SCIENCE FRONTIERS

SEPTEMBER, 1947—VOLUME XXVIII, NO. 6

CONTENTS

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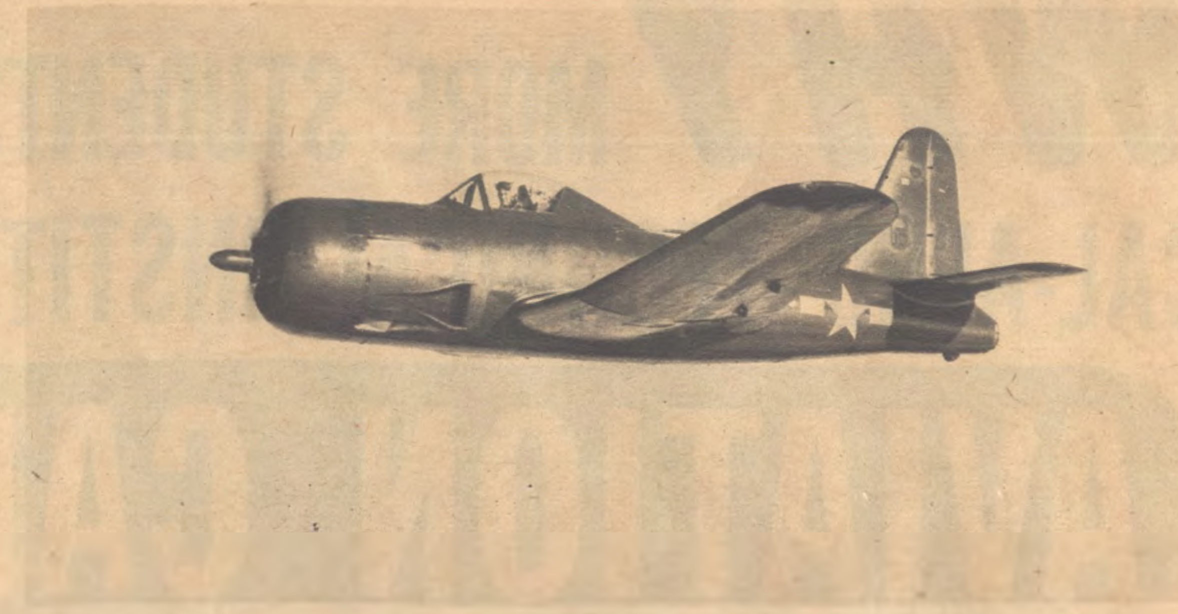
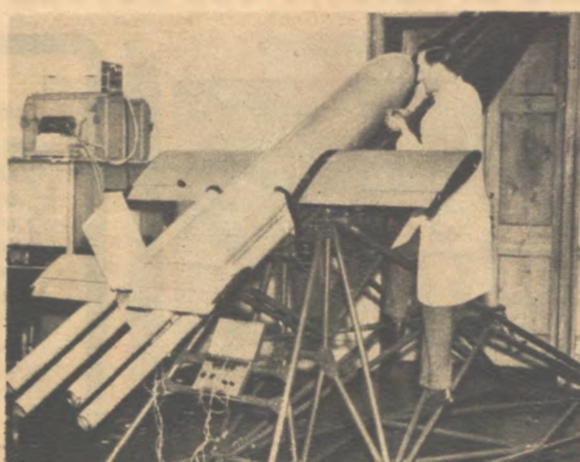


● The Ryan XFR-4. Although similar to the FR-1 Fireball, this new Navy experimental fighter has flush-entry air ducts at forward section of fuselage and the more powerful Westinghouse 24C turbo-jet engine.

NEW AIRCRAFT

● Made in Canada, the North Star is powered by four Rolls Royces, is in service with Trans-Canada Airlines.

● First postwar airplane produced by Fokker in Holland holds four people, has maximum speed of 150 mph.



● The Stooge, first pilotless radio-controlled rocket missile developed by England has a speed of over 500 mph.

● The Commuter, produced by Stanley Hiller, Jr., is a compact helicopter featuring unified control system.

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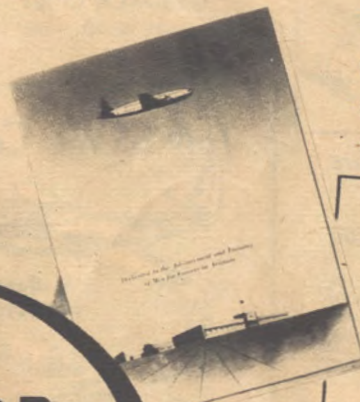

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APPROVED FOR VETERANS

MEET THE AUTHOR

Five years ago, John F. Mason (co-author of "Private Flying Today," p. 22) plunged headlong into aviation. When he comes up, it's only for air. He likes it and plans to stay in it. Today, at 26, he's already covered a lot of ground in planes ranging from AT-6s to B-29s; was an aerial gunner trainee on the former to radar-navigator on the latter. In between came B-17s, C-47s, and combat.

In 1942, immediately after being graduated from the University of Mississippi, he left his home town, Jackson, Miss., for a career in aviation. This move had all the earmarks of an ideal setup: free instruction plus clothes, room, board, and even a modest salary. There were disagreeable aspects, of course—that bugle in the morning for one. But he liked the Air Corps from the first day at Kelly Field and continued to like it until he was separated in late '45.

His training in the States won him two sets of wings (navigation and aerial gunner). Phase training on a B-17 crew followed and then a flight to England. Because of Mason's record in night flying he was switched to an American night bomber squadron, one of the few in the ETO. Here he started school all over again and spent three weeks tinkering with British radar.

It was there in a fog-bound Quonset hut that Mason fell in love with radar. There were two reasons for this: one, he knew radar would get him to his target over blacked-out Europe and also get him back; and, two, it was fascinating stuff. He read every Tech Manual on electronics ever published and by the war's end had used about 15 different types of equipment.

His first few missions were night bombing raids with the RAF. Later his squadron was changed to the unglamorous, but none the less exciting, task of slipping out, one plane at a time, and dropping news leaflets to the Occupied Countries and propaganda to the enemy. These "nickel raids," as they were called, were more interesting from a navigator's standpoint because of the way in which they were accomplished. The leaflets broke apart when released at 30,000 feet spread into a 15-mile-wide cloud, and settled on the town one hour and 40 minutes later—at times as much as 90 miles from the point of release. The distance depended on the wind

(Turn to page 110)

John F. Mason


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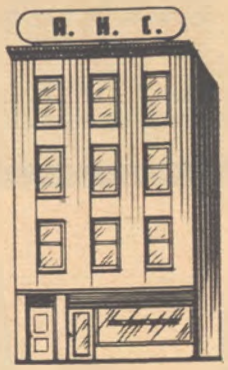

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we hear

that . . . . The S & S Engineering Company of Brooklyn, New York, has now prepared a diesel conversion kit for the popular 1946 and 1947 model Arden .199 engines. The kit, complete in every respect, including a supply of Diesoil fuel, is designed to convert the .199 from gas to diesel operation within a total time of 5 minutes. Such a conversion makes possible elimination of the ignition system, thereby greatly simplifying installation and operation of the unit.

that . . . . Bernard Schoenfeld has prepared a new speed and limited stunting U-Control biplane for Master Modelcraft Supply Co. of New York. Dubbed "Greyhound," the craft is designed for any "A," "B," or "C" motor. Top-flight performance is guaranteed when powered by engines of the Ohlsson "23" to McCoy "49" range. The model measures 16" in span and 19¼" over-all length. Available in kit form, material for construction includes a completely carved and hollowed balsa fuselage, wing and tail parts shaped, steel-wire ready-formed landing gear, balloon-type sponge rubber wheels, prefabricated motor mount, fully detailed plans with exploded views, and a host of other material essential for construction of the model.

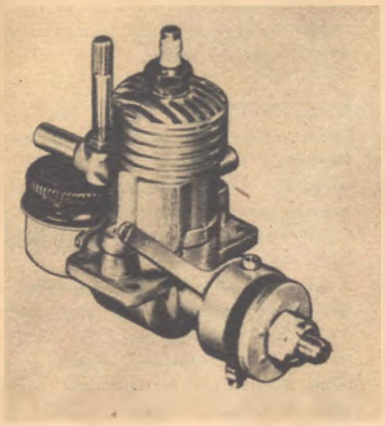
that . . . . Mr. Nils F. Testor, president of Testor Chemical Company of Rockford, Ill., announced the firm's woodworking division is now in production of select hardwood free-flight and U-Control gas model propellers. Available in 21 sizes, the props vary in seven different diameters and stamped for size and pitch identification, the units are precision manufactured, statically balanced, and spray finished with "Testor's Sanding Sealer" for over-all smoothness.

that . . . . A VIBRA-TAK indicator designed to indicate accurately engine r.p.m. readings has been developed by the Fowler Mfg. Co. of Los Angeles, Calif. The unit available through the Verdell Instrument Sales Company of Burbank, Calif., operates on a vibrating reed principle and includes a slide indicator adjustment with calibrations clearly marked on the instrument handle. Readings of 2,000 to 15,000 r.p.m. are accurately possible with this device. Priced well within the reach of all model builders it should prove a worthwhile addition to your instrument kit.

that . . . . The Megow Corporation, of Philadelphia, Pa., has recently released two new U-Control flyers designed by Matt Kania. First of these, the "Bantam Special," measures 18" in span and can be powered by any Class "A" or "B" engine. Featuring completely carved fuselage and tail assembly, the ship is equipped with a dropaway landing gear, Jim Walker control system, and single elevator control for greater flight stability. The latter, known as "Sky Streak" (see photo), is designed for any Class "A" engine, including several of the smaller diesels. The craft, completely carved and ready for assembly, will retail at an amazingly low price in keeping with the present trend for more value at less cost. This kit also includes the Walker Control System.

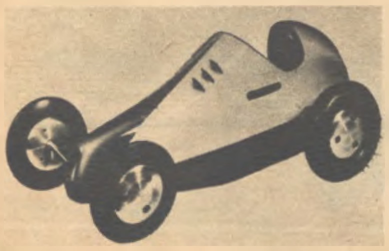
that . . . . High on the list of "Just Out" photographic accessories are the new Chess-United Filter Mounts and Sunshades. Developed to accommodate the Omag, Wratten, and other standard series filter disks they are interchangeable with similar parts of known manufacture. Engineered for close tolerance fit, easy adjustment, and permanent grip these are truly precision products.

we hear



that **. . . .** Genie Models, of New York City, have readied a new model powerplant known as the Genie 29. The new gas engine has been developed to make available all of the advance features incorporated in expensive units, a host of additional innovations, and all at low cost. Weighing but four ounces, the motor has a .29 displacement, develops 1/6 horsepower, and operates at 300 to 10,800 r.p.m. The design features Doehler-Jarvis die castings, silver contact points to eliminate pitting, beryllium copper breaker point spring, transparent fuel tank with built-in gauge, and many other of the latest engineering developments.

that **. . . .** A new and economical Fed-Flash camera has been produced by the Federal Manufacturing and Engineering Corp., of Brooklyn, N. Y. The unit, compact and graceful, is of non-warping fog-proof bakelite construction. It features a 64 mm. Ultar fixed focus lens, Flash-matic shutter, built-in flash synchronization and view-finder. The flash unit features a professional size spheroidal reflector. No. 127 or No. A-8 roll film is used with the camera.



that **. . . .** The Engineering Development Co., of Del Mar, Calif., has completed plans for releasing two new items in their ever-expanding line of products. The new designs include a model Auto-Giro and a novel model racing car. The former is designed for any engine from .232 to .600 cubic inch displacement and embodies all the flying features of full-size autogiro aircraft. Measuring 27" in length, with 25" rotor blades, the model is available in kit form. Included in the kit are rotor head, blades, and other prefabricated parts. Complete hardwood, preformed landing gear and new type progressive assembly photo-plans insure rapid construction. The latter of Edco's two new items is known as the "Meteor." The car features uni-power drive with engine, rear axle assembly and driving gears as one unit. Ball-bearing axles, proper weight distribution and aerodynamic designed body further enhance the model. Weighing five pounds, twelve ounces ready to run, the car is available either track-tested complete with the Hassad motor or minus the powerplant.

that **. . . .** The Persons J. Crandall Co., of Dallas, Texas, is now marketing Killy's Speed Tables. The tables designed for fast and positive computation of speed for control-line models have already been successfully adapted in several Texas competitions and proven exceptionally useful in determining "close races." Enthusiastic approval has also been expressed by approximately 1,000 leader members of the A.M.A. after viewing the basic data available in the Killy Tables.

that **. . . .** The de Bolt Model Engineering Co., of New York, has finally, after over two years' development, released its demco Special, Jr. The model, an outstanding contender in many of the leading competitions throughout its period of engineering, has been officially clocked at 93.75 mph at the recent New York *Mirror's* Flying Fair. Designed to use an engine from .099 to .49 displacement, the craft measures 16" in span and 17½" in length. Available in kit form, materials include redi-carved and shaped parts, metal hubbed wheels, unbreakable plastic cowl, and a host of other fine features.

AVIATION TOMORROW

by JOHN FORNEY RUDY

Air Power: The nation's air power now, and for the immediate future, is in a sorry state of affairs.

Nearly every major nation is already or may soon be outproducing the United States in military aircraft.

Most of the aircraft manufacturing facilities used in 1944 no longer exist. If 50,000 planes were ordered at the present time, with money being no object, the nation would find it difficult indeed to produce as many as 5,000 planes within the next 12 months.

The air mobilization plans drawn in such seriousness at the end of the war are not being carried out. A minimum output of 5,780 military planes a year was deemed advisable, although the total military plane production in 1946 amounted to approximately 1,330 aircraft. The outlook for 1947 and 1948 is very depressing.

Of equal seriousness, the lagging air power has brought about a near-financial crisis in the aircraft manufacturing industry and will delay by months, and perhaps years, the research and planning now so desperately needed for both military and commercial planes.

The need for a consistent long-term production program, based on a period of at least five years, is urgent. No one in the industry contemplates a huge volume of military orders. Everyone agrees to the necessity for a sufficient number of planes to be built which would guarantee a consistent and continuous program of research, development and manufacture.

Lacking an adequate program for the military, commercial aviation is bound to lag. Manufacturers cannot be expected to spend millions of dollars on research and development lacking a well-rounded manufacturing volume of military, commercial, and private planes. Each is dependent in large degree upon the other, and the aviation industry has already found that it takes all three to meet the challenge of the present aeronautical revolution.

Tractor-Tread Planes: Army Air Forces is now testing a Fairchild Packet equipped with tractor-tread gears instead of conventional landing gear.

Although weighing nearly 1,000 lbs. more than conventional gear, tests are showing that the 58,000-lb. Packet can land and take off in almost any cleared area without needing treated surfaces. The braking effect of the tractor-treads cuts down the landing run. Other logistics problems of the AAF may be solved by use of tractor-treads, such as Arctic operations on ice and packed snow.

Explosion-Proof Planes: The recent Decoration Day weekend series of transport crashes again serves to illustrate the urgent necessity for explosion-proof equipment in the electrical systems of modern passenger-carrying planes.

According to aircraft engineers, the use of a continuous air duct system completely segregating the machine from the surrounding explosive ambient appears to be the only practicable solution, although vented construction also offers considerable safety in the larger motors.

General Electric has recently developed new types of enclosures for electrical motors and controls which permit the escape of gases which are generally locked in such enclosures and constitute serious fire hazards. GE's enclosures are equipped with venting windows covered with a porous material which permits the gases to escape.

5,000-Lb. Thrust Engine: After six years of secrecy, AAF is finally permitting disclosure of its 5,000-lb. thrust jet engine, the XJ-37, which is almost ready for use. Developed by Menasco and Lockheed for AAF, the XJ-37 has a small frontal area permitting its installation on either wings or fuselage.

The 1,500-lb. engine may be used on the XB-36 bomber. While full details haven't been disclosed, it's interesting to note that the XJ-37 can be applied as a pure jet or as a turbine with propeller.

Jet After Burner: The propulsive thrust in the tailpipes of jet engines can be increased by as much as a third by the installation of a new "after burner" developed for the Navy by Ryan Aeronautical Co.

The "after burner" enables the pilot, by manipulating a simple control, to spray additional fuel into the tailpipe. The burning of the fuel adds greater mass and velocity to the gases already in the exhaust stream, adding as much as 30% to the propulsive thrust. Thus, "after burners" may be the means to push fast jet planes through the compressibility barrier. (*Turn to page 116*)

● Fairchild Packet equipped with tractor-type landing gear which will enable the craft to operate from sand, mud, and unimproved landing strips.

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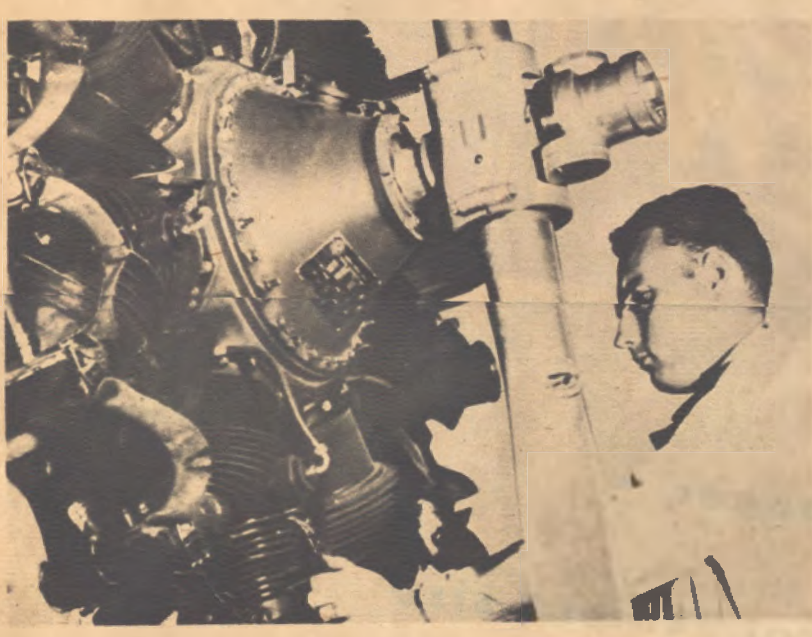
One Year From Today? . . . or Out of a Job?



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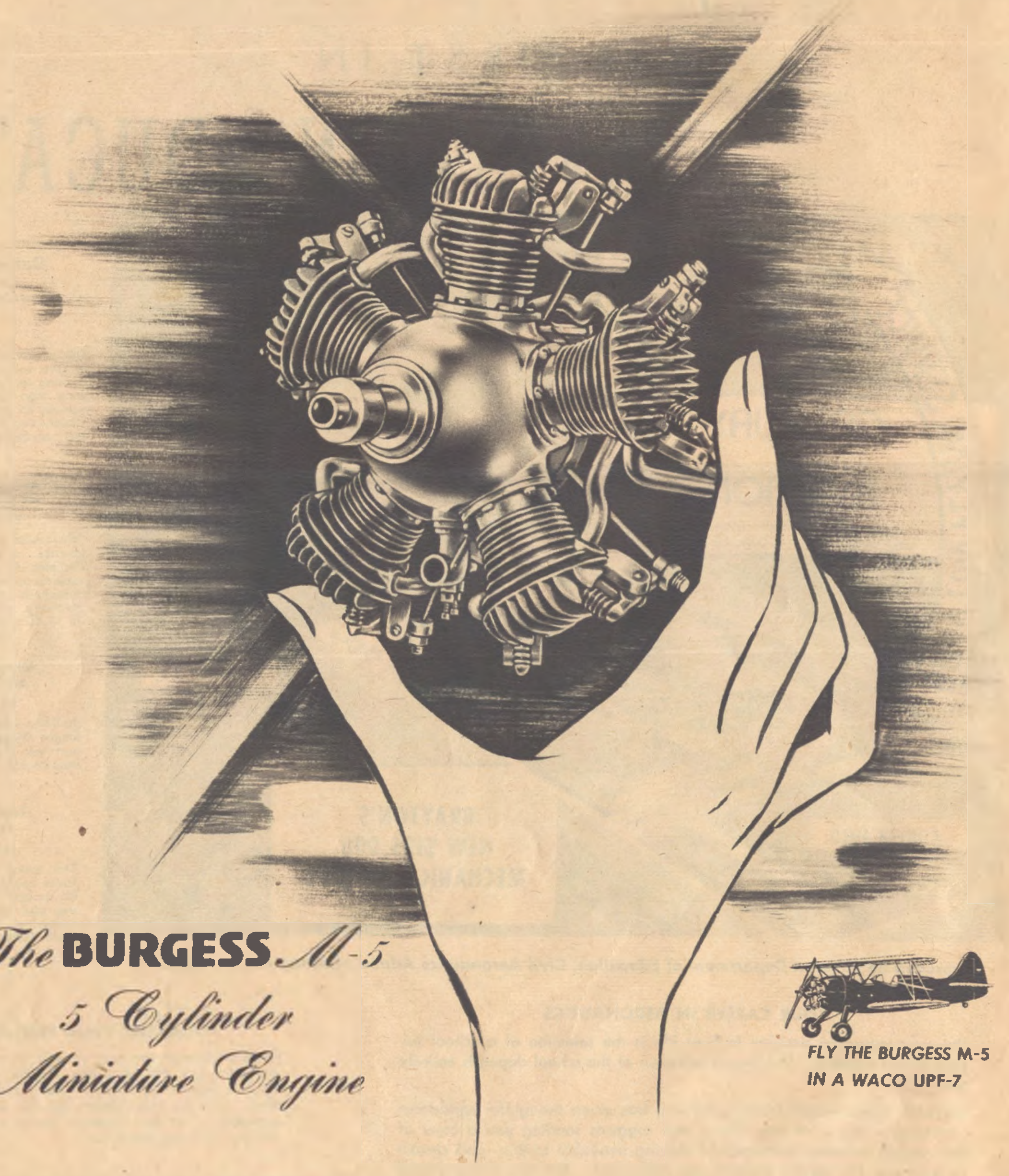

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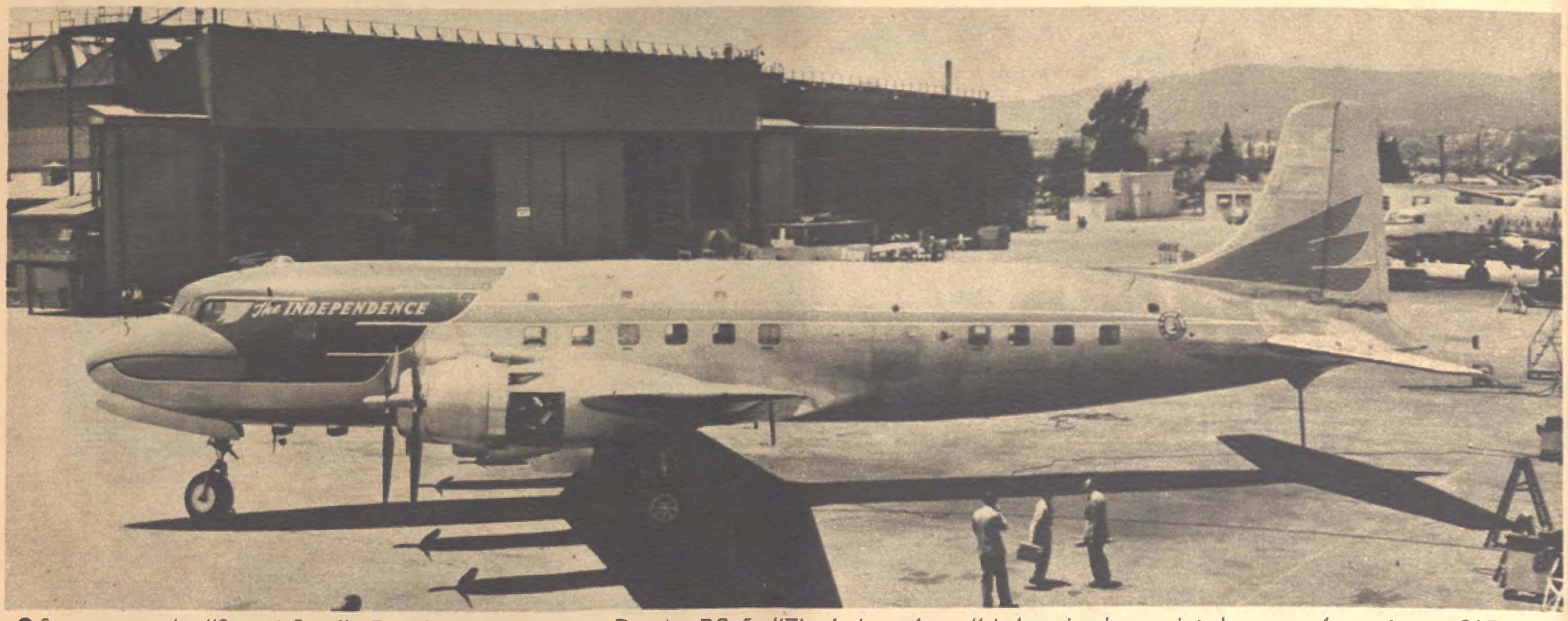
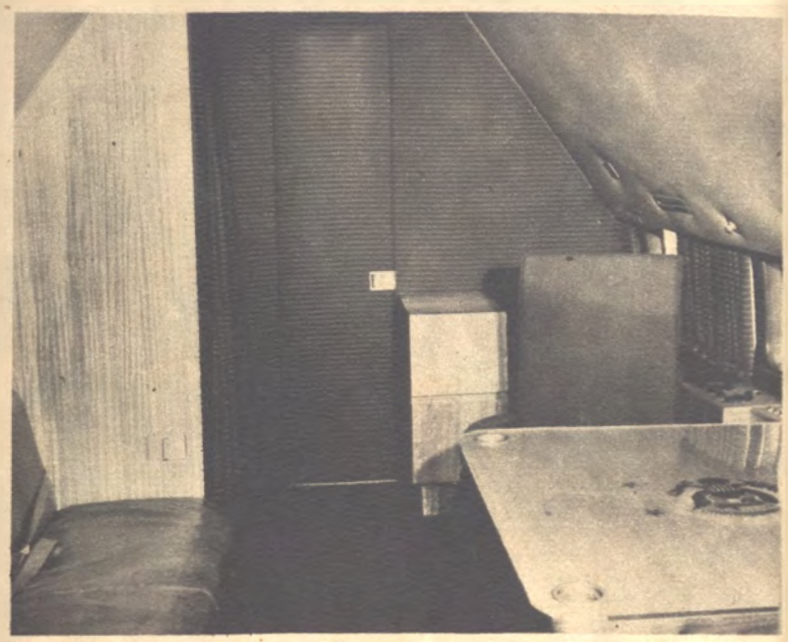


● Successor to the "Sacred Cow." President Truman's new Douglas DC-6, "The Independence," is luxuriously appointed, super safe; cruises at 315 mph.

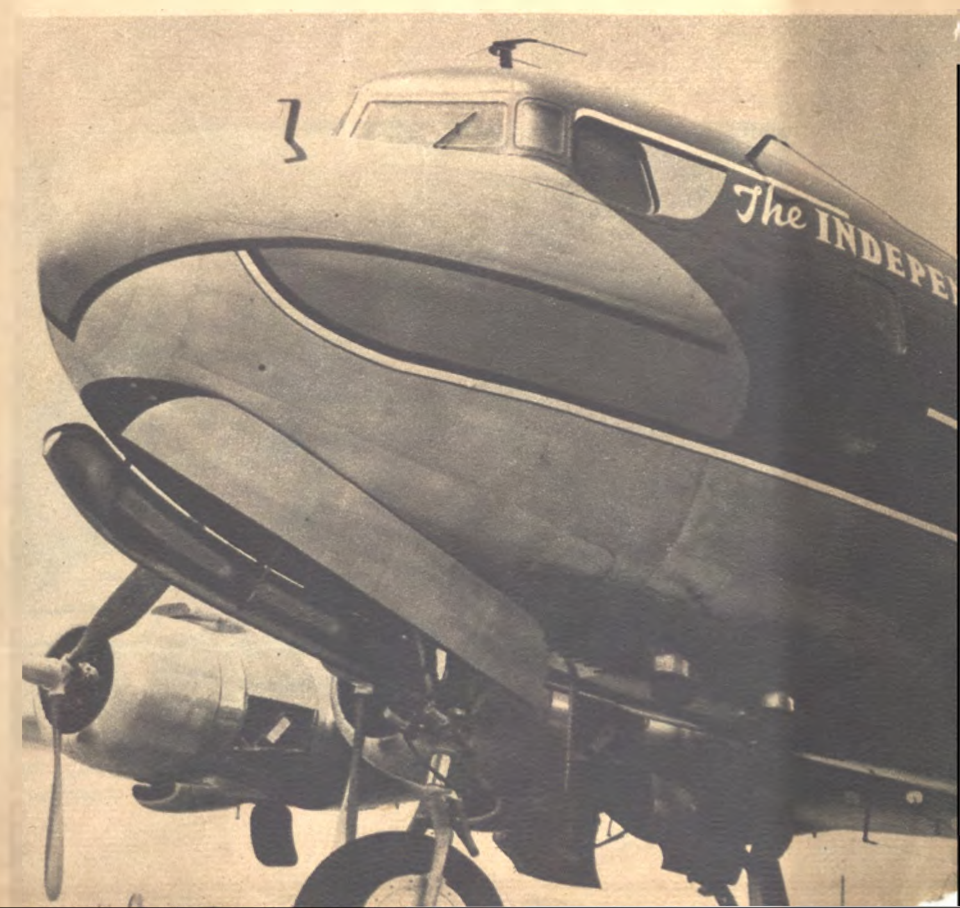
THE FLYING WHITE HOUSE

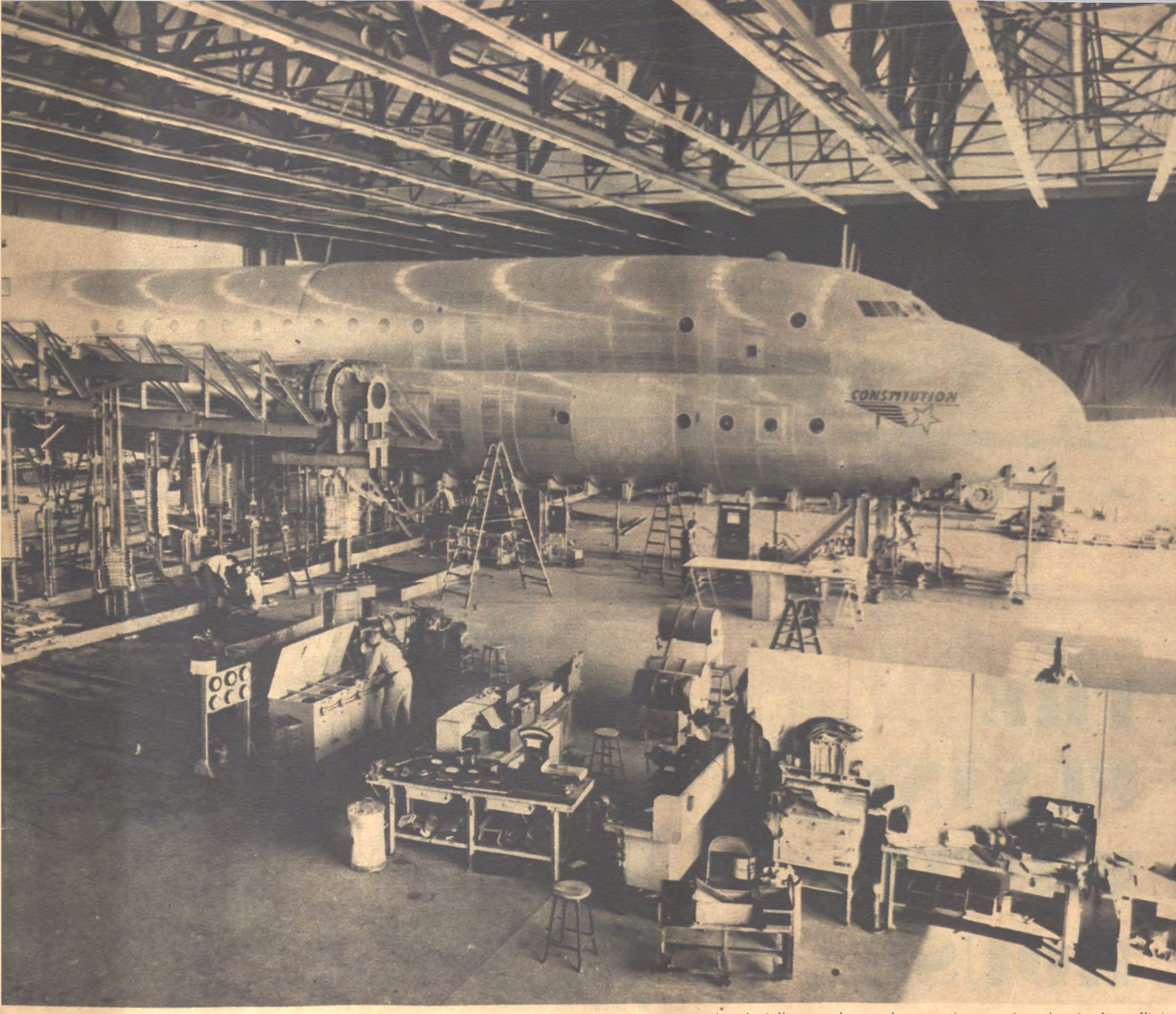


● Looking aft in executive stateroom. Conference table has Great Seal of the United States inlaid in natural wood. Built-in bed is elkhide, covered.

● Above. President's-eye view of executive stateroom. Flight instruments at left, built-in wardrobe, and maps pulled down from recess in the ceiling.

● Right. Distinctive markings make "The Independence" easy to identify. Delivery to ATC expected in July. Crew will then make shake-down flights.





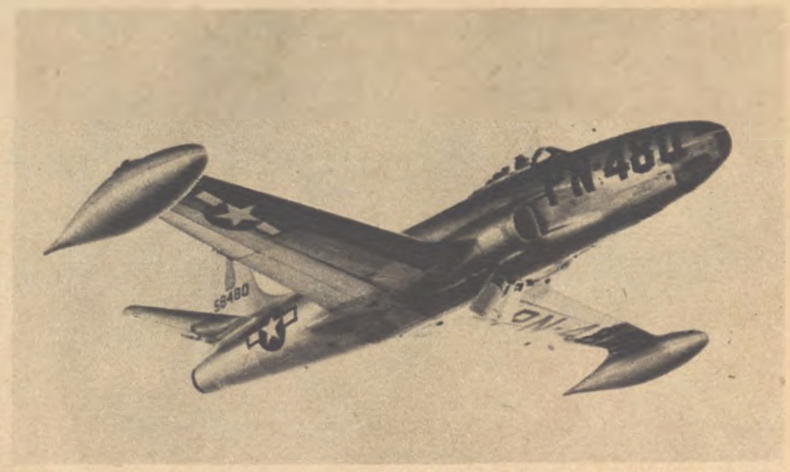
● Static testing of the Lockheed Constitution involved expenditure of many thousands of dollars and man-hours prior to the plane's first flight.

● Water ballast tanks permitting transfer of loads to different parts of the airplane in center of gravity tests, were first developed by Lockheed.

● Tremendous size and fine lines of the Constitution are apparent here; but Lockheed has built only two, not enough to build up a production line.

LET'S PLAN NOW

Robert E. Gross



● The same organizations that built 96,000 airplanes in 1944 are trying now to live on contracts for only 1,330 combat planes, such as the P-80B.

by

ROBERT E. GROSS

Pres. Lockheed Aircraft Corp.

As Told to Andrew R. Boone

EVERY doughfoot, on no matter what front, felt immeasurably safer and reassured when he had plenty of air power overhead. When no wings were present to cast their shadows across the front, he was lost—and knew it. You don't have to sell air power to a man who has fought, on the ground or in the air. He sees the end result, the airplane, and recognizes its worth. But he may not have thought back to the guts and cornerstone of aviation—the manufacturing end of the business.

You cannot fly airplanes and you cannot fight airplanes until you have airplanes. You've got to have them first. It is the industry that must invent them; the industry must produce them, deliver them, test them, and make them workable. It is not to belittle the other branches when I say that fundamentally the industry that produces the planes must be there if we are to have any other part of aviation.

That industry—the hen that lays the eggs—today faces terrifying problems:

1. The aircraft industry has been so over-expanded it cannot possibly survive in its present pattern.

2. Too many companies are competing for too small an amount of total business.

3. In addition to its own special problems, the industry is plagued and distracted by every kind of standard business problem faced by all the big, standard companies.

4. We do not have the compensating advantages of standard business. We do not have peacetime, consumer goods—the volume products on which they but not we can survive.

So, we have great troubles. We are expanded to a level from which we cannot recede properly. Too many companies compete for too little business. And we are plagued with both the problems of ordinary business, and a multiplicity of troubles accruing especially to aviation.

Let's examine our problems, and consider a possible solution.

Take the matter of expansion. In 1935-36, we had some 35,000 people in this business. Seven years later, at the height of the war, there were some 2,102,000 persons engaged in the aircraft business. Today: 160,000. In 1936, our people worked under 6 or 7 million square feet of roof. Seven years later, they labored under 90 to 100 million square feet of roof. Now, the workers labor under 44,000,000 square feet of roof. We must support that plant, yet we have nothing to put under half of it.

We cannot possibly recover from the after-effects of this tremendous expansion unless some good, sound planning is done to help us. Why not close half the factories, why not rid ourselves of a lot of overhead? This double-headed question over-simplifies the problem. We face this dilemma: there is some expansion from which we simply cannot retreat, but which in turn we cannot support. We cannot rid ourselves of taxes. We have all kinds of overhead of which we cannot rid ourselves, even if we build only one airplane.

Why can't we reduce our expansion to a prewar level? Here's one reason. Airplanes have become so complicated and expensive, and the demands of the transport companies, the Army, and Navy have become so exacting, that we must maintain organizations of specialists. These include many valuable and highly paid men. If we lose them, recession or no recession, we fear we cannot build them up again. Further, we have all these plants, and they must be maintained properly. These represent expenses we cannot drop, no matter how we try. Already we have let many thousands of people go, and have cut expenses to the very bone. Yet we continue to have too much organization, too much investment and too much paraphernalia for the present size of the AAF, Navy, and commercial requirements to support.

Also, we are competing for too small a total volume of business. There are today 14 standard aircraft companies—the ones that did the lion's share of prime contracting for the Army and Navy during the war. These companies built 96,000 airplanes in a single year. At the peak, we were going at the rate of 109,000 airplanes a year. Last year those same companies built 1,330 military airplanes! Think of it. The same organizations that built 96,000 airplanes in 1944 today are trying to live on 1,330 combat airplanes.

Finally, we are plagued with the complications and difficulties of ordinary business. What do I mean? We have tax, fiscal, and labor problems. We have all the Government regulations to cope with, all the harassing things business is faced with, and special aircraft problems on top of them all. Unfortunately, we do not have the good compensating things that often go with those problems. General Motors, Telephone, duPont—the big standard American companies which represent the backbone of our industrial fabric have all these problems. But they also have millions of buyers for cars, users of telephones, and customers for chemicals. We haven't got millions of buyers for anything. We would drop dead if we got an order for 50 or 100 of anything, and that's a fact! We have no standard volume market on which to survive. We cannot go back from 96,000 to 1,330 airplanes and maintain the nation's aviation plant.

(Turn to page 112)

PRIVATE FLYING TODAY

by JOHN F. MASON

News Editor, Aeronautical Engineering Revue and Lillian E. Bermont, Assistant Editor

ALL RUMORS AND SPECULATIONS ASIDE, THIS IS WHAT THE PICTURE OF PRIVATE FLYING IS TODAY

MOST of us flyers and would-be flyers have quit scanning the skies for the roadable planes, helicopters rising from every garage, and the sleek, thousand-dollar "Buck Rogers" space ships. They just aren't up there. Throughout the war over-optimistic aviation writers reported seeing these visions and many more in their cloudy crystal ball. You may recall some of them: an aerial version of a Cadillac with the lines of a Spitfire; a low-priced roadable-amphibian air flivver, burning cheap fuel and costing little for maintenance. Someone's silver-haired grandmother was usually pictured at the controls. Poor weather flying would be overcome through mass-produced radar. Helicopters would be available for the commuter. One-control planes, small enough to fit in the garage, would be as stable in the air as a DC-3.

But predictions went haywire and now the gloom birds cry that the industry has reached its service ceiling and is beginning to mush. Some have even recommended a quick retreat to the roadable auto. The anticipated market just hasn't materialized. Has the market been milked dry? Where are the thousands of military pilots who longed for a plane of their own? The answer to that one is simple. The flying bug is still biting but personal problems on the home front come first. Civilian life is no breeze.

The disappointment, voiced by so many, may be due in part to the unfortunate overselling that took place by a few companies during the war. Actually most people would be glad to come down to earth long enough happily to take off in a "postwar" plane if they could afford the price.

So much for speculation—let's look at the situation as it exists. Let's delve into a few figures and look at the proof that's flying around over our heads. As far as design goes, planes look much the same as they did in 1939, with a few exceptions. The number of planes, however, is a different story, despite the rumored market "slump."

As a basis for comparison with 1946 figures we will use 1939, the last comparable "normal peacetime year." Civilians then were buying planes for approximately the same reasons as they are now; domestic production and planning had not been stepped up by gathering war clouds, and orders from European countries had not pushed the aircraft plants into high gear. Nor had the beginning of our own accelerated program, the Civilian Pilot Training Program, come into being to give the production picture an abnormal slant.

The record proves that personal plane production is enjoying a healthy, although not fantastic, boom. In 1939, 3,583 (5-place and under) personal planes were manufactured. For 1946, the first postwar year, production of private planes totaled 34,441, an increase over 1939 of 861%. If this isn't progress, it isn't backsliding either. True, perhaps in terms of potentials—plant capacity, know-how, materials available, etc.—the total 1946 production was too small. But fitting it properly into the over-all economic and social picture it is a healthy sign.

Interest in private flying is increasing tremendously among diversified age and professional groups. National and regional air shows, air tours, and breakfast flights, are mounting in frequency and are attracting greater numbers of participants and spectators than ever before. All this should mean greater design improvements and lower prices in the future.

The total number of licensed private pilots at the end of 1939 was 20,832. At the end of 1946 the figure had grown t an increase of 808%. The G.I. Flight Training Program l to attain this figure, which, however, is still short of tions.

The outlook for more landing fields is encouraging. the total number of airports suitable for personal planes v as against the 1939 total of 2,117, an increase of 53%. Federal Airport Plan calls for 232 new Class I airports with Class II specifications. A total of 800 new or impr ports are slated for 1947. The cost to the Federal Govern be $33,899,265, with local and state sponsors providing an a $36,692,600. This plan should do for aviation what the Highway Program in the '20's did for the automobile.

Texas leads in the number of planned projects with 70 ne Montana is second with 46; Idaho third with 45; Minnesot with 41; and California fifth with 33.

But for every step forward there seems to be another b jump. Because of noise, Massachusetts, Pennsylvania, a courts have labeled airports as nuisances. The inhabitants states feel that airplanes should be seen and not heard. plane manufacturers and individual flyers are alarmed, an to battle. However, public apathy, and in some cases active onism, are making the fight difficult. The Technical Devel Service of the C.A.A. and the A.O.P.A. *are making a survey* port noise to determine the noise level of each plane and acceptable to the average community.

For 1939 the total registered non-air carrier aircraft wa At the end of 1946 the total was 66,400 (estimated as 31, 1947). An increase of 394%, which is good, not bad the war the number of pilots generally stayed a little more times the number of certificated private aircraft. Few p a plane who can't already fly. In other words, teach th and 50% will buy planes.

So far, design seems to be evolutionary, rather than revo Probably the most radical change in structural design occur Republic Seabee's almost-ribless airfoils. This is descr later on.

Changes in evidence are: increase in horsepower, in power loading range, and higher wing loading. Cruising been inched up slightly and more planes are being "spin- Cabin arrangements have taken on a new polish. Larg greater visibility, and more comfortable seats are the styl and upholstery are definitely more pleasing. Luggage a space has been improved. Instrument panels are more con arranged and controls are handier. Although controls are standardized there has been an attempt to eliminate protr cabin interiors.

The trend is toward all-metal construction, tricycle land wheel control instead of the stick, and, for the most part, l instead of high. The two-control system used in the Er found again in the new Aeronca Chum. The Chum can be l the three-control system if desired.

Controllable-pitch propellers, improved flaps, and greate floats are additional signs of development. Research is conti reduction of noise, in swivel-type landing gear, and in the d ment of lighter engines at lower cost.

Private flying enthusiasts and manufacturers may well be of the 1946-47 organized flying activity. Increased activity plane shows, meets, and cross-country hops, plus the grov private flying clubs, marked the year brightly. The Nov National Aircraft Show in Cleveland drew 100,000 spectator National Aircraft Show in New York was seen by 21 Regional and local air shows were frequent and well atte throughout the country; among them—the 1947 All-America Maneuvers in Miami assembled 2,300 planes and a maneuve tendance of 125,000 people. Twenty thousand spectators atte the St. Petersburg First Annual Festival of States Air Sho March.

The Civil Air Patrol, established in 1939 with 313 students colleges, is now 100,000 strong. With the aid of the A.A.F., C participates in air shows in every state in the country.

With the abundance of good air shows being backed by Nat Aircraft Shows, the entire program is on a more constructive than ever before.

ır, the Air Market Data Service made a survey on aircraft
ıich provides interesting information on who is flying to-
average age of the private owner was found to be 38.
narried. Men outnumber the women by 53 to one. He
d high-priced planes or high-cost maintenance. He uses
183 hours a year at a cost of $751. 88% of his flying is for
58% live in towns of 25,000 or less; 21% in towns of
less; and only 8% in cities of one million or more. His
in this order: 1) speed 2) modest initial cost ($2,500) 3)
-) reasonable operating cost 5) range 6) load-carrying abil-
y 43% are insured, because of the formidable expense.
ı deterrents to greater use fall in this order: lack of time,
ıaintenance and service, and lack of adequate airports.

tly, an attempt was made to cut customs red tape at the
The Aircraft Owners and Pilots Association held a break-
ıt from Seattle to Sea Island, Vancouver; the first inter-
mass-flight of private flyers ever recorded. But A. O. P. A.
ch more than stage breakfast flights. J. B. Hartranft, Jr.,
Manager of the 32,000-member organization, goes straight
ɔp when he feels that the private pilot is getting a raw deal.
.pril 3, Hartranft gave a testimony to the Committee on In-
and Foreign Commerce in the House of Representatives.
ıeral plea was for more over-all consideration for the personal
Specifically, he asked for the small plane to be considered in
out move to do away with the low-frequency radio range sta-
Added weight and expense would preclude the use of the
ni-directional, high-frequency equipment in light planes.
ed out that there are 100 personal planes for every com-
lane; there are almost 20 times more airway equipped non-
l aircraft utilizing air-navigation aids than aircarrier air-
hirteen personal plane manufacturers are now delivering
raft with two-way radio as standard equipment.

ınft stated that federal aid in research was needed for this
here were some 35,000 personal aircraft units built last
pproximately 23 manufacturers. No one manufacturer can
pay the price of extensive research.

ıre 16 recommendations for design modification by A.O.-
mination of stall-spin characteristics; development of light,
er landing lights for emergency night landings; improved
lds and visibility and deicing provisions; self-floodlighting
so they can be seen easily at night, standardization of small
cluding design for ready replacement of parts and com-
; use of lower cost fuels; wing design permitting 200 mph
ınd 35 mph landing; standardized cockpit, simple and
al, incorporating crash-resistant equipment; fuel injection
natic carburetor heat to reduce idling failures; improved
tection; system of running on low-flash fuel, even though
flash is needed for starting; leak-proof storage battery of
weight; system of simplified controls; more rugged landing
absorb impact of landings on rough terrain and better shock
ngs for engines; cross-wind landing gear; increased speed
covering subjects as spoilers, full-span flaps and boundary
ontrol by pressure and suction blowers; convertible or road-
rplanes with folding wings of strong design, perhaps power-
ed.

important piece of pioneering research that has been in ex-
ce for some time is Hugh DeHaven's Crash Injury Research
sored by the Cornell University Medical College. Mr. De-
en realizes that accidents *will* happen; his work takes up from
e. DeHaven has found that the materials and design of cabin
cture, seats, safety belts, and controls often govern the chances
ife or death in an accident. His findings may influence the
ign of safer planes.

So much for the picture behind the scenes; it's time now to squint
the sun as well as to inspect a few landing strips and see what
ple are using for wings. In the four-place line-up there are four
orites: Stinson "Voyager 150" which sells for $5,849; the North
ıerican "Navion" $7,750; Republic "Seabee" $6,000; and the
echcraft "Bonanza" $7,345.

These planes were built with much the same purpose in mind—
h speed, comfortable travel at a low operating cost—and for the
ne market—professional men and women and corporations.

Leading the field in sales is Stinson's Voyager 150, a fabric-
ered modest-looking, high-wing monoplane. In late '45, Stinson

did a quick change-over from manufacturing
L-5 Flying Jeep to the peacetime Voyager
"Flying Station Wagon" was added to the St
are alike except that the "Station Wagon" ca
4-place plane or as a light cargo carrier; in th
plane can carry the pilot and 600 lbs. of ca
seats are removed to provide a 24 cu. ft. cargo

The fuselage is constructed of welded chrom
tubing, a complete application of Fiberglas i
fabric, and then paints.

Originally the plane was powered by a 125-hp
pilot felt that there was too much plane and
The engineers agreed and a Franklin "335," 150-
cooled, horizontally-opposed engine was installe

The only structural change made after the fir
rudder modification. The test pilot complained
enough of it; the controls weren't as sensitive as
new rudder was designed that filled the bill. Muc
the inherent stability of the plane goes to the larg

Accidental stalls and spins have been prevent
slots. Slots are also used in the flaps to permit slo
descent, and small-field operations. A spring-load
ing gear, with 7-ft. tread, provides safety-cushio
greater stability in cross-wind taxiing. Single-disk
were designed for easy ground handling and short

The Voyager weighs 1,224 lbs. empty and has
1,006 lbs. Sea-level take-off run is 620 ft.; landi
Fuel cells—one in each wing—have 40 gallons total
ing at 125 mph fuel consumption is 9 gallons p
miles per gallon, with a total range of 500 miles. M
is 133 mph, landing speed 57.

North American suspended production of thei
Navion in May to adjust production schedules and
tion. The four-passenger, low-wing, all-metal Nav
by a 185-hp, Continental engine. The fuselage, s
construction, is manufactured as a single unit.

Top speed of the Navion is 156 mph, cruising spe
is more than 500 miles fully loaded. Fuel capacit
Landing speed at sea level is 58 mph, flaps full d
speed 58 mph, flaps full down; 71 mph, flaps up. The
is 13,000 ft.

Unusual aileron control at low speeds is the result
sign factors; the tip airfoil is inclined 3° nose-down
root airfoil. As the angle of attack is increased to a
sections stall first. There is no tendency for the ai
Good aileron control is maintained up to and through
addition, the tip airfoil section is provided with a larg
camber. This further reduces any stall tendency in th
of the wing.

Retractable tricycle landing gear utilizes air-oil s
The large nose wheel, steerable with the rudder pedals
right and left, works well on rough fields.

The Republic "Seabee" represents a major change in
design. This 4-place, all-metal amphibian began as a s
and-fabric amphibian that P. H. Spencer had tried to sell R
1941. When Republic began thinking about a new type of
production in '43 they remembered Spencer's plane. $30
put into the development of an all-metal version.

Alfred Z. Boyajian, Republic engineer, simplified the air
cutting the total number of parts from 1,800 to a mere 45
reduced airframe production time from 2,500 man-hours p
to only 200. He surprised engineers by designing airfoi
fixed and moveable, that were essentially ribless. His airf
comprised of simple spar foundations covered by a stiffene
On the hull alone he eliminated from the prototype, 20 lb
parts, 560 man-hours, 4,100 rivets, and $1,400 in labor.

Experimentation and development by Republic began in N
ber, 1944, and lasted until early 1946. Four virtually handbuil
duction models, incorporating Boyajian's simplified design, the
derwent accelerated land, flight, and water tests at the comp
Farmingdale plant, and at its Aircooled Motors engine plant.

During this phase, the Seabee's cruising range was extended
520 to 560 miles; the horsepower boosted from 185 to 215.

Further economy measures were taken by *(Turn to pag*

ght at Fort Myer, Va. Ward
t. Copy of Ward's orders,
ie Army Air Forces birth cer-
War I observation balloon.

N POWER AS BORN

IEUT. EDWARD WARD, RET

aeronaut of the times; the other was Captain Charles
handler who went along as an observer. They were off
f historic significance because that morning, unofficially,
the first seeds of American air power.

westerly breeze carried the balloonists over the rolling
ie. And as they rode in the swaying basket the two men
spirited tones of the potentialities of a balloon this size
ubic feet) for military purposes. Chandler expressed the
hat Armies could no longer ignore the fact that they must
he air above them as well as their ground positions. When
t ended at Harrisburg, Pa., four hours and thirty minutes
handler penned this admonishment to his superiors in the
epartment and recommended that the United States buy the
iental balloon. A few days later it became Government
y, designated Signal Corps Balloon No. 10.

ough there had been meager attempts at aerial operations in
il War and later during the War with Spain in 1898, interest
tary aeronautics in this country had died. The performance
loon No. 10 revived the interest to the extent that a group of
s and men of the Signal Corps were assigned to aeronautic
o make minor repairs and care for the new balloon. That small
iization was the nucleus of our present Army Air Forces.
e was one officer, Captain Chandler, and two enlisted men, no
anes!

s one of the enlisted men assigned to that special detachment, I remember the events that followed as though they had happened but yesterday.

I can recall, for instance, the day Captain Bunnell, Commanding officer of the Signal Corps Post at Fort Wood on Bedloe Island in New York harbor, called me into his office. "Ward," he said, "you're going to work with balloons. It's a great opportunity to be in on something very new. Someday it may grow into a whole new military force."

Those words didn't mean much then but they keep ringing in my ears today. It is small wonder. From where I am writing this I can look out the window of my home and see the long ribbon-like runways of Wright Field the Air Forces' test center near Dayton, Ohio. There is seldom a minute during the day or night that giant planes aren't roaring down the white carpet strips and into the sky, sweeping low over the house, their throbbing engines vibrating the window panes. The "force" Bunnell talked about is the thunder of horsepower or the swoosh of a jet plane overhead.

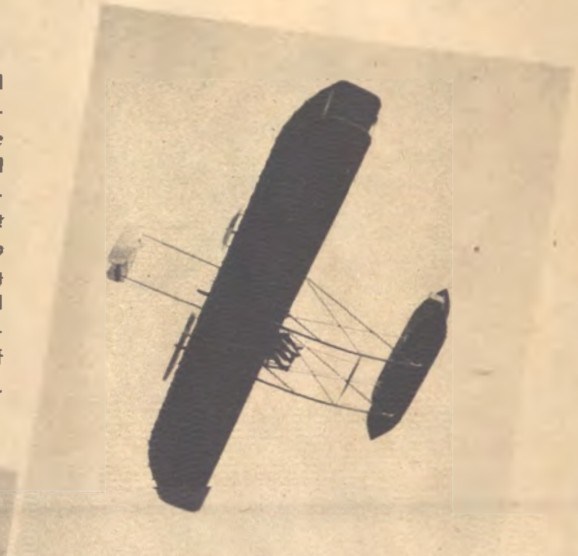
Of course, none of us realized it back forty years ago, but we were nursemaids to a stepchild that was to grow up to be a husky youth, henceforth a partner and leader in all our defense plans, the fighter with the knock-out punch that saved the world in the late war, the deliverer of the first Atom Bomb unleashed from the belly of a B-29 Superfortress over Hiroshima in the year of our Lord 1945 A.D. We were the founders of our Army Air Forces.

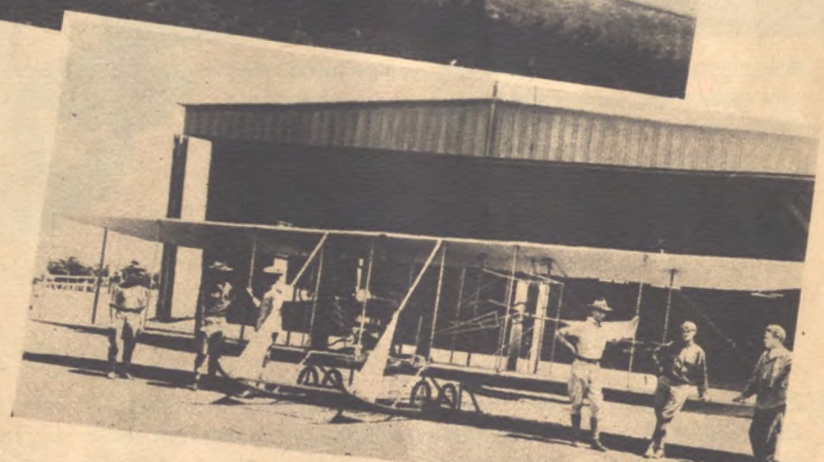
We began by going to school. The schoolhouse was the Stevens Factory at 982 Ninth Avenue, where Balloon No. 10 was constructed. Here, Aeronaut Stevens conducted a course in practical balloon handling, flight training, and maintenance. This was a month before there was any official organization. It was, however, the first aeronautics training school in America—the Army's first air college.

We didn't get any diplomas. After we had learned the tricks we got a piece of paper and it was probably one of the most unheralded yet most vitally important documents of the last half century. It was an office memorandum from Brigadier General James Allen, Chief Signal Officer of the Army. You can call it the birth certificate of our Air Forces.

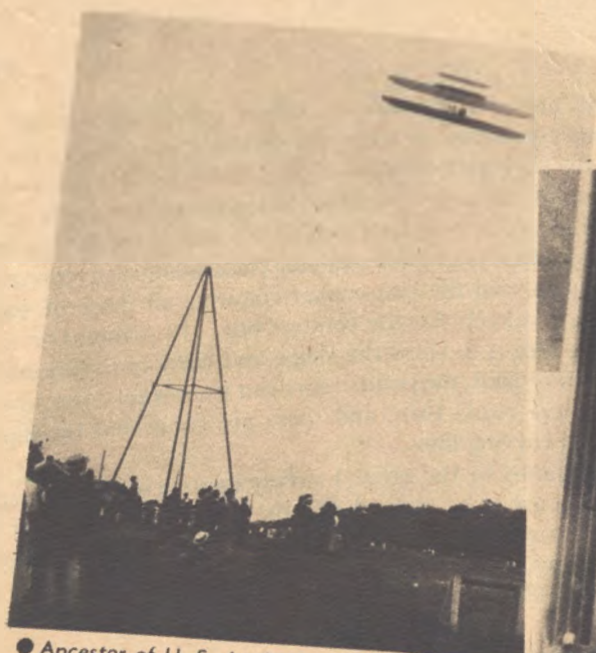
If man survives the Age of the Atom and decides to perpetuate his civilization instead of obliterate it, historians of that miracle era will differ when they write of the birth date of our Army Air Forces.

Some will say that the Air Forces was born in the walnut-paneled offices of the Pentagon building on June 20, *(Turn to page 102)*





● Top. Major Squier, Signal Corps Examining Head, and Orville Wright on test flight of the first Army airplane. It crashed later, killing Lt. Selfridge. Center. Lt. Selfridge and the test plane in which he crashed to death. Bottom. First training school for pilots was established at College Park, Md. Maintenance had to be paid for out of men's pay, due to lack of funds.

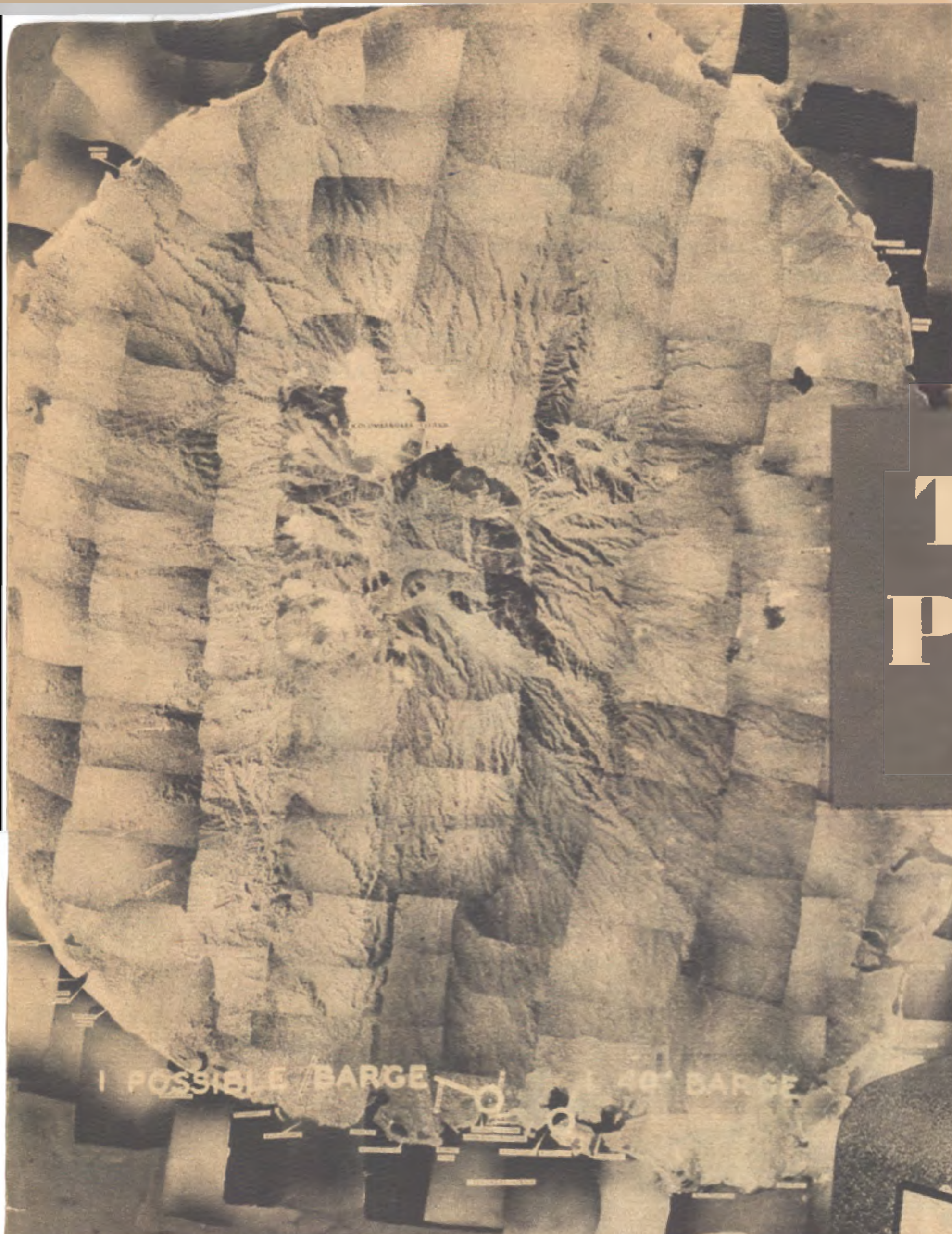


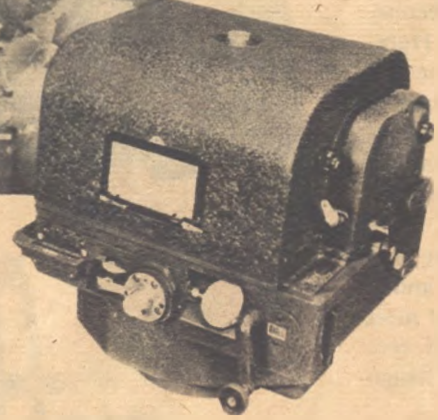
● Ancestor of U. S. Air Power. Flight lasted 1 minute 11 seconds. A sceptical friend of Ward's, seeing plane fly, said, "I still don't believe it."

