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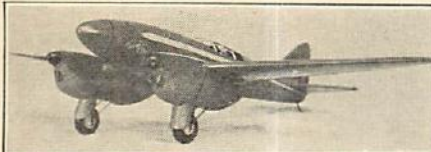
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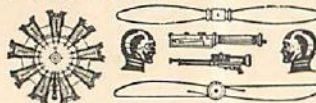
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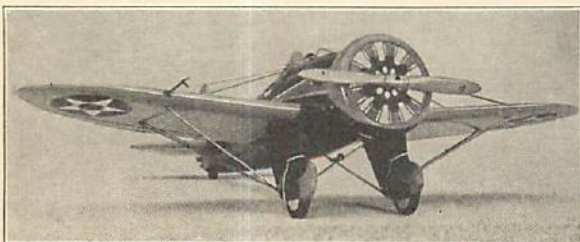
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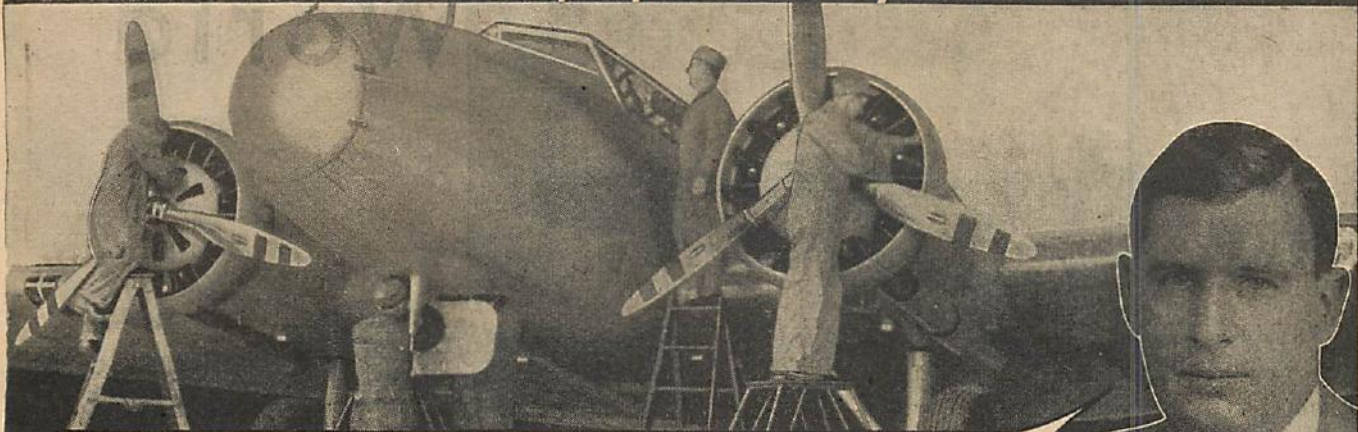
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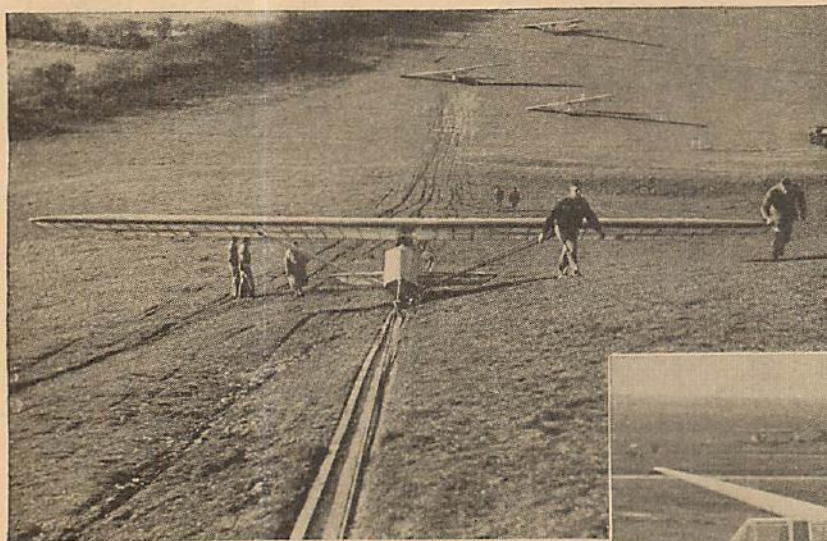
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This Winged World

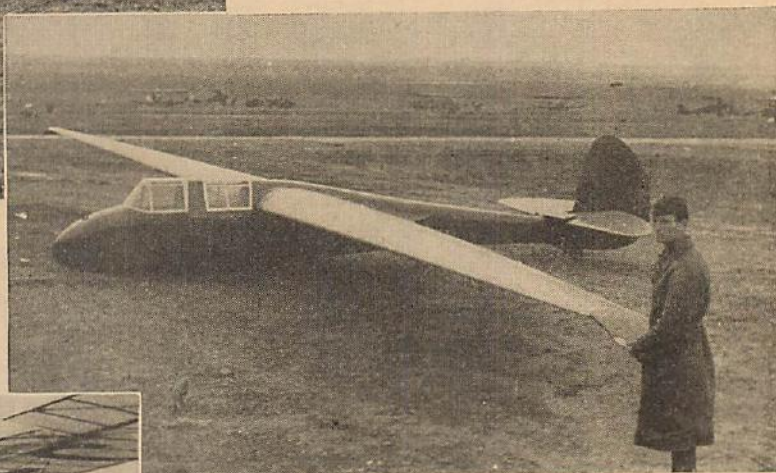


COL. CHARLES A. LINDBERGH, now living in England, tries his new half-British, half-American plane. It's the Miles Mohawk, a fast, light, two-place job created under the famous flier's supervision by F. G. Miles, noted British designer, and powered by a 200 h.p. American Menasco.

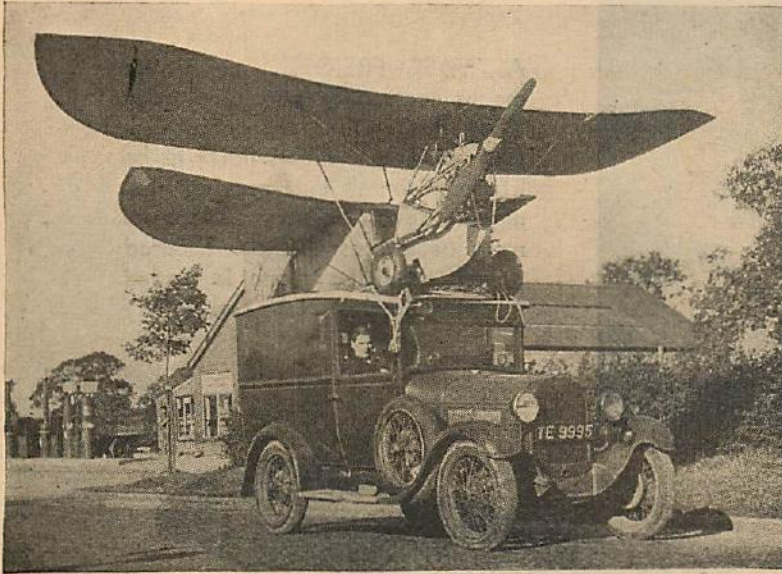


GLIDING makes the whole world kin when it comes to taking to the air. At left, a cable windlass hauls a British glider to the top of Dunstable Downs. Note others below waiting their turn.

TWO-SEAT Russian soarer at right recently carried pilot and passenger 83 miles in 1 hour 40 minutes after airplane tow to 3,600 feet.



JAPAN, like Germany, finds that gliding is good air training for her future military pilots. These lads, lugging a primary glider to the practice field, belong to the air force "junior division."

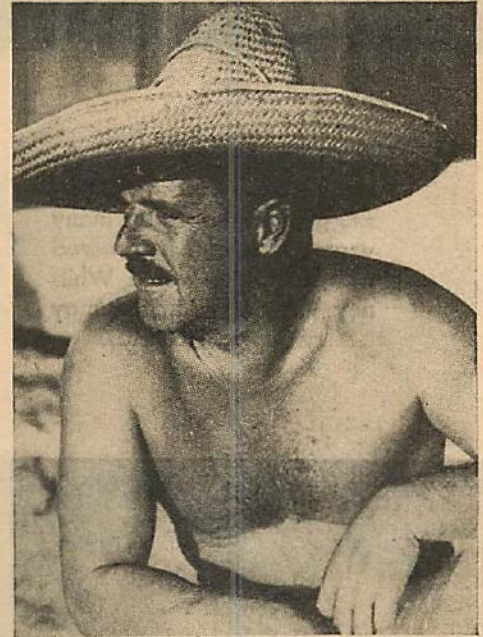
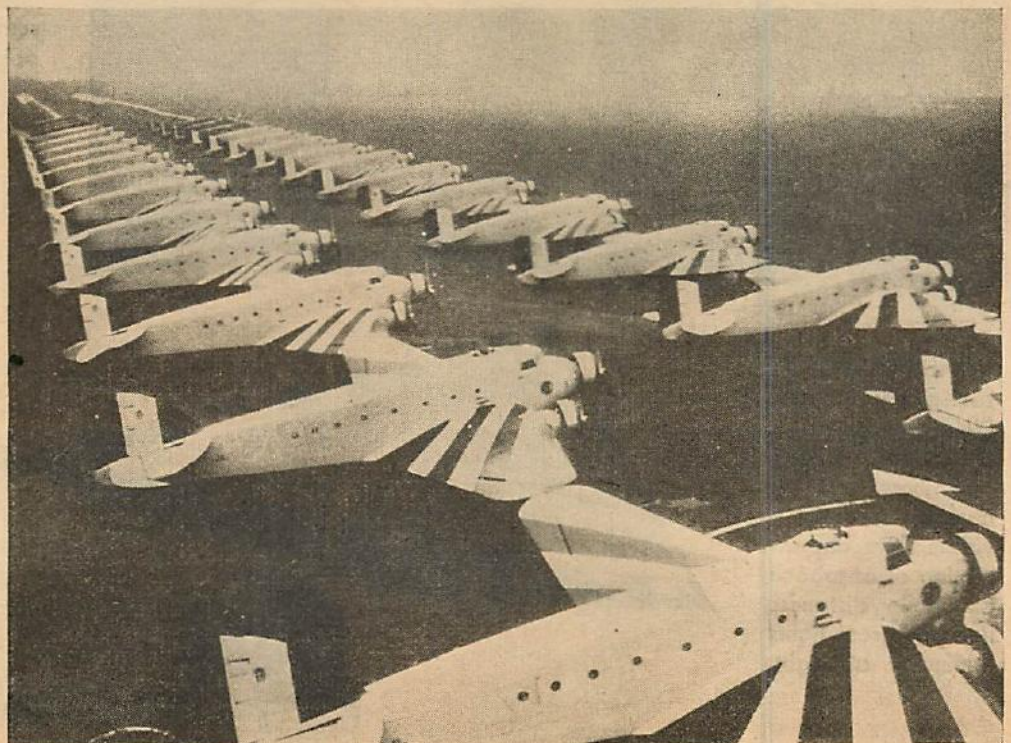


NO, Lemuel, the airplane did not land on the automobile, nor is it being taken to a garage for repairs. The man is English—you can tell that because he's driving on the left side of the road—and he's looking for a likely field to launch his Flea. A clever idea, we call it.



"POLYPARACHUTE," which looks as if somebody had been careless with cigarette stubs, is really a new French invention of M. Dupuis that opens in 3 seconds, has slow fall, and soft landing. Multiple surfaces total 488 square feet.

ITALY is strengthening her wings with an ever-growing force of war planes such as these Savoia-Marchetti S-81s at Milan. The tri-motored bombers can do well over 200 m.p.h. and carry 2 tons of bombs.

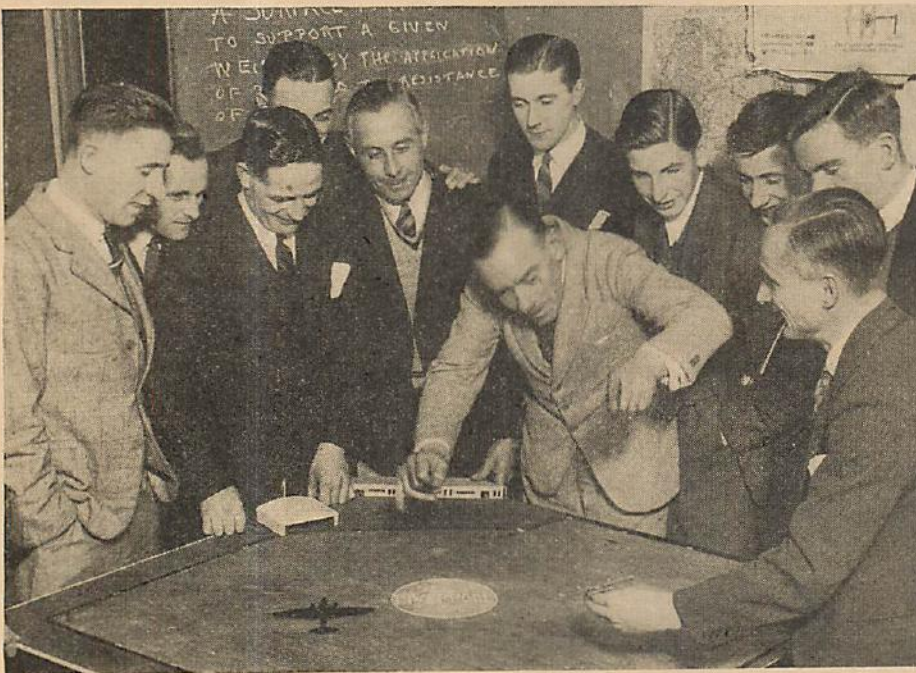


WHAT the well-dressed mid-Pacific airport manager will wear is displayed by Stewart Saunders of PAA's Wake Island.



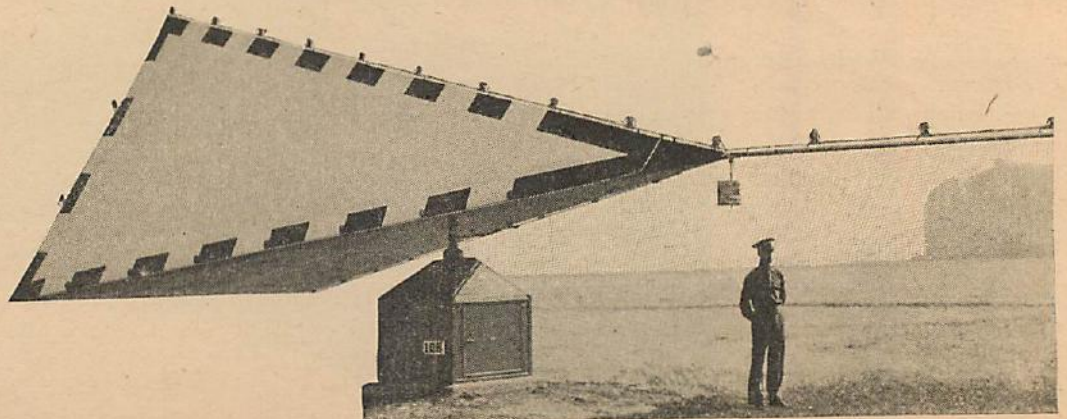
A "FAST FREIGHT" no longer means necessarily a railroad train. TWA has started east coast-Chicago all-freight flights (later to be transcontinental) that provide mid-night-to-dawn delivery at special rates as low as \$12 per hundred pounds. Left, a piano is loaded aboard at New York.

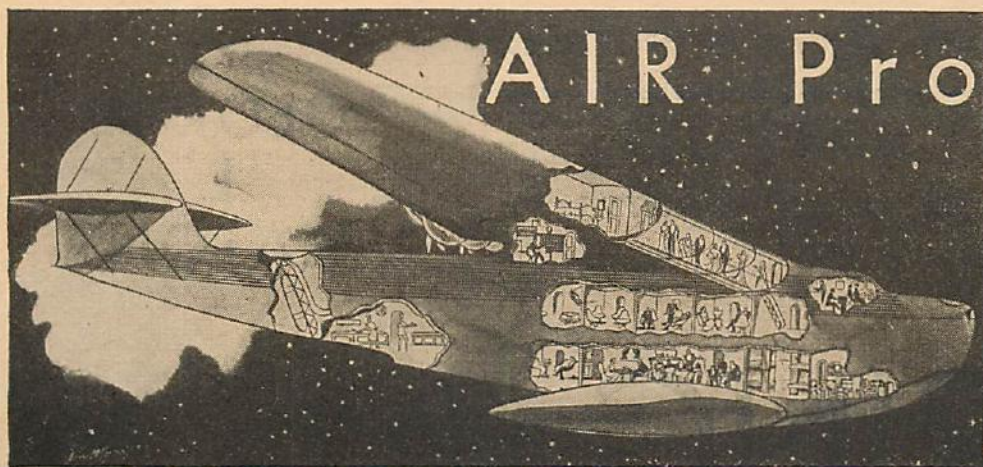
FLYING BOX CARS are the old reliable Ford tri-motor, still going strong after many years. This one is powered with 420 h.p. Pratt & Whitney Wasps. Cargoes may run up to 3,500 lbs.



SHOWING the way to aviation training for those who normally could not afford it, this group of Liverpool workers have formed an air club; for dues averaging about 25¢ a week, they hope to produce 20 licensed pilots before next summer. They are pictured being taught take-off and landing procedure.

WIND INDICATOR for army's Scott Field, near Belleville, Ill., is 40 feet long and because of triangular shape is visible from any direction of approach at 5-mile distance. Red and green lights outline it at night.





Martin is reported developing this idea of a future ocean Clipper.

A summary of aviation news

Air Forces

More estimates are available in the international guessing game. Major General Westover, at an N. A. A. meeting, quoted our total plane strength as 1,329 as of July 1, 1936; Arthur Dudley said that on Jan. 1, 1937, France would have 4,400; Russia, "planes ready for war," 5,000; Britain, 1,790; Germany, 2,800; Italy, 4,400; Japan, 2,000.

France will form two "air infantry" groups, dropped by parachute with rifles and light machine guns. Germany revealed work on two aircraft vessels of about 20,000 tons, known as "Carrier A" and "Carrier B." In Spain, aerial warfare continued with German and Italian planes on the Fascist side and French and Russian ships rumored in service for the Loyalist government. Bert Acosta and some half a dozen other American pilots went to fly for the Loyalists.

Answering rumors that Britain would buy American military planes, the U. S. decreed that two years must elapse before an American manufacturer delivering a new ship to our forces may sell the design abroad. The navy awarded a contract for 66 big Consolidated patrol bombers of the P3Y type, adding to those already ordered. The army awarded contracts to North American for 117 basic trainers and 120 three-place observation planes.

Transport

American passenger planes have received direct and indirect acknowledgment of superiority from Britain, the country whose planes, except a special racing job, were beaten in the 1934 London-Melbourne race by Douglas and Boeing transports. Imperial Airways is buying Lockheed Electras for its subsidized London-Sweden night route. Overloading of her own industry and failure of the De Havilland 86 liner to meet requirements has forced Britain to turn abroad for transports.

Indirectly, the high speeds of U. S. transport service and the example set by Dutch K. L. M.'s Douglasses have led Imperial Airways to order 12 new 4-engined monoplanes from Armstrong Whitworth. They will be 123 ft. in span, 110 in length, weigh 20 tons gross, carry 42 passengers, do 200 m.p.h. and cut the 2¼-hour London-Paris trip of the present 120-m.p.h. planes to 1½ hours.

Army proposals to considerably enlarge PAA mid-Pacific bases on Midway, Wake and Guam, although called commercial and only secondarily a defense measure, have caused alarm in Japan, which feels such a move would alter the whole Pacific strategic set-up. Mean-

while Japan intends to tie together her own Pacific islands with an aerial line.

Despite 11,000-foot altitude, a short runway, and bad weather, a Curtiss Condor set a cargo record by flying 33 tons of mining machinery and passengers on 13 trips in 2 days from Cuzco to Huanacabamba, in the lofty Andes, averaging over 2½ tons per trip.

Flights

An unusual feat of skill and endurance ended unfortunately when André Japy, young Frenchman, crashed on a Japanese island near the goal of his Paris-Tokyo trip. He left Paris before midnight Sunday, Nov. 15; Wednesday he was in Hongkong, having en route cut the Paris-Hanoi record of 5 days 20 hours 45 minutes to 2d 3h. Hopping for Tokyo Thursday in strong head winds, he suffered serious injuries in a forced landing. Had he reached his goal, he would have flown 10,000 miles in 4 days.

James Mollison took his transatlantic Bellanca Flash into the air at London Nov. 29, accompanied by Edouard Corniglion-Molinier, to lower the 7d 22h 42m London-South Africa-London record set last summer by his wife, Amy Johnson. On Dec. 2, with 27 minutes left to beat her 3d 6h 29m trip to Cape Town, they radioed that they were lost over the ocean off Africa's southern tip. Fears for their safety were relieved next day when it was learned they had made land unharmed. Their record attempt was abandoned.

Science

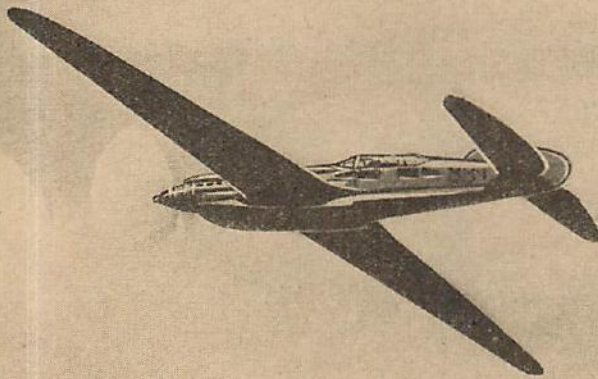
New advances have been made in stratosphere research with small balloons. Dr. Robert A. Millikan reported that his cosmic-ray instruments had been carried up 92,000 feet, or nearly 17½ miles. Five balloons were strung in tandem 20 feet apart; when bursting level was reached, the topmost balloons ripped in succession, slowing the ascent of the remainder so that the apparatus hovered for several hours until released by clockwork for a parachute drop.

At Harvard, a method of keeping a temperature recorder from freezing by wrapping it in a wool-packed balsa box permitted launching the first night weather balloon. Released at an early hour as an army plane took off for the regular daily weather flight, it passed the plane at the latter's 17,000-foot ceiling—where the temperature was 9° below zero—and continued up about 10 miles, where it radioed a report of 77° below.

*Pestilence rode the sky lanes as a new
and horrible weapon took wing, with
only Bill Barnes in his Silver Lancer
blocking the way to its objective—*

by
GEORGE
L.
EATON

The RING of DEATH



Ship after ship, they came
like an avenging horde—
ready to kill—eager to
massacre— They were
carrying out orders!



A Bill Barnes Air Novel

Behind him, in the glass-inclosed pilot's cockpit, two men sat at the controls. One of them, an American with fear in his eyes and a haggard expression on his gaunt, lined face, spoke to the tall, black-haired Russian who sat opposite him.

"I can't believe it's true, Vasiloff," he said. "No human mind could be so inhumane. No one but a madman could have such lust for money and power."

"So!" the huge Russian snarled. "Who says he is not a madman? Why do you suppose you have been paid such a fabulous salary? Why did you take the job? Because you were desperate and hated the world. You thought you were hard, that you hated all men. Now you will see. Why do you think we are hidden away on an island that no one can find? Do you think it is all for fun?"

The big Russian slipped his ear phones back over his ears and bellowed with laughter that came from deep down in his stomach. He said, in his precise Oxford accent, "Ha! He cannot believe it is true. He thinks it is a fairy tale and after a while he will wake up. *Sacré bleu!*" He pushed his ear phones back again.

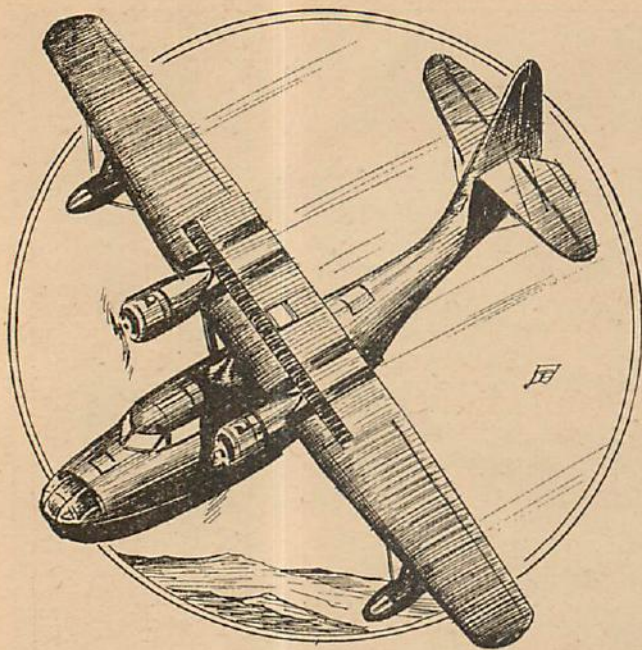
"Wait until we dive on that column of dust down there," he roared. "Then you will know it is true! After a couple of trips you will lose the thing that makes you sick in your stomach. You will remember you hate the world and all men."

"I thought they were collecting and culturing bacteria to find antitoxins to fight disease," the American

THE dull-black, twin-motored amphibian circled slowly above the creeping speck of dust some twenty thousand feet below. The two 1200 h.p. motors, streamlined into the leading edge of the single cantilever wing, droned ceaselessly on and on. There was something both horrifying and menacing in that constant drone. Something as inevitable as death itself.

No machine guns bristled from the nose or fuselage of the big black ship; no bomb racks bulged from beneath its belly. Yet the cold hand of death seemed to ride by its side, seemed to drape its icy cloak over it like a shroud.

Far up in the glass-inclosed nose of the blunt fuselage a man with fair skin and hair and the blue eyes of an Englishman ran an aerial machine-gun camera with a telescopic sight back and forth on its track. On each side, beneath and in front of him, was an intricate combination of sights and levers to release the horrible cargo of pestilence and death that rode in the bowels of the black ship.



half whispered. "I thought the high pay was because of the danger involved in carrying deadly germs and because of the isolation on that horrible island of death. I thought——"

"It is not good to think too much," a voice behind him said. He swung around in his bucket seat to gaze into the smiling, apologetic face of a rugged little Japanese. That is, his lips were drawn back over his teeth in what might have been a smile, but his eyes were small, hard and metallic.

"I am very, very sorry to have to listen to what you have to say," the Jap hissed through his large, even teeth. "I do not like to listen to conversations that are not meant for me to hear. But you were talking into your microphones, and I could not help but hear.

"You must not think too much and you must not talk too much. It will be very, very bad for you if you talk too much, Mr. Emerson. The big chief does not like to have his men talk too much. It is very, very bad for them if they do."