● The year 1910 was an important one in the annals of Air Power. That was when aerial bombing was born. Although crude, its implication was obvious.

THE AERIAL PHOTOGRAPH

by HENRY E. SOSTMAN





IN WAR OR PEACE, THE ADVANTAGE OF AN OVER-ALL VIEW FROM ABOVE IS OF MAJOR IMPORTANCE

● Maps like these, and the mapping cameras and crews that made them, made possible many wartime operations which could not have been attempted without them.

—PART 2.

FULLY two-thirds of the vertical photographs that are taken by the Army and the Navy, and an even higher proportion of those made by the civilian aerial survey corporations, are used in the plotting of photogrammetric maps. Photogrammetry is the science of photo-measurement; these verticals are pictures which can be measured, and from which dependable quantities of length and distance can be scaled.

If we overlook refinements in the accuracy of instrumentation, map-making of the ground *from* the ground has undergone little change since the day when young G. Washington was surveying estates in Virginia. In making topographic maps, those which show elevation contours, the surveyor picks a base point and measures its height with an aneroid, or preferably he finds a point on an existing map whose altitude he knows to be accurately stated. On that point he puts an optical instrument called a transit. The transit is an accurately-made instrument with a cross-hair reticle for locating the center of its field, and two protractor circles, one horizontal and one vertical, so that the operator may read within several minutes of arc the angle at which the telescope points above and below the horizon, and East and West of North. An assistant with a chain or calibrated tape measures off a distance to another point; and with the aid of his transit the surveyor measures the direction and the height of the second point, relative to the first. Then he moves his instrument to the second point, while his assistant moves on to the third, and so on, until the salient points are covered.

In simplest reduction, when the surveyor later makes his map he repeats the surveying process, laying down the first point on paper, measuring off the proper distance along the proper angle to the second, and so on until he has worked his way through them all back to the first. In topographic mapping these points are representations of elevations, and the map-maker connects all those of equal altitude with a smooth-flowing contour line. In planimetric mapping, where the idea is to show the shape and borders of physical details or sections of land, the points represent the corners of a farm or the places where roads turn, and these are connected by appropriate straight or curving lines.

Cartography by the ground-survey method is good enough when small areas are to be mapped, like the limits of an estate, or the borders of a town. But when the problem is to prepare maps of the Trinity Alps, or the State of Texas, or the Atlantic Coast between Maine and Florida, ground-survey methods would consume literally years.

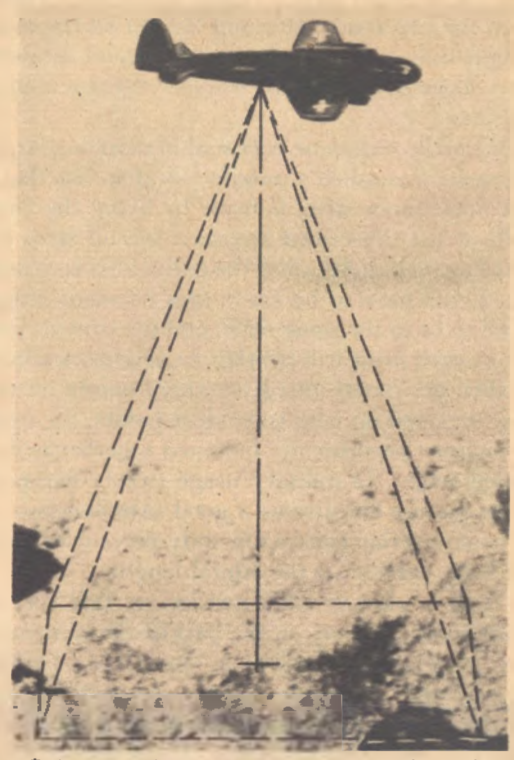
At the beginning of the second World War, the Army and Navy found themselves confronted with the serious problem of mapping vast areas in short periods of time. Most people are under the impression that the larger portion of the earth's surface has been accurately charted, but it just isn't so true as ten-inch schoolroom globes would lead one to believe. In the Pacific area, operations often included island groups which covered hundreds of square miles; islands which in peacetime had never attracted the attention of cartographers. The preparations for invasion of each island demanded accurate information about the shoreline, above and below the water; beach conditions, contour topography, roads and paths, vegetation, and countless other items of data that could be known and distributed only by means of accurate maps.

In Europe, the problem might have seemed at first glance simpler. Major Locke of the Army Corps of Engineers says in an article in *Photogrammetric Engineering* that when he arrived in England with his company, his first assignment was to prepare maps of France to the scale of 1/25,000. He had been under the impression that France was well covered with maps, and found to his surprise that the only available large-scale map of France was one which had been prepared to the scale of 1/80,000 in the time of Napoleon, later expanded to the scale of 1/50,000 with altitude notations at the considerable distance of thirty feet apart. The maps were entirely inadequate for the needs of modern warfare, and for all practical purposes Major Locke was faced with the staggering task of preparing an entirely new map of an entire country.

Following ground-survey methods, and in peacetime, the project would have consumed at least a decade. In wartime, of course, it was entirely impossible; France was occupied by the Germans, who would no doubt have regarded Allied surveyors with suspicion. The Army and Navy, therefore, had in all areas to rely upon a system of mapping from the air. Such a system had already been established and tested in the years between the wars, by the Armed Services and by the civilian aero survey corporations.

A truly vertical aerial photograph is essentially a photogrammetric map in its simplest form, when the scale or the data for computing it (the focal length of the camera lens and the altitude of the airplane) are given. Distances between objects shown upon it may be measured with assurance that they are a rough approximation of the true ground distance. Points are shown in their relative locations, and an idea of ground configuration may be had from the study of the photograph.

There are some data that the simple vertical cannot provide. The first, and perhaps the most important of these, concerns coverage. There are practical limits to the height at which an airplane can fly, and consequently to the size and inclusion of a vertical photograph. A second objection is that it cannot furnish a high order of accuracy in showing distances. A third is that it shows no vertical dimension. You can tell how long and how wide things are, but not how high.



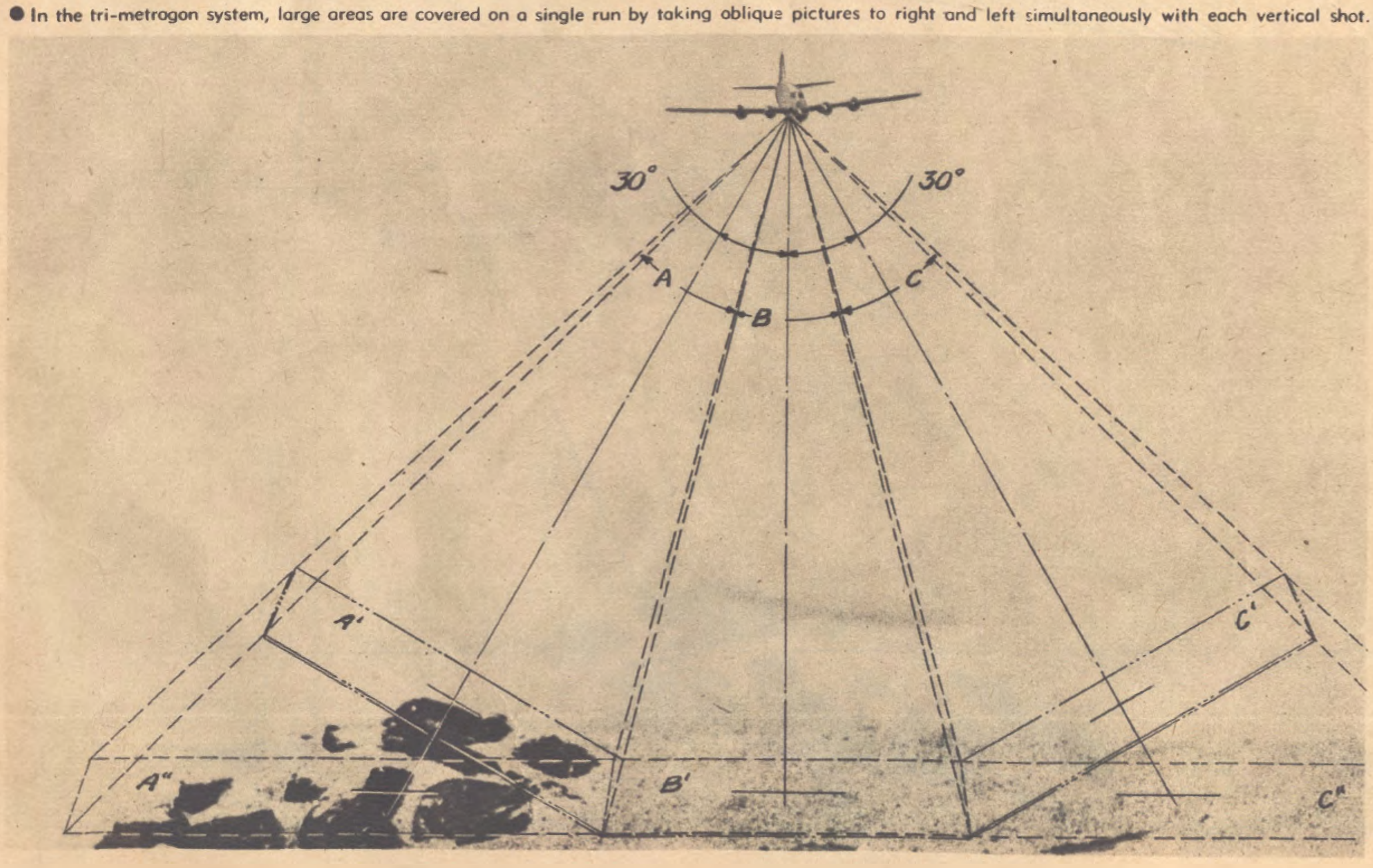
● The straight vertical picture is much used in mapping and survey work for its high dimensional accuracy and other technical reasons.

Beginning with the basic vertical photograph which is the heart of the mapping technique, all these data can be obtained by modifications of the essential process.

The answer to the first problem is not hard to find in theory. If one picture isn't big enough, take more. Take two, take a dozen, or a hundred, until the ground is completely covered.

Let's suppose the case in which a map is needed of a long road, built across country in an absolutely straight line. The airplane flies directly over the road from beginning to end, and meanwhile the cameraman takes pictures covering the distance. Now imagine a second road, parallel to the first, but a little too far away to be in the pictures. It can be photographed, too, if the pilot turns his ship through half a circle and flies back again, over the second road, while

● In the tri-metrogon system, large areas are covered on a single run by taking oblique pictures to right and left simultaneously with each vertical shot.



more pictures are shot. If one wanted to see the relationship between the two roads, he could lay out all the prints of the first in a straight line, and all those of the second in another, alongside the first. Together the strips would comprise a composite map of the highways.

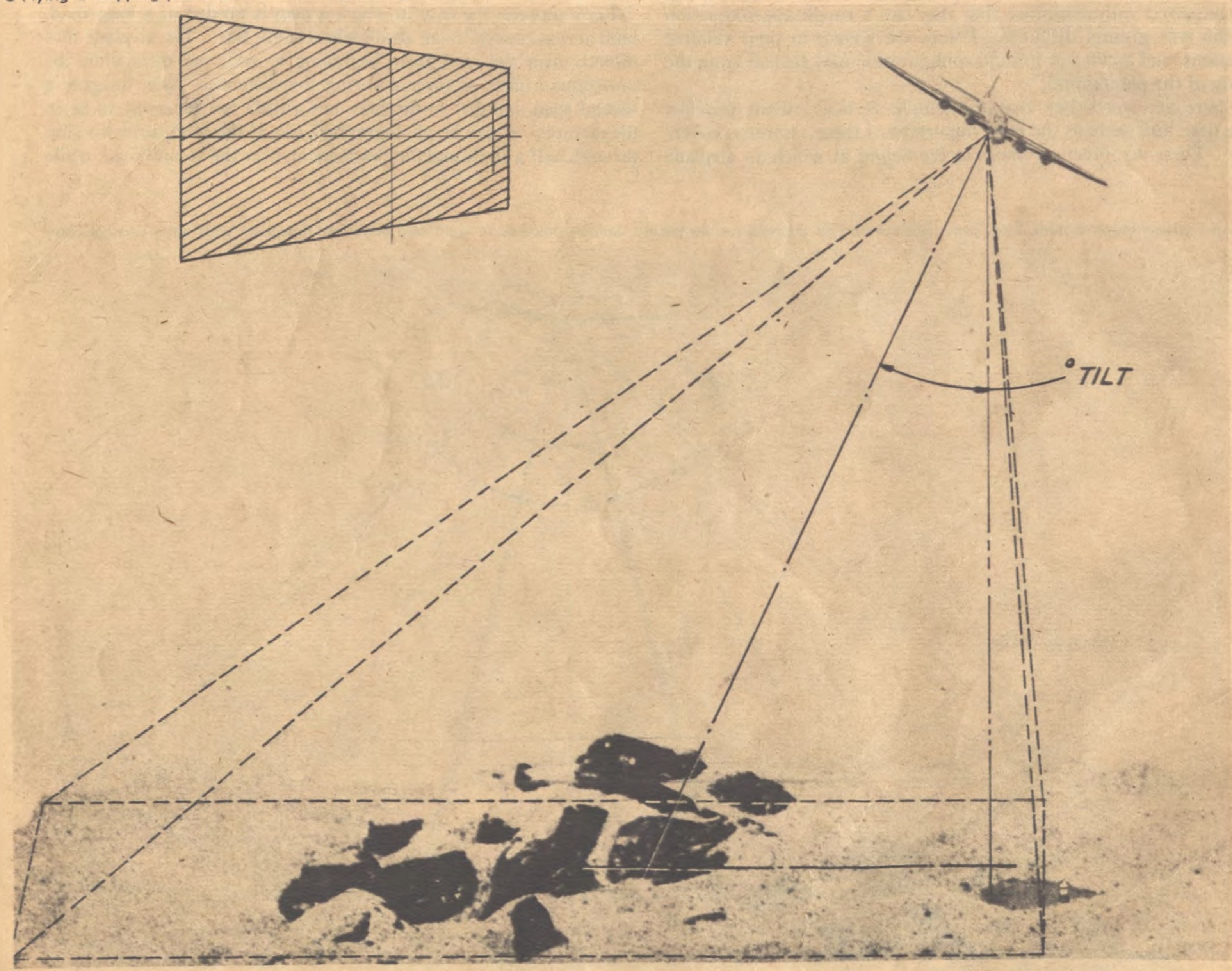
This is the technique followed in mapping large areas, and the resulting strip is called a mosaic. A strip like that of the road, called a reconnaissance strip, is made by flying the airplane from start to finish of the prescribed sector, a second strip parallel to the first, a third again parallel, until the entire area is covered by photographs. The flights have to be made at a constant altitude if the pictures are all to be in the same scale, and the courses are calculated so that part of each print will overlap its neighbors at all sides. The prints are then accurately fitted together; points on the overlapping sections are lined up with coincident points, the overlap cut away, and the pictures permanently mounted together to form a single photographic map. In military usage twenty-five percent of the length of the picture constitutes a good safe overlap. In civilian survey, the usual overlap consists in sixty percent of the forward direction, and forty percent of the lateral length.

Flying a photographic mission of this sort takes accurate and steady work not only on the part of the cameraman, but also of the pilot. His take-off must be as smooth as possible, because precision cameras and lenses are delicate instruments, and excessive shock can put them out of commission and ruin the flight. Once he is in the air the pilot has three things to worry about. Before the take-off he and the photographer have decided on the altitude to be flown, and have worked out a flight plan. The pilot is responsible for flying a straight course in spite of gusts, crab, yaw, air pockets, or anything else, including student pilots. It is a common impression, even among practiced airmen who have not flown photo missions, that it isn't hard to fly a straight line between two points chosen in advance. As a matter of fact it is quite difficult. Unlike other flying, where the important points are those of departure and arrival and considerable latitude in the course makes little difference, it takes exacting navigation, a smooth hand, and feeling for and training in dynamic meteorology to fly a photographic line.

The pilot must be careful to hold his ship level at all times. Tilt carries with it a tendency to slip, with consequent loss of altitude. If the airplane falls below or climbs above the basic height even when the camera shutter is not open, there is the risk of running into wind strata which may take it off course. In correcting tilt the pilot will use rudder and ailerons, shifting the plane from level flight, and inviting enough skid to throw the instruments off correct reading momentarily. In attempting to regain correct altitude the nose of the ship has to be raised, again losing level flight. And if the wings are not held horizontal at all times, the course will not be a straight line, but part of the circumference of a gigantic circle.

The error of tilt is shown in the illustration. Tilt in the nose-to-tail plane of the ship is usually called tip, but the difference is the same. The camera is rigidly mounted in the airframe, and when the wings are tipped at an angle from the horizontal, the optical centerline of the photograph is no longer perpendicular to the ground. The cross-sectioned area at the upper left-hand corner of the cut shows the distortion of the picture rectangle. It is elongated toward the left side of the figure, and distances between objects in the camera's field of view would be similarly out of proportion. Some tilt can be corrected in printing the picture, by tilting the plane of the printing paper in exactly the same angle. We shall come to a functional use of this tilt later when we discuss tri-metrogon photography.

● Flying a mapping plane is a stiff test of piloting skill. The slightest departure from straight, level flight introduces errors which are hard to correct.



Normally, tilt is considered undesirable.

When machinery as complicated as the airplane and the automatic camera are in use, one can be sure that somewhere in the functioning of the mechanisms or in the navigation of the aircraft there are bound to be minute errors which may multiply each other, but which cannot be eliminated. The great factors of height and scale by which these errors are complicated enlarges them to a degree which would be objectionable in a precision map, but which may not be too much for some purposes of rough survey. Human errors are usually much larger than the errors of machinery and instruments, and it is absolutely necessary to keep them to a minimum. Both photographer and pilot must approach the mapping of a strip as a most painstaking and vital operation.

Photogrammetric cameras are built to extremely close tolerances, and finished to eliminate error wherever possible. Most, in addition to manual operation, can be connected to an intervalometer, a variable timing device which automatically opens the shutter at intervals chosen in advance by the photographer, on the basis of airspeed and percentage of overlap specified. Stopwatch, bubble-levels, ground-glass viewfinder and altimeter are supplied to the cameraman so he can keep a constant check on the progress of the work.

All photogrammetric cameras use roll film and the negative size is nine by nine inches. Cameras have been built which contain enough film for four hundred exposures without reloading, and all use film magazines which may be removed and exchanged in daylight during flight. At the moment of exposure the film is automatically squeezed flat and tight against the film plane by vacuum, supplied by a motor-driven pump or by a venturi placed in the slipstream.

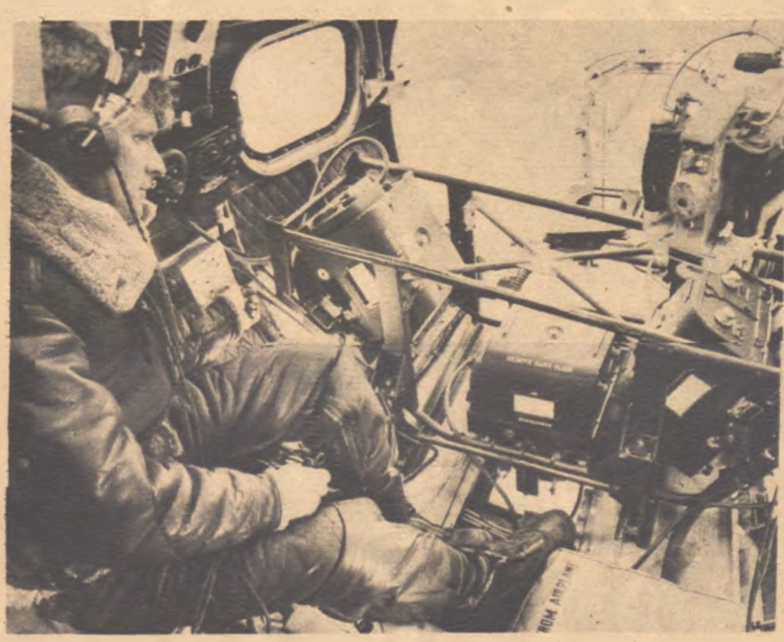
For mapping with extreme precision, care in the manufacture of the camera and in its use during the photographic run are supplemented by ground checks of the area covered by the pictures. Distances on the ground can be measured with great accuracy with chains or tape, or by triangulation and trigonometry. Outstanding control points, several in each photograph, are measured on the ground and their actual distance from each other is compared to that scaled from the photograph. The photograph can be brought to proper scale in printing the picture.

An optical device called Multiplex is called into service for the making of the topographic map. The Multiplex is essentially a series of from two to eight photographic enlargers hung on a bar. Their chief difference from the ordinary enlarger is that they are placed above a table whose surface is absolutely flat, and that each unit can be adjusted vertically by means of micrometer-calibrated knobs, respective to their distance above the table. A series of diapositive copies of overlapping vertical photographs placed in the Multiplex projectors and projected onto the tabletop can be focussed with the adjusting knobs until the distances between the control points they show are correct in relation to each other, and to the actual ground dimensions. The mosaic which is then projected from these diapositives then not only represents a high order of dimensional accuracy, but is seen in stereographic dimension, from which contours and altitudes may be measured and drawn.

Civilian aero survey work almost always requires the fine precision that comes only from controlled mapping. The military requirements for charts, however, seldom demand control, because the time needed to establish adequate ground-control is in war prohibitive, and because the areas mapped are most often occupied by the enemy, who would frown upon the presence of a hostile surveying party. The Army and Navy need chiefly map coverage of the greatest possible area in the least possible time; and with the least possible flying, too, for every flight means the chance of enemy resistance and loss of men and equipment. In North Africa it was necessary to map two and a half million square miles of country, and to do it immediately before invasion. For jobs like this, the seemingly impossible jobs, was developed the tri-metrogon system of aerial mapping.

The Metrogon is a wide-angle lens of very flat field, built especially for aerial cartography. In the tri-metrogon installation, three cameras carrying six-inch Metrogon lenses are located rigidly in the floor of the airplane at equal angles to each other, in a plane parallel to the wings of the ship. The center camera takes a picture straight downward, and that on either side of it takes an oblique. The cameras are locked together in their angular position, and their angles of view, from sufficient height, make a strip of three pictures across the flight line which covers the ground from horizon to horizon. A single airplane, mounting a tri-metrogon installation and flying in a straight line, can photograph twenty thousand square miles in three hours.

The illustration will help make clear the relationship of the camera angles. The center negative, which is shown projected as "B," is a true vertical photograph, and as such is in proper scale. The projected negatives "A" and "C," of course, show an impression of the ground which is considerably distorted in the long (Turn to page 101)



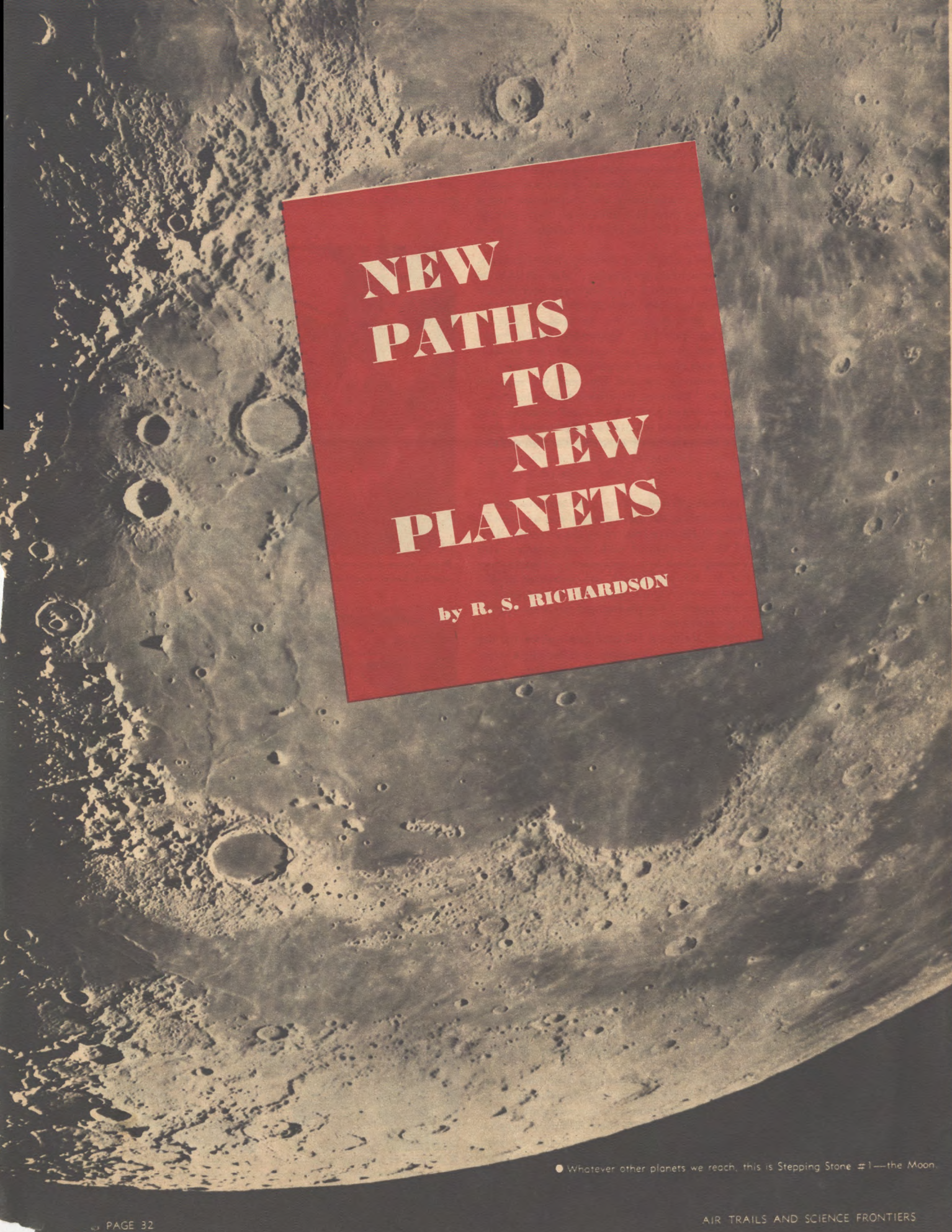
● All set for a tri-metrogon run. Aerial cameras and control systems must operate under rigorous conditions with fantastic precision and reliability.

● Stereoscopic viewing devices are a big help in certain types of mapping work. Only with their aid can surface elevations be correctly established.

● Batteries of precision projectors are used to project mapping negatives in proper relationship to show surface detail accurately in the final mosaic print.

NEW PATHS TO NEW PLANETS

by R. S. RICHARDSON



● Whatever other planets we reach, this is Stepping Stone #1—the Moon.

PLANES SWING THEIR COURSES NOW TO TAKE ADVANTAGE OF THE WINDS OF THE AIR. BUT THE INTERPLANETARY SHIPS OF TOMORROW WILL SWING TO THE GREATER "WINDS" OF SPACE—THE GRAVITY PULL OF SUN AND PLANETS!

Three Planets Discovered

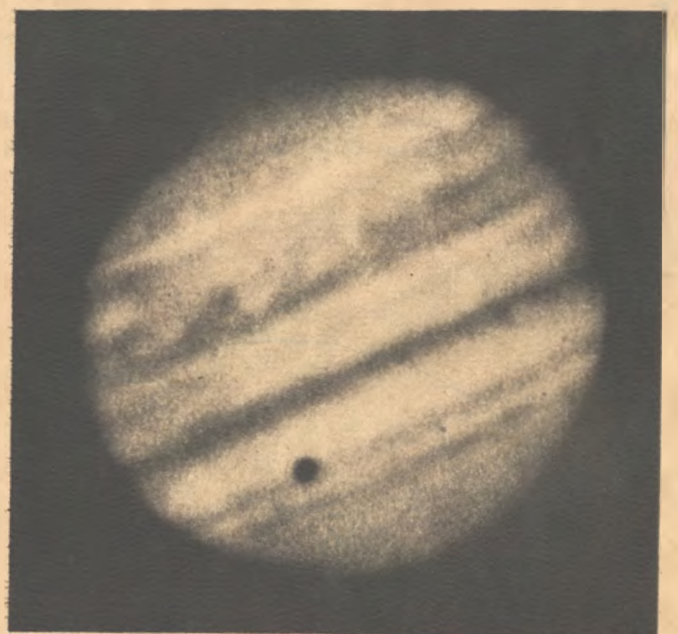
SANTIAGO, CHILE.—Discovery of three planets at the Observatorio Ninguno, situated on a remote peak 9,000 feet high in the Andes, was announced today by the Director, Señor Romero Gonzalez. In a paper read before the Inter-American Scientific Congress, Dr. Gonzalez reported that photographs taken under his general supervision indicate the possibility that life may exist on at least one of the new worlds. The discovery, which was received with the greatest enthusiasm, was the result of a patient search. . . .

Such a flash coming over the wires would be big news indeed. Discovery of the outermost planet Pluto was hailed as one of the ten biggest news stories of 1930. Imagine the excitement aroused by discovery of three major planets revolving close to the earth! There would be a stampede by newspapers and picture magazines for the latest details. Double page spreads would show photographs of the new planets, the Observatorio Ninguno, its distinguished director, with small insets of his two assistants who did all the hard work. Noted astronomers would issue ponderous statements to the press and deplore the publicity to which they were being exposed, although actually enjoying every minute of it. Columnists would gravely discuss the possibility of repercussions on the good neighbor policy. A dozen spiritualists would claim they had prophesied where the planets would be found years ago.

Unfortunately, the discovery of even one new planet now seems very unlikely. Clyde Tombaugh, who discovered Pluto, has completed a survey covering three-quarters of the sky, without detecting a single suspicious object among the 90 million star images examined. He had hoped particularly that some large asteroids might be found revolving between Saturn and Uranus, but here also was disappointed.

Yet, in a sense, there are three planets in the sky today that were unknown less than a generation ago. They are "new" in the sense that our conception of them is new. Their names are Venus, Mars, and Jupiter. Certainly the accounts of Venus and Jupiter written before 1920 bear scant resemblance to those in textbooks today. Our picture of Mars has not altered so radically, but the outline is more definite than before and the whole image is in much sharper focus.

Progress in planetary research during the past thirty years seems pitifully slow compared with the rapid strides that have been made in stellar astrophysics. This is due partly to lack of workers in the planetary field as well as the intrinsic difficulty of the subject itself. Incredible as it sounds, analysis of the atmosphere of a planet a few million miles away is a much more difficult undertaking than analysis of the atmosphere of some star millions of millions of miles distant. The stars are luminous bodies with atmospheres composed of simple elementary substances. We can turn our telescope on a star, take a photograph of its spectrum, and within a few minutes state that its atmosphere contains the elements scandium, magnesium, and calcium, that the surface temperature is about 20,000°F, and that the star is moving toward the earth at the rate of 12 miles per second. But the atmosphere of a planet is visible only by reflected sunlight. If it absorbs certain portions of the sunlight or leaves some other mark upon it, we may be able to identify the gases it contains. But identification is complicated by the fact that our own atmosphere absorbs sunlight strongly, so that possible faint planetary markings have to be disentangled from those made by the terrestrial gases. Also, a planetary atmosphere is not composed of simple elements



● Jupiter—the Solar System's giant. Ten times the diameter of Earth, its atmosphere is some 12,000 *miles* deep. And colder than our South Pole! Gasoline would solidify there.

● Mars, the most talked-of planet, definitely has atmosphere and plant life. Probably there are some lower insect-like animal forms, too; but no men—yet!

● Saturn, second biggest planet, has so low a density it would about float in water. It, too, is mostly gas, colder than Jupiter.

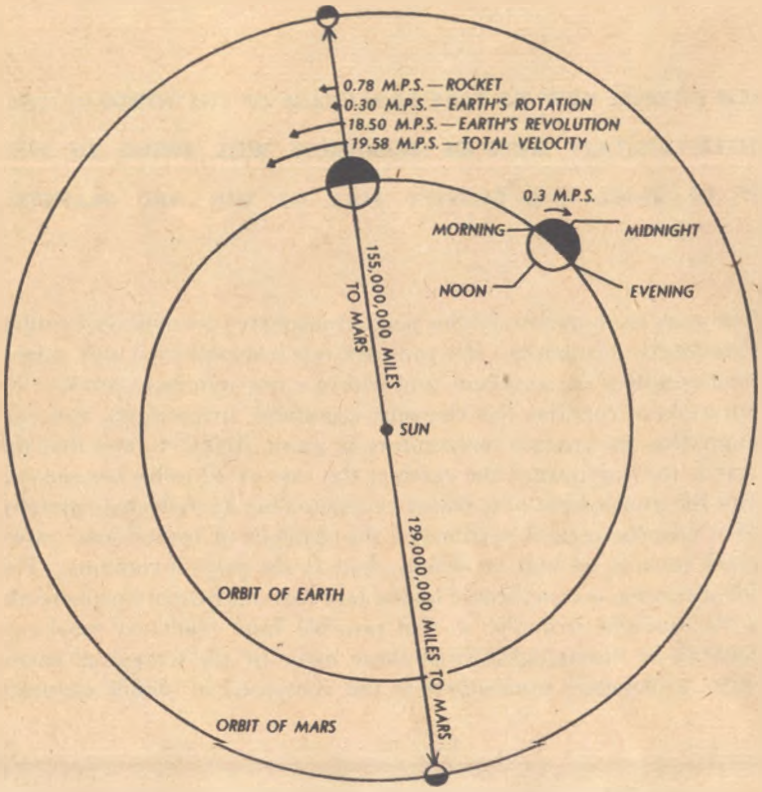


Fig. I. The large, or economy size, route to Mars, involves an elliptical orbit; to establish such an orbit, a rocket must move 19.58 miles per second. But that can be made up of Earth's own speed in its orbit, plus Earth's rotation, and only 0.78 m.p.s. extra. Sadly, however, it takes an added 6.77 m.p.s. to escape Earth's gravity. V-2 easily exceeds ¾ m.p.s.

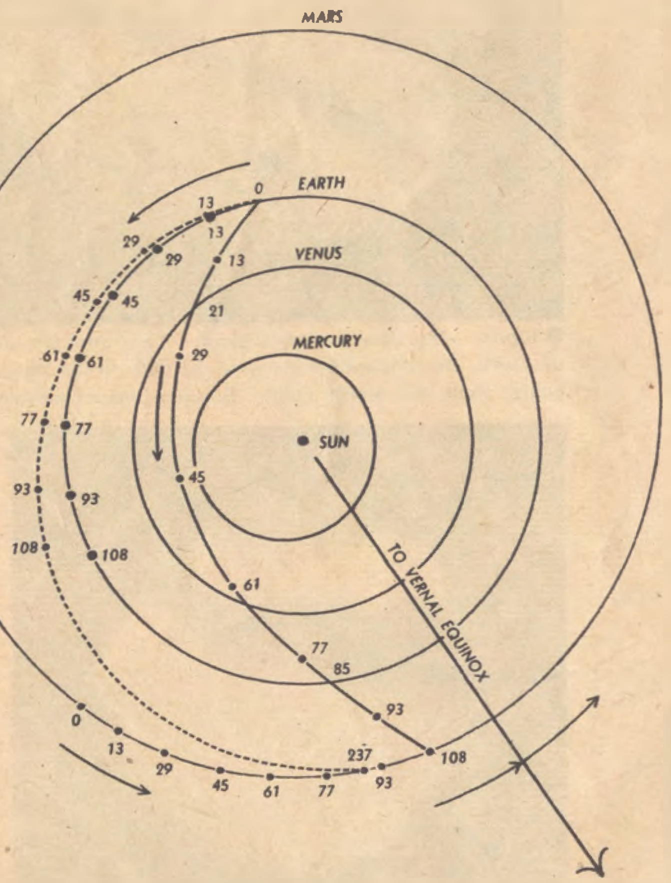


Fig. II. Comparison of the larger, slower, but less fuel-consuming classical orbit (dotted) with the high-speed hyperbolic orbit to Mars. The figures on the orbits show days-after take-off, with the positions of Mars, Earth, and rocket shown at corresponding times. Calculated for the fast orbit in this case, the slow orbit will bring the ship to Mars' orbit months after the planet has passed the intersection. The slow orbit calls for different times.

like that of a star but of compounds, which may never have been studied in the laboratory from an astronomical point of view.

Reviewing the record of planetary exploration since the time of Herschel about 1780, one cannot help wondering how much farther we may expect to go depending upon earth-based telescopes alone. You can look at a planet night after night through a big telescope and see nothing that was not familiar to astronomers a century ago. It is true that the photographic plate, the spectrograph, and the vacuum thermocouple have contributed much that was beyond the reach of visual observations. Undoubtedly, new electronic techniques will contribute much more in the near future. Yet the uneasy feeling persists that the present quest is hopeless. That the only way to know what is on Mars is to go there and find out.

Already rockets have been sent to altitudes above 100 miles to study meteoritic phenomena in the upper atmosphere. Rocket photographs of the solar spectrum have been obtained that show lines impossible to observe from the surface. The Army has stated that if necessary a small mass could be placed upon the Moon within less than ten years. Of course, sending a manned rocket to the Moon or Mars is a problem of a much higher order of difficulty, which in my opinion is still far from solution.

There is no reason, however, why certain aspects of space travel cannot be discussed now as well as a hundred years from now. I feel confident that in 2047 Newton's laws of motion and the law of gravitation will still be in operation, and that the same formulae will be used in applying them. Here is one field in which nothing really new is likely to be uncovered.

So let us proceed to examine these new planets that loom in the sky today, and in imagination plot the paths that will lead us to them tomorrow.

The Cheapest Route to Mars

The most economical way to send a rocket to Mars (or any planet) is to give it just enough velocity to carry it to the desired point of contact and no farther. Once the rocket is properly launched no more energy need be expended to keep it moving, since there is no friction in space. Theoretically, the rocket should faithfully follow its prescribed path as effortlessly as the planets revolve in their orbits. Sending a rocket to Mars might be compared to rolling a ball up an incline into a basket at the summit. In both cases, work must be done against gravity. When going to Mars, we must do work against the attraction of the Sun and Earth. On the incline, work is done against gravity at the surface of the Earth. We will get the ball up the incline with the least effort by starting it just fast enough so that it barely attains the summit and topples into the basket. Too little velocity will cause the ball to roll back again. Too much velocity may cause it to fly on past the basket.

Figure I shows the orbits of the Earth and Mars. The orbit of the earth is almost a perfect circle with the sun at the center. The orbit of Mars is slightly oval, with the sun noticeably off center. At the point A on the orbit of Mars the distance to the Sun is 155 million miles; while at P, the point nearest the Sun, the distance is only 129 million miles. As we are supposed to be on a very limited budget we will therefore aim for P, since we would be foolish to do any more work than is absolutely necessary.

Calculations show that a body launched from a point on the orbit of the earth needs a minimum velocity of 19.58 miles per second in order to reach Mars at P. Now the Earth moves in its orbit with a speed of 18.50 miles per second, and rotates at the equator with the speed of 0.30 miles per second. Inspection of the greatly exaggerated figure of the Earth shows that at midnight the point M will be carried by rotation in the same direction that the earth is revolving in its orbit. Thus, by launching the rocket horizontally toward the east it will acquire a speed of $18.50 + 0.30 = 18.80$ miles per second, with no cost to us whatever. In fact, all the speed we have to give the rocket ourselves is a mere $19.58 - 18.80 = 0.78$ miles per second.

I can hear someone in the back of the room rise up and demand, "Why wait any longer? We can give a rocket that much velocity right now. I want to start for Mars tomorrow!"

The answer is that we have vastly oversimplified the problem. The path we have described is what might be called the classical route to Mars, to borrow a favorite expression from the atomic

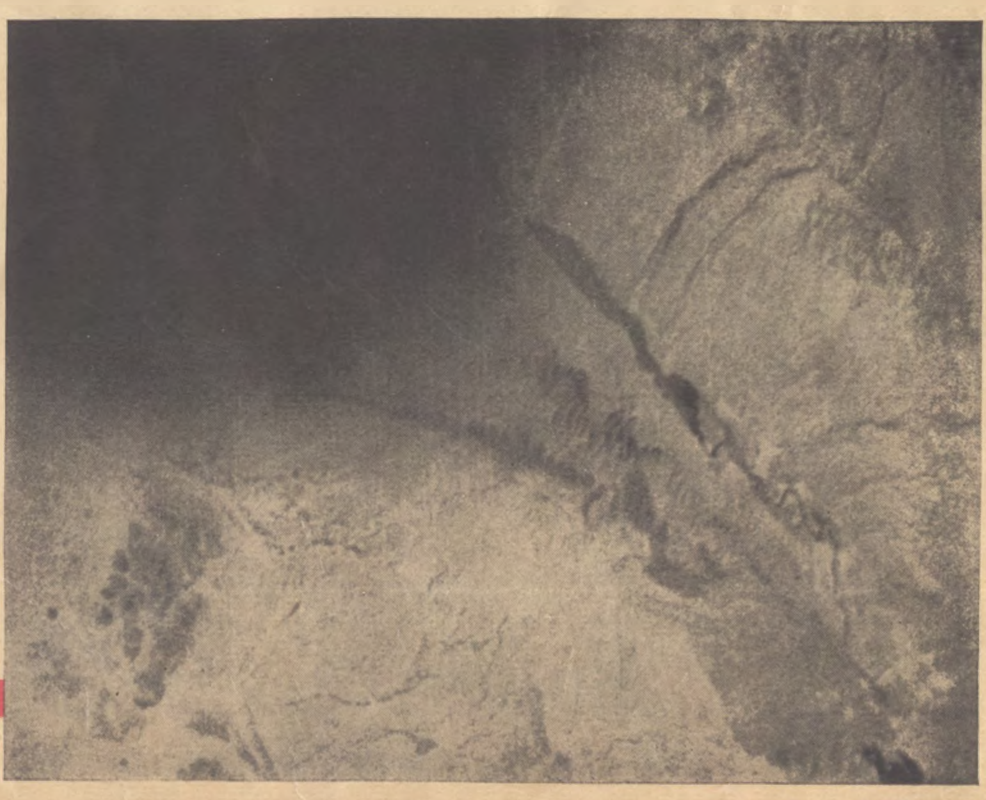
(*Turn to page 39*)

MARTIAN LANDSCAPE

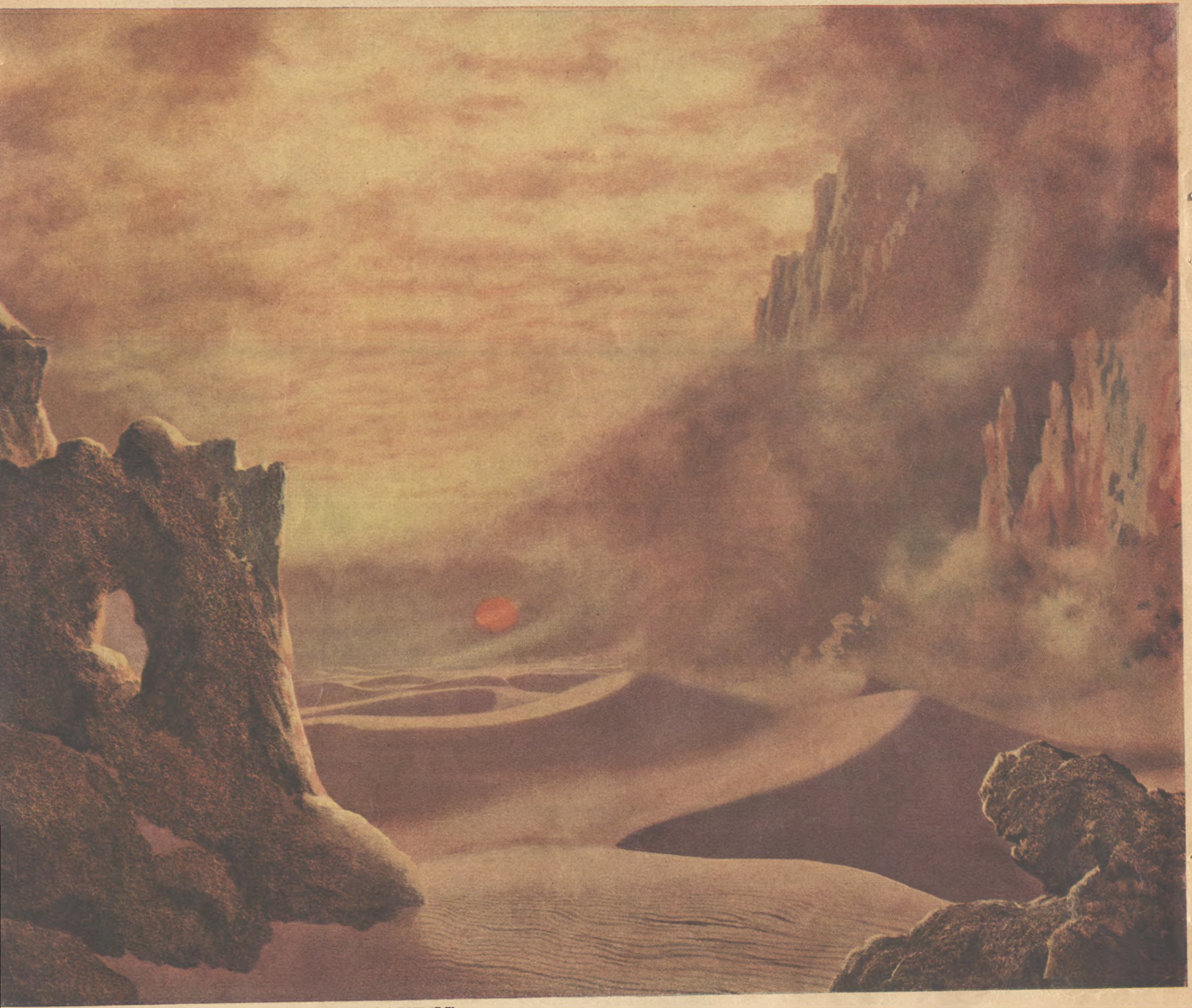
● Going up! The automatic camera caught this view looking downward from a rising V-2 at the 35-mile level. As a super-elevator for measuring and recording devices, V-2 is still tops, although new types of rockets now under development promise ultimately to surpass it.

● Another view from V-2, this one at the 45-mile level. Even large areas of high cloud seem to float very close above their shadows on the surface beneath. Topographical features are drawing together into the appearance of a good relief map as the altitude increases.

● This way out! Out to the stars, that is. This vista of the horizon and the darkling background of space beyond is one no living creature on this planet has viewed directly—yet. From 65 miles up, 40,000 square miles of surface are visible stretching away to the horizon 720 miles distant. Mankind will some day travel this road to the moon . . . and beyond.



● From 60 miles up, the earth directly beneath definitely has the wrinkled, foreshortened look of a topographical map. Such pictures may have important practical applications.



VENUS—DRY, WIND-SCOURED

physicists. This is the route discussed in all the books on interplanetary travel. It is important because it is the fundamental basis for all discussions of inter-planetary travel. But you would never get to Mars or even the Moon by following the directions as stated. In the first place, the resistance of the air would stop the rocket almost before it got started. But even neglecting the air, gravitation would soon put an end to the project. A rocket launched horizontally from an elevation of 500 feet with an initial velocity of 0.78 miles per second would land—not on Mars—but somewhere over in the next township about 5 miles from the starting point.

To send a manned rocket to Mars, engineers must somehow devise a way to launch it gently into space at a low speed until at a height of around 200 miles, when it is essentially in a perfect vacuum. Then the speed must be stepped up gradually to at least 6.77 miles per second in order to leave the Earth. Such a rocket will be able to reach the orbit of the Moon. In order to reach the orbit of Mars, a velocity of 7 miles per second at 200 miles elevation will take it there in 259 days.

Ellipse vs. Hyperbola

As a home-loving individual who dreads the thought of packing a suitcase for a week-end trip, I shudder at the thought of trying to stow away enough water, oxygen, food, etc., to last a crew of three people for 259 days, within the limited interior of a space ship. Worse still, for a person with a disposition like my own, would be the strain of trying to live in such close contact with anybody for 259 days. A couple starting for Mars on their honeymoon would hate each other by the time they arrived at the end of the line! And we still have made no plans for a stopover on Mars itself or the trip back!

It is my contention that if space travel is ever going to become a reality we must speed things up considerably. The trouble is that all calculations have been based upon minimum energy requirements, which naturally demand more time. But if we have barely sufficient fuel to reach Mars by the most rigorous economy, then we have no business attempting to go there in the first place. Far better to wait another hundred years until powerful fuels are developed that will take us to Mars in fast time with a comfortable margin of safety.

(Turn to page 72)

These uniquely beautiful paintings of the planets, by Chesley Bonestelle, were prepared in collaboration with R. S. Richardson, of the Mt. Wilson Observatory staff, and represent the present latest knowledge and belief concerning the surface character of the planets.

Venus, always cloud-wrapped, naturally has been spy-proof; we can only infer what the surface is like. The spectroscope has shown no water vapor, and the best present estimate is that the clouds must be dust. Because the surface is hidden, we can't determine the length of Venus' "day" accurately, but it is estimated that the planet turns once in 20 to 30 days. The day side gets extremely hot; the night side gets enormously cold. The resultant tremendous difference in atmospheric temperatures sets up wind storms of unimaginable ferocity.

Jupiter, on our cover, is another cosmic mystery, veiled in cloud. Ten times the diameter of Earth or the Earth-size Venus, Jupiter is nearly four times as far from the Sun as Earth, and gets but a sixteenth as much light and heat. It's *cold.* Apparently, Jupiter consists of a solid, rocky core, covered by an immensely deep frozen ocean of ice, topped by oceans of half-frozen liquid ammonia gas. Finally, an atmosphere more than 12,000 miles deep presses down with hundreds of tons per square inch. But Jupiter, like Venus, is a violent planet. Stupendous cyclonic storms as big across as our whole planet scour through that incredible soupy atmosphere of free hydrogen and methane, heavily and noxiously tainted with ammonia. Apparently enormous volcanic violence is still at work; it's a Titan planet of titanic violence.

In strong contrast is the quiet beauty of the Martian landscape. Low, gently rounded hills in the foreground fall away to the blue streak of a marshy area below, and the broad, almost flat, meadowland beyond. In the distance is another marshy area, and another range of low, worn hills. From Earth's distance, this constitutes a "double canal." The blue water and green of the marshy meadowland, against the reddish, iron-oxide stained desert areas appear straight and narrow from 45,000,000 miles away.

Mars has the peace and quiet of a graveyard—for Mars is a nearly dead planet. Jupiter has the violence of a squalling baby—young and still forming. Venus is dying now; it's a mature planet, like Earth, but fighting the drag of the too-near Sun's gravity—a grip that has already slowed its rotation almost as much as Earth has slowed the Moon's.

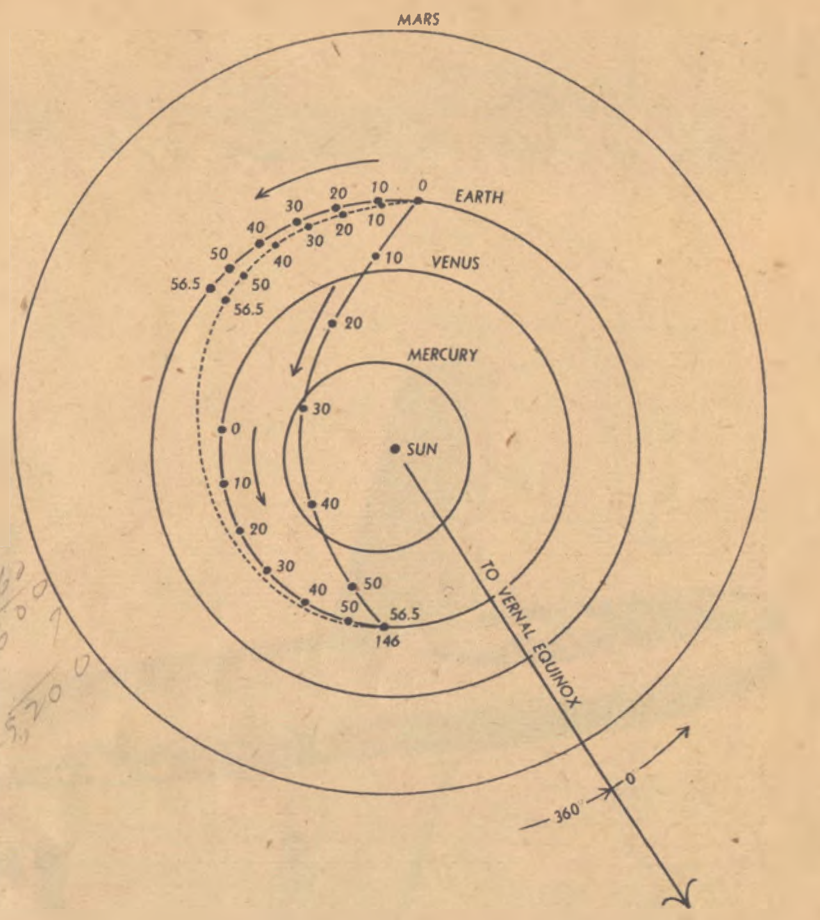


Fig. III. Similar comparisons of the two orbit-types for the Earth-to-Venus trip. In this case, the economy orbit—dotted—takes 146 days vs. 56.5 days for the faster hyperbolic orbit. Freight vs. passenger orbits?

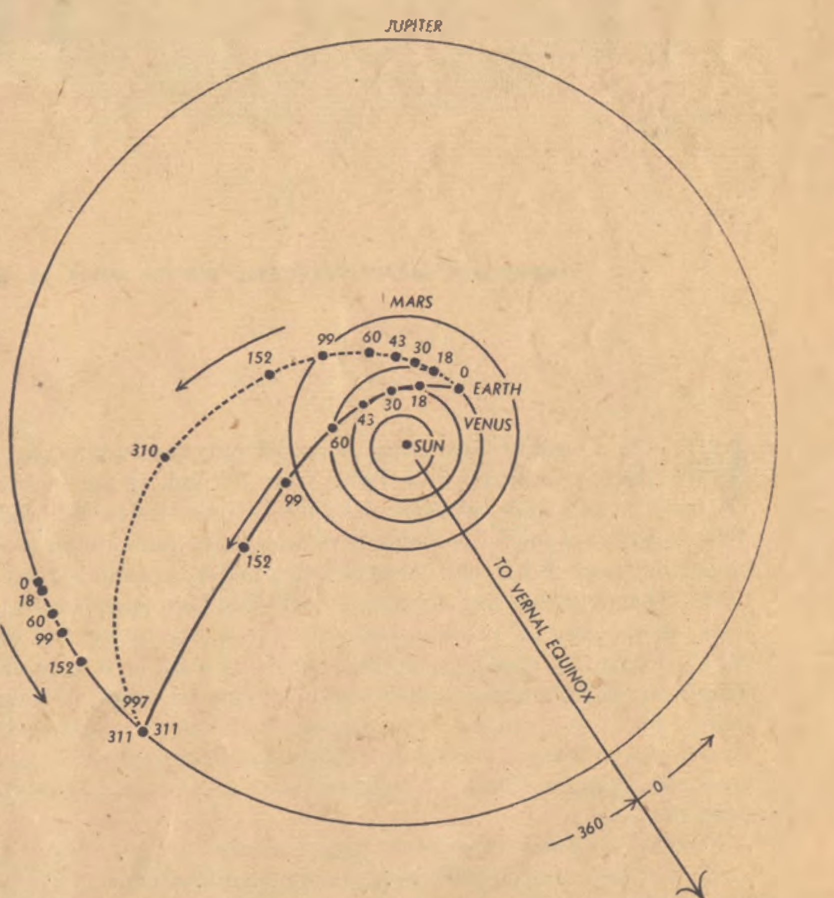


Fig. IV. The trip to Jupiter is long and slow, anyway you take it. But the hyperbolic orbit is 686 days—almost two years!—faster. Notice the small arc Jupiter covers in 331 days; Earth will have made nearly 11/12ths of a full circle. On the long route, Earth would make nearly two and three-quarters full circles around the Sun. Something a lot faster than any presently-known rocket type engine will be needed to make Jupiter trips popular! Hm-m-m- —and Pluto's seven times further out! And the stars . . .

● Gene May, left, who will test-fly the Skystreak, and E. H. Heinemann discuss problems of high speed.

PROBLEMS OF HIGH SPEED FLIGHT

by E. H. HEINEMAN
Chief Engineer, Douglas Aircraft Co., Inc. El Segundo, Cal.

THERE ARE MANY PROBLEMS WHICH MUST BE SOLVED BEFORE SUPERSONIC FLIGHT IS PRACTICAL

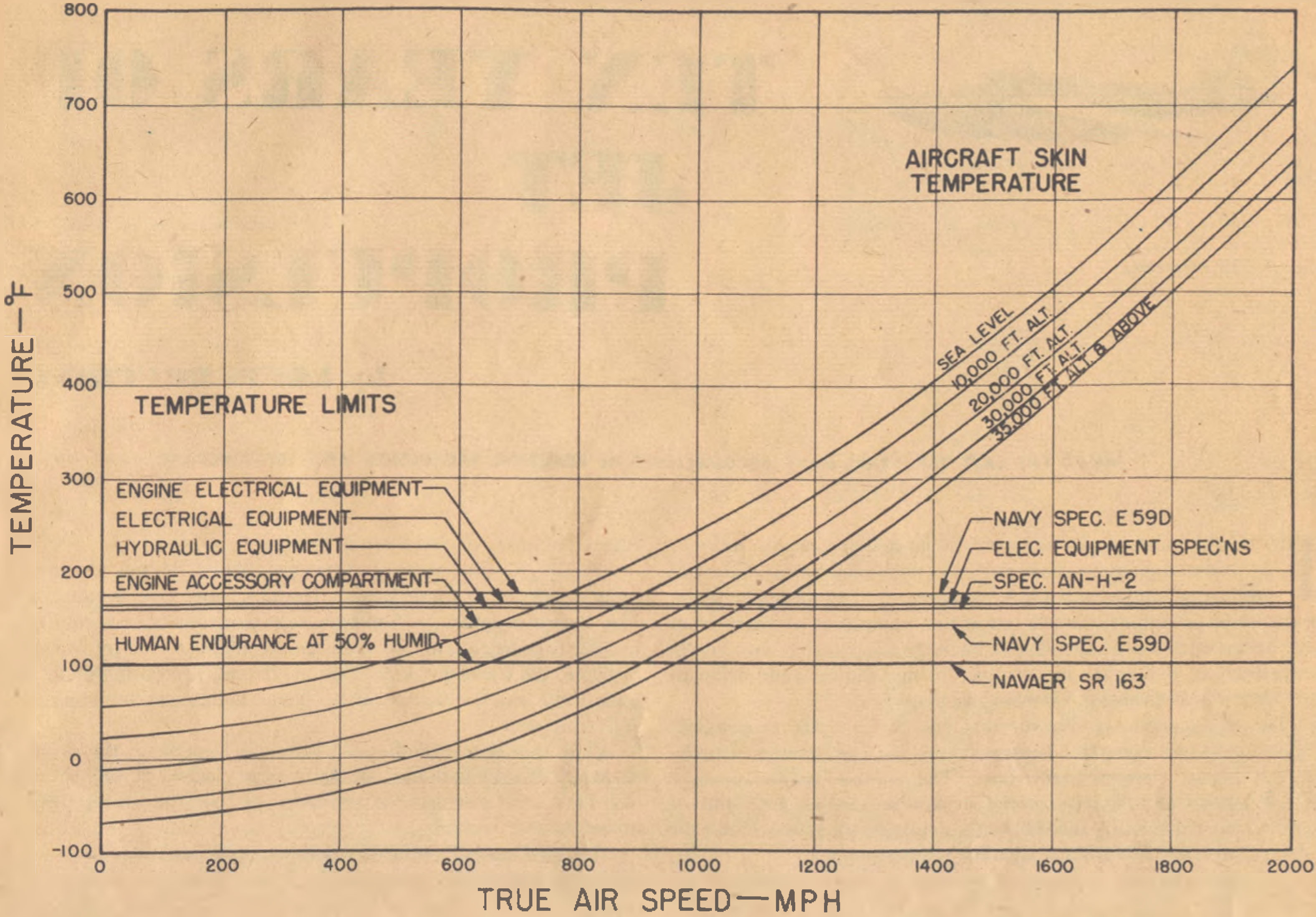
AIRCRAFT speed records have increased quite consistently, since the Wright brothers' first flight, from 31 mph to the present mark of 616 mph, established by the British Meteor last year. This progression should probably have been logarithmic rather than linear, but since it has been largely influenced by economic conditions, it happens that our progress to date has been approximately linear at the rate of 14 miles per year. It is interesting that air transport cruising speeds have been increasing steadily at approximately one-half the speed of the record breaking airplanes, or seven miles a year. With all the recent attempts to break the world speed record, it was thought certain that the 14 miles per year rate would be exceeded during 1946. The 1946 gain, however, was only 10 miles per hour.

Progress is always improved by an incentive of stimulus. As a result of the research development and money spent during World War I, there was a pronounced postwar reaction for a period of approximately five years. Under the impetus of the Schneider Trophy, there was a pronounced acceleration in seaplane speeds causing them to surpass landplane speeds in 1927. The increase during World War II probably can be accounted for by the experience gained in assisting our allies during the period just prior to the war, and it is probable that a postwar reaction will take place during the next few years as a result of the great scientific advancement made during war years.

Comparing the progress of aviation with other speed record histories, we note that the rate of progress for each new scientific development seems to be greater than previous developments, due, no doubt, to the general advancement of science. An exception to this is the rocket. Rockets have been in existence since the thirteenth century, but it was not until the last few years that a rapid advancement in this field was made, and only then after vast sums of money were made available for rocket development.

One might naturally conclude that rocket travel may be the next mode of high speed travel, and little wonder. The development of the German V-2 has pointed out to the world the great potentialities of rocket flight. The development of rockets as uninhabited missiles capable of being fired to any point on the face of the earth appear to be within the realm of possibility in the relatively near future. The greatest unsolved problems in this field are generally considered to be those of obtaining satisfactory guidance and control. Since rockets operate most efficiently above the earth's atmosphere, the problem of using them for human transportation is somewhat more complicated due to the necessity of reentering the atmosphere and landing safely. Various methods *(Turn to page 92)*

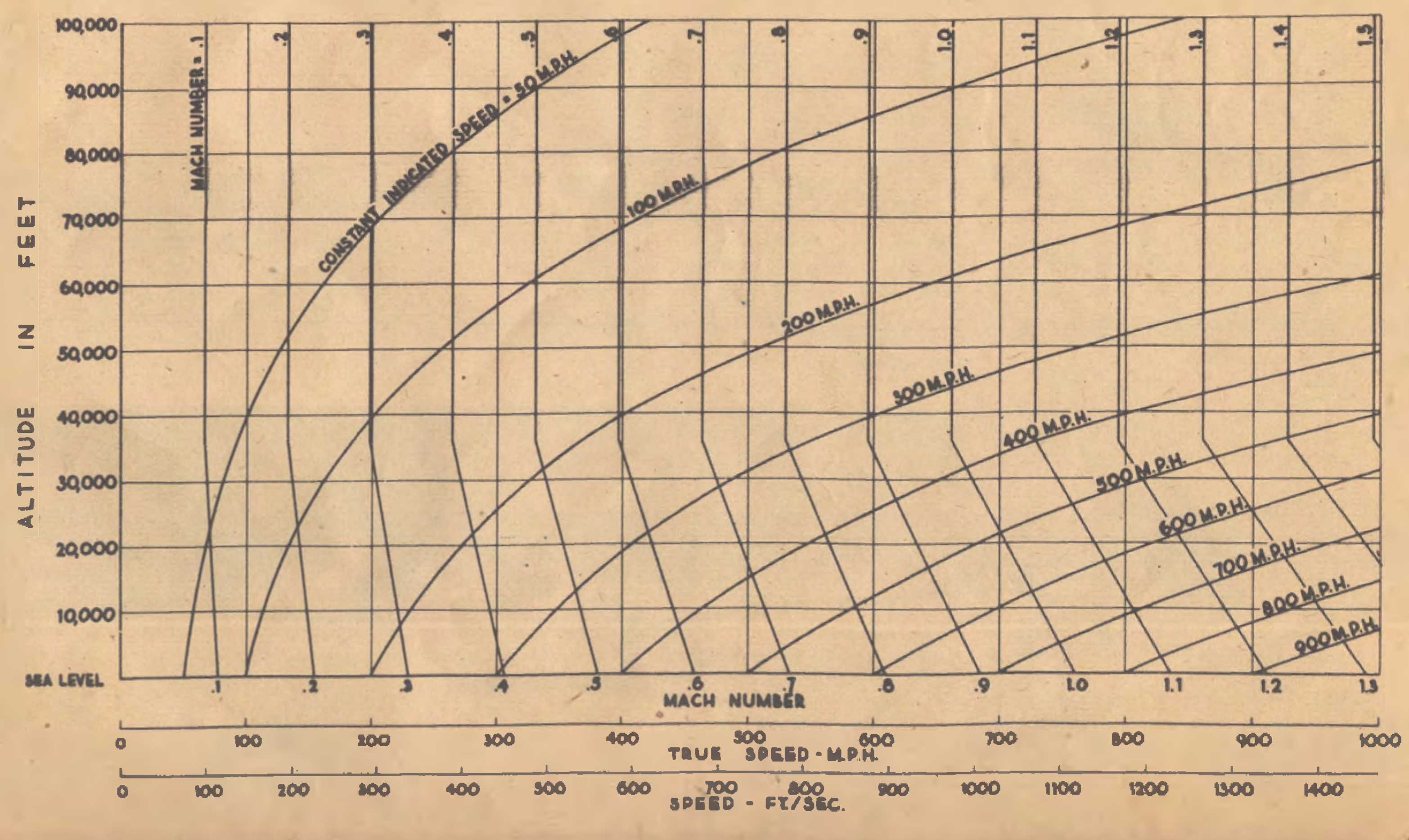
LIMITS OF COMPONENT SYSTEMS



RELATIONSHIP

INDICATED SPEED TRUE SPEED MACH NUMBER

0 - 100.000 FEET **0 - 1000 M.P.H.**




Bell P-59B Airacomet

TEN YEARS OF JET PROPULSION

by LOUIS BRUCHISS

WHAT THE LAST TEN YEARS HAVE ACCOMPLISHED IN REACTION PROPULSION AND JET AIRCRAFT

FROM the musty pages of international patent journals, aircraft jet propulsion engines have risen to a triumphant achievement in mechanical and aeronautical engineering. The principle of the exhaust jet is simplicity itself, yet it took thousands of years from the first conception of the idea of heating, compressing, and finally expelling air, before the modern gas turbine engine could drive an airplane at speeds above 700 miles per hour.

The development of the aircraft gas turbine was progressing quietly in three countries before World War II started, namely, Great Britain, Germany, and Italy. The first two nations brought the jet engine and the jet-powered airplane to a rather high state of perfection, considering the short time available for research and the urgent necessity of fulfilling wartime requirements.

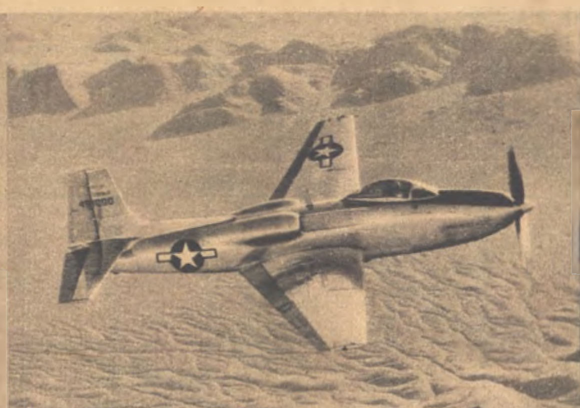
Germany's defeat, of course, precludes any further work on German engines or German lines of endeavor, and it will be the purpose of this review to trace the efforts of English designers and the later American accelerated research, together with a view of the future prospects of jet-powered aircraft.

Actually, it is just about ten years ago that the designs which were being developed in Great Britain, Germany, and Italy began to jell. The Italian engineer, E. Campini, a designer for the Caproni firm, was the first successfully to manufacture and fly a true jet-propelled airplane, the Caproni CC2. This craft made initial flights in August, 1940, and the famous Milan-Rome flights was announced the following year.

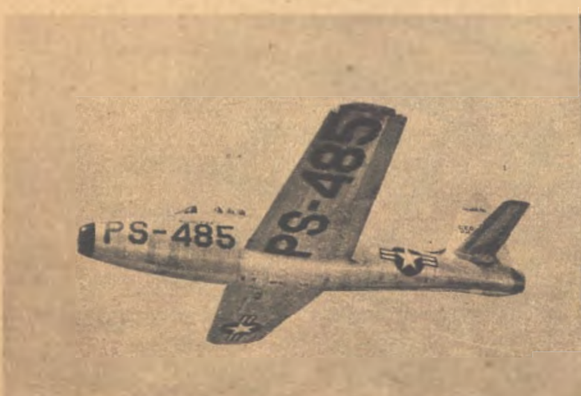
While this remained the sole Italian achievement, the developments of the British and Germans were cloaked in secrecy until World War II necessitated revelation of their jet planes through actual combat service.

Although some American engineers and inventors were aware of the literature and potentialities of jet propulsion, government and industry impetus were lacking and practical progress was practically nil in the United States up to 1941. After America's entry into the war, the British revealed their gas turbine designs and Gen-

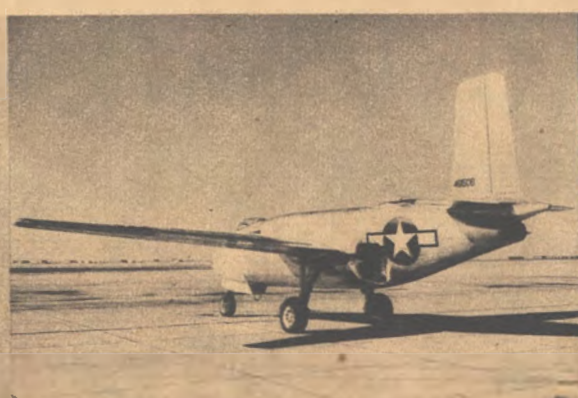

Lockheed P-80A Shooting Star

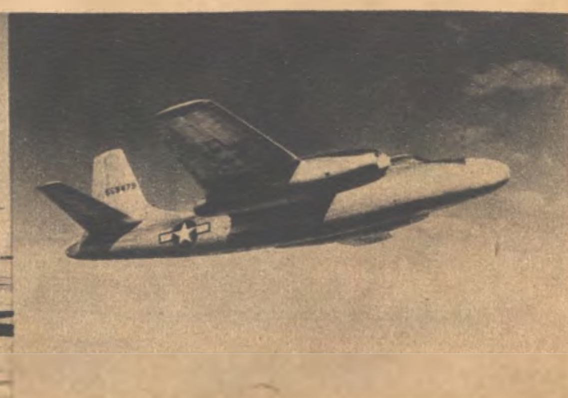

Consolidated-Vultee XP-81


Bell XP-83



Republic P-84 Thunderjet


Douglas XB-43


North-American XB-45

eral Electric was designated to develop an American gas turbine, based on Air Commodore Frank Whittle's design.

At the beginning of this decade of aircraft propulsion progress, many aeronautical men were frankly skeptical of jet propulsion powerplants. Their lack of vision and disbelief in the possibilities of this radical type of power utilization were countered by the startling performance of German and British jet planes.

Now, in 1947, the United States alone has a total of about 37 different aircraft powered by some form of jet propulsion. 90 percent of our military aircraft types in process of construction or design are powered by jet engines. The advance has even gone beyond the gas turbine and combination gas turbine-propeller drive types. True liquid-fueled rocket engines have been installed in man-carrying aircraft in attempts to travel beyond the speed of sound and to reach altitudes where no gas turbine could operate because of lack of air.

A number of annoying mechanical and thermodynamic problems were the cause of several years of anxious experimentation and tests before the jet engines visualized in 1938-1940 could actually power a plane in flight. One of these problems involved the metallurgy of the detail parts, particularly that of the turbine blades past which super-heated air had to flow. The centrifugal forces on compressor and rotor blades rotating at tremendous speeds was another difficulty which required considerable metallurgical research. Fuel consumption at various engine speeds and at various air pressures or altitudes was another factor which jet engine designers had to study carefully.

Since the efficiency of the jet engine increases with the temperature of the gas in the turbine, and also with the speed at which the aircraft is flying, it is apparent that much active research is still required. Improvements in heat-resisting metals resulted in the raising of gas temperatures some 400 to 500 degrees Fahrenheit. Studies are now being made for coating turbine blades with ceramic materials and for actually cooling the blades themselves. A ceramic material in itself would be lacking in the physical properties which would qualify it for use as a turbine blade. However, a ceramic coating which would resist the impact of super-heated gases, backed up by a metal for the required strength, seems to be the solution.

English experimentation with gas turbines in the early nineteen-thirties took on the familiar form of all new inventions and developments. The British Air Ministry was not interested; and private firms were equally negative. Frank Whittle finally got some private capital to finance an experimental turbine which ran for a few hours before the turbine blades failed. Then, however, the government took notice and a contract was placed with Power Jets, Ltd., the company formed by Whittle, for an engine to be installed in a Gloster E28/29 airplane.

The first engine, the W1X, powered the Gloster E28, which left the ground for a short hop in April, 1941. It developed about 850 lbs. of thrust at 16,500 r.p.m.

This initial success led to the development of the W2 engine, which had considerably more thrust, 1,450 lbs., intended for the Gloster Meteor, twin-engined fighter. The W1X turbine unit, drawings of the W2, and technicians were flown to the United States late in 1941 to establish the now-famous jet engine collaboration with General Electric.

The first American gas turbine was the General Electric 1-16. It had a single-stage radial compressor and was rated about 1,650 lbs. thrust at a turbine speed of 16,500 r.p.m. Two were installed in the first American jet fighter plane, the Bell XP-59A. By 1943, G.E. gas turbines were being used to power the Lockheed P-80 Shooting Star. The latter were equipped with one G.E. I-40 (J-33) gas turbine each, rated at 4,000 lbs. thrust at a turbine speed of 11,500 r.p.m.

The XP-80, forerunner of today's fleets of jet fighters, bombers, and transports, remains a remarkable example of aeronautical design. Its clean-sweeping aerodynamic lines have evoked the admiration of engineers everywhere, and its performance has fulfilled all expectations.

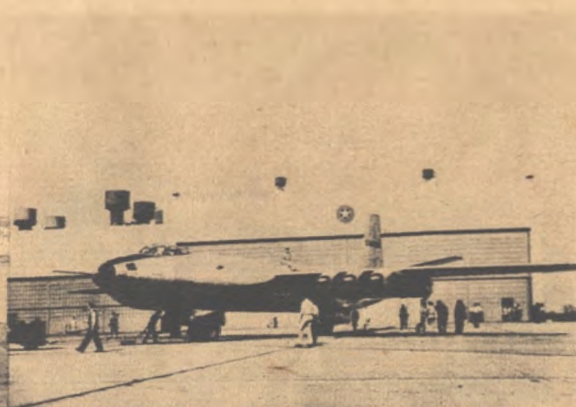
On January 26, 1946, Col. W. H. Council, flying solo and nonstop from Burbank, California, to New York, attained a speed of 583 miles per hour in a P-80 fitted with auxiliary fuel tanks.

The official speed record of 616 miles per hour is held by the British. They had already jumped the gun by setting up a 606-mph official mark on November 7, 1945, in a twin-engined Gloster Meteor with Rolls-Royce Derwent V gas turbines.

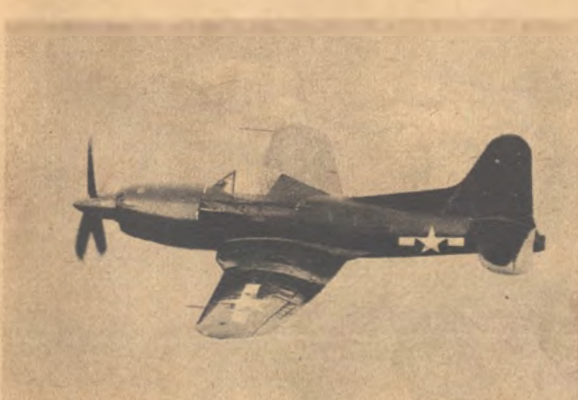
An American XP-84 Republic Thunderjet has chalked up 619 mph, at Muroc Army Air Base, but since this does not exceed the British record of 616 mph by at least five miles, it is not accredited.

Of particular interest in a running analysis of both small and large craft powered by the gas turbines is the versatility permitted by the size and characteristics of the engines themselves, which are taken


Consolidated-Vultee XB-46


Glenn L. Martin XB-48


Ryan FR-1 Fireball


XF2R-1


Chance-Vought XF6U-1 Pirate


North-American XFJ-1

full advantage of by the designer. Combinations of a conventional engine plus a G.E. centrifugal gas turbine has been successfully accomplished in the Ryan Fireball, first Navy part-jet carrier plane. Single and double axial flow engines in the fuselage of a fighter, wing mounted jet engines with a reserve plant in the fuselage, all point to far greater installational flexibility. Greater visibility with reduced frontal areas and lack of propellers adds to the advantages.

Superseding the famous P-59, Bell produced the XP-83, a medium wing monoplane of semi-monocoque construction powered by two G.E. I-40 engines.

In tests it has exceeded 500 mph and is capable of flying extremely long ranges. Its large size is emphasized by the fully loaded weight of 27,000 lbs., or almost 14 tons, against an empty weight of 15,500 lbs.

As in the XP-59, the XP-83 mounts its jet engines underneath the wing roots and has individual exhaust tubes.

Another interesting development is Consolidated-Vultee's XP-81, another long-range jet fighter which employs both a prop-jet and a pure jet engine. A gas turbine in the nose drives a propeller and a G.E. J-33 jet engine provides a powerful rear exhaust. Either or both of the engines can be used, giving the XP-81 high efficiency at all operational levels and speeds. The 81 is an all-metal monoplane with a laminar flow wing.

Flight-tested almost concurrently with the XP-81, Republic's XP-84 is a mid-wing monoplane differing from the other fighters in that the air scoop is located in the nose. It is rather smaller than either the XP-81 and XP-83, since it has a wing spread of only 36 feet, 5 inches as compared to more than 50 feet for the other two jet fighters. It holds the American speed record of 619 mph and can go to 40,000 feet with a range of 1,000 miles. Together with the P-80, the XP-84 will join the AAF as a standard jet fighter.

Powering the P-84 is the new G.E.-designed, Allison-built, J-35 axial flow gas turbine.

The P-84 is aerodynamically refined, having clean lines, flush surfaces without any protruding parts. Pilot cockpit has full vision bubble canopy, is pressurized and fully air-conditioned, with provision for automatic ejection.

The U.S. Navy has a remarkable carrier plane in the McDonnell FD-1 Phantom, a twin-jet engined craft of rather small dimensions. Thick wing roots almost bury the two Westinghouse 19B axial flow engines, each developing about 1,400 lbs. of thrust. It is capable of 500 mph and a 1,000-mile range.

A more recent Navy plane is the XF6U-1 Pirate, produced by Chance Vought Division of United Aircraft. Like the FD-1, it employs two Westinghouse 19B engines, but these are installed in the rather bulbous fuselage. The air intakes are filleted in the leading edges of the wing at the roots, to minimize drag. Pilot cockpit is well forward of the wing, almost on the nose of the craft, giving unusual good visibility.

Both the Army and Navy have been exhorting manufacturers to turn out their experimental jet bombers as fast as humanly possible.

Douglas has the XB-43, an offshoot of the XB-42, powered by two General Electric T.G. 180 (J-35) axial flow engines, each producing about 4,000 lbs. of thrust. These engines are located in the fuselage of the XB-43, much the same as the conventional in-line engines were in the XB-42. Twin jet exhaust tail pipes replace the propellers in the tail. The XB-43 has passed tests successfully and is expected to perform at over 500 mph with rapid climb and service range of 1,400 miles. Air intake ducts are built into the fuselage, where main landing gear also retracts. Double bubble canopy gives pilots good visibility.

A more ambitious bomber is the sleek XB-46, Convair's contribution to the large jet aircraft field. Two engine nacelles each hold two G.E. axial flow gas turbines. Classed as a medium bomber, it has the pointed nose of a rocket and its appearance gives promise of fighter plane speeds.

The Navy has one 4-engine bomber, the Martin XP4M-1, that is very likely to fool the onlooker. Two engine nacelles each contain one conventional engine driving a propeller and one Allison J-33 gas turbine, in line with each other, giving the plane a two-engine appearance.

The XP4M-1 is designed for over-water operation with a range of over 3,000 miles at normal cruising speed, which is only 200 mph with the two propeller engines, but a top speed of 350 can be attained with all four engines. Primary purpose is as a patrol plane and it is equipped with complete electronic devices for communications and search and rescue work.

Glenn Martin has jumped with hands and feet into the landing gear stowage problem on multi-jet thin-winged planes. In a B-26 Marauder, experimentally modified and dubbed the "Stumpjumper," Martin seems to have found one solution in his two-wheel

McDonnell XF2D-1 Banshee in foreground and FD-1 Phantom in rear.

Glenn L. Martin XP4M-1

Gloster E.28/39

Gloster Meteor Mark III

De Havilland Vampire

De Havilland 108 Swallow

tandem landing gear arrangement, which is aided by two small outrigger wheels on either side of the fuselage. The tandem set-up permits retraction of the large wheels into the fore and aft parts of the fuselage. Retraction of conventional tricycle gear into the main section of the fuselage would interfere with the bomb bay in the case of a bomber and with the passenger cabin in a commercial transport.

It looks as though this gear will be designed and tested as a unit on Martin's XB-48, the experimental six-jet bomber they are building for the AAF.

Current British jet engine designs and aircraft built around one or more types of these engines are even more ambitious than the program under way in the United States. Not only is Britain patterning her whole air force on the ascendency of jet propulsion, but most of her civil airliners and even large flying boats are intended to operate on gas turbines., Some aircraft already built are being redesigned or modified for jet engines.

There is almost a complete lack of interest in piston engines in England at the present time. Engineering thinking and practical manufacture has been slowly but surely swinging toward Britain's astonishing array of gas turbines. Unlike the United States, where only two manufacturers have produced workable engines, she has a whole group of companies actively and competitively engaged in research and production.

The British Armstrong-Siddeley Company, based on successful results with their model A.S.X. axial flow gas turbine, which developed 2,600 lbs. of thrust, has brought out the Python, an axial flow prop-jet job delivering 3,670 horsepower to the propellers and 1,150 lbs. of pure jet thrust. It first ran in March, 1945, passed acceptance tests the following month and now has had thousands of hours of developmental running.

The Bristol company has come out with the Theseus I, an engine having both an axial and centrifugal flow compressor in series. This engine provides 1,950 horsepower to a propeller in addition to 500 lbs. of jet thrust. It is claimed that the centrifugal compressor part of the combination is an aid during starting operations.

De Havilland has been in the picture since January, 1941, when they began design on a turbine for their Vampire fighter. Eventually they evolved the Goblin II, a centrifugal compressor job delivering 3,000 lbs. of thrust. This has now been superseded by the de Havilland Ghost, a 5,000-lb. thrust gas turbine of similar design to the Goblin II.

Metropolitan-Vickers has the F.2/3 gas turbine which delivers 4,000 lbs. of thrust and which embodies a ducted fan thrust augmentor, by means of which the thrust is increased by 67 percent for an unchanged fuel consumption and an increase in weight of only 33 percent.

Rolls-Royce was one of the first British companies to show an active interest in jet propulsion and began work in 1938, soon after Whittle got his first encouragement from the government. The Derwent series of centrifugal gas turbines were developed until the present Derwent V, which powered the record-breaking flights of the Meteor, was brought forth. The Derwent V is a 4,000-lb. thrust engine and weighs under 1,500 lbs.

The Nene engine, another Rolls product, is even more compact than the Derwent V, and develops 5,000-lb. thrust.

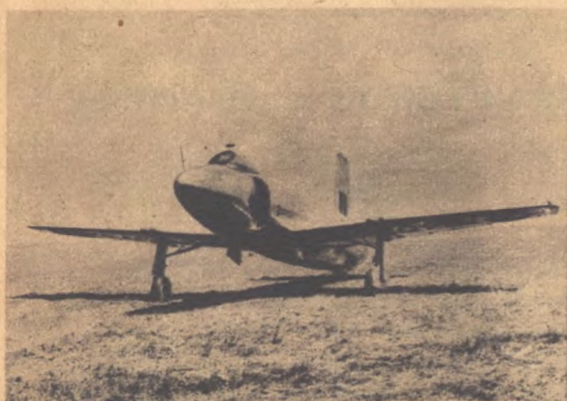
The Rolls-Royce Trent engine was an experimental design to test the prop-jet set-up, and was essentially a Derwent with reduction gear and a small 5-bladed propeller added. It resulted in the Clyde, a prop-jet engine comparable in output to the Armstrong-Siddeley Python; it also has a combination centrifugal and axial flow compressor. It is rated at 3,000 shaft horsepower and 1,200 lbs. of jet thrust.

British jet aircraft are even more varied than the engines which power them. The planes which are flying are largely fighters, which is quite natural, since the gas turbine produces high power and results in a high-speed ship. And, obviously, many of Britain's latest military designs are being held under cover for the time being.

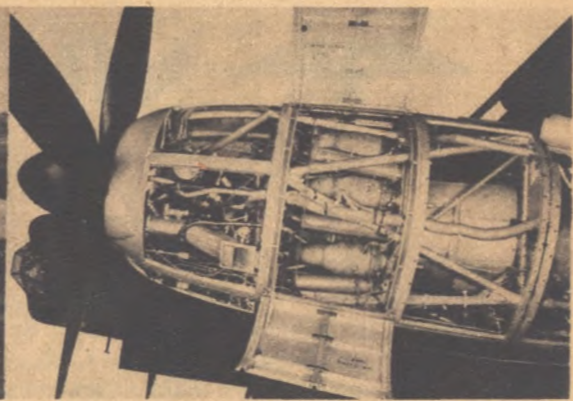
Chief among the fighter craft is the de Havilland Vampire, powered by a single Goblin II engine. It has exceeded the maximum top speed of 450 mph at 20,000 feet. The Vampire is a twin-boom ship with a low wing loading, about 32 lb/sq.ft., which is 10 to 12 lbs. less than that of the conventionally powered Hornet and Mosquito. This seems to result in exceptionally good control response at all speeds.

The Gloster Meteor IV is a twin-jet engine fighter, with the engine nacelles built over and under the mid-sections of the wings. It has a 585 mph sea level speed and can do 500 mph at 30,000 feet.

In the field of commercial air transport, British European Airways has ordered 25 Miles Marathons, powered by two propeller-turbined Armstrong-Siddeley "Mambas." Hitherto, the Marathon was powered by four de Havilland Gipsy Queen piston engines. The Mamba develops 1,200 horsepower. (*Turn to page 78*)


Vickers-Supermarine Attacker


Armstrong-Witworth M.W.52 Flying Wing


Bristol Theseus propeller-turbine engine


Avro-Lancastrian with two outboard RR Nene jet engines


Handley-Page Hermes V with four Bristol Theseus engines


Avro-Lincoln with two Bristol Theseus' outboard

SOLO CLUB CONDUCTED by C. B. COLBY

REMEMBER some months ago when I commented upon a little booklet issued by the CAB on mixing "rye with fly," that covered the subject of drinking and flying? Well, members, I have another booklet, also from the CAB, that I'm going to comment upon this time. Its title is simple and to the point: "Students .... DON'T FLY PASSENGERS!"

Perhaps some of you will wonder how there could ever be a need for such a booklet with a title like that. Just let me tell you a few facts. In just one year, 1945 for example, there were 104 accidents in which student pilots carrying passengers were to blame. Of these 104 accidents, 30 resulted in the deaths of student pilots and 29 in the death of the passengers; 23 student pilots were seriously injured and so were 29 passengers, making a gory total of 59 killed and 52 seriously injured, to say nothing of the 104 wrecked aircraft and other folks battered and cut not seriously enough for this list of dead and seriously injured.

Figures for 1946 and 1947 will be higher yet, but the percentages will be about the same. Now what in blazes gets into these student pilots who not only break the law but break it willingly and knowingly. Ever since 1927 when CAR 43-50 ("A Student shall not pilot an aircraft carrying a pasenger and shall not pilot aircraft for hire or reward or in furtherance of a business") was passed, such use of any aircraft has been illegal—and for a darn good reason.

Strange as it may seem to some folks, EVERY CAB regulation published has a darn good reason behind it!

As you look through the reports of pilot license revocations it seems as though every other one was for some lame-brained student carrying a passenger. Oh yes, my friends, these characters DO get caught and often, if not by the old buzzard with the beard and scythe, then by the chap with the CAA card in his pocket, and believe me they both are bad.

IF the CAA representative DOES nail you for violating CAR 43-50 it can go mighty hard with you—a thousand dollars worth, plus a possible jail sentence under a civil suit (if damages result) and certainly the loss of your Student ticket. Nearly all of these accidents happened to students in ships being flown from isolated fields and from small airports where the operator was NOT aware of what was going on. Very rarely were the accidents at airports where the student was known or the operator able to spot the illegal passenger flying. A few of the students met their fate trying to get into or out of out-of-the-way fields where they had gone to pick up their passengers for their last ride. Lord knows how many have gotten away with this without being caught—YET! The stupid part of it all is that many of these chaps had almost enough hours logged to get their own Private license, but they threw it all away just because they couldn't wait the few more hours.

An attempt has been made to find out just WHY these students insist upon doing this highly dangerous and illegal sort of thing time after time. Ten students who had somehow or other lived through nasty crashes with their passengers were given the "third degree" by the examining Board. The answers were all about alike and a composite of them would sound something like: "Yes, I knew it was illegal and I shouldn't but it seemed OK for I'd had about fifteen hours of solo and had made about fifty landings OK and I wanted to show my friend just how easy it was. All of this shows a knowledge of the illegality of the act and a complete indifference to the law. All ten had their certificates revoked, of course, plus heavy cash penalties in some of the cases.

Just to see whatever possessed the passengers to fly with these quaint pilots, the examiners questioned ten passengers who were lucky enough to live through a student pilot crash. In general they were in complete ignorance of their having flown illegally. They were amazed that the pilot had had no right to be flying them and usually gave an answer something like: "Why I've known Joe Doakes a long time, knew he could fly for I've seen him do it, knew he had some sort of a permit and thought it was OK to fly with him. I didn't know it was against the law."

It was obvious to the examiners that in the main the poor passengers had NO idea that they were supposed to check to see if the pilot COULD fly them legally, or that they had broken any law.

Just keep this in mind, those of you who hold Student Pilot Certificates—you may have soloed but in no way are you yet entitled to fly with anyone who is not a duly licensed Private Pilot or an Instructor. You'll fool no one but your passenger and he MIGHT live long enough to get wise and take it out of your hide later on.

Now let's look at the letters before I tell you folks about a 6,000-mile air trip I just returned from.

The first letter is from Jerry Stewart of Phoenix, Ariz. He is a member of the High School Flying Club sponsored by the Phoenix High School System. They have an Aeronca Champion owned by the school system and rented to the student for $2.25 an hour. Each student pays $6 dues a month to cover all expenses of the plane and its maintenance and club expenses. Sounds like a grand idea to me and I wish other high schools would adopt a similar system, for it appears ideal as a way to get our young men and women into the air under grade "A" supervision.

New member Jerry says there are about twenty members in the club and as the weather is good there the year around, the plane is just about always going. Right you are about the weather out that way. I'll never forget the one and only time I ever landed at Phoenix; it was the night the Japs bombed Dutch Harbor in Alaska. I was flying to the coast to visit all the aircraft plants when the news came over the plane's radio and everything in the air out there was grounded—but sudden! Our nearest field was Phoenix and down we went to spend the night in your splendid Westward Ho hotel. Someday I'll get back there to see what Phoenix really looks like. It looked mighty good to us that night, you bet.

The next letter gives me a real pleasant feeling, I must admit. Sure we all like a kind word from the readers. It's from Midshipman 4/c John D. Lesser of Annapolis, Maryland; and thanks for the kind words, Mister Lesser.

Midshipman Lesser soloed back in 1945, at Warren, Penna., and got his Private license four months later. Because of Naval Academy regulations he may only fly on Saturday afternoons, and although the weather doesn't always cooperate he manages to keep his hand in. He has a few comments to make on my blast (in the May issue) on drunks who fly and concludes his plug for "dry flying" with the sage comment: "As a liquor container a bottle has it all over a pilot!"

Mr. Lesser also mentions the various "breakfast flights" that are held down in that neck of the woods. Any of you other chaps down that way go along on those affairs? Come again, Mr. Lesser.

From Royalton, Mass., comes a nice letter from new member John Wells. He has been flying since he was fifteen. He could not solo, of course, until he was sixteen, so had 22 hours of dual instruction before he "took it around alone" the first time. He is now working for his Commercial ticket and does his flying up at Keene, N. H., at the Dillant-Hopkins Airport. He certainly gives that field a good plug, particularly for their strict field and traffic rules, and the added fact that just across the road from the field is a nice little seaplane base. There are about twenty different ships at the field and John has flown about all of them, besides having just finished a course in Aeronautical Engineering from the Ryan Aeronautical Institute.

The next letter is from a chap you members have perhaps seen on the stage. It's from Lew Fine, a comedian from Denver, Colo., who has been in show business for over twenty-five years, writing, acting, and producing "funny business." His career has taken him all over the world, but right now he is located in Denver, where he soloed.

Major Bill Wheeler of the CAP, who is also a theatrical agent, got Mr. Fine started in flying, and he soloed last April. He now has his Private license and flies for business as well as pleasure. Let us hope he finds plenty of ideas around the airport to use in his stage work and producing.

Now a letter from a couple of new members who both signed the letter. These two new members are from Michigan and they have a complaint to register. They fly at Center Airport, at Armada, Mich., and have logged quite a few XC flights It's about something they have noticed on these XC trips they want to kick (*Turn to page 85*)

ABOUT THE SOLO CLUB AND HOW TO BECOME A MEMBER

FEELING THAT THERE IS A DEFINITE NEED FOR A MEANS OF RECOGNIZING THOSE PILOTS WHO HAVE EXPERIENCED THE THRILL OF SOLO FLIGHT, *AIR TRAILS AND SCIENCE FRONTIERS* HAS FOUNDED THE SOLO CLUB.

THIS CLUB IS OPEN ONLY TO THOSE WHO HAVE ACTUALLY SOLOED A HEAVIER-THAN-AIR CRAFT, EITHER POWERED OR MOTORLESS. IT DOES NOT MATTER WHERE OR WHEN THE FLIGHT WAS MADE. APPLICANTS MUST FURNISH THE MEMBERSHIP COMMITTEE WITH A SATISFACTORY PROOF OF THEIR QUALIFICATION FOR ACCEPTANCE. THERE ARE NO DUES. ONCE A MEMBER, ALWAYS A MEMBER.

To obtain the sterling silver SOLO CLUB wings and life membership card, applicant must comply with any of the following requirements. Send the coupon, with fifty cents, to the SOLO CLUB Membership Committee, Air Trails and Science Frontiers, 122 East 42nd St., New York 17, N. Y.

Proof of qualifications as a SOLO CLUB Member
1. CAA Airman Certificate, number and rating ....

2. F.A.I. license and number ....
3. Evidence of: service in the Army or Navy air forces either as a rated pilot or having received flight training including solo time (attach).

PLEASE PRINT
APPLICANT .... **AGE** ....
STREET .... **CITY OR TOWN** .... **STATE** ....

ELECTRONICS IN MINIATURE

● Dr. Cledo Brunetti of the National Bureau of Standards examines a transmitter complete with batteries and microphone. A receiver is on the desk.

L. Jerome Stanton

AS ELECTRONICS GADGETS SHRINK, THEIR USEFULNESS EXPANDS

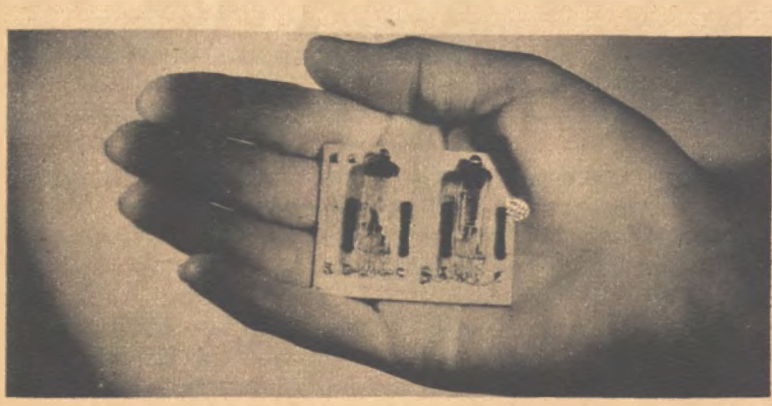
SOONER or later, everybody who has anything to do with flying has to give some thought to weight and space requirements of whatever is to be flown. This includes atom bombs, that fishing tackle you're taking along for your week-end cross-country, or your Aunt Matilda, who weighs 390, ringside. Inevitably, headaches creep in when "pay" load begins to bump against the carrying capacity of the plane, and designers burn gallons of midnight oil and guzzle quarts of . . . coffee in their efforts to increase the net payload and decrease the tare, or empty weight of aircraft, without sacrificing performance and safety.

He puts a gimlet eye on every component entering into the design, right down to the rivets, and, knowing his job, he squeezes out all the weight possible from the structure and powerplant. That done, he aims his critical eye at all the equipment going in, such as deicing gear, pressurizing, cabin heaters and other such hoot-nannies, and sooner or later his frosty glance hits the radio equipment, which may run to some hundreds of pounds in a big ship. "Do we *have* to have all that junk?" he's likely to explode. "Why don't you radio designers learn to get the lead out of your . . . . designs?"

And right about now the radio designer's going to have some very fine—and light—comebacks to make to the plane designer, or to any one else who needs or wants radio and electronic gadgets of really midget size and weight. Enter, the printed circuit!

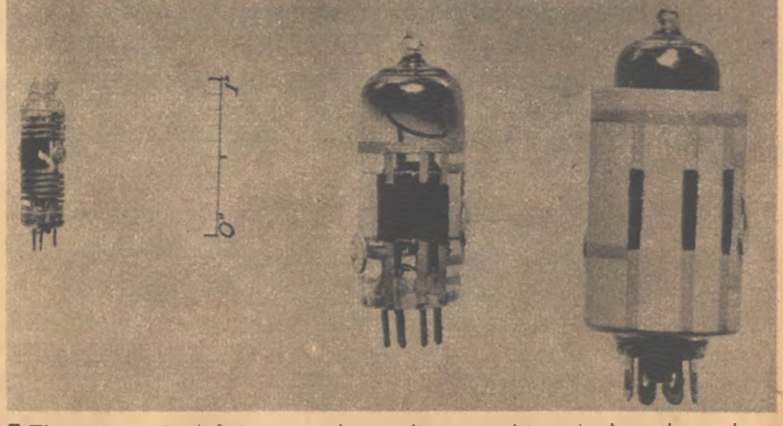
Yes, that's right, electrical transmitting, receiving, and amplifying circuits can now be "printed" or painted directly onto suitable surfaces with special inks, with several distinct advantages over more conventional designs for certain applications.

Most readers will have guessed by now that de- (*Turn to page 89*)



●A two stage amplifier using sub-miniature size tubes and a circuit "printed" on a ceramic supporting plate. Yes, it will have plenty of applications!

● A sub-miniature amplifier gets put through its paces at the Bureau. Performance of the tiny unit is practically equal to conventional types.



● The unit at the left is a complete radio transmitter wired on the surface of the tube itself. To the right of the inch scale are two audio amplifiers.

THE LAIRD "SOLUTION" RACER

by DICK STRUHL
Member A.M.A.

A FINE REPLICA OF AN OLD-TIMER, ONE OF THE MOST ADVANCED DESIGNS OF ITS DAY

INDEED it must have been a great moment way back in 1930 when "Speed" Holman won the Thompson Trophy Race with the terrific average of 201.96 miles per hour. There is no doubt, however, that Holman was flying one of the best designed racers of the times.

The Laird "Solution" was one of the first small span racers and was destined to start the design trend that ultimately ended with the extremely dangerous "Gee-Bee." The Laird never did show the treacherous instability of the later hybrid designs.

But to avoid arguments on the relative merits of the original Thompson Trophy Racers, let us dwell on the Laird as the subject of a control-line gas model. The design has everything to offer the model builder except the extremely high speeds. Yes, and if you have a strong whipping arm perhaps you can bring its speed beyond the 100-mile-per-hour bracket! The design has the word "strength" all over it. Need we say much about the stunting ability of a biplane such as this? And the top wing mounted flush with the fuselage has its advantages too; on one flight the engine cut out while the model was upside-down, and having only about 20 feet of altitude there was no choice but to bring her in in that position. The only damage suffered by the model was a scratched wing and the tip of the rudder worn off. Damage to the author's nervous system was much more extensive.

Construction was kept as simple as possible, as is evidenced in the drawings. With a little care and patience you can have a model that will give you endless hours of flying fun. The original model had a Bantam for power, but the model can take engines up to .35 displacement with no structural alterations.

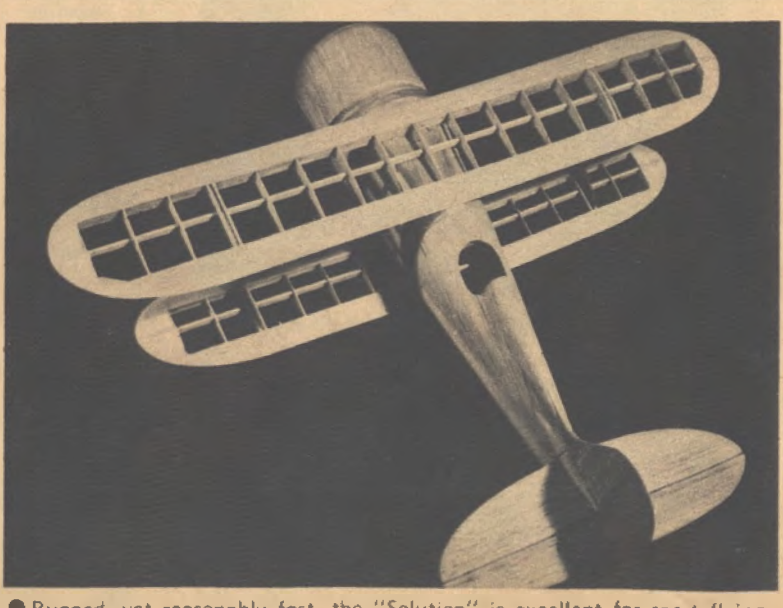
The fuselage is built around a crutch foundation. The upper and lower sections of the fuselage may be carved from solid balsa blocks, hollowed to about 3/16" thickness and attached to the crutch. If you don't want to go to the expense and trouble of securing blocks of the right size you may build the planked method shown in the plans.

First cut all the fuselage bulkheads to shape from the indicated size sheet. Note that the plans are one-third actual size, so the plans must be enlarged three times. Build the crutch from 1/4" sq. balsa with 1/8" by 1/4" crosspieces. Space the hardwood motor mounts to fit your individual engine then fill-in around the motor mounts with 1/4" sheet. Build the bottom half of the fuselage directly on the crutch and plank with soft 1/8" sheet before removing from the plans. This insures perfect alignment. Now remove the framework and add the bulkheads beneath the top wing and the wing platform. Plank this section as before. The removable cockpit section is carved from a solid balsa block and hollowed as sketched in the plans. It is held to the crutch by large dress snaps or wire hooks. The lower half of the engine cowl is fixed, but the upper section is removable to gain access to the engine. Of course, a spun aluminum cowl is best, but a built-up balsa is very satisfactory as you can see in the photos.

The landing gear is bent to the design shown from 3/32" wire. The top crosspieces are mounted in drilled hardwood blocks and heavily cemented to bulkheads F and G. You must mount the landing gear before completing the planking of the lower fuselage section. Tail skid is bent from 1/16" wire and imbedded in the solid balsa tail block as shown Carve the head rest from solid balsa and secure in place. Note that the windshield extends slightly over bulkhead H. Be sure not to cement it to the bulkhead or you won't be able to remove the cockpit section. Do not mount the coil or battery box until the model is complete, then they may be used for balancing.

The tail surfaces are cut from hard 3/16" sheet balsa to the design shown. The elevator has a 3/16" sq. bass spar to act as a connection between the two halves and for a sound foundation for the control horn. The author has found the silk thread hinges to be far superior to cloth hinges. They are stronger and do not have the "play" that cloth does. Cement the stabilizer to the top of the crutch very carefully and don't spare the glue; there is a terrific load on the stabilizer in flight. The rudder may be offset slightly for your mode of flying.

The wings are of very simple construction. The only thing unusual is the over-size leading edges. True, this type of leading edge is heavier than a built-up one, but the strength and time saved are more than worth it. Both wings are built directly over full-size drawings and in one piece. The lower wing is then cracked at the center for the necessary dihedral. You may use plywood gussets to brace this joint and plenty of cement. Solid balsa wing tips enable you to achieve the required compound curves and thus look much better. Cover the wings with bamboo paper or double layers of tissue. Do not cut the slit between the two 1/8" ribs for the wing



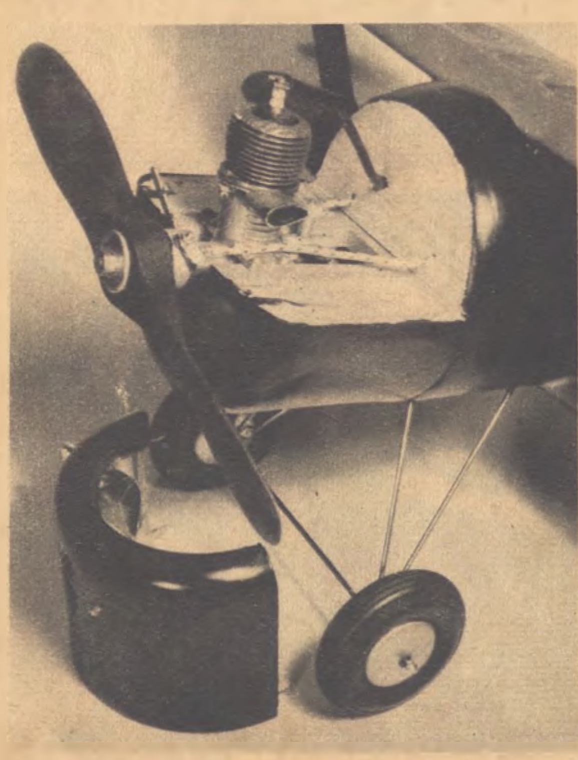
● Rugged, yet reasonably fast, the "Solution" is excellent for sport flying.

struts until you have doped the covering and are ready for assembly. Two wing struts are required. They are cut from 1/16" plywood. Note the notches for slipping and locking with the wing spar and leading edges.

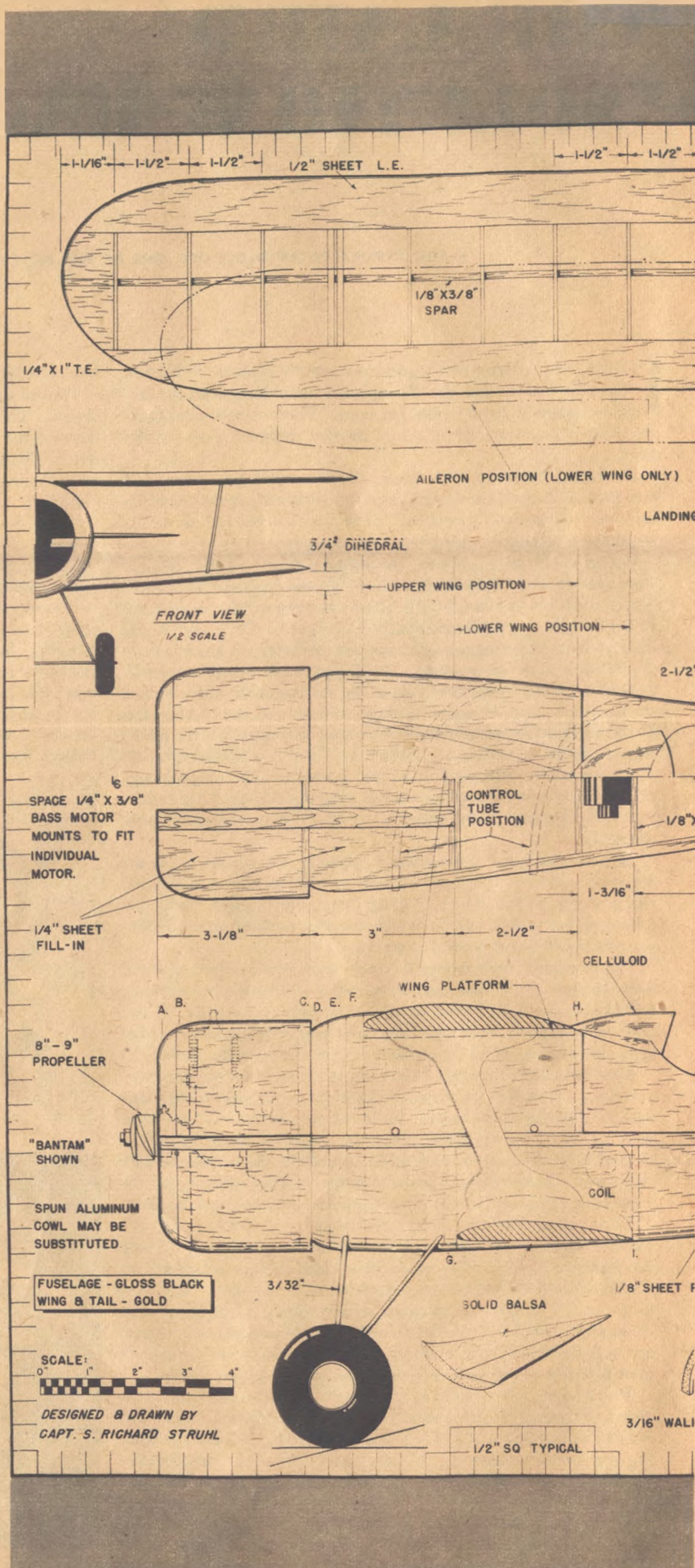
You may now install the flight controller. Use brass tubing bent to a large radius. Bind and cement these tubes to the crutch. Add some grafite for smooth operation. Solder all connections between control lines and control horn. If you intend to use an engine of over .30 displacement it might be wise to use the bell-crank system for control as it will handle greater speeds and weights then the system shown.

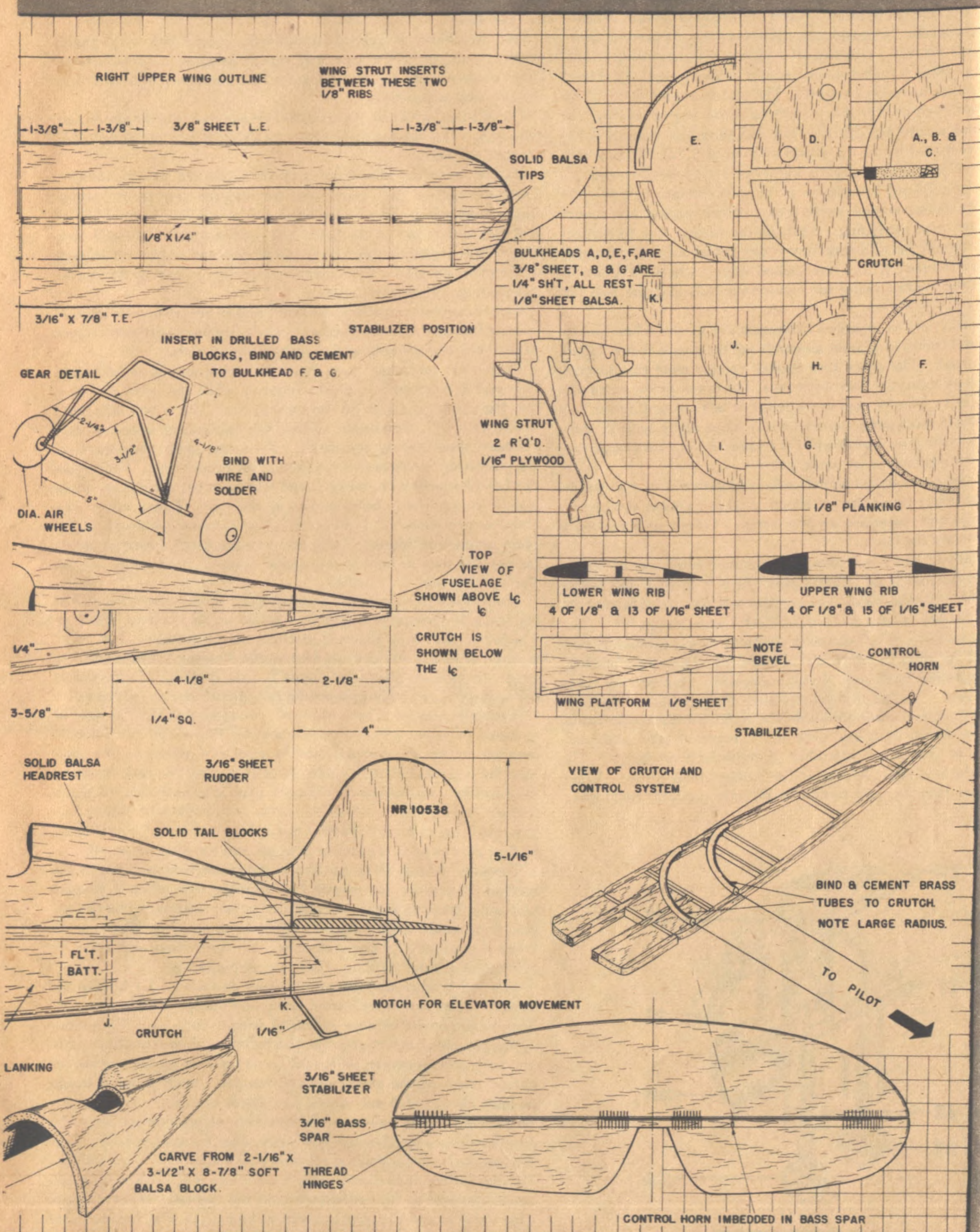
The finest made model can be ruined by a poor finish, so heed these words of advice: The entire model is given two coats of rather heavy clear dope and lightly sanded with 6/0 sandpaper. Mix some wood filler from a good grade of talcum powder and clear dope to the consistency of heavy cream. Brush enough coats of this filler on the model (including the wing covering), with sandings of 10/0 sandpaper between coats, until all the wood grain is filled and you have a solid smooth surface. You may now apply the colored dope. The wing and tail surfaces are gold (or yellow) and the fuselage and other details are gloss black. Either spray the colored dope or use a red sable brush. Cut the dope fifty percent with thinner and apply at least six coats of color. Rub the final coat down with 400 wet/dry finish paper and water. The water keeps the paper from filling up and prevents scratches. After the finish is completely rubbed apply a coat of automobile Simonize. This should net you a finish that will do you proud in any beauty event.

All that is left is final assembly. Very carefully cement the top wing in position. Note that all flying surfaces are set at zero degrees incidence. Cut the slit between the two 1/8" ribs on the bottom surface of the upper wing only and cement the wing struts in place. Observe that the strut slips up between these two ribs till it touches the upper camber. Now slit the strut space on the top of the lower wing and drop the lower wing in position. It should fall snugly between bulk- (Turn to page 88)



● Motor mount and cowling are easy to construct.




RIGHT UPPER WING OUTLINE
WING STRUT INSERTS BETWEEN THESE TWO 1/8" RIBS
1-3/8"
1-3/8"
3/8" SHEET L.E.
1-3/8"
1-3/8"
SOLID BALSA TIPS
1/8" X 1/4"
3/16" X 7/8" T.E.
E.
D.
A., B. & C.
CRUTCH
BULKHEADS A, D, E, F, ARE 3/8" SHEET, B & G ARE 1/4" SH'T, ALL REST 1/8" SHEET BALSA.
K.
J.
H.
F.
I.
G.
1/8" PLANKING
INSERT IN DRILLED BASS BLOCKS, BIND AND CEMENT TO BULKHEAD F. & G.
STABILIZER POSITION
GEAR DETAIL
2-1/4"
2"
3-1/2"
4-1/8"
BIND WITH WIRE AND SOLDER
5"
DIA. AIR WHEELS
WING STRUT 2 R'Q'D. 1/16" PLYWOOD
TOP VIEW OF FUSELAGE SHOWN ABOVE ℄
CRUTCH IS SHOWN BELOW THE ℄
LOWER WING RIB
4 OF 1/8" & 13 OF 1/16" SHEET
UPPER WING RIB
4 OF 1/8" & 15 OF 1/16" SHEET
1/4"
4-1/8"
2-1/8"
3-5/8"
1/4" SQ.
NOTE BEVEL
WING PLATFORM 1/8" SHEET
CONTROL HORN
STABILIZER
4"
SOLID BALSA HEADREST
3/16" SHEET RUDDER
NR 10538
SOLID TAIL BLOCKS
5-1/16"
VIEW OF CRUTCH AND CONTROL SYSTEM
BIND & CEMENT BRASS TUBES TO CRUTCH. NOTE LARGE RADIUS.
FL'T. BATT.
J.
CRUTCH
K.
1/16"
NOTCH FOR ELEVATOR MOVEMENT
TO PILOT
LANKING
3/16" SHEET STABILIZER
3/16" BASS SPAR
THREAD HINGES
CARVE FROM 2-1/16" X 3-1/2" X 8-7/8" SOFT BALSA BLOCK.
CONTROL HORN IMBEDDED IN BASS SPAR

THE BURGESS M-5

THIS month, Air Trails presents the most unusual model airplane engine the field has to offer. When originally produced, Morton Bros. of Omaha, Nebraska, manufactured it. At present, however, Burgess Battery Company, of Chicago, Ill., is putting it out.

This little job is a scaled-down version of the famous Le Blond series 5D radial, air-cooled engine. The parent engine is $33\frac{1}{4}''$ in diameter and weighs 219 lbs. Burgess' little engine is $5\frac{3}{8}''$ in diameter and weighs but 22 oz. The M5 develops $\frac{1}{2}$hp at 3,500 r.p.m. as compared to the Le Blond's 85 hp at 2,125 r.p.m. which gives the smaller engine a slightly higher power-to-weight ratio.

The Burgess to our knowledge is the only miniature four-cycle five-cylinder radial engine made today, which makes our model engine game most intriguing. Perhaps the easiest way to explain the motor would be to break down the radial engine principle. Suppose we compare it to a five-spoked wagon wheel. Picture in your mind the spokes' being the connecting rods and the hub the crankshaft.

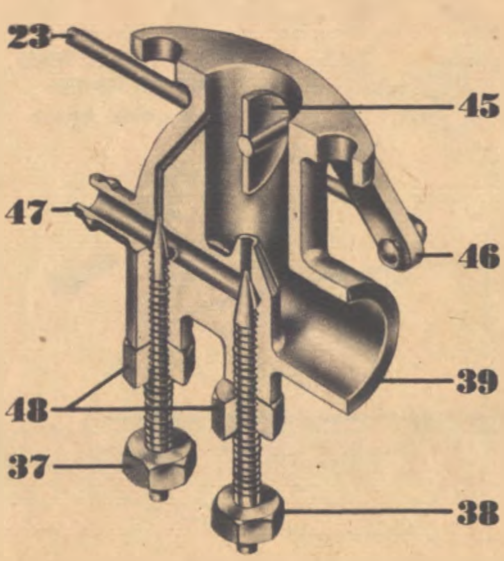
One spoke (rod) is mounted independently of the other spokes or rods and fastens to a main assembly on the crank throw called the rod journal. The other four spokes (rods) meet this journal and connect by means of four wrist pins. The crank throw naturally is offset as in 1 cyclinder engines, whether it be two- or four-cycle.

As the shaft rotates the spokes (rods) move along with it, thus moving the pistons up and down. We know it isn't very clear but it's not as complicated as we make it.

Now to get down to the actual parts and material of the engine itself. The offspring of the Le Blond is copied almost directly as far as design and materials are concerned. To get an actual idea we will compare the two.

The Le Blond has a heat-treated aluminum crankcase of which the intake manifold is an integral part. It is ring-style and encircles the case. Intake tubes connect the cylinders to this ring by means of smaller tubing formed to meet the openings.

The crankshaft is of $\frac{3}{8}''$ diameter steel and closely ground to meet the two ball bearings in which it is suspended. These ball bearings are fitted into the front end of the crankcase. One bearing takes the thrust load. The master rod including the journal and the four other rods (which are aluminum die cast) fit into the crank throw. The cam is driven by a lead gear shaft, made of steel and heat-treated. The gear shaft resembles a crankshaft in design. The throw on the lead shaft fits inside the hollow crank throw. When put together they are end to end or directly opposite each other.



CARBURETOR DETAIL

The rear section of the case holds the lead shaft, cam, and the distributor lobe.

The distributor is typical automobile system but very much smaller in design. The case and cap is bakelite in construction. Upon removing the cap and the rotor, the points are accessible for cleaning and adjustment.

The M5 has hardened, ground-steel sleeves cast into the aluminum cylinders. The sleeves themselves are ground very accurately and finished smoothly.

Pistons are cast aluminum and fitted closely to the sleeves. Two oil rings of $\frac{1}{64}''$ radius are cut into the pistons to provide ample lubrication. The upper wrist pin is machined smoothly of drill rod and is $\frac{1}{8}''$ in diameter and approximately one-half inch long. Pads are used in the piston pin at each end to prevent scoring of the cylinder walls. Each cylinder assembly is held to the crankcase by 6 #2-56 machine screws.

Cam followers, something we don't find in any two-cycle engines, operate the push rods and valves. These followers are constructed of drill rod and are hollowed to meet the push rods.

Push rods are made from $\frac{3}{32}''$ drill rods and have ball ends. One end is received in the cam follower while the other end goes into the adjusting screw on the rocker arm. The rocker arm itself is cast of 17ST. aluminum. There are two rocker arms for each cylinder, thus making ten in all. The arms upon pressure from the push rods, forces the valves open at the proper time. Each cylinder has two push rods, rockers, and valves. One valve is an intake and of course the exhaust makes up the pair. These valves incidentally are made of 1130 steel. The exhaust manifold is just plain aluminum tubing. They are pressure-fitted (same as intake tubes) and may be bent to any shape desired. Personally, we like them as they are.