Emerson's gaunt face was a pasty white now. He knew that the little Japanese who hissed at him through smiling teeth was not really smiling. He knew that behind that exterior of calm politeness and imperturbability was something more horrible than death. He dug his finger nails into the palms of his hands and tried to match the soft, modulated voice of the Jap.

"I understand your warning, Mr. Hoko," he said. "I understand and appreciate it. But the thing seems too horrible for me to contemplate. I had no idea. I——" He stopped speaking because his voice broke and he knew he was losing face in the eyes of the polite little Mr. Hoko.

"You will some day be a very, very rich man," Mr. Hoko hissed through his teeth. "It is very, very nice to be very rich. After a few experimental trips like this one you will not mind. You will learn that things are not of very much importance in this life. You will learn that you must be very, very discreet. Dying as these people will die down below is a very, very easy death. But dying as the chief sometimes asks people to die for being indiscreet is very, very bad. I would be very, very sorry if anything bad happened to you, Mr. Emerson."

Guy Emerson blinked his eyes, nodded his head and dug his finger nails into his hands again, to be sure that he was not dreaming this thing. It was too fantastic. The deadly little Jap, Hoko, telling him he would be very, very sorry if anything bad happened to him. He knew what the Jap meant. He shuddered as he thought of it. He thought of the things Vasiloff had just made clear to him. Myriad thoughts flashed through his mind, thoughts that took him back to his childhood. He wondered if this was that last review of one's life that was supposed to come just before death. Then Hoko's voice cut into his consciousness again.

"We will dive now, in a very, very few minutes," he was saying. "I will be in the control chamber, giving orders. Mr. Vasiloff, you will handle the controls of the ship while we make our attack. Mr. Emerson will watch so that next time he will understand."

The big Russian turned and looked at Hoko with eyes that were quite as hard as Hoko's own. His lip curled for an instant, and he nodded his head.

Two minutes later he shoved the wheel of the big ship forward, as Mr. Hoko's soft, sibilant voice came through the ear phones. The twin motors began to whine as he stuck the nose down and opened the throttles.

Miles below, the little-known province of Sin-Kiang was a land of deserts and sand dunes, rock-ribbed canyons and grassy lowlands. Far to the north the great ice-clad mountains of Siberia towered into the sky. No railway connects Sin-Kiang with the outside world. Newspapers are permitted neither to be published nor to be brought into the country. Its inhabitants are peacefully unaware that there have been revolutions anywhere in the world within a generation.

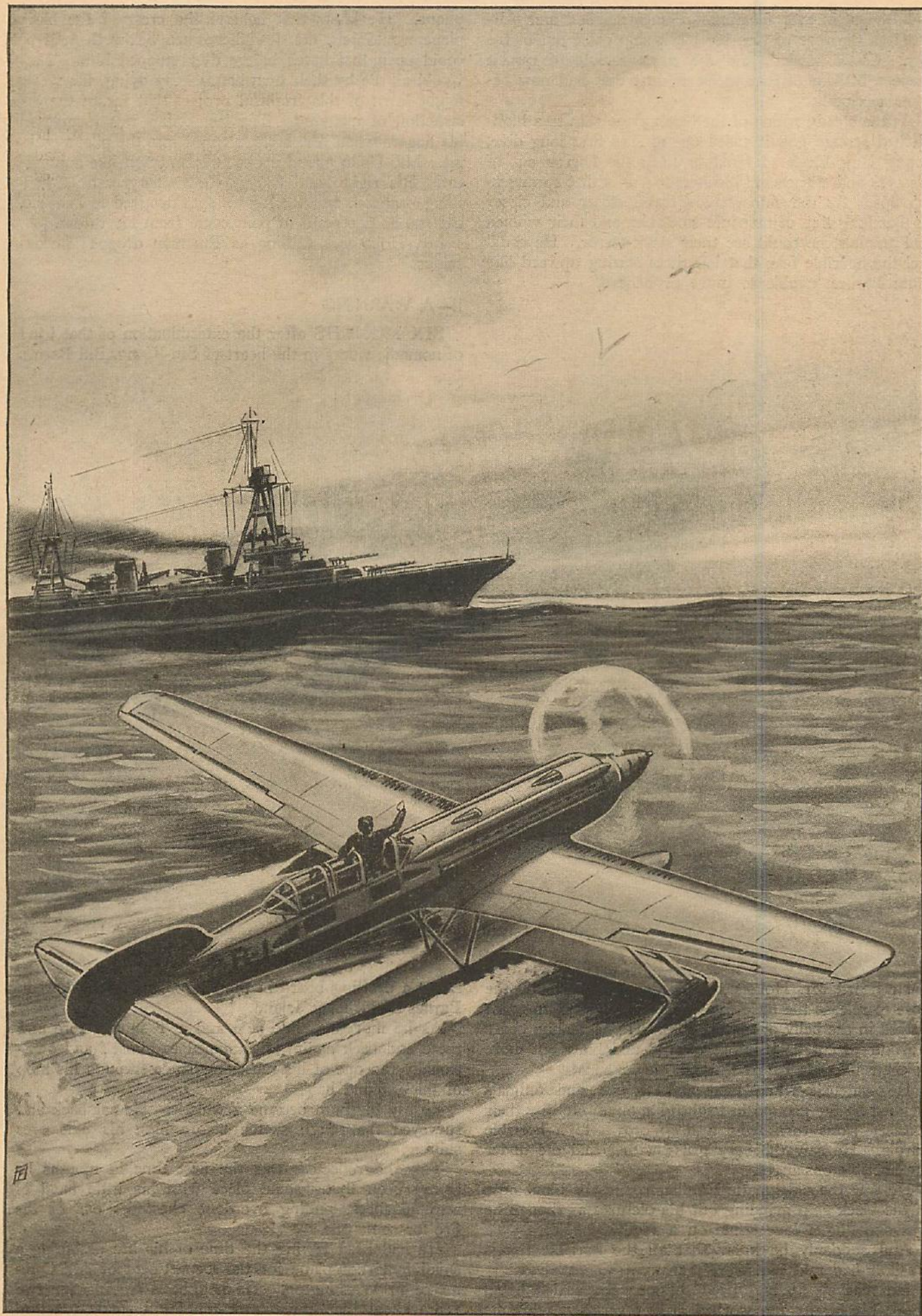
For twenty centuries Sin-Kiang has slept, first under the rule of the Chinese, then the Turks or Mongols, and now again the Chinese. Genghis Khan conquered it in the thirteenth century, and Tamerlane a century later. Down through the ages the natives have been slaughtered by one leader and then another. They know nothing of the outside world. The nomad riders of the high meadows have heard of China and of the land of the Franks to the east. But most of them have never heard of America. They are light-hearted people, cheerful and easy to govern, and without any desire for advancement either educationally or in any other sense.

Twice each year the nomadic Turks carry their felt yurts from the lowlands to the mountain pastures. In the early summer, when the blazing sun dries up the grass, they seek the cool air and green pastures of the plateaus. In the fall the first snow flurries send them to the lowland rivers. There the winters are milder and the snowfall light enough to permit flocks and herds to paw through the white blanket and eke out an existence on dead grass until spring.

That creeping speck of dust far below the huge black plane became a thing alive as the big ship dived toward it. It became a long, thin line of animals and human beings that were hardly more than animals.

Fine herds of shaggy ponies were being guided by the younger, more active men in their brightly colored coats. The long-legged camels were led and ridden by older men, while the placid oxen and sheep were herded along by the squat women.

Here and there a baby camel was strapped across its mother's back. The heads of baby lambs stuck out of



Bill skimmed the top of the cruiser and set the Lancer down on the waters of the Atlantic.

saddlebags, forever bleating. Ponies neighed and skittered as the roar of that big black ship came out of the sky. Cattle bawled, and the raucous note of camels made a bedlam of that speck of dust that had now become a cloud.

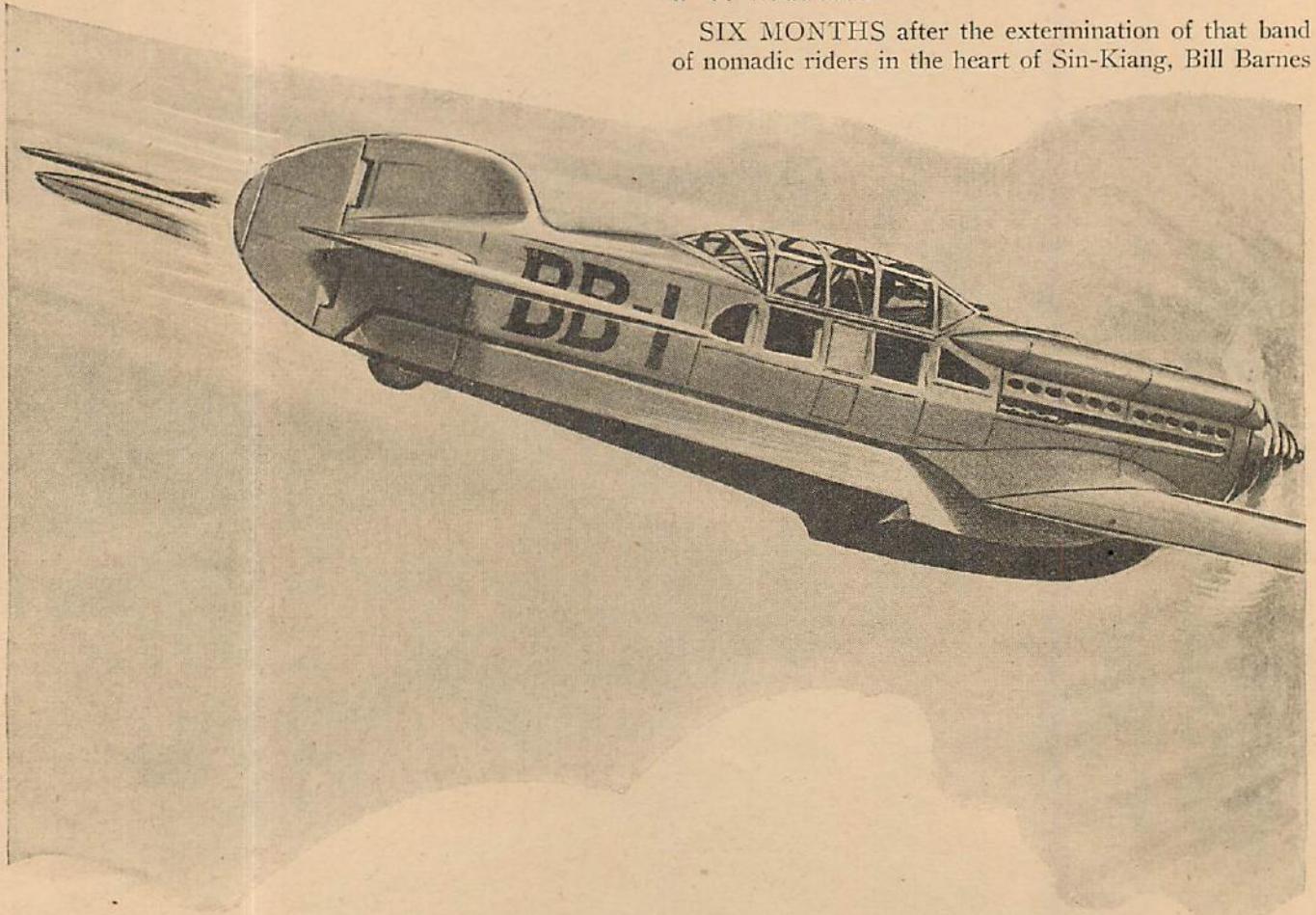
As the steady whine of the black plane rose to a high-pitched scream and it eased out of that first long dive, young Guy Emerson tried to keep the horror out of his eyes and silence the incoherent words that sprang to his lips. As the ship shallow-dived closer and closer to that long line of nomadic stockmen and their women and animals, he could see their stark terror. He could feel the horrible fear that left them staring upward like mute statues, unable to move or believe.

phone. He knew that he and the crew of the black plane would join the dead herdsmen below them if he could open that hatch before they stopped him. They would all die by their own hands. By dying, the world might learn of this frightful project that meant the destruction of mankind. The last clamp was turning in his fingers when Mr. Hoko stepped into the pilot's cockpit. Mr. Hoko glided up behind Emerson like a jungle cat. His right hand caught Emerson's wrist. Something snapped, and Emerson's arm dropped to his side, useless, as a scream of pain came from his throat.

Mr. Hoko was smiling as Emerson dropped unconscious.

II—A WARNING

SIX MONTHS after the extermination of that band of nomadic riders in the heart of Sin-Kiang, Bill Barnes



He heard Mr. Hoko's voice order the bomber in the nose to release the little five-ounce explosive bombs that bulged in the belly of the big ship. He heard him order Vasiloff to cut back into the wind and blow out more of their horrible cargo through the exhaust.

He watched while men and women and animals writhed on the ground in frightful agony. He saw their leathery skins turn from a deep brown to a horrible purple. He saw the very grass wither and die under the horrible onslaught.

He saw the phlegmatic Englishman in the blunt nose of the black ship grinding out his pictures as though he was shooting a love scene on a Hollywood lot.

And suddenly he knew that all the horrible things Vasiloff had told him were true.

He reached up and tried to open the sealed hatch above his head. He worked at it feverishly, while he heard Vasiloff's voice rise as he spoke into his micro-

sat at a drafting board in the study of his bungalow on Barnes Field, Long Island.

As he moved a slide rule and a T square here and there and back again, he hummed to himself and occasionally ran one of his muscular hands through his mop of thick, blond hair.

Finally his hum became a whistle. He sat back and surveyed the rough sketch before him, his blue eyes shining.

This, he reflected, was the first time in months he hadn't been flying some place with his little band of intrepid fliers, pulling overdone chestnuts out of the fire for some one.

He had been having the time of his life designing a small foolproof plane for the Department of Air Commerce in Washington. He had been reading for two years about that bureau's search for a small, practical plane that would be to the air-minded what the old

Model-T Ford had been to the automobile industry at its beginning. He had been itching for those two years to design and then build such a plane in his own shops. Now he was well on the way to realizing his ambition.

"She'll develop one hundred and twenty h.p.'s," he said to himself, "and she'll cruise at the same speed and carry five hundred pounds, not including the gas and oil. Who could ask for more than that?" He tossed his pencil on the board and climbed off his stool as one of the telephones on his desk clanged.

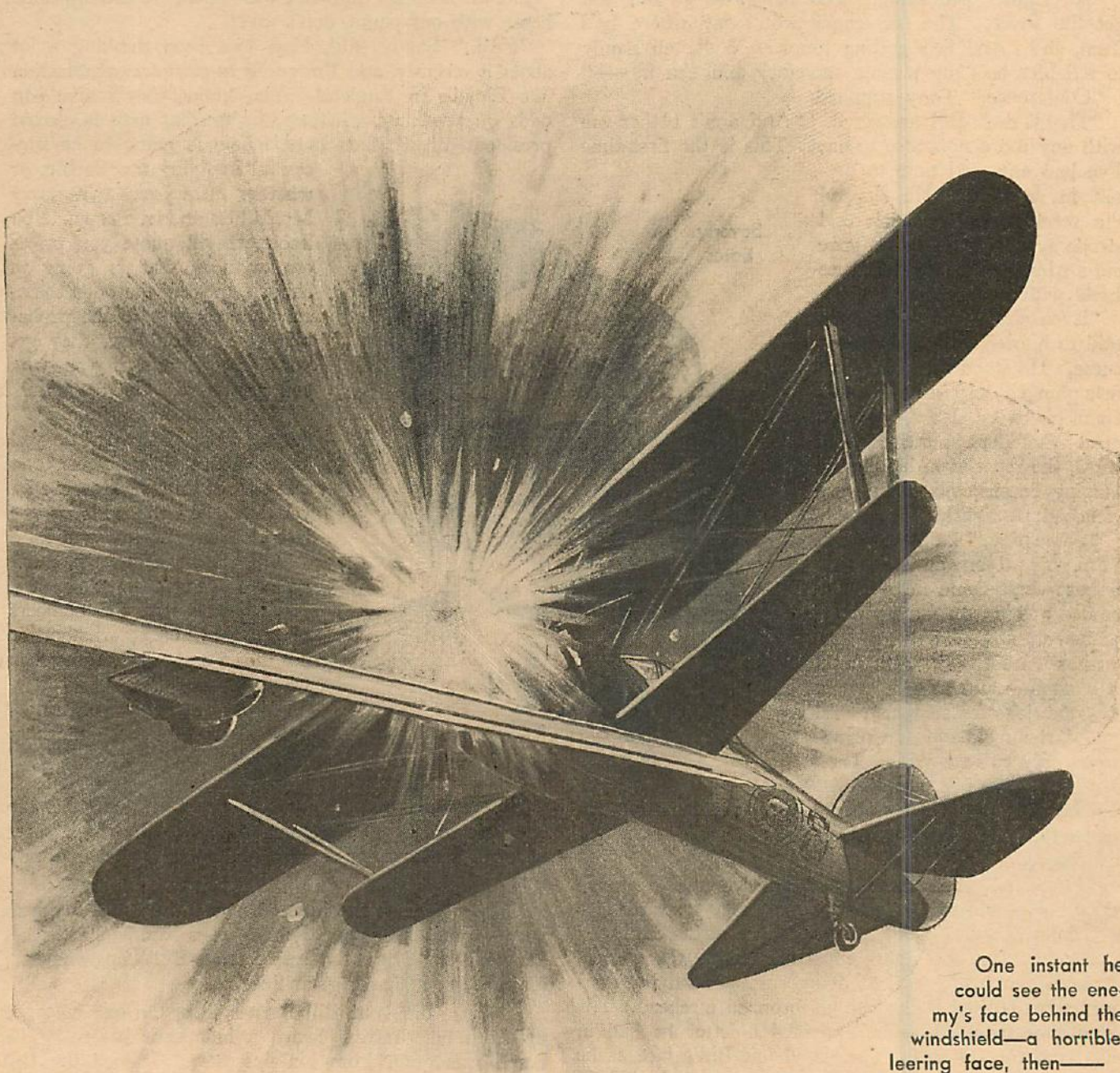
"I'll have Scotty get some blue prints in order," he

who says he has a letter for you," Tony said. "He says he can't deliver it to any one but you. The guards won't pass him through, of course, until they get your O. K. What shall I do about it?"

"Tell him to go fry his ears," Bill said distinctly, while Tony Lamport laughed. "That's what Sandy would tell him."

"You sound as though things were breaking your way to-day," Tony said. He was amazed at Bill's let-down from character. It wasn't often that Bill had a chance to shed his cloak and mask and resort to such levity.

"They *are* breaking my way, and I don't want any



One instant he could see the enemy's face behind the windshield—a horrible, leering face, then——

went on, "and send 'em down to Washington and ask 'em how they like those apples."

"Bill speaking," he said into the mouthpiece.

"Tony, Bill," Tony Lamport, the chief radio operator on the field, said into his ear.

"What's on your mind, young fella?" Bill asked.

"There is a bozo outside the Wauchuck Road gate

one to spoil them," Bill answered. "Tell him he can deliver it to one of the guards and it will come through the regular channels to me, or he can take it back where it came from."

"O. K., Bill," Tony said.

Bill edged over to the drafting board again. He couldn't keep his eyes off it.

"Let's see," he said aloud. "She'll have a wing span of forty-two feet, length of twenty-seven—a total wing area of two hundred and—" He stopped talking and shook his head impatiently as the phone clanged again.

"Bill," he said abruptly.

"Tony again, Bill. Listen, this bozo insists that you'll want this letter he's carrying. He's a pest, and he won't go away. He—"

"Tell him," Bill half shouted, "to go— Wait a minute. Where's Sandy?"

"In your office. He just brought in the Eaglet," Tony said.

"All right," Bill said. "Tell Sandy to go out and get the letter. The messenger won't say where he's from, eh? And he's getting tough? Well, tell Sandy to tell him he's my private secretary and I'm in—"

"Conference," Tony supplied.

"That'll do," Bill answered. "And don't bother me with any more nonsense to-day. This is the first time I've had any real time to myself in months." He slapped the receiver on its hook and strode across the room, to gaze out a window and across Barnes Field with unseeing eyes.

"Even now I can feel it," he said to himself with a muttered curse. He stood there with his fists plunged deep into the pockets of his tweed slacks, his powerful shoulders hunched forward, the muscles in his cheeks bulging because his teeth were clenched so tightly.

"Some day," he said aloud, "I'm going to buy an island that a boat can't come near." He smiled at his own fantasy. "A plane won't be able to get within a mile of it. I'll build a bungalow and have a couple of good dogs for company. I'll go to the mainland for provisions only twice a year. Then I'll have some peace and quiet. I'll be able to design planes until I get so goofy I'll begin to cut out paper dolls. Then it won't make any difference.

"Come in!" he bellowed as a knock sounded on his door. He whirled to see the grinning, freckled face of young "Sandy" Sanders, the kid ace of his outfit.

Sandy's fast-developing muscular body was clothed in a spotless white overall flying suit. His flying goggles were pushed back over his bronzed forehead. His blue eyes twinkled as he extended a letter he had in his hand toward Bill. The scowl left Bill's face as he saw the expression in Sandy's eyes. He couldn't help returning his grin.

"Here yuh are, Toots," Sandy said, and stuck the letter in Bill's hand.

"That's a fine way to speak to your boss," Bill growled at him. "Did you find out where this thing is from? Who brought it?"

"He wouldn't say where he was from," Sandy said, "and he insisted that no one but you must open it. He looked like something that had been in a wreck

and the doctor put his teeth back where his nose ought to be."

Bill laughed and threw the letter on his desk. Sandy's face suddenly became serious as he pointed a finger at the letter.

"He said it was important, Bill," Sandy said. "Maybe you better open it. You know, I always get a funny feeling, kind of as though I couldn't breathe, when something like that arrives. So many things like that have happened in the past and then everything broke wide open."

"It'll keep," Bill said, looking at the letter grimly. "And when things do break wide open, we usually come home with our pants, don't we?"

"Yeah," Sandy said, "but I've been thinking a lot about it recently, and I'm going to start an organization like Lloyd's in England. You know, they'll give you odds on anything, whether this or that man is elected president, or whether some fellow is going to be successful in flying the Pacific, or whether Miss Jones will marry Mr. White or Mr. Brown. You know, they'll quote you prices on anything that is going to happen, making the odds themselves, according to the probabilities. If you lose, they get your money, and if you win, you get theirs. Get the idea?"

"Yes," Bill said, grinning. "I get the idea. But what do you know about percentages and that sort of thing? How would you have laid the odds on the last election, for instance?"

"Oh," Sandy said, "I wouldn't go into things like that. I'd just lay odds with the members of our own outfit whether or not they'd come back alive when we took on a job."

"What a nice boy you turned out to be," Bill said, chuckling. "Gambling on your friends' lives."

Bill reached over, picked up the letter and slit the envelope with a letter opener. He drew the single sheet of extra-heavy paper from it absent-mindedly as Sandy went on talking.

"You don't get the idea," Sandy said. "I'd lay bets with—" He stopped, and his eyes became startled as he heard the grunt that came from Bill's lips and saw his face set in hard, grim lines.

It was a different Bill Barnes from the one who got up from his drafting board a half hour before. The laugh was gone from his lips now. It was the Bill Barnes who had faced a thousand dangers above the seven seas. It was the face of the Bill Barnes the world had learned to know, respect and admire. It was the face of a man who kept driving on in the face of insurmountable odds. The grim, tenacious face of a man that will not, or cannot, be beaten, while there is breath left in his body.

Bill's eyes ran down the few lines of the letter again:

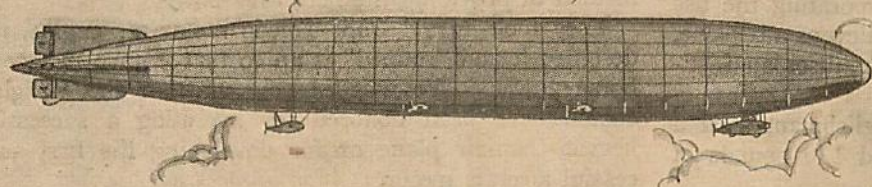
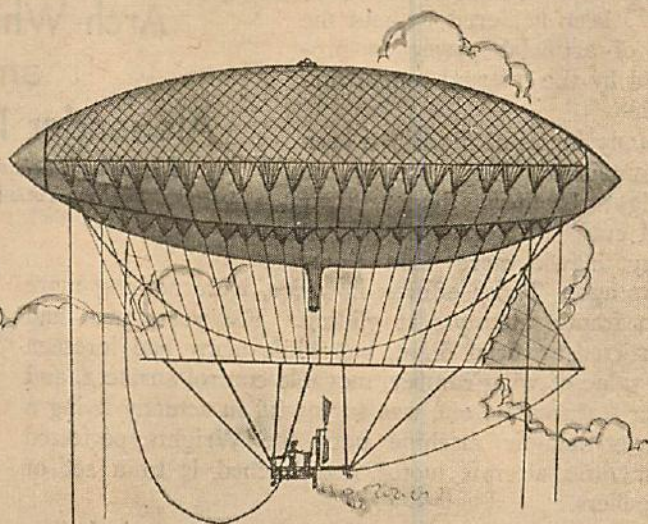
(Turn to page 64)

Beverly
Bates



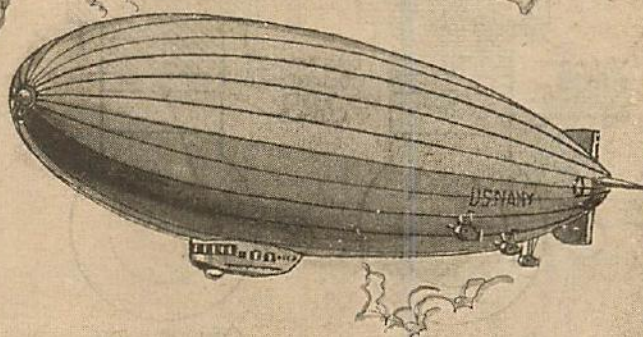
Dirigible Development

THE FIRST DIRIGIBLE WAS
FLOWN SEPT. 24th, 1852.
IT WAS 144 FT. LONG AND
WAS FLOWN OVER PARIS
AT 6 M.P.H. BY ITS BUILDER,
HENRI GIFFARD.



GERMAN DIRIGIBLES
OF 1918 WERE 693
FT. LONG AND FLEW
45 M.P.H. WITH THE
LOAD OF 38 TONS!

THE "LOS ANGELES" OF 1928
COULD CARRY A 40 TON
LOAD AT 76 M.P.H. - IT IS
656 FT. LONG AND HAS A
CRUISING RANGE OF 5,200 MI.



THE "HINDENBURG,"
OF TODAY, IS 803 FT.
LONG AND HAS A
CRUISING RANGE OF
OVER 8,700 MILES.

ITS TOP SPEED IS 85 M.P.H. AND CAPACITY 200 TONS.