The carburetor is mounted between #3 and #4 cylinders. Looking from the front, this is directly between the two bottom cylinders. The air intake faces forward catching the prop blast. The "pot" has two adjustments, one for high speed running. These jets are set at the factory when the engine is first checked. Occasionally the settings have to be changed slightly due to various altitudes.

A throttle control is an additional feature of the M5. It may be operated by either a third line when flying U-control or a solenoid mounted in the ship and activated by a battery carried by the pilot. Spot landings and other realistic maneuvers may be made by using the throttle. For example, the pilot may land and take off again without leaving the center of the circle or touching the ship. In a large field, he walks along with the ship in a taxi run. When ready, he flips the solenoid, the engine revs up, and the plane takes off.

The only ticklish thing we find in the carburetor assembly is the method of keeping the engine fuel mixture rich when it is cold. One must keep his finger over the carburetor opening while the engine is perking. Just imagine a 16" aluminum prop chomping in front of you and your finger close by. We figure that with a wee bit of thought, a hand-choking system can be hooked up.

The M5 is lubricated differently from its father, "Le Moteur Le Blond." The parent has an oil sump and pump. Neither is practical on the model because of added weight and cost. To build a miniature pump and arrange the two bottom cylinders so they would not foul with excessive oil would boost the cost of the engine far out of reach of the average model builder. Such a pump would be built like a watch and would cost about as much. Another difference in the two motors is the electrical or ignition set-up. The Le Blond has a magneto and two spark plugs for each cylinder. The M5 has the typical coil and condenser deal but only one plug for each cylinder. Five more spark plugs would only add extra weight and would not add to the performance of the engine. Other changes were made in order to save as much weight as possible, but these are not apparent without a careful study of both engines, and in no way do they detract from the scale proportions of the Burgess. In rough language, we could say it's a spitting image.

The fuel mixture, we should have said before is the conventional 3-to-1 mixture. The engine is broken in though on $2\frac{1}{2}$ to 1.

Burgess wants the model builder to use a third grade gasoline in order to make the engine start more easily and run more smoothly. Hi-Test gas should not be used, either in the M5 or any other small gas engine. It will not start any more easily nor develop more power. As a matter of fact, Hi-Test gas will make the engine sputter and miss as soon as it is warmed up.

The gas tank capacity is up to the owner as far as running time is concerned. We don't know how long the Le Blond ran on a gallon of gas, but we do know that the little job runs ten minutes on two ounces of fuel. That, in our estimation, is pretty good economy.

The mounting is radial, as in larger radial aircraft engines, and the same type of mounts are used. They are tubular steel and are adapted to most class "C" ships.

The M5 is not just an ordinary engine to be used for flying model planes. It is a real miniature powerplant that is an almost perfect replica of the engine from which it is scaled. While it is true that many parts of a full scale engine are more complicated than those of the M5, the basic system is identical.

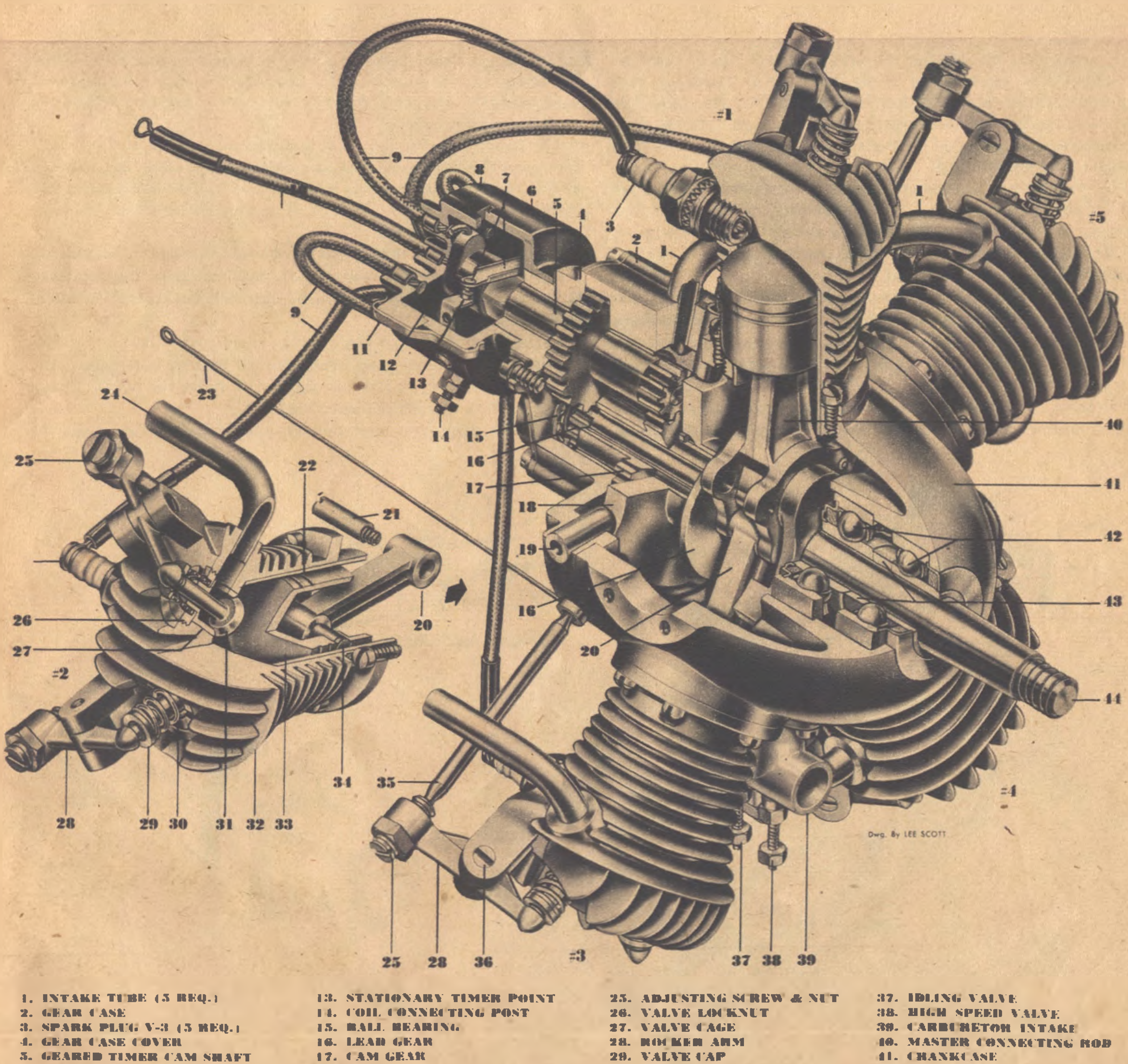
The exhaust sound and speed as far as r.p.m. is concerned is much lower than the conventional two-cycle engine. While the horsepower in a two-cycle job is reached at high r.p.m., the M5 delivers its maximum output at approximately 3500.

The only other disadvantage we find besides the choking method, is the fact that the pistons are cast aluminum. Even with plenty of lubrication, aluminum is soft and has a tendency to wear quickly. But don't get us wrong. We heard of M5's that have run for 275 hours, and are still going.

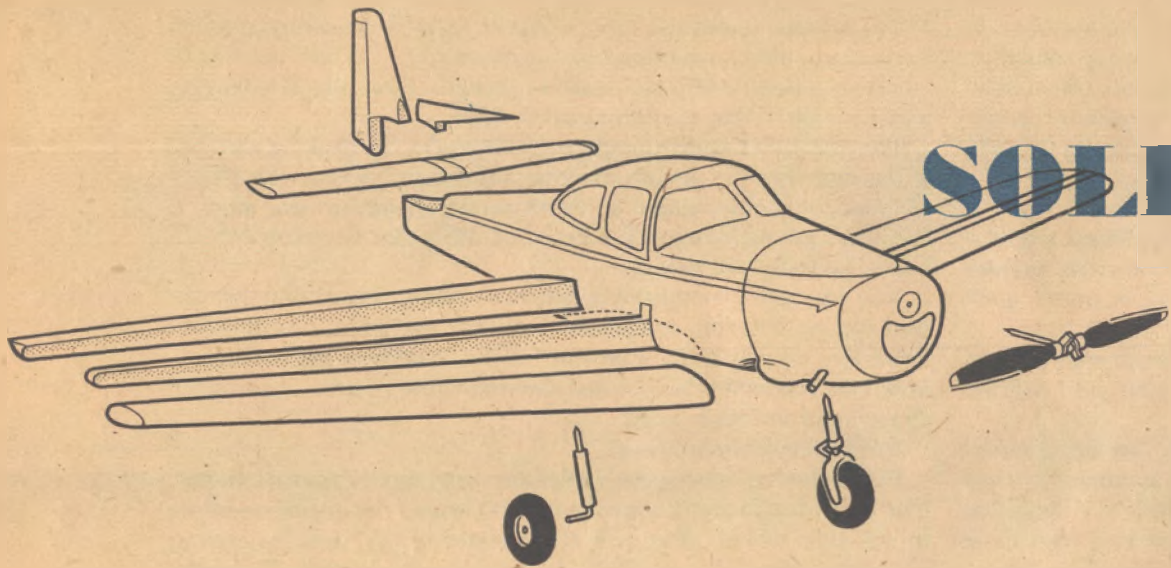
You may get a completely assembled, factory tested and guaranteed engine, less coil, condenser, fuel tank and prop, or a knocked down kit. If you really want the "works," you may get the engine, tank, coil, condenser, two-bladed aluminum prop, battery, and switch all mounted and ready to go.

Brief specifications are—

Five-cylinder, four-cycle, radial aircooled model aircraft engine. The bore of .625 and the stroke of .600 brings the displacement up to .92 cubic inches. The over-all diameter is 5¾" and it develops approximately ½ hp at 3500. Its bare weight is only 22 ounces.



1. INTAKE TUBE (5 REQ.)
2. GEAR CASE
3. SPARK PLUG V-3 (5 REQ.)
4. GEAR CASE COVER
5. GEARED TIMER CAM SHAFT
6. DISTRIBUTOR CASE
7. CAM FOLLOWER & TIMER POINT
8. DISTRIBUTOR CAP
9. HIGH TENSION WIRES
10. LEAD TO COIL
11. SPRING CLIP
12. ROTOR
13. STATIONARY TIMER POINT
14. COIL CONNECTING POST
15. BALL BEARING
16. LEAD GEAR
17. CAM GEAR
18. CAM
19. CAM FOLLOWER
20. AUXILIARY CONNECTING RODS
21. AUXILIARY ROD BEARING
22. CYLINDER SLEEVE
23. THROTTLE
24. EXHAUST TUBE
25. ADJUSTING SCREW & NUT
26. VALVE LOCKNUT
27. VALVE CAGE
28. ROCKER ARM
29. VALVE CAP
30. VALVE SPRING
31. VALVE
32. CYLINDER
33. PISTON
34. WRIST PIN
35. PUSH ROD
36. ROCKER ARM PIN
37. IDLING VALVE
38. HIGH SPEED VALVE
39. CARBURETOR INTAKE
40. MASTER CONNECTING ROD
41. CRANKCASE
42. BALL BEARINGS
43. SPACER
44. CRANKSHAFT
45. BUTTERFLY VALVE
46. THROTTLE ARM
47. FUEL INLET
48. LOCKNUTS



SOLID SCALE NAVION

by H. A. THOMAS
Scientific Leader A.M.A.

THE NAVION'S CLEAN LINES LEND THEMSELVES READILY TO SCALE MODEL MAKING

THE four-place Navion, an all-metal personal plane, bears an unmistakable resemblance to the famed P-51 Mustang; both products of the same firm, North American Aviation, Inc. And in its class, the Navion ranks correspondingly high. While in no sense a lightplane, it brings fast, comfortable transportation to its passengers at moderate cost.

A 185-horsepower Continental engine with controllable Hartzell propeller powers the Navion. Forty gallons of fuel provides a 700-mile range at a 150-mile-an-hour cruising speed. The service ceiling is 15,600 feet, stalling speed is 53 miles per hour, and rate of climb is better than 800 feet per minute.

This scale model is drawn to one-quarter-inch scale. Builders who prefer larger-sized models can enlarge the working plans to three-eighths or one-half-inch scale. This may be done with proportional dividers, by photography, or a photostat enlargement can be made at very low cost.

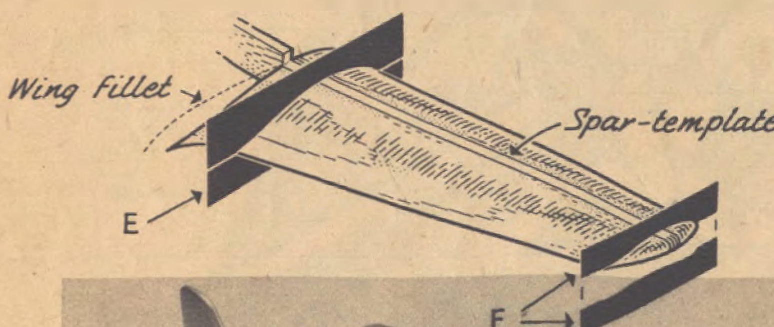
Firm balsa of uniform texture is best for all parts. Transfer the fuselage outlines to the block and saw it to side then to top outline. Using a sharp penknife, carve the body to approximate shape and bring it to final contours by sanding. Check the templates at their respective stations. Emery boards are handy for sanding the more inaccessible places.

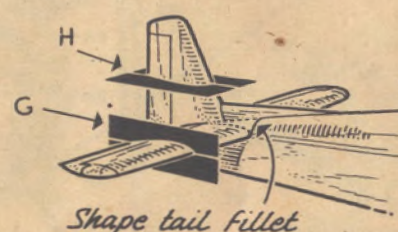
The balsa spar-template is next cemented into the slot provided for it and the four wing parts are fitted to it. These are attached in the rough; final tapering and shaping can be done after the cement hardens. Dope-talc putty is used to fill neatly any crevices and to finish the wing fillets.

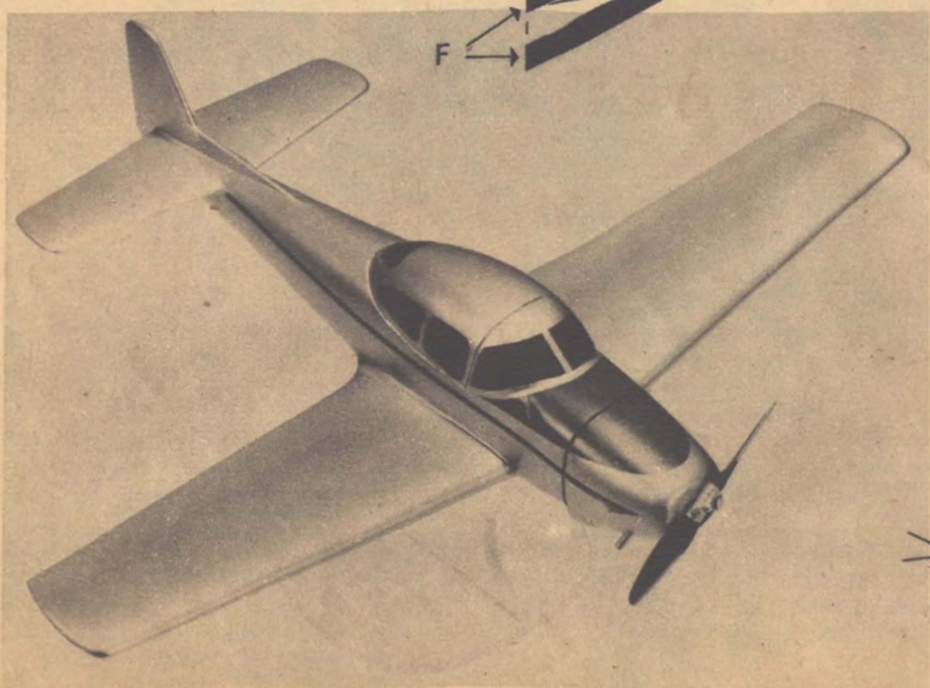
Tail parts are next shaped and fitted to the fuselage. To facilitate hollowing the front cowl opening, the nose section of the body may be neatly cut off, the opening made, then the nose section cemented back in place.

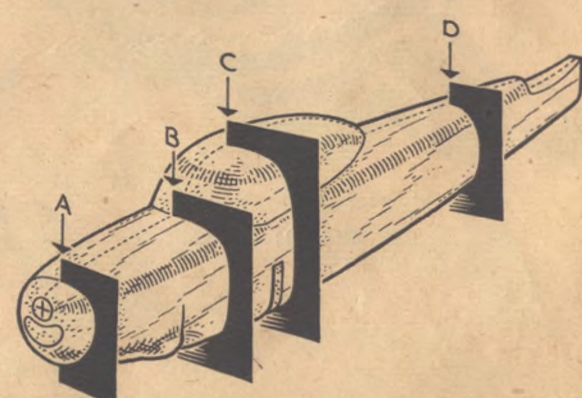
Carve the propeller of pine, adding small counterweights of aluminum. The landing gear struts may be bent of paper clip wire, wrapped with paper to realistic shape. Fit rubber or plastic wheels to the struts or else carve them of balsa.

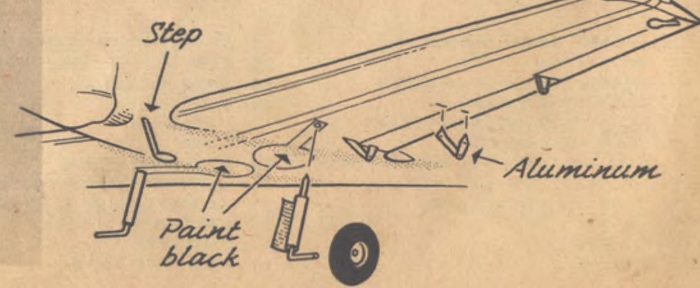
Combine dope, talc, and thinner into a thick (*Turn to page 111*)

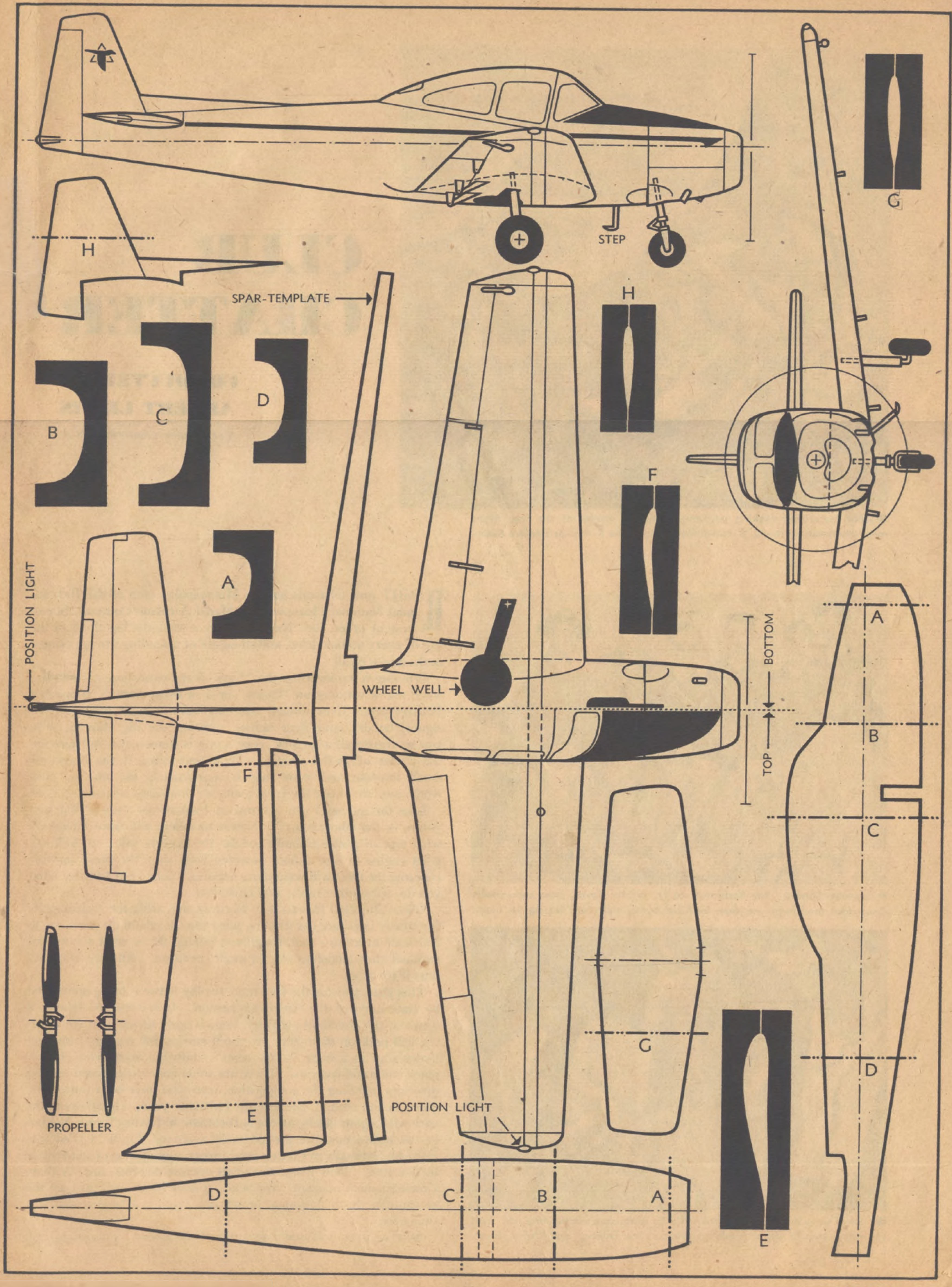











STEP
H
SPAR-TEMPLATE
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POSITION LIGHT
WHEEL WELL
BOTTOM
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PROPELLER
POSITION LIGHT
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E

● Scout contestant making adjustments on his model at the free flight meet sponsored by the U. S. Naval Reserve and the S. Florida Dealers Assoc.

CLUB CHATTER

CONDUCTED by: ALBERT LEWIS

Coordination Chairman A.M.A.

● Cowtown Sahibs, "The Redshirts" of Ft. Worth, Texas, have successfully flown four models at one time from the same circle, are hoping for eight.

● "The Flying Bisons," of Buffalo, N. Y., start up a control-line job. Left to right—Harold deBolt, John Truman, Ross Dilling, and Darcy Joyce.

RIGHT now all roads lead to Minneapolis—site of the 16th annual National Championship Model Airplane Contest. Somehow or other, the "Nationals" are always the big thing in the life of every aeromodeler, and thoughts of attending are uppermost in the minds of all.

Winning a top award at the "Nats" is the equivalent of a Hollywood star's winning an "Oscar" or a newspaperman's copping a Pulitzer prize. Even though you may have been an unknown designer, builder, and flyer before entering the big shindig, once you've registered a victory, your name is known far and wide in the circles of model aviation. You find yourself the object of much interest, and your models—particularly the one or ones which took first—are the focal point for thousands of pairs of eyes.

Like the gal on Fifth Avenue at Eastertime, "you'll find that you're in the rotogravure." Newer modelers will want advice on what type of planes to build and fly, the experts will want to know what engine or size rubber powered your ship, the press services covering the meet will want more details on your local address, what you do, what other meets you have won.

What Churchill Downs is to horse racing, what the Indianapolis Speedway is to race car drivers, what the Cleveland air races are to full scale aviation—well, roughly speaking, that's what the annual national championships are to model aviation. And we wouldn't miss it for a bet.

This year, and for the first time, the big battle is being sponsored by state units of the American Legion. It is expected that as a result of the attendant publicity, Legion posts throughout the country will perk up their ears (if you'll pardon the analogy) and get under way in a huge "grass roots" campaign sponsoring model-plane clubs and contests. There are some very experienced contest directors handling the competition, men who have been putting on meets in and around Minneapolis for many years. In addition, the national Legion headquarters is fortunate in having Frank Nekimken as its assistant director for model aviation. Frank "CD'ed" the 1940-41 Nationals in Chicago and brings a great deal of experience to the meet. Paul Ring, Nationals contest director, and William Crockett, meet manager, are bending over backwards to give the entrants in the 16th annual brawl just about the biggest and best time ever.

So take a tip and don't miss the Minneapolis- *(Turn to page 82)*

DOPE CAN

CONDUCTED by: CARROLL MOON

Scientific Leader A.M.A.

AT this moment we are in one of our "mad-modeler-moods." We find ourself sniffing at the summer breeze, watching the clouds drift by, and then idly pawing through our correspondence looking for certain dates. From afar we can hear the little woman warning the youngsters to stay away, for she knows that the old man is planning on attending a contest.

Yessir, with four ships completed in the workshop, test flights all complete, there's nothing like a contest to clean the shop for future building. We've a Vagabond with a Super-Cyke, a Banshee with an Ohlsson "19," a hybrid design for the Ohlsson "23," and another for the Ohlsson "60." The Class "B" job uses a Zipper wing with 88 square inches cut from the center section, and the fuselage resembles a Jersey Javelin. The big "orphan" has a Playboy fuselage with a Westerner wing and tail. But they all fly well, and best of the lot is the Playboy-Westerner job which can do three minutes in a pouring rain. (All right, in an evening calm then.)

Our letter of the month comes from G. G. Valk, who writes from 52 Kamer Lonnesweg, Hilversum, The Netherlands. He enjoys Air Trails, and states a bit wistfully that the ads make him sorrowful. Seems the Dutch are not allowed to buy in foreign lands; thus he solicits our aid. He has a gas motor but no spark plugs. He has no airwheels, balsa, silk, motor accessories. He would like to correspond with some American modelers and thinks they might cook up a deal whereby some of those rare items could be shipped to him with payment to be made sometime in the future. How 'bout it, you fellas . . . . can you help a guy out?

We receive many letters such as the one received from Roger Gladwish of Brooklyn. He has a Baby Playboy with a CO_2 motor installed. The ship is tail-heavy and he asks our advice. Well, Roger could weight the nose with modeling clay to bring the C.G. forward. Probably that would be the best method, although we've seen some awfully tail-heavy ships fly very well with the proper adjustments.

Fellow readers, we're awfully sorry we missed a few in our recent article on motors (June issue). We're reasonably sure we listed the Brown motor, but it got missed somewhere in the process of editorial preparation. Sherman Thompson of Dallas, Tex., calls our attention to the fact that we missed the M&M at .292 cubic inches, the Gnat at .156, the Precision at .363, the World Wide Demon at .154, the Hurleman Aristocrat at .488.

Then we ignored the Trojan, the Rebel, the G-9, and Ajax, and glossed over the Feeney A, B, and C motors, the Little Dynamite, the Drimmie, Dwarf, the Dragon, Hi-Speed. We're blue and a bit under the weather at such a calling-to-task, but we're bringing the list up to date and may prevail upon the editors to republish it again soon.

Since we penned the article we've noted many new engines, such as the Everson '29, Mite Diesel, Tom Thumb (an old engine redesigned) Novo Diesel, the new Hurleman, and there must be many others. Keeping up with them is harder than running around underneath a hot control-line job.

Had our first occasion to tinker 'round with a diesel the other day and liked it very much. It was a Drone, and drone it did, giving plenty of zing that surprised and pleased us very much.

Many manufacturers are putting up awards for the 1947 Nationals and the latest we have noted is an award posted by John Broadbeck, of K&B Torpedo engines. Every winner at the Nats who uses one of the K&B jobs will receive $50 in cash, a new Torpedo, and a year of free service on same. In addition, Mr. Broadbeck has stated that any modeler who *(Turn to page 108)*

A.M.A. NEWS

CONDUCTED by: RUSSELL NICHOLS

Exec. Director A.M.A.

Technical Conference Being Planned in Conjunction with Brain Busters' Contest

A "TECHNICAL CONFERENCE" is being planned in conjunction with the "Brain Busters" Hydro and Free Flight contest scheduled for October 5 at Langley Field, Virginia. The contest itself is being sponsored by the "Brain Busters Model Club" and it is anticipated that the technical conference, which will be held the preceding day, Saturday, October 4, will be cosponsored by NACA Supervisors Club, the "Brain Busters," and the Academy of Model Aeronautics.

An extremely interesting and enlightening program is being planned which will include technical papers on important phases of model aviation and aerodynamics and, it is hoped, a tour of Langley Field, all of which will be topped off by a banquet. Arrangements have been completed for sleeping quarters in either the barracks on the field or rooms in a nearby hotel.

Complete information, including reservation blanks and entry blanks for the contest, may be obtained by writing directly to Charles Folk, Secretary, "Brain Busters Model Club," 315 Cottonwood Avenue, Hampton, Virginia, or to AMA Headquarters.

CD's Please Note

The attention of all contest directors is called to the new record performance report form which includes spaces for data needed by the Contest Board for control-line speed records. This new form has been prepared by AMA Headquarters in order to facilitate application for records and to outline specifically the particular type of information needed by the Contest Board in order accurately and correctly to appraise the flight for which a record is claimed. The Contest Board has requested that all contest directors use these forms in applying for records. Copies may be obtained by dropping a postcard to AMA Headquarters. By filling out these forms completely and furnishing all of the information requested, contest directors can save considerable time in not only having the record officially recognized but in eliminating additional correspondence between themselves, the contestant, and Contest Board representatives. Particular caution is directed toward the use by many CDs in computing speeds shown on record applications by the use of tables or slide-rules. These are handy little gadgets for ordinary competitive work, but when it comes to the question as to whether or not a national record has been established, it is of absolute importance that all mathematical computations be correct. One formula for computing speed which is acceptable to the Contest Board is included on the new report forms for the assistance of both the Contest Directors and the flyers.

Should We Grade Contest Directors

As every good contestant knows, there seem to be some fellows in every section of the country who just have a knack for conducting a good contest. By this same token, every now and then undesirable conditions are encountered which, in some cases, may be traced to lack of experience and know-how although certainly not through lack of interest and effort on the part of the directors. This condition has apparently prompted several contestants to suggest that it might be advisable to create several grades of licenses for contest directors. While we have not completely thought this idea through, there is obviously some merit to the suggestion and we are simply tossing the idea out to see what you think about it.

Apparently the idea is that various grades of contest directorship should be created and based on experience *(Turn to page 112)*

THE DEVELOPMENT OF DIESELS

by JIM NOONAN *Scientific Leader A.M.A.*

AN HONEST AND TRUTHFUL COMPARISON OF AMERICAN AND FOREIGN COMPRESSION IGNITION ENGINES

SPURRED by lack of gas motors and ignition equipment due to the German occupation, the diesel (or more correctly, compression-ignition) motor was developed from the basic Swiss patents into a very reliable and powerful power unit in all European countries. Today, European modelers prefer diesels to gas motors and obtain remarkable performance, winning even in the international contests held at the Model Aerodrome at Eaton Bray, England, against all competition.

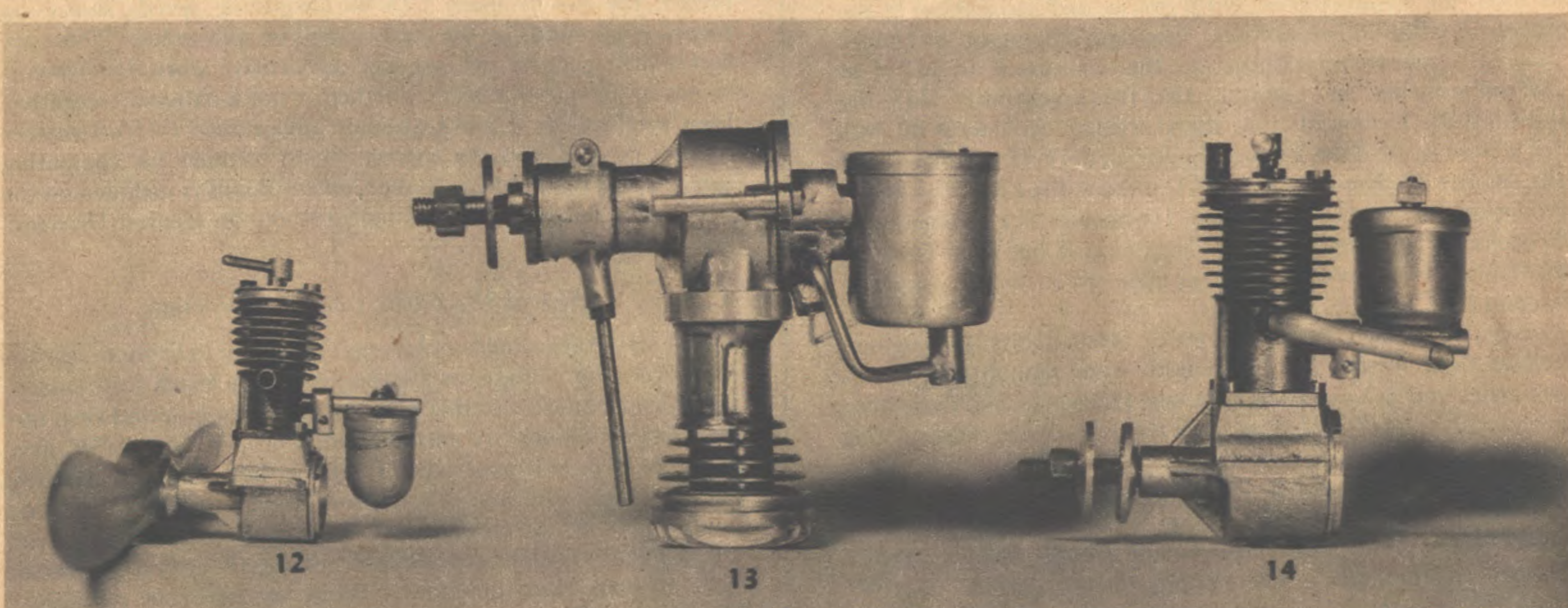
At first, diesels were built in home workshops, on homemade lathes and drill presses (nothing stops these guys, except lack of metal!), but as the war progressed and materials and a market became available, motors began to be produced in quantity, so that today some fifty different types and sizes are on the market. The author made many side trips (mostly AWOL) in search of motors and knowledge, during his service in Italy, France, and Germany, resulting in this article, which, it is hoped, will create interest in these fine power units and encourage their development in this country.

You may note that the motors shown in the photos are somewhat massive in construction and vary a great deal in outward appearance, but you must take into account the fact that Europeans practically disregard weight in their models, most of which are of hardwood and ply construction, covered with whatever paper or cloth is available, and they do not contact each other to exchange ideas as we do. At present, a little balsa and some magazines are obtainable. Articles are sketchy and advertisements (which contain a wealth of information in Air Trails) are almost totally lacking. Contests are few and necessarily local, because of travel restrictions.

Basically, the design of a diesel is the same as your two-cycle gas motor. Early designs used a long stroke and small bore, which, when used with a large diameter prop would give good results, usually 4-5000 r.p.m. The latest motors show more of a tendency to use the equal bore and stroke so prevalent in American design, with a decided increase in r.p.m. (6-7000) and, of course, results in greater power. This was the result of finer workmanship, since the lapped piston must be an extremely tight fit with the cylinder to hold compression ratios of from 14 to 20 to 1. Only a master craftsman can make a diesel that will run at all. High compression makes strong construction necessary and to offset the resulting weight more attention is being paid to selection of materials and structural design.

European designers favor the conventional type of motor of which the Dyno 1 and Movo D-2 are the best known examples. This embodies the contra-piston and screw to adjust the compression ratio and form the cylinder head seal (the ultimate in a push fit is required) a flat top piston working from a single inlet port and scavenged by two large (?) exhaust ports. This system is improved upon by the German motor builder, Eisfeld, who uses two inlet ports and a single exhaust port with a flat-top piston, the ports being carefully timed to give good scavenging and the smoothest performance of any European diesel. We shall see the reason for this as we go into the subject of fuels.

All diesels use sulphuric or motor ether as a whole or part of the combustible fuel and no substitute for it has been found. A table of fuel mixtures for the motors illustrated is shown. Ether seems to have a tendency to burn slowly, but it will ignite readily when properly mixed with air and compressed. Smooth operation depends on the careful adjustment of the compres- *(Turn to page 94)*



12 13 14

(1) Dyno I, (2) Eisfeld DU 2, (3) Uranio, (4) Micron 5cc, (5) Delmo, (6) Allouchery, (7) Movo D-2, (8) Arden .099, (9) Drone, (10) C.I.E., (11) Mite, (12) Micron .8cc, (13) Ouragan, (14) Micron 2.8cc.

9

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11

12 13 14

COLOSSUS II

by AL. CASANO
Scientific Leader A.M.A.

AT LONG LAST GOOD RUBBER IS BACK, AND HERE'S A DESIGN TO CELEBRATE ITS RETURN

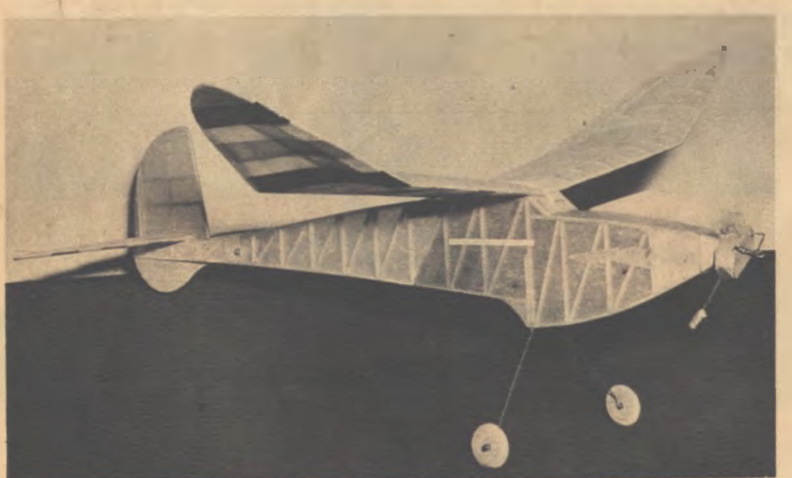
THAT whirring sound you hear is the rubber-power model builder winding up his crate after a lapse of too many years. Yep, T-56 rubber is back, in carloads, so let's try a rubber job.

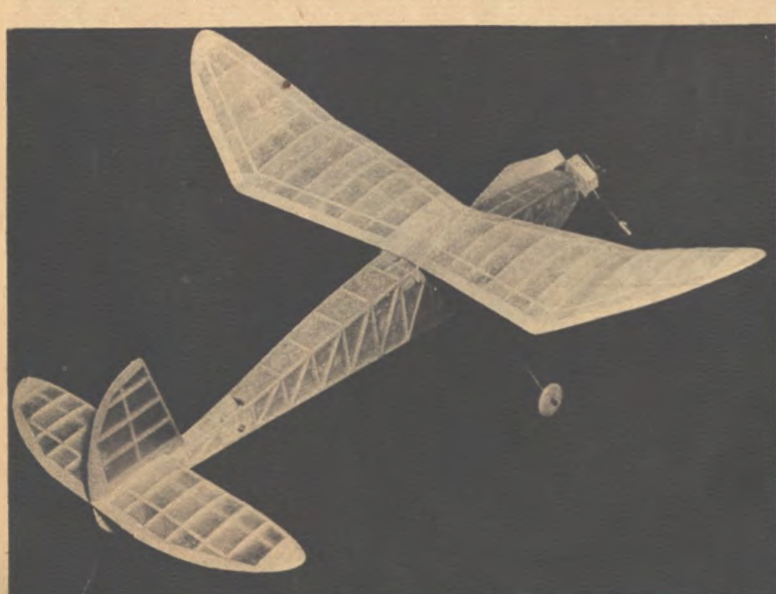
Colossus I was designed, built, and flown early in 1946, when rubber was both scarce and poor in quality. Its performance was slightly spectacular, and since the return of good rubber, even more so.

Let's start with the fuselage. One eighth square is used entirely. The use of cross braces to form triangles in the two sides adds tremendously to the strength, and will prevent folding of longerons under impact or heavy winding. The weight increase is negligible; in fact, with this or any other job, it is better to build the required weight into the ship, in the form of structural bracing, than to add it in the form of clay, lead shot, or other dead weight.

The nose section and rear dowel section are planked with one sixteenth balsa, or pine, if obtainable, and the side body former, at the landing gear station, is made up of one eighth sheet. Plank brace for wing hook with one eighth by one quarter.

When the two sides are thoroughly dry, sand well on both sides, using a very fine sandpaper. This will take off superfluous cement and give an even base for papering later. Do not use a coarse sandpaper, for although it does a faster job, it rips out many of the needed wood fibers, thus greatly weakening the structure of the wood.





● The butterfly wing with deep undercamber provides a fast climb and slow sinking speed. Cross bracing adds strength with little weight.

The fuselage structure is completed by adding the crosspieces at top and bottom. Four one-eighth sheet formers are used at top of fuselage at wing location, to match dihedral of center of wing. Top and bottom of nose section are planked the same as sides, with one-sixteenth.

The curved step behind landing gear station can be planked with one-eighth soft balsa, and sanded well for a clean job. Install landing gear. Put on one-and-three-quarter-inch diameter wheels. Again sand the entire fuselage, and round the corners well. The front wing hook is next installed. It is a good idea to fit and finish the nose block now, as the finish sanding can be done right on the plane, without rubbing off paper. Be sure the fuselage lines up and is perfectly square in cross section.

The fuselage is now ready for papering. Use a bright, easy-to-see color. Avoid white or light blue, as the plane is lost to sight too easily. Use either Silkspan, or double cover with Jap tissue, crossgrained. Spray with water, and, after drying, apply one coat of clear dope. Allow to dry one hour, sand lightly with superfine wet-dry paper, and apply another coat of clear dope. Use a fairly thin dope, with sufficient plasticiser (castor oil is O. K.) to give a glossy, blush-free finish. More than two coats of dope will cause the paper to become too brittle, resulting in cracking on impact, such as in tough landing, etc. Now install back wing hook.

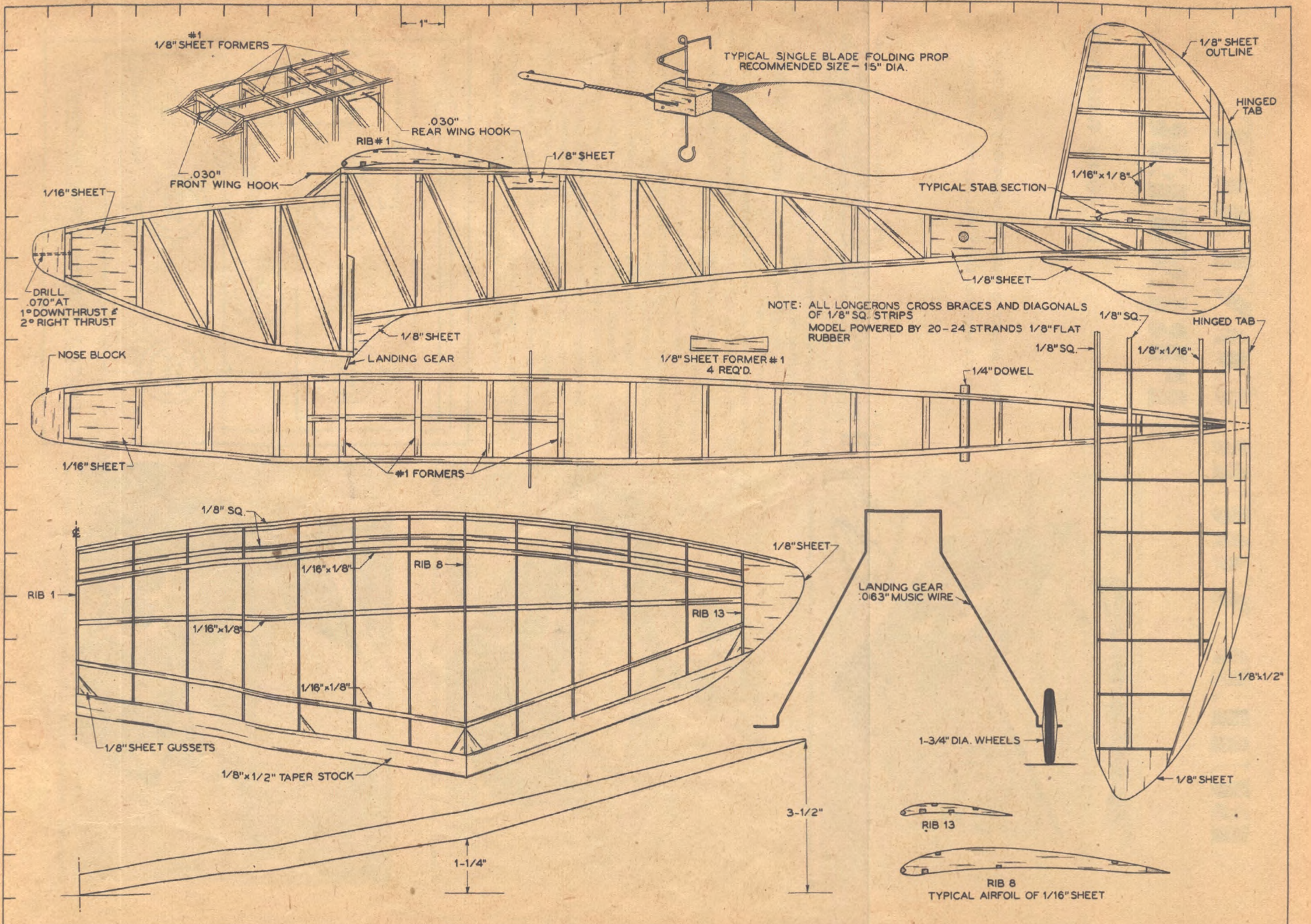
Since the bottom or under rudder is an integral part of the fuselage, it is best to make it and cement it on. It is made of medium hard one-eighth balsa, sanded to a nice, streamlined edge, and doped. The fuselage is now completed, with the addition of the back wing hook.

Drill out the nose block with an .070 drill, making hole to give one degree downthrust, and two degrees right thrust. Insert one eyelet in front and one at back of block. Bend hook, and be sure to use a Jasco Bearing between prop and nose block. This adds many r.p.m.'s to the prop, by helping to overcome friction. Use the conventional tensioner and positioner. If care is taken to install this simple mechanism correctly, no elastic band is ever needed to hold nose block in. Many a contest has been lost because a sloppy job on nose block and tensioner has allowed the prop, nose block, and half the motor to pop out after the power run. This usually results in a grade A spiral dive and crack-up.

Use a single-bladed folding prop, swinging a fifteen-inch-diameter circle. Twenty strands of one-eighth-inch rubber, with six inches of slack will do the trick nicely. Lube motor with equal parts of green soap and glycerine. Beware of colored castor oil lube. It's murder on the rubber. The motor is held in at the rear of fuselage by a quarter-inch-diameter dowel.

Pre-wind all rubber motors before using in ship. Stretch well, and pre-wind by stages from three hundred turns to eight hundred. Always store motors in a cool, absolutely dark place. Light ruins the thin rubber.

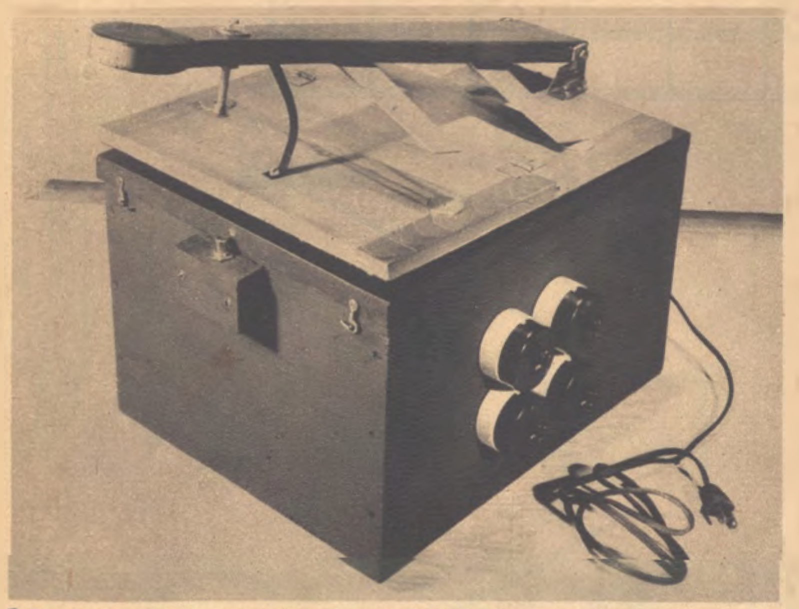
The wing is a polyhedral butterfly, with a deep undercamber. This undercamber results in a slow forward speed on power and glide, but a fast climb and slow sinking speed. The low power in relation to the one-hundred-and-sixty-five square *(Turn to page 100)*



1"
#1
1/8" SHEET FORMERS
.030"
REAR WING HOOK
.030"
FRONT WING HOOK
RIB # 1
1/8" SHEET
TYPICAL SINGLE BLADE FOLDING PROP
RECOMMENDED SIZE - 15" DIA.
1/8" SHEET
OUTLINE
HINGED
TAB
1/16" x 1/8"
TYPICAL STAB. SECTION
1/16" SHEET
DRILL
.070" AT
1° DOWNTHRUST &
2° RIGHT THRUST
1/8" SHEET
1/8" SHEET
LANDING GEAR
NOTE: ALL LONGERONS CROSS BRACES AND DIAGONALS OF 1/8" SQ. STRIPS
MODEL POWERED BY 20-24 STRANDS 1/8" FLAT RUBBER
1/8" SQ.
HINGED TAB
1/8" SQ.
1/8" x 1/16"
NOSE BLOCK
1/8" SHEET FORMER # 1
4 REQ'D.
1/4" DOWEL
1/16" SHEET
#1 FORMERS
1/8" SQ.
1/8" SHEET
1/16" x 1/8"
RIB 8
RIB 1
1/16" x 1/8"
RIB 13
LANDING GEAR
.063" MUSIC WIRE
1/16" x 1/8"
1/8" x 1/2"
1/8" SHEET GUSSETS
1/8" x 1/2" TAPER STOCK
1-3/4" DIA. WHEELS
1/8" SHEET
3-1/2"
RIB 13
1-1/4"
RIB 8
TYPICAL AIRFOIL OF 1/16" SHEET

BUILD YOUR CONTACT PRINTER

by JOHN WHITNER


Finished printer incorporates almost all of the features of professional job.

THIS CONTACT IS EASY AND INEXPENSIVE TO BUILD, AND IS A MUST FOR EVERY WELL-EQUIPPED DARKROOM

ONE of the most useful pieces of all darkroom equipment is a contact printer that has been *built by the photographer himself.*

You may reasonably ask yourself at this point, "Why build one myself when a good printer can be purchased for very little more than it would cost me to build one?"

Well, let's go into it a little bit.

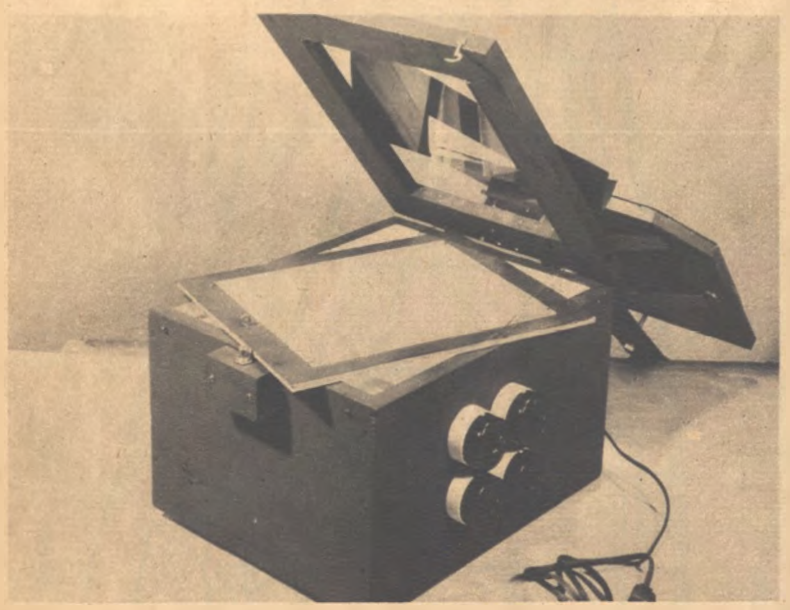
Most of us, in addition to being photographically minded, are model enthusiasts as well.

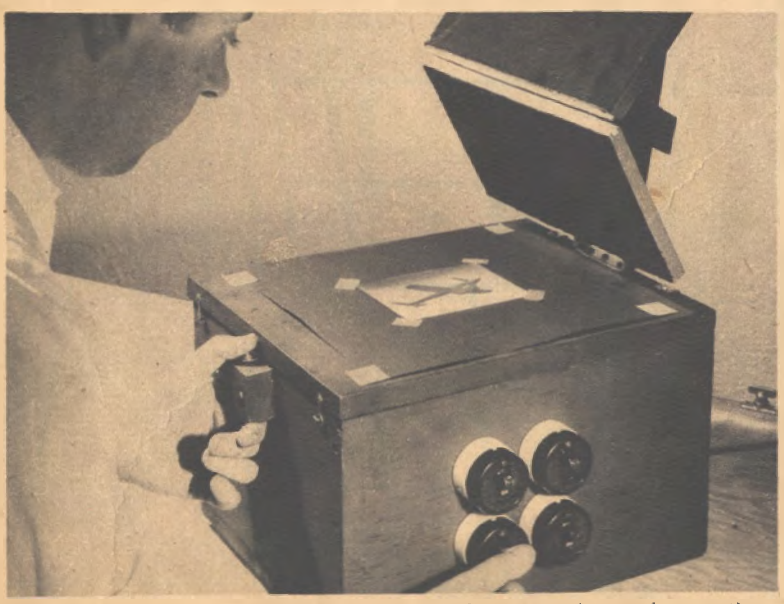
As both model builders and amateur photographers, a little thought will show us that some of the photographic equipment we would like to have is strikingly similar to some desired piece of model building equipment.

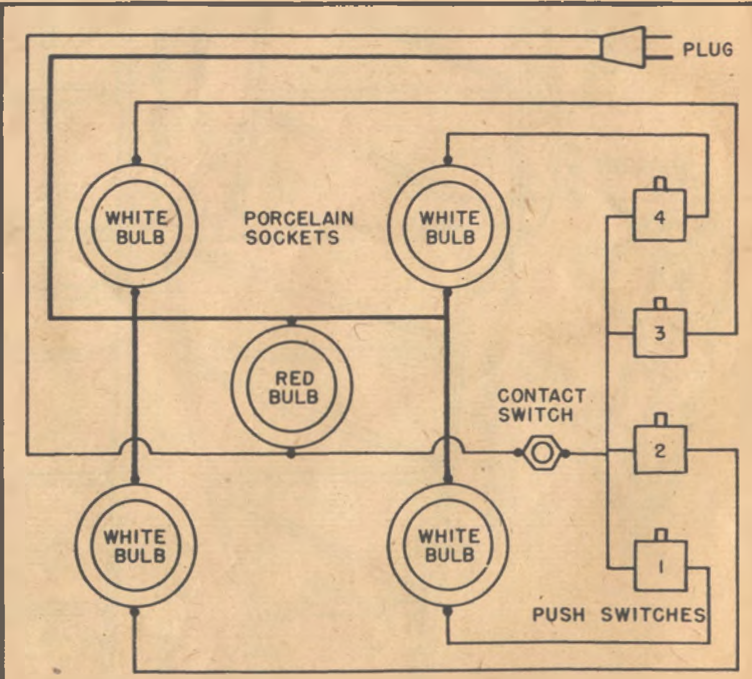
You have probably, for instance, come across the problem at home more than once, of how to copy sections of plans. The ideal way, of course, would be to own and use a tracing or shadow box.

In photography, now, have you ever wanted a Kodachrome viewer? A negative viewer? A retouching stand? A contact printer? Certainly you have; we all have, but the acquisition of ALL this equipment is often impractical either because of the expense, or because of lack of space for all this equipment.

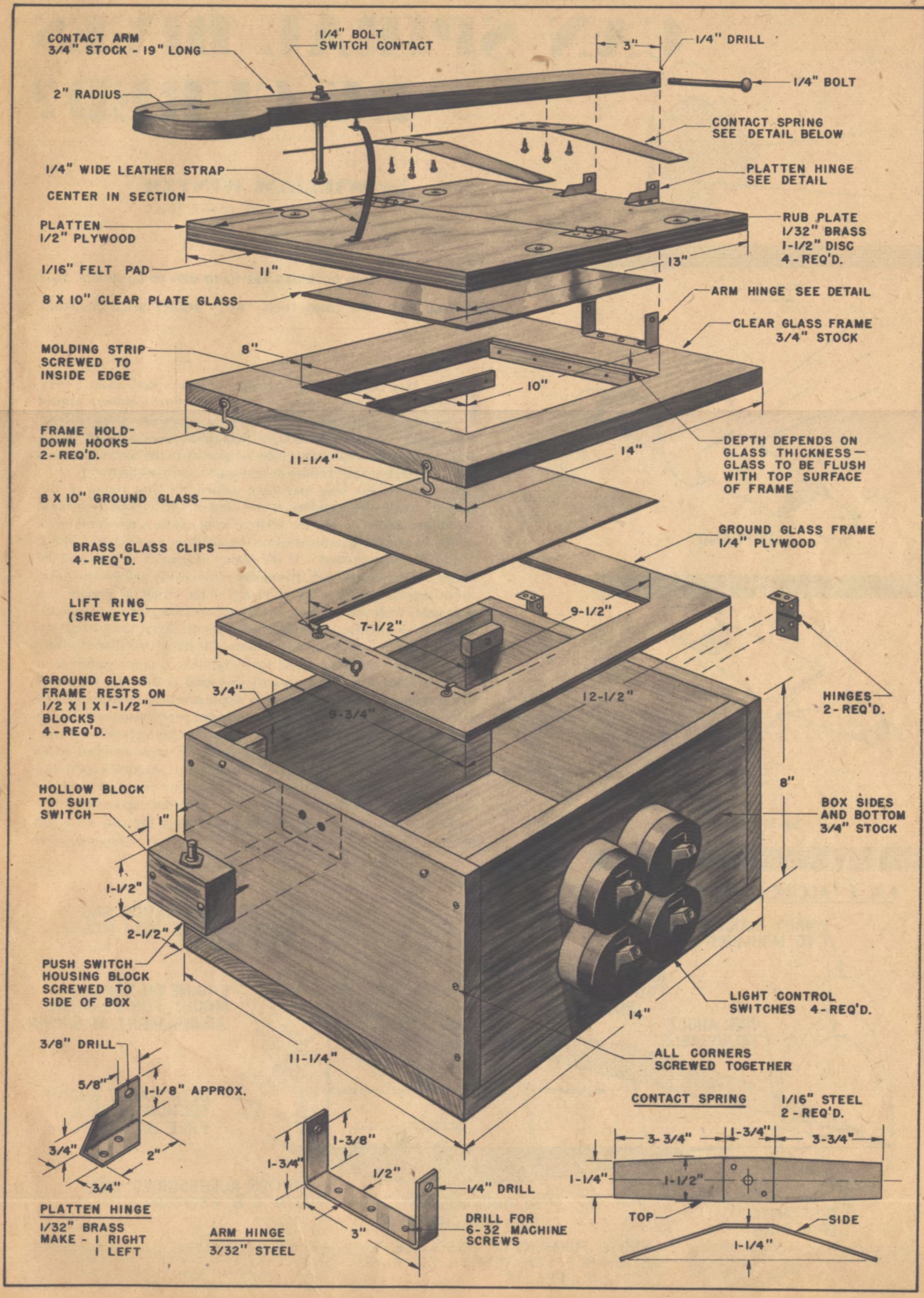
Well, would you like to build a piece of equipment that will serve you long and well as a contact printer, and as a shadow box, a Kodachrome or negative viewer, and as a retouching stand besides? Such a printer is illustrated and discussed (*Turn to page 105*)


Ground glass frame is removable for easy replacement of bulbs.


Individual switches permit light control to portions of negative.



CONTACT PRINTER WIRING DIAGRAM



CONTACT ARM
3/4" STOCK - 19" LONG
1/4" BOLT
SWITCH CONTACT
3"
1/4" DRILL
1/4" BOLT
2" RADIUS
CONTACT SPRING
SEE DETAIL BELOW
1/4" WIDE LEATHER STRAP
PLATTEN HINGE
SEE DETAIL
CENTER IN SECTION
PLATTEN
1/2" PLYWOOD
RUB PLATE
1/32" BRASS
1-1/2" DISC
4 - REQ'D.
1/16" FELT PAD
11"
13"
8 X 10" CLEAR PLATE GLASS
ARM HINGE SEE DETAIL
CLEAR GLASS FRAME
3/4" STOCK
MOLDING STRIP
SCREWED TO
INSIDE EDGE
8"
10"
FRAME HOLD-
DOWN HOOKS
2 - REQ'D.
11-1/4"
14"
DEPTH DEPENDS ON
GLASS THICKNESS—
GLASS TO BE FLUSH
WITH TOP SURFACE
OF FRAME
8 X 10" GROUND GLASS
GROUND GLASS FRAME
1/4" PLYWOOD
BRASS GLASS CLIPS
4 - REQ'D.
LIFT RING
(SREWEYE)
7-1/2"
9-1/2"
GROUND GLASS
FRAME RESTS ON
1/2 X 1 X 1-1/2"
BLOCKS
4 - REQ'D.
3/4"
9-3/4"
12-1/2"
HINGES
2 - REQ'D.
HOLLOW BLOCK
TO SUIT
SWITCH
1"
8"
BOX SIDES
AND BOTTOM
3/4" STOCK
1-1/2"
2-1/2"
PUSH SWITCH
HOUSING BLOCK
SCREWED TO
SIDE OF BOX
LIGHT CONTROL
SWITCHES 4 - REQ'D.
14"
3/8" DRILL
11-1/4"
ALL CORNERS
SCREWED TOGETHER
5/8"
1-1/8" APPROX.
CONTACT SPRING
1/16" STEEL
2 - REQ'D.
3/4"
2"
3/4"
1-3/8"
1-3/4"
1/2"
3-3/4"
1-3/4"
3-3/4"
1-1/4"
1-1/2"
1/4" DRILL
PLATTEN HINGE
1/32" BRASS
MAKE - 1 RIGHT
1 LEFT
ARM HINGE
3/32" STEEL
3"
DRILL FOR
6-32 MACHINE
SCREWS
TOP
SIDE
1-1/4"

CAN SPIRAL DIVES BE CURED?

by WILLIAM WINTER
Scientific Leader A.M.A.