Modern Motors

MODERN heavier-than-air flight could never have been achieved without the aid of artificial power as provided by the internal combustion engine.

Many forms of flight had been accomplished long before the Wright brothers flipped their frail craft off a greased skid at Kitty Hawk more than thirty years ago. Those efforts, however, were nothing more than frantic attempts at gliding. For years men had visualized artificial flight, but while many had foreseen the value of wing camber, movable control surfaces, and other features, no one was successful in actually flying a heavier-than-air machine until the Wrights perfected their little aircraft motor and hitched it to a set of propellers.

True, others had tried various power means, including a form of the steam engine. As far back as 1868, John Stringfellow devised an airplane, incorporating the use of a steam engine, which in model form flew as a triplane. That engine is on view to-day at the Smithsonian Institution.

In 1875 Thomas Moy, another Englishman, used a 3 h.p. steam engine, and actually lifted 120 pounds of

by
Arch Whitehouse
and
Alexander N. Troschkin

*Guggenheim School of Aeronautics,
New York University*

"airplane" a few inches off the ground. Lawrence Hargrave, an Australian, tried out model compressed-air motors on a flapping-wing monoplane and proved that, with suitable power, even this type would fly. Hargrave's original model is also in our Smithsonian. Clement F. Ader, a French electrical engineer, claims to have flown 300 feet at an army

camp at Satory in 1891 with the aid of a small steam engine.

Hiram Maxim invented a steam plane in England in 1893. Although it weighed three and a half tons, it actually flew off the ground, only to crash. Chanute and Lilienthal proved to the world that the successful airplane must be inherently stable and incorporate curved airfoils.

Thus by the time the Wrights were ready to fly most of their flight-theory problems had apparently been solved. What they had to do was to develop a new method of providing the necessary power.

They took an old Pope-Toledo motor-car engine, redesigned it and "souped" it up so that it gave increased horse power. We wonder now whether the Wrights should have been honored for inventing a successful heavier-than-air plane or for developing the first successful aircraft motor.

The old argument concerning the claim as to who actually flew first, the Wrights or Langley, can best be settled by remembering that Langley used a steam motor in his earlier exploits, but in his ill-fated "Aerodrome" he attempted to use Charles M. Manley's amazing radial gasoline engine.

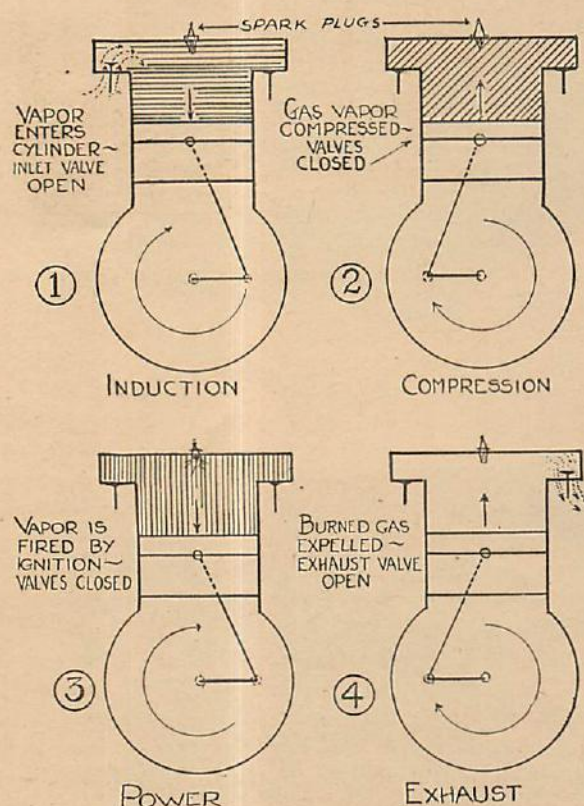
The question as to whether the ship actually flew when it went off that catapult into the Potomac on October 7, 1903, will never be amicably settled. They will always say (those who take the Wrights' side) that the rear wings and rudder of Langley's plane were wrecked before the machine was clear of the guideways. We must remember, however, that years later the "Aerodrome" was rebuilt and actually flown with a Curtiss motor as its power plant. It flew off a set of water pontoons.

Thus again we get proof that the world was waiting for a motor, and that the Wrights provided one.

Their successful flight was staged on December 17, 1903, only a few weeks after Langley's gallant attempt. Of two correctly designed planes, both capable of flight, the Wrights' plane flew when the proper power plant was installed.

From that date begins the true history of the aircraft motor.

The original Wright motor developed, according to some experts, about 12 h.p. Manley's power plant was the first five-cylinder radial built in this country. It was water-cooled and turned up 52.4 h.p. Some historians declare that the Wrights' motor developed 35 h.p. at 1,200 r.p.m., but no one seems quite certain.



Piston strokes in operation of four-cylinder engine.

Basic principles of aero engines that you should know are set forth in this authoritative article, first of a series.

As we stated above, it was a redesigned Pope-Toledo automobile motor, lightened wherever possible, fitted with an aluminum alloy crankcase and equipped with two gears from which the twin propellers were driven. The problem then was to build an engine light enough and powerful enough to get the plane into the air.

Manley was years ahead of his time with his radial, and had the Langley "Aerodrome" been successfully flown, there is every reason to believe that the radial would have been given more attention than it received and that it would have reached its present high standing much sooner. However, as the Wrights had actually flown with a water-cooled, 4-cylinder, in-line engine, inventors all over the world immediately focussed their attention on that type and for years the radial was neglected.

The Wrights had perfected their plane in glider form long before they had power for it. Motorcycle engines of 1902-4 were light enough, but not powerful enough. Motor-car engines had the reverse qualities, and the Wrights had to find one that would suit their particular requirements.

Months of work in their shop eventually produced a power plant which, if it developed 35 h.p. at 1,200 r.p.m., had a power loading of 6 lbs. per h.p. The modern high-power radial has a power loading of little more than one pound per horsepower.

The Wright cylinders were cast iron with applied sheet aluminum water jackets for cooling. The valves were placed in the cylinder head; the exhaust was mechanically operated by a rod and the intake valve was of an automatic type. Fuel was forced into the manifold by an injection system and ignition provided by a Mea high-tension magneto. The crankshaft of this power plant was machined from a solid billet of steel and the crankcase made of an aluminum alloy which probably provided what little weight-saving the Wrights could achieve.

Since those days of 1903, the aircraft engine has undergone so many changes and improvements that it will always be one of the great controversies of the aviation industry as to whether airplane design to date has kept pace with motor design.

The motor industry takes the point that very little real improvement in airplane design has been found since the Wrights first flew. They state, and probably with some justification, that we use the same cambered wing and that the only true improvements may be found in the slotted and flapped wing.

This is hardly fair to the airplane designers, of course, for they have cleaned up their designs, given us a far better wing loading and certainly a far more efficient system of streamlining, enabling man to fly at over 400 miles an hour. The designers, on the other hand, denounce the motor experts for not being able to produce a motor that will turn out much more than 1,500 h.p. They declare that if they could get a single engine that

would turn up 5,000 h.p., they could design a plane that could carry a high pay load at unbelievable speeds.

But the leap from 35 h.p. in 1903 to 3,100 h.p. (the Macchi-Castoldi Fiat) in 1935 is quite a jump, at that. There are many others that turn out 1,000 h.p.

They are geared, supercharged and shielded. They are economical in fuel consumption and unbelievably efficient.

The average man on the street knows little of all this. He knows little of the history of aircraft motors. He *does* know about monoplanes and closed-cabin jobs. He recognizes an air-liner and can often distinguish a racer from a military plane.

But he can't tell a radial engine from a rotary, and hasn't the faintest idea of the difference between a Curtiss Conqueror and a Junkers Diesel.

It is not that he has not been interested. He has had little opportunity to find out. Flying has been made an exalted profession and aviation instruction, whether on the ground or aloft, has necessarily been expensive. Fliers of the War decade and a little later created a strange language and attempted to build up a wall of mystery around flight and flying. As a result, the man

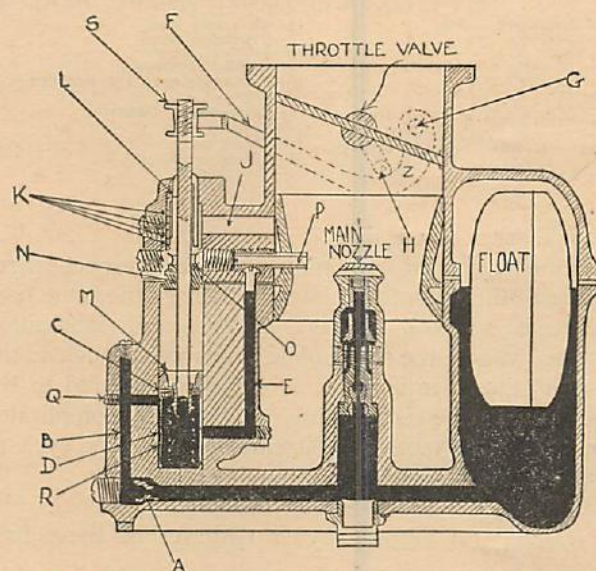
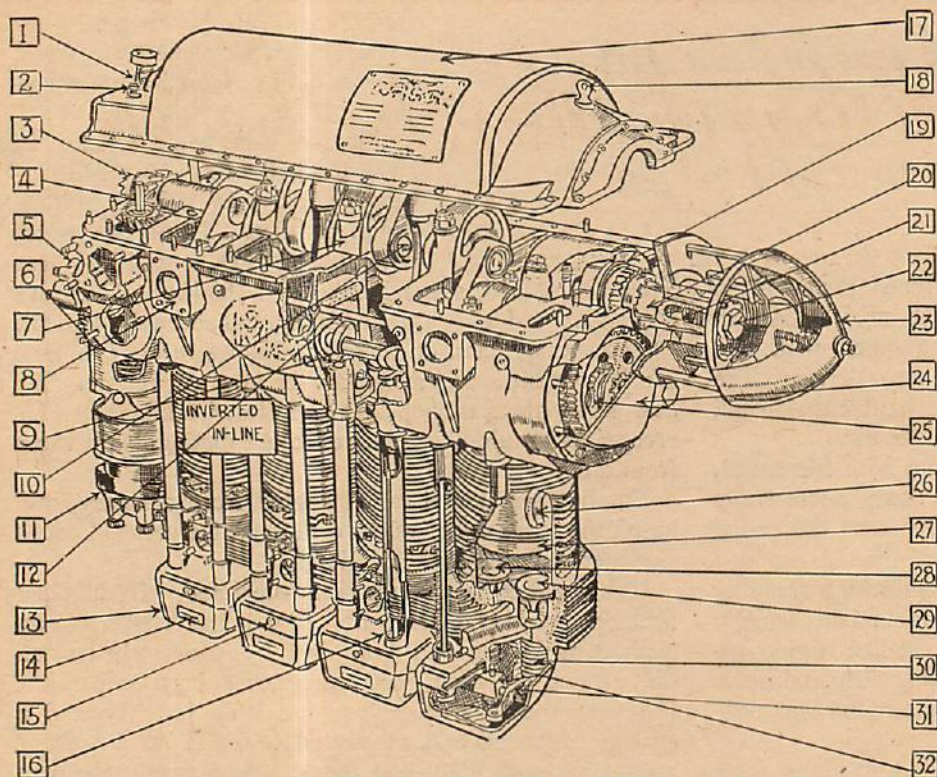


Diagram of modern carburetor arrangement.

on the outside was left ignorant of the true facts of aviation. There are still many people in the world who believe that there are "air pockets" in the sky and that if the motor fails a plane must crash.

Aviation is no mystery. The industry is based on sound business and proved theories. Any normal person can fly if he has the money to buy the proper instruction. There are no fantastic bugaboos anywhere in the profession.

With all this in mind then, we are attempting to take much of the manufactured mystery out of the modern aero engine and at the same time offer a little common-sense information on the various types. We do this, honestly believing that hundreds who read this to-day will be flying regularly to-morrow, and the sooner they obtain a basic knowledge of aircraft motors, the sooner they will take up aviation, facing it with much of the secret-fraternity mystery eliminated.



TYPICAL INVERTED IN-LINE AERO ENGINE

- | | | |
|---|--|---|
| 1—Crankcase breather | 12—Oil supply pipe | 22—Prop-boss locking nut |
| 2—Tachometer drive | 13—Detachable covers | 23—Prop spinner |
| 3—Starter dog | 14—Oil level gauge | 24—Timing gears |
| 4—Tachometer drive shaft | 15—Breather aperture | 25—Camshaft drive |
| 5—Oil filter unit | 16—Push-rod sleeves and retaining spring | 26—Connecting-rod small end |
| 6—Fuel pump studs | 17—Crank-casing (removed) | 27—Slipper-type piston |
| 7—Main bearing | 18—Hoisting loop | 28—Exhaust valve |
| 8—Engine-bearer base | 19—Thrust race | 29—Intake valve |
| 9—Cam and cam-follower | 20—Hollow crankshaft | 30—Valve spring |
| 10—Hollow crankshaft with sealing disks | 21—Sealing plug | 31—Rocker arm |
| 11—Magneto | | 32—Valve-rocker spindle block with oil ducts to the rockers |

WHAT then is an aircraft motor?

The modern aircraft motor is in many respects a refinement of the automobile motor. It uses the same fuel, carburetion system, ignition system, and lubrication methods. Where the automobile is geared through to the rear axle, the aircraft motor is sometimes geared to the propeller. There is nothing particularly complicated about an aircraft motor, for it employs the same cycle of movement that the automobile engine uses.

This is known as the four-stroke cycle principal. We have offered an accompanying diagram of these four movements.

It will be seen that a cylinder is usually set above the crankcase so that the throws of the crankshaft force the connecting rod up and down and draw the piston up and down with it. We will assume that we are studying a single-cylinder engine for simplicity.

In Fig. 1 of the "four-cycle" illustration, it will be seen that the piston is being drawn down while the intake valve shown at the left is open. This is known as the intake or suction stroke. During this movement gasoline vapor created in the carburetor is sucked into the cylinder.

In the next movement, Fig. 2, the valve is closed and the piston is forced upward, compressing the gas vapor in the combustion chamber. Both valves are closed during this stroke.

The third stroke, in Fig. 3, shows how an electric spark, intensified through a high-tension system, is ignited at the top of the cylinder through the medium of a spark plug. This spark ignites the compressed gas vapor, which in burning creates a high pressure of up to 600 or 700 pounds per square inch in the combustion chamber

(the upper portion of the cylinder) and forces the piston down. This is known as the power stroke.

After this combustion there is a certain amount of burned gas in the combustion chamber which must be removed before the cycle of strokes can start again. Thus we have the exhaust stroke, Fig. 4, during which the exhaust valve opens, while the piston rises and forces the exhausted gas out through the exhaust ports.

There you have the four-cycle system in a nut-shell.

It must be remembered, however, that while the crankshaft turns twice during these four strokes, only one of the strokes is an actual power stroke. Thus if our engine is running at a speed of 1,200 r.p.m., it means that only 600 power strokes take place during that minute of action.

THE VALVE SYSTEM is not particularly complicated. It will be seen that to open and close at the correct instant to insure efficient working cycles, these valves must be correctly timed. The general method is to employ a system of gears driven

off the crankshaft and a camshaft which is so built as to move a number of cam-followers and rods, which open or close the valves at the proper time.

Ignition is supplied to the interior of the combustion chamber from a magneto, driven in turn through a set of gears by the motor. The magneto sends a current along an insulated wire to the spark plug, which is screwed into an opening in the combustion chamber. Points in the plug offer a gap over which the spark jumps, thereby igniting the combustible mixture of air and gasoline vapors.

CARBURETION is one of the real mysteries of the internal combustion engine. It is the method by which a liquid fuel—usually gasoline—is converted into a combustible vapor.

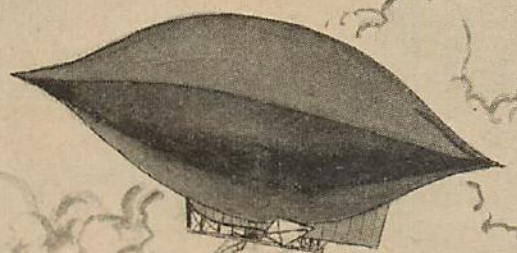
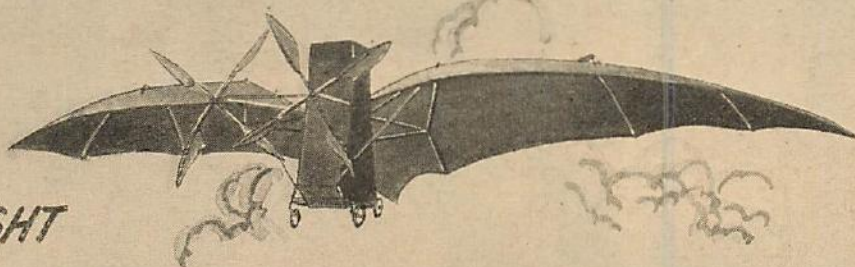
Carburetion is the process of combining certain volatile vapors of hydrocarbon liquids with suitable portions of air to form an inflammable gas. We will, of course, consider regulation gasoline in this explanation.

In our illustration we offer the modern form of the carburetor. It will be seen from the drawing that the carburetor is composed mainly of a float chamber, containing raw fuel drawn from the main fuel tank, and a mixing chamber, where the fuel passes through a nozzle to be suitably mixed with proper portions of air to make a combustible vapor. The proper proportion is approximately 15 lbs. of air to 1 lb. of gasoline.

The suction caused by the engine in the starting sequence draws fuel from the float chamber where the level is maintained by a simple form of needle valve. From here it is drawn into the main mixing (Turn to page 91)

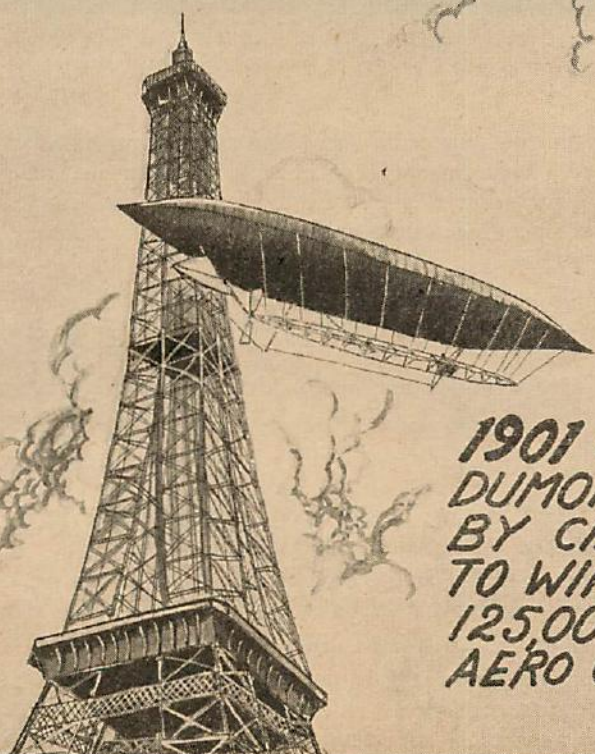
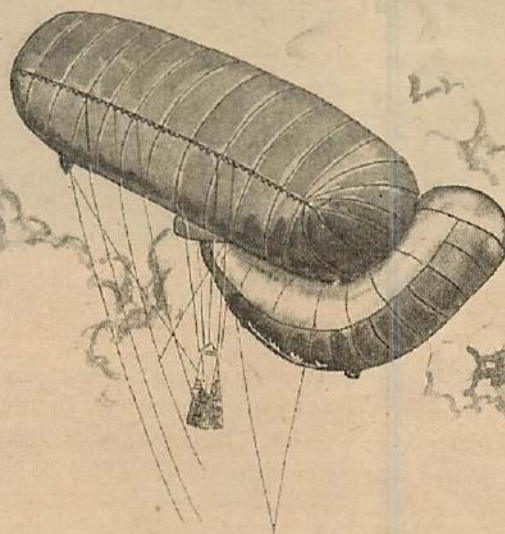
Pictorial History of Man in the Air

**1897 ADER'S
"AVION" CRASHES
AFTER ACTUALLY
TAKING OFF IN FLIGHT**



**1897 MYERS BUILDS HIS
SMALL ELECTRIC "AERIAL
TORPEDO" WHICH MAKES
HUNDREDS OF FLIGHTS**

**1897 MAJOR VON PARSEVAL
AND CAPTAIN VON SIGSFELD
INVENT THE KITE BALLOON
FOR OBSERVATION FLIGHTS**



**1901 ON OCTOBER 19TH SANTOS-
DUMONT ASTOUNDS THE WORLD
BY CIRCLING THE EIFFEL TOWER
TO WIN THE DEUTSCH PRIZE OF
125,000 FRANCS AND THE PARIS
AÉRO CLUB'S PRIZE OF 4,000 FRANCS**

NOSE DIVE



Things fluttered in the air: papers, hats, handkerchiefs. The crowd broke through the police lines. Joseph

IT WAS a muggy, dull morning, particularly depressing around the airport. The dense sky hung heavily over the deserted flying field, closing it in. Visibility on the ground was half a mile; the ceiling was barely two hundred feet. It was anything but flying weather.

Larry Oliver came out of Hangar No. 3 and started toward the lone ship on the line. His shoulders slumped; his slim figure moved without spirit. His lean face, burnished a hard red-brown by wind and high speed, had a tinge of the morning's gray in it. A crisscross of adhesive tape at his temple drooped his right eye a little.

He stopped in front of the ship and squinted at it distastefully. It was a queer-looking affair, not—legitimate. It had an old, round-bellied fuselage, oil-dyed, and very stubby, deep wings. It looked like a bird too frightened to fly.

Larry knew "Runt" Haggerty had reassembled it at practically no cost to himself. Runt was a good mechanic. He had rebuilt the motor, jazzed it up to the limit, and then tacked on a supercharger. He'd clipped the wings

shorter and shorter, in successive attempts to increase its speed. Last time it had been up it had made amazing time, for what it was. Runt Haggerty had clipped it again since then, taken two feet off each wing. Runt was not a flier.

Runt, a squat, thick-necked man, waddled up to Larry from the hangar. "There she is, skipper," he said proudly.

Larry wrinkled his face at him. "How do you know it's a she?"

Runt looked hurt. "You're going to take it up, ain't you?"

"If it'll go up," said Larry. "Can't be too choosy these days. Airplanes don't grow on trees."

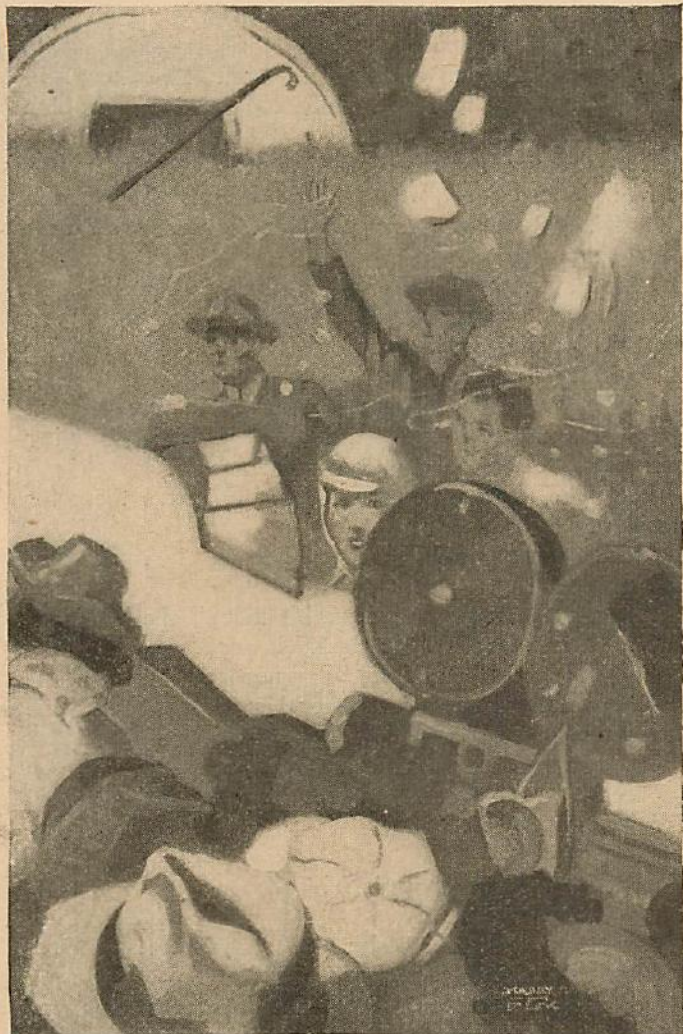
Runt glanced at the cross work of adhesive tape over Larry's right eye. "Don't even stay on 'em, do they?"

"Shut up," growled Larry.

Hangar doors rolled open heavily behind them. They both turned. An all-white ship was wheeled out, and then another, a silver-and-black low-winged monoplane.

by Pierre Gendron

The story of a transcontinental race, a motor, and a man who believed that serious flying was for men only.



Stephens, wild-eyed, climbed up on the wing.

"Whose is that?" said Larry.

"Cyril Porter's"

Larry frowned. Cyril Porter was entered in the transcontinental air derby, too. Cyril Porter wasn't a serious competitor, but with that ship—"When did he get a Benton?"

"Just after you crashed yours."

Larry didn't say anything.

"That other ship is Emily Featherstone's."

Larry looked at him sourly. "Who doesn't know that?" He was thinking of all the newspaper publicity—"Emily Featherstone, world-famed aviatrix, and her *White Swallow*"—but he glanced at the white ship again. No question, it was a sweet job. Pretty, too—for a lady. He shrugged. All that power and speed being wasted on a girl—Well, her old man had money to burn.

"Let's get this damned mess moving." Larry threw his cigarette at the clipped ship. "If she does move—"

"She's got speed, all right," said Runt.

"If she has, that's all she's got!" said Larry, swinging himself into the dirty cockpit.

"Switch off?" Runt asked, from near the propeller.

"Hell!" Larry swore. "A flying ark!" He fumbled over the patched instrument board. "Switch off! Wind her up!"

The propeller turned a few times. Larry adjusted his helmet and goggles, and took a tuck in the safety belt.

"Contact?" Runt asked.

Larry threw the switch. "Contact!"

Runt gave the blade a twirl. The motor coughed, sputtered and caught on. The old carcass vibrated viciously. Larry taxied to the lower end of the field. He glanced up into the leaden sky, from habit. It wasn't necessary. No ships would be in that soup. He swung the ship onto the runway and opened the throttle. The ship lurched; the tail came up and he was covering ground, fast. But the thing wouldn't leave the ground. It moved faster and faster over the smooth cement and bumped a few times, heavily, on the rough. It just cleared the fence.

From then on it was a tricky battle. The ship kept wanting to turn over on him, quickly. The stick jerked in his hand. He had to concentrate all his sensitiveness into his stick hand. He was up,



a little, in the damp gray, but dark blotches slipped past, close below—too close. He nosed her up more.