FIG. 1

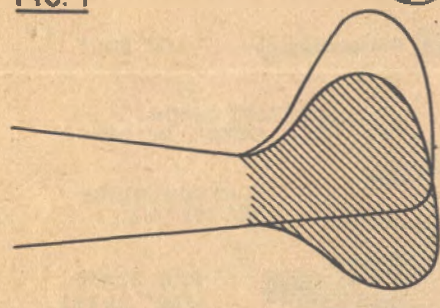
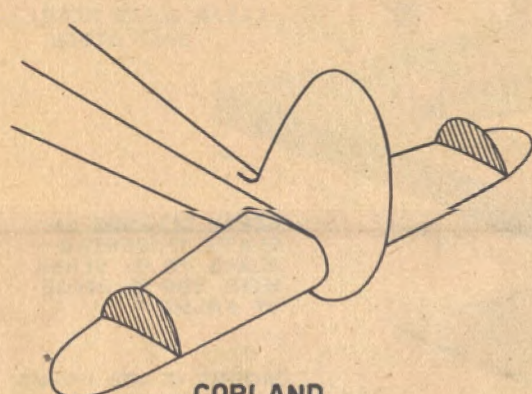
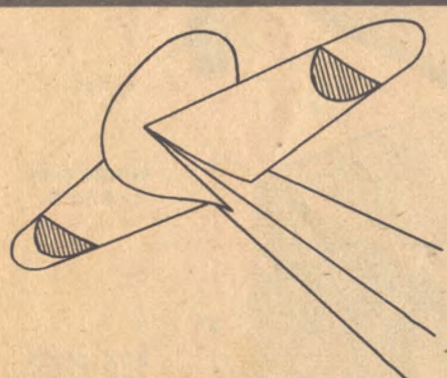


FIG. 2



COPLAND



WARRING

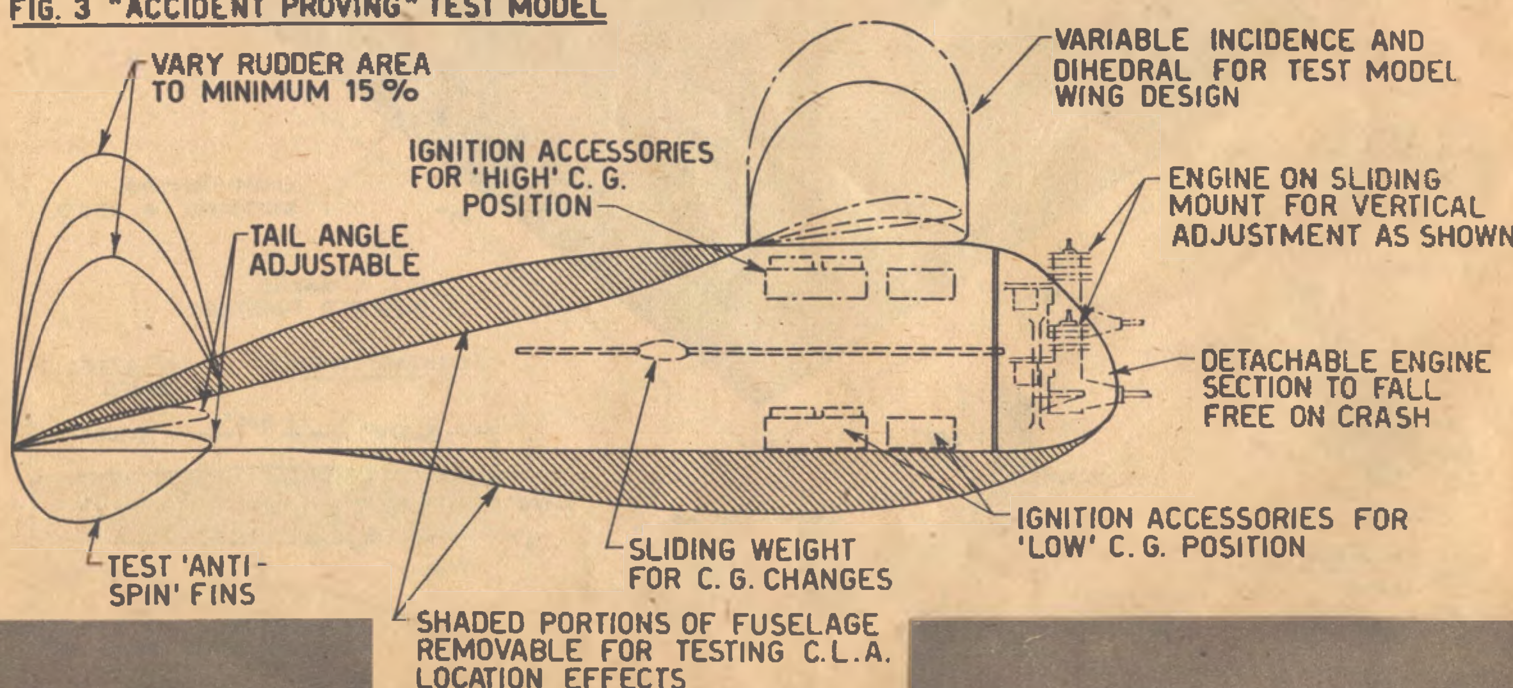
BILL WINTER AND CARL GOLDBERG ARE HARD MEN TO CONVINCE. TIME WILL TELL JUST HOW LONG THEIR "HOT" DEBATE WILL CONTINUE

IN the May issue of this magazine a lot was said about a very small part of the airplane—the rudder. Carl Goldberg argued that excess rudder area was the sole cause of spiral dives (excepting warps). The writer thought that spiral dives resulted mainly from the relationship of the center of gravity to the center of lateral area, although proper rudder design is an important matter.

For late-comers who may have missed the first round in this friendly battle of the rudder, it was said of C.L.A. that, in a high-speed turn under power, the relative wind exerts a powerful effect on the banking characteristics of the airplane, tending to make it "wind" into the ground. If the center of gravity is low, and the center of lateral area high, the model all too easily will go into those steepening diving turns. Conversely, if the center of gravity was reasonably high and the center of lateral area low, say on a line with the C.G. or slightly above it, tendencies to spiral dive would be minimized. For this and other reasons, the writer felt that whittling down rudder area as a cure-all for spiral dives was not sufficient.

The trouble with arguments of this kind is that the discussion sounds theoretical, whereas there is ample practical evidence on both sides of the question. Carl had conducted many tests over a long period of time in determining rudder areas for his high-performance pylon models—why we don't know—and the areas he cited could be relied upon for such designs. There is also practical experience which tends to prove that the proper locations of C.L.A. and the center of gravity will cure spiral dives. Offhand, we know of two cases where an increase in rudder area proved the cure to spiral diving. *(Turn to page 79)*

FIG. 3 "ACCIDENT PROVING" TEST MODEL



SEA HAWK

by CHARLES HOLLINGER
Member A.M.A.

● The high aspect ratio wing and tail, plus proper location of C.L.A. and C.G., give this ship a high rate of climb and a slow, shallow glide.

CONVERTIBLE FROM LAND TO SEA PLANE WITH A MINIMUM OF EFFORT, THE SEA HAWK IS IDEAL FOR VACATION FLYING

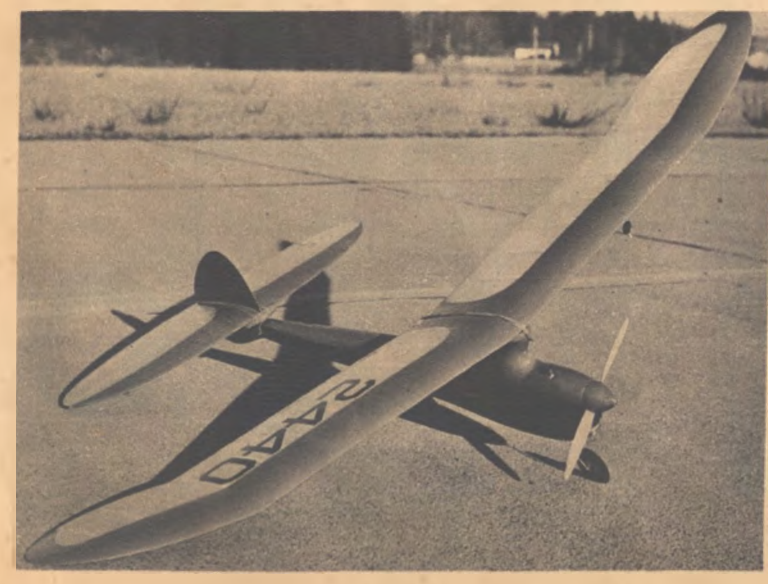
THE "C" Hawk was designed and developed in accord with the firm conviction that consistent flight qualities come first in the winning of contests.

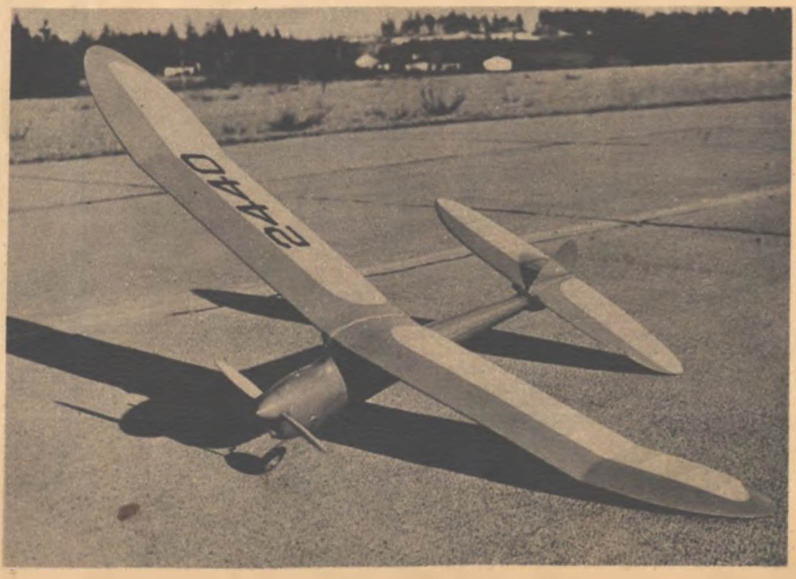
We have all seen a number of potentially hot performers, but they are so unreliable from flight to flight that the average (and expert) modeler doesn't stand a chance in controlling them—for long. The basic cause of these disastrous spirals and loops is A.M.A.'s antiquated 80-oz. power loading rule. With our present-day motors developing *twice* the thrust of the completed ship's weight it's not surprising that the casualty rate is so high.

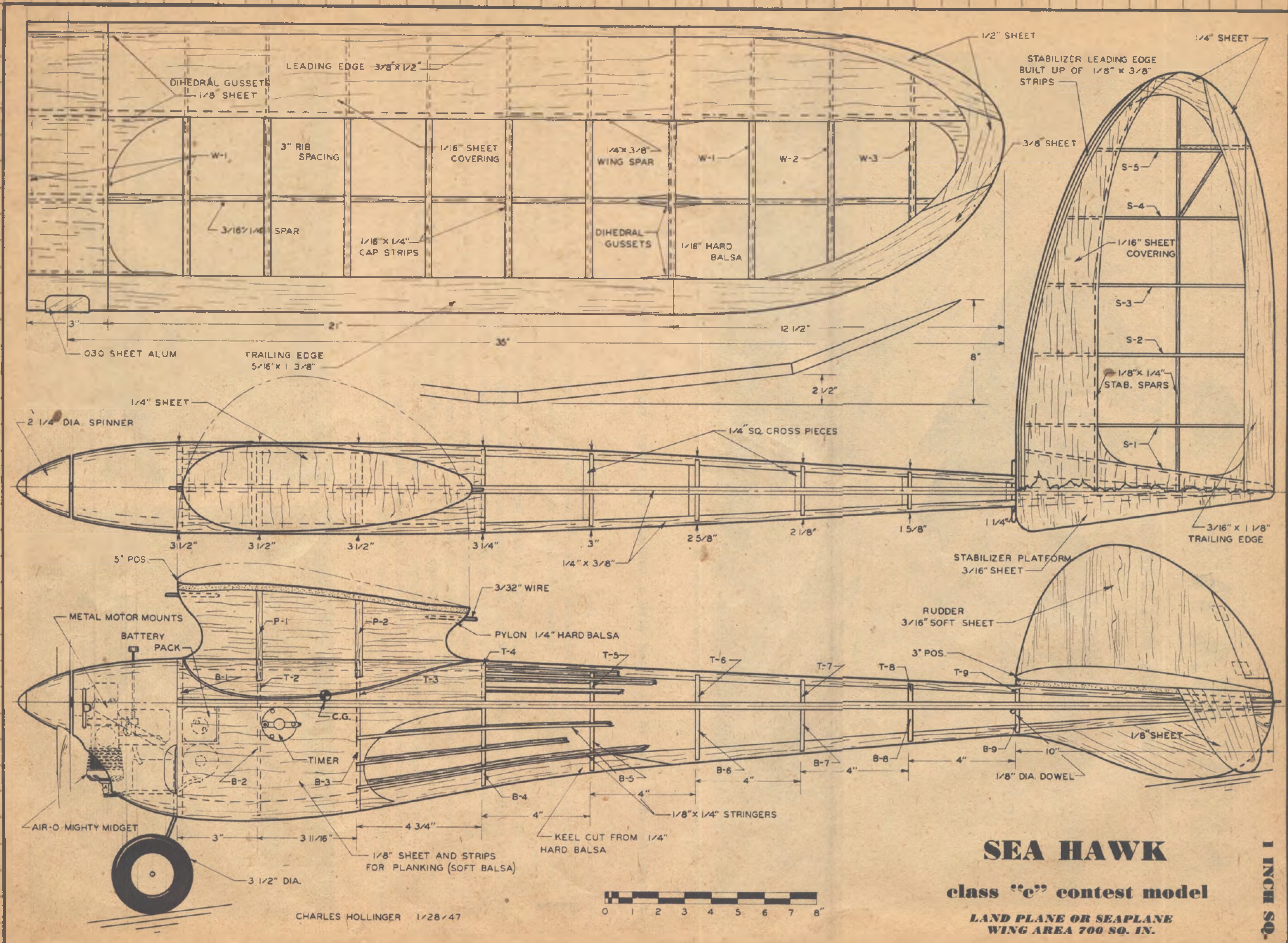
Here in the Northwest the majority of clubs adopted a minimum power loading requirement of 120 oz. per cu. in. of engine displacement. It is around this standard that our ship was designed.

For those who might believe this loading to be outrageous, let's see what happened at a contest sponsored by the Salem Cloud Chasers, a die-hard club of 80-oz. fans. Even with the lightweights greatly out numbering the 120-oz. models, all first places, plus the highest three-flight average for the day, went to the heavier loading ships. Oh yes, one of the 80-oz. entries did win a prize for the *worst crack-up!*

During the summer, our "C" Hawk won five out of six contests entered here in the Northwest, also turning in the highest three-flight average for all classes at four meets. The one contest was muffed by the plane's going out of sight on its first (*Turn to page 110*)

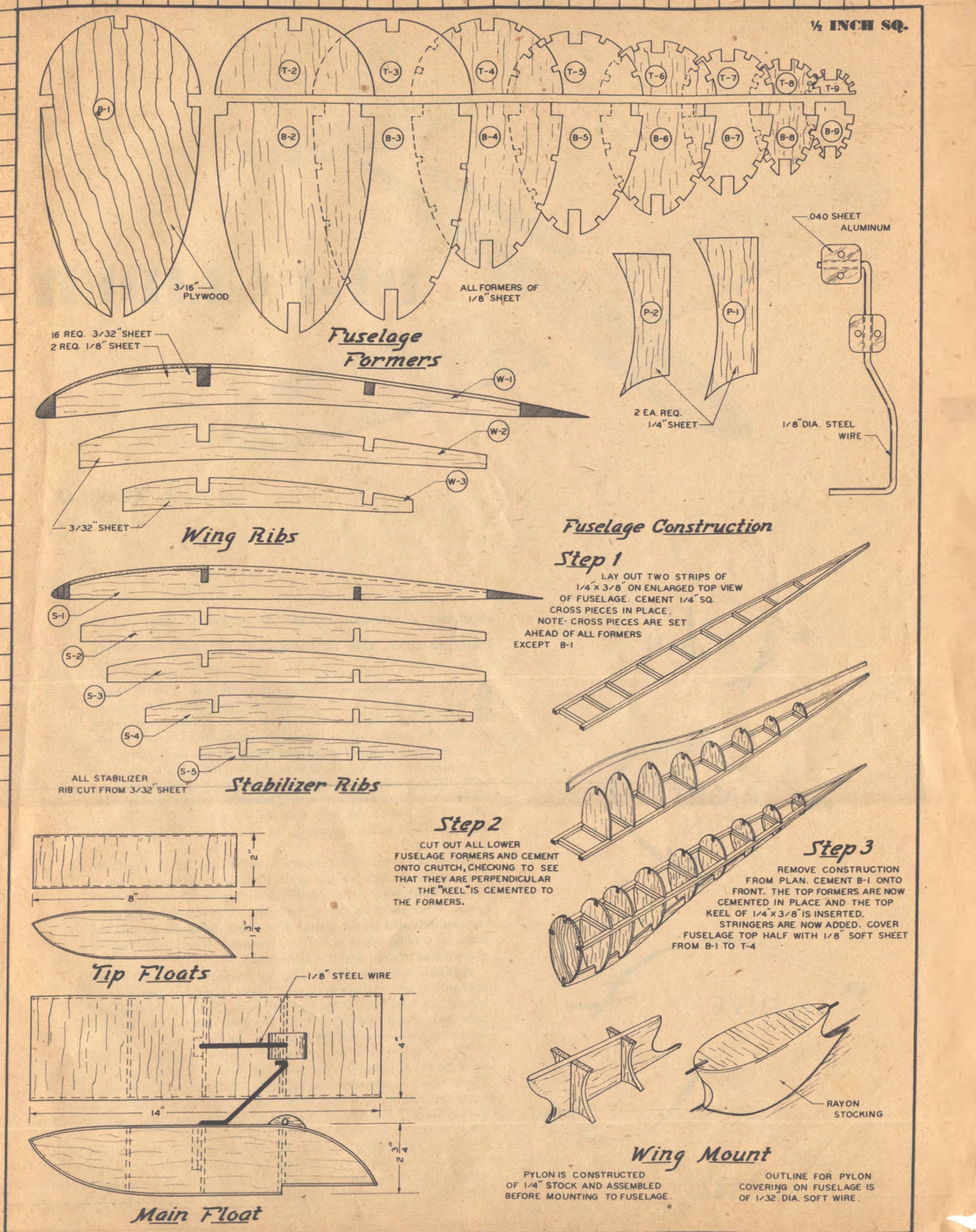




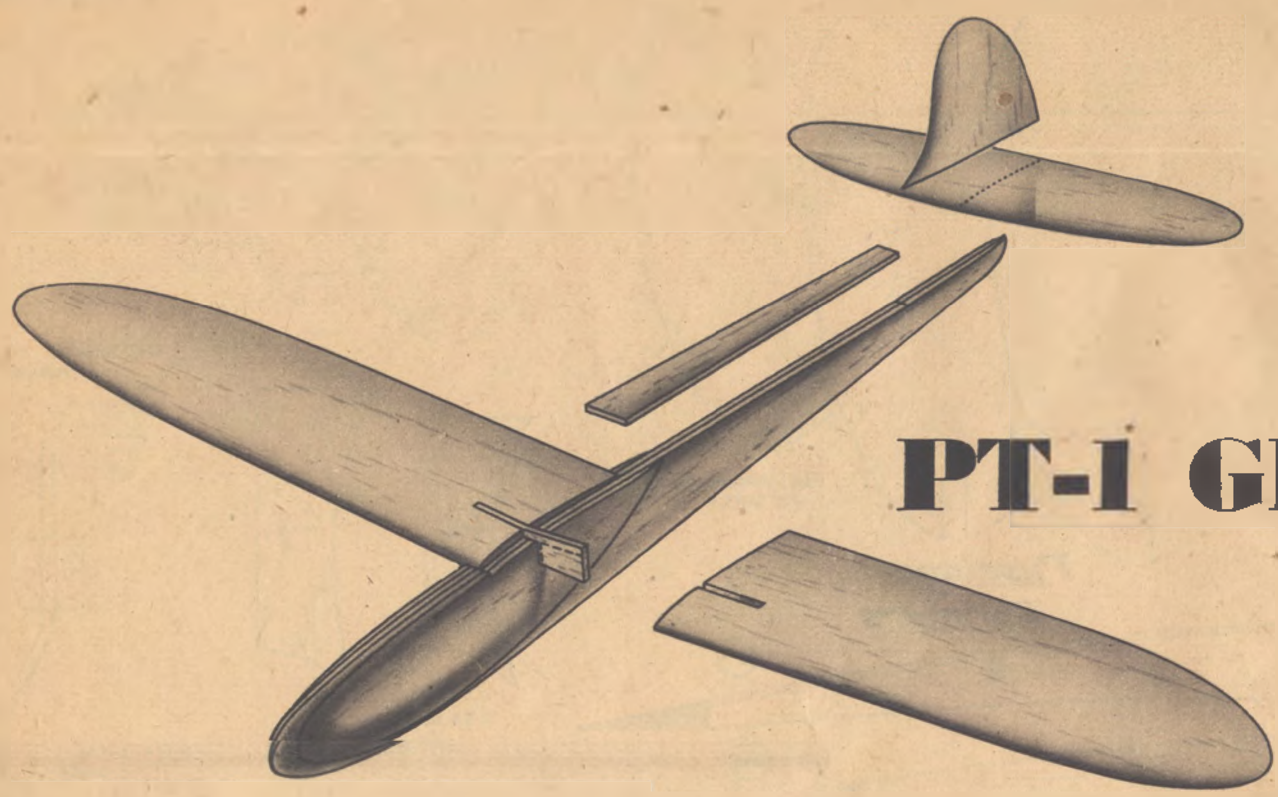


SEA HAWK

1 INCH SQ.



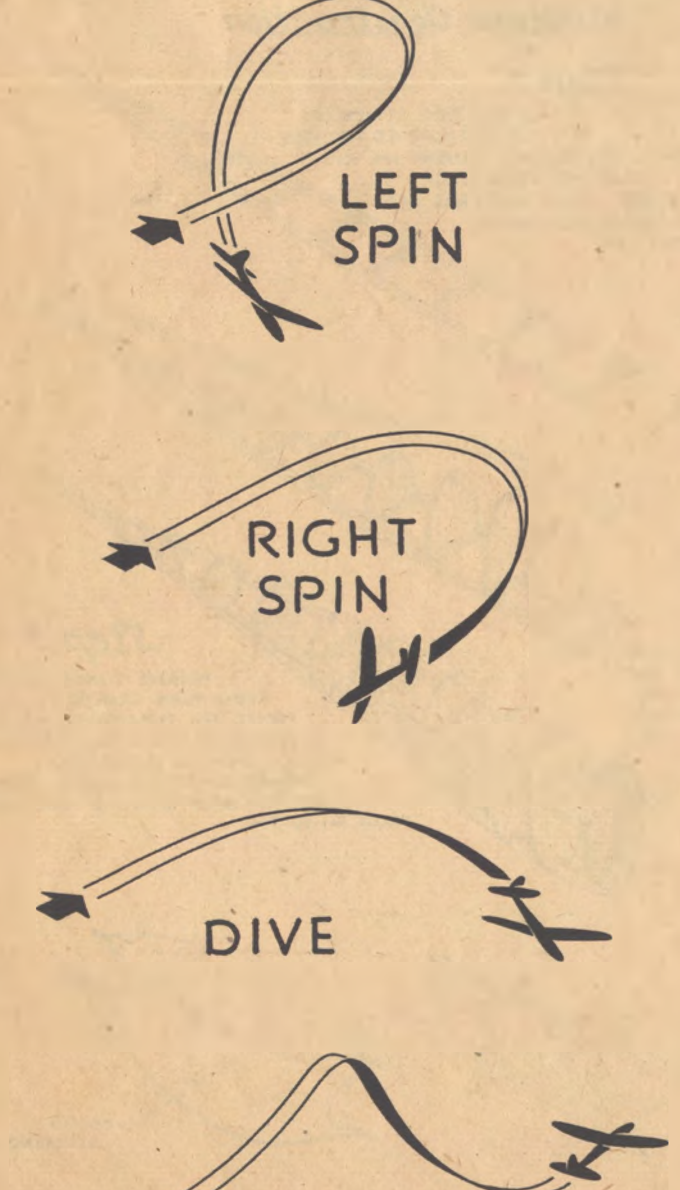
1/2 INCH SQ.
T-2
T-3
T-4
T-5
T-6
T-7
T-8
T-9
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
3/16" PLYWOOD
ALL FORMERS OF 1/8" SHEET
Fuselage Formers
.040 SHEET ALUMINUM
P-2
P-1
2 EA. REQ. 1/4" SHEET
1/8" DIA. STEEL WIRE
16 REQ. 3/32" SHEET
2 REQ. 1/8" SHEET
W-1
W-2
W-3
3/32" SHEET
Wing Ribs
Fuselage Construction
Step 1
LAY OUT TWO STRIPS OF 1/4" x 3/8" ON ENLARGED TOP VIEW OF FUSELAGE. CEMENT 1/4" SQ. CROSS PIECES IN PLACE.
NOTE- CROSS PIECES ARE SET AHEAD OF ALL FORMERS EXCEPT B-1
S-1
S-2
S-3
S-4
S-5
ALL STABILIZER RIB CUT FROM 3/32" SHEET
Stabilizer Ribs
Step 2
CUT OUT ALL LOWER FUSELAGE FORMERS AND CEMENT ONTO CRUTCH, CHECKING TO SEE THAT THEY ARE PERPENDICULAR
THE "KEEL" IS CEMENTED TO THE FORMERS.
Step 3
REMOVE CONSTRUCTION FROM PLAN. CEMENT B-1 ONTO FRONT. THE TOP FORMERS ARE NOW CEMENTED IN PLACE AND THE TOP KEEL OF 1/4" x 3/8" IS INSERTED.
STRINGERS ARE NOW ADDED. COVER FUSELAGE TOP HALF WITH 1/8" SOFT SHEET FROM B-1 TO T-4
2"
8"
1 3/4"
Tip Floats
1/8" STEEL WIRE
4"
14"
2 3/4"
Main Float
RAYON STOCKING
Wing Mount
PYLON IS CONSTRUCTED OF 1/4" STOCK AND ASSEMBLED BEFORE MOUNTING TO FUSELAGE.
OUTLINE FOR PYLON COVERING ON FUSELAGE IS OF 1/32" DIA. SOFT WIRE.



PT-1 GLIDER

by H. A. THOMAS

Scientific Leader A.M.A.



REQUIRING A MINIMUM VARIETY OF MATERIALS, THE PT-1 IS SIMPLE TO BUILD, EASY TO ADJUST AND FLY, AND INEXPENSIVE

ONE sheet of one-sixteenth balsa, two inches wide, 36 inches long, is the complete bill of materials for this unusual beginners' glider. All parts have not been designed of this single weight just for the novelty of it, for the fuselage, built of four layers, has more strength than if it had been carved from a single piece.

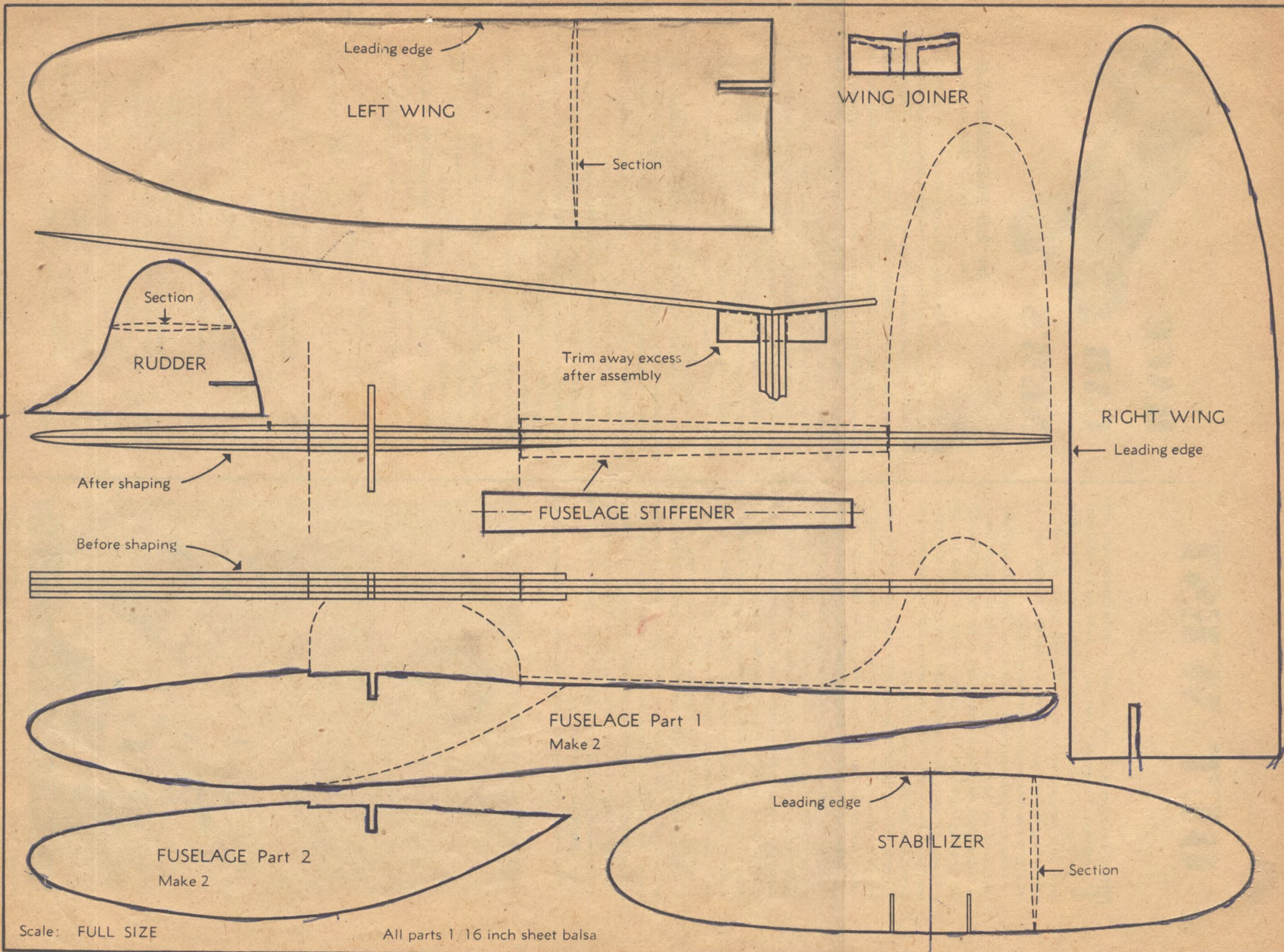
An ideal first step for the new model fan, the PT-1 is staunchly built. Its unusual wing assembly assures correct dihedral; the wing joiner is not meant to be a structural member. A fuselage stiffener, fitted to the top of the body between the wing and tail, gives a tough T-section to the aft part of the fuselage where they so often tend to break.

Using the patterns, trace all parts to the sheet balsa stock and trim them out neatly with a sharp model knife or razor blade. Cement the two inner body parts together and then attach the two outer parts. While these are drying, taper the wings and tail to the cross sections indicated on the plans. Use a sanding block for this and finish all trailing edges to uniform thinness. These parts may be given a coat of dope and laid aside to dry.

A penknife is ideal for shaping the fuselage. Nose is rounded smoothly as are the bottom edges. Upper edges, however, are left square as a base for the fuselage stiffener. Sand the fuselage and then apply a coat of dope to it. It is a good idea to rub a layer of cement over the nose and the bottom of the fuselage.

The wing joiner is now cemented into the fuselage slot and, with the aid of pins, the wing panels are joined. Use cement liberally here as well as in attaching tail parts. After the wing joint dries, carve the wing joiner flush with the fuselage and wing (as shown by dotted lines). Next fit the fuselage stiffener in place and see that all joints have a skin of cement over them.

Finally, the entire glider may be smoothed with very fine emery paper, then rubbed with a piece of bread wrapper which leaves a thin coating of wax on the surfaces. Add a bit of modeling clay to the nose, if necessary, to make the glider hang level (*Turn to page 105*)


Leading edge
LEFT WING
Section
WING JOINER
Section
RUDDER
Trim away excess
after assembly
RIGHT WING
Leading edge
After shaping
FUSELAGE STIFFENER
Before shaping
FUSELAGE Part 1
Make 2
Leading edge
STABILIZER
Section
FUSELAGE Part 2
Make 2
Scale: FULL SIZE
All parts 1/16 inch sheet balsa

OUT WEST

THE Westerner is, for the moment, a Midwesterner and will soon be an Easterner. Just so you don't get too confused we'll explain this column is being written in Chicago while we're on a transcontinental tour. We will take in some of the outstanding Midwest and Eastern contests this summer and will try to give you the over-all picture as we see it.

We have just talked to Frank Nekimken at The National Headquarters of the American Legion. Frank has moved his family to Indianapolis, the Headquarters city, to be right on hand for the working out of the tremendous amount of details that are necessary for such a gigantic task as the Nationals. Nearly everyone knows Frank's ability for just such a task and his record of successes in the past speaks for itself.

Frank tells me that even at this early stage most of the plans are now complete, for instance the housing situation which is always one of the principal headaches will be taken care of by the erection of a tent city. Five hundred four-man tents will be available; the only item that the contestant will have to furnish will be his own bed linen. This is all being done by the Air Scouts. Guards will be posted both day and night for the policing of the grounds and the protection of the contestants. In addition to this a special site to accommodate trailers will be set up near the river. Hot and cold showers and hot meals will also be available at both locations. For the Industry members, Minneapolis' leading hotels are cooperating with Mr. Hugh Kenney, Chairman, by reserving an adequate number of rooms.

Between 1,200 and 1,500 contestants are expected and in all probability this will be the last Nationals as most of us know them. Because of the large number of contestants it probably will be necessary to have elimination contests in the future. Although we know this must take place we will miss the color and excitement of a big and open Nationals; there just isn't any other contest like it in our opinion.

Many new and beautiful trophies will be (*Turn to page 99*)

● Keith Storey, of Pasadena, California, holder of Class IV record.

RACE CAR NEWS

by ED FITZGERALD
American Miniature Race Car Assoc.

EVERY year the American Miniature Race Car Association has a Championship Race to decide the National Champion in two classes of cars and for three distance races. These are for one quarter mile, one half mile, and also the full mile. This year, the average fan is looking forward to his participation in these annual affairs at the famous Race Car City of Indianapolis, Indiana. Dates have been set by the Association Officers for August 14th to August 17th, inclusive.

From the earliest hour of the first race day, contestants will begin to arrive by train, bus, and motorcar for four days of almost continual racing. More than four hundred active fans are expected to enter this "Speedfest" and push their small cars off to what may well be a new World or National Speed Record. If the weather is at all favorable, the record of 120.32 miles per hour, set last February by Wm. Thomas, Jr., of Daytona Beach on the Eustis, Fla., track, is expected to fall.

Those of you who would like to see real speed and fierce competition should try to get to this race. If you can't attend this one, then take a Sunday joyride to the home track of one of the following clubs; it will amaze you to see the high degree of skill that is expended on the operation of these miniatures.

In numerous letters received, the most frequent question asked is the location of tracks and clubs and how to contact the responsible officer or secretary of same. In response to this request, I have gathered together the following list of known clubs and their respective secretaries. This list should be filed by Club Officers and Race Committees so that neighbor clubs can be notified of coming events and races. If your own club is not listed, then instruct your Secretary to forward all pertinent information to The American Miniature Race Car Association, Inc., H.Q., Hotel Governor Clinton, 31st St. and 7th Ave., N. Y. C.

This list is offered for your guidance in locating the track nearest your home town but it is comprised mostly of clubs which have had direct contact with the writer and may not be all inclusive.

City	*Name of Club*	Secretary	*Address*
		ALABAMA	
Mobile		Paul Alred	153 So. Jefferson St.
		ARIZONA	
Glendale		Eldon Marshall	320 N. 3rd
Phoenix	M. R. C. Club	Q. F. Webster	1238 E. Willeta
Phoenix	Regional Director	Robt. Graham	P.O. Box 1293
		CALIFORNIA	
Azusa	A. M. R. C. A. Director	Tony Aguilar	151 E. Foothill Blvd.
Bakersfield	Min. Race Car Club	L. Leong	1405 K St.
Fresno	Valley Min. Car Club	Jim Gilmore	4985 Madison Ave.
Fresno	Hornet Hobby Park	Ray Snow	3849 Ventura Blvd.
Los Angeles		Louis Paridiso	1622 W. 107th St.
Modesto		Jim Keller	515 Mono Ave.
Ontario		Woody Woodward	331 E. H St.
Oakland	Model Race Car Club	Clif Fox	1595 [illegible]th Ave.
Pomona	Miniature Car Club	Dick McCoy	457 Randolph
Pacific Beach		Joe Havlik	1352 Homeblend
San Francisco	Perfect Circle Speedway	A. E. Gunn	127 San Mateo Dr.
San Diego	Model Club	O. E. Meecham	4536 Estrella Ave.
Santa Barbara		R. J. Benjamin	726 Lawrence Ave.
San Leandro	Model Race Car Club	Ray Hook	548 Elsia Ave.
San Dimas		Bert Torrey	236 W. 5th
San Jose	Miniature R. C. Club	Bill Walls	2nd and San Antonio
Torrance	Min. R. C. Club	Bill Finch	1005 Satori
Tujunga		L.S. Cottle	7710½ Wentworth

(*Turn to page 97*)

CYCLOGIRO by ALAN L. SMITH

HERE'S ANOTHER INTERESTING APPROACH TO ACHIEVE LIFT AND PROPULSION

EAST coast families may be weekending in California resorts via future aerial sedans. An experimental rotor-type plane, dubbed the Cyclogiro, has possibilities of replacing the automobile in residential garages.

Designed by Professor Kirsten, originator of the Kirsten radiator smoking pipe, and the staff of the Department of Aeronautical Engineering of the University of Washington, the unconventional aircraft will combine helicopter maneuverability with supersonic speed.

Based on an entirely new propulsion principle, the family Cyclogiro will look like a streamlined car with airplane tail surfaces and a stubby rotor on each side. These rotors, or Cycloid propellers, as they are technically named, take the place of wings and propeller, rotating about a spanwise axis perpendicular to the sides of the fuselage.

The cycloid prop is the secret of the radical but amazing Cyclogiro, and it is being put through tests at present for both aircraft and ship usage. It consists of a steel-housed rotor with from three to eight vertical blades revolving in the air like a swimmer doing the butterfly stroke. The attitude of each individual blade attains a pitch setting as it reaches the proper point of arc, and automatically full-feathers on the opposite point of the rotor when the blade is moving away from the direction of the slipstream.

The Cyclogiro is still in its experimental stage at the University of Washington Aeronautical Laboratories. Its possibilities were first suggested by Professor Kirsten in June of 1934 in a paper, "Characteristics of Cycloidal Aircraft—Their Performance and Stability in Flight." Since then, wind-tunnel models have been successfully undergoing tests. The latest model, built in 1941, may be the last before the first actual Cyclogiro takes to the air.

With the ability to take off and land vertically, the supersonic family model will find an unobstructed driveway a satisfactory runway. Because of its high propulsive efficiency at low speeds and a low take-off speed, the Cyclogiro is expected to take an extremely short take-off run even with high wing, or blade, loadings, which would be ideal for airmail runs from post-office roofs and for long-range bus service. Using moderate loadings, a 25-foot take-off run with an almost vertical ascent is considered possible. The model expected to replace the automobile, with a normal small plane blade loading, will rise from a dead standstill.

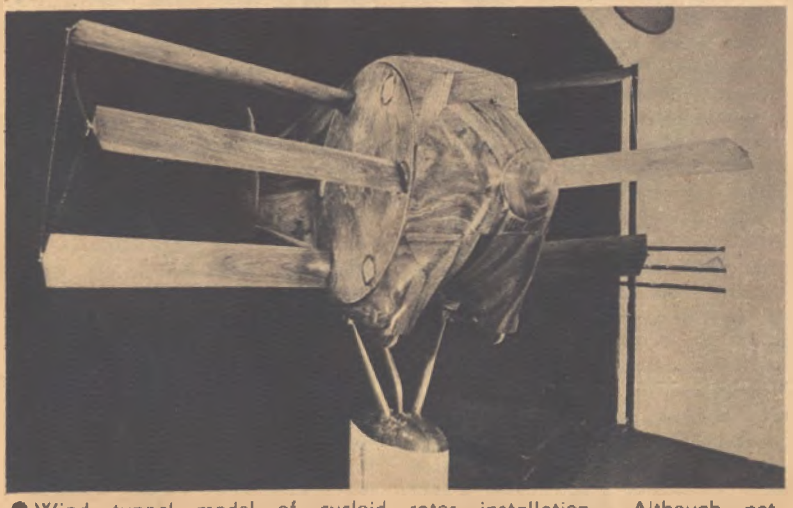
It may be necessary to incorporate a gear shift in the flying model of the Cyclogiro, so that a change can be made in the rotor's r.p.m. Conversely to conventional aircraft, a high r.p.m. must be maintained for slow flight, hovering, and vertical descent, while a lower one is used for high forward speeds. Changing gears would permit the engine to run at its most efficient r.p.m. during all conditions of flight.

The reverse order of needed r.p.m. is due to the fact that speed is controlled by blade pitch. Each blade is controllable to suit any ratio of forward speed to rotational speed. When the blades are rotating in low pitch, the rotational speed exceeds the forward speed of the plane. The low pitch ratio can go as low as O, giving the plane the ability to hover, or drop lightly to a landing directly below.

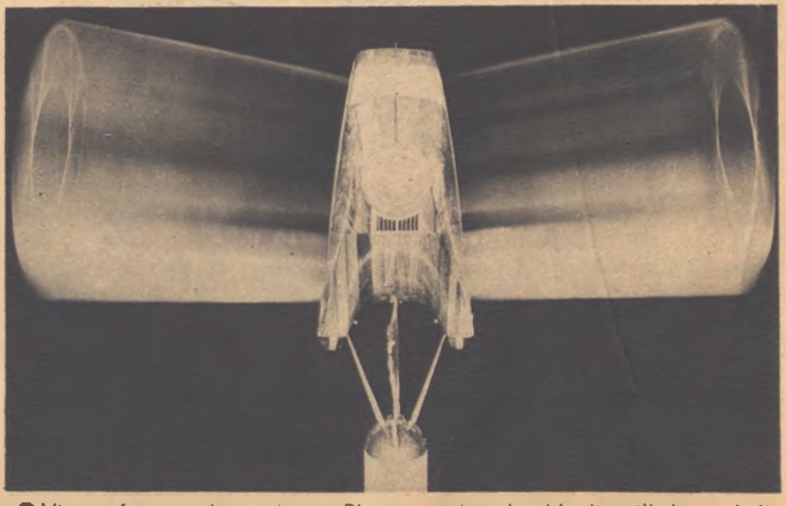
High pitch allows the forward speed of the plane to more than double the peripheral velocity (rotational speed) of the cycloidal blades. Since the entire blade rotates at the same speed, there are no problems encountered from tip velocities, the limiting factor of conventional prop planes attempting to crash the sonic barrier. When a prop attains the speed of sound it loses its ability to propel. Screw-type prop tips travel at a speed much greater than either the spinner or the plane. The cycloid rotors, on the other hand, will function comfortably below the sonic limitations, while the entire plane is traveling in the supersonic range.

The propulsive efficiency of the cycloidal prop principle is phenomenally high. At high speeds a 100% efficiency is entirely possible. Mechanical losses can be kept well below 5%, so that more than 95% of the power supplied by the engine to the cycloidal blades is converted to useful thrust horsepower. This is partially because there are no added surfaces for propulsion, since the rotors act as both wings and propeller.

At low speeds the efficiency is still high because there is no swirl from the props. The slow-flying helicopter, with its wings rotating about a nearly vertical axis, cannot maintain the desired angle of attack between the wings and the relative air. The spanwise rotating cycloid is able to meet the desired angle at any point on its arc. Consequently, with a normal blade loading, it is safe to predict an efficiency as high as 80% in a vertical climb at 65 mph. This far surpasses that of the helicopter and is greater than that of all conventional type airplanes. *(Turn to page 116)*



● Wind tunnel model of cycloid rotor installation. Although not yet in flying stage this new propulsive method shows promise.



● View of rotor in action. Planes equipped with it will have helicopter performance and be capable of exceptionally high speeds

New Paths to New Planets

(*Continued from page 39*)

Instead of traveling to the planets on a closed oval curve or ellipse, the one proposed here is a far more exciting type of curve called the *hyperbola*. (Don't be frightened by these technical sounding terms. You don't have to be an organic chemist to understand the general meaning of such technical terms as "Pepsodent" or "Alka-Seltzer," do you? Well, you don't have to be a mathematician to grasp the general significance of "ellipse" or "hyperbola," either.) For our purposes, it will suffice to say that an ellipse is a closed curve and the hyperbola is open at one end.* A comet passing by the Sun on an ellipse will eventually return although the journey may take a thousand years. But when a comet whizzes past the Sun on a hyperbola it is good-bye forever. One branch of the hyperbola goes out to infinity in one direction, and the other branch goes out to infinity in another direction, and never the twain shall meet. There is no road back on the hyperbola.

Why do some objects move in ellipses and others in hyperbolas?

It is all a matter of initial velocity. If a particle at the distance of the earth from the Sun is started moving with a speed of less than 26 miles per second it will describe some kind of an ellipse. As the speed is increased, one end of the ellipse extends farther and farther from the Sun, beyond the orbits of Uranus, Neptune, and Pluto. Finally, the 26-mile-per-second mark is overstepped, the ellipse is stretched beyond its elastic limit, so to speak, and the end farthest from the Sun snaps apart. Now it is no longer an ellipse but has been transformed into a hyperbola.

The hyperbola in the past has been a kind of ugly duckling or black sheep in a family of curves called the conic sections. If a young astronomer told his old professor that he had calculated the orbit of a newly discovered asteroid and found it to be hyperbolic, he would be promptly told to get busy and do it over again since asteroids never move in hyperbolas. In fact, hyperbolic motion occurs so rarely that I doubt if many astronomers have ever calculated a hyperbolic orbit. There are a few comets on record that seemed to have been following hyperbolas, but it is hard to be sure that they were not merely greatly elongated ellipses instead.

Space enthusiasts have shied away from the hyperbola chiefly because the fuel situation has always loomed so large that the watchword has been to keep down the initial velocity at all costs. The hyperbola has also been unpopular because it has always been understood that if the rocket missed its mark the occupants were doomed to death in the depths of trans-Plutonian space; whereas on an ellipse revolving at a moderate distance from the Sun they would soon be picked up by a rescue party.

But we have already assumed that ample fuel will be always available. If the navigator sees that he is a trifle off course he would simply touch one of the numerous buttons on the illuminated panel before him. Instantly rocket motors would respond which by their reaction upon the ship would speedily put it back on course again, so that it would continue smoothly forward along its charted hyperbolic path to Mars.

We are now in a position to visit the planets—not by slow and cumbersome ellipse—but by fast streamlined hyperbola. The time saved by an increase of a few percent in the initial velocity is amazing. Jules Verne's old elliptical route to the Moon called for a velocity of 6.88 miles per second at the surface of the Earth, which was supposed to have taken him to the Moon in about 100 hours. By starting the rocket at an altitude of 200 miles with a speed of 6.99 miles per second the time drops to 26 hours 42 minutes. Make the velocity 8 miles per second and Luna is only 13 hours away. Corresponding reductions in time are possible on journeys to the planets.

Man Goes to Mars

Figure II shows the path of a rocket following one of many hyperbolic routes that might have been selected. The zero hour would occur on the dawn or "front" side of the Earth. For the special case of the trip to Mars, the orbit has been worked out by mechanical quadrature taking into account both the attraction of the Sun and Earth. The process is slow but when completed you have the satisfaction of knowing that if the rocket were actually started moving under the conditions assumed it would follow the path laid down for it. The dotted curve is a portion of the old classical elliptical route to Mars.

Going by hyperbola, the rocket would cross the orbit of Venus after 21 days and by 45 days would be within 8,050,000 miles of the orbit of Mercury and 51,400,000 miles of the Sun. The Sun would be a dazzling white hot globe in a black sky that looks nearly twice as large as seen from the earth. Around its edge would be a seething fringe of scarlet flames with perhaps a rose-colored "heliosaurus" towering 200,000 miles above them, like a prehistoric animal grazing upon fiery grass. Sunspots of moderate size would be easily visible. Most glorious sight of all would be the pearly streamers of the corona extending motionless from the sun for millions of miles as if frozen in space.

But the travelers would be allowed little time for solar observations. The rocket is now at the point on the hyperbola where it moves at the greatest speed it will ever attain of 33.7 miles per second. At 66 days the rocket crosses the orbit of Venus and 19 days later the orbit of the Earth. Finally the rocket overhauls Mars at the end of 108 days, when the rocket pursuing the classical route is still about 175,000,000 miles away.

The landing on Mars was effected without mishap, the ship coming to rest at the northern tip of the great hourglass marking known on our maps as the Syrtis Major. Now the men are getting into their spacesuits preparatory to stepping outside the protecting walls of the ship. What definite information could we have given them about Mars before leaving Earth?

We could have told them that although Mars has an atmosphere of some sort it certainly does not contain sufficient oxygen for the requirements of beings like ourselves. Photographs taken with powerful spectrographs attached to the largest telescopes have failed to reveal a trace of absorption lines in the Martian atmosphere, despite what you may have read otherwise. This does not mean that oxygen is necessarily absent from the atmosphere. It simply means that if present the quantity is less than we are able to detect. Liberal estimates put the amount of oxygen at less than one percent of that in our own atmosphere.

The spectrograph has also failed to detect water vapor on Mars. In this case, however, direct visual observations provide a more sensitive test than is possible with the spectrograph. The most conspicuous feature upon the disk of Mars is usually the white cap at one of the poles. When Mars makes its closest approach to the Earth every 15 and 17 years, the planet is oriented with respect to the Earth so that the south pole of Mars is tilted toward us. During winter in the southern hemisphere of Mars this polar cap increases in area, but begins to shrink as spring advances, while a dark border forms around the outer edge of the cap. The appearance and behavior of the polar caps indicate strongly that they are thin deposits of snow and ice, the dark border being marshy ground formed by the melting snow. Thus there is visual evidence of water on Mars, although the total amount could probably be emptied into one of the Great Lakes. The eye has an advantage over the spectrograph here because the spectograph can detect only water *vapor*, which is spread very thinly throughout the whole atmosphere, instead of being concentrated in a small area at the poles.

The question of oxygen and water vapor on Mars has been well summed up by Dr. Theodore Dunham, Jr., to whom we are indebted for much of our present knowledge of planetary atmospheres. According to him, "It would be unwise to say that there may not be enough of both oxygen and water vapor to support life in some form which may have become gradually adapted to the rigorous conditions existing on Mars."

About fifty years ago there was a strong movement in favor of Martian polar caps composed of frozen carbon dioxide, the "dry ice" of commerce, instead of frozen water. If so, it would imply a very low surface temperature. Direct measures of the planetary heat from different parts of the disk, however, show that the temperature is much too high for carbon dioxide to remain long in the solid state. These measures are made with a delicate heat-sensitive instrument called the vacuum thermocouple "which when used on the 100-inch telescope is able to detect heat from a candle 100 miles away." (The astronomers who made these measurements patiently explain that they never actually measured the heat from a candle 100 miles away. It is just a way of expressing the theoretical sensitivity of the instrument.) At noon on the Maritan equator the temperature is about 50° F and some of the dark areas may even be as high as 72° F. Portions of the disk near sunrise or sunset are at about 9° F. Measures on the night side would be very desirable, but Mars never shows enough phase so that reliable readings can be obtained. But the temperature must fall rapidly after sunset so that by midnight it is colder than the lowest temperature ever recorded on Earth of −96° F in Siberia.

The first effect a man would notice on Mars would be that the surface gravity is considerably less than on the Earth. This is one point on which we can really speak with confidence. The surface gravity on Mars is 0.3717 g, so that an object which from experience we expect to weigh about 12 pounds, would only have the feel of 4 pounds. At first we would be continually using too much strength in picking things up, which would lead to some awkward accidents. But my guess is that we would soon become adjusted to the effect, so that upon returning to Earth we would feel it in reverse: our legs would seem to be made of lead with the sinews of a jelly fish.

In certain respects conditions on Mars closely resemble those on the Earth. The period of rotation of Mars is 37 minutes longer than that of the Earth, so that day and night would succeed each other at about the rate to which we are accustomed. After sunset the same old constellations would begin to come out although probably more quickly than in our twilight sky. From the latitude at which our spaceship landed on Mars of 23° N, the stars would look about the same as seen from near the equator of the Earth; so that in addition to the northern constellations of Lyra, Cygnus, Cassiopeia, etc., there would be many that are unfamiliar to most of us, such as Horologium, Apus, and Phoenix. After a few hours an alert observer would notice that the northern stars were describing circles centered near the first magnitude star Deneb, which is the Polaris of Mars.

Two astronomical objects that would soon be sure to attract attention are the tiny moons of Mars, Phobos, and Deimos. Phobos, the nearer moon, moves eastward around Mars so fast that it has achieved fame for the fact that it rises in the west and sets in the east. The time from one rising to the next rising, or from one setting to the next setting, is 11 hours. But the time from *rising* to *setting*, believe it or not, is only 4.3 hours. The reason is that Phobos revolves so close to the surface of Mars that it cannot be seen throughout an entire half revolution; or, to put it crudely, the planet gets in the way and cuts off the view. Observers in the polar regions would never see the moons at all. Phobos never appears above the horizon in Martian latitudes higher than 69°, and Deimos never above latitude 82°.

Deimos, the outer moon, rises and sets as a well-behaved moon should, but its eastward motion exceeds the eastward rotation of Mars so little that it would seem to be hanging in the sky practically motionless. Not until 59.6 hours after rising, during which Deimos would have run through its phases twice in succession, would it finally set below the western horizon. The phases would have to be observed through a telescope, however, since Deimos with a diameter estimated at 5 miles would not show a disk to the unaided eye. The changes in phase would make Deimos seem like a variable star, at full phase being about as bright as Venus and at the quarter phase about like Vega.

Although Phobos revolves around Mars only 3,800 miles above the surface (the distance between Los Angeles and Panama) and is estimated to have a diameter of 10 miles, it is too small to produce a total solar eclipse. But it could produce fairly creditable partial or annular eclipses. Deimos, on the other hand, could not even produce a first-rate partial eclipse. Its passage across the disk of the sun would be

* Rigorously defined, the hyperbola is the locus of a point moving in a plane such that the difference of its distances in either order from two fixed points is a positive constant less than the distance between the two fixed points.

more like a transit, the satellite having twice the diameter of Venus as seen from the Earth.

Lunar eclipses would be rather common. On the average, Phobos is eclipsed about two out of every three times that it is in the position of full moon; Deimos, about two out of every nine times.

Near the beginning of spring or autumn on Mars it would be possible to see two total eclipses of Phobos on a single night. Thus, suppose that Phobos is rising in the west just as the sun is setting, which would be six o'clock in the evening Martian time. About three hours later at nine o'clock Phobos would enter the shadow of Mars and remain eclipsed for 54 minutes. At approximately 10:18 P.M. the moon would set below the eastern horizon. At five o'clock next morning it would rise in the west but be wholly invisible since it would again be in eclipse. Half an hour before sunrise the eclipse would end when Phobos was 15° above the horizon.

No wonder that when Asaph Hall first spotted Phobos in 1877 its bewildering motion made him think that perhaps Mars had half a dozen moons!

The most characteristic feature of the Martian landscape would be its deadly monotony. There are no sharp peaks and steep canyons to break the uniformity of outline, although early observation at the Lick Observatory indicate there may be mountain ranges rising gradually from the level plains to elevations as high as 10,000 feet. But for the most part our explorers gazing through the thin air would see nothing but acres and acres of reddish colored ground. Far in the distance they might discern a giant dust cloud sweeping majestically across the surface. The golden tint of the soil would be in striking contrast to the dark blue of the sky, a Maxfield Parrish sky of deep ultramarine.

On Earth the oceans cover 70 percent of the surface. On Mars the deserts are dominant. Mark carefully the following words by Percival Lowell: "Not only are the desert belts in existence, but the whole surface, except for the sea bottoms, has gone the same way. Five-eighths of it all is now an arid waste, unrelieved from sterility by surface moisture or covering of cloud. Bare itself, it is pitilessly held up to a braze sun, unprotected by any shade." *

Is There Any Life on Mars?

Abandoning your readers on Mars without discussing the possibility of life, would leave them feeling as frustrated as seeing Dick Tracy shot dead just as he was closing in on the current villain. So far we have managed to keep our feet on fairly firm ground. Now we are going to take a flyer into the realm of pure speculation where we will be treading thin air. What can we say about life on a planet that at best can never come closer than 33,900,000 miles?

Most of the discussions of life on Mars that I have read consist in saying "Nobody knows" for about a thousand words, a fact everyone is quite willing to grant in the first place. Unless we can make some positive contribution to the subject it would seem better to avoid it entirely. Let us see if we cannot at least make a little headway by trying to answer the question, "Is there any place on Earth where conditions so closely resemble those on Mars, that study of the plant and animal life there may give us clues to the nature of plant and animal life on Mars?"

* *Mars as the Abode of Life.*

Such a region *does exist*. In fact, conditions there in many ways are more typical of those on Mars than those upon the Earth itself. This region is the vast elevated area known as the Tibetan plateau. As nearly as I can gather, we probably know just a little more about Mars than we do about conditions in the interior of Tibet.

Keeping in mind the words of Professor Lowell just quoted, read this report by a naturalist describing the Tibetan plateau.* (The italics are mine.)

"Tibet is a desert, a *high-altitude mountainous* desert at an elevation of about 14,000 feet. This is a point we must thoroughly realize, for the life of Tibet is in many particulars the life of a desert waste. It differs from the deserts of Arabia or Sahara in one particular: it has *none of their intense heat*. But otherwise Tibet is essentially a desert—*empty, bleak, and bare.*

"As we travel across it we see all the features of the desert, the *wide tracts of brown and barren soil*, the vast distances spread out before the eye, the fierce display of light. Here, as in the desert, we meet *tracts of sand*, often loose and crumbling and at *mercy of the wind*. In one place we see how its surface is rippled, in another how it is covered with a saline incrustation, in another how it stupefies the scanty vegetation or piles it into crescent dunes. . . .

"There is a *great range of temperature* characteristic of the desert, often 50 degrees between day and night. The *atmosphere is so dry* that it *splits the skin and nails*, and *prevents the ordinary decomposition of flesh. Fierce winds* blow across it from the main range . . . frequently they *raise up vortices of dust* which careen over the empty plain.

"As in the desert, we observe the same *scantiness of vegetation*, the *monotonous growth* that gives *no color to the landscape*, the *absence of trees*, the *thorniness of the plants*, the *short active season* in which flowers bloom rapidly and as rapidly die away. These are some of the desert features which we meet in our journey through Tibet."

In such a region animal life is not a mere struggle for existence but is more like a perpetual war in which no quarter is given and none asked. Yet fragile forms of life are observed in considerable numbers. These animals cannot escape their foes by some familiar method such as climbing a tree because there are no trees to climb. Neither can they find concealment in high grass or among dense foliage, nor can they dive into some convenient lake or stream.

Instead, they survive by making themselves as nearly invisible as possible. The one outstanding characteristic exhibited by the common animals of the Tibetan plateau is protective coloration, which is developed to an amazing degree. Not only do the colors of the animals blend with the surface but their very shapes and outlines as well. The lizards, for example, are of variable coloration, some speckled and others sandy, but all harmonize with the arid soil. There is a species of grasshopper finely mottled in gray and black, which lives as high as 18,000 feet on decomposed granite, resembling the granite flakes so closely that it is hard to discern it at all.

There is one formidable natural enemy, however, against which protective coloration is of no avail—the intense cold. Here the answer is found in hibernation which is often prolonged for months. Survival consists in going underground, by burrowing into the plain and by creeping under rocks. In April the plateau often seems absolutely destitute of life. Yet actually life is everywhere, but concealed and dormant beneath the surface. Ants are hidden in subterranean galleries, weevils are motionless beneath stones, centipedes are rolled into coils, and spiders are lying within snail shells. Naturalists found that at 17,000 feet where the air temperature varies by 44° during the twenty-four hours, the temperature under a rock changed by only 12°. And a foot below ground the temperature is practically uniform.

If we postulate animal life on Mars then we must include plant life, too, for animal life as we know it cannot exist alone. Animals lack the ability to obtain nourishment from purely inorganic substances, a trick which plants can perform with the aid of sunshine and their green coloring matter. Although some animals feed entirely upon others or live where no vegetation grows, yet persistent search will always disclose a chain connecting them with the vegetable worlds. Thus the so-called abyssal fishes live at great ocean depths where sunlight never penetrates and vegetation is unknown. Their link with plant life is exceedingly tenuous—the food that sifts down to them from above—but it is sufficient to provide for their existence.

The type of vegetation which would seem most likely to survive on Mars are the lichens, plants of simple structure with the ability to adapt themselves to almost any conditions. Lichens grow at a height as great as 20,000 feet. They are found in strong sunlight and in caves. They can withstand the burning heat of the desert and the freezing cold near the region of perpetual snow. Lichens spread over soil or even bare rocks in extensive flat crusts which exhibit a display of colors ranging from white, through yellow, brown, gray, and black.