In the mist he cursed himself mercilessly and the rotten luck that led him to take up such a mutilated relic. He cursed old-fashioned cocktails, girls in brown, and The Flying Club for admitting women to the bar. Old-fashioned cocktails and new-fashioned girls in brown were an insidious combination—no matter what you thought to the contrary while combining them.

Girls in brown might not even have names you could remember, but they went to finishing schools and dared you to fly out and air-serenade them at night. And old-fashioned cocktails in quantities made you sensitive to dares—so adolescently sensitive you took the dare. You even took the beautiful, new, latest-model Benton—loaned you by Benton Aircraft Corporation for the transcontinental air derby, and you pulled a kid show-off stunt! You flew so low and close to the girls' dormitories you tangled in their telephone wires and crashed through a tree.

And what a pretty spectacle you made of yourself to top that! Groggy on your feet from the bump, but with whisky on your breath, you tried to let on you'd lost your way—and on such a clear, moonlight night! Who could blame the Benton crowd for being sore, with thirty-five thousand dollars' worth of their ship used for tree decorations and nothing salvageable but the instruments? And who could blame the other manufacturers for crawfishing when you offered them publicity, and possibly the transcontinental trophy, for the use of one of their planes? After all, it wasn't the first time you'd cracked up, nor was it the first time you'd been crocked, although you'd never cracked up crocked before. But, who'd believe that after the fifty school-girl versions of the tanked aviator's miraculous escape! Dandy razzing material it made for the gang at the club, too. Dandier still, if they guessed that the only ship available to you, at terms you could meet, was this crazy wingless wonder!

The ship was jerking and twisting like an amateur on a tight rope. It seemed determined to throw him. He knew it was no go for the transcontinental, but he stubbornly battled it. He got it up to three thousand feet, finally. That was something. He'd had enough. Irritably, he kicked the rudder and slammed the stick over to take her down. She munched through her bank, hung quivering, then whipped under with such violence his neck ached. When his brain cleared, the plane was spinning at a wicked rate. The nose was almost straight down and the stubby wings were boring around through the soup like a corkscrew. The altimeter needle was dropping fast: three thousand feet, twenty-nine hundred, twenty-eight—

The stick was still forward, uselessly, the wind still slashing his right cheek and the soup still whirling around him, when he remembered that Emily Featherstone might be down on the side lines. Her ship being out of the hangar meant she was expected at the airport. She'd be waiting for the weather to clear. She'd be watching. He fought the lax stick hard.

Finally, for no apparent reason, it began taking hold. When he had the wings almost trimmed, something loomed at him on the left—something fuzzy in the soup—but fast and white. He ducked, stick and all. He pounded the controls down. It was only for an instant that nothing happened—that the ship failed to respond—but it was like an eternity. The white ship tore at him.

He cringed. Then his nose dipped. He felt the shock of air drive him downward. He slipped below the white wings, crouching. He had missed her. But not even by inches—

He righted the cranky ship close to the ground. He hadn't stopped rolling when the white ship soared down, landed cross wind and stopped abruptly. His heart wasn't beating normally yet, when the pilot of the white ship jumped out and came toward him. She was all in white. Her oval face was white, too, but her light-blue eyes blazed murderously.

Larry climbed out heavily and went to meet her.

She stopped short when she recognized him. "So!" she raged, "it was you, Larry Oliver!" Her breath came in short gasps.

"I'm it, Emily," he admitted, grinning. But he knew his grin was a wasted effort. She wasn't looking at him; she was looking through him.

"Still the flying fool, eh?" she said coldly.

"Still," he said, "thanks to you." He thought that ought to appease her. It didn't. She took her flying seriously. "How did you think to zoom?"

Her blue stare widened. "What else was there for me to do?"

"Most women would have nosed down," he said. "It's in the book."

"And most men would have hit them," she said brittlely. "I suppose that's in the book, too?"

"I don't know," he said. "I've never read it."

"Apparently!" she said. Then her eyes grew curious. "How did you execute that crazy maneuver?"

He grinned. "I was in a crazy ship."

"Yes." She turned and studied it appraisingly. "What is it?"

"A penguin."

"What were you doing in it?"

"Trying to make it fly."

She turned back to him. "Are you totally mad, Larry?" she asked, concerned. "Haven't you got away with enough foolhardy stunts—and on the eve of your big race? Or, is it that you don't even care whether you live to fly the transcontinental? Isn't there anything you can take seriously?" A note of despair crept into her voice.

He smiled deeply into her eyes. "Yes. One thing."

She colored and looked away again. "I don't suppose it's the proper moment to ask a favor of you—but I'm going to ask it."

"Good," he said.

Her chin went up. "There's no point in having two transcontinental air derbies, you know: one for men and another for women. I've been trying to consolidate them and, to a degree, I've been successful. The officials are willing, but they say the male pilots must agree to it. So, I must ask your help."

"Mine?" He laughed mirthlessly.

"Yes," she said. "You could put it over for me, if you would. You could say to Wingate, or any of the officials, 'Let the girls fly with us.' The other men would follow you, as usual."

"Thanks," he said bitterly.

"You'll do it?"

Slowly, he shook his head. "No."

Her light-blue eyes widened. "Why?"

"You know it's always been my contention that flying is a man's game."

(Turn to page 82)

THE FLIER'S DICTIONARY

The seventeenth lesson in the technical terminology of the air. Save your files!

METEOROLOGICAL INSTRUMENTS

- 1 **ANEMOMETER.** This four-cup anemometer revolves in the wind; the revolutions are transmitted to a recording dial. This tells the speed of the wind.

The **SPLAYED WIND-VANE** below it tells the direction of the wind.

- 2 **SUNSHINE RECORDER.** This instrument tells the extent and duration of the sunshine during a given period. It is adjustable to either summer or winter.

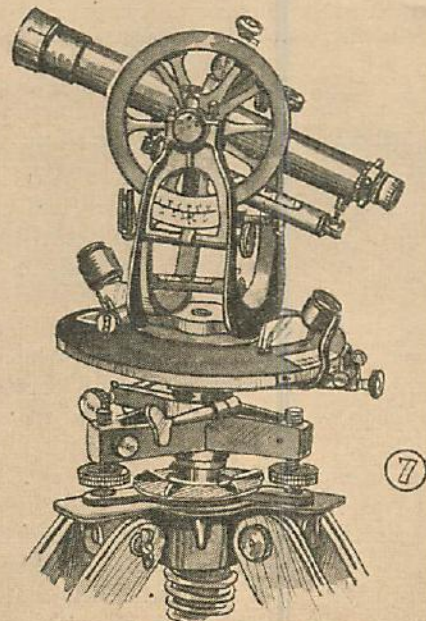
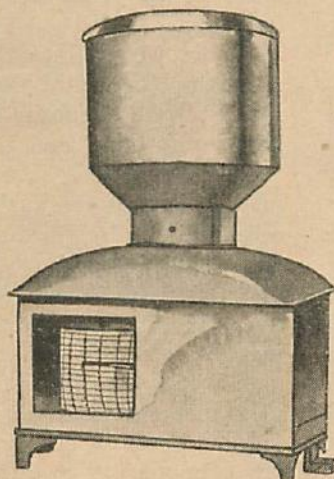
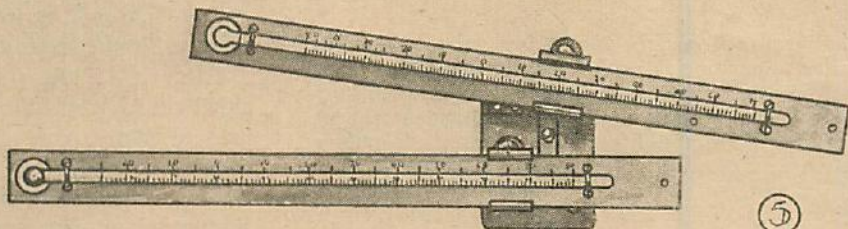
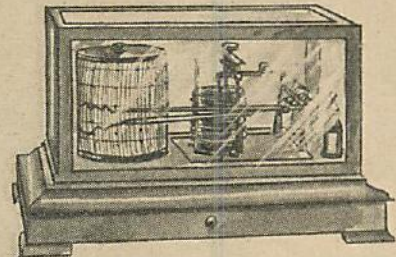
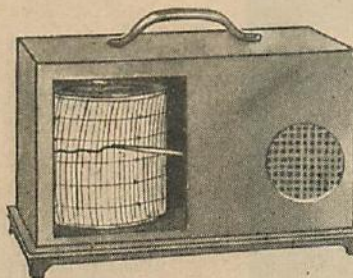
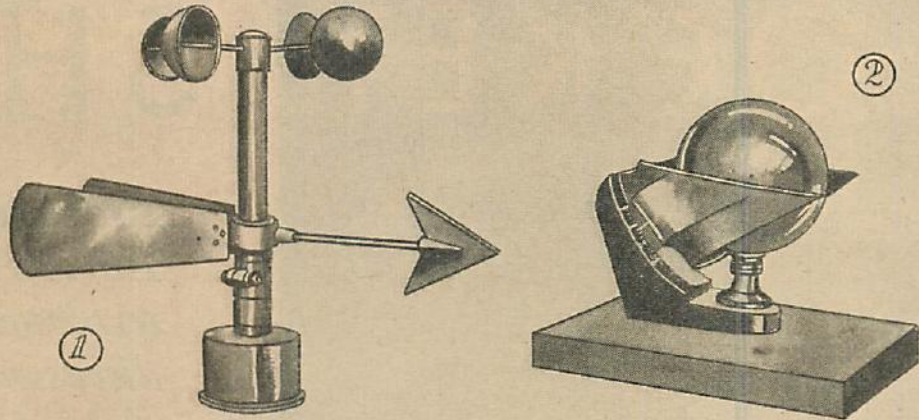
- 3 **THERMOGRAPH.** This is a continually recording thermometer that keeps accurate record of the temperature for a week at a time. It records it by degrees and hours.

- 4 **BAROGRAPH.** This instrument keeps accurate record of the atmospheric pressure changes, which forecast storm areas approaching. The record may be kept for a week at a time, and also by hours. The particular type shown gives thermometer readings at the same time for comparison.

- 5 **THERMOMETER.** This weather-bureau type records the maximum and minimum temperatures. It is held in what is called a Townsend support for best efficiency.

- 6 **RAIN GAUGE.** This instrument records the amount of rainfall in a particular locality. It is so adjusted that the rain falling into the top actuates a pendulum that in turn moves a needle on a chart. It keeps an accurate record over a period of days.

- 7 **THEODOLITE.** This instrument is used to follow the course of pilot balloons, which are about thirty inches in diameter and filled with hydrogen. The theodolite charts their course and by this means indicates their height and direction, and the presence of varying winds. With the help of pilot balloons, the height of cloud layers and formations may be determined accurately. They are extremely valuable in locating advantageous winds at different altitudes for lighter-than-air flights and airplane transport lines.

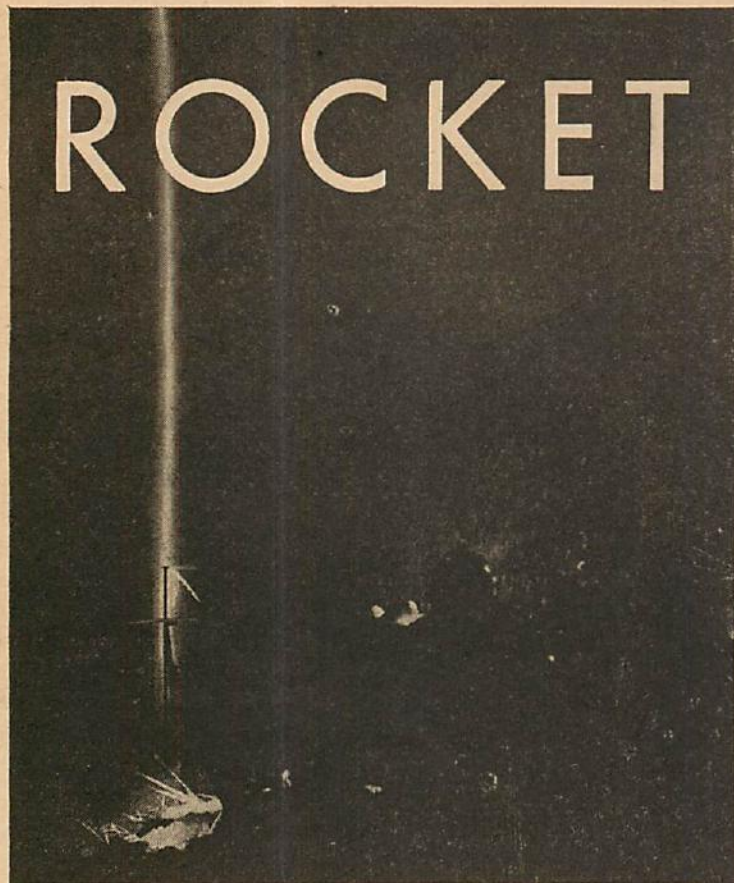


ROCKET

SHIPS

Problems of overcoming Earth's gravity for interplanetary travel are discussed this month in the second of three articles.

by Allan Finn



A swift streak of light was all that the camera could catch of a German rocket fired at night.

(In the preceding article, the writer related how the rocket, after originating in ancient Greece and China as an instrument of war, virtually dropped from recorded history for many centuries, except in sporadic military experiment, in fireworks displays and life-saving, or as the plaything of super-science fictionists; then how, in 1903, the Russian Ziolkovsky discovered the scientific truth that a rocket, unlike an airplane, does not require the presence of air in operation. It can not only function, but function at its maximum efficiency in the vast vacuum of space outside the earth's atmosphere. The result was the first practical theory of interplanetary travel. In this, the second of three articles, rocketry's mechanical aspects are discussed, particularly in respect to its chief avowed purpose: to shoot human beings to the moon and the planets beyond.)

DEVELOPMENT of the rocket for both earthly meteorological and space use is little more than a decade old. After Dr. Robert H. Goddard's pioneer theory and formula work (1907-19) in the United States, the pendulum of interest and experimentation swung in one swoop to Europe, then back to this country, which to-day has the lion's share of world-research activity.

Upon the shoulders of Dr. Goddard and the enterprising American Rocket Society (of which he is a leading member) is centered almost all current experimentation. Biggest and most influential of world-wide rocket societies, it has experimented with four rockets to date, and planned a fifth.

The first was fired at Stockton, N. J., in 1931, but due to an accident, was not actually propelled upward; the second, partly made from No. 1, exploded at the society's proving ground at Great Kills, Staten Island, which is part of New York City, after rising 250 feet;

No. 3, shot on a proving stand, is used for exhibition purposes; No. 4 was sent a mile up at a speed of 700 miles an hour.

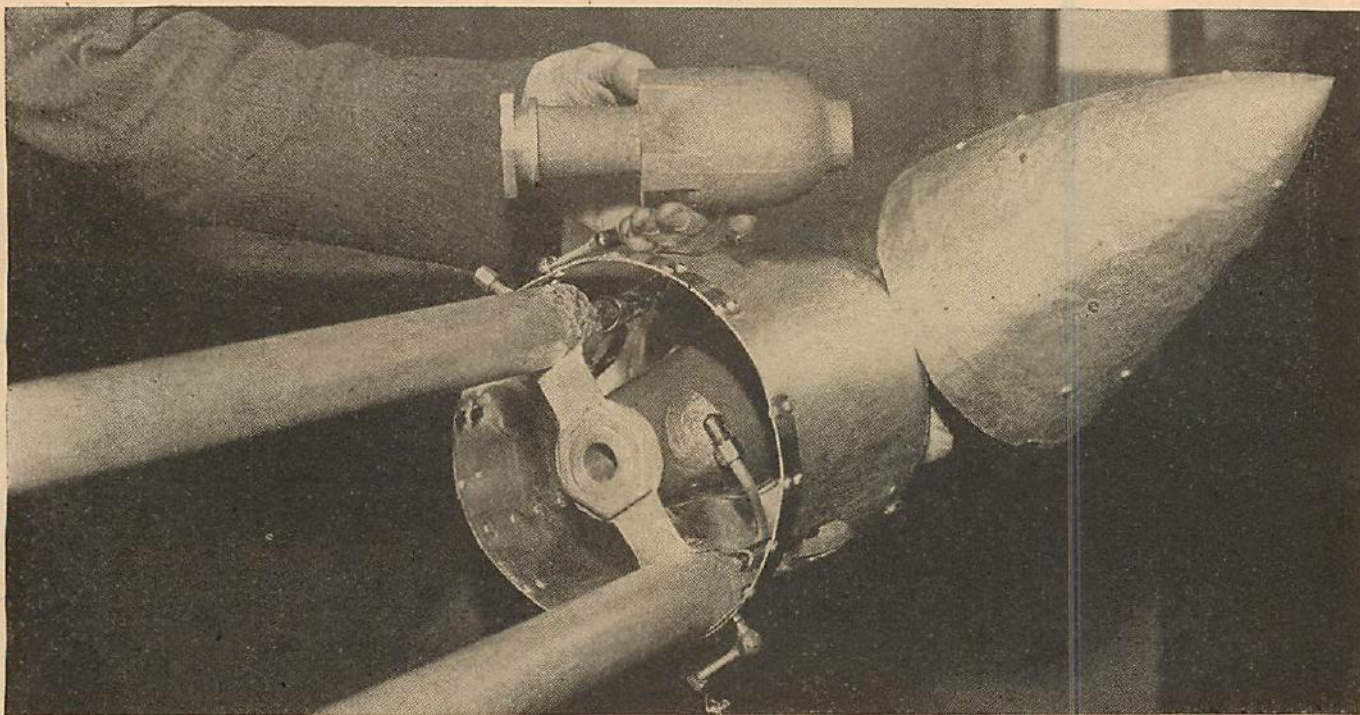
Between fifteen and twenty trial shots were made with these rockets. No greater altitude was reached, but the knowledge derived is regarded by rocketeers in this and other countries as immensely gratifying.

After 1934, the society's experimental committee decided that it could learn more about rockets under their present state of development, not by building more of them for flight, but for ground tests. Accordingly, a series of such tests were held on proving stands at the Staten Island site and at Crestwood, N. Y., where G. Edward Pendray, one of the founders and foremost experimenters, lives. They proved highly satisfactory, and as a result, other tests are to be held on a new proving stand which John Shesta, current society president, is building.

Before we go into these ground tests, which entail all of the danger, the same technic and a lot of the realism of flight attempts, let us discuss what a rocket is, how it functions, and what is expected of it.

Essentially, a rocket is a contrivance which transmutes chemical energy into mechanical motion. This is accomplished by burning powder or liquid fuel in a compartment called a blast chamber. The burning produces gas, which expands. The pressure thus created forces the burning gas through an exhaust nozzle. The reaction from this causes the rocket to develop a thrust in the opposite direction—the thrust being equal to the mass of the ejected gas multiplied by its velocity.

This physical phenomenon involves Newton's third law of motion, to wit: to every action there is an equal and contrary action, or the two actions are equal and opposite. The force acting on the gases to eject them from the rocket has an equal and opposite reaction on the rocket itself. It is like the kick of a gun; the surrounding air has nothing to do with it.



The combustion compartment and the nozzle constitute the rocket's motor, or, as rocketeers call it, the reaction motor. It forms, of course, only a small part of the actual rocket, which must carry fuel tanks, flight-controlling apparatus, landing gear, and the "pay-load"—astronauts and their instruments.

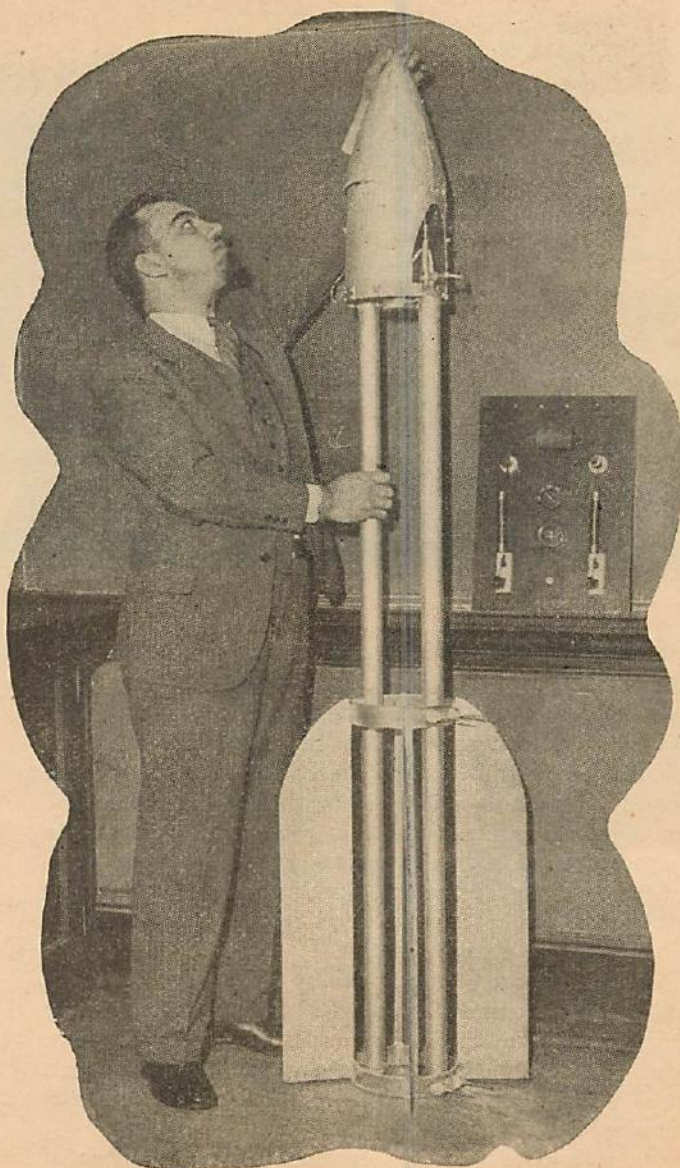
In the ordinary fireworks rocket you have a hollow tube with a pointed cap. Plugged into the bottom is a smaller tube containing compressed gunpowder. When the fuse is lighted, the flame runs up and ignites the powder, which blows out with a hiss through an aperture at the base.

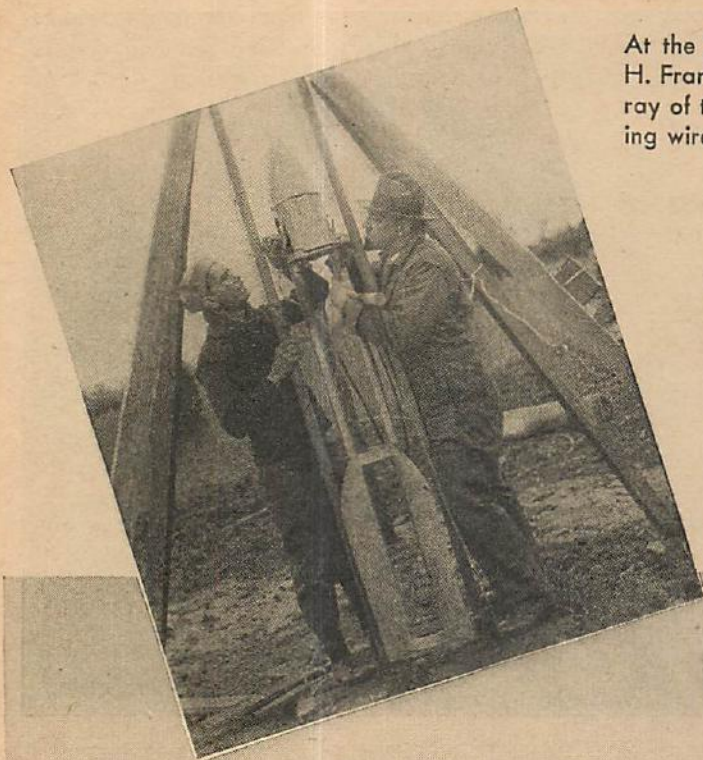
The flow of powder, burning from top to bottom, cannot be controlled; soon exhausted, the rocket is finished. The reason for this is that the fuel tank and the blast chamber are one and the same.

In experimenting with modern rockets, this shortcoming quickly became obvious to Professor Hermann Oberth, of Austria, and other veteran experimenters in Germany in the middle 1920's, who had been attaching their "flying needles" to automobiles, sleds and gliders. Moreover, gunpowder was not only dangerous to handle, but the disproportion between its weight and the rocket itself was too great for practical purposes.

Liquid fuels, which could be burned continuously from feed tanks, promptly suggested themselves. Simultaneously, the Germans and Dr. Goddard began experimenting with liquid oxygen and gasoline, or liquid oxygen and alcohol. They were easy to work with, were not explosive in themselves like powder, and were vastly more powerful. Professor Oberth used liquid hydrogen for a time, but because

Held above the business end of A. R. S. #1 is the "motor," minus the water jacket that incloses it below. At right, G. Edward Pendray, American Rocket Society secretary, closes the cap over the parachute.





At the Stockton proving ground, H. Franklin Pierce and Mr. Pendray of the A. R. S. adjust the firing wires during a stationary test of rocket #1.

Ensconced behind the protective sandbag shelter, Miss Lee Gregory takes movies of the proceedings. Before her is the board holding the electric ignition keys.

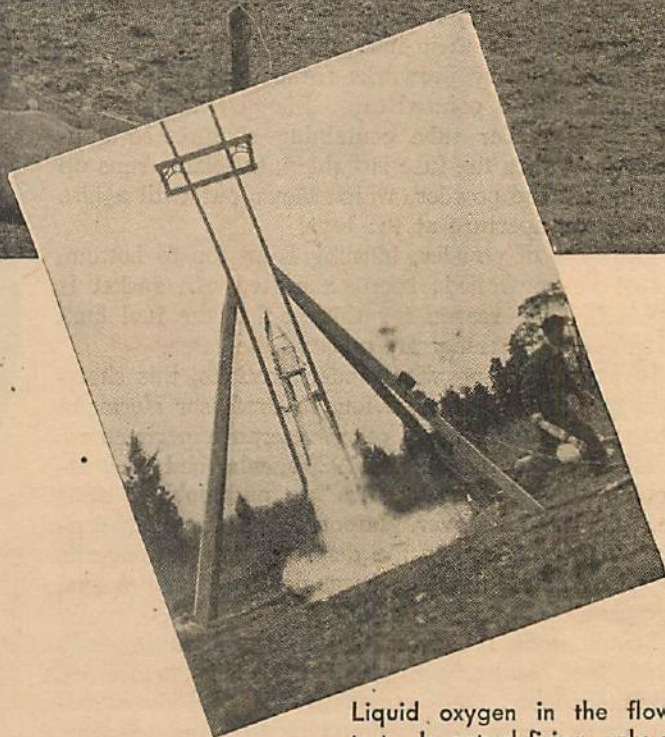


it is expensive and extremely difficult to handle, he soon dropped it. The dream of all rocketeers as they pour their precious liquid fuels is mon-atomic hydrogen, which may solve all future problems of mechanical energy.