Returning again to the space travellers surveying the boundary between the dark Syrtis Major and ochre colored Isidis Regio, they find that the Martian "sea" is a thick flat crustal growth of gray lichen which covers the ground and also what appears to be a rather peculiarly shaped mass of low rocks nearby. The lichens are the sole visible form of life. There is nothing moving. The men contemplate this desolate scene long and sadly, then say to themselves, "Many forms of life may have passed this way ages ago but now they are gone. Nothing remains but this lowly plant life. It is the last survivor."

Yet there may be life in abundance all around them, but invisible, slumbering beneath their very feet, subtly concealed under stones, in tiny crevices and burrows. Or perhaps even in plain view studying these visitors intently at only a short distance, but blending so perfectly with the soil as to be wholly overlooked by the eyes of inexperienced Earth-men.

How would these Martian creatures look? Would they be large or small, fierce or meek, intelligent or stupid? It is impossible to say. They might look like anything between a grasshopper and a yak—and be just as intelligent!

The Question of the Canals

Probably there is no subject in astronomy that has done so much to stimulate controversy and name-calling among members of the profession as the question of the canals. Despite all this tumult and shouting, we know little more about the canals today than we did shortly after their discovery seventy years ago.

I was wondering how to say something new on a subject about which everything has been said already, when by great good fortune a report on the canals came along by Dr. Edison Pettit of the Mount Wilson Observatory to the Astronomical Society of the Pacific. Dr. Pettit not only has something brand new to say about the canals, but also some definite recommendations for photographing these illusive objects when Mars makes its next close approach in 1954.

Since readers interested in science are doubtless already generally familiar with the canal question, only the briefest outline will be given here.

In September, 1877, Mars came within 35,000,000 miles of the earth, the closest approach since 1845. The noted Italian observer, Giovanni Schiaparelli, while engaged in mapping the planet's surface, discovered that many points were connected by fine straight lines having a remarkably artificial appearance. He called them *canali*, which was simply his shorthand way of referring to them while working at the telescope. When his publications were translated into English, this reference to canals caused readers to assume that Mars was covered with artificial waterways. The news was received by the public with great enthusiasm, but got a cold reception from the astronomers. The criticism which Schiaparelli had heaped upon him disturbed him not at all. He went right ahead observing canals and two years later added more fuel to the fire by announcing that one of his canals had become *double*; that is, where there had been only one canal before there were now two running side by side for hundreds of miles like a railroad track. By 1882 he had detected numerous cases of doubling among the canals, which seemed to be one of their most characteristic features.

W. H. Pickering, in 1892, discovered still another type of marking which he called an *oasis*—a small round dark spot found only at the junction of several canals.

Investigation of the canals was undertaken with great vigor about 1892 by Percival Lowell. As the result of his observations, he became convinced that the canals are what their name implies, channels constructed by highly intelligent beings for the purpose of conducting the water from the melting snow cap down over the arid ground. He developed this hypothesis and expounded it with no little literary skill in two semi-popular books about Mars. (Lowell was the brother of Amy Lowell, the poet, who originated an unusual type of free verse.) Lowell's ideas were generally rejected by astronomers, who considered them much too far-fetched to be taken seriously.

The principal trouble is that most astronomers are unable to see any fine lines on Mars like those described by Schiaparelli, Lowell, and others. They are quite willing to admit that there is a lot of detail visible upon the disk but nothing canal-like. Some have gone so far as to claim that the canals are purely subjective, the eye integrating minute dots and streaks into continuous lines. The Canal Men assert that once anyone has seen the canals they would never make such a statement. The No-Canal Men reply that apparently a special kind of "eye" is the chief prerequisite for seeing the canals; an

* Major R. W. G. Hingston, "Animal Life at High Altitudes," from the Geographical Journal, Vol. LXV, No. 3, March, 1925.

eye which, they hint darkly, is curiously detective in its optical properties.

Right here is where Dr. Pettit's experience is of timely interest.

Pettit says that he had examined Mars when it was close in 1907 and 1909, and made some casual observations in 1924 and 1926, without seeing any canals. He came to the conclusion, as so many had done before him, that the canals were either wholly illusory, or that a special kind of eyes was necessary to see them, and that his were of the great majority to which the canals are invisible.

In the summer of 1939, when Mars was close, he began some observations of the planet in his backyard observatory in Pasadena, with a telescope containing an excellent six-inch lens made by Alvan Clarke & Sons. His program was begun largely as a matter of self-education, to see if he could verify the well-known change in tint of the markings with progress of the Martian seasons. He had no thought of seeing the canals, which he naturally supposed were far beyond the range of so small an instrument.

Early on the morning of July 6, 1939, he was working at the six-inch, trying to discern the character of a large oval marking on the disk. He had made an outline sketch under fair seeing conditions, but by the time it was finished the seeing had improved so much that he felt dissatisfied with it. Then while concentrating upon the boundary between a dark and light area it happened—a canal flashed out, followed almost immediately by another one! In the next few hours two more canals were seen, sometimes the four being visible simultaneously. Toward morning a southern California fog came in, abruptly putting a stop to observations of Mars and its canal system.

On the following nights, although the definition was not so good as formerly, he was able to see the canals originally observed, in addition to several others. He decided not to consult the maps of Mars so that his drawings would be more valuable as constituting independent observations free from bias. During 1939 he completed a map of the planet using both the six-inch and a twenty-inch reflector on Mount Wilson. A total of forty canals was recorded, only that known as Thoth being probably double.

After seven years, Dr. Pettit has just completed comparison of his drawings with those of earlier observers and written a summary of the results obtained. The new feature about his work is that to him the canals look *colored*—a distinct olive green. It was W. H. Pickering who first suggested that the fine lines we see are not the actual waterways themselves but only the vegetation growing along their borders. It is rather surprising that neither Pickering, Lowell, nor Schiaparelli, ever saw the canals as anything but black or occasionally gray. On the other hand, Pettit was never able to see canals in the gray-green areas which were visible to others, presumably because they failed to appear in sufficient contrast.

Pettit is convinced that no special type of eye is required to see the canals, that anyone with good vision can see them when the atmospheric conditions are exactly right. He also feels that little of importance is likely to be learned by continuation of present methods of observation. Each observer merely repeats the work of those before him. Rather our efforts should be concentrated upon securing the best photographs obtainable during the 75 days when Mars is closest every 15 and 17 years, as will next occur in 1954 and 1956.

Now in this entire 75-day interval there may be only a single "period of opportunity" when the canals are revealed with all their startlingly sharp line-like characteristics. How can this rare moment of visibility be used to greatest advantage?

It would be virtually impossible to try to tie up a large telescope for so many days on the project. Assigning a few nights would be practically useless, as there is little chance that they would happen to coincide with a period of opportunity. Orders might be issued that should the seeing suddenly begin to improve during the night, the astronomer in charge of the telescope shall stop his program, turn the telescope on Mars, and start shooting with a camera previously installed for that special purpose. Trouble here is that the astronomer in charge (who probably is not in sympathy with the program in the first place) will fail to see any canals and return to his own work. Or after several false alarms he will conclude that the telescope cannot show canals and refuse to be bothered any more.

Pettit believes the best method would be to keep Mars under continuous observation during the 75 days with a small pilot telescope mounted near the grounds of the large reflector. On Mount Wilson the 20-inch reflector is available, and on Palomar Mountain one of the 50-inch mirrors of the interferometer could be installed for observations near the 200-inch. If the seeing begins to improve so that a period of opportunity seems imminent, the astronomer at the big reflector should be notified by an electrical signal, as positively no time must be lost if the precious moments of perfect definition are to be utilized.

Large-scale images that show sharply defined canals would surely do much to clarify a muddled situation that by 1954 will have dragged on for three-quarters of a century. It is true that several astronomers state that they have already secured photographs that show canals. I have seen only the printed enlargements of these negatives and have no doubt that much detail has been lost in the process of reproduction. But the vague streaks upon them bear little resemblance to the descriptions of the canals I have read. (I have never been able to see canals through a telescope.) The need is for images that show canals so perfectly that they can be put upon a machine and measured with respect to reference points upon the disk. Then if such measures show that the canals invariably follow the arcs of great circles which are the shortest distance between points on a sphere, it would be hard to maintain the position that the canals are natural rather than artificial in origin.

The thought of really establishing such a fact makes one's head whirl—proving the existence of life on another world by visible evidence of its intelligent activity! From this point of view, as Lowell said, the canals are the most profoundly impressive sight in the whole heavens.

Fine lines and little gossamer filaments only, cobwebbing the face of the Martian disk, but threads to draw one's mind after them across the millions of miles of intervening void.

VENUS—World of Illusion

Thirty years ago writers who were bold enough (or foolish enough) to attempt the description of life on the planets, usually pictured Venus somewhat as the Earth must have looked back in the early Paleozoic: a warm watery globe enveloped in a thick blanket of steaming clouds, inhabited by trilobite and sea snail. This conception of our sister planet was a natural consequence of the fact that Venus is 26,000,000 miles nearer the sun than the earth, and that it always appears covered by a uniform layer of white clouds. Beginning about 1926, new knowledge of Venus forced astronomers to do a complete about face with regard to conditions on that planet, as we shall see.

Going to Mars meant doing work against the force of the Sun's attraction, as if we were climbing up the side of a long sloping hill. In order to move outward from the Sun it was necessary to make the rocket go faster than the Earth in its orbit. When going to Venus the situation is exactly reversed, as if we were rolling down the side of a hill. In order to fall toward the Sun the rocket must move more slowly than the Earth in its orbit. Although it might seem easier to lose velocity than to gain it, as a matter of fact, one is about as hard as the other.

In order to reach Venus by the classical route the rocket needs an initial velocity of 16.96 miles per second. Therefore, we will launch the rocket in the direction opposite to that of the earth in its orbit. The site would be the equator as before but this time the zero hour would be—not midnight—but twelve o'clock true noon. The direction of rotation is then toward the west, allowing us to gain 0.30 miles per second, so that the initial velocity is reduced to a minimum of 18.50—16.96—0.30=1.24 miles per second. The rocket would follow the arc of a moderately elongated ellipse, as shown in Fig. III, reaching Venus in 146 days.

The same point on the orbit of Venus could be attained by hyperbola in 56 days. In fact, we could reach Venus in 12 days if necessary, since, as shown in the diagram the rocket first crosses the planet's orbit at V_1. But as it would be cheating on the ellipse to use this short cut we will pretend that Venus is not in the vicinity when the rocket first crosses her path.

The hyperbola takes the rocket within 37,000,000 miles of the sun at closest approach or slightly inside the orbit of Mercury. This means that the travelers would probably be nicely tenderized before reaching Venus, a result of the fact that my hyperbolic routes were selected from a mathematical rather than a utilitarian point of view. I imagine that future lawmakers will compel navigators to keep outside a central solar torrid zone. The theoretical temperature of a black meteorite in the vicinity of Mercury is 670° F, which is above the melting point of tin and lead. The walls of the spaceship could be maintained considerably below this temperature by having the outer surface highly polished so that it sheds heat instead of absorbing it, and by rotating the rocket so that different sides are exposed to the sun. The problem of temperature control does not appear particularly serious so long as the ship keeps at a reasonable distance from the sun. In the future, one may be able to tell at a glance if a ship plies the interior or exterior trade routes, depending upon whether it has a reflecting or absorbing surface.

The Transformation of Venus

In June, 1927, Dr. Frank E. Ross began a program of observations on Venus with the 60- and 100-inch telescopes on Mount Wilson that constituted the first step in the transformation of that planet from wet to dry. This happened to be my first month at the Mount Wilson Observatory and I was very much the eager beaver, anxious to see everything that was going on around me. Dr. Ross began work at the 60-inch about half an hour before sunset by making a thorough visual examination of the disk under a magnification of 240, using various filters. After dinner I usually found an excuse to drop into the dome and watch operations. If not pressed for time, Dr. Ross would allow me to climb up on the ladder beside him for a peek through the eyepiece. Invariably I saw only a beautiful smooth white crescent that resembled the moon after being thoroughly scoured with silver polish, with not the faintest trace of markings.

Following the visual examination and still before sunset, Ross inserted a special camera into the focal plane of the telescope and took a series of exposures on emulsions sensitive to infra-red, red, blue, and blue-violet light. Now one could naturally suppose that infra-red light would be most likely to show surface markings, owing to the great penetrating power of rays of long wave-length. Thus photographs of Mars taken in short wave-length violet light show nothing but a blank disk, whereas infra-red exposures reveal the surface markings in strong contrast. For Venus, however, just the opposite is true. Ross found that the ultra-violet photographs always showed surface markings, the blue-violet showed them faintly, and the infra-red not at all.

Photographs in the ultra-violet could not be started until about ten minutes after sunset without danger of fogging the plates. As soon as conditions permitted, exposures were taken in rapid succession as long as Venus was far enough above the horizon so that unsteadiness of the atmosphere did not blur the delicate markings. The total time available was seldom more than an hour.

Why Venus shows markings in ultra-violet light and not in the red is certainly puzzling. The explanation which Ross advanced in 1928 was regarded only as a working hypothesis, although it has since acquired some support from spectroscopic observations.

The surface layer of Venus is assumed to consist of dry reddish soil. Strong winds blow perpetually, filling the air with dense clouds of fine brown dust. The white disk seen in the telescope is an outer shell of light cirrus clouds overlying the dust clouds below. Occasionally the surface layer is torn aside partially exposing the dusty atmosphere beneath. Exceptionally violent storms may be dimly apparent by direct visual observations. But ordinarily they are revealed only by photographs taken in ultra-violet light, owing to the high contrast between the image of Venus formed by these rays and the dark under-exposed dust layers.

After writing this paragraph it occurred to me that perhaps it would be a good idea to ask Dr. Ross if he still believed in his explanation of twenty years ago. He thought awhile and then had to confess that he could not remember what it was! So I had to give him an account of his own theory, to which he listened with much interest. He said it still sounded pretty good and saw no reason for changing his earlier remarks on the subject.

Ross's photographs give no clue to the chemical constitution of the Venusian atmosphere. First information on

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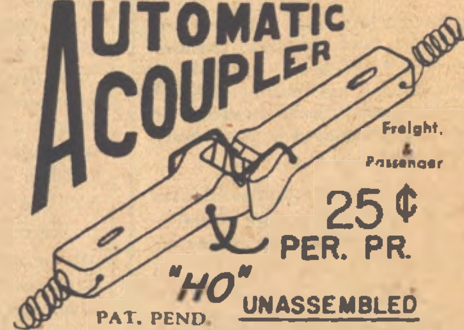

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City ________ Zone ________ State ________ this point came in 1932 as the outcome of large-scale spectrograms taken by Adams and Dunham with the 100-inch. The plates failed to disclose the spectrum lines of oxygen or water vapor, but did show two strong absorption bands in the near infra-red. At first the origin of these bands was a mystery as they could not be identified with those of any molecule already studied in the laboratory. But from the distance between the band lines it was possible to calculate the moment of inertia of the unknown molecule that produced them. The value so obtained agreed so closely with the moment of inertia of the CO_2 molecule that identification seemed highly probable. Any lingering doubts were settled by sending a beam of light through a long pipe filled with carbon dioxide gas and photographing its spectrum. Sure enough, the plates revealed a faint line at the same place as the strongest lines in the spectrum of Venus.

Later work on the spectrum of Venus by Adel at the Lowell Observatory and Dunham at Mount Wilson showed that there is a tremendous amount of carbon dioxide gas in the planet's atmosphere, as much as a hundred times the amount in the atmosphere of the earth. Persistent search still failed to reveal any trace of absorption lines due to oxygen or water vapor. The absence of water vapor is especially puzzling, for it is hard to see why a planet so nearly the same size and mass as the earth should not have about the same amount of water on its surface. Although the bulk of the water vapor would be in the lower part of the atmosphere, the spectroscopic test is very delicate. The conclusion seems inescapable that Venus is bone dry!

An atmosphere containing so much carbon dioxide would exert a powerful "greenhouse effect," allowing the short rays of sunlight to pass through to the ground and warm the surface, and then holding imprisoned the long heat rays. Wildt estimates the temperature on Venus may be as high as the boiling point of water at sea level of 212° F. Since Venus probably rotates rather slowly—from all the evidence available Ross deduced a "compromise" period of 30 days—violent winds undoubtedly blow between the dark and illuminated hemispheres. The terrific heat, the absence of oxygen and water, and the abundance of carbon dioxide, make it hard to see how life of any kind could exist on the planet.

Since no one has ever had a glimpse of the actual hard surface of Venus it is impossible to say what kind of landscape would confront us there. We shall, therefore, have to design a Venusian landscape as best we can from what little evidence is at our disposal. So far as it goes, the probability is that the surface of Venus is about as irregular as that of the Earth. Several experienced observers have reported bright spots on the disk often flanked by deep shadows. These visual observations have been confirmed by Ross's photographs so that their presence seems well established. According to Clayden, the most reasonable explanation is that they are due to the flow of air over the uneven ground below. The bright spots are produced by clouds thrown to great elevations, and the dark regions are caused by the destruction of clouds by descending currents.

Our party has landed near the evening terminator of Venus. Soon after leaving the ship they were compelled to take refuge from the wind by crouching behind a low outcropping of rock. From this position they watch the Sun as it creeps toward the horizon. The Sun is a great glowing copper colored disk with two black spots at its center.

Silhouetted against the sunset a mountain peak rises abruptly from the billowing sand dunes, towering so high that its summit is lost amid the dark clouds swirling all around it. Suddenly the light begins to fail. A thick curtain of dust is advancing rapidly upon the Sun, one fold standing out in sharp contrast against a background of white cirrus that momentarily appears through a rent in the brown sky.

The explorers flatten themselves closer to the bare rock as the wind blows with increasing violence. But the rock, worn to a glistening smoothness by the ceaseless impact of the fine sand, affords little protection. As darkness falls, the earthmen fail to notice that their spaceship already is half buried under the drifting sand.

So much for conditions on Venus. For centuries man has looked upon this bright star as a symbol of hope and love. Now modern science rudely destroys that illusion. Under that beautiful silvery surface lies only barren sterile soil. In a stifling atmosphere choked with red dust the only moving thing would be the wind sweeping endlessly over the dry ground.

JUPITER—An Inferno in Ice

After Venus and Mars distances lengthen enormously. If we ever expect to visit the giant worlds beyond Mars then we *must* go by hyperbola, there is no other alternative. To reach Jupiter by classical ellipse would take 997 days. The hyperbolic route shown in Fig. IV reduces the time to 311 days, not much longer than the time usually quoted for the trip to Mars. Despite the formidable hardships involved in such a voyage it would be well worth the effort, for the *natural* state of matter on Jupiter far exceeds the most extreme conditions we can create in the laboratory.

Jupiter could hardly be studied at firsthand, for it is difficult to see how a man could survive there for only a few moments no matter how carefully prepared in advance. The Jovian atmosphere could, however, be studied to good advantage from one of the five inner satellites, two of which would make fairly respectable planets. Thus Ganymede (J III) is about the same size as Mercury, twice as massive as our moon, and revolves around Jupiter 577,000 miles from the surface. If necessary, special observations could be made on little J V, which is within only 68,000 miles of the surface. J V is estimated to be 160 miles in diameter, and since it is known to undergo rapid changes in brightness, is probably rough and highly irregular in shape.

Jupiter used to be regarded as a sort of miniature solar system. According to Young's *Lessons in Astronomy*, edition of 1918, which was a standard text in those days, ". . . many things in the planet's appearance indicate a *high temperature*. . . . In short, it appears very probable that the planet is a sort of *semi-sun*—hot, though not so hot as to be self-luminous." The italics are Young's.

Measures made with the thermocouple have since shown that the outer layers of Jupiter's atmosphere—far from being red hot—are at a temperature of around —210° F. Beneath the surface the pressure must rise rapidly until at a depth of only a few miles it becomes enormous, judged by terrestrial standards. It is interesting to note that the researches of Dr. P. W. Bridgeman, who was awarded the Nobel prize in 1946 for his work on high pressures, have been of great value and guidance in the study of Jupiter's atmosphere.

Numerous dark absorption bands and lines have been observed in the spectrum of Jupiter and the other giant planets for nearly three-quarters of a century. They have been exceptionally hard to identify, although there has been no lack of candidates brought forward. Someone noticed that chlorophyll has a strong band that coincides with a prominent planetary line. In 1928 some physicists in England passed a beam of light through a long column of water and found three dark bands that they identified with those in the planets. Finally, in 1932, Rupert Wildt proved beyond question that the planetary absorption was due entirely to methane or marsh gas and ammonia.

These are precisely the gases which we would expect to find on a planet such as Jupiter, with a cold atmosphere and high surface gravity (2.5 g). Such a massive planet would be able to retain light gases like hydrogen and helium which would speedily escape from worlds such as the Earth or Mars. As Jupiter cooled in the course of its evolution, the hydrogen would combine with other abundant gases to form familiar compounds such as water (H_2O), ammonia (NH_3), and methane (CH_4). Eventually the water would freeze to ice and sink deep beneath the clouds. The ammonia, in the form of minute crystals, would constitute most of the atmosphere together with the methane. The colors of the changing cloud belts may be due to metallic sodium, which in solution with ammonia produces brightly colored compounds.

According to the English geophysicist, Harold Jeffreys, who is one of the best in the business, the only heat which now warms Jupiter is that of the Sun. After considering every reasonable assumption about the amount of heat originally stored in the planet, he concludes that it has cooled down to the temperature maintained by the Sun alone. Other scientists are reluctant to accept Jeffrey's dictum. The astronomers, in particular, find that the rapid changes which they see in the cloud belts are hard to reconcile with a planet frozen solid clear through to its middle. Schoenberg, from a detailed analysis of the best observations of these motions, is convinced that the only possible explanation admissible is violent and widespread volcanic action.

The structure of the atmosphere has been explored theoretically by making various assumptions as to the way pressure, temperature, and density change with increasing depth. No matter what laws are assumed to hold good, the density rises so rapidly with increasing depth that at about 15 miles down the "atmosphere" would be unrecognizable to a meteorologist as it would have more the characteristics of a terrestrial ocean. At slightly greater depths the pressure would solidify hydrogen and helium into metallic-like substances.

It was easy to visualize the surface of Mars and not too much of an effort to dream up a landscape for Venus. But in trying to picture conditions a few miles below the cloud belts of Jupiter we are delving into transcendental regions beyond our range of experience entirely. It is like extrapolating from a single point. Therefore, we shall have to "cheat a little," as they say in motion picture studios when putting something over on the camera.

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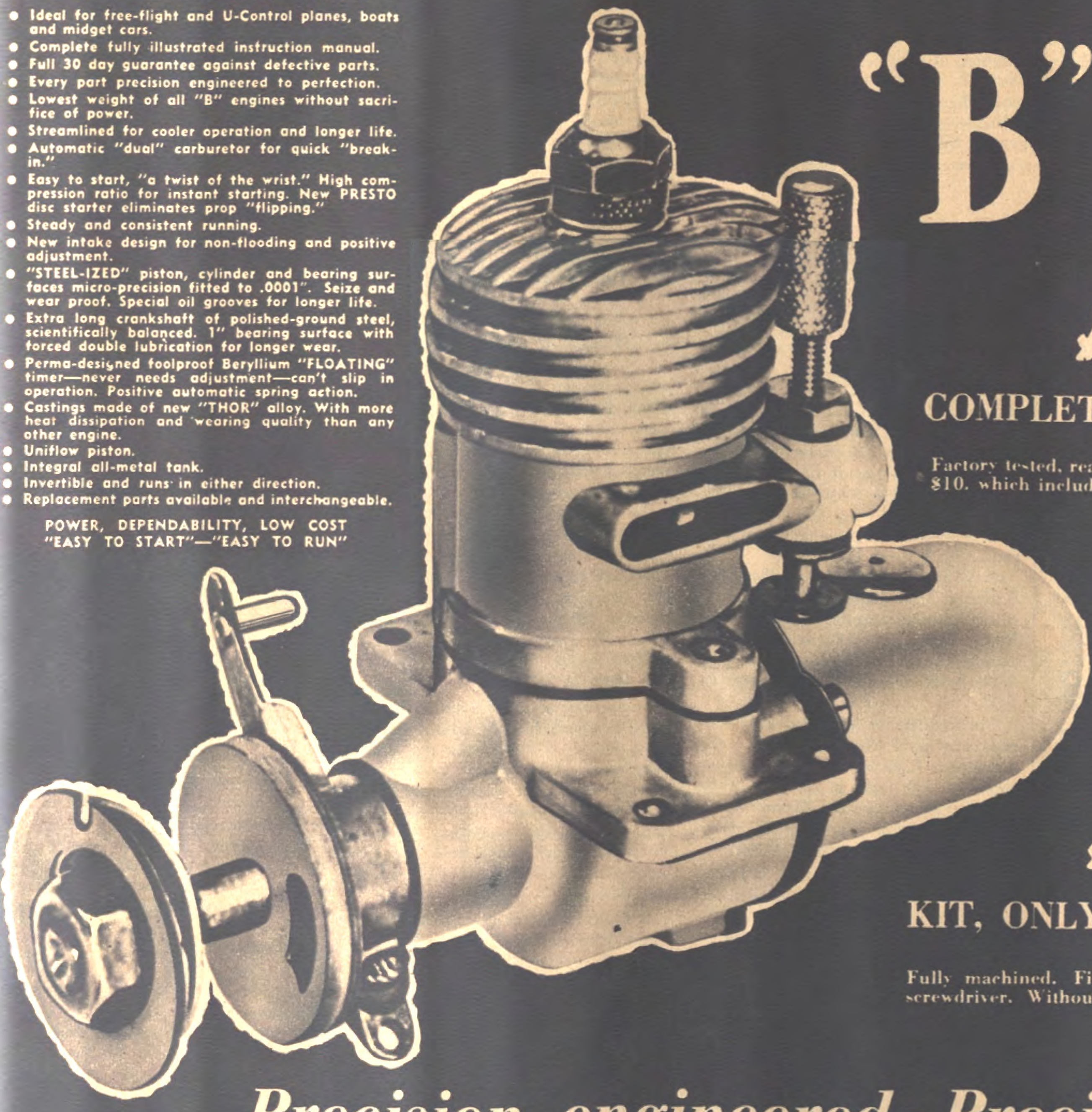

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Readers will not embarrass us by wanting to know just how the spaceship reached the point described, or how the travelers managed to tell their story afterward.

A party of geophysicists and meteorologists had been dispatched to investigate a disturbed area about 1,000 miles west of the following surface of the great red spot. But in their eagerness to secure scientific data, they ventured too far beneath the clouds and crashed into a high volcanic peak not marked on their charts. The spaceship was so badly damaged that the men barely had time to get into their space suits before the walls split wide open. Now they are groping their way around the wreckage through the dense, poisonous atmosphere, for they are in total darkness. The high surface gravity is like a magnet persistently dragging at their feet. As in a nightmare, the slightest exertion requires a tremendous effort of the will.

Suddenly they are hurled to the ground by the impact of a volcanic explosion. Immense sheets of flaming hydrogen gas together with steam and lava pour through a vent in the surface, temporarily dispelling the murky vapor and illuminating the scene with a vivid crimson glare. The explorers perceive that the spaceship rests precariously upon a narrow shelf projecting from the side of a cliff. Peering cautiously over the edge they see a sheer glistening wall of ice that drops a thousand feet below into an ocean of liquid ammonia. Giant waves race over its surface raised by the steadily increasing shocks of the eruption. The travelers grow dizzy and faint at the sight.

With a dull, muffled, rumbling sound the whole side of the cliff begins to rise slowly upward. The earthmen flatten themselves upon the ledge and clutch frantically at the ground, but the surface is as hard and smooth as glass. As they slide toward the edge the flames die away leaving them in darkness again.

The scene reminds us of one that Dore might have painted to illustrate the horrors of Dante's *Inferno*.

In our solar system of nine planets the only one upon which life seems possible besides the Earth is Mars, and the prospects there are not particularly bright. Doubtless other stars have planets revolving around them but they are hopelessly beyond the range of direct observation with the most powerful telescopes. Recently, a so-called interstellar planet was detected in the nearby system of 61 Cygni, by means of slight irregularities in the motion of the two known components. But although this object falls within the definition of the word "planet," it certainly would not look like any planet that we would recognize.

Yet even if one hundredth of one percent of the stars in the galaxy have planetary systems similar to that of the Sun, then, at a conservative estimate, the total number of inhabitable planets must be somewhere in the neighborhood of a million.

And since there are about 75,000,000 galaxies within photographic range of the 100-inch telescope. . . .

Well, you figure it out for yourself!

Ten Years of Jet Propulsion

(Continued from page 45)

Marathon is a feeder aircraft with a cruising speed of 230 mph and a range of 750 miles. It can carry 14 passengers and half a ton of luggage. The cargo version has a two-ton payload. Featuring a high wing, the cabin floor level is so low that passengers can step right into it from the ground.

A. V. Roe has brought out the Avro Brabazon 3 (a Tudor II replacement), which is to be powered by four Rolls-Royce Nene turbojet engines. Two prototypes are in construction, with flight tests scheduled some time in 1948.

Airspeed has an Ambassador II version carrying 4 Napier prop-jets, each developing 1,500 hp. With a cruising speed of 300 mph at 50 percent of power, it can carry 20 to 40 passengers, according to range requirements. Prototype order is practically certain.

The Armstrong Whitworth 55 (Brabazon 2B) is a 36,000-lb. low wing, 24-31 passenger transport powered by four Mamba engines. Cruising speed is 320 mph at 80 percent of power, with a top speed of 360 mph and a 1,000 mile range. This type of plane is vying with the Vickers Viceroy for the European air routes.

Bristol's Brabazon I is a huge 285,-000-lb. aircraft, Britain's largest landplane, with the first model scheduled to carry piston engines and the later ones prop-jets. An eight-engined craft, it is destined for transatlantic service, carrying 72 night passengers and up to 200 during the day, with about 80 for overseas service. Five are ordered and flight is scheduled in 1948/49. Speed 350 mph at 35,000 feet.

The de Havilland 106 (Brabazon 4) is a swept-back wing, tailless design mounting four unspecified jet engines. Estimated speed 550 mph at 40,000 feet, with range sufficient for Atlantic service carrying 40 passengers. Prototype order in and flight scheduled for 1949.

The Handley Page Hermes is a low-wing, long-range transport for 52 passengers, powered by four Bristol Theseus prop-jets. Cruising speed estimated at 297 mph at 72 percent of power and a maximum of 360 mph with a range of 2,000 miles. Order for five expected, with flight in 1949.

Britain's largest plane of any type is the Saunders Roe/45, a 290,000-lb. giant high-wing flying boat with retractable wing tips and a double deck. There are 12 unspecified engines, probably prop-jets. Cruising speed estimated at 300 mph for a range of 5,000 miles. Passenger capacity 100 by night on two decks. Three boats ordered with flight in 1949/50.

Besides this array of commercial aircraft, England, like the United States, has a number of flying wing and supersonic exploratory aircraft to test new jet engines, rocket engines, and various unconventional aircraft construction and engine mounting designs. These craft are being used also for aerodynamic research at high speeds and altitudes.

It is very obvious that the turbo-jet engine has established itself. To what extent these types of engines will dominate commercial air transport in the next decade is hard to predict, because already simpler types, such as the ramjet, show great promise. Considering that the ramjet has no moving parts whatsoever, the merest possibility that such an engine will work on passenger aircraft will be eagerly grasped by engineers and operators alike. Maintenance with ramjets would be at a minimum, and profits soar. Safety would doubtless be enhanced, and the higher speeds would insure more frequent schedules and eventually result in greatly expanded air travel.

It is exactly because the turbo jet engine has come out of relative obscurity to actual safe operation within the past decade, that predictions for the near future must be made cautiously.

It has already been revealed that under the leadership of the Fairchild Engine and Airplane Company, about ten of the foremost aircraft engine companies in the United States are co-operating in active research on nuclear energy for the propulsion of aircraft at Oak Ridge, Tennessee. In theory it is already known that such engines are possible. In practice, a number of difficult problems must first be solved. Let but a few of the major headaches be cured, however, and an atomic engine will be forthcoming that will make present-day jet powerplants look like children's toys. A successful atomic engine would probably have rocket engine characteristics, that is, would not depend upon the atmosphere for part of its fuel combustion cycle and therefore have unlimited altitude. Speed, too, would be limited only by the design of the aircraft itself, and if it can be held to low values in the atmosphere, even current transports could travel at supersonic speeds above the stratosphere, because there would be no air to deter their progress.

The next ten years will be an exciting period for aviation. Proportionally, as much development may be expected as was accomplished during war years, because of the impetus given to the imagination of designers and engineers. The proven fruitful results of research on every type of jet propulsion powerplant is sufficient to insure that these same types will be vastly improved. There is also the tantalizing expectation that new developments are at all times around the corner.

With atomic power for supersonic speed at extreme altitudes and long ranges, passenger comfortization will follow automatically. Flight by the end of the next decade will probably be more comfortable than in any transportation vehicle known today. Neither ocean-going liners, luxurious trains, busses nor motor cars are able to give a passenger true rest and comfort. There is always some measure of vibration, motion, or noise. But jet-engined airplanes with pressurized and air-conditioned cabins can already give passengers smooth, silent, and restful flight. Before 1957, air travelers may expect completely passengerized flight, transportation geared to the demands and needs of men and women who want to be moved over great distances with a minimum of emotional and physiological disturbance.

Can Spiral Dives Be Cured?

(*Continued from page 64*)

Theory or fact, it appears that C.L.A. is a familiar term on both sides of the Atlantic. In a recent issue of Model Aircraft, the journal of the S.M.A.E. (England), there appeared a most revealing article by R. H. Warring, one of Britain's widely known authorities. In that article, Warring reveals how he and Bob Copland (generally regarded as England's top Wakefield man and, we believe, an engineer at Hawker) had, by unbiased study of C.L.A. and C.G. relationship, solved a perplexing mystery of why their latest Wakefield ships tended to spiral dive under initial high power. These men came up with the startling conclusion that more vertical tail surface in the shape of auxiliary rudders was the solution (note that we didn't say rudder). This was not theory, but was proved in tests.

Working independently of each other, Warring and Copland both developed shoulder-wing "slab-siders," or "boxes," as we call them. Copland's ship proved to be a persistent spiral diver. Warring had noticed all through the development series of his design that a slight tendency to spiral dive was present. This tendency had become more pronounced with each successive airplane. Finally, when Warring streamlined his fuselage, he was in real trouble. At this point, Warring and Copland, putting their heads together, decided that the bad tendencies of their shoulder-wing models, were due to the lowering of the center of gravity, resulting from the lowering of the wing position. "For good stability," says Warring, "a model requires: (1) A relatively high center of gravity and (2) a relatively low placement of aft side areas." (That word aft is thought-provoking!) It should be noted that Warring already had used the minimum rudder area possible and, in fact, had cut down so far that the ship had displayed the usual symptoms of inadequate rudder area by swinging its tail from side to side.

According to Warring and Copland, the C.G. should be above the center line of the fuselage and the C.L.A. should be behind and on a line approximately horizontal with the C.G. We are not going to argue for the English boys' solution of auxiliary rudders, for we have no firsthand experience with these surfaces used in the English manner. Warring and Copland added small auxiliary rudders, not with the usual intent of increasing rudder area, but as a means of controlling spiral dives. They refer to these surfaces as "anti-spin" fins. Warring states, "I have fitted these anti-spin fins to several models with poor spiral stability and results in all cases have been excellent. So convincing have been these demonstrations, that I have incorporated them as a feature on new designs."

Warring sheds further light on the question that merits serious consideration. On a single-rudder job, the same effect can be had by using a generous subrudder and cutting down the section of the rudder above the fuselage. This is common practice in our country. Warring notes that the single rudder and subrudder combination will not work on all ships, because of the tendency of the airflow to break away from the fuselage back of the wing, in such a manner that effective flow over the rudder is reduced. The auxiliary rudders used by Warring and Copland, being located out from the fuselage, retain a satisfactory flow of air. An interesting side-light to the auxiliary fin idea is that, according to Warring, the total rudder area becomes less critical. A rudder can definitely be too large without any ill effects (we suppose within reason). Since rudder area is, as Carl pointed out in May, determined exactly only by test flying, this feature, if true, will prove valuable both to save models during tests when mistakes are easily made and to cut down the number of test flights. This alone is more important than the tyro may realize, because some builders take weeks in adjusting new high-powered free-flighters.

Warring summarizes by saying that anti-spin fins are an almost certain cure for spiral instability (except for warps); to keep the C.G. high, especially on a model that makes steep climbing turns; and that on a gas model it might even pay to locate coil and batteries high up in the fuselage or in the pylon. The blame that Britishers put on low-thrust lines as the cause of spiral instability, Warring shifts to the low position of the C.G. and says that, in such cases, anti-spin fins are a necessity. How effective Warring's anti-spin fins would prove on a very high-performance gassie is not known, but that anti-spin fins do have a beneficial effect on spiral instability seems obvious.

When you think about this idea, you can see tie-ins with some of our own troubles. For example, the writer was struck with the extreme sensitivity of rudder area on Goldberg's pylon models, and the wide range of possible rudder areas on his own designs. Carl measures rudder area in one-half percent of wing areas, while the writer only once has had to make a correction in rudder areas selected by rule-of-thumb practice. That exception was Wog, a fairly well streamlined model, and rudder area on that ship did prove delicately effective. It was reduced to lessen the effect of rudder adjustment and not because of any spiral diving tendencies. With their high locations of heavy objects, such as coils and batteries, the writer's jobs, by coincidence, exhibit a tolerance of rudder area claimed by Warring. It seems to follow that lowering the C.L.A. while raising the center of gravity does at least have an effect on the rudder, if not on the spiral dive itself.

We can recall one famous ship that was a steady trophy winner for its expert builder but which was dangerous in the hands of the average guy. This was a crutch design with most of the profile area well above the crutch and the coil and batteries in the rounded bottom of the fuselage under the crutch. With sound adjustments—living on the edge of the cliff as Carl puts it—this ship was a great competitor. The point is: would elevating the center of gravity convert this ship into a safe flyer for all? It certainly would be small trouble to find out. Or leaving things the way they are, how would such a ship respond to Warring's anti-spin fins, possibly combined with a change in the C.G. in a vertical sense.

It seems generally agreed that excess rudder area is a contributing cause of spiral dives. Conversely, it would seem that, by reducing rudder area, the spiral diving tendency should disappear, regardless of type of model. However, when, as Warring did, you reduce that rudder area to the minimum required for directional control and the spiral dive remains, then other factors besides rudder are involved.

In Carl's first article he recorded Frank Zaic's cute remark that if one doesn't have the fortitude to whittle down his own rudder area he should let his friends do it. Apparently, Frank now believes that it takes more than a scissors or razor blade to cure spiral instability. When C.S. Rushbrooke, editor of the *Aeromodeller*, was staying in America we had the opportunity of many hours' discussion with him on theory, practice, etc. It seems "Rushy" has been doing some hard thinking on this spiral dive problem and has come up with an entirely new notion from the modeler's point of view. Rushbrooke has questioned Roy Chadwick, chief designer for Avro, about the susceptibility of models to spiral dives, and Chadwick spoke of "circular flow" as the culprit. Frank, Rushbrooke discovered, held the same point of view, and passed on Frank's reasoning to us. The way Rushbrooke explained it, a ship that circles tightly in a near-vertical bank, presents its wing to a relative flow of air that strikes slightly from above, instead of dead ahead. Thus a steep bank means that the wing is operating in a condition of less lift, more severe than what one would ordinarily think. The obvious conclusion is to use a greater angle of attack. The implication seems to be that the wing and tail should be positioned tangent to the circle described in the average steep power turn. We may have bobbled this one a bit, but we think it is well enough suggested to make possible further discussion. We do wonder, though, if Frank's chop-down-the-rudder golden rule was one of Carl's exhibits, what happens to Carl's case that rudder alone causes spiral instability. Frank apparently now knows the problem is not that simple.

Henry Cole, who goes in heavily for the aerodynamic approach and backs his play by winning contests, mysteriously remarks from time to time that he hopes to blast the C.L.A. "theory." Now we have had the pleasure of reading one of Henry's yet unpublished articles which discusses the effect on stability of the fore-and-aft location of the C.G. in relation to the aerodynamic center of the airplane. Finding this center is a laborious process for you and for me, but Cole has worked out some graphs that present the information in simple form. Up to a point, Henry contends that moving the center of gravity ahead of the aerodynamic center increases longitudinal stability in that the ship has a greater tendency to restore position after being displaced, and that moving the C.G. rearward of the aerodynamic center causes instability. Here he makes a remark that suggests he is thinking of more than longitudinal stability. "It is possible," says Cole, "to fly the model successfully with the C.G. back further than shown, but these models are not consistent, usually one super flight, then a spectacular one, after which the spectators dash in for souvenirs." The reason the remark interests us is that souvenirs almost always are found at the end of spiral dive crashes. If you rule out the C.L.A. concept, as Henry hints he plans to, that would seem to leave rudder alone, or a relationship between dihedral and rudder, or, like Zaic, a high angle of attack, unless he has a new thought of his own. (Cole writes that, in his opinion cutting down either rudder area or lateral area distribution in relation to C.G., is not the answer to spiral dives. He thinks aft-position of C.G. in combination with slipstream causes many spiral dives. Spiral stability, according to Cole, is a complex matter involving other factors, such as rate-of-roll, etc.)

In this connection it is interesting to know that Cole's asymmetrical pusher (Air Trails '47) was designed according to his C.G. location ideas. We first heard of the plane from Don Foote who recommended publishing it. Henry made hundreds of flights with this model and then added dope which shifted rearward the C.G. position. To compensate, increased tail incidence was used. The following flight was disastrous. Cole describes it as a spectacular display of aerobatics followed by a vertical dive from three hundred feet. This sounds like more than a stall to us.

With an ever-growing multiplicity of reasons for spiral dives, it seems high time that some practical fact-finding experiments were performed. Since we design to avoid spiral dives why not, this once, go to the opposite extreme and build a ship with all of the known bad features? Then we could apply all of the theories!

This test ship should have an abnormally high C.L.A., the lowest possible C.G., and oversized rudder. It would have to be ruggedly built, with a quickly detachable engine section which would fly off like a wing in a crash. Some means of changing the spark should be employed so that the ship would climb safely to a good altitude, before opening up. Then the engine might cut before a spiral dive reaches the earth. A fairly heavy sliding weight inside the fuselage would permit C.G. variations on a horizontal line; an ignition tray that would permit moving coil and batteries up and down in the fuselage would enable a check-up on the effects of vertical changes in C.G. Means would be provided for altering the angles of wing and tail. The center joint of the wing would be designed to permit changes in angle of dihedral. It might even be possible to make sections of the fuselage removeable to work large changes in C.L.A. This test-pilot's nightmare is shown in Figure 3. Among the possible experiments would be:

1. Reduce rudder area until the bare minimum for adequate directional control is reached, meanwhile observing any beneficial effects on spiral instability.

2. Distribute the vertical tail area between the normal rudder and progressively larger sub-rudders.

3. Add auxiliary rudders with the oversized rudder to check any increase or decrease in spiral instability.

4. If experiment #1 shows that rudder area reduction alone left room for further improvement, try auxiliary rudders in conjunction with reduced rudder area.

5. With the oversized rudder, elevate the position of the center of gravity by moving batteries and coil from the bottom of the fuselage

progressively to a position just under the wing.

6. Reduce the rudder area and elevate the position of the center of gravity.

7. If necessary, try #6 in conjunction with auxiliary rudders.

8. Try large angle of attack with stabilizer and wing positions trimmed to test "circular flow" suggestion.

9. Try variations in the elevation of the wing (this would have to be done in conjunction with the other experiments and is not thought out here; combinations could be many).

10. Try dihedral variations, first by increasing dihedral with the oversized rudder, then in combination with other likely factors.

11. Try left and right turns, possibly with the best and worst set-ups discovered.

In addition to such basic aerodynamic trial-and-error experiments, there are other leads to follow. What about adjustments? If we didn't have such pronounced prejudices that real planes and models don't mix, or that the facts of aerodynamic life are entirely theory, we might learn something. Here is an example of something we would note quickly. A lightplane (we say lightplane because they are nothing but low-powered gas models) that is banked steeply requires up-elevator to keep the nose from dropping into that same spiral dive. If that dive were held, the results would be exactly the same as with the errant gassie. Now, if in that steep bank, held at constant altitude with a touch of elevator, rudder is used toward the inside of the circle a drastic, spiral dive immediately results. Yet we do exactly this same thing on many of our models. But let's go into this a little further. If a turn in a lightplane is made at the top of a steep climb, as in a Lazy-eight, you do need a little rudder toward the inside of the turn PLUS a little cross-control with the outside aileron up to depress that wing. Smarter builders unconsciously do this same thing by using washout on the outside wing, or sometimes washin on the inside wing. The similarity becomes uncanny if we push on.

For instance, an Aeronca Champion has a very great difference between power-on and off-trim, exactly like a high-wing gassie. If you trim the Champion for level power flight, then shut the throttle and take your hands off the stick, you go into a steep dive. But if you trim for the glide, as on a gas model, and then fly power-on the ship will zoom steeply and stall (of course you stop it with the stick), exactly like a gas job. But at this point with our gas model, we go in for steep turns as a means of trim, and spiral upward in a definite tail-heavy condition (when power is on). In fact, we trim so tail-heavy, power on, that many of our models virtually loop around the circle. Because we are not in the model we don't realize the effect of this type of adjustment. For instance, a lightplane is spun by gradually bringing it to a stall and, at the instant of stall, applying full rudder. If the ship is not quite stalled a steep spiral dive results. So here we are flying a model at an almost stalled position, usually with rudder to boot. Why be surprised when a spiral dive results? Why shouldn't a right-ruddered model, we'll say, go into a right spiral dive? If the real ship did that, you'd at least remove the right-rudder and probably would use opposite rudder. Offset thrust in the direction of turn builds up spiral diving tendencies. Fellows like Korda and Ehling may not fly real planes but they certainly understand adjustments. Why not do some fact finding and publicize the information for the common good?

Ever notice how the crowd sighs with relief when a spiral diving model is saved by the engine cutting. In a split second the ship is on the safe side. What happened so quickly? It is hardly likely that a bit of rudder area one way or the other really mattered when that engine stopped. A Piper Cub might suggest a clue. As nearly 4,000 members of the Solo Club know, a ship that lingers on the verge of an intentional spin can be pushed into that spin by a touch of the throttle (don't fiddle around without the instructor). The only thing that happened was that the slipstream from the propeller passing over the rudder, which was being held in the direction of the hoped for spin, increased the effectiveness of the rudder, enabling it to put the plane into the spin. When the model engine cuts it suddenly takes away that slipstream and its rudder becomes less effective. Consider that that rudder was permanently fixed, perhaps in the direction of the spiral dive, and you have something to think about. Of course, when the engine cut other factors disappeared, such as thrust, torque, and gyroscopic force. But all these adjustments are, and always will be, living on the edge of the cliff. They are safe enough when properly used and when correctly balanced against each other, but even the loosening of damp covering, or a tiny warp, may spell trouble.

You might ask, "What can be done about this; one must adjust." There is plenty that can be done once you face the problem by considering all the obvious things that make a plane spiral dive, and doing, after that, what you can to test these model builder's theories. For instance, if slipstream aggravates rudder effects, why not move the rudder, or rudders, out of the slipstream by using twin rudders. Why not stick to a combination of adjustments that minimize dangers of steep, tight turns. Why not do something about a power-on and power-off compensating device, which would relieve the need of "lopping around the circle," with fingers crossed that the nose stays pointed upward. Jim Walker, incidentally, once published a device in this magazine but we have yet to see any such device on the field. But the purpose of this article is not to give the answers; it is to provoke thinking. If we knew all the answers, we wouldn't be writing this kind of an article in the first place.

(Author's note—Late mail brings some useful comments. Bernard G. Roer, Chicago, claims that any type of model can be adjusted as follows to avoid spiral dives. For a right turn, he says, raise the right tip of the stab; for a left turn, raise the left tip. All power adjustments are then made with thrust-line adjustments. The rudder is not touched nor is washin or washout resorted to.

To complicate things a New Yorker named Fisher reports strange doings with McCoy's and Hornet's. For example: with right rudder and some right thrust, model spirals in to right under low power; straightens out on more power. But when left rudder is used, model turns right under power! Or, with right rudder, ship turns left when fixed landing gear is added. Fisher blames gyroscopic force of fast-turning propeller. But with such power and speed, twisting surfaces must be considered and stronger structures may be required.)

Club Chatter

(Continued from page 56)

Monticello meet. More details on it in the "Contest Calendar."

After you've had a chance to recuperate from the "Nats," and if you live on the eastern side of the Mississippi River, we suggest you plan to pack your bag in time to get to Langley Field, Virginia, on October 4 when the projected (that means it's still in the formulative stage as we go to press) Eastern Technical Model Aero Conference is scheduled at the government's National Advisory Committee for Aeronautics labs.

Last time a conference was held down there, it developed into an all-night session and a drag-down-and-knock-out fight by a band of east coast free flighters to bar the first pylon model which was cleaning up contests. Model in question was the "Zipper," and the argument has become a highlight of aeromodeling history.

Maybe not as many fireworks can be promised this year if the conference goes through as planned, but it should certainly be a most interesting gathering. It all began when the Brain Busters Club of Hampton, Va., announced its 5th annual hydro meet for free-flight gas models and rubber-powered cabin models on Oct. 5. Suggestion was made that the gathering of the clan be turned into a two-day affair, with the first day (Oct. 4) being set up as a technical conference for the presentation of scientific papers on the deeper aspects of slow speed and high speed aerodynamics, a tour through the NACA aviation labs, and round table discussions by everyone attending.

Dr. H. J. E. Reid, engineer in charge, at the Langley laboratories, has given backing to model aviation for quite some time, and was expected to lend his support to the conference idea. The Chamberlain Hotel at Old Point Comfort, Va., in historic Fort Monroe, is noted for its reasonable rates at that time of the year and its good food, so the entire plan sounds like a "natural."

Among the NACA groups which have been supporting model aviation in fine fashion is the Supervisors Club. This group would probably help in running off the conference in cooperation with NACA, the Brain Busters, and the A.M.A. Charlie Folk, whose address is given in "Contest Calendar," is secretary of the Brain Busters Club; George Poythress is president. The club has about 40 hot-shot members, 85% of whom work at NACA. The club is about ten years old, and the average age of the club members is 23.

On "Hospital Day" last spring a group of modelers in the New York City area put on a bang-up show at Halloran hospital which is filled with army veterans. We want to tell you a bit about the affair and perhaps your club can conduct a similar demonstration sometime at vet hospitals near you.

The show was arranged by the Union and Elizabeth, N. J., Exchange Clubs under the chairmanship of Irving Levy. Among the participants were Leon Shulman, Art Hasselbach, Tom Herbert, Ernie Babcock, John Diehl, Mattie Sullivan, Tom Henning, and others. You will recognize those names as industry and activity leaders. Using the Halloran parking area, and running from 1 to 3 p.m., the U-control flyers put on a show which the vet patients applauded as the most interesting in a crowded day of entertainment. Almost 400 patients witnessed the flying, plus countless visitors and nurses. All manner of stunt flying was on the program, plus scale-model ships and jet-powered planes.

A sound truck was used to explain the models and maneuvers and give a little data on the flyers. As a result of the show a number of patients showed up at the hospital's hobby room on following days and started building model planes. Many of the bedridden vets had seen no entertainment at all for a long period and from their beds on the balconies cheered themselves hoarse over the stunt antics of the control-line pilots. Biggest applause went to team flying when two or more of the fellows flew at the same time from the center of the circle.

Give that show a thought. Can you bring a note of entertainment into the lives of vet hospital patients near you? Maybe there is a children's home or training school—how about the club's putting on a demonstration? Let's share our hobby with others.

"Dawn Flights" are a big thing with the Minneapolis Model Aero Club and each is sanctioned by the Academy of Model Aeronautics so any records set during the windless morning hours can be registered officially in Washington, D.C. More data in "Contest Calendar."

Paul Ring's hobby shop was broken into in Minneapolis not long ago and the following motors stolen among others: Hornet #3275; Ohlsson "60" #32967; Super Cyke #11815; Arden 099 #4775; Arden 199 #5062; Melcraft #1631; Merlin #78879. We call these to your attention because their theft is just one of many reported lately in various sections of the country. Every modeler is urged to register his motors, serial numbers, and identifying marks with the A.M.A. in Washington. Idea behind registration plan is to make it mighty hard for anybody to resell a stolen motor and to help the loser establish prior ownership when the engine shows up at a meet.

Be sure you know the individual from whom you purchase an engine. If you don't, get his name and address and make certain from identification of some type that you have that correct. If you're flying with a stolen engine you are guilty of receiving stolen property even though you consider yourself innocent as a newborn babe. The Academy will furnish you all the motor registration cards you want—a separate one must be used for each engine—for 3¢ each or 50 for $1 to clubs. That is the only cost.

Some manufacturers of motors include a motor registry card with each engine. Purchaser fills it out and sends it in to Washington. All manufacturers should do this; each should be "educated" into putting numbers on every engine by the Model Industry Association. How about it M.I.A.—let's get cracking on that idea.

Incidentally, if you come across or hear of any of those missing motors listed above, write to the modeler's best friend, the A.M.A. in Washington, D.C. Street address of the Academy is 1025 Connecticut Avenue, N.W.

Pete Andrews, the maestro of the indoor model, and holder of top time with such ships, informs us that Jesse Bieberman has secured permission from the Navy to hold a series of indoor record trials in the Lakehurst, N.J., dirigible hangar this Summer and Fall. The September affair is listed in the calendar and it is expected that East coast indoor flying fans will turn out in number for the opportunity to fly in the gigantic airshed. Roof at peak is more than 150 feet high—if memory serves. Anyhoo — it's a mighty long way up even for a big Class "D" hand-launched rubber powered job.

Maybe the indoor lads will do 30 minutes after all!

From down Texas way—Fort Worth, to be precise—Helmer Johnson, secretary of the "Cowtown Sahibs," dashes off a few lines about his up-and-coming crowd. The club was started last November and now boasts a winning team of 31 members. Meetings are held on alternate Wednesdays at the YMCA and the flyers have plenty of parks in which control-line activity is welcome. Roy Pate is the acknowledged speed king of the crowd; he has hit 104 mph with his McCoy "49" powered "Lil' Vamp."

Mr. Johnson shines with his Wasp twin-powered Navion according to reports reaching us. Bobby Lutker and Jimmie Eastland are ready to put on a good show any time of the day or night by flying tight formation with what they call the most beautiful "Sloppy Joes" in captivity. For all 'round fun, a free-for-all dog fight is usually the main attraction of any flying session when it includes Gordon Bourland, Eastland, Pogue Ramsel, Lutker, and Chuck Cunningham all flying in the same circle at the same time.

A past president of the club is handsome Johnny Casburn, control-line kit magnate and current head of the Southwest Gas Model Association. While visiting Air Trails offices recently, Johnny revealed the Sahibs are readying a new act which will have eight men (yep, we said "eight") in the center of the circle. "Stunt flying," contend the Cowtown Sahibs, "is lots of fun." Brother, with that gang, that's an understatement!

From the U. S. Military Academy at West Point, N.Y., Cadet Don Kavanagh reports on the gas model contest sponsored by the West Point Model Airplane Club at Stewart Field. There were about 200 entrants and more than a thousand spectators. Everyone had a good time, mainly due to the fine weather. It was a warm, calm day with many risers running around. As a matter of fact, six models disappeared into the wild blue yonder (it is an AAF field!) by 11 a.m., an hour before the meet officially opened. High time was a single flight of 36:54.8 on a 15-second motor run made by William E. Davey of New Jersey. His average of 12:34.6 for 3 flights wins him 1st place in Class "B" free flight.

Class "A" and "C" were won by Lt. Burtner of Long Island with averages of 6:09.0 and 5:27.4 respectively. He also won the Air Trails trophy for high points. Class "C" U-control was taken by "Red" Ryder, with a top speed of 120 1 mph. "Red" also won Class "B" with a speed of 75.7 mph. The biggest surprise came in Class "A" when Don Gudaitis was clocked at 91.4 mph.

Due to limited time and facilities the contest was run on somewhat original rules. Free-flight motor runs were limited to 15 seconds. U-control ships were flown on any length lines with tables used to convert radius and time for four laps into miles per hour.

The best part of the meet was the "jeep" transportation available to contestants. Although a great number of free flight jobs went out of sight, nearly all were recovered. The jeeps also provided a means of transportation about the field for the contestants. The West Point club hopes everybody will return next year for the '48 meet.

While our thoughts are turned to the New York area, readers in that locality will be interested to learn that through the efforts of Air Trails and the *Daily Mirror* flying was scheduled to return to the New York City parks on an official basis at the end of June when the Park department opens its $1 model flying site at the old World's Fair parking lot in Flushing Meadow, a stone's throw from the United Nations building and Flushing line stops on two subway lines.

Six circles were set up in an area 400 by 800 feet. Police protection was assured and barricades were to keep spectators at least 100 feet from any circle. The Metropolitan Hobby Guild is cooperating with the Park department in handling control-line flying at the first modelport established by America's largest city. Additional data may be obtained by New Yorkers from the offices of this publication.

From out San Diego, Calif., way, Donald T. Hoyle shoots in plenty of dope on the free-flight gas meet run off by the Aeroneers club. The meet was held at Kearny Mesa with 350 entrants and 4,000 spectators in attendance. Prizes amounted to $1,200 in cash, trophies, and merchandise.

Results were as follows: Class A—B. Hanford, Ocean Park, Bantam-powered original, 10:32; K. Newbeiser, Hollywood, Arden 199-Playboy Jr., 9:07; R. Randolph, Bellflower, Bantam-original, 7:21; M. Hubbard, Los Angeles, Ohlsson 19-original, 6:41; D. Davis, San Diego, Arden 199-original, 6:40. Class B—D. Davis, K&B Torpedo-original, 13:32; D. Hinkle, Vista, K&B Torpedo-Honeybee, 11:26; J. Thompson, San Diego, Bullet-Spearhead Sr., 11:01; R. Acord, Los Angeles, K&B Torpedo-Zipper, 10:11; E. Brown, San Diego, Torpedo Special-Zipper, 10:10.

Class C—M. Rooney, Los Angeles, Thunderbird-Sailplane, 17:57; L. Caton, N. Hollywood, Ohlsson 60-Westerner, 16:01; H. Glines, San Diego, Tiger-Zipper, 12:15; J. Haywood, Tucson, Ariz., Orwick-Playboy Sr., 11:19; F. Davis, San Diego, Thunderbird-Sailplane, 10:34. Junior—J. Haywood, 11:19; C. Ransom, San Bernadino, Aero Midget-Zipper, 7:37; W. Trumbull, San Diego, Orwick-original, 7:35; J. Butler, Inglewood, K&B Torpedo-Zipper, 7:19; C. Ramsom, Ohlsson 23-Playboy Jr., 6:05. Longest single flight, M. Romney, 14:37; second, E. J. Brown, 10:10.

Processers were G. Wagner, R. Goddard, G. Ryan. Recordesses: C. Hoyle, L. Wagner, M. Brown, and A. Davis.

First meeting of the Medford, Mass., Gasshoppers was held recently and the 45 members voted to divide into two groups: 12 to 21 to be known as "juniors"; over 21 classed as "seniors." Officers for each group were elected and those winning positions were—Junior: Maurice Gion-

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friddo, president; Gilbert Greenberg, vice-president; Frank Gentile, secretary-treasurer. Seniors: Stanley Petroski, president; Jerome L. Guarino, secretary-treasurer; manager and contest director, Albert Orlando.

Flight timer is David Gough; flight captain, Arthur Menezes. Meetings for juniors are scheduled once a week. Senior meet every two weeks. During the initial formulative session an intensive contest program was drawn up, calling for the distribution of adequate prizes by means of a point system. Older, more experienced, members will act as instructors for the newcomers. Mr. Orlando has offered the facilities of his hobby shop as a club meeting place and workshop. Modelers desiring additional information about the club and its activities are requested to contact M. Guarino at 34 Washington St., Medford 55, Mass. His phone number is Mystic 4927-M.

William Sweet has been elected corresponding secretary of the Thermal Thumbers model club of Los Angeles which was organized ten months ago and now has 35 members. Meetings are held the first and third Thursdays of each month. The organization is strictly free flight and a wing of the Los Angeles Aero Modelers, which affords the members a very good insurance policy at reasonable rates. All members are A.M.A. licensed; this is one of the requisites for admission.

Mr. Sweet may be contacted at 6901 Eastern Avenue or by phone at LAfayette 6516.

The Flying Bisons, officially known as the Buffalo, N.Y., Miniature Aircraft Engineers, held a control-line meet at Wherely Drive in Williamsville which is reported by Mike Jordan, corresponding secretary. Times were: Class "A"—DeBolt, using a Bantam engine, 74 mph; Jordan, Bantam, 64. Class "B"—DeBolt, RB Special, 95; McCarthy, RB Special, 89; Kirk, DeLong, 82. Small Class "C"—DeBolt, McCoy 49, 104; Milliand, Madewell, 68; Kreihbal, Madewell, 58. Class "C"—Campiony, Hornet, 113.87; Wagner, Hornet, 108; Millet, Hornet, 107. In the stunt flying, following A.M.A. point system were Millet, 81 points; Kreihbal, 76; DeBolt, 68.

A bid for national recognition in the field of super speed and super acrobatic control-line antics is being made by the Capital City Controlaires, Columbus, Ohio's newest control-line club. Last winter plans were made for the construction of a flying area that when finished will be second to none in the country. By the time this reaches print the flying site at North Way Air Park, north of the city, should be in complete operation with three circles, each equipped with staked and roped pits. Work was hampered by the late and wet spring which turned the area into a swamp but with warm and clear weather, work was completed and the "hot job" and "stunt" boys began to get in their licks in a confident hope that many records will be brought to Columbus.

Work was begun when the management of the airport granted the "Controlaires" a ten-year lease on a section of land, 600 by 300 feet, for the building of the last word in flying fields for controlled models.

The more than 50 members of the club, some new to the "spin-dizzy" game and some converted free flighters, who still sneak away on calm, sunny afternoon for a chase across country, began work on the field with the first thaw. Safety first is the motto of the club and one of its first acts was the purchase of the fence which completely surrounds the flying circles and pits. The "Controlaires" hope to have the best possible flying conditions for the pilots, mechanics, and officials. Also, spectators get an excellent view of everything that goes on and everyone can do his part in good style when a contest rolls around.

Also, the crowds that visit the area can get a view of both model and full sized aircraft. A schedule has been set up that enables every member to get a chance in the air.

It works like this:

West Circle—120 feet in diameter—Classes 1, 2, 3, & 4, Speed.

Center Circle—160 feet in diameter—Classes 5 & 6, Speed.

East Circle, 160 feet in diameter, sport, scale and stunt.

All flyers must stay inside a six-foot center circle when flying and engine runs are limited to six minutes. Pylons are available for contests and races between members, and a circle must be clear before a new flyer enters. This eliminates mixups. All regulations follow AMA.

To enable contest flyers to keep up on latest news concerning meet dates and data, Air Trails presents "Contest Calendar." Here, in brief form, you will find pertinent facts about competitions.

Additions to the Calendar should reach the editorial offices 2½ months ahead of scheduled contest time for inclusion, three months in advance is even better. Additional information will be welcome on meets listed here where blank spaces indicate incomplete data. The publication can assume no responsibility for contest data. Dates, prizes, events, and personnel are subject to change without notice.

LOCATION	*DATE*	*EVENTS*	*PRIZES*	*CONTACT:*
Toronto Canada	Aug. (late)	Canadian "Nationals"		Canadian National Exposition, Toronto Ontario, Canada
Minneapolis Minn.	Aug. 10	Dawn Meet FF, Rubber		Minneapolis Model Aero Club 611 E. Franklin
Kansas City Mo.	Aug. 10	Control		Harry Schrieber 3507 Prospect
Omaha Nebr.	Aug. 10	Control Endurance (teams)		Mrs. John Fluehr 6223 Pierce
Detroit Mich.	Aug. 14-16	Indoor Outdoor	$6,000 93 Trophies	Plymouth Motor Co. P.O. Box 658
Salem Calif.	Aug. 17	FF		
Omaha Nebr.	Aug. 17	FF (marathon)		Mrs. John Fluehr 6223 Pierce
Minneapolis & Monticello Minn.	Aug. 18-22	16th Annual National Contest	Perpetual & Permanent Awards	A.M.A., 1025 Conn. Ave., Wash. 6, D. C. (enclose 10c)
London England	Aug. 20-30	Model Engineer Exhibition	Cups Medals Other awards	Exhibition mgr. 23 Great Queen London, WC2, England
Wenatchee Wash.	Aug. 24	Control		John Gruenewald E. Wenatchee
Hicksville L. I., N. Y.	Aug. 24	FF	Trophies	Arnie Penenberg 305 Martense Brooklyn 26, N. Y.
Omaha Nebr.	Aug. 24	Rubber HL Glider (jr.)		Mrs. John Fluehr 6223 Pierce
Oakland Calif.	Aug. 31	"Poor Man's Nationals" Rubber		Harvey Robbers 5610 E. 17th
Minneapolis Minn.	Aug. 31	Dawn Meet FF, Rubber		Minneapolis Model Aero Club 611 E. Franklin
Omaha Nebr.	Aug. 31	Outdoor		Mrs. John Fluehr 6223 Pierce
Kansas City Mo.	Aug. 31-Sept. 1	FF Control		Harry Schrieber 3507 Prospect
Waterloo Iowa	Aug. 31-Sept. 1	FF Control		Gale Fenstemaker 1419 E. 4th
Los Angeles Calif.	Aug. 31	FF Rubber (RT)		Ray O. Acord 5111 Lemon Grove Ave
Lakehurst N. J.	Sept. ?	Indoor Rubber (RT)	In Navy's dirigible hangar	Jesse Bieberman 21 Dartmouth Rd. Cynwood, Pa.
Philadelphia Pa.	Sept. ?	FF	Flying Circus Awards	"Evening Bulletin"
Belleville Ill.	Sept. 1	FF Rubber Glider		Walter E. Harter 1011 W. Main
St. Louis Mo.	Sept. 6-7	East-West Control Challenge Meet	Open only to 2 teams	
Kansas City Mo.	Sept. 6-7	FF Control		Harry Schrieber 3507 Prospect
Naperville Ill.	Sept. 7	FF Rubber HL Glider	Cash Trophies Medals	Bob DeMar 620 S. Webster
Santa Barbara Calif.	Sept. 7	FF		
Minneapolis Minn.	Sept. 14	Dawn Meet FF, Rubber		Minneapolis Model Aero Club 611 E. Franklin
Los Angeles Calif.	Sept. 14	FF Glider (RT)		Ray O. Acord 5111 Lemon Grove Ave.
Los Angeles Calif.	Sept. 21	Control (RT)		Ray O. Acord 5111 Lemon Grove Ave.

LOCATION	DATE	EVENTS	PRIZES	CONTACT:
Oakland Calif.	Sept. 28	FF		
Minneapolis Minn.	Sept. 28	21st NW Model Meet		"Star Journal"
Sacramento Calif.	Oct. ?	FF		
Langley Field Va.	Oct. 4	Eastern Technical Conference (pending)	NACA lab tour Scientific papers	Charles Folk 315 Cottonwood Ave. Hampton, Va.
Langley Field Va.	Oct. 5	FF, FF ROW Rubber Rubber ROW Gliders (RT)	Trophies Mdse.	Charles Folk 315 Cottonwood Ave. Hampton, Va.
Los Angeles Calif.	Oct. 5	Control		Ray O. Acord 5111 Lemon Grove Ave.
San Diego Calif.	Oct. 12	Control		
Minneapolis Minn.	Oct. 12	Dawn Meet FF, Rubber		Minneapolis Model Aero Club 611 E. Franklin
Albany Calif.	Oct. 19	Control		W. S. Biscay 513 Pomona Ave.
Gilroy Calif.	Oct. 19	FF		
Philadelphia Pa.	Oct. 20-25	Show	Philadelphia Amateur Science, Hobby & Craft Show	
Los Angeles Calif.	Oct. 26	Rubber Glider (jr.)		Ray O. Acord 5111 Lemon Grove Ave.
Fresno Calif.	Oct. 26	FF		
Minneapolis Minn.	Oct. 26	Dawn Meet FF, Rubber		Minneapolis Model Aero Club 611 E. Franklin
Los Angeles Calif.	Nov. 9	FF		Ray O. Acord 5111 Lemon Grove Ave.
Fresno Calif.	Nov. 30	FF		
Los Angeles Calif.	Dec. 14	FF (jr.)		Ray O. Acord 5111 Lemon Grove Ave.

Modelers: When writing "contact" man (or gal) for information send self-addressed, stamped envelope to speed up entry blanks and help club defray expense of mailing.

The following abbreviations are used in this Calendar: "FF" for ***free flight gas models;*** *"TL" for* ***tow-line;*** *"Mdse" for* ***merchandise awards*** *(kits, accessories, etc.); "jr" for* ***events open only to entrants under 16 years of age;*** *"RT" for* ***record trials*** *sanctioned by Academy of Model Aeronautics where no prizes are offered but opportunity is afforded to set new records; "HL" for* ***hand launched*** *gliders; "Control" for* ***control line gas models;*** *"Rubber" for* ***rubber powered cabin and stick-type models.***

All events are outdoor unless otherwise stated. Contact man's address is in same city as meet unless otherwise noted; the word "street" is understood after each address unless otherwise indicated.

Solo Club

(Continued from page 47)

about. They say if some of the fields that fly dirty wind socks would only wash or replace them it would make everyone happier. They say you have to go down to "neck-risking altitudes" at times to see which way the wind IS blowing. I agree 100% with Harry and Dwight Newton, for there's nothing makes me madder than to arrive over a strange field and then have to hunt for something to indicate the wind direction. I can't quite understand why so many small operators apparently hate to help the strangers find their fields in the first place and then cleverly conceal the wind sock, or fly such a battered and dirty one you can't see it till you are too DARN close. Harry and Dwight Newton both soloed within a few minutes of each other, a real sort of "brother act" as it were, and we are glad to have them both in our Solo Club.

From out Chicago way comes a nice letter from Shelia Ryan who just soloed a few weeks ago. By now she probably has her Private license. Her brother started her flying after her sixteenth birthday, and she has been plugging at it ever since, out at Sky Harbor where she flies. Her instructor, Dora Daugherty, sent her solo unexpectedly (don't they all!) and as Miss Ryan says "when a Daugherty and a Ryan get together there's bound to be fair weather." Here's to plenty of "fair weather" for both yourself and Instructor Daugherty. Miss Ryan—come again!

Here's another forced landing experience reported by a new member, Jack Trier, of Los Angeles, Calif. Before he recently obtained his Private license he was on a solo XC trip from Los Angeles to San Bernadino when the engine began to slow down. He says he spotted a field and headed for it with his engine only turning up 9,000 to 10,000 r.p.m.'s (I have a hunch you mean 900 to 1,000 r.p.m.'s, don't you, Jack?) and just skimmed over a fence into the grass beyond. He said he almost had to lift himself off his seat to clear the fence but he made it and that's what counts. I'd

say it was good pilotage for a solo XC pilot with only 32 hours to be able to handle a situation like that as you did. He says it developed later on that his plane's engine had some sticky valves, hence the forced landing in the field over the fence. What other of you members have had forced landings? Let's hear about them.

Now let me tell you folks about a trip I just had. The Aviation Writers Association, of which I'm an old, battered charter member, held their annual convention in Los Angeles last week (at the time of writing), so the Air Transport Command, along with the Naval Air Transport Service, with their usual splendid cooperation, got busy to help us really have a time. Both the services did their best to make it possible for us to see what they have on the fire for the future in the way of new ships, instruments, guided weapons, rockets, and what have you. The ATC flew us from Washington to Los Angeles for our business meetings and then back over the mountains to Muroc Army Air Field to see what this fantastic and usually secret base really has cooking. I can use that word "cooking" literally, for the place is in the Mojave desert where everything cooked, including my nose.

The day before we flew to Muroc, the Navy flew us out to a crazy spot on the California coast. It's called Point Mugu and is the U. S. Naval Air Missile Test Center. Located along the coast near Oxnard, on U. S. Highway 101, the Test Center surrounds Mugu Lagoon (I love that name) and faces the islands of San Miguel, Santa Rosa, Santa Cruz, and Anacapa.

Here we were noisily introduced to such gadgets as the "Loon," the "Gorgon," the "Gargoyle," and "Little Joe," all designed to make warfare quicker and anything but quieter. We spent several hours dodging from one concrete-and-bullet-proof protection to another from which we saw, and felt, all kinds of rockets, ram jets, and other assorted means of pilotless destruction the Navy has been quietly dreaming up. What a place for Buck Rogers to spend a week end, only the poor chap would find he was obsolete.

Out at Muroc we saw such stuff as the Bell XS-1 and Douglas "Skystreak," both designed to break the sonic barrier of high speed; the radio-controlled Lockheed P-80s, and the faster P-80D; the jet-propelled North American XFJ-1; the little Northrop N9M flying wings, the prototypes of the giant XB-35; the Douglas XB-42; and the Consolidated-Vultee four jet-propelled XB-46 bomber and plenty more.

The Navy and Army went all out to put on a show-to-end-all-shows, and they certainly did just that!

From Muroc, the Naval Air Transport Service took us over, and shot us up to San Francisco for a quick overnight look around. To tell the truth, folks, I sneaked off and did what I'd always wanted to do—ride one of those goll-darned cable cars. Boy, am I a farmer!

The next morning the Navy DC-4s, or R5Ds as they call them, hauled us back to Los Angeles, but not before we'd had a surprise on the way back. About halfway there, while I was up in the "front office," someone yelped "bandits at three o'clock!" and sure enough, barreling in from the right was a line of seven Ryan "Fireball" fighters. These ships have a propeller on the nose and a jet engine in the tail and they flew alongside of us and stopped their nose engines and feathered their props, keeping up with us with their tail jets. Sure looked funny to see those props slow down and stop—yet the planes keep right up with us. They looked like a bunch of scale models in a Model Shop window with a moving background behind them. One of the "Fireballs" peeled off and came over to have its picture taken. It kept sidling closer and closer and I mean CLOSER!

When I say closer I mean just that. He was so near I found myself checking my wrist watch with his. He had the nicest eyes and wore yellow gloves. A Navy photographer with us kept motioning him to come in a bit closer while all the rest of us were just as busy motioning him to go AWAAAAAAYYYYYY! He was so close I couldn't get him all into the finder of my movie camera so first I took a picture of his tail and then moved left to get in the rest of him. It was then that I noticed his watch was three minutes faster than mine.

After the return to Los Angeles we reboarded the ATC DC-4s and took off for Fort Worth, Texas, to see the XB-36 bomber. That's the giant six-engined bomber you won't believe after you HAVE seen it, built by Consolidated-Vultee.

I forgot to mention that while in Los Angeles we were all invited to see the President's new "flying White House," a brand new special Douglas DC-6, bigger and better than the famous "Sacred Cow" DC-4. The new ship, named the "Independence," is a ship worthy of any President, and is fitted with every device for safety and comfort. It has a built-in teletype and the President has a private plane-to-ground telephone at his elbow. There are built-in maps, divans, swivel chairs, wash rooms, radar, crews quarters, bunks, and you name it and it's there. It is finished in maroon and grey and natural woods and is a magnificent example of our aviation industry's products. One point I noted with interest. The door into the "business end" of the ship, up forward, is fitted with a combination lock whose secret numbers are known only to the crew members.

To get back to the XB-36 and its sister ships the YB-36 planes following it (of which over a hundred have been ordered). They are the most awe-inspiring aircraft ever produced. Everything about them is on such a colossal scale. For example, one of them took off with total gross load and it was the greatest load ever lifted from the earth by a plane—278,000 pounds, or over 139 TONS. Its wing spread is 230 feet, its length 163 feet, and its height over 46 feet. Its top speed is over 300 mph and its service ceiling is 40,000 feet. Its range is 10,000 miles with 10,000 pounds of bombs, but for a shorter distance it can carry over seven times that load or 72,000 pounds of "that stuff." Its fuel tanks will hold enough gas to send your car sixteen times around the world and then let you tour every state in the union to tell about it.

They flew it for us and let us climb all over it and we still didn't believe it. It must be the Texas air or something. After seeing these ships at Fort Worth there was nothing to do but head for home and some aspirin.

Enough of this, and so until next month we'll be watching for your letters. Make them plenty and send them often, for we all like to hear about YOUR flying, too.

WATCH FOR THE NEW AIR TRAILS

Private Flying

(Continued from page 25)

using automobile parts instead of expensive airplane equipment. For instance, automobile locks and handles were $6 cheaper than the conventional aircraft handles. Aircraft batteries costing $25 were replaced by an $8.50, 65-ampere jeep battery.

Alfred Marchev, then president of Republic, studied sales potentials and mass-produced the plane from the start. The first price, $3,995, was jumped to $6,000. This is still a lot cheaper than it might have been due to Boyajian's new design and Marchev's mass-production formula.

The 215-hp, 6-cylinder, opposed Franklin Aircooled Engine is a floating powerplant, on rubber mountings. This minimizes vibration and consequently reduces engine noises. The engine is mounted above and behind the cabin, which affords unobstructed visibility for pilot and passengers through seven large Lucite windows. Standard equipment on the Seabee is the Hartzel controllable and reversible-pitch pusher-type propeller. Both main landing gear and steerable tail wheel are retractable, manually operated with a hydraulic mechanism, which also operates the flaps.

The Seabee cruises at 103 mph with a top speed of 120. Landing speed is 58 mph; service ceiling is set at 12,000 ft. The cabin interior is 110 inches long, 46 inches wide, and 50 inches high. 1,050 lbs. of the 3,150-lb. gross weight is useful load.

The Beechcraft Bonanza can be described as an all-metal, low-wing monoplane with sleek, tapering lines, strictly modernistic, uncluttered surfaces, and with an unconventional V-tail.

The Bonanza is one of the few small commercial airplanes that has ever had complete wind-tunnel testing. A fatigue-testing program was carried on in the laboratory before the plane ever flew, in which the fatigue-failure of structures was tested for an equivalent of 20,000 hours of flying.

The V-tail, a new tail assembly design, was adopted after extensive tests with this type on a Beechcraft AT-10. The V-tail proved to be superior to the conventional tail configuration; high speed was increased by 5 mph, and appreciable savings in weight and cost were realized. Control of the plane is conventional, although use of the rudder is unnecessary except for cross-wind landings and take-offs. Excellent turns are made without the use of the rudder at all.

A flat-six engine was chosen because of greater visibility and savings in weight and cost. The Continental E-165 used in the Bonanza develops 165 hp at 2,050 r.p.m. normal rating and 185 hp at 2,300 r.p.m. for take-off. The Beech-designed, slow-turning controllable propeller achieves quiet operation and optimum performance.

The Bonanza's top speed is 184 mph, cruising at 172 at 8,000 feet (70 per cent power), with a range of 750 miles on a 40-gallon fuel capacity. Take-off run at sea level with a 10-mph wind is 425 ft., landing roll under the same conditions, 315 ft. Stalling speed at sea level with 20° flaps is 55 mph; without flaps, 64 mph. Fuel consumption, depending on speed and altitude, varies from 14.5 miles per gallon to 18.8. Service ceiling is 18,000 feet.

In looking over the lower-priced, two-place line-up we see an impressive row of Aeroncas, Ercoupes, Cessnas, Pipers, and Buscombes.

The Aeronca line includes the Chum, the Champion ($2,475), the Scout ($2,475), and the Super Chief ($2,665). The new Chum is slated for production this year. This all-metal, low-wing plane will come in either two- or three-control. It is said to be spin-proof and soundproof. Its top speed is 118 mph. Cruising speed is 108 and it lands at 49. The range is 400 miles, fuel capacity 22 gallons. An 85-hp engine powers the craft. A baggage compartment accommodates 60 lbs. of baggage.

The two-place, tandem-type Champion, still a favorite training plane, is efficient and safe and provides excellent visibility. The stick control has been retained to allow the student to get the feel of the plane more quickly. Powered by a 65-hp engine, the Champion's top speed is 100 mph, cruising speed 90, and range 270 miles. Landing speed is 38 mph.

In the last couple of months Aeronca has made a few additions. In May the Chief was modified and is now known as the Super Chief. The horsepower was stepped up from 65 to 85. Tow brakes were installed in place of heel brakes. Mufflers were attached and a new stainless steel exhaust added. The price remains the same.

The Scout trainer is also a modified version of the Chief, with a few Champion features incorporated. In order to turn out a more inexpensive plane the Chief was stripped of a few embellishments: a starter and an extra gas tank. $190 was cut off the price. The Scout is 80% interchangeable in parts with the Chief and the Champion.

A streamlined, low-wing, all-metal, spinproof plane, designed to be "particularly easy to fly," is the Ercoupe. Development began 16 years ago by a group of engineers at the N.A.C.A. laboratories at Langley Field. They constructed two planes, the W-1 and the W-1A. From these early models the Ercoupe has evolved. The Ercoupe was a success before the war and is still a popular member of the two-place class.

In order to obtain their easy-to-fly, high-safety qualities they deviated from the conventional in three ways: First, the airplane was made spinproof and provided with effective lateral control at all speeds. Second, the control system was simplified by having both the ailerons and the rudders linked to the control wheel. This eliminated the rudder pedals entirely and consequently the necessity of learning to coordinate three separate controls. Third, the tricycle landing gear was used, an unconventional step at the time of the plane's design.

The Ercoupe is powered by a 75-hp. Continental engine. Cruising speed is 103 mph and a maximum of 117 with the wood propeller. Use of the aluminum McCauley prop boosts cruising speed to 109 mph. Cruising range is 525 miles with 23 miles to the gallon. Fuel capacity is 25 gallons. Service ceiling is set at 13,000 ft.

Cessna's 140 and 120, side-by-side, all-metal, two-place planes, won first and second place, respectively, in the lightplane races at the Miami Air Maneuvers this year. Designed in 1945, the conventional high-wing design is still retained in the newer models. Cessna maintains: "Approximately two-thirds of the lift comes from the top part of the wing. By making the cabin section the same contour as the wing itself, an uninterrupted flow of air over the engine top surface is achieved. This results in more lift per wing area." Cessna also feels that high stability results from a high wing because the weight of the fuselage is suspended underneath the wing.

Cessna sought particularly to design a plane that would require a minimum of maintenance costs. The wing is built in sections so that one section, if damaged, can be replaced without having to replace a whole new wing panel. The cowl has quick-action trunk-type fasteners permitting easy access to the engine. The entire cowl can be removed without removing the propeller.

The Patented Safety Landing Gear, an outstanding feature of the new Cessna, requires no maintenance since there are no moving parts. Made of chrome vanadium steel, this new spring gear is the result of two years of research and experimentation. Design engineers had to solve the problem of providing a spring that would absorb the shock of landing and still not bounce the airplane off the field on the rebound. A conventional gear will take so much load, then bottom and start breaking. This spring gear will spread out until the belly of the ship touches the ground. Even under such excessive loads the gear will return to normal and usually show no set or damage. Oleo or hydraulic type gears absorb shock only until the oleo is fully deflected. The remainder of the shock is transferred into the plane structure. This spring gear will continue to absorb shock as long as there is any to absorb.

Ground-handling characteristics for cross-wind landings, take-off, and taxiing compare favorably with planes equipped with tricycle landing gears.

The 120 and 140 are alike except for price and a few luxuries. The 140 costs $3,245. By eliminating a few items—starter, generator, battery, flaps, and the lush finish—the 120 sells for $2,695. Top speed is over 120 mph, cruising speed 100 mph, range 450 miles on 25 gallons of gas, landing speed, 41 mph. Service ceiling is 15,500 ft. The engine is an 85-hp Continental.

The Luscombe "Silvaire," side-by-side, all-metal, high-wing monoplane, was first produced in 1938-39 in the form of a 50-hp trainer. Later modifications increased power and weight to add the sportsman and businessman pilot to the formerly limited trainer and operator market.

The Silvaire 8-A is powered by a Continental, air-cooled, 65-hp engine. Cruising speed is 105 mph, maximum speed 115. The plane lands at 39 mph and with its 14 gallon fuel capacity has a range of 350 miles.

The "Silvaire Deluxe" 8-E, has a Continental, 85-hp engine. Cruising speed is 112 mph with a maximum speed of 125. Landing speed is 48 mph; range is 650 miles.

Two wing tanks hold 30 gallons of gas. Consumption is 5½ gallons an hour.

It is interesting to note that postwar conversion to an all-metal wing was accelerated by the lack of available fabric covering and steel tie rods.

The Standard Silvaire, advertised as the lowest-priced, all-metal airplane in the world, sells for $2,495. The Special Silvaire with larger gas tanks, $2,695, and the Deluxe, 85-hp Silvaire, for $3,595.

The Piper Aircraft Corporation, dating back to 1931, has on the market today the 3-passenger Super Cruiser, the tandem-seater Cub Special, and float-plane versions of each one. The 4-passenger Skysedan is still in the experimental stage but may go into production some time this year.

The Super Cruiser, priced at $3,495, has been heralded as the "family plane" but is being widely used by businessmen as well. A much revised version of the prewar J-5, the Super Cruiser PA-12, is powered by a 100-hp, 4-cylinder Lycoming horizontally-opposed engine. Cruising speed is 103 mph, top speed 115 mph, and landing speed 48. The fuel capacity is 38 gallons; consumption of 6½ gallons per hour.

Other than the increase in horsepower factors contributing to the increased speed of the Super Cruiser, there were the additions of thinner and wider steel lift struts faired into the wings and a streamlined landing gear. The tandem-seater Cub Special, selling for $2,445, has a long record of safety in training and in combat. Distinguished as the "ship that has trained more students to fly than any other type of ship," it began as the 35-hp, E-2 in 1931, became the famous J-3, and was known as the 65-hp L-4 during the war. In the new Cub Special PA-11 the gas tank is located in the wing; formerly it was in front of the instrument panel. The special cruises at 87 mph, maximum speed 100 mph, landing speed 38 mph, and range 300 miles. Gas capacity is 16½ gallons, consumption 4.5 gallons per hour.

Private flying is suffering from growing pains—nothing more. And there's no cause for alarm. A good pilot knows that a slow climb preserves the life of his engine.

WATCH FOR THE
NEW AIR TRAILS

The Laird "Solution" Racer

(Continued from page 50)

heads G and I. Apply cement heavily at all intersections. Now add the solid balsa block fairing below the lower wing. A control guide device may now be added to the left wing strut.

Decals may now be added. The number 77 is under the cockpit and the license number is NR 10538.

The model should be balanced by locating the coil and battery in the fuselage to have the C. G. about one inch behind the front control line. If you are a control-line flyer with lots of experience, we needn't tell you what to do about test-flying your Laird. If you are new to this type of flying, our best advice is to ask one of your more experienced friends to teach you the tricks of control flying. Although this design is seventeen years old, she has plenty of kick in her yet. When powered with a Bantam and an eight-inch propeller, the original model did well over 60 miles per hour. Good luck to you.

Electronics in Miniature

(Continued from page 48)

velopment of these rather startling new radio circuits was touched off by the special requirements of the recent war. Actually, the performance capabilities required by the Armed Forces for some of the devices dreamed up for the discomfiture of the enemy were so severe that conventional components and circuits could not even begin to accomplish them. Electronic gadgets of unheard-of complexity (a complete GCA equipment has about 750 vacuum tubes!) were developed, and, since wars have a habit of moving around, portability alone began to become something of a problem. The Army and Navy, blessed with fat budgets in wartime, at least, and teeming with the pick of the nation's manpower, were inclined to list as "mobile" anything which could be carried by a battleship, or a fleet of ten-wheelers. But of course there are some applications in which it is highly desirable to have an electronic gadget to do some vital job, but where other requirements are such that very rigid limitations as to size, weight, and ruggedness are imposed on the desired electronic what-izzit.

One of these jobs with tough requirements resulted from the plaintive and oft-repeated cry of the Forces for projectiles that had sense enough to explode themselves when they got close enough to the enemy target to do it some bad. What was needed was a fuze in the projectile which would sense the proximity of the target and detonate the bursting charge at the right instant, and because of the speed of approach between shell or bomb and target and the lack of actual physical contact, a device using electro-magnetic radiation and electronic principles was indicated.

As early as 1940 a project under the joint sponsorship of the Army and the National Defense Research Council was initiated at the National Bureau of Standards, for the development of such a fuze for non-rotating missiles such as bombs and rockets. At the end of Spring, in 1944, the proximity fuze for most of the common projectiles such as rockets had been successfully developed and produced in quantities. However, the shell fired by the Army's smaller trench mortars was so pint-size that the generator driven fuzes produced for the larger projectiles were out of the question, even small as they were.

A three-to-one reduction in size was needed in a device already justly regarded as a triumph of design and production. Early in 1945 this project was given a top priority, and, in spite of additional and even more drastic requirements, was pushed through to successful completion. One of the additional requirements for the tiny mortar fuze was the ability to withstand and operate normally under an acceleration of about 10,000 times the force of gravity, as compared to the 1,000 Gs setback force encountered in the fuzes designed for rockets and bombs. The heart of all the proximity fuzes is an electronic circuit which goes into action when the projectile is launched, producing and radiating a radio wave. When the projectile approaches a target, some of the radiated energy is reflected back from the target to the projectile, and is picked up in the "antenna" part of the device which originally radiated it.

Due to the rapidly changing distance between the projectile and target, the reflected energy is alternately shifted in and out of step (phase) with the wave being transmitted, causing the radiation resistance of the tiny antenna to change periodically. As the projectile and target get closer together this change in the antenna radiation resistance caused by the reflected energy gets progressively larger, and when it reaches a predetermined value, a firing circuit built into the device is tripped, setting off the bursting charge. This brief description can give only the bare outline of what goes on in the fuze innards during its brief period of active life, but it will suggest something of the complexity of the fuze itself, and the difficulties faced by the men who designed it.

The printed hook-up circuit which played such a large part in the successful design of the proximity fuze is a direct result of the need to overcome the problem of the 10,000 G acceleration when the mortar shell was fired, and to fit the fuze into the small space in the shell which could be allotted. Resistors and capacitors of an ordinary radio are often supported by their own wire leads between stand-off insulators. This is quite all right for the accelerations it is called upon to withstand, unless Junior decides to test its glide angle out the front window, but under the aforementioned 10,000 Gs these parts would be torn loose like so much confetti in a hurricane, to say nothing of the vacuum tubes themselves.

To the group of men gathered around the "headache" table, it occurred that one way to keep the parts and wiring from being torn loose by acceleration was to bond them to a suitable supporting plate all along their length, and a logical extension of this idea was the printing of the connecting leads directly on the surface with a kind of ink that would conduct current. Another short step was the use of an ink for the resistors in the circuit as well, since such inks could readily be prepared. The condensers were a slightly knottier problem, but here again the difficulty was overcome, once the group knew in which way the solution lay. Thin, small flat plates of ceramic dielectric material are coated on opposite faces with a thin film of silver, forming a condenser which is extremely rugged when properly mounted. The high dielectric constant of the ceramic insulating material used permits attainment of a relatively large capacity with a small plate area. The units actually used in the proximity fuze measured from 1/8 to 3/8 inches in diameter and less than 4/100ths of an inch thick!

Before going further, we may as well take a look at the group who gathered around the design conference table periodically in the course of solving the proximity fuze problem, which provided the spur for the development of the printed circuit. There were men from the Services, of course, who knew what was required in the practical device. There were men from the N.D.R.C. also, and from the Centralab Division of Globe-

Union, Inc., an industrial firm which had long been concerned with the development and production of ceramic components used in the radio industry. There were also men from the Bureau of Standards.

Chief among the Bureau men were Harry Diamond, Chief of the Ordnance Development Division, and Dr. Cledo Brunetti, Chief of that Division's Ordnance Engineering Section. Mr. Diamond has been called the father of modern aviation radio, and is well known for his development of ILS, the instrument landing system widely used, and a number of other air navigation and weather study aids such as radiosondes. Dr. Brunetti came to the Bureau by way of Lehigh University where he was an assistant professor in 1939. The scientific organization Eta Kappa Nu awarded him recognition as the outstanding young electrical engineer in the country in 1941, the year he became a permanent member of the Bureau of Standards staff.

Such were the men who pitted their intelligence and training against the problem of squeezing an automatic radio transmitter and detonating device into the nose of a mortar shell with such dependable performance characteristics that men could and did stake their lives upon it in action. With this background we can go on to consider the printed circuits themselves and their potential uses in our everyday life, for their can be little doubt that they will play a significant part in future technology.

Let's consider for a moment the advantages of the printed circuit over more conventional designs. It's smaller of course, since parts like binding posts are eliminated, and as we have seen, it can be made rugged enough to be fired from a gun or mortar without collapsing into a thin layer of uselessness. Another advantage not at first so apparent is that it can be made very much more cheaply than most conventional circuits, because almost the entire wiring job can be done in one operation. As now set up, wiring assemblies represent one of the major labor costs, as individual wires must be cut to length, the ends skinned, the wire bent to shape, and all joints soldered or connected. With the printing technique, each unit is practically a photographic reproduction of the master unit, permitting greater uniformity and less rejects at the end of production lines, and this should be reflected in lowered costs to the ultimate user.

Also, extensive use can be made of the idea of plug-in sub-assemblies, reducing the servicing of such devices to a simple operation of pulling out one small circuit section at a time and plugging in a replacement known to be good until normal operation resumes. The defective unit can then be taken to the shop for checking, and repaired or discarded as its condition indicates.

It's easy to see what an advantage this sort of servicing offers in equipment where continuity of service is vital, and on-the-spot repair by ordinary methods difficult or impossible because of the location, or the conditions existing. In a pinch, such replacements could be made by anyone without special training, and the defective unit turned over to the attention of the qualified repair staff later.

Of course the ruggedness and small size of circuits made by the printing method immediately open up many new fields for which electronic devices have hitherto been poorly adapted. Small personal radio transmitters and receivers can now really be made "pocket-size," without requiring any stretch of the imagination . . . or pocket. Hearing aids, portable recording equipment, control equipment for pilotless aircraft or guided missiles, automatic weather reporting stations, aircraft and shipboard radars, and scientific measuring and recording devices for field use; all these may benefit from use of the printing technique in their manufacture.

But it is time to take a look at just what that technique is, and how it produces such desirable characteristics. In developing the proximity fuze, it occurred to the men tackling the problem that a small plate of suitable insulating material could carry on its surface thin lines of conducting ink which would form the electrical connecting paths from the various coils, condensers, resistors, and miniature vacuum tubes. Several types of ink or paint were used for this part of the circuit. One satisfactory kind is a sodium silicate paint known as Sauereisen Conductulite. Another suitable one consists of powdered silver in a lacquer solution, the consistency being adjustable with an acetate solvent. The silver powder makes up about 65 percent of the mixture, which is usable for the coils as well. Silver-plating the coils after they are formed increases their efficiency by reducing their resistance to radio frequency current. In passing, a word about the shape of the coils may eliminate some puzzlement on the part of radio enthusiasts who were not in the field before 1925 or so. The coils are printed as a flat spiral of conductor on the surface of the ceramic plate (shades of the old helix of spark transmitter days!), or, as we shall see, wrapped spirally around a small cylinder of the ceramic, or even around the vacuum tube itself!

The resistors are made of another kind of ink, containing graphite, and lampblack in a liquid consisting of a mixture of methyl-methacrylate lacquer and toluene, and the condensers are of the type described earlier.

Assembly begins with placing of a silk screen mask of stencil over the base plate, through which the conducting lines are printed with the silver bearing ink. The plate is then heated to a temperature which dries the ink or paint, and bonds it firmly to the plate. Some of the paints developed do not require high firing temperatures, and these can be used in applications where other parts of the circuit would be damaged by much heat. The main advantage of the high temperature firing is that much stronger bonding to the backing plate can be secured.

After the "wires" are in place, the resistors are applied, also through a silk screen stencil which puts them right in place where the gaps have been left for them in the wiring pattern. The electrical resistance value obtained is adjustable either by varying the amount of graphite and lampblack in the mix, or by varying the length, width or thickness of the resistor strip itself.

With resistors painted in place, the plate is again heated in an oven to cure the resistors and stabilize their electrical values against intolerable changes in operation. Usually a special water-resistant resin coating is applied over them afterward to guard against atmospheric humidity effects.

With the resistors in place, the tiny ceramic condensers are put in place and soldered to the connecting wires. Then the sub miniature vacuum tubes of the types developed by the Sylvania and Raytheon Companies are mounted against the plate, or in some cases fitted into holes in the ceramic designed to receive them, and their terminals are connected to the rest of the circuit. After this it is ready for final test before being fitted into the fuze or other device.

Of course for experimental work it is not necessary to have the silk stencils made up. The circuits can be painted on the plate by hand with small brushes, or even directly on the glass of the tube itself, as shown in the picture.

Recently at a meeting of the Institute of Radio Engineers in New York's Commodore Hotel, several transmitters and receivers were shown and demonstrated which truly justified the name of "midget" radios. These were developed by Dr. Brunetti and W. J. Cronin of the Bureau of Standards, and several of their associates, working after their regular hours in a volunteer effort. One of the units shown is about the size of an ordinary lipstick, yet it provides enough output to permit communication at distances up to as much as ten miles under favorable conditions.

In experiments conducted at the Bureau and also at Columbus, Ohio, and during two nationwide broadcasts, the tiny transmitters and receivers provided excellent communication from separate rooms in the same building, from inside a metal body car four blocks away with the doors closed, and from a parking lot half a mile away. Of course, the power which can be applied to the tiny sets is limited, but the energy available from miniature batteries now being marketed is limited, too, and the small drain of the midget units will permit very reasonable service life for the completed units. Those built by Dr. Brunetti and his associates at the Bureau, which includes besides Mr. Cronin, J. J. Gurtowski, Robert L. Henry, Miss C. G. Moon, Max Shufer, G. J. Tedore, P. E. Landis, L. A. Riley, and E. A. Vogelsang, were designed to operate in a government frequency band assigned by the Federal Communications Commission between 132 and 144 megacycles, far above the regular broadcast and long distance communication bands. However, the design is not by any means limited to one band of frequencies.

It can be readily adapted by a slight modification of the coils and condensers to almost any range in the VHF region (30 to 300 megacycles), and also into the UHF part of the spectrum, where the newly conceived Citizens Radio channel is tentatively pegged at about 465 megacycles.

Since no license is required for operation of communications gear in this band when it is finally opened for service, this looks like a real opportunity for model plane enthusiasts who want to try radio control to go to town with their pet project. Probably opening of the band and evidence of a sufficient public interest will find several manufacturers of electronics equipment turning out subminiature sets for use in all sorts of ways by persons who do not feel able to devote the time and trouble necessary to obtain a radio license.

Judging from the reductions in size and weight effected in the units shown in the photographs, and in the various proximity fuzes, it should also be possible to produce radio control units light enough for use even in Class B or Class A free flight model planes. Even if the circuits are printed on plastic plates instead of the vacuum tubes themselves, we must remember than several of the suitable plastics are far lighter than aluminum or even magnesium, the materials which formerly were used for chassis construction in radio control units.

For other applications of course, the midget units offer equal or greater advantages. Crime detection, the location of illegal radio equipment or sources of radio noise which are a nuisance to the private citizen who wants to hear Crosby and Hope and a deadly danger to airways communications and other services where dependable communication are vital; these are uses in which the ruggedness and portability of the printed circuits can really show their worth. Also, the inconspicuousness of the equipment is very important. The entire unit, including the tiny batteries, can easily be concealed in a pocket, and very small microphones and earpieces have already been developed to round out the apparatus for real service. Even the antenna need be only a short spike of wire, and this readily lends itself to disguise as something else, such as a pencil or woman's hat ornament.

Another group that stands to benefit from the development is the increasing army of glider enthusiasts, who want to be able to communicate with each other in the air and often with their take-off point, but who don't want to lower the performance of a good sailplane with needless added weight. Since very few gliders can provide any power source other than batteries, it is obvious that the midget sets with their very low battery drain and almost negligible size and weight will be a real answer to this troublesome problem. And in addition to communication, they can be used to provide direction indication and several other features of full size radio apparatus formerly impracticable in equipment of light enough weight to justify inclusion in a sailplane's equipment. Even with the sailplane out of sight above a cloud deck, its direction can be determined from the base by taking radio bearings on the midget transmitter in the plane, and advice or instruction can then be given the pilot as conditions warrant.

More elaborate equipment than the simple one or two tube transmitters and receivers can be constructed, of course, and many of these offer large fields of application. An electronic "memory" circuit is possible which could be built into the base of a telephone. By using such a device the telephone subscriber could dial the number before lifting the receiver, and the "memory" device would complete the central station switching in perhaps a tenth of a second, thereby speeding up considerably the flow of traffic through heavily crowded switchboards, since the "waiting" time entailed while numbers are dialed amounts to an appreciable portion of the total usable time on any telephone circuit.

Portable recording devices using either wire or ribbons of magnetic material can be made small enough by this method to permit a business man to easily make permanent records of conferences where no stenographic aid was available, or even without the knowledge of unauthorized persons who might be present. Also, the uses of such really small and portable equipment would be a great help to touring theatrical groups, bands, political speakers, salesmen, and many others who need to keep a record of what is said or done at remote or inconvenient locations.

Little has been said about applications of these circuits for military purposes, as many of these remain high on the secret list. The secrets of the proximity fuze were revealed only after long and careful consideration by Colonel H. M. Roberts of the Army Ordnance Department, upon whose recommendation the details were released by the Chief of Ordnance for use in industry.

Nevertheless, a little serious thinking must reveal to anyone that literally dozens of ways can be found to take further advantage of the small size, ruggedness and small power drain of the new apparatus. Without going into detail we can see that the problems of controlling pilotless aircraft and guided missiles become much simpler with such units. The problem of mass production of equipment for such purposes, usually a headache in itself because of the heavy requirement in plant floor space and skilled or semi-skilled technical labor forces, is also sharply reduced. Remember that much of the operation is reduced to a simple stencilling procedure which can be learned by inexperienced workers in a relatively short time compared to that consumed in learning good radio wire soldering, stripping, etc., and the bugaboo of the wrong connection is almost completely eliminated, as the stencil can be carried by registry pins which won't permit misalignment.

The Centralab Division of Globe Union, which was closely connected with development of the new circuit building technique, has already put on the market a small sub-assembly based on the new method, which is now being offered to manufacturers of radio equipment for inclusion in new designs. It seems almost certain that other manufacturers will follow suit, as the sales appeal of greater lightness and portability will surely prove attractive enough to the public to justify revamping old designs in the near future.

It is impossible in a short article to cover all the applications where the new circuits may be utilized with profit, even if one person could think of them. Doubtless many readers of these pages already have a pet idea where a really small radio transmitter, receiver, amplifier electronic control unit or measuring device will really make possible what was formerly only a wishful dream, and many will probably be putting such schemes into practice before long. Possibly a really good and reasonably priced control unit for model planes will be marketed by some enterprising manufacturer which can be included in free flight ships to end the bugaboo of lost planes and wasted effort! Such a unit could be of a standard weight for each class of competition, which would keep planes on an equal footing and still offer reasonable assurance that a fellow would take home almost as many models as he left with, something that often doesn't happen in free flight competition.

Of course, many of these same considerations apply to other things like model boats and cars, or for trick stunt applications and in handling the crowds at big outdoor meets where communication between the various contest rings and the judges, weighing stations, etc., are, to say the least, inadequate, but we can safely leave these uses to the imagination and ingenuity of people who have to deal with such problems. The midget circuit put on with a brush and stencil is here to stay, and will soon be stating its own case better than any one article can.

Problems of High Speed Flight

(Continued from page 41)

of slowing down a rocket, without its becoming overheated while reentering the atmosphere at several thousand miles per hour, appear possible. No practicable method, however, has yet been developed. Everyday rocket travel, therefore, appears to be in the rather distant future.

There have been many recent developments in aircraft and space craft. These are shown in the accompanying drawing, entitled a Flight and Propulsion Spectrum. This chart was prepared in order to facilitate the thinking and understanding of this subject, and to illustrate that there is a most suitable type of craft and method of propulsion for each purpose. At the left side the origin and development of various aircraft and propulsion means are illustrated. At the top of the chart are curves illustrating some of the more significant characteristics of high speed flight. These curves pertain to airborne machines and do not apply to rocket or space devices operating beyond the earth's atmosphere. The first of these illustrates that with present knowledge propeller-driven airplanes are limited to speeds of approximately 600 mph. The second curve illustrates that a vehicle flying through the atmosphere at increasing speeds for sustained periods of time will experience an increase in temperature from friction or aerodynamic heating. This was considered, until the last few years, as unimportant and often overlooked. Although the temperature will increase as the square of the speed, the chart does not show it beyond 200 degrees, or 1,000 mph. The third curve illustrates the abrupt increase in power required at speeds above 500 mph with present-type aircraft. The dotted line illustrates a probable power requirement that may be realized in the not too distant future, as the result of intensive aerodynamic development. The vertical band illustrates a speed range between approximately 600 and 900 mph, generally referred to as the sonic barrier.

It is interesting to note in this connection that a present day hypothetical 20,000-pound airplane of conventional design, flying at 40,000 feet, would require approximately 11,000 thrust horsepower to fly at a speed of 600 mph. If it should be desired to increase the speed of the same airplane to 1,000 mph, it would be necessary to increase the power sixfold to 67,000 thrust horsepower. It is doubtful that any present-day airplane could withstand the forces imposed at 1,000 mph even if this power were available.

The airplane illustrations shown on the chart indicate the most probable operating ranges for each of the various types of craft and methods of propulsion. Unfortunately, no simple method of introducing altitude effects into this chart has been found. It must be borne in mind that the reciprocating engine, propeller turbine engines, turbo-jet engines, and ram-jet engines are all air breathing and are therefore confined to the lower atmosphere. Rockets, carrying their own oxidizers, are independent of the atmosphere and, therefore, operate best in space.

Why has "sonic barrier" been illustrated so prominently? Perhaps one of the best answers to this question is that, in spite of all the attempts that have been made, there is no living person who has ever been able to reach the speed of sound. The only self-propelled machines that have exceeded the speed of sound are uninhabited missiles or rockets. This situation has naturally been a strong challenge, not only to our abilities, but our imagination, and has resulted in the logical expression, "sonic barrier."

Discussion of present-day flying requires frequent reference to the speed of sound and the Mach number. The Mach number is the ratio of a given speed to the speed of sound, a Mach number of 1 being the speed of sound. These references are very important to present-day flight studies as compressibility effects, which are perhaps among our greatest problems, bear a direct relationship to the speed of sound. The speed of sound varies directly with altitude between 761 mph at sea level and 663 mph at 35,000 feet. It is constant above that point to 100,000 feet. For example, a compressibility characteristic that may occur at a Mach number of .9, or approximately 685 mph at sea level, will also occur very much the same at a Mach number of .9 at a 36,000-foot altitude, but at that altitude at a true speed of only approximately 595 mph. Contrary to common belief, the speed of sound is proportional to temperature variations only, not density.

Perhaps one of the greatest problems in going through the so-called sonic speed barrier is learning to control the inconsistent air forces encountered in that speed range. Airflow in the subsonic range below about three-fourths of the speed of sound is relatively consistent. At about that speed, however, local velocities over highly contoured surfaces reach the speed of sound resulting in compressibility effects or shock waves.

An accompanying illustration shows that when a normal subsonic wing travels at 500 mph, local velocities are accelerated to the neighborhood of 600 mph or more depending on the contour of the airfoil. The same airfoil, however, when traveling at 700 mph, will have local velocities in the neighborhood of 1,000 mph, well above the speed of sound. This results in compressibility effects and shock waves, as diagrammatically illustrated. The typical supersonic airfoil shown at a Mach number of 2, has a definite shock wave pattern, but is believed much more stable than the transonic case.

To reduce the adverse effects of compressibility and shock waves with airplanes of recent design, great effort has been made to keep local velocities as low as possible. This has necessitated decreasing both thickness and camber of wings. Where wing sections of 18 percent thickness were quite common a few years ago, many high speed airplanes now have wings of only eight and 10 percent thickness, and some designs under consideration as thin as four to six percent. This trend imposes many new structural and aerodynamic problems and will continue to challenge the ingenuity of designers for many years to come.

Supersonic airfoils of the future will probably have pointed leading edges similar to the typical supersonic airfoil shown. The greatest objection to this type of airfoil is the low lift coefficient which makes it, at present, impracticable to meet the low speed stability control and landing requirements for human-carrying airplanes. The development of extensible rounded leading edges may offer a solution to this problem but, as yet, there has been no satisfactory full-scale application.

The two most likely methods of achieving supersonic flight appear to be to increase the speed of subsonic type airfoils by controlling the compressibility effects, and the development of the supersonic airfoils to permit their efficient use at low speeds. Both methods are being investigated and show promise.

This chart also contains a simplified description of subsonic, transonic, and supersonic speeds. Subsonic extends from zero to approximately three-fourths of the speed of sound and is defined as a speed range where local velocities over an airplane are all less than the speed of sound. The transonic region is shown between approximately three-fourths the speed of sound and 1.2 times the speed of sound, and is defined as a region where local velocities are both above and below the speed of sound. It is this combination of speeds that causes transonic stability difficulties. The supersonic region is simply defined as the region where all velocities exceed the speed of sound, and although these conditions are generally believed to be relatively steady there is still very little known about them.

In addition to the adverse effects of compressibility on stability and control, compressibility greatly increases the power requirements in the transonic range. Again, to illustrate the point, a typical 20,000-pound, hypothetical airplane of modern design was chosen, but the requirements in this case are based on sea level operation. Without compressibility it would be possible to reach 1,000 mph at sea level with approximately 12,000 horsepower. Due to compressibility effects the actual power required to fly 1,000 mph at sea level is a little over 80,000 horsepower.

Recently, knowledge of the upper atmosphere has taken on a new and important significance. With the operating altitude of airplanes increasing to the stratosphere for greater reduction in aerodynamic drag, and rockets operating at their greatest efficiency outside of the atmosphere, it has become necessary to increase our general knowledge on the subject. To this end, various Government-sponsored high-altitude exploratory projects are understood to be in progress. According to the present somewhat arbitrary but best available knowledge, the absolute air pressure drops off from 14.7 pounds at sea level to .16 pounds per square inch at 100,000 feet. In this connection it is interesting that the world's airplane altitude record of 56,176 feet established by Colonel Mario Pezzi of Italy in 1938, and the occupied balloon altitude record of 72,395 feet established by Anderson and Stevens in 1935 still stand. There has been surprisingly little activity in this field in recent years.

The standard air temperature variation with altitude for our latitudes is represented by a straight line from 59 degrees F at sea level to -65 degrees at 35,000 feet, and constant above that point to 100,000 feet. The true average probably follows a slightly different path. Above 100,000 feet it is believed to rise to approximately 300 degrees F at 200,000 feet. It is apparent, too, from noctilucent clouds at altitudes of approximately 250,000 feet that temperatures are below freezing. The speed of sound curve parallels the temperature curve, since, as previously mentioned, it is influenced only by temperature.

The effects of higher altitudes on human beings and aircraft are of considerable interest. For the average inactive human being, supplementary oxygen is required between 15 and 20,000 feet, if not lower. At 21,000 feet there is insufficient oxygen to support the combustion of a candle flame. At 32,000 feet where the temperature is -65 degrees, gasoline boils if unpressurized. At 33,000 feet pure oxygen must be breathed in order to supply a human body with oxygen equivalent to the amount normally breathed at sea level. At 63,000 feet and body temperature of 98.6 degrees, blood will boil without pressurization. At approximately 250,000 feet sound waves are no longer propagated due to the increased distance between the molecules of the air. These points of interest clearly indicate the need for cabin pressurization and air conditioning.

The development of the rocket has supplied the scientists with a new tool for the investigation of the upper atmosphere, and it is hoped that sounding rocket flights to the upper atmosphere will, in the near future, supply the aeronautical engineers with much more complete and reliable data than are presently available. Here again the possibilities of rockets can be appreciated by comparing the 65-mile altitude of the German V-2, which late in this country reached over 100 miles, with the 10-mile altitude record of the airplane.

During the past few years, the problems of designing and testing aircraft equipment to operate at the frigid (-65 degrees F) temperatures encountered in the upper atmosphere have, in general, been satisfactorily solved. There now appears a much more serious problem in raising the upper temperature limit of structures and equipment. The Figure, Airspeed Limitations, illustrates temperatures that may be encountered in continuous flight at speeds between zero and 2,000 mph, and at altitudes from sea level to 35,000 feet due to the compressibility heat rise.

It can be seen that sea level flight at 800 mph would result in the entire aircraft and equipment exceeding the temperature of all structural and equipment design specifications. This does not take into account engine heat or solar radiation which usually further aggravates the problem. At 35,000 feet and above, this speed would be raised to 1,150 mph because of the cooler upper atmosphere.

It is quite obvious from this chart that at speeds much above 600 mph it will be necessary to develop equipment capable of withstanding higher temperatures than present equipment, or provide sufficient refrigeration for vital items of equipment. Many modern airplanes are already being provided with refrigeration in order to maintain cockpit and cabin temperatures at endurable levels.

Remembering there is an aerodynamic temperature rise of 200 degrees at a speed of 1,000 mph, let's see what would happen to an aircraft structure when traveling 1,000 mph near sea level on a standard 100-degree hot day. Add the 200-degree temperature rise to the 100-degree ambient and you will see that the approximate allowable stress of various materials is as follows: chrome molybdenum steel is down to about 92 percent; 24S aluminum alloy, to 87 percent; magnesium, to 72 percent; phenolic moldings, to 68 percent; nylon, to 67 percent; phenolic laminates, to 52 percent; 75S aluminum alloy, to 40 percent; and the various plastic materials are down to zero.

Now, of course, if this same airplane were flying at 35,000 feet or above where the temperature would be approximately -65 degrees, it would be possible to operate at 1,000 mph with less than a 10 percent strength reduction in the structural materials mentioned, with the exception of the plastic materials. Thus it can be seen that every present indication is that the 1,000-mph airplane would be required to confine its full speed operation to higher altitudes and limit its sea level operation, particularly on hot days, to the neighborhood of 700 mph.

While the possibilities of high speed aircraft are unlimited, it is apparent many problems will be encountered in approaching sonic velocities. Too, although we may expect future progress to equal or surpass that already achieved, the development problems are becoming greater at a rapidly increasing rate. Because of the high costs involved, future development will be largely proportional to the financial appropriations made available. Money, not science, will largely govern the rate of progress. From a theoretical viewpoint, there appears no reason why aircraft speeds will not advance in the future at an increasing rate.

Development of the Diesels

(*Continued from page 58*)

sion and the mixing valve; when a mixture containing much ether is compressed and ignited at a high compression, or if the compression adjustment has been attained and there is a too rich or lean mixture entering the cylinder slow burning results, giving the motor a pinging, or knocking, sound. The theory is that the ether ignited and burned during the power stroke and continued to burn on the compression stroke, since it could not escape entirely when the tiny exhaust ports (a bad feature of European motors) were open. But, as stated before, any diesel will run smoothly if properly adjusted and the correct fuel mixture for that motor is used. Note how formulae vary on the fuel table. (These motors run successfully on other mixtures, but for comparison the manufacturer's fuel formulae are given.)

From observation we note that no diesel burns the fuel completely. Eisfeld apparently noted this and tried with some success to correct it by port timing and arrangement. Note on the photo that the Eisfeld DV-2 motor has a single small exhaust port. Inlet ports deflect the fuel-air mixture to the opposite side of the cylinder and the exhaust port begins to open well before the inlet ports. (The piston is flat-topped.) Thus he overcame to some extent the bad feature of a flat-topped deflectorless piston which necessarily must be used in combination with a contra-piston; such an arrangement is necessary to give ease in handling for the average modeler whose fuel mixture may vary. It also eases the work of production.

Eisfeld worked from the original Swiss Dyno design and could only draw from that and his experience gained as a builder of gas motors. He did not know of the French experiments of Gladieux and Morin who must have obtained the diesel idea also from the Swiss Dyno, but discarded its primitive fuel and power wasting porting and design for the rotary valve and fixed compression of an American gas motor known to them, the world famous Baby Cyclone. The stroke was only a very little greater than the bore. A magnificent production job of lapping of the crankshaft and piston, and a fixed, finned cylinder head which almost touched the piston at top dead center sealed the motor. Fuel entered the mixing valve at the bottom of the crankshaft bearing, passed through the crankshaft rotary valve into the crankcase, then was ported upward through the bypass and deflected by a milled slot on the top of the piston. This milled slot forms almost the only space into which the mixture is compressed at top dead center. See photo of the Micron 5cc. and the Ouragon diesels. Walt Schroder demonstrated a similar American made fixed compression motor (known now as the Mite) at the Wichita Nationals.

A motor requiring a great deal of ether for its successful operation runs cool and does not seem completely to burn all of the fuel. The exhaust is smelly and oil comes out in gobs. In contrast some motors knock badly when much ether is used, requiring the addition of another fuel such as naphtha to the mixture. The ether ignites under compression and when the motor warms up, it in turn ignites the naphtha The Eisfeld will start instantly on a mixture containing as little as 10% ether. Under these conditions higher temperatures are reached since there is less ether to give a cooling effect due to its high volatility, and a more complete combustion results in higher r.p.m., the ether serving its true purpose as an igniter.

Ordinary motor oil seems to contain too much sludge. Europeans long ago found that an oil with a paraffin base was best because it is more soluble in the ether and the paraffin will burn at least partially because of its low ignition temperature. They recommend light oils such as SAE 30, and specifically state that American motor oil is not to be used. The Gladieux Micron for instance calls for lard oil and paraffin oil mixed with ether. These oils will lubricate effectively at cool running temperature on the flying field. They also seem to dampen the knocking qualities of the ether, possibly because they are combustible also at low temperatures. All diesels have a trickle of oil dripping from the exhaust port during operation, that oil being black and small in quantity when excellent running is obtained. All diesels are accompanied by a set of instructions and a fuel formula which must be followed exactly. If you have a "liberated" European motor and lack this information, write the author, c/o Air Trails, for a fuel formula for it.

Frequently, the author has been asked to evaluate the diesel motor and this is an attempt at it. First, remember that we are speaking of a motor which is in its infant stage of development and, therefore, cannot be compared to a highly developed American gas motor. Second, it is hardly suitable for high speed U-control work, because of its comparatively low r.p.m. due, of course, to lack of knowledge and, therefore, poor design. It is difficult or in some cases impossible to handle or start a diesel with a small prop and when it is started, little or no improvement is noted in r.p.m. (American diesels show better performance giving high r.p.m. with small, heavy props.)

On the other hand, a diesel will give a definite advantage in free flight model work because it will turn a large prop at a fair speed. A motor of .301 cu. in. (the 5cc French Micron shown in the photos) will turn a 14" prop at 4-6,000 r.p.m., performance equal to the old Brown, Jr., which was a .60 cu. in. motor. This shows well in European competition, where the Micron 5cc motor is pulling heavy 5 ft. models up in the traditional American tight spiral climb, (to the amazement and sometimes disgust of British modelers who favor slow precision flight).

The following table of temperatures (centrigrade) at which various fuels ignite will serve to explain the use of the fuels shown in the table of fuel mixtures.

Cetane—250°C.
Fuel oil or kerosene—265°C.
Petroleum—290°C.
Lard oil—250 to 300°C.
Oil of turpentine—300°C.
Paraffin—380°C.
Sulphuric (motor) ether—390°C.
Gasoline (depending on its source) —500 to 600°C.
Alcohol—700°C.
Benzol—750°C.

This table is of European origin and it is suggested that you do further research on this matter.

A major fault of some diesels is the ability to run in either direction and to reverse direction without stopping (caused by too lean a mixture)! A motor with a rotary valve corrects this because it is timed to run in one direction only, despite the mixture settings.

Several types of cut-off valves are in use to give desired motor run. All are spring-loaded and tripped by an air or mechanical timer.

1. The Micron 5cc uses a spring-loaded needle valve to cut off the fuel at the tank outlet. It is an integral part of the tank assembly. By far the most positive, it kills the motor 2 to 3 seconds after being tripped.

2. The Eisfeld and Mills (British) use a sleeve valve on the fuel line which is spring-loaded and timer-tripped, causing air to bleed into the mixture leaning it and (we hope) cutting the motor. Positive results can only be obtained by careful carbureter and compression settings.

3. Some Italian motors have a tapped hole in the bottom of the crankcase into which a spring-loaded needle valve is fitted. Positive results are obtained but you must make the parts yourself!

Evaluation and History of the Motors Illustrated

1. The Arden .099 is shown only for comparison of size, workmanship, and design. With a diesel head performance is not too good.

2. The Allouchery 1.25cc was picked up while the author was in Paris. It is a handmade production model on the lines of a Dyno, and gives fair performance. Its life was only one hour. M. Allouchery showed a tiny motor of similar design of only .0098 cu. in. which he said turns up 12,000 r.p.m. His collection of motors is second only to that of Ray Arden, some dating back to pre World War I years.

3. The Movo D-2 is built by Signor Clerici of Milan. Spurred by large orders from the U.S. it has the largest production of European motors. Its performance is good with proper fuel. Workmanship is excellent. Basically, it is an improved Dyno.

4. The Eisfeld DV-2, built by Gus-[illegible]ave Eisfeld of Germany, is notable [illegible] its typically fine functional design [illegible] workmanship. Performance is [illegible], since the speed can be varied [illegible] starting requires only a flip of the prop.

8. Developed from the Swiss Dyno, during the time when Germany began to be hemmed in 1944-45, it shows no other influence in its design and it certainly served its purpose in giving the German modelers a reliable diesel at a time when ignition equipment could no longer be produced due to the all-out war effort. A .5cc (.037 cu. in.) motor also was produced in quantity. Its appearance was similar, but it turned up 9,300 r.p.m. Seems the little ones tend really to wind up. The author was to be given one by a German modele , but it was lost O.O.S. on that last flight! Russia is getting Eisfeld motors now.

5. The Dyno 1, the original diesel [illegible] Europe. It is still produced and used throughout Switzerland (and the rest of the world!) The motor shown was used to power a model built by the author in a tent by candlelight in the mud of Italy during the winter of 1944-45. The Dyno has a long life (this one is 6 years old) and is built with typical Swiss precision. Performance is good, but it is very heavy.

6. The Micron .5cc. Note the rotary valve and fixed compression head. It combines decent appearance with terrific power. Its life is 12 to 24 hours of peak performance, due perhaps to the soft cast iron piston working in a hard steel cylinder. The motor shown was rebuilt by plating the cylinder and relapping the piston so that now its compression (20-1) is really something.

7. The Delmo, a product of Paris, gives fair performance, flying a five-foot free-flight model nicely and doing 66 mph on a control-line model. Its power is equal to a Baby Cyclone with only half of the displacement. Note the lever on the top of the intake tube, which is used to bleed air into it, thereby leaning the mixture and cutting the motor. The plates on the side of the cylinder serve as baffles to deflect the spray of oil from the exhausts downward.

8. The Uvanio, a new product of Signor Manicini of Florence, Italy, is designed primarily for U-control, but is used also for free flight. It is powerful, but heavy. Note the typical Italian design in the placing of the tank, streamlined over-all appearance and single radial mounting screw.

9. The Micron .8cc, a really tiny motor, is dwarfed by the 9" prop it swings. Its displacement is .048 cu.in. (half of the Arden .099) and since it weighs only 1½ oz. complete making a 3-oz. model possible (mine weighed 4½ oz. complete; 40" span). It starts with ease and shows remarkable power for its size. Workmanship is a tribute to French motor builders.

10. The Ouragon, which just arrived, shows several outstanding features. Compression is regulated by an off-center drilled moveable main bearing, worked by the lever shown. Note the fixed cylinder head and exhaust ports. A rotary valve takes fuel through the rear of the crankcase and the motor is meant to be run inverted. Better piston fit and all round workmanship would show its tone value.

11. The Micron 2.8cc., a good reliable compact and light motor, built with Micron precision. It flies a Zipper quite well with its displacement of .172 cu.in.

12. The Helium C-6, of .388 cu.in. displacement is claimed to develop ¼ hp at 6200 r.p.m. Its design is conventional except for the vertical fins which are ornamental (for that matter all fins on all diesels are ornaments). The author's Helium starts on a single flip, runs well, but has a lot of vibration.