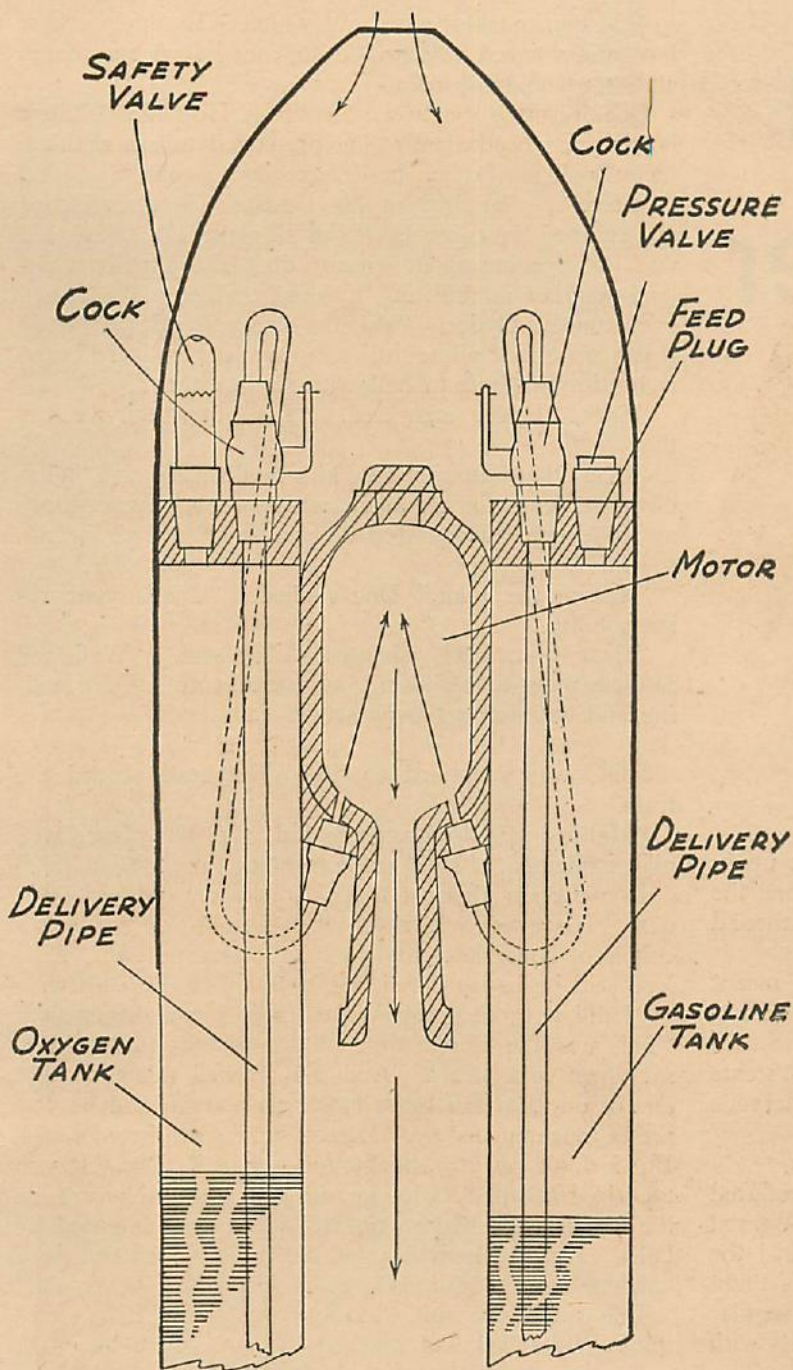
Whatever their limitations, liquid fuels already at hand seemed the natural choice to early plodding rocketeers. Feeding them to the combustion chamber was easy. By the pressure of its own evaporation, liquid oxygen automatically was forced from its tank into the compartment; gasoline or alcohol was pressed inside by compressed carbon dioxide gas or nitrogen.

As liquid oxygen boils at minus 182.5 degrees Centigrade, its low temperature rendering most metals brittle and useless, duralumin was selected for fuel tanks. Heavy copper alloy was used for the blast chamber, whose walls were water-cooled. Flow of the fuel was controlled by valves.

Using this set-up, the Germans made a number of



Liquid oxygen in the flow test. In actual firing, only a thin stream of flame is visible.



Schematic diagram of the American Rocket Society's #2 rocket.

successful tests with their famed Mirak (minimum) and Repulsor rockets. To-day experimenters everywhere center upon this liquid-propellant rocket type. The experimenters have found that the ideal combustion chamber must have good thermal efficiency, high specific tensile strength at high temperatures, and good durable qualities to resist erosion from exhaust gases. American Rocket Society men favor cast aluminum bodies with nichrome nozzles. These nozzles have melted, however, which indicates a combustion chamber temperature of more than 3,000 degrees Fahrenheit.

Consequently, the nozzle is one of the main problems to be worked out in laboratory and proving ground. Use of molybdenum or tungsten whose melting point

exceeds that of the flame temperature has been suggested. A pressing problem, too, is the thermal efficiency of the motor, which at present is only 10 per cent compared to 2 per cent for a Fourth of July skyrocket, and 25 per cent for a gasoline or steam engine.

Research also centers upon ways to cool the motor by circulating the fuels through its walls; use of a refractory such as carborundum for a lining; injection of water to create a layer of insulating steam on the inner walls of the chamber and nozzle; better tanks and connections to withstand high pressures; and aerodynamic principles of design to fulfill kinetic energy requirements.

While all this seems like a vast task impossible of any immediate accomplishment, rocket experimenters proudly point to the fact that the two fundamental problems of their science have been solved. The first is how to use and control explosive and volatile fuels, and the second is how to burn them properly to obtain the needed jet velocity.

The American Rocket Society has done much to solve both these. In its experiments it has been using rocket motors about the size of a hen's egg. They weigh anywhere from one to one and a half pounds. Nozzles are about one half inch in diameter at the throat. Given a 500-pound pressure, such a contrivance is capable of providing a 100-pound thrust, whose measure is obtained by rule-of-thumb, the pressure in the chamber being multiplied by the cross section of the nozzle throat. Hitched to a rocket weighing, say, 50 pounds all told, this motor is theoretically able to provide a 25-mile skyward ride in less than a minute.

As explained earlier in this article, the American Rocket Society confines all of its tests to-day to a proving stand. The motor is hooked up to a complicated apparatus which contains practically all the necessary paraphernalia for a flight. Instead of ascending, though, the rocket motor drives its nose against a thrust-measuring device. Instruments record and measure the flow of fuel, the pressures, resistance, and the whole business is automatically photographed by a motion-picture camera.

These tests are carried out under the supervision of Mr. Shesta, assisted by Mr. Pendray and the individual experimenters and their aids, all of whom don white trench helmets and loose clothing. Flanking the stand are sandbag trenches and a 2-inch plank barrier, the latter for the photographer.

Everything is arranged with the utmost caution and a complete rehearsal made of the operation before the motor is hooked up, the gasoline poured into the stationary tank, and the fusee attached to the nozzle. The dangerous job of filling the liquid oxygen tank, carried out by Mr. Pendray, follows. He wears loose gloves which he can instantly cast off if a drop or so of the fuel falls upon his hands.

Each stage of the business is directed by a blow upon a whistle. Finally, a wire leading from (Turn to page 86)

Phantom Night Flier

Behind the veteran pilot rode a ghost—and the identity of that specter was revealed at last in a crumpled plane on a lonely mountain peak.

by A. S. Gregory

DOC STEVENS knew he had no business up in the cockpit. But he was afraid that before the big transport pulled into Oakland Airport there'd be a crack-up.

The liner was cruising at 12,000 feet. That meant little in the way of safety to Doc, because the mountains below stuck up 9,000. One minute off the controls—with the two crazy fliers at each other's throats—meant death for himself, death for the five nervous passengers!

Doc Stevens started forward.

He remembered that from the moment he introduced young Fred Ryder to Pilot Paul Whitehead he sensed there was going to be trouble. He'd just finished the preliminary physical examination of Ryder in his flight surgeon's office when Whitehead came in for his regular monthly check-up. He said, "Whitey, shake hands with Fred Ryder. I understand he's your new co-pilot."

"Oh, yes," Whitehead said. "You're the chap Ted Mallory, our operations manager, was telling me about. Gonna be first pilot in six months, eh?"

"No, sir," Ryder replied. "If I make the grade in a year, I'll be lucky."

Whitehead laughed. To Doc it sounded more like a sneer. "Some of the guys here have been co-pilots three years," the pilot said. "But I understand you're Mallory's fair-haired boy, so you'll make it."

Doc Stevens understood now what Whitehead meant. He never believed a situation like that could develop between a veteran of twenty years' experience and a youngster just breaking into the air-line game. Within three months the thing built up fast, until this afternoon the atmosphere of the whole transport was charged tight enough to explode at the first hot word.

Doc opened the cockpit door. He saw he was just in time.

Whitehead had swung his feet off the rudder pedals. He let go the control wheel. Both hands were clenched

so that the knuckles stood out white. His thick, square face was a caged volcano. And young Ryder appeared all set to hold his own.

Doc Stevens got between them fast. He said: "Whitey, how's your headache?" He pretended to see nothing. "You look as if your head is ready to split."

Whitehead laughed in his throat. He straightened up, grabbed the controls. "I'm all right, Doc. The kid was just arguing about what to do. The dope on Oakland weather is rain and lowered ceiling." He leaned over toward Ryder. "What's that you said you'd do if you were first pilot, sitting in my chair? You'd barge right through and to hell with the weather?"

"Sure," Ryder answered. "I'm not a fair-weather flier!"

"Hear that, Doc? The kid thinks he's still flying down in Texas for the army, with a quartermaster looney as passenger! Doc, what do you say? How's it look to you?"

"You're the pilot," Doc replied. "That's your responsibility."

"Hear that, kid?" shouted Whitehead. "Well, tell Mallory we're ten minutes from Sacramento. We're landing and entraining the passengers and mail."

DOC was surprised to find Whitehead aboard the train.

"Mallory said to leave the kid with the plane," the pilot explained. "He'll come in when the weather lifts."

Doc Stevens thought that was a queer piece of business. His guess was right when he reached the field a couple of hours later and found the transport in. Mallory said he had ordered Ryder to fly through alone.

"I did it to show up Whitehead," the manager said. "This was the second time in two months that Whitey sat down in a storm. And it happened this time that one of our Eastern brass hats was aboard, and he was pretty much burned up. Missed some sort of conference. But I don't get any satisfaction out of it, Doc. It was too close a call. Ryder got in just under the wire, as the fog closed down so tight a gopher couldn't find its hole. That's where a pilot of Whitey's caution is a valuable asset. Still, Whitey is forty-three years old."

Doc caught the hint. Mallory was asking if he didn't think Whitehead had reached the age where he ought to be retired. That was exactly the problem he'd been mulling over in his mind for the past year. Whitehead was the oldest pilot in the organization. He knew that the constant nervous strain developed spells of neurosis, or staleness. He'd known for some time that Whitehead was stale.

The first symptom to Doc was a pilot's disinclination to fly in bad weather. Younger pilots whang through without a thought—just the way Ryder did to-day—and perhaps got a kick out of the close call. Ryder may pull the same trick again and come through. But the time comes when Old Man Weather wins. That is the reason the older pilot goes around a storm if possible. Otherwise he sets down, like Whitehead did at Sacramento, until the storm blows over. Older pilots just didn't take chances. Which, Doc believed, should be a fast rule with all commercial lines. On the other hand, he recognized such a thing as becoming too conservative—a bit overcautious.

Doc had set a tentative age limit for air-line pilots at forty-five, depending entirely upon the individual.



A pilot and co-pilot who didn't like each other meant trouble.

Many became burned out at thirty-eight, with ears deafened, impaired vision—called horizon eyes—and over-taxed nerves. He didn't intend to have his pilots die at the throttle like locomotive engineers, yet he believed it was to the company's advantage to have long-experienced fliers.

Doc told all this to Mallory. The manager agreed a fair balance should be maintained. Just the same, Whitehead was taken off the big transports and assigned to single-motor jobs on the night mail run. No passengers.

Whitehead wasn't so dumb that he didn't get the meaning of the transfer. He asked Doc if the skids weren't being put under him. That was a hard question for Doc, because he'd flown many hours with Whitehead, and he was of the same age, which had led to an unusually strong bond of friendship between them. He evaded the question by telling the pilot he was passing a perfect physical.

Despite this assurance, Doc began to notice a subtle change coming over Whitehead. It looked like fear. But whether fear of his job or of the air, Doc could not tell. He knew most pilots at some time become afraid of the air. Terribly afraid. They wouldn't be normal if they weren't. Doc remembered one ride with Whitehead when sweat burst out on the pilot's forehead and there was desperation in his eyes. Yet three minutes after the take-off, his ship trimmed for level flight, Whitehead was utterly nonchalant.

For a while nothing happened.

Then Old Man Trouble blew in with a bang!

Whitehead was forced down. Though the weather was soupy, he made a safe landing in a farmer's back yard. The official report was that the gas line had become crystallized and snapped from vibration.

But the next morning on the field another report began to spread along the grapevine telegraph—a sinister rumor to the effect that Whitehead's plane had been tampered with. And Fred Ryder's name was mentioned.

Doc Stevens first overheard two greaseballs discussing it. He took them to task about it. They said that was what they had heard. He thought nothing more about it because that same day he left on a two weeks' trip to the Eastern end of the line to give physical examinations.

Only then did Doc Stevens realize how serious the matter had become. The rumor preceded him. Whitehead was widely known, and everybody appeared to like him. Perhaps that was the reason, Doc thought, that the thing had developed out of all proportion to the facts. He remembered that Ryder had been advanced to first relief pilot. On this status, the young flier received a small base pay and mileage whenever he flew. And at the first vacancy caused by resignation, failure to pass a physical, or death, he was in line to become a first pilot.

Doc found the rumor had grown to the point where it was being said that Ryder had become impatient and had tampered with the plane in an attempt to create a vacancy. Due to the peculiar circumstances, the rumor carried some weight.

Doc knew that was very bad. It was demoralizing. Pilots had always seemed to him to be an ultra-superstitious bunch, which added to their load of mental hazards. He hurried back, determined to trace the source of the accusation.

The flight surgeon was surprised to find things rather quiet. He believed the gossip had spread like a small prairie fire and had burned itself out. After a few days, though, he became aware that beneath the surface of the apparent calm there was still a subtle undercurrent. He spent considerable time in the shops and on the line, yet found not one of the ground crew that he could point his finger at and say, "He might have started it."

Doc watched Ryder closely. The relief pilot was a clear, gray-eyed youngster of twenty-three, with a quick smile. He kept his head cool and chin up. Finally Doc tried to persuade the young flier to seek employment with some other distant air line. Ryder refused; he said no matter where he went the rumor would catch up with him, and that his resignation would be taken as an admission of guilt. Doc realized at once that the youngster was right. When doubt of any kind is cast upon one, it is hard to live down, no matter how unjust.

Presently the affair took a sudden turn for the worse. The talk again became open. Even passengers seemed to sense that something was wrong. It irritated Mallory.

"Doc," said Mallory, "I'd like to know who spread that crazy story. Why, it's like cutting a man's throat. I'd break the liar's neck! It must stop. It will stop, if I have to fire the whole ground crew and any pilot that I hear talking about it!"

That was the first time Mallory had indicated to Doc Stevens how strongly he felt about the unfortunate affair. However, the rumor could not be spiked.

So Doc Stevens took matters boldly into his own hands. He told Ryder his Snyder test, which checks the circulatory efficiency of the human system, was below normal. He gave the young flier a rating of six. The highest, for one in perfect condition, was eighteen, and the lowest minus four, though at six Doc generally disqualified a pilot as unsafe. Ryder begged so hard for another chance that Doc told him to get a good night's rest and come back. Next morning he juggled the figures some more and gave a five. He grounded Ryder indefinitely and gave him some fatherly advice to get away for a couple of months. He was careful to say nothing about the rumors. Ryder cried, said the girl he was engaged to was waiting for him to get on the regular list. Mallory raised a little hell, too, but Doc stuck by his guns.

In a month Fred Ryder was back at the field.

During his absence the operations had returned to normal, and for that reason Doc Stevens refused to check him over. Just the same, his mere presence on the field seemed to be an omen of disaster.

That night Doc stayed late at his office. So he went out on the line to watch Paul Whitehead take off with the Eastbound night mail. That was at 11:50 p. m.

At three minutes past midnight, Doc was positive Whitehead had crashed. That was the time Mallory dashed into Doc's office.

The manager gripped Doc's shoulder. For a moment he was speechless. His face rippled with excitement.

Doc broke away. He asked: "What's happened?"

"Whitey is down!" Mallory fairly shouted. "Should have had his first radio call ten minutes after he took off—at midnight. He didn't report. His radiophone was working O. K. Checked in when he circled the field. There was no answer to our call. So he's down! Better stand by, Doc! We'll need you in the searching party!"

Before Doc could say anything, Mallory tore back to his office. The shock dazed the flight surgeon. He couldn't keep his eyes from the electric clock upon the wall. Thirteen minutes since the take-off, was the thought that pounded in his brain. As he stared at the swiftly moving red hand, a strange thing occurred. He guessed it was the combination of the refraction of light on the convex clock glass and his last impression of Whitehead. That was the only hard-headed explanation he could reason for the startling appearance there of Whitehead's face.

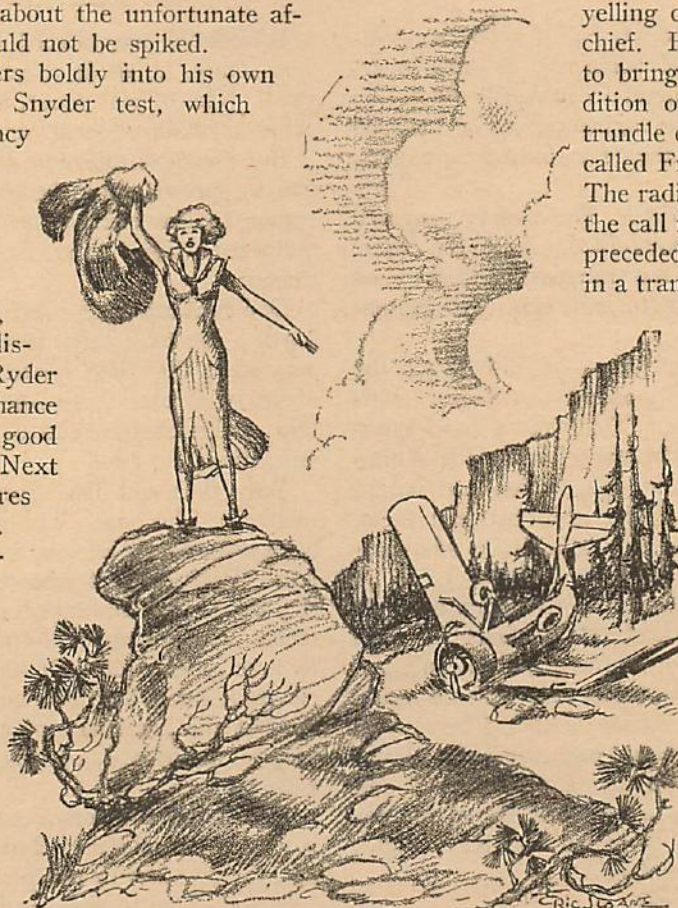
Doc suddenly found himself running to Mallory's office. Mallory was on the phone, yelling orders to Zinke, the hangar chief. He was telling the mechanic to bring in all reports on the condition of Whitehead's ship and to trundle out another plane. Then he called Fred Ryder to report at once. The radio operator was taking down the call from Pilot Fowler, who had preceded Whitehead by a half hour, in a transport. Fowler's voice came

clear from the sky some hundred and fifty miles away. He was above the clouds at 8,600 feet, bucking a stiff quartering wind, he said.

Zinke rushed in with a sheaf of papers and tossed them on Mallory's desk top. Doc saw that the mechanic was very much worried. He knew the chief mechanic nursed the planes as if they were babies.

"Nothing was wrong with Whitey's engine or ship," Zinke told Mallory. "The gas line didn't break this time. I checked it myself. It was

(Turn to page 88)



Doc saw the girl frantically waving her coat

What's Your Question?

By CLYDE PANGBORN

Wing Commander



As soon as possible after the questions are received, the Wing Commander of the Air Adventurers will answer on this page such questions as appear to be of general interest to our members.

Question: Do the same qualifications hold true for the naval flying school at Pensacola as at Randolph Field in Texas for the army school? What is the difference in course of study? S. F. J., Milwaukee, Wis.

Answer: In general, the same requirements are necessary for entrance to both schools. They include college education, good physical condition, etc. The courses of study are pretty much alike, I believe, with the exception that the navy naturally emphasizes seaplane training. There was an article on Pensacola in the November issue. In the next issue, March, Lt. W. M. Wood and I will have an article on the subject of getting into aviation, which may answer in more detail the above question and others concerning aviation training.

Question: What is drift and how is it corrected? A. G., North Bergen, N. J.

Answer: Drift, according to the official N. A. C. A. vocabulary, is the lateral velocity of an aircraft due to air currents. Which means simply, the effect of wind in pushing an aircraft sideward off a straight course.

The amount of drift is determined by measuring the horizontal angle between the fore-and-aft axis of the plane, which is presumably kept pointed at the place where it's going, and the direction of the plane's movement over the ground. This is done with the aid of a drift meter, a device in one form or another which incorporates a movable line which is placed parallel with the ground movement and thereupon indicates the drift angle.

Drift is corrected by nosing the plane into the side wind to the amount of the drift angle. Although by counteracting drift in this way, the plane will be pointed off course, it will fly to its goal in a straight line.

Question: How would I be able to obtain a permit to take pictures of the planes at my local airport, or isn't a permit needed? D. B., Jr., Berlin, N. J.

Answer: Taking photos at an airport depends entirely on the field's rules. You can ask an employee, or better still, go to the manager's office.

Usually there's no restriction, as long as you keep out of the way and don't trespass in reserved areas. Occasionally, however, the field may retain for itself all photo

rights, or give the sole right to a particular photographer. In this case, the field or photographer sometimes won't object to your taking pictures if you ask permission first and state that you won't sell the pictures or allow them to be used for any commercial purpose. As for government fields (army, etc.), better tread carefully there. Never take pictures without permission, or there may be trouble.

Question: Would you please tell me if they used Spads in the World War on the American side? G. S., Centralia, Wash.

Answer: Indeed they did; the French Spad was the leading American fighting plane, the most popular type being the Spad XIII. Most of our aces flew Spads.

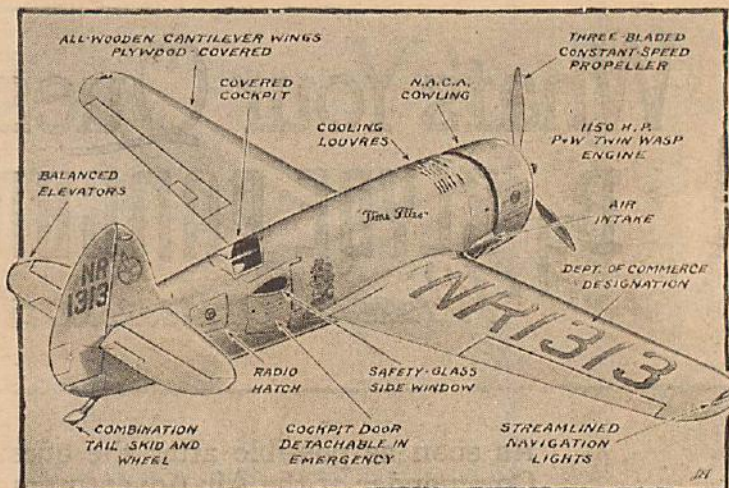
Question: When a pilot attempts to set a speed or distance record, he sometimes lightens his load by dropping the landing gear. How does he make his landing? N. M., Vancouver, B. C.

Answer: It was not only lightening of load, but reduction of air resistance that was gained. This trick has become pretty rare nowadays, what with retractable wheels and more efficient planes. After the landing gear was gone, you glided in to take the landing on the belly of the plane, so to speak, trusting to luck that the nose-over that might follow would not prove serious. Given a well-built ship with reinforced fuselage bottom, and a smooth, grassy field, the damage would be practically nil, it being possible even to protect the dead prop by holding it in horizontal position with rods sliding out from between engine cylinders.

Question: What is overhang on a plane? H. O., Worcester, Mass.

Answer: It may be either of two things, both of them, however, appearing only on biplanes or other multiplanes. First, it is the extent to which one wing (usually the upper wing, in which case the overhang is "positive") extends spanwise beyond another wing. This kind of overhang is measured by taking the difference in total span between the two wings and dividing it by half. Second, it may be the extent to which any wing extends from the outermost strut attachment to the tip.

The Biggest Little Plane in the World



About Frank Hawks' new racer "Time Flies"—the plane on the cover.

by Frank Tinsley

THE Hawks HM-1, christened *Time Flies* for its sponsor, the Gruen Watch Company, is the product of the combined brains of Frank Hawks and Howell (Pete) Miller, famous aeronautical engineer. Working under a blanket of secrecy in Hawks' tiny plant at Redding, Conn., these two men, each a master of his own specialty, have produced a plane that has been characterized as "brilliant in conception and scientifically guarded against any possibility of error."

This is the judgment of no less an authority than Dr. Alexander Klemin, director of the Guggenheim School of Aeronautics in whose wind tunnel the model was tested. In discussing the HM-1, Dr. Klemin described it as "a sound ship, with every desirable aerodynamic characteristic," adding, "It is well ahead of current practice."

Hawks, himself, says of it: "High speed with safety and the utilization of every modern device for both safety and the proper operation of aircraft are my goals in this venture. This airplane has all the speed of a racer, with the practicability and installed devices of the most modern transport airplane. It is roomy enough to carry a large complement of instruments and radio equipment, permitting scientific research not possible in a small racing plane. In other words, it is the *biggest little ship in the world*."

On October 16th, before an audience of news reel and press men, Commander Hawks took the wraps off his new baby and exhibited for the first time in public the plane in which he expects to smash the world's land-plane speed record. According to the calculations of its designers, the little silver-and-blue bullet should show a top speed of between 375 and 400 m.p.h.

Powered with a military type P & W Twin Wasp, which Hawks wheedled away from the war and navy departments, *Time Flies* cruises at 340 m.p.h. (at 13,000 to 15,000 ft. altitude) using but 600 of the available 1,150 horse power. This is the most economical throttle setting. The enormous power developed by this big war-plane engine permits sea-level rate of climb of no less than 7,000 feet per minute, coupled with a landing speed (with flaps) of only 65 to 68 m.p.h. The ship has a tremendous terminal velocity and boasts a safety

factor of 12, thus qualifying it for military pursuit work. With an eye toward future developments, the motor mounting is stressed to accommodate an engine of 2,000 horse power, when such a power plant is available.

The present motor has automatic mixture control and

high-altitude supercharging, and is fitted with a three-bladed Hamilton Standard constant-speed propeller, 10 feet 6 inches in diameter. In the rear of the engine compartment is an oil tank of 25 gallons capacity, separated by a fire wall from the 230-gallon gas container. This fuel load permits a normal range of 1,700 miles.

The HM-1 follows the low-wing, cantilever monoplane form now so popular with speed-plane designers. At first glance the ship appears to be nothing more than a super-powered conventional job. Closer examination, however, reveals many features that are far in advance of contemporary practice. The streamlining comes as close to perfection as it is possible to achieve with a motored plane. The ship's remarkably clean lines, plus a hand-rubbed silver surface of mirrorlike smoothness, contributes materially to the high performance of *Time Flies*. Rival designers will probably be nettled to hear that Hawks declines to reveal the ordinates of the streamlining, as well as two technical refinements embodied in both the wings and fuselage. The closest he comes to a revelation of his secret is to state that these features materially increase the speed and stability of the plane.

The materials used in the construction of the HM-1 may seem a bit unusual in these days of all-metal aircraft. The full cantilever wing is fabricated entirely of wood with a box-type structure consisting of three spruce spars, plywood ribs and maple corner blocks. It is covered with plywood. The fuselage design differs in that the basic structure is built up of Summerill chrome-molybdenum steel tubing, with wooden fairing strips and a Haskelite plywood skin. The fin is constructed in the same manner, consisting of a tubular steel frame with plywood ribs and covering. A cantilever structure similar to that of the wings, with the same materials, is used in the tail surfaces. Plywood covering is used throughout. All control surfaces are

provided with trimming tabs which may be adjusted from the cockpit during flight.

The landing wheels of this interesting ship are of the fully retractable type, nesting smoothly into the under side of the wings and fuselage. In order to secure simplicity of structure and certainty of operation, a manual system of retraction is used. In addition, the belly of the fuselage is strongly reinforced against emergency landings without wheels. The tail skid is new and unusual in design. It consists of a streamlined aluminum form faced at the bottom with Sta-light, a substance which protects metals subjected to excessive wear. Protruding slightly from within the streamlined form is a small wheel capable of carrying landing loads when alighting on asphalt or concrete runways. The lower part of the skid itself comes into use for soft landings.

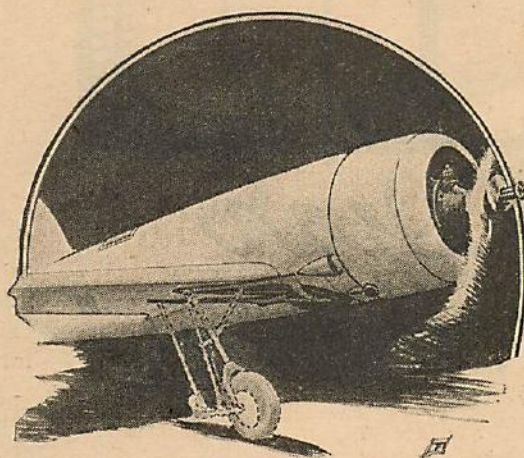
An unusual and ingenious cockpit arrangement has been developed to maintain the perfect streamlined form of the fuselage. The conventional cockpit cover is entirely absent, being replaced by a pivoting wind screen which retracts during flight to form a skylight top to the pilot's compartment. Smaller elliptical windows in the sides of the fuselage provide further visibility. The top and side lights, of safety glass, are faired smoothly into the fuselage form, which presents an unbroken line from nose to tail. For landing and taking off, the pilot's seat may be raised by a manually operated hydraulic jack. This apparatus is geared to the skylight which, being pivoted at its forward edge, rises simultaneously with the seat to form an inclined windshield. In the raised position, Hawks' head is well above the top of the fuselage, where he enjoys perfect

vision both ahead and to the sides. When flying with his seat retracted and the top down, the pilot is provided with a further aid to forward vision in the form of a retractable periscope.

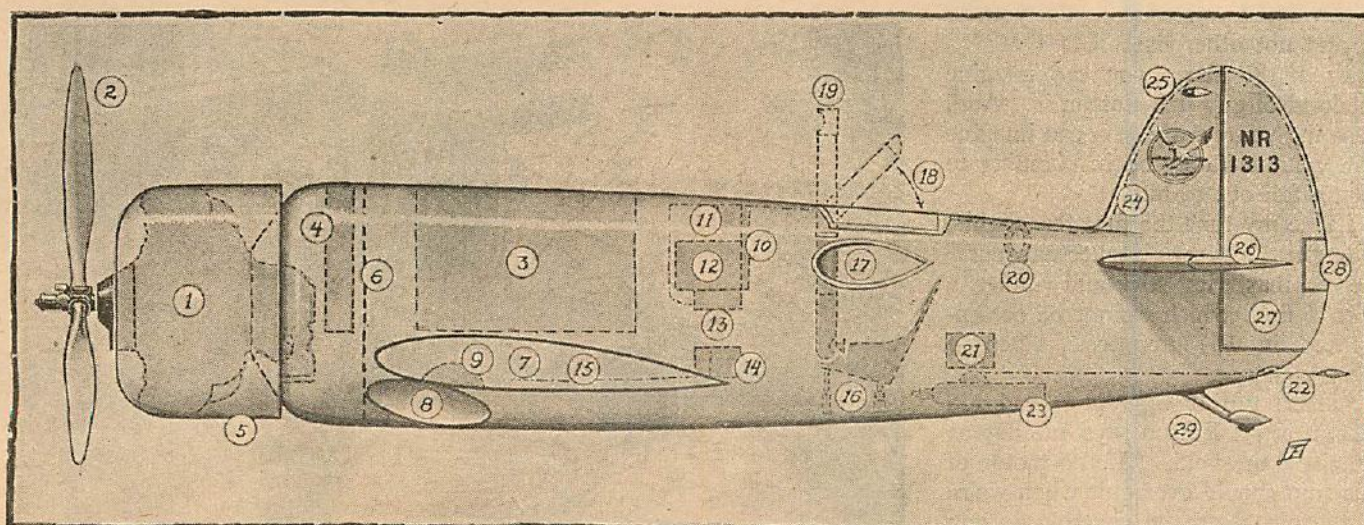
The cabin is fitted with a large door on the right side through which Hawks enters and leaves the ship. In the event that the pilot is ever forced to abandon his ship, a quick jerk on a trip control pulls the hinge pins and the door drops away, leaving an unobstructed opening for the parachute jump.

Fresh air is constantly circulated through the cabin by means of an aluminum duct connected with an opening in the leading edge of the wing. This device prevents the concentration of carbon-monoxide fumes in the cockpit and also helps build up air pressure for flight at high altitudes. Above 20,000 feet, oxygen is supplied to the cabin itself, thus eliminating the clumsy breathing apparatus commonly used.

Time Flies boasts an unusually complete array of controls and instruments. As far as we know, this is the first racing plane to be equipped with an automatic pilot. This particular one is a new Sperry gyro-pilot of unusual sensitiveness. Another Sperry contribution is the recently developed gyro-magnetic compass, a combination of two former instruments that simplifies the pilot's task in following a straight course. In addition to this "two in one" device, the ship carries a Pioneer "Straight-flight" aperiodic compass. This extremely accurate and stable instrument will be used to check against the other for additional accuracy of navigation. One of the most interesting of the full complement of instruments on the dash is a Breeze exhaust-gas analyzer. (Turn to page 88)



Landing wheels tuck smoothly into wing and fuselage.



- 1—1,150 h.p. Pratt & Whitney Twin Wasp (supercharged)
- 2—Hamilton Standard three-bladed Constant-speed propeller
- 3—250-gallon fuel tank (range 1,700 miles)
- 4—25-gallon oil tank
- 5—Latest type N.A.C.A. engine cowling
- 6—Fire wall
- 7—Wing stub
- 8—Landing-wheel well
- 9—Retractable landing light
- 10—Instrument panel (light, engine and radio)

- 11—Sperry gyro-magnetic compass
- 12—Sperry gyro-pilot, artificial horizon, directional gyro
- 13—Radio receiving set
- 14—Ultra-high-frequency transmitting and receiving set (1 to 5 meters)
- 15—Antenna for above set in wing
- 16—Pilot's seat (elevated and lowered by hydraulic jack)
- 17—Side window
- 18—Safety-glass skylight pivots up to form windshield

- 19—Retractable periscope
- 20—Loop antenna for radio compass
- 21—Radio transmitting set
- 22—Trailing antenna for above set
- 23—Oxygen bottles
- 24—Antenna for radio receiving set (13)
- 25—Navigation light
- 26—Balanced elevators (equipped with trimming tabs)
- 27—Rudder
- 28—Rudder trimming tab
- 29—Combination tail skid and wheel



From—STEVE STERLING,
Skyways Air School,
Greenville, Calif.

"Dear
Harry—"

To—HARRY REED,
Burton, Pa.

DEAR HARRY,

I'm flying! Since my last letter I've had five hours of dual instruction. Am I an aviator now? And how! Has my temperature risen 30 degrees? And how! Has my chest expanded 6 inches? And how!

But to business. Remember how I told you in my last letter things were going to happen on this field? Well, they're happening. Here's the story, a story which might be entitled, "Two Forced Landings."

To begin with, the pilot who is assigned to me as an instructor turns out to be a real sarcastic wisecracker.

"So," he says the day of our first flight, "here's the smart-Aleck who thought he could fly a ship without benefit of instruction. Well, listen to me, and listen hard. When you and I go up in the air, I'm the boss, understand? You don't know anything about flying. I do know something about flying. When I tell you what to do, you do it, and not otherwise. Get that?"

From the above you can imagine the kind of guy this Easton is. And, knowing yours truly, you can imagine how I immediately begin planning to take a fall out of him.

I bide my time the first few flights, concentrating my intellectual energies on mastering stick and rudder, a task, I find, which cannot be accomplished in 1½ minutes. Then—I see my chance.

"Insert this thought in your brain cells, if any," Easton says one day as we circle the field. "If the motor of this ship should ever quit when we're in the air, drop the controls as you would hot potatoes. Forced landings are work for experienced pilots only."

"Ah," I murmur to myself as an idea occurs to me. And again, "Ah."

I send the plane down for a prac-

Letters of an Air Student to His Friend

by George Swift

tice landing, bounce off the ground as often happens, and lift the ship into the air again. When we've climbed a few hundred feet I lean forward and switch off the motor.

Easton turns in his seat. Oh, boy! His mouth is wide open and his eyes are all but popping out.

"Did you stop the motor?" he blurts.

"Sure I did." I grin. "Now show me how an experienced pilot makes a forced landing."

For some reason he doesn't say anything more. Instead, he grabs the controls.

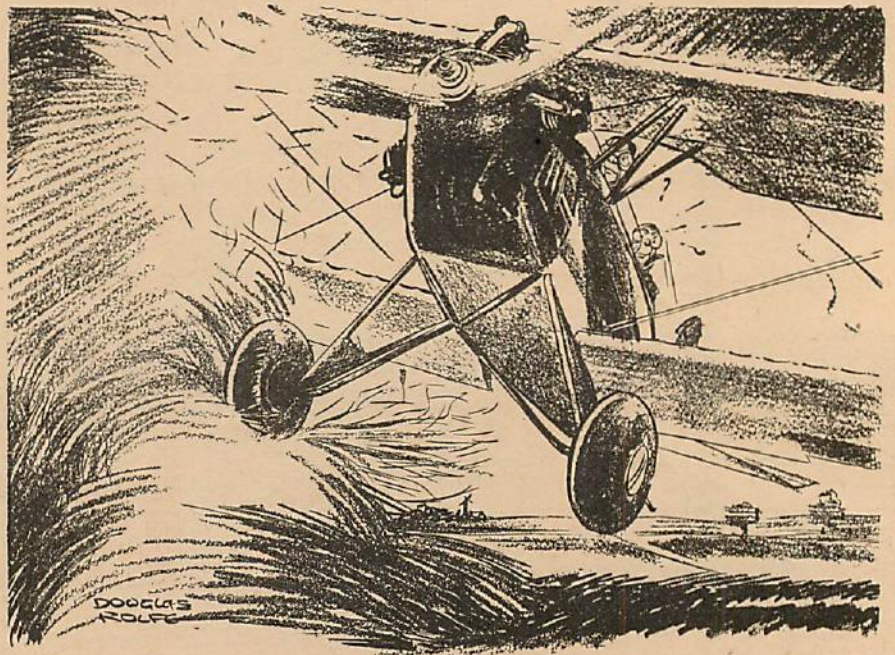
And now comes the queerest part of the whole thing. I haven't figured it out yet. Naturally, I expected Easton to bank the plane around and land on the airport. Instead, what does he do? He lets the plane drive straight ahead, away from the airport.

I look down. There's not a single landing place in sight. Nothing but houses, trees—and one small pond. And we're losing height like nobody's business.

"Why don't you turn back to the field?" I yell.

Easton whips around.

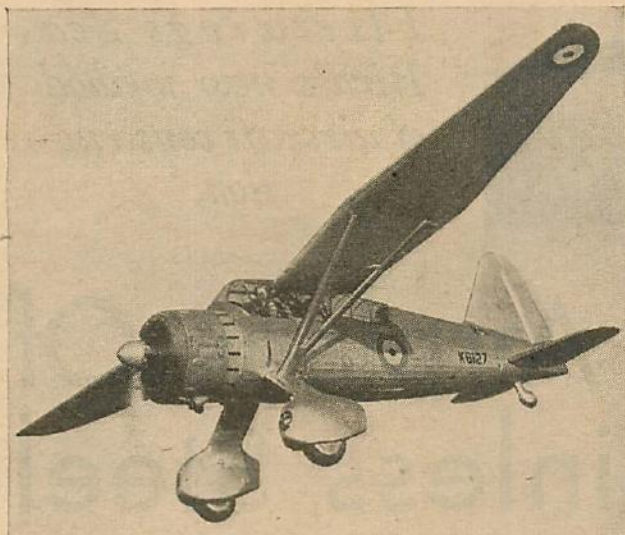
"If I tried that we'd both be washed (Turn to page 31)



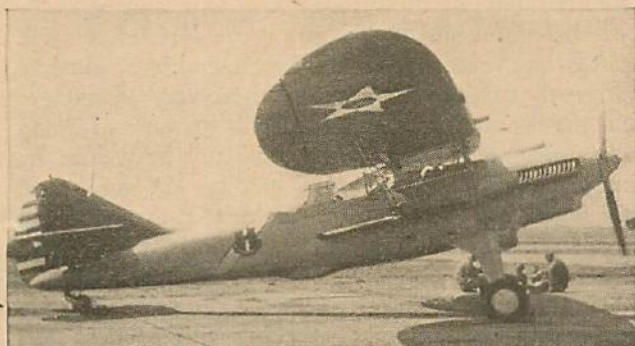
We hit the haystack. The plane falls back on its tail.

AIR TRAILS GALLERY

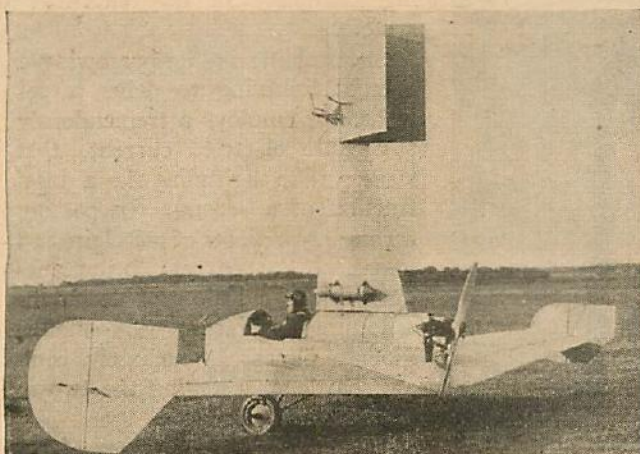
A Picture Page of Modern Planes for the Collector



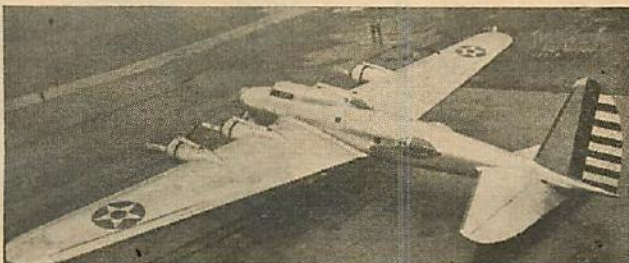
WESTLAND "army coöperation" monoplane, 600 h.p. Bristol Mercury, has wide field of view. Span is 50 ft., length 30. Note landing lights in wheel pants.



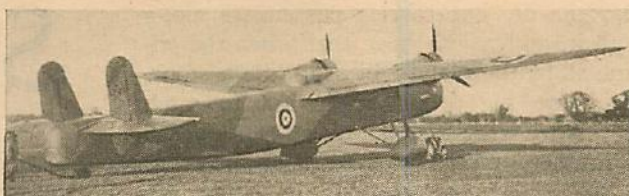
DOUGLAS O-43 standard army observation parasol monoplane, with 650 h.p. Curtiss Conqueror, has 188 m.p.h. top and climbs 10,000 ft. in 7 minutes.



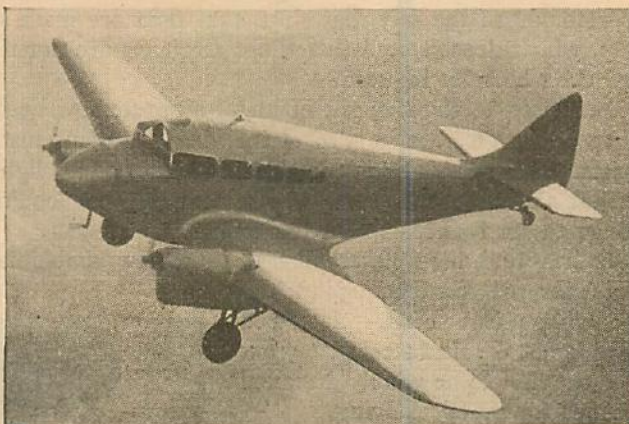
ELYTROPLANE, 30 h.p. French lightplane developed by Viscount de Rougé, claims stability and 45° landing angle. Length is 6½ ft., span 26¼.



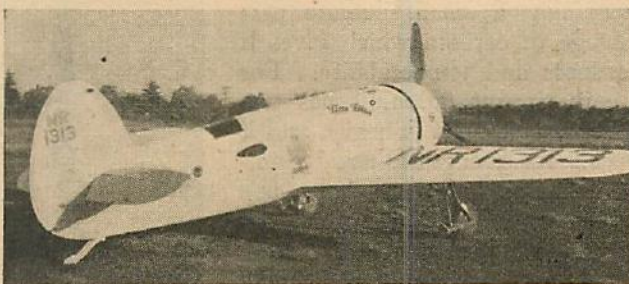
BOEING B-17, world's fastest heavy bomber, has 5 gun turrets. Engines are 1,000 h.p. Cyclones. Span is 105 ft., length 70, height 15; full weight 16 tons.



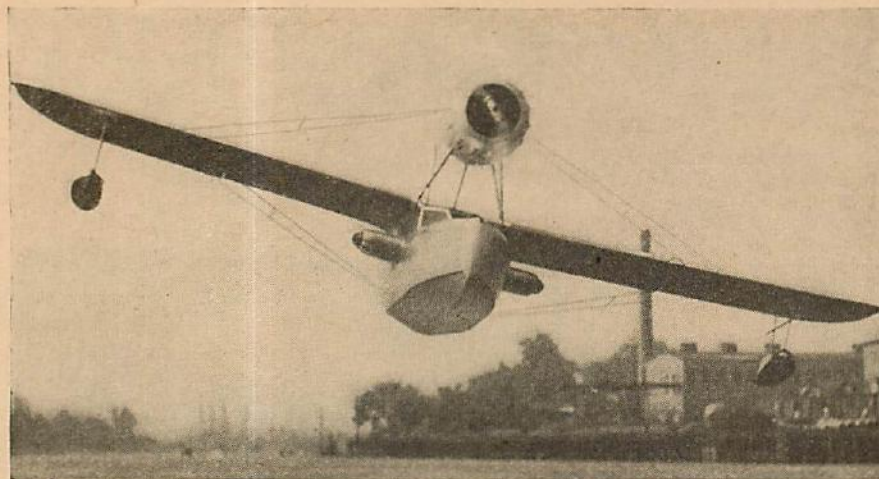
HANDLEY PAGE Harrow, camouflage-painted, is newest all-metal long-range bomber or troop transport for R. A. F. Engines are 960 h.p. Bristol Pegasus.



MILES Peregrine small transport carries pilot and 5 or 6 passengers on 200 h.p. Gypsy Six engines. Wheels retract into engine nacelles.



HAWKS HM-1 "Time Flies," built by Frank Hawks and Howel Miller, is described elsewhere in this issue; flying model appears on page 48.



by Albert J. Carlson

Strength and beauty are combined in the Fleetwings Sea Bird's new method of aircraft construction.

An Airplane Of Stainless Steel

THERE are still some people who marvel that an airplane flies, that a complicated chunk of metal known as an engine not only pulls its own great weight into the air but carries passengers along with it, and who believe that when the engine stops the plane will drop like a stone. They are the people we're apt to catch off guard with the old question, "Which is heavier, a pound of feathers or a pound of lead?"

Modern-minded, we aviation enthusiasts have passed beyond that stage of popular enlightenment. We have grasped, consciously or unconsciously, the engineering philosophy that lies in the phrase "strength-weight ratio." We know that all heavy materials are not strong and tough, nor are all light materials weak. We have become accustomed to the fact that ships that float are made of iron, which doesn't, and that those airplanes are not the lightest which fly highest.

Yet, used to the thought of metal aircraft, how many of us are not a little startled at the idea of a plane made almost entirely of *steel*? Duralumin and other light-weight aluminum alloys are familiar enough, but lending wings to steel seems like a big order.

It has just been accomplished in a new amphibian plane for the sportsman pilot, the Fleetwings Sea Bird. The Sea Bird is not the first steel plane, but it is the first to be wholly designed as such for practical flying.

The basis of the Sea Bird's success is twofold: the particular type of steel used, and the method by which the steel parts are assembled.

Ordinary steel is simply iron containing a small, definite percentage of carbon, which gives it hardness and temperability. For use in transportation, it has two disadvantages. It is heavy, and it rusts. Its strength is usually ample for most purposes, but that's where its weight comes into account, for its strength-weight ratio, though high, is not quite sufficiently high to assure safety when you want to shave your steel brace, or girder, 'way down for maximum

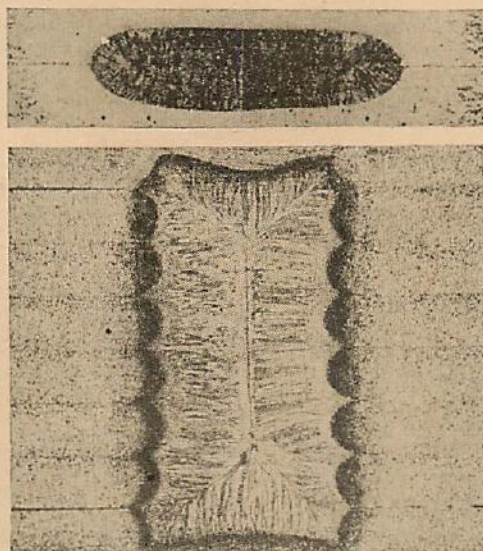
lightness, as in airplane construction. And even if you do so—without suffering serious consequences—your steel member will need constant care to prevent rust from reducing its strength still further.

From an alloy, or mixture, of steel with small quantities of chromium and nickel was created stainless steel. That was many years ago; the new metal was found to be extremely hard and strong, but these very advantages gave it the reputation of being difficult to work with and its use spread only slowly. It could not be welded by ordinary methods without losing quality. It was prized mostly for its stainless feature. Because it does not rust and resists most acids and other chemicals, it was used chiefly for shiny decorative surfaces, industrial tanks, sanitary and kitchen ware.

Obviously a new method of working with stainless steel was needed before this desirable metal could be used as much as it deserved. That method was developed by the Budd Manufacturing Company in its "shotweld" system.

Shotwelding is like borrowing a bolt of lightning to drive carpet tacks. It employs a tremendously powerful electric current that strikes, like lightning, in a brief fraction of a second. In passing through two pieces of metal pressed together, the current instantaneously melts a little globule on the adjoining surfaces; this molten globule almost immediately cools and hardens, fastening the two as if they were one piece.

In practice, the surfaces of the pieces to be welded are pressed together under several hundred pounds' pressure between two flat-



Cross sections of "shotwelds"—a typical two-piece weld and a weld of eight $\frac{1}{8}$ " pieces.

pointed electrodes, much as you would hold two pieces of paper between thumb and forefinger; a switch is closed and a current of about 12,000 to 35,000 amperes, depending on the thickness of the metal, is shot through for a period that may vary from approximately 1/60th to 1/6th of a second. The resulting "bubble" or "ingot" of melted metal that forms is shown in accompanying photographs.

The shotweld method solved the problem of working with stainless steel. It has enabled Fleetwings, Inc., the firm located in the huge plant at Bristol, Pa., formerly occupied by the Keystone company, to start a small-sized revolution in airplane construction.

Stainless steel, as utilized in the Sea Bird, weighs just as much as ordinary "mild" steel (low carbon value), but it is almost *three times* stronger. That means that you can use only one-third as much metal for the same strength, thereby making your structure two-thirds lighter. Other comparisons, including aluminum alloy, are as follows:

	Mild Steel	Stainless	Aluminum Alloy
Tensile strength @ 70° F.	60,000	150,000	55,000
Tensile strength @ 500° F.	73,000	125,000	22,000
Tensile strength @ 1,000° F.	30,000	118,000	0
Yield point	30,000	120,000	32,000
Weight per cubic inch	.286	.286	.115

Now let's look at our new airplane, the Sea Bird. It's easy to look at, for it's one of the prettiest ships to emerge in a long time. Its lustrous hull and floats—rivetless and absolutely smooth, for shotwelding leaves no bumps or depressions—are polished in circular knurls, giving it a richly patterned effect.

The wing and tail covering is fabric, finished in whatever color the owner may desire; every other part of the plane, inside and out, except upholstery and windshield, is stainless steel.

Hull structure is of semi-monocoque type in the cabin mid-section, the skin sharing part of the stress with the framework there, and purely monocoque elsewhere. The non-tapered wing has two box spars, corrugated longitudinally, and is braced internally with drag struts and double diagonal tie rods, and externally with flying and landing wires. A notable feat is the construction of the two fuel tanks, which are necessarily flat to fit inside the thin wing; they are of corrugated sheet and hold 26 gallons each, yet weigh only 14½ pounds apiece.