13. Arden deisel, compared to ignition version, power and r.p.m. is poor. Detonation is bad; sometimes a little mineral oil in the fuel helps. Advice: convert back to ignition and get the 10,000 r.p.m. an Arden will give!

14. Mills. A finely built midget from England. Turns fast, starts fast, instant cut out, .078 cu.in. flies 60" jobs in England, costs $22. Mine was delivered 12 months after being ordered.

15. Mite. First American diesel, small in size, big in power. Follows lines of French Micron. Dandy for sport flying small ships. Has tendency at times to detonate (pre-firing) which does not seem to harm it. Has high r.p.m. I use it for free-flight scale models.

16. C.I.E. American diesel closely following European design, but it packs more power. Easy starting and good performance. High r.p.m. Advice: use mineral oil or crude oil instead of naphtha specified by the manufacturers. My C.I.E. never fails to start instantly. "Beware of the prop." I join the manufacturer in this warning as I look at a line of skinned knuckles.

17. Drone. Hot! But take it easy now, bud. Run it in carefully with 14" prop and recommended fuel, about one to four hours. Now use a ten-inch plastic prop for a while, and join me in being surprised at the high speed, smooth running and lots of noise (for U-controlers lonesome for the snare of gas motors) all three—Mite, C.I.E., and Drone are a credit to U.S. designers.

So you want a diesel? Buy American, bud, for quality and service. Trade, money exchange, mails, and dishonesty, combine to make it difficult to obtain foreign motors. I have paid $35 to $60 for a single motor and have lost several being passed hand to hand where mail service does not exist.

Operation of a Diesel

1. Attach prop firmly for easy cranking. Use only prop recommended by manufacturer.
2. Mount the motor *solidly*.
3. Close needle valve, fill tank with recommended mixture. Be careful; the stuff is very inflammable and if exposed the ether evaporates leaving the fuel worthless.
4. Open needle valve recommended turns. Prime one turn.
5. Flip prop over smartly. Motor will start immediately. If it runs continuously, adjust needle valve and

compression lever for smooth running.

5. If the motor fires, but reverses direction or oscillates, stop it by putting your finger over the exhaust, open the needle valve or release compression and crank. Cause was lean mixture and/or too high compression.

6. A diesel starts so quickly that if it is not running immediately, look for trouble. Quiet reasoning often leads to a solution quicker than frantic cranking.

Last Minute Notes:

Some Europeans are running their motors without ether. (Chemicals with the same properties as ether are known, but ether is easiest to obtain.)

Commercial ether at about $1.10 per pound is satisfactory and cheapest. Any kind of ether will run a diesel. If your motor misses and will not start and run smoothly, use mineral oil (medicinal) as a dampener. It has not failed to help any stubborn motor to perform well for the author. However, don't try to improve on a manufacturers fuel formula, except to use mineral oil in place of naphtha when naphtha gives poor results.

Crude oil works well also as a dampener.

Formulae:	10% #30 to #70 oil
65% ether	70% ether
25% mineral oil	30% crude oil

Formulae may be varied somewhat, but these are OK for most motors.

Do not experiment with fuels unless you have trouble.

Run motors out of doors to avoid becoming sick from exhaust fumes.

Prepared fuel is supplied with many diesels. It saves time and money.

Diesels, like any motor, must be run in and require careful handling. Use largest prop the motor will turn for break in.

When using small diameter pr[illegible] on diesels, select heavy wood or p[illegible] tic or combine a flywheel wi[illegible] prop. They work [illegible] under [illegible] This applies to America[illegible] European do not always w[illegible] small props.

When a twin exhaust diesel starts but will not continue to run, close one exhaust port with your finger (It ain't hot!) until it is running, then let go. To stop a motor, quickly close exhaust with your fingers.

FUEL MIXTURES (MFGR'S SPECIFICATIONS)

Motor	Ether	White Gas or Naphtha	Turpentine	Paraffine	Motor Oil
Micron .8	75%				25%
Micron 5	75%			15%	10%
Allouchery	33⅓%	33⅓%			33⅓%
Movo D-2	38%	38%			24%
Eisfeld	13%	24%	24%	24%	15%
Dyno 1	13%	24%	24%	24%	15[illegible]
Delmo	50%				50%
Uranio	38%	38%			24%
Ouragan	45%	15%			40%
Helium	43.5%	43.5%			13%
Mills	50%	Special oil 50%			
Mite	50%	SAE 20%-50%			
C.I.E.	45%	45%			10-15%
Drone	75%	Mineral oil 25%—A few drops #70			

NOTE: When a motor gives poor performance (4 cycling and missing or detonating) use mineral oil in place of naphtha. It is almost a cure-all. Crude petroleum is sometimes O.K. also.

TABLE OF MOTOR SPECIFICATIONS FOR COMPARISON

Motor	Displacement		Prop. Dia.	Bore	Stroke	Wt. (Oz.)	R.P.M.	Origin
	CC.	Cu. In.						
Micron	0.8	.048	9"	.395"	.395"	1.48	5,000	French
Micron	2.8	1.72	12"	.560"	.618"	4.95	4,500 5,000	French
Micron	5.0	.301	14"	.680"	.875"	9.90	5,000	French
Allouchery	1.25	.076	10"	.394"	.630"	3.00	6,000	French
Movo D-2	2.0	.122	12"	.475"	.682"	5.25	4,000 5,000	Italian
Eisfeld DC-2	2.5	.153	12"	.547"	.609"	6.00	7,000	German
Dyno 1	2.0	.122	13"	.400"	.700"	7.00	4,000 5,000	Swiss
Delmo	2.65	.162	12"	.520"	.784"	8.80	5,500	French
Uranio	4.0	.245	11" 14"	.610"	.850"	9.50	6,000*	Italian
Ouragan	3.36	.205	12"	.590"	.750"	7.00	5,000	French
Helium C-6	6.3	.380	16"	.719"	.950"	11.65	6,200 6,500	Italian
Arden (Gas Motor)	——	.099	9"	.5"	.5"	2.0	8,000 10,000	U. S.
Arden (Diesel Head)	——	.099	8"	.5"	.5"	2.0	6,000	U. S.
Mills	1.3	.078	9"	.422"	.609"	4.5	7,000	English
Mite		.099	9"	.5"	.5"	2.6	9,000	U. S.
C.I.E.	——	.14	10"	.5"	.75"	6 (Approx.)	7,000*	U. S.
Drone	——	.297	10" 14"	.656"	.875"	10	5-8,000	U. S.

Race Car News

(Continued from page 70)

City	Name of Club	Secretary	Address
COLORADO			
Pueblo	Min. Race Car Assn.	Mel Baker	310 W. 21st St.
Denver	Min. Race Car Club	Lee Ziegler	3927 Yates
CONNECTICUT			
Bridgeport	Model Race Car Club	Stanley Westlake	350 Hooker Rd.
Stamford	Model Engineers	C. E. Cartwright	34 Pacific St.
Stratford	Fairfield County R. C. Club	Bob Anderson	820 Nicholas St.
Hartford	Nutmeg Model Car Club	Larry V. Clinton	25 Bonner
CANADA			
Quebec		Wm. Vertilnick	711 Provost St.
DELAWARE			
Wilmington		R. L. McKnight	16 No. Pennewill Dr.
DISTRICT OF COLUMBIA			
Washington, D. C.	Miniature Car Club	Bob Kirwan	4318 No. Fairfax, Arlington, Va.
FLORIDA			
Eustis	Min. Race Car Club	Ed. Stone	Box 966, Eustis Airport
Daytona Beach	Miniature Race Car	William Thomas	105 No. Halifax
Jacksonville	Naval Air Station "Flywheels"	Frank Ironmonger	1109 Cherry
		Chief R. Hubbard	Naval Air Station
Miami	Society of Model Engineers	Wm. Charles	1404 Court House
Ormond Beach	Model Midgets	Lawson Diggett	Box 104 Daytona Beach
Pensacola		L. L. Wilhite	301 No. Alcaize
Tampa		W. A. Wilson	4607 Bay-to-Bay Blvd.
St. Petersburg		D. W. Hulse	28 1st St.
GEORGIA			
Atlanta	Motor Race Car Club	C. E. Simmons	205 No. Ave. N.E.
Decatur		W. F. Roberts	105 E. Lake Dr.
ILLINOIS			
Belleville		Walt Glatthaar	548 No. 14 East St. Louis
Chicago	Rail Track	James Thompson	1922 So. 61, Cicero
Champaign	Model Race Car Club	Mel Knell	606 No. Lincoln, Urbana
Urbana	(Same as Champaign)		
Danville	Model Racing Club	C. Allen	109 Pennsylvania Ave.
Harvey	Model Race Car Assn.	Hap Wyckoff	4708 Ellis Ave.
Kankakee	Model Race Car Club	H. Laflamme	768 So. Main
Peoria	Model Race Car Club	C. E. Sapp	2007 Main
Rockford		Glenn Matthews	732 Park View Ave.
Rock Island		Richard Brooks	626—12th Ave.
Waukegan		John Mayfield	2011 North Ave.
INDIANA			
Anderson	Min. Race Car Club	Gerald Wilson	3313 Morton St.
Indianapolis	Model R. C. Club	L. E. Wallace	3541 North Temple
Hartford City	Min. Car Club	B. Cronin	521 No. Jefferson
Kokomo	Miniature Car Club	Bob Chapman	Box 3 West Middleton
Lafayette	Miniature Race Car Club	Ed. Hitze	1514 No. 12th
South Bend	M. R. C. A. (Near Mishawaka)	W. Ewers	623 So. Union, Mishawaka
New Castle	Model Car Assn.	E. E. Luttrell	1014 Southern Ave.
Gary	Miniature Race Car Club	C. Jeffries	625 W. 6th
IOWA			
Des Moines	M. R. C. Assn.	P. O. Pickle	4110 University
Davenport	Miniature Car Club	A. W. Groman	1726 West St.
KANSAS			
Kansas City	Greater K. C. Model Car Club	W. Kaiser	1020 Oak St.
Salina	Race Car Assn.	F. E. King	749 Highland
	A. M. R. C. A. Director	Joe Addison	302 So. College
Wichita	Model Car Club	J. E. McFall	130 M St. Francis
KENTUCKY			
Louisville		B. S. Hurdlow	140 E. Woodlawn
LOUISIANA			
Monroe	La. Miniature Race Car	Fran Brennen	515 Ouachita Ave.
New Orleans	Car Club	Wm. Wunderlich	1627 Melpomene St.
MARYLAND			
Baltimore	Miniature Race Car Club	S. L. Tenberg	5274 Park Heights
Annapolis	Ritchie Model Speedway	T. R. Riley	R.F.D. 2
Hagerstown		John Young	Box 691
MASSACHUSETTS			
Auburn	Model Race Car Club	Al Dion	3 Mayfield Rd.
Boston	Miniature Car Assn.	F. A. Barry	36 Tileston St.
Worcester		W. Underwood	262 Pleasant St.
Everett	(Same as Boston)		
MICHIGAN			
Detroit	Miniature Race Car Club	John Weightman	11645 Griggs
	A. M. R. C. A. Director	Ken Held	144-446 Eastburn Ave.
Saginaw	Race Car Club	W. F. S. Schmidt	809 East Genesee

City	*Name of Club*	*Secretary*	*Address*
	MINNESOTA		
St. Paul Minneapolis	Twin Cities Model Car Club	Lyton Calrow	593 No. Snelling St. Paul
	MISSISSIPPI		
Greenwood	Miniature Race Car Assn.	Jack Morales	320 W. Adams
	MISSOURI		
St. Louis	M. R. C. Assn.	Al Winter	1254 Delaware Ave.
Kansas City	Heart of America Car Club		3225 Holmes
	NEBRASKA		
Lincoln	Min. Race Car Club	Ed. Berryman	746 B St.
Omaha	Race Car Club	G. Zenchuk	1706 Howard St.
	NEW JERSEY		
Trenton	Model Car Club	Bela Janowics	1924 Chestnut
Kearney	M. R. C. Assn.	Chas. Poterala	405 Walker St., Cliffside
Garfield	Jersey Model Club	J. Denuto	245 Lincoln Pl.
Atlantic City		E. F. Price	9 E. Frombes, Pleasantville, N. J.
	NEW MEXICO		
Alburqueque	Model Race Car Club	R. P. Roebuck	601 So. 6th
	NEW YORK		
Binghamton Johnson City Endicott Vestal Auburn And nearby cities	Tri-Cities Club and Susquehanna Valley Miniature Race Car Club	Dave Reed, Jr.	Box 11, Vestal, N. Y. Phone ENd 902
New York City	Greater N. Y. M. R. Car	James P. Kenney	368 E. 152nd St.
	WestChester Club	Bob Dunkly	414 E. 204th St.
	Brooklyn Model Car Club	Walter Connors	15 Berkeley Pl.
	Model Knights	Alex Remez	324 E. 9th St.
	Bronx	John Thorp	2304 Sedgwick Ave.
	A. M. R. C. A.	E. D. Fitzgerald	Hotel Governor Clinton, 7th Ave. at 31st
Spring Valley and Nanuet		R. Van Hauten	8 Elliott Pl., Spring Valley
Buffalo		E. P. Carr	91 Mendola Ave.
Elmira		Joe Keller	304 E. Waters St.
Hempstead, L. I.	Long Island Auto Racing Society	Chas. Drower	31-26 93rd Rd., Jackson Hgts.
	NORTH CAROLINA		
Burlington		Thos. Way	P.O. Box 844
Charlotte		O. A. Ritch	1918 Winter St.
	OHIO		
Akron	M. R. C. A.	John B. Yarger	R.D. 2, Uniontown
Cincinnati	Soc. Model Eng.	R. Bassett	1269 Rutledge
Cleveland	M. R. C. A.	R. S. Bugby	1766 Collomar
Columbus	M. R. C. A.	J. A. Finnicum	2859 E. 13th
Forest City	M. R. C. A.	Walter Werntz	8412 Wade Park Ave., Cleveland 3
Dayton		M. Eberhart	R.F.D. 2, Troy
Toledo		Jack Hines	621 Madison Ave.
Troy		(Same as Akron)	
	OKLAHOMA		
Tulsa		Fred Magee	908 So. Sandusky
	OREGON		
Portland	Hayden Amusements	H. Klingbeil	P.O. Box 1882, Zone 11
	PENNSYLVANIA		
Broomhall	M. R. C. A.	Wm. MacWilliam	109 Fitzgerald St.
Bethlehem	Lehigh Valley Race Club	J. G. Petrakis	447 Beach
Campbelltown		M. W. Dissinger	Box 1882
Harrisburg			
Roaring Spring		R. [illegible] Grove	R.D. 1, Blair County
Wilkes-Barre		R. H. Uhl	28 No. Main
York	Hilltop Speedway	Phil Stiles	109 E. Market
Philadelphia	M. R. C. A.	M. W. MacWilliams	109 Fitzgerald St.
	Flying Hornets Club (Perkasie)	Wm. Detwiler	325 Calenhill
Allentown			
	RHODE ISLAND		
Providence		Frank Vales	95 Printery St., E. Providence
	TENNESSEE		
Lewisburg		C. E. Reynolds	Care of Marshall Motors
Shelbyville		T. L. Ray	300 No. Main
	TEXAS		
El Paso	M. R. C. A.	Lind	809 Brown St.
Houston	M. R. C. A.	B. O. Shecter	950 Gardenia
Lubbock	M. R. C. A.	L. Kelso	2706—24th St.
Ft. Worth		Page Ramsey	3000 W. Victory
San Antonio		R. A. Weatherford	410 W. Lenwood
	UTAH		
Salt Lake City		K. Sudiko	P.O. Box 688
	VIRGINIA		
Arlington	(Wash., D. C., Club)	Bob Kirwan	4318 No. Fairfax
Richmond		R. H. Vaiden	2223 Park
Portsmouth		R. E. Beck	1600 "A" St.
	WASHINGTON		
Seattle		E. Hanson	7315 Aurora Ave.
Walla Walla		R. A. Rook	230 White St.
Yakima		C. L. Chapman	1415 So. 8th
	WISCONSIN		
Kenosha	M. R. C. A.	D. Tuttle	531—60th St.
Milwaukee	M. R. C. A.	Bill Decker	1334 So. 56th St.
Janesville	(Wisconsin Thunderbugs)	V. Campisi	34 Racine

Out West

(Continued from page 70)

added this year. Some of these will be perpetual trophies; a $1,650 scholarship has been added by Cal Aero. This school has been exceptionally generous to the model builder. At least $1,000 in cash is also assured and the usual great number of merchandise prizes from the Industry.

It is most gratifying to see the great job being done by the Legion in the promotion of model activities. We must all realize that such a great organization as the Legion cannot and will not jump into a project without proper planning and timing. Just look at the grand job done with Junior Baseball and we will begin to see what we may look forward to in the future. When it is realized that there are over 16,500 Legion posts in the United States, we begin to see the tremendous possibilities there are. We must realize that it takes time to acquaint all these posts with our aims and programs.

Frank is going down to Nashville to assist the Legion in its promotion of the big contest to be held there July 4 and 5. This is for the state championship. Then on to Cincinnati and later to Indianapolis, July 13, for the state meet co-sponsored by the *Star*, a newspaper. The site is Fort Benjamin Harrison. A real job is being done on this one. Lots of newspaper publicity, street car cards, cabs, radio programs, etc. This is one that we don't want to miss. It's good to see that nearly all the contests coming up carry as part of the prize money at least one all-expense-paid trip to the Nationals.

More good news is the growing interest of the Exchange Clubs in Model Aviation. At St. Louis our good friend Pat Morrisey tells us that everything is all set for the big East-West Challenge meet.

At Oklahoma City we were guests of Ed and Bob Barlow at their Exchange Club luncheon. The day was dedicated to Model Aviation and among other guests were the winners of the last club-sponsored contest. Here is a section of the country that really has enthusiasm; some of the best builders and flyers in the nation are here.

The principal speaker of the day was Raymond C. Mathews now with the C.A.A. Aero Center at Oklahoma City. Ray is well known to most of the old-time model builders and one of the best informed men in Aviation. His really informative and inspiring talk was enjoyed and appreciated by all present.

We hear that Glendale, California, is to get the much dreamed of "Model Park"—a Park consisting of three U-Control circles, a rail track, a flat track, and a boat pond. All this came about through the efforts of Glendale's Exchange Club. Hats off to Glendale. Now that Los Angeles has voted the bond issue for all those new playgrounds, maybe we can squeeze in just one place for all the poor pushed-around model builders.

Every large city we have visited so far has the same problems. No facilities for the model builder. The smaller communities are where the most progress is being made. However, the future sure looks a lot brighter with all this fine sponsorship by real live organizations. Let's all get in line and give our sponsors every bit of help that we possibly can.

At this time the Southern California contestants for the West team are all set. Keith Storey, Don Newberger, Wally Wallick, Les Macbrayer, John Thomas Conrad, Bud Jamieson, Burriss, Landsberg, Gulotta, Roy Gregson, Bill Deamer, Royce Childress, Lew Mahieu, L.A. men to Alamedo June 15th for the coveted places on the West's team. We hear that Jack Gilroy and Bob Keech had tough luck in the high wind. Crack-ups were the only thing that kept them from sure wins. The most significant thing to us is the fact that Davey Slagle, National Junior U-Control champ, did not even place on the team. What happened, Davey? After watching Davey walk away with the Nationals last year we can't understand what happened. Does it mean the others have improved that much? If so, what a battle that East-West will be. Save me a seat in the front row.

Another tip-off is Storey trimming the boys with his Class V. Keith has won the last three in a row and has consistently been faster than the Class VI boys. For instance, he won the Bellflower meet at 124.85, nearly two miles per hour faster than Class VI first place. This was a new world's record—Keith breaking his own record. Another record was set the same day by Troy Burris with his Jr. Whirlwind at 106.25. Classes I, II, and III were certainly overlooked by the smart boys. These classes were wide open while everyone was knocking himself out in V and VI. After all, it's a team event, boys, and that free trip on the "O & R Special" goes to ALL classes. Precision and stunt the best yet, with lots of inside loops, outside loops, vertical and horizontal eights, upside down eights and balloon busting overhead eights, inside and outside square loops and others all very spectacular.

Interesting note on the "All Western" flying scale is dropped as a competitive event and instead will be by invitation only. News from the North:

Jack Douglas of the Albany Control Flyers won himself a nice $250 scholarship at the Sacramento meet. Jim Smith took first again in Flying scale with his beautiful World War I Spad. This is win number four for Jim.

Walt Peterson, Fred Ernst, John Pedracci, Lewis Howard, and Ken Skilling all in the money.

These boys from Albany are really sharp. At Crissy Field, San Francisco, the Albany Club won the Aero Modellers Association Perpetual Trophy, nosing out Alameda by two points!

Roy Mayes, a consistent performer if there ever was one, again took first in Class C Precision in spite of a bad crack-up. In another event a strong gust of wind tore the lines out of Roy's hands and the ship ended up a half mile away in the Bay. Some of Roy's pals fished the job out, so it wasn't a total loss. We note that Win Biscay is coming right along. Win is finishing in the money consistently. Which reminds us, we have been getting the pros and cons from various members of the rules committee and we sincerely hope the near feud is settled by this time. We are sure that much of the unpleasantness was the result of pure misunderstanding.

Those ever active and always interesting Oakland Cloud Dusters are at it again. The following was sent to me by "Wind em up" Pop Robbers.

OAKLAND CLOUD DUSTERS

TEST HOPS OF RAMBO'S PRODUCTION-BUILT BABY ROG TISSUE COVERED STICKS

Larry Parsons	0:36.8
Pete Demos	0:33.4
Carl Rambo	0:31.9
Stanley Burns	0:30.7
Pop Robbers	0:26.4
Bob Blau	0:23.7
Charles Potto	0:23.1
Art Wells	0:18.8
Harvey Robbers, Jr.	0:17.9
Larry Mongeon	0:15.6
Manuel Andrade	0:14.0
Mom Robbers	0:13.5
Mike Demos	0:11.0
Don Robbers	0:10.5
Dave Acker	0:10.0

Notes on above Pop Robbers:

Test Field—Robberses' Living Room.
Pilots—Those—Cloud Dusters.
Time—10 P.M. to 1 A.M.
Weather—TORRID!
Conditions—HAZARDOUS!

Commentary — The impossible was achieved when Carl Rambo built sixteen identical models, requiring a full week to do it, and, with the cooperation of Mom Robbers, had them ready and out of sight at the meeting without anyone having the slightest knowledge of their existence. The way those two kept their secret and then wrangled us all into an argument and a lot of side bets and then shoved all those models under our noses and made us all put up or shut up was nothing less than "sharp practices," or would you call that "sharp shooting"??? We got our models (2 and ¾" by 13") by lottery and I'm here to tell the world there was as much difference as A to Z in them. It was a lot of fun. We were only allowed to adjust them, no rebuilding or cambering permitted. Larry Parsons got out ahead on the first hop and nobody ever caught him. Just imagine 16 husky people winding up these jobs, standing in line, and then taking their turn at flying. One timer and one recorder, and thanks to each ship being lettered, Jim Robbers and Guy Dake did a swell job of that. Quite interesting to have your model wound up and be standing there waiting your turn, hoping your motor won't go dead, and about then some jaboo, winding up, stretches his motor backing up a yard in a one-foot space occupied by your model. Or, keeping the motor alive with just a few hand turns and just before you get to the take-off strip, one turn too many and WHAM. With cuss words costing a nickel apiece that's a plenty rough deal. Or had you heard yet that this is the way Mom is financing her trip to The Los Angeles Western Open???? We kept our models, and with two weeks to practice in, it should be a really hot contest at the next meeting on May 29. "Who said I can't get a minute"; you know what I mean? During this two week period no one is allowed to do anything more than learn how many winds you can safely put in a 11" loop of 1/16th Jasco rubber to get the best flight out of your little tissue covered speed demon.

See you at the "Poor Man's Nationals," Livermore Airport, Aug. 31.

The Westerner

Colossus II

(Continued from page 60)

inches of wing area is proof of the efficiency of this rib design.

The leading edge is one-eighth square, as is the front bottom spar. The remaining bottom spar and two top spars are one-eighth by one-sixteenth laid on the flat. The trailing edge is one-eighth by one-half. Tips are one-eighth sheet, as are the gussets. The ribs are all one-sixteenth sheet, and are plotted from rib number eight, which is the longest. Since even little Joe Blow, age six and seven-eighths can plot ribs, let's not bore each other with that detail.

After putting in dihedral, one inch and a quarter at the first break, and three and a half inches at the tips, sand wing thoroughly, and cover with single thickness of Jap tissue, and dope two coats of clear same as fuselage.

The rudder is built up of one-eighth-square leading edge, and the rest of the outline is of one-eighth sheet. The three horizontal cross members of one sixteenth by one eighth are cemented in, then the one vertical member. Next, three more horizontal members are cemented over this, to give an airfoil section, resulting in a natural right hand turn. Hinge rudder at rear with milk bottle cap wire, and single cover rudder and dope same as fuselage.

Stab is made with lifting section, as shown in rudder detail. The stab is identical in construction with wing. Cover stab, dope per fuselage, and cement to fuselage as shown on plan. Cement rudder to stab and everything is all set.

Now for flying. Fasten wing to fuselage and test-glide. Do not throw ship into a stall; rather, push ship from you, aiming at a spot on the ground twenty feet in front of you.

The design is such that Colossus is balanced very nicely, and only slight adjustment on stab trimming tab, plus proper right turn, will give a long, flat glide to the right.

Now put in two hundred turns and hand-launch. Power flight should be to the right in approximately hundred-foot circles. Any stall must be killed off by increasing the downthrust. Add one hundred turns on each succeeding flight, until a maximum of seven to eight hundred turns are packed in.

This ship will climb fast, with a slow forward speed, and a tail-high attitude.

We've told you how to build and fly the Colossus, but now that it's going out of sight, it seems we forgot something! Oh yes, we didn't caution you to put your name and address on the plane!

The Aerial Photograph

(*Continued from page 31*)

direction, since the photographs are really obliques.

In the darkroom, negative "B" is held plane-parallel with the printing paper, and negatives "A" and "B" are tilted at exactly the same angles as the cameras which took them. The printing is a reverse of the original process of photography; the light from the printer passes through the negatives and projects the original ground-view onto the printing paper, as it was seen from the airplane.

Still the methods so far mentioned relate to flat, horizontal measurements. From them we can find the distance between two towns or the length of a railroad, but not the height of a mountain or of a tower, or the depth of a canyon. The only way to measure height or depth is to see height or depth; and in modern photogrammetric technique, that is exactly the method used. The stereopticon, the two-eyed viewing gadget of a generation ago that lived in the best parlor and showed views of Niagara Falls in three dimensions, contains the basis of the system by which the altitudes of physical objects may be quickly and accurately measured from aerial photographs.

Most people's eyes are somewhere between two and three inches apart. It is their location which allows us to see things in perspective. Two lines of telephone poles disappear over the horizon, and, just as they vanish, the lines of poles seem to come together, although we know that the rows are parallel to each other. When we look at a distant object, the line of sight from one eye is approximately parallel to that from the other. When we look at something nearby, this is not so; the lines of sight converge upon it. We have learned to use this automatic judgment of angle in realizing the feeling of distance.

The slides your grandmother slipped into the stereopticon contained two pictures which looked alike, but were not. Between the two exposures the camera had been shifted slightly so that it looked at the view from a slightly different angle, as your two eyes would have. Two prisms in the viewer brought the lines of sight together in a distance of several inches instead of at the actual distance of the object, and your grandmother saw a close approximation of what she would have seen on the spot.

Experiments have proven that any two photographs of the same scene from different angles can be viewed stereoscopically. The pair of aerial photographs that fill this requirement are no exception to the rule. When laid side by side and examined through an instrument called the stereocomparagraph (which is basically a grown-up stereoscope equipped for making micrometer measurements) the objects shown on the flat prints leap from the surface into three-dimensional relief.

When two stereo photographs—a stereo pair—are examined through the stereocomparagraph, the distance between a pair of images of any distant object seems greater than that between any pair of nearby points. If a piece of transparent celluloid with a tiny black dot on it is slipped under one side of the instrument, and a similar transparency from the other, the dots also will be seen in stereo.

In measurements of height, one dot is placed over some point in the picture whose height is known, or which, if you care only about relative heights, can be called altitude zero. The left-hand dot of the stereocomparagraph is fixed in position, and is located first. The other transparency is adjusted until its dot merges with the first; and such is the magic of stereo that at that moment the single dot you see seems to float away until it is in actual contact with the point on the map.

Now, if you move the stereocomparagraph until the left-hand dot covers the point whose altitude you want to measure, and the right-hand dot is again adjusted with the screw until the marks merge and float to the point, the measurement of the distance the right-hand dot must be moved is the difference in altitude between the two points, and the direction in which the dot must be moved tells whether that distance is up or down. These movements of the dots, or floating marks, are the basis for highly complex, rapid and automatic instruments for the plotting of contour maps, and for the rubber or plastic relief maps which permitted the planners of Naval operations in this latest war a realistic concept of topographical conditions which they could have obtained in no other way.

The experience of the military services with photogrammetry and the rapid evolution of new instruments and techniques in the science, are certain to make their effect felt in the aerial survey work of the postwar years, and yet, as has been said, civilian concepts and requirements of precision begin where the military leaves off. The mechanical impossibility of adjusting the angles between the cameras of the trimetrogon system to degrees of error permissibly small for exacting civilian use effectively rules out that installation. Designers of aircraft camera equipment, looking forward into the future, foresee the need to pare even further the thin rind of error which covered prewar surveys. To meet the requirements of government and mapping agency services, Fairchild has now in production its new 9 x 9 inch Cartographic camera. Among its original features are two cones, lying one within the other, instead of the usual one. The inner cone, the optical heart of the camera, contains the focal plane and the optical system of the camera in a single casting, readily removable as a complete unit for calibration of the focal length and the fiducial marks which locate the exact center of the focal plane, by the National Bureau of Standards. Where error cannot be eliminated in such a system it can still be measured, and compensated for by calculation. These calibrations are part of the pedigree of each camera. The outer cone, which contains all operating mechanisms for semi-automatic and automatic photography, is readily accessible for servicing, and can be removed without disturbing the collimation of any part of the optical system.

Plato, the Greek sage, once posed a logical problem to one of his students. If, he said, a man walked toward a tree, and covered half the distance in the first minute, half the remaining distance in the second, half that which was left in the third, and so forth, how soon would he reach the tree?

The lad was of an experimental turn of mind, and he tried it out. He walked half the distance to a convenient tree, and half that distance, and half that, until the distances got too small for him to divide. He realized then that he would never actually reach the tree, because there was always going to be some infinitesimal distance yet to cut in two; but he discovered also that in not reaching it, he had still got pretty close, and was getting constantly closer.

Nobody dreams of the day when a perfect instrument will be built. Every instrument engineer knows that no matter how good his design may be, some inequality of workmanship or material, some physical limitation will keep him a little short of that mark. But it is possible to get pretty close, and to get closer every day. The biggest war that ever was between men is over, but the bigger one, of man to master his environment, is more important than ever, more challenging, more immediate. Alfred North Whitehead said: *The reason why we are on a more imaginative level is not because we have finer imagination but because we have better instruments. In science the most important thing that has happened is the advance in instrument design.* Every day, impossible victory is a little closer.

When Air Power Was Born

(Continued from page 27)

1941, the day General Henry H. Arnold assumed command of the organization which grew to 2,500,000 strong and tens of thousands of aircraft and which he led to victory in World War II. That day they changed the name of the Air Corps, designated it the Army Air Forces, made it a combat air power with the skies over the four far corners of the earth its battlefield.

Others will record the birthday as July 2, 1926, the day the Air Corps Act became a law. Still others will claim the date of birth was 1921 when the Aviation Section of the Signal Corps was reorganized as the U.S. Air Services.

The official birthday, however, is recognized as August 1, 1907, and you need only look at the accompanying reproduction of the original orders for proof that your Air Forces was born forty years ago with this military-sounding announcement: "An Aeronautical Division of this office is hereby established, to take effect this date."

Our first duties were attending to Balloon No. 10. Stevens instructed both Captain Chandler and Lieutenant Frank P. Lahm, the two officers in charge, in balloon avigation, and a great deal of interest centered around the balloon flights from Fort Myer, our base.

The first year saw two events of major importance. On May 13, 1908, for instance, Lieutenant Lahm took off in the balloon, trying out a novel idea. We had rigged up a "chicken wire" framework around the balloon basket and suspended from this crude outer structure was about 300 feet of antenna wire which trailed below. Lahm reported that he could hear clearly the radio messages sent out from the Washington Navy Yard and those from Annapolis. The idea of radio communication between ground and aircraft was proved feasible.

In the same year we took delivery on the Baldwin Airship (Signal Corps Dirigible No. 1) the first power-driven aircraft of any kind to become a part of our Army military aviation. It was an important event because it showed our military leaders had at last begun to recognize the real value of aeronautics, following the lead of countries abroad which had been experimenting with airships for military purposes.

There were numerous trials of the airship No. 1 at Fort Myer, Virginia. Those of us who worked on the small horsepower Curtiss motor that propelled the gas bag through the air were fascinated at its unique control principles. A long bridge-like affair suspended below the sausage-shaped gas-filled envelope permitted change in elevation by allowing the operator to run fore and aft, thus shifting the balance of the ship. Rudder arrangements permitted steering. We learned to know Lahm, Captain Baldwin, Glenn Curtiss, Lieutenant Foulois, and Lieutenant Selfridge—new officers assigned to the division and our first flying personnel—as true pioneers of the art of aerialogy.

But even as we watched the flight of the dirigible another interesting experiment was going on in the shed-like hangar at Fort Myer. A quiet, unassuming inventor named Orville Wright was working with his mechanic Charley Taylor on a flying machine. The man who had flown in the first heavier-than-air machine at Kitty Hawk in 1903 had built an airplane specifically for the Signal Corps.

They called this first airplane built to Army specifications, the "Wright Flyer." It didn't have any wheels but instead it landed on ski-like skids. It was assisted in take-off by a heavy weight dropping from a tower effecting a catapult that sent the plane along a launching monorail.

As soon as this first airplane was assembled the whole group of us turned out to watch its flight. There were some who didn't yet believe in airplane flight. I remember one newspaperman saying to me: "Corporal, you're about to see another failure."

He was dead wrong. On September 3, 1908, Orville Wright got the ship out of the hangar and climbed aboard. He took off and flew for one minute and 11 seconds around the field. My newspaper friend said: "I still don't believe it." But in following days he and the rest of the people who came in crowds to watch the experiments became convinced that the airplane was a practical machine. Those of us who were there all the time got used to seeing the machine hop up and down; its sputtering engine became just another noise and we seldom even looked up from our work.

One day, however, on September 17, 1908, the men looked up suddenly and saw fate strike a terrible blow at the struggling little group of men trying to make our wings grow strong.

Orville Wright was flying the ship on a routine trip. With him as a passenger and observer was Lieutenant Thomas E. Selfridge. They flew around the parade ground which was used as the flying field, circling a couple of times around the spot. Then on its fourth turn around the field something happened. The crossed chain driving the two pusher propellers jumped a couple of links, flapped loosely for a split second, just long enough to let it strike one of the propellers.

There was a sickening cracking sound. The wooden propeller blade cracked and snapped. The ship whipped over on its back and plunged to the ground. The heavy engine fell on Selfridge's chest. Four hours later he died of the injury. Orville Wright suffered a broken hip and internal injuries and had to spend weeks in the hospital. The airplane was a total wreck.

Contrary to what might be the opinion, the effect of this first crash didn't seriously hamper the interest of our officers in the airplane. There was much talk about the crash around the barracks. But everyone seemed to accept it as something to be expected. Work went right on with trial flights of the powered dirigible. It was encouraging to all of us to see that we were a part of an organization that was going to stay alive and face the future, even disasters such as the Selfridge episode. Our Air Forces was strong even when it was a handful of men.

Next year all of us were encouraged to see another Wright plane being unloaded at Fort Myer for assembly and tests. This time the craft met every test. The Signal Corps purchased the first military airplane. Our Army became the first military power in the world to own an airplane. The fact that we let other nations get ahead of us in the second decade of aviation was not due to the spirit of the men in our small group at Fort Myer in 1909.

We had the first military airplane. A few months later from one of our early balloons Lieutenant Lahm discovered an ideal landing field at College Park, Maryland. We had the first air training college. But it was tough going. We even had to buy some of the repair parts out of our own pocket money or there wouldn't have been any early flying. In addition to the hazards of trying to stay aloft we had the problem of trying to stay alive as a unit.

There was a great deal of talk among those of us who worked on the airship and the airplane as to what military application the Army would derive from these new machines.

One answer we got in August, 1910, during an aviation meet at Old Sheepshead Bay Race Track near New York City. A Major Samuel Reber of the Signal Corps suggested to Glenn Curtiss who was putting on an exhibition with his latest planes, that an experiment be tried firing a rifle from an airplane.

At first Curtiss was against the idea but Major Reber argued so enthusiastically that the famous airplane designer agreed to try it. Reber then went to the War Department and secured the services of Lieutenant Jacob E. Fickel of the 29th Infantry to do the actual firing.

(This I feel was an important event in military aeronautics because it showed a willingness on the part of two different arms of service to get together and work out a common problem. One might easily interpret this early bit of cooperation between the newly born Aeronautical Division and the Infantry as evidence of the need for a unified command which even now—forty years after—is an important issue before our legislators.)

The first use of an armed airplane took place on August 20, 1910. Considerable anxiety swept over the little group who witnessed the experiment. The betting was high that Fickel couldn't hit the target which had been stretched out in the center of the race track. It was a piece of cloth about the size of the ordinary window with a bulls-eye painted on it.

When everything was ready, Fickel climbed aboard the plane and took a position along the lower wing since there was no special seat for an extra passenger. He held the rifle across his legs. Then, with Curtiss at the controls the flimsy airplane bounced along the rough ground and rose sharply into the air. It made two sweeping passes at the target so that Fickel could get used to the effect of the powerful airstream on the gun barrel. After these dry runs, Curtiss banked the airplane and brought it directly over the target. Fickel fired. They repeated the maneuver. The rifle blazed twice.

Back on the ground again they found two bullet holes in the target! Fickel immediately recommended to the War Department that the Remington Arms Company be detailed to design a rifle sight that would compensate for the different motions, speed, and elevation of the aircraft in flight.

But arming the flying machine didn't stop there. The following year at College Park, Maryland, a former officer of the Coast Artillery, Riley E. Scott, came to College Park. He brought with him a device that was to have earth-shaking effects on the future of air power. It was a bomb sight.

Weighing about 65 pounds, the gadget consisted of a small telescope, a stop watch and a set of mathematical tables. The telescope was so arranged that it was possible to determine the speed of the airplane over the ground and the height above the ground by sighting at different objects as the plane approached or passed over them. Rapid calculations of these figures and use of the attached stop watch permitted measuring time and distances. The charts, or tables, automatically compensated for the aircraft speed and its distance from the target; along with the data obtained from telescopic observations they told when to drop the bomb.

An old Wright Type B airplane became the first bomber. Scott took his place on the lower wing and lay prone so he could squint through the bomb sight which was rigged up immediately in front of him on the leading edge of the wing. On the initial trials he took aloft two 18-pound bombs, both of which had to be released at the same time in order not to throw the airplane off balance.

A Lieutenant Milling, recently assigned to the College Park aggregation, was the pilot. The target was a rectangular piece of white cloth spread out on the ground.

The first bombing mission was flown at 400 feet which was the altitude Scott had selected in making up his set of tables. The plane flew over the target twice to give the bombardier a chance to adjust the sight. Then on the third pass Scott released the bombs. They struck within ten feet of the target.

Bombardment aviation was born that day.

Another interesting experiment that occurred during the same period was the first firing of a machine gun from an airplane. We advanced out of the rifle stage. Lieutenant Milling again was the pilot. Captain Chandler, the Commanding Officer, became the first "aerial gunner."

The machine gun was brought to us for test by Colonel Isaac N. Lewis, the inventor of the famous Lewis gun. It weighed about 25 pounds and it fired regulation Army rifle ammunition from a drum holding fifty cartridges that slipped on a spindle atop the gun. It could fire between 300 and 700 rounds per minute.

For the experiment a target about seven feet square was laid out on the ground directly in front of the hangar. Mechanics were warned to stay away from the area because of the danger of ricocheting bullets. It was like telling a youngster to stay away from the ball game. Everyone tried to get just as close as possible. But no one was quite sure what would happen when the gun let loose.

Chandler, like Fickel, carried the much heavier gun in his lap. But he could sit upright in a seat, the Wright plane having seating positions for two.

The tests were run from an altitude of 250 feet. The plane flew low over the target several times without firing. On the next pass it didn't shoot at the target, but the gun started firing into a small pond nearby; the splashes from the bullets striking the water looked like a lot of fish jumping out of water. When the inventor of the gun, Lewis, saw them, he thought the gun had suddenly cut loose without Chandler firing it and he and everyone else ducked for cover.

But Chandler had fired the gun purposely into the water so he could get an idea of the spacing of the bullets as they struck. On the next trip over the target he shot a burst of 44 shots into the cloth. Fourteen of them struck home.

Although this was not a very good average of hits it was good enough considering the gun had no sights on it. It led to further experiments with the design of a lightweight machine gun for airplanes. We had pioneered the airplane as a military weapon.

● Ancestor of U. S. Air Power. Flight lasted 1 minute 11 seconds. A sceptical friend of Word's, seeing plane fly, said, "I still don't believe it."

I could go on. There were many other early experiments. But these in my opinion were the most important because they show how we began to apply the first airplane to military tactics and to use it as a weapon.

In these experimental incidents we began to see the tremendous potentialities of the airplane in any future warfare. It was no longer regarded as merely an "observation post in the sky." It was a weapon by itself and in any future war it would have to be used as such. There would always have to be an organization of men to maintain the aeronautical equipment and use it in combat or for standby defense.

The flight of Signal Corps Balloon No. 10 on that bright sunny June day in 1907 had started something.

PT-1 Glider

(Continued from page 68)

when suspended by the extreme wing tips. This balancing point (center of gravity location) is very important in adjusting the model for flight. If it tends to be too far rearward, with the model hanging in nose-down position, the flight path will be a dive; too far forward, the model will stall.

Toss the glider into the wind from shoulder height and observe the flight path carefully. If all surfaces are in good alignment and the balancing point is correct, a smooth straight glide will result. You will have to learn to launch the model at just the correct air speed. A mistake of many beginners is to toss the glider upward where, even though it may be perfectly adjusted, it can do nothing but stall. It may tend to recover but most likely will strike the ground before it can assume level flight. So, before changing the balance or warping any surfaces, make sure that the glider is definitely out of adjustment and that the fault does not lie in your launching technique.

Accompanying sketches indicate the four most common errors in flight adjustment. First, the stall results when surfaces are warped—or improperly mounted—to make too much wing incidence or too much stabilizer negative incidence, or when the balancing point is too far to the rear. Add more clay to the nose to move the balancing point forward or correct any warped surfaces. A dive results when conditions are opposite to those causing a stall and corrections are also just the opposite. When the model spirals tightly to the left, losing altitude, check the rudder and wings for faulty alignment. Sometimes heavier wood in one wing half will bring about very confusing flights. This may be corrected by adding a little clay to the lighter wing tip. Ordinarily, spirals are cured by warping the trailing edge of the rudder in the opposite direction or by bending the trailing edge of the wing, the one on the outside of the turn, upward. This last will reduce elevation somewhat. By warping the trailing edge of the inner wing downward, the bank will be corrected and a bit of elevation will be added. It is usually best to make slight adjustments to both wing trailing edges.

To warp a glider's surfaces, simply twist them excessively in the desired direction and hold them so for a few moments.

Contact Printer

(Continued from page 62)

in the following pages and it can be built fairly easily and for approximately five dollars, and have, at the same time, features that will be found only in the higher priced printers presently on the market.

Construction: To start construction of the printer, cut out all the wooden parts to the exact dimensions as shown in the drawings. Sides are cut from pine ¾" x 8" x 51" and the bottom is cut from pine ¾" x 14" x 11¼".

Coat the edges of the front piece, the sides, and the rear piece (with the exception of the top edges) with casein glue and screw together as shown. The bottom is then attached in a similar manner to form the box. Allow the glue to dry overnight and then sandpaper the entire box until smooth.

The ground glass frame supports are cut from the piece of pine ½" x 1½" x 6" and screwed in place on the inside of the box three-quarters of an inch from the top.

The ground glass frame is cut from ¼" plywood. Cut out the center rectangle 7½" x 9½" and attach the lifting ring as shown. The 8" x 10" ground glass is then placed over the hole and fixed in place by four brass clips. Care must be taken in tightening these clips so as not to break the ground glass. This assembly is then placed in the box and held in position by the frame supports.

Cut the clear glass frame from ¾" pine. Again we have a hole in the center. This must be exactly 8" x 10" to accommodate the 8" x 10" piece of glass. Since this glass must be absolutely flush with the top it is advisable to attach moulding strips after the glass has been fitted.

We come now to the most exacting part of our work on the printer—the platten. This is cut from ½" plywood which must be absolutely flat and free from any warps whatever to prevent cracking of the clear glass when pressure is applied. This piece of plywood is then cut exactly in half. All edges must be square and sanded smooth. Apply three or four coats of shellac and allow ample time for drying. The hinges are attached as shown on plan and the spring contact washers are screwed in place. They must be positioned so that the contact springs do not at any time touch the wood.

Cut the contact arm from ¾" pine (hard), care being taken that this piece also is straight and free from warps to insure even pressure on the platten. Next, drill a ¼" hole at rear of arm where shown in plan. Extreme care must be exercised to insure a parallel hole.

Give all wooden parts at least three coats of dull paint, with the exception of the platten, which should be left shellacked only, and the inside of the box which should be painted white.

While we are waiting for all the painted parts to dry, we can get to work on the metal fittings.

The contact arm hinge is bent to the dimensions shown in the plan and two ¼" holes are then drilled for the pivot. These holes MUST be exactly on a line with the hole previously drilled through the contact arm to accommodate the pivot.

The contact springs are now cut and bent from ¹⁄₁₆" steel to the dimensions shown on the plan.

Cut the platten pivot hinges from ¹⁄₃₂" brass and bend to the proper shape. Be sure to make one hinge for the left side and one hinge for the right.

The position of the ⅜" pivot holes will depend on the exact thickness of the platten and felt when assembled.

The push switch housing is cut from a pine block and hollowed out to accommodate the switch.

By this time, the box should be dry enough for installation of the wiring system. This is somewhat complex and a thorough study of the diagram should be made before attempting the installation or a few fuses may have to be replaced. First mount the light sockets in the positions shown, and the four switches on the side of the box. Drill all necessary holes for the wires leading from the switches into the box, and then, following the *wiring diagram exactly*, mount the contact switch and install all wiring. Solder and tape all bare wires to prevent short-circuiting. It will now be found that the red light goes on as soon as the male plug is placed into the house line, and that the 25-watt white lights can be turned on and off individually by the corresponding switches on the side of the printer. However, it must be remembered that the contact switch controls all the lights (except the red) simultaneously, unless turned out by the side switches. This has been so arranged that when the contact arm is depressed in making prints, the lights will automatically go on.

Now attach the contact arm hinge to the clear glass frame with three ¼" 6-32 machine screws, countersinking the nuts.

Cut the piece of felt to size and glue to the bottom of the platten. Now attach the platten hinges with four wood screws as previously mentioned. It will now be noticed that the ⅜" pivot holes permit the platten always to seat itself properly on the glass.

At this point attach the contact springs to the contact arm, making sure that when the arm is depressed the springs line up with the contact plates on the platten.

Fit the contact arm into the contact arm hinge. Line up the platten pivots and insert a 3¾" machine screw through the pivot holes and the hole previously drilled through the contact

inserting strips of thin tracing paper between the glasses, the amount of light can be reduced anywhere on a negative area that it may be found necessary.

By cutting individual masks from black opaque paper any size negative from 35 mm to 8" x 10" may be accommodated in the printer.

In addition, this printer can be used as a shadow box, a negative viewer, or a Kodachrome transparency viewer or retouching stand by the simple expedient of extracting the 3¾" machine screw and removing the platten and contact arm. In this case, it will be found necessary to lock the contact switch in a depressed position.

Use of the printer for a period of time will bring out its many advantages and conveniences in both the photographic darkroom and the model builder's workshop.

MATERIALS REQUIRED

1. 1 piece pine, ¾" x 14" x 11¼" (Bottom).
2. 1 piece pine ¾" x 8" x 51" (Sides, back, front).
3. 1 piece pine, ½" x 1½" x 6" (Ground glass frame support),
4. 1 piece pine, ¾" x 3" x 19" (Contact arm).
5. 1 piece pine, ¾" x 11¼" x 14" (Clear glass frame).
6. 1 piece pine, ½" x 1" x 1½" (Switch housing).

● Hinged frame assists in placing thin paper for additional control.

arm. Secure in place with washer and nut taking care to allow free movement of the parts.

Now take this entire assembly and position it on the box with two brass hinges at the rear and two catches at the front as shown.

Position the 3¾" carriage bolt (which acts as a plunger) so that it depresses the push switch when the contact arm is perfectly parallel with the platten. This is necessary to insure even contact over the entire area of the glass.

The piece of leather is attached to the platten and the contact arm. This serves the purpose of raising the platten simultaneously with the contact arm, thereby permitting the operator free use of his other hand.

Now that the printer is assembled we are ready to appreciate its convenience in darkroom use as previously discussed in the March, 1947, issue of Air Trails.

This printer, however, has certain advantages over printers discussed in previous articles.

In the printing of unevenly exposed negatives, the convenience of the individual side switches can be readily appreciated since this system of lighting offers a method of control not available in lower priced printers. Also by

7. 3 ft. moulding strip, ⅛" x ½" (Clear glass supports).
8. 1 piece plywood, ¼" x 9¾" x 12½" (Ground glass frame).
9. 1 piece plywood, ½" x 11" x 13" (Platten).
10. 1 piece black felt, 11" x 13" (Platten cushion).
11. 1 strip brass, 3/32" x ½" x 5½" (Contact arm hinge).
12. 1 sheet brass, 1/32" x 4" x 4" (Platten pivot hinges, ground glass clips).
13. 1 strip steel, 1/16" x 1½" x 20" (Contact springs).
14. 1 piece ground glass, 8" x 10".
15. 1 piece clear heavyweight glass, 8" x 10".
16. 4 toggle switches.
17. 1 push switch (Contact).
18. 5 light sockets.
19. 1 male plug.
20. 20 feet double strand wire.
21. 4 one inch hinges.
22. 4–25 watt bulbs (Frosted).
23. 1 photographic ruby bulb.
24. 1 strip leather, ⅜" x 5" (or light chain).
25. Black masking paper.
26. 4 large washers (Contact plates).
27. 1 screw eye (Lifting ring).
28. 2 hook catches.
29. Sandpaper.
30. Roll electrical tape.

Dope Can

(*Continued from page 57*)

sets a new AMA official record with a Torpedo, will receive a new motor free of charge. First to receive one of these was Tony Naccarato, who copped the Class III open control-line record recently with an official 102.8 mph. (And several years ago the boys were pretty cocky if they hit 50 with a .60 cubic inch motor.)

Pfc. Harold P. Anderson, who is serving with the U.S. Marines, at present in Camp Lejeune, N.C., comes up with a question which we aren't able to answer with any authority. Seems he has done a lot of control-line flying, and has a couple of nice jobs back home in Pennsylvania. Being in the Marines (he enlisted a short time ago) he is unable to compete with these ships, and wants to know whether he can have them entered and flown by a proxy flyer back in the old home town.

Our best advice is to submit this problem to Russ Nichols at AMA headquarters in Washington, D.C. That is, to have the matter cleared legally. But most hot-shot modelers wouldn't do that. They'd just have said friend modeler enter the ships, making no comment as to whether or not he had built them. A question like that is very seldom asked anyway, and the proxy flyer could split prizes or make some other sort of deal with the original builder. It would be better to submit the problem to AMA, but aren't there a lot of ships flying now that were NOT built by the contestants . . . . and nobody says a word about it.

While we were perusing issues of current model mags with the thought that we might find a listing of coming contests, we received in the mail a cardboard poster put out this season by the Mid-States Model Aeronautical Association, which would have been swell if it had listed any meets nearer than 1,000 miles from our door.

This Association covers Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, and Oklahoma, and the genial Al Hummel, of Wichita, is its secretary. The sheet covers contests from April to September, lists the type of meet, sponsor, gives the name of individuals who can give further dope on each. All contests give points to winners which count toward the Association trophies which will be awarded to high point winner at the end of the season.

The idea is really swell, and should be followed by similar associations (if any) in other areas. We'd particularly like to see one for the Eastern seaboard. We'd hang same on our shop wall and make plans to attend every one within striking distance.

That Wichita really seems to be quite a model center and was one even before the Nationals last year. Of course Al Hummel deserves a great part of the credit for this condition and another big reason is the monthly publication "Dope Fumes," put out by the Wichita East Side YMCA Hy-Flyer Clubs, in cooperation with the Association mentioned in the above paragraphs.

Quite recently we have been trying to gain permission to use an airport field in our vicinity for model flying. We have asked for permission to use said field on Sunday mornings, when the field is usually empty, but have had very little luck with same. But good fortune has smiled upon us, and light is beginning to break through the clouds. We'll probably get the field, and our manner of obtaining same may help others. Noting that there was a big campaign in the area to stamp out juvenile delinquency, we pointed out that modeling was one of the greatest sports in the world to do just that. Not only did it keep potential delinquents occupied but it often opened up new futures for them. We can recite tales galore of boys who were on the downgrade who took up modeling and eventually launched themselves in a career of aviation.

The committee which was to investigate our plea for a place to fly is smiling in our direction. Given a field, any community can start a successful model club. Given a club any boy can learn to build, fly, and really get into this flying age.

T. R. Mildeft of Buffalo, N.Y., wants our advice on the best woods for carving gas model props. Well, there are several schools of thought regarding this subject. Personally, we've always believed sweet gum (gumwood) is the best for free-flight props. It's quite hard, close-grained, does not split easily, and will polish to a fine finish. Some modelers use pine, and we recall that many props in the old days were hacked out of wood obtained from orange crates. We've tried spruce and found it hard to work. Pine, to our mind, splits too easily. Basswood isn't bad and there are probably other domestic woods that would do the job.

In carving control-line speed props, which require thin edges, many builders use hard woods such as mahogany, but for all around gas model hacking-out, gumwood is about the best stuff to use. And, by the way, the use of a wood rasp will shorten carving time greatly. It really gets off the chips and you aren't as likely to split the job when shaping it.

Many times we receive suggestions in the mail, and it's pretty hard to dope them out. Despite explicit instructions, we find ourselves confused and don't really savvy whatever gadget some modeler is trying to tell us about.

Joe Campione of Rochester, N.Y., probably figured that his idea would be hard for a poor columnist to savvy and one day we received in the mail a model of the Body Pylon he has devised, plus a complete description of same.

It's designed to eliminate whipping and it should really work. In appearance it resembles a miniature telegraph pole on a pedestal. On the arms of the pole are two guides, while down near the base is a guide finger and a small handle. The modeler fastens the pylon to his tummy with a strap with the pole part in front of him and takes the ship off in any way he desires. When he is ready for official timing he must hold the handle on the pylon with his flying hand and keep his flying lines to the left of the upright finger. If he tries to tow, the pressure of the flying wires will trip the upright finger, disqualifying the flight.

According to Joe, the handle on the pylon steadies control greatly. The ship can be held accurately on flipath, but as soon as one tries to tow the finger will trip every time. The device is extremely inexpensive to build, the model now on our desk being built from parts of a broom stick, coat hangar, and an old belt.

Yes, we must admit we tried the device and it did work and just as well as the inventor claimed. It has a great deal of merit and after further testing (by control-line fans of this area) we intend to give it further publicity.

Jack Douglas, of the Albany Control Fliers Model Airplane Club, was fortunate enough to win a $250 scholarship in a recent meet at Sacramento. Which brings up the point that meet prizes are definitely going up and greatly exceeding prewar levels. Years ago the top prize winner in a big meet would receive a motor, or kit, or some such hardware. He might even take home a cup or trophy, but nowadays his winnings resemble those of one of radio's question and answer programs.

One Eastern father-and-son combination won two Ercoupe planes last season and is going great guns so far this year. Another modeler admitted cleaning up several thousand dollars. It gets to the point where we wonder if model contest competition is a sport or a racket. And the solicitation of such big prizes handicaps the small meet director. Unless he can offer nearly $1,000 worth of awards, he'll find his meet unpatronized by the big-shot modelers. It's really a problem.

Many modelers have written us asking if the "hot" fuels will ruin their engines. Answer is that it all depends what is in said fuels. Some of them are composed of alcohol and castor oil, others use special gasoline blends, and our best advice is to wash out motor and tank with clean gasoline after using the super-dooper juice. However, they do improve a motor and many hot engines won't run well without them.

Speaking of fuels, many years ago the boys were very careful to mix proper proportions. Some of them used 2 to 1 mixtures, others as high as 5 to 1. All claimed their particular mixes were the best. Now in our shop was a large glass bottle, and upon returning from flying the boys used to dump gas cans into same. The mixture was carefully noted as "something to one." When pressed, the boys used it, and the motors seemed to run as well as they ever had. Which brings up the point . . . . are the super fuels as good as the manufacturers say, or is a lot of their performance just modeler imagination. Of course, strobotac tests have proven some of the new fuels better, but the average modeler would probably do just as well on a 3-1 mixture of gasoline and 70 oil. (Now will the manufacturers PLEASE not all gang up on me at once.)

Note that the AMA has announced it is physically impossible to run elimination meets for the Nationals in many states. We always contended same and are glad the boys came to the same conclusion. We're sorry we can't make it to Minneapolis this year for the big event and seriously suggest they get the big meet back closer to the East in the 1948 season. Gas is no longer rationed, but the pocketbook still doesn't allow us to take time off and go rambling across country—much as we like modeling.

WATCH FOR THE NEW AIR TRAILS

Meet the Authors

(*Continued from page 8*)

The wind, often 125 miles an hour at this altitude, varied in velocity and direction all the way down. Mason's job was to determine the wind (by radar) at all altitudes, *then* fly to a point of release that was right for hitting the designated town. This often meant going past the town 50 or 100 miles. It never once meant dumping the papers over the town itself. What with the destination of the plane depending on which way the wind blew no one besides the navigator ever knew where he was nor where he was going.

After 32 missions he returned to the States in '44 with a DFC and a 21-day leave.

His next assignment took him out of high-altitude bombers and into Troop Carrier Command's war of low-flying C-47s which dropped men instead of bombs or leaflets. As Director of Flight Training at TCC's Pathfinder Radar School in North Carolina his job was to dream up two flights daily, planning brain-teasers for the radar-navigators. The trick was for the student to find several simulated "drop zones" entirely by radar, signal their imaginary paratroopers to jump, then check results with the pilot. Mason also briefed the crews, interrogated them after missions, and acted as Assistant Operations Officer for the outfit. Here in North Carolina he was active in the experimentation going on with new radar from MIT and also in testing new means of dropping men more accurately.

His next and last move placed him in charge of a Loran School at a B-29 base in Alamogordo, New Mexico. Separation came in October, 1945, and he moved to New York.

Out of the Air Corps, but still a first lieutenant in the Reserves, he stepped back into aviation. Since early '46 he has reported the march of science for gentlemen who batten on blueprints and formulae—aeronautical engineers. As News Editor of the *Aeronautical Engineering Review*, published by the Institute of the Aeronautical Sciences, he records the news of the world of jet engines, lightplanes, wind tunnels, and rockets. Prior to this he was Associate Editor of the *Review*. This entailed extracting meat from long technical magazine articles and books in both French and English, then reframing them into abstracts.

Mason likes free-lance aviation writing because it enables him to get around more and report on things first-hand. In order to do just that he is leaving his job as News Editor of the *Review* and from now on will devote all his time to free-lance writing. This summer he also plans to get in a little soaring, a long unfulfilled yen.

Sea Hawk

(*Continued from page 65*)

official flight with a 22-sec. motor run.

The idea of converting to a seaplane came about upon learning there was to be an R.O.W. event at the Nationals. A three-float arrangement with the main float at the front and two on the stabilizer seemed to be the logical answer. The model floated very well with this set-up, but was reluctant to leave the water. Charlie Grant saved the day, however, when he said that the center of lift of the main float was behind the C.G. of the model. Having no way in which to move the float further forward, we set to work with a knife, cement, and pins, and proceeded to shorten it. The succeeding take-offs were successful. Our drawings show the corrected shape.

Construction: The fuselage is built up, using the crutch system, which makes for ease of construction and true alignment. Follow the steps shown on the drawing. All formers, wing, and stabilizer ribs may be enlarged to full size by the criss-cross line method or by having them enlarged photostatically.

Completely assemble wing mount before mounting to the fuselage. Use plenty of cement. The stabilizer platform is built up of 3/16" sheet and is securely cemented onto the top of the fuselage. Check for absolute alignment with top of the wing mount.

Form the landing gear of 1/8" steel wire and bolt to firewall using the aluminum brackets and lock washers. Steel motor mounts are recommended over dural or wooden ones. When mounting motor is in place, be sure to give it four degrees *left* thrust.

For the ignition use a coil of known quality and a battery pack containing four to six cells. Your motor will not only perform better but the pack will last indefinitely. Our model has made well over one hundred and fifty flights and the original pack is still in the ship.

Begin the stabilizer construction by laminating the three leading edge strips together. The remainder is conventional. Use 3/16" soft or 1/8" medium quarter grain stock for the rudder. Cover both sides with silk or Silkspan and prop upright for half an hour; then set it on a flat surface and lay some magazines on top. Leave it overnight. This will assure a perfectly true rudder that doesn't warp as many of the built-up types do.

The wing is not only very simple to construct but sturdy as well. Taper the trailing edges before pinning on plan. When cementing the ribs in place use a generous supply of glue where they join the trailing edge. After the wing construction is ready for the dihedral, cut the tips loose. Bevel the leading and trailing edges so they meet squarely when the tips are raised 4". Cement the two tips in place and apply gussets. Cut wing on each side of center section and raise respective panels to the total dihedral of 8". Use hard balsa only for the dihedral gussets.

Material cut from a gal's rayon stocking is used for covering the pylon. The grain must run vertically for strength. The pylon