Specially interesting is the treatment of the retractable land wheels. With the stainless-steel wing flap, they are operated hydraulically from a simple lever in

Fleetwings Sea Bird

Engine: Jacobs L-5, 7-cylinder 285 h.p.
 Wing span 40 ft. 6 in.
 Length over-all 31 ft. 5½ in.
 Height over-all, on ground . . 12 ft. 6 in.
 Wing area 235 sq. ft.
 Wing loading 15½ lbs./sq. ft.
 Power loading 12 4/5 lbs./h. p.
 Empty weight 2,435 lbs.
 Useful load 1,215 lbs.
 Gross weight 3,650 lbs.
 Maximum speed (full weight) 150 m.p.h.
 Cruising speed, 75% power, sea level 133 m.p.h.
 Landing speed, flaps, sea level 55 m.p.h.
 Cruising range 515 mi.

the cockpit. A close-up in extended position is shown in an accompanying photo. When they are retracted, the tubular strut hinges in the middle and the hinged elbow swings up into the hull slot beside the pilot, lifting the wheel in a quarter-circle arc until it rests endwise against the hull. The strut and slots are then smoothly concealed and the wheel itself faired so that it produces little drag and acts as a small lifting surface. The tail wheel also retracts; in its down position, it

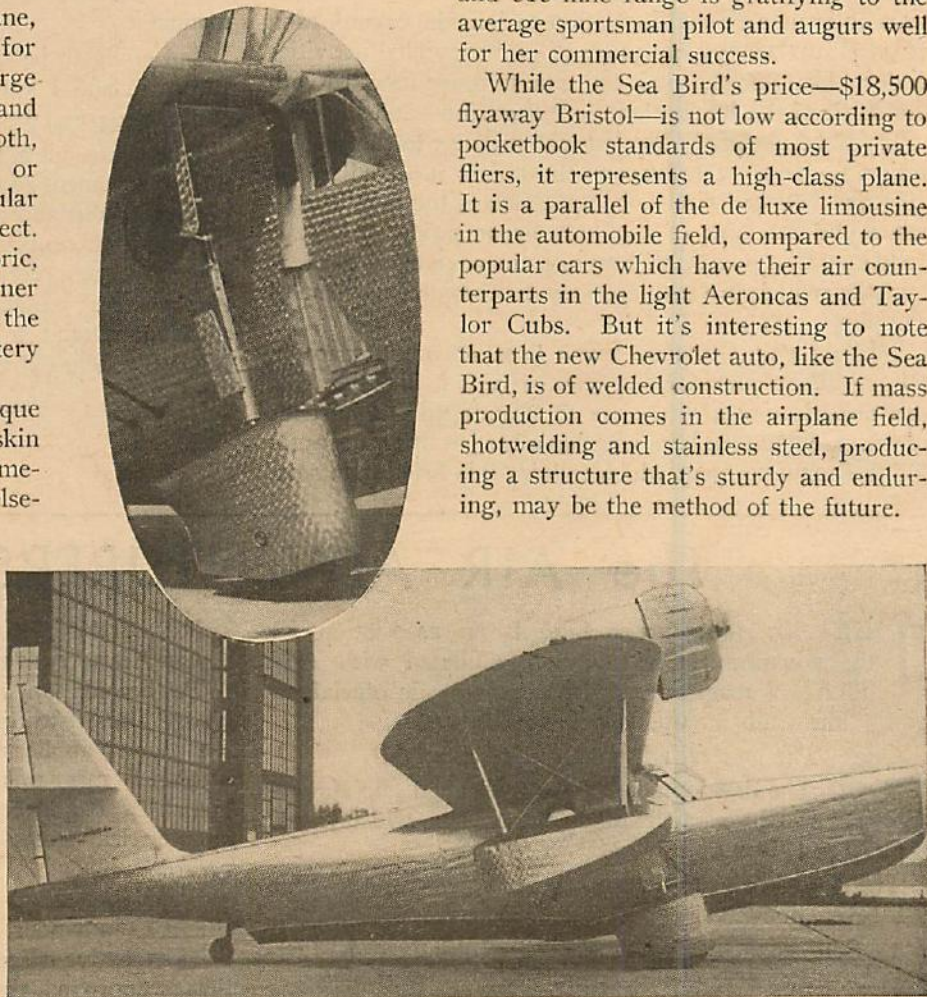
is pivotable to act as a water rudder.

Luxurious accommodations are provided inside. The soundproofed cabin is reached by a hatch in the front deck or a door at the top of the hull behind the engine mount. Four upholstered seats are in tandem pairs. The controls are of the throwover wheel type. The windshield is of a new material called plexi-glass, harder than the usual cello, more transparent than glass, and colorless.

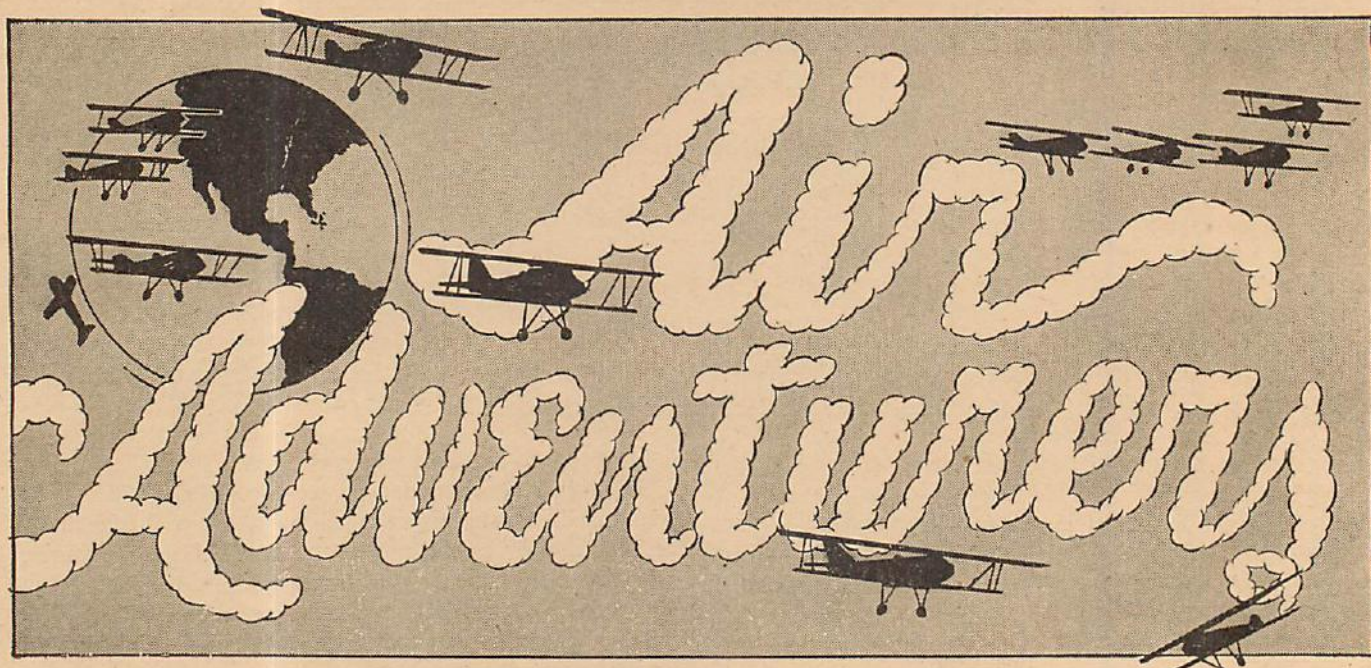
The Jacobs L-5 285 h.p. engine swings a Curtiss-Reed one-piece aluminum prop and is provided with direct electric starting.

Reports say that the Sea Bird handles fast and clean in the crucial matter of water take-offs, and certainly her performance of 150 m.p.h. top speed, 133 m.p.h. cruising, and 515-mile range is gratifying to the average sportsman pilot and augurs well for her commercial success.

While the Sea Bird's price—\$18,500 flyaway Bristol—is not low according to pocketbook standards of most private fliers, it represents a high-class plane. It is a parallel of the de luxe limousine in the automobile field, compared to the popular cars which have their air counterparts in the light Aeroncas and Taylor Cubs. But it's interesting to note that the new Chevrolet auto, like the Sea Bird, is of welded construction. If mass production comes in the airplane field, shotwelding and stainless steel, producing a structure that's sturdy and enduring, may be the method of the future.



A side view and a close-up of the novel wheel retraction system.



Here's The Good News!

LAST month I promised that we'd step out in this issue and I hope every *Air Adventurer* in the organization is ready for the announcement I'm going to make in just a minute.

But to those of you who are not yet *Air Adventurers*, I want to issue a cordial invitation to join the organization at once, at the very inception of our expanded activities under which our club will continue to move forward with the spirit of the largest aviation magazine—and the best.

It will be necessary for you who are new to the organization to read carefully over the points included in the *Air Adventurers'* Creed, because this is the very corner stone and strength of the new organization, and it is necessary that you be willing to train yourselves to those qualities which are so necessary to the advancement of aviation.

I'm not going to take much time or much space in talking about our past activities, except to mention that our organization already has thousands upon thousands of active, loyal members who have been waiting patiently for the announcement which follows this brief statement.

The new ratings and regulations become effective the day this issue of *AIR TRAILS* reaches the news stands, so I am announcing them not as *future* developments, but as actual, existing organization facts. They are in force now! Be sure to save this issue. It can serve as your manual.

I'm going to be mighty busy keeping up my end—but I'll do it, and I know you are going to make me proud of the progress we show during 1937.

If you are not a member but are interested in helping the advancement of aviation through your own individual efforts, fill out and mail the coupon on the opposite page, inclosing ten cents for club costs. If your application is approved, your certificate of membership and your *Air Adventurers'* wings will be mailed to you as promptly as I can attend to it. Now, let's go on to the **BIG NEWS**. There'll be more next month!

Your Flight Commander,

Albert J. Carlson

The AIR ADVENTURERS CLUB

THE *Air Adventurers Club* is an association for the advancement of aviation, affiliated with *AIR TRAILS* magazine, which serves as its official organ. The Club maintains a twofold purpose.

One: The general advancement of aviation.

Two: The development of the individual *Air Adventurers* as worthy participants in the air age, which is fast coming into being.

The Creed which governs the members of the Club has seven points:

1—Self-reliance, 2—Courage, 3—Initiative, 4—Loyalty, 5—Integrity, 6—Independence, 7—Obedience.

This Creed is one of the foundation stones on which the organization has been built.

Membership is divided into three ranks:

AIR ADVENTURER:

To become an *Air Adventurer* the applicant must pledge himself to uphold the Creed, and sign and submit the coupon application contained in every issue of *AIR TRAILS* magazine. Each application must be accompanied by 10¢ in coin or stamps to pay mailing expense and clerical costs involved in maintaining the club records.

Each application is taken under consideration by the Flight Commander, Albert J. Carlson, who serves as the chief executive officer of the organization. If the application is approved, the certificate of membership and gun-metal winged pin are mailed at once and the new *Air Adventurer* welcomed into the organization.

FLIGHT LIEUTENANT:

An *Air Adventurer* may advance his rank in the organization to Flight Lieutenant by either of the two following methods:

1. (a) Enlist three new *Air Adventurers* and send their signed applications, together with the 30¢ for their wings, to headquarters.

(b) Write a two-hundred-word discussion, commenting on the current issue of AIR TRAILS.

(c) After the candidate has accomplished the two above requirements, the Flight Commander will mail the regular Flight Lieutenant's examination of eight aeronautical questions to the member. Within ten days he will mail to the Flight Commander the answers to the examination questions submitted. If the paper is rated 75% correct, he will immediately receive a certificate of new rating and his silvered badge as Flight Lieutenant of the *Air Adventurers Club*.

Or—alternate method:

2. (a) Qualify for three of the five available Craftsman Awards which are granted for special knowledge of aviation subjects.

(b) Same as (b) first method.

(c) Same as (c) first method.

FLIGHT CAPTAIN:

Only those who have already achieved the rating of Flight Lieutenant may apply for advancement to the rating of Flight Captain.

To become a Flight Captain, the Flight Lieutenant must pursue either of the two following methods:

1. (a) Enlist five new *Air Adventurers* and forward their applications, together with the 50¢ for their wings, to headquarters.

(b) Write a two-hundred-word statement of the particular aeronautical job or activity he would like to follow, its value to aviation, and his reasons for choosing it.

(c) Upon receipt by the Flight Commander of the report, together with the applications for new membership, the regular Flight Captain's examination of twelve aeronautical questions will be forwarded. The Flight Lieutenant will be given two weeks to complete his work and mail the examination to headquarters. The paper will be rated carefully and if it is considered to be 75% correct, the Flight Lieutenant will be advanced to the rate of Flight Captain and a certificate and gilt wings will be mailed at once.

Alternate method:

2. (a) Qualify for all five Craftsman Awards.

(b) Same as (b) first method.

(c) Same as (c) first method.

CRAFTSMAN AWARDS:

Every *Air Adventurer* may, by specializing on one phase of aviation, qualify for a Craftsman Award and become entitled to the special listing associated with that effort.

A Craftsman certificate will be awarded immediately upon successful completion of any of the following Craftsman efforts: (It is possible for any *Air Adventurer* to qualify for all five, provided not more than one application for merit awards may be made in any one month.)

1. Topographer:

Draw an accurate scale map of one airport in your vicinity, or one intermediate landing field, or two unmarked areas suitable for emergency landings. The map must indicate correct distances, compass directions, slope and character of surface, location and nature of

navigation aids such as wind socks, beacons, markers, etc., near-by obstacles, approximate elevation above sea level, and prevailing winds.

2. Observer:

Write in eight hundred to one thousand words a detailed report of an aviation news event or occurrence in your vicinity, or a detailed report covering a period of at least five consecutive hours of regular aviation activities at a near-by airport. If the airport is a large and busy one, the report may cover the operations of one air line, or of an air school, or of a plane-charter service, or other active aviation organization.

3. Photographer:

Submit a photograph of any aviation subject taken by yourself. Inclose a brief, written description of the subject and its aviation significance, and a statement of make and model of camera used, type and focal length of lens, kind of film and paper, time of exposure, light conditions.

4. Airplane Mechanic:

Build and submit a finished flying or nonflying model, or a close-up photograph of it (not necessarily taken by yourself). Nonflying models must be solid or built-up scale replicas with wing span of at least five inches; flying models may be of any size and type except small beginners' balsa gliders. Powered flying models must have made at least a thirty-second flight; gliders at least ten seconds. Flights must be testified to by a signed statement of at least two witnesses.

5. Engine Mechanic:

Submit a statement of not more than one hundred words to the Flight Commander telling why you are specifically interested in aviation engines. If your statement is considered to be sincere and to indicate a worthy desire to learn, the Flight Commander will forward the special Engine Mechanic examination of twenty questions, for which the passing grade will be 75%.

As soon as an *Air Adventurer* of any grade, whether he be a member, a Flight Lieutenant, or a Flight Captain, has achieved the necessary requirements for a merit award, the Flight Commander will sign and forward the special merit award certificate and the change of rating will be indicated on the membership roll here at headquarters.

EACH MONTH our club page will contain news and photos of these new activities, honor rolls of Flight Lieutenants, Flight Captains, and Craftsmen, and information of value to all members. Let's go, Air Adventurers!

(MEMBERSHIP COUPON)

To the Flight Commander, Air Adventurers,
79-89 Seventh Avenue,
New York, N. Y.

I am interested in aviation and its future developments. To the best of my ability I pledge myself to support the principles and ideals of AIR ADVENTURERS and will do all in my power to further the advance of aviation.

Please enroll me as a member of AIR ADVENTURERS and send me my certificate and badge. I enclose ten cents to cover postage.

Name Age

Address

☐ Check here if interested in model building.

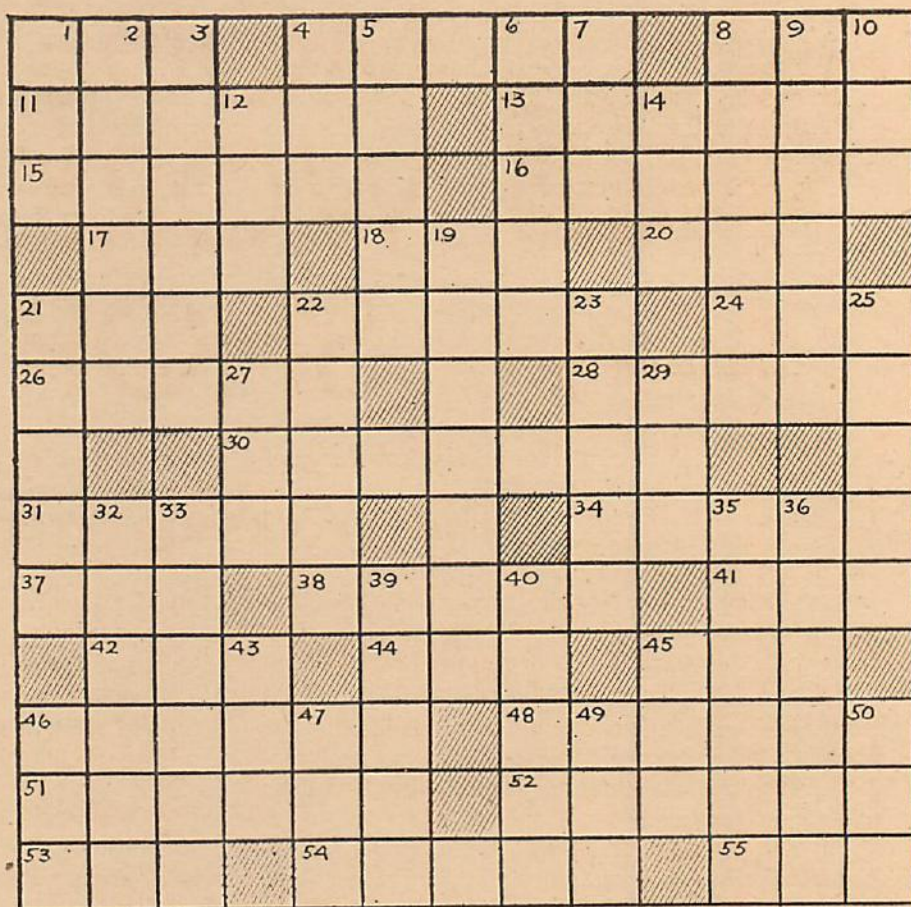
(This coupon may not be used after March 15, 1937.)

CROSS WINDS

*Can you answer
the aeronautical
definitions in
this puzzle?*

Across

- 1—Portion of biplane wings enclosed between struts and fuselage
4—Type of Lockheed plane, in plural
8—Compensate
11—Earth line of no magnetic declination
13—Type of Caudron fast-sport plane
15—Kind of engine in which cylinders are arranged in circle around crankshaft
16—First flier to crash
17—Experienced soldier, shortened form
18—Tailless monkey
20—Jewel
21—Elongated fish
22—Lose wing lift
24—Compass direction midway between northeast and north, abbreviated
26—Outcome
28—Very small quantities
30—Pilot of heavier-than-air craft
31—King of birds
34—Pass a rope through
37—Regret
38—Make of French aero engines
41—Negative connective
42—African antelope
44—Winglike part, in anatomy
45—Type of Dornier flying boat
46—Sparkless internal combustion engine
48—Delivered by post
51—Steady flow
52—Complete



- 53—Beverage made from shrub leaves
54—American plane manufacturer who made Doolittle's "Super Solution"
55—To stain

Down

- 1—Support for rudder pedals
2—Century plants
3—Sings with sudden tone changes
4—By way of
5—Brilliance in success
6—Spirit of the air
7—Baglike part
8—Father or mother
9—Girl graduate
10—Affirmative adverbial particle
12—Parasitic insect egg
14—To exhaust
19—Type of wing set above fuselage
21—Large sea duck
22—Cut apart
23—First word in name of French aircraft company whose plane designation is LeO.
25—Kind of chemical compound
27—Transcontinental air line flying northernmost route, initials
29—Native metal
32—Aluminous silicate
33—Categories of scientific classification between family and species
35—Plant growing on sea bottom
36—Aviary
39—Kind of checkerboard game
40—One who names
43—Employ
45—Mental faculty
46—Designation of Douglas sleeper plane
47—Air line of which Eddie Rickenbacker is general manager, initials
49—Connective particle
50—Scottish river



The MODEL WORK- SHOP



Conducted by

Gordon S. Light

EVERYBODY who has ever tackled model-airplane building in a serious way has

been troubled by the problem of where he should work and where he should store his materials and models. Usually the selection of workshops does not rest entirely in the model builder's hands. The activities of the other members of the family require that he be shunted off to some out-of-the-way place where he will offer the least resistance. Quite conveniently, the model builder finds the out-of-the-way workshop ideal, since his materials will not be disturbed and the models themselves will suffer less damage.

But where should the modeler set up shop? The cellar and the attic offer the first havens. Both of these places are spacious and out of the way. For modelers who live where winters are cold, however, the attic and the cellar are pretty dismal places and can be downright unhealthful.

Finding winter quarters is a problem which faces both circus and modelers. Many a good model has come to life from a kitchen table workbench. But such a "shop" has its disadvantages. Every evening you must clean off your materials from the table so breakfast can be prepared. If you spill a few drops of cement or banana oil on the table, all the speed in the world will not prevent marring the finish when you wipe it off. These troubles, coupled with the natural confusion of having you in the kitchen, are certain to make you unwelcome. The kitchen is worth while fighting for, however, since it is usually warm and the stove makes a convenient place to bend bamboo and balsa. It's true, too, that you'll keep your supplies in better order if you work in the kitchen. Scattering balsa shavings

The Workshop Problem

and tissue scraps to all parts of the room, as you habitually do in your attic or cellar, is strictly taboo.

If a kitchen workshop is out of the question, the dining room is the next possibility. Maybe you can set up shop in a little-used corner, on a small table. We'd recommend a card table—it can be folded and concealed in the closet on special occasions. Shavings, objectionable even in the kitchen, find no place at all in the dining room, so be careful.

Your bedroom is the next possibility. Permission to work there depends on your mother's judgment. Maybe you can get conditional permission—either you keep the bedroom clean of shavings and your materials orderly, or out you go. If you're fortunate enough to get started with a bedroom workshop, be sure to keep things tidy. When you feel yourself slipping, remember your less fortunate brothers who have no permanent location, but are forced to move from one part of the house to another to fit in with the activities of a non-air-minded household.

For the modelers who move from one room to another there are a few pointers. Keep things packed away in a convenient set of portable shelves or drawers. Such a cabinet can be nailed together from a few boards and will eliminate running back and forth for tools and materials when you begin work. Or maybe you'll be peacefully covering a wing in the dining room when your mother excitedly announces that Mrs. Brown is coming and she would hate to have her see how untidy the dining room is. To cope with this situation, you should be able to move immediately to the kitchen, leaving the dining room free from any evidences of your having been there a few short seconds before.

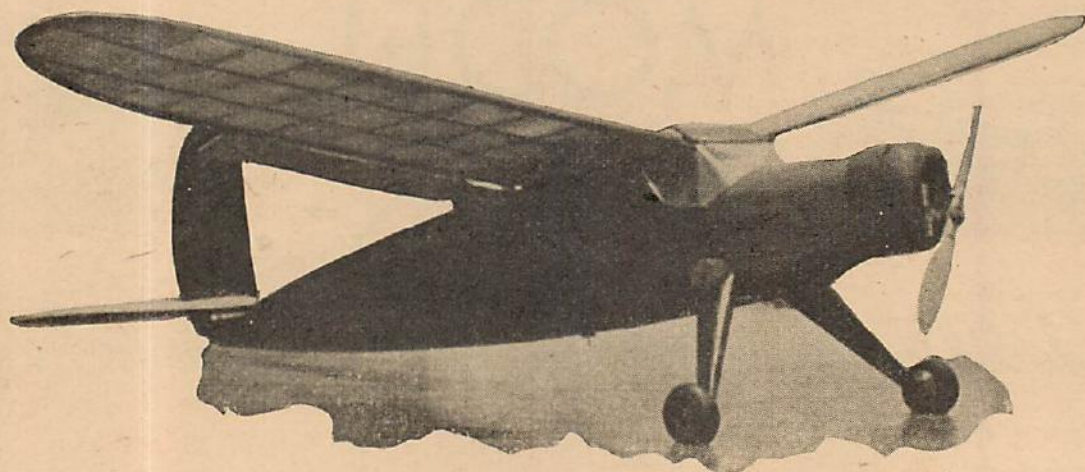
The Contest Calendar

RISE-OFF-SNOW Contest for gas models; date set tentatively for January, depending on condition of snow on field; probable site, Holmes Airport, Queens, New York City. Gas supply limit, 45 seconds. Models to be judged on take-off, landing, general flight attitude. Details from Irwin Polk, Metropolitan Model League, 421 7th Ave., New York City.

FLYING SCALE MODEL Contest for beginners, all flights by proxy; Louisville, Ky., tentative date, Feb. 26. Models to be judged 50% for flying ability, 50% for resemblance. Prizes of cash, kits, model materials. Rules, entry blanks: Fred Harwood, 1814 W. Burnett Ave., Louisville, Ky.

The Model Workshop asks the aid of readers and clubs in developing for their benefit a complete, detailed report of all model contests and exhibitions, large or small, everywhere. Listings should be received by The Contest Calendar, AIR TRAILS, 79 7th Ave., New York City, at least two months in advance; news of winners and results as soon as possible.

Contact!



AS "music hath charms to soothe a savage breast," so the exhaust fumes from a small model motor soothe the "savage" model builder. With the odor of burning oil and gasoline in his nostrils, oil and grease on his fingers, and the roar of the motor in his ears, he will forget his troubles so completely that he will oftentimes neglect important school work. A poor report card will touch things off and the gas model will be put away in a closet while the modeler catches up on back lessons. But the temptation will be too strong. After a few days spent exclusively in studying, the modeler will take it out of the closet to "sort of look it over." This is the beginning of the end. It's just a matter of a day or two until he'll be flying it again, repairing it, and planning his next gas job.

If you don't think this is true, try building the Sky King. After its first successful flight you'll be in the same position as the modeler just described. But it's such a happy and satisfying feeling that none of us would want to be without it. However, there's a lion's share of work waiting for us—we've had to divide it into two monthly instalments—so let's get started.

Before taking up actual construction I'd like to point out some of the features of this ship which make it interesting and easy to fly. It is the result of the coöperative efforts of three experienced builders, and we feel that it has several important advantages.

It is compact and convenient to handle. The wing is built in three pieces—center or cabane section, and two outer panels. The one-piece rudder-elevator unit is detachable from the rear of the fuselage with little trouble.

From an aerodynamic viewpoint the model is particularly clean. The wing fits flush atop the fuselage with no outside fittings. Four rubber slings inside the fuselage hold it in place. These are reached through a demountable door at the side.

The ignition system for the motor is mounted on a flat board which is carried inside the fuselage near the trailing edge of the wing. This method provides a painless way of balancing the model. The board is secured by a single bolt, fitting through a groove in the bottom of the

fuselage, on which a wing-nut turns from the outside. The groove is 8" long, allowing ample travel for balancing. A 4x8¼" removable door fits into the left side of the fuselage directly beneath the center of the wing. Ignition can be serviced through this door when the wing is attached.

The landing gear is full cantilever and well covered with balsa fairing and balsa tire cuffs. The strength and shock absorption quality do not suffer by this clean design. Built as a separate unit from ⅛" diameter piano wire, the landing gear is attached to the bottom of the fuselage with rubber. Thus any excess landing force is absorbed by the rubber and not transferred to the fuselage. Sections of the sheet balsa covering are cut

away, and subsequently covered with small pieces of balloon rubber, to allow the landing gear to move back and forth.

The motor cowling is rigidly attached to the front motor mountings with two small machine screws and is removable in a few seconds, if necessary. A section of the cowling is hinged and swings outward to permit access to the motor for refueling and needle-valve adjustments. After you're satisfied with the motor adjustment, you merely snap down the cowl and the model is ready to take off.

The propeller has variable pitch and can be fitted with individual blades as desired.

The automatic timing switch which controls the length of the motor run has been a life-saver. With it gas models can be flown in relatively small fields. Originally intended as a camera timer, this device is a small, lightweight spring-and-gear system. It can be accurately timed for any period up to 1 minute. It has never failed us, despite the additional duties imposed on it, such as clicking a small camera for "aerial photography" and actuating the wing-flap mechanism for extending the flaps while the ship is in full flight.

FUSELAGE

The fuselage is built to the same requirements as those for a rubber-powered model. Balsa longerons are used.

The SKY KING

Presenting the AIR TRAILS gas model you've been waiting for! The Sky King has clean lines, automatic flaps and adjustable prop, and is designed for simple, rugged construction and easy servicing.

with spruce strengtheners at the landing gear and pine at the motor mount. The Pratt type of fuselage truss is used; that is, diagonal braces are added between the upright and vertical braces. Stringers are added to the four sides of the fuselage, and the longeron outside corners smoothed to give it a partially rounded shape. This improves the appearance over the flat-side type of fuselage, without the additional trouble that follows an attempt to build a completely circular or oval cross section.

Drawing #1 shows the side and top views of the fuselage with complete dimensions. We've found that rubber-model construction can be successfully used in gas models, and this is especially true with fuselage construction. First draw a full-size side view of the fuselage. Nothing better than brown or white wrapping paper is necessary. The first line on the paper should be the datum or thrust line. All the fuselage measurements are referred to this line, as are the wing and tail settings.

The $\frac{3}{8} \times \frac{3}{8} \times 57$ " hard balsa longerons are pinned in shape on the drawing. Our fuselage was built with the floor of a dormitory room serving as the workbench. This is a dangerous practice to follow unless the floor has aged to the point where pin holes are no longer objectionable, but it does give you ample space to work with the 5' longerons. A thorough soaking in hot water

of mounting the motor is described separately, as it is different from anything encountered in rubber-powered modeling.

FRONT OF FUSELAGE

The engine is mounted on two dural angles of $\frac{1}{2}$ " flanges. See drawing #2. Drill three $\frac{1}{8}$ " diameter holes on one face of the flange. The first hole is $3\frac{1}{2}$ " from the end, the second $6\frac{3}{4}$ " and the third $10\frac{3}{4}$ ". On the other face drill $\frac{1}{8}$ " holes 1" and 2" from the front. Drill identical holes in both angles. The angles are bolted to the pine cross pieces with their faces opposite each other.

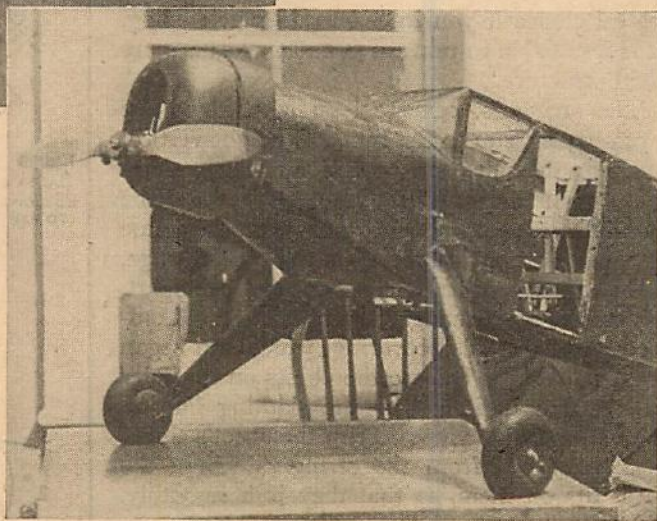
The nose is made of $\frac{3}{8} \times \frac{3}{8}$ " balsa built up as the drawing indicates. Put in the cross pieces as you would on any rubber-powered model. Pine cross braces are installed at the nose to provide a solid mounting surface for the dural angles. The angles are bolted to the cross braces and the nuts secured to the bolts with liberal coatings of cement.

The curved portion of the nose is built up from three-ply balsa formers, shown actual size in drawing #6 and labelled A, B, C, D, E, and F. Use three thicknesses of $\frac{3}{32}$ " balsa, to make the plywood, running the grains crosswise to each other. The nose is covered with sheet balsa, with the twofold objective of increasing the strength and retaining the curved shape. This covering cannot be applied in wide sheets, but must be "planked"; that is, applied in a series of narrow pieces which are carefully cemented together and later sanded to the curved shape. The "planks" should be cut from $\frac{3}{32}$ " sheet balsa $\frac{3}{8}$ " wide tapering to $\frac{3}{32}$ ". Add these planks, one along-



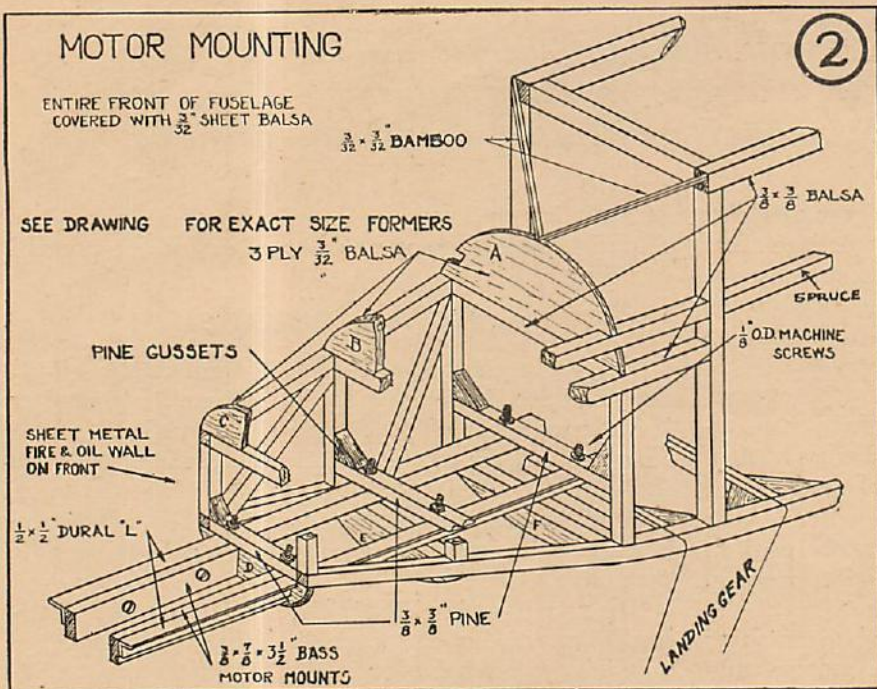
will make them easier to bend into shape. Spruce strengtheners $\frac{1}{4} \times \frac{3}{8}$ " are added inside the bottom longerons from the rear of the door to former F, and horizontally below the cabin window. It will probably be a trifle awkward to make both of the fuselage sides at the same time—that is, one atop the other, so be accurate in pinning each half to the drawing. The braces are $\frac{1}{4} \times \frac{1}{4}$ " hard balsa unless otherwise indicated in the drawing. Incidentally, the usual wax-paper protection between the wood and the drawing is a wise move. Without it you'll probably remove most of the important lines of the drawing when you finish the first fuselage half.

The two halves are joined, putting in all the cross braces back of the front cabin window. The method of building up the nose of the model along with the method



Rear view shows wing flaps. Top and door give easy access; braces hold flap mechanism described next month.

MOTOR MOUNTING



side the other, until you've covered the entire nosing.

The rear edge of the balsa covering on top of the nose is cut to a circular shape where it forms the front cabin window. The windshield itself is celluloid, cemented in place. Two slivers of bamboo cemented diagonally across the inside of the windshield serve as strengtheners.

A piece of tin-can metal is cemented on the extreme front of the fuselage. It serves as a fire wall and prevents oil from being blown back into the fuselage.

The motor mounts are made of $\frac{3}{8} \times \frac{7}{8} \times 3\frac{1}{2}$ " bass wood. Bass is used since it is soft and in the event of a crash, the motor will be torn loose. This is preferable to having the motor fixed where it must take all the shock. The bass motor-mount pieces are bolted to the sides of the dural angles. The bolt can be removed to permit replacement of these pieces if necessary. The motor itself is screwed in place to the top of the bass pieces.

COVERING THE FUSELAGE

The fuselage should be covered with either silk or bamboo paper. Silk seems to be the logical choice if you intend to do much flying. It is less liable to punctures and makes a more rigid structure.

The stringers, cemented on edge along the cross braces, run to the first full-height vertical brace on the sides and bottom, and to the cross brace under the wing trailing edge on top. The middle bottom stringer is cut away in the frame sections in front of and behind the trailing edge, and two strips of bamboo substituted $\frac{1}{4}$ " apart, to accommodate the ignition-board bolt. Complete the sheet balsa covering, which you began around the nose, back to the points on the sides and bottom indicated by the slanting line on the fuselage side view. Trim the sheet's thickness, or $\frac{3}{32}$ ", from the stringers where the sheet fits on them, so that they join smoothly. Apply three coats of dope. Now you are ready for the silk, which runs from fire wall to tail except on top, where it begins at the wing.

Cover the sides first. Apply a liberal coating of banana oil to all parts of the fuselage. Allow this coat to dry. Now spread the silk over the side of the fuselage and stretch it and pin it. Secure it with banana oil applied from the top of the silk. The banana oil will penetrate the silk and "stick" to the banana oil on the balsa beneath. This is an easy way to cover, since all objectional wrinkles can be smoothed out before it is attached to the fuselage. The silk is attached to the longerons and the stringers, but not to the cross braces or the uprights. In doping, you must exercise the same precaution of not sticking the silk to the cross braces. Several coats of light clear dope, either brushed or sprayed, will shrink the silk, making the fuselage strong and rigid.

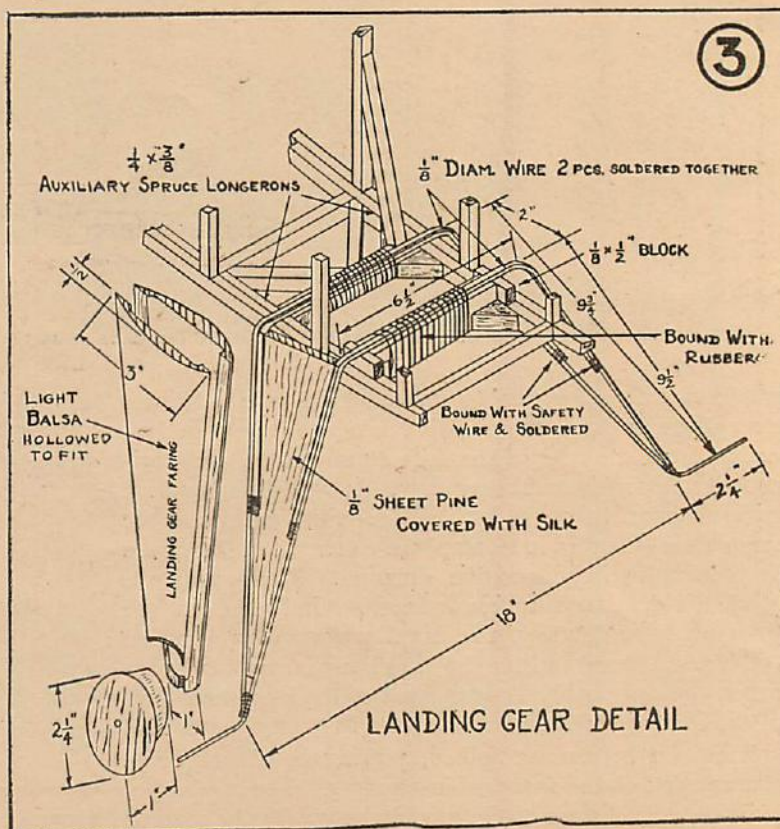
If you use bamboo paper, it will be necessary to use a light grade of cement rather than banana oil, but the same procedure of pinning the paper to the

fuselage before fastening with cement can be followed.

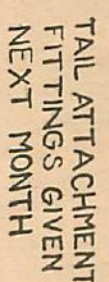
For the side door, shown in drawing #4, cement additional side, top, and bottom $\frac{1}{4}$ " braces around the inside edge of the panel shaded in #1, and cut it out. Fix a wire prong in the bottom brace to slip behind the lower longeron, and through the top insert a springy bent piece that will snap behind the upper longeron when the door is pressed into place. The outer end of this wire can serve as a handle.

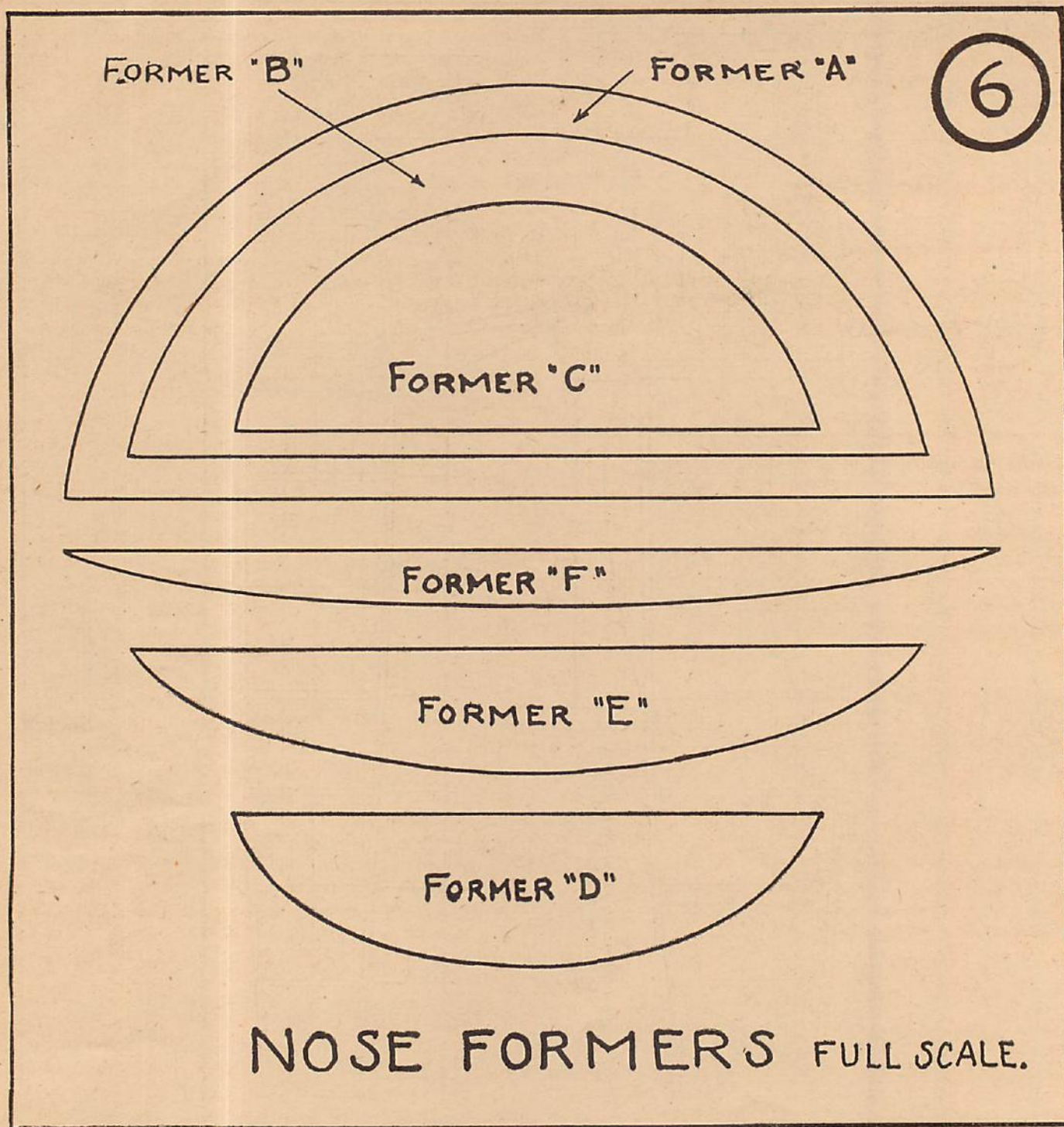
LANDING GEAR

The landing gear is made as a separate unit. It should be finished completely except for adding the wheels and



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then inserted through the fuselage and secured to hardwood braces with rubber bands. An article telling how to make your own pneumatic wheels appeared in AIR TRAILS for October, 1936.

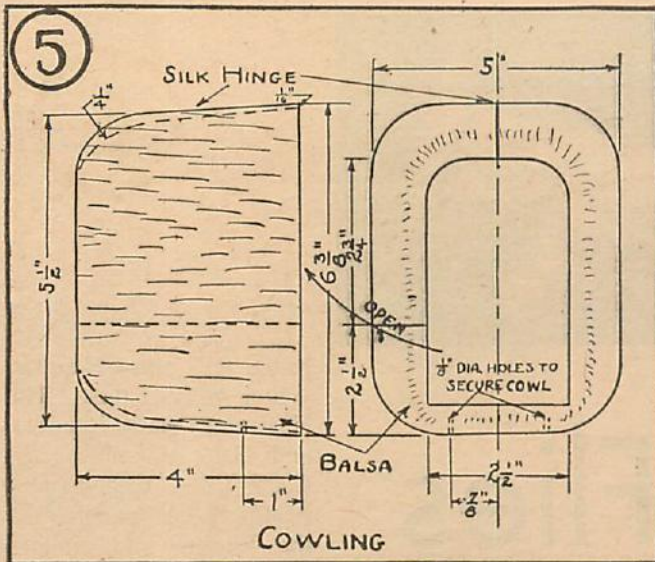
Piano wire of $\frac{1}{8}$ " diameter is used for the landing gear. Two pieces of wire about 32" long are bent into the shape in drawing #3. One wire is used for the front and the other for the rear. Short $\frac{1}{8}$ " diameter wire strengtheners extend across the top and halfway down each side. These are wired and soldered to the main pieces.

A piece of pine is inserted in each side of the landing gear between the two wires forming the "V." The purpose of the wood is to reduce flexing of the wire and prevent the bending from breaking the balsa fairing which is put on the outside of the struts. Pine $\frac{1}{8}$ " thick is used. The edges should be grooved so the piece fits

snugly between the wires. Secure the wood in place with cement and silk wrappings.

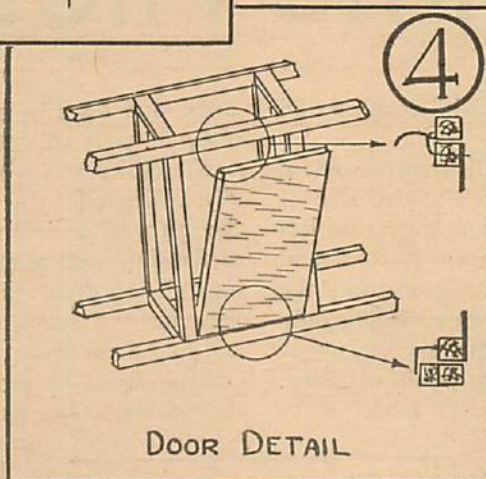
Balsa fairings $\frac{1}{2}$ " thick are added as sketched, one outside and one inside of each V. They must be grooved to fit over the strut. Cut the outsides to a streamline shape after cementing in place. At the top of the V the fairings are tapered so they fit smoothly against the fuselage. Balsa blocks carved from $1 \times 2\frac{1}{4} \times 2\frac{1}{4}$ " are the tire cuffs. These should fit into the shape of the landing gear and then gradually flare out to fit into the shape of the tire.

From the various drawings you can locate the position for the landing gear. The upright fuselage brace forming the front of the cabin fits between the front and rear wires of the landing gear. To get the landing gear into position, first insert it through the fuselage. If you have

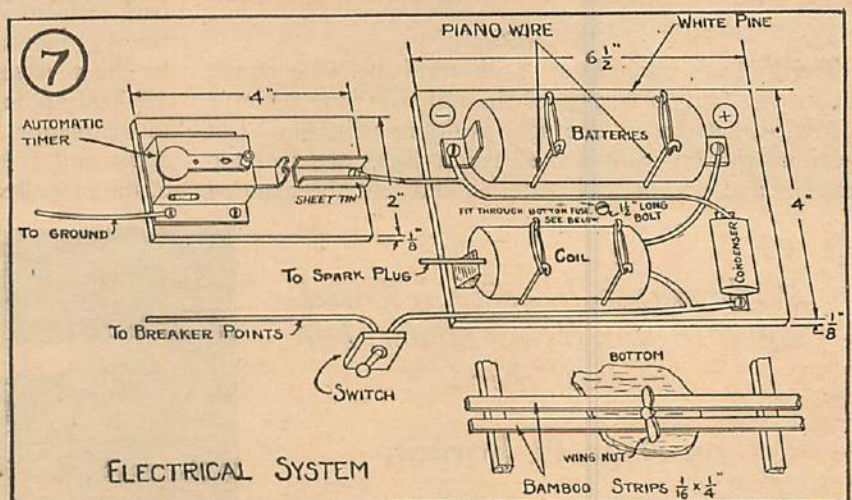


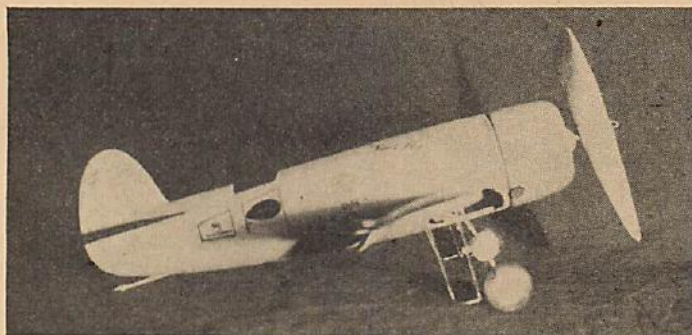
Cement a scrap of balloon rubber over the fuselage strut opening. Use a color that will match your final fuselage color as nearly as possible.

The timer is made from a camera self-timer. You can get one from a camera-supply house for about a dollar and a half. It is put into the circuit as shown in the sketch, being mounted on a board placed inside the fuselage a short distance ahead of the ignition board and within convenient reach of the doorway. The plunger pulls clear of the sheet-tin channel to break the circuit. The current going to the ground passes through the timer itself. This is simpler than having the timer actuate a separate switch. Our timer had a maximum period of about a minute. It can be set at any shorter interval.



Eight evenly spaced slits are cut in the ends of the tube with a hacksaw. They should extend down to the hardwood plug just mentioned. The ends of the slits are tipped with solder to prevent the tightening collars from slipping off. Each collar is cut from sheet tin of .02" thickness and the machine. (Turn to page 92)





REMEMBER the Travelair "Mystery S" Capt. Hawks flew on so many record-breaking trips several years ago? Now he's testing a silver-and-blue ship similar in appearance to the "Mystery S" and promises to set as many new records with it as he did with the old red-and-silver speedster.

The model of *Time Flies* is faithfully reproduced in miniature to conform with the outward appearance of the big ship. It even boasts of a landing gear that lets down at the end of flight, an anti-torque aileron, and flaps that also let down. With all these features the model, ready to fly in any speed-model race, weighs only 2 ounces. With the aid of the anti-torque aileron, maximum thrills with a minimum of crack-ups can be obtained.

The first step in building this type of model is to make plywood sheets for the formers and wing-cover panels. The four wing panels can be cut from two 7x8" sheets of two-ply $\frac{1}{64}$ " balsa, cemented together cross-grained. The formers are cut from a 4x6" sheet of two-ply $\frac{1}{32}$ " balsa. Carve the nose block, wheels, propeller, and cut out the ribs while these are drying.

FUSELAGE

Now cut out the formers; that is, two each of the halves. The formers may be cemented together and the fuselage frame assembled on the two side $\frac{1}{16}$ " square longerons, or, the right half of the fuselage may be built up on the top and bottom longerons, working directly on the drawing, and then the other half built to the already assembled half. The latter way is more accurate.

WINGS

The fuselage frame is set aside until the wing panels are made. Only a tracing of the full-size wing patterns is needed, but the rib and spar positions will help. Cut the four patterns and make certain there are two top patterns and two bottom patterns, and that the exposed

Time Flies

grain will run from the center to the tips. The ribs and spars interlock and make assembly easy. Cement the ribs and spars to the lower panels. If the leading and trailing edges of the panels are blocked up with tapered

stock, and the ribs and spars held down with plenty of pins, all parts will fit snugly.

No left aileron is needed, but may be workable manually, if desired. Cut through the bottom panels between the spars in several places, so the exact cutting location of the flaps and aileron can be found after covering the top. To prevent the top cement from sticking to the flap ribs and spars, insert small pieces of waxed paper and fold them over. Notch out for the #12 wire aileron control, lay it in and cement the top patterns on. Use the trailing edges as guides and let the front edges remain uncemented to the leading strips until the panels are removed, then use pins and clamps to pull the edges together. Attach the wings to the fuselage with the stub spars with $\frac{3}{4}$ " dihedral.

Before going farther with the other parts of the model, install the operating mechanism in the fuselage.

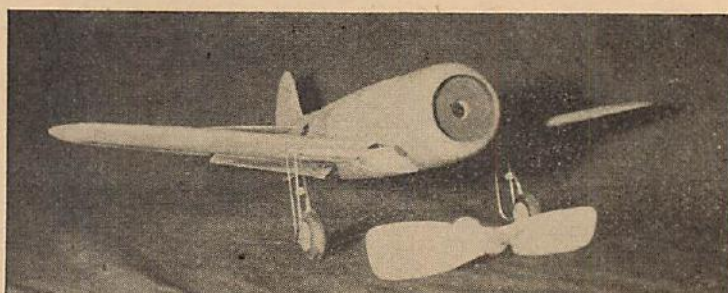
THE MECHANISM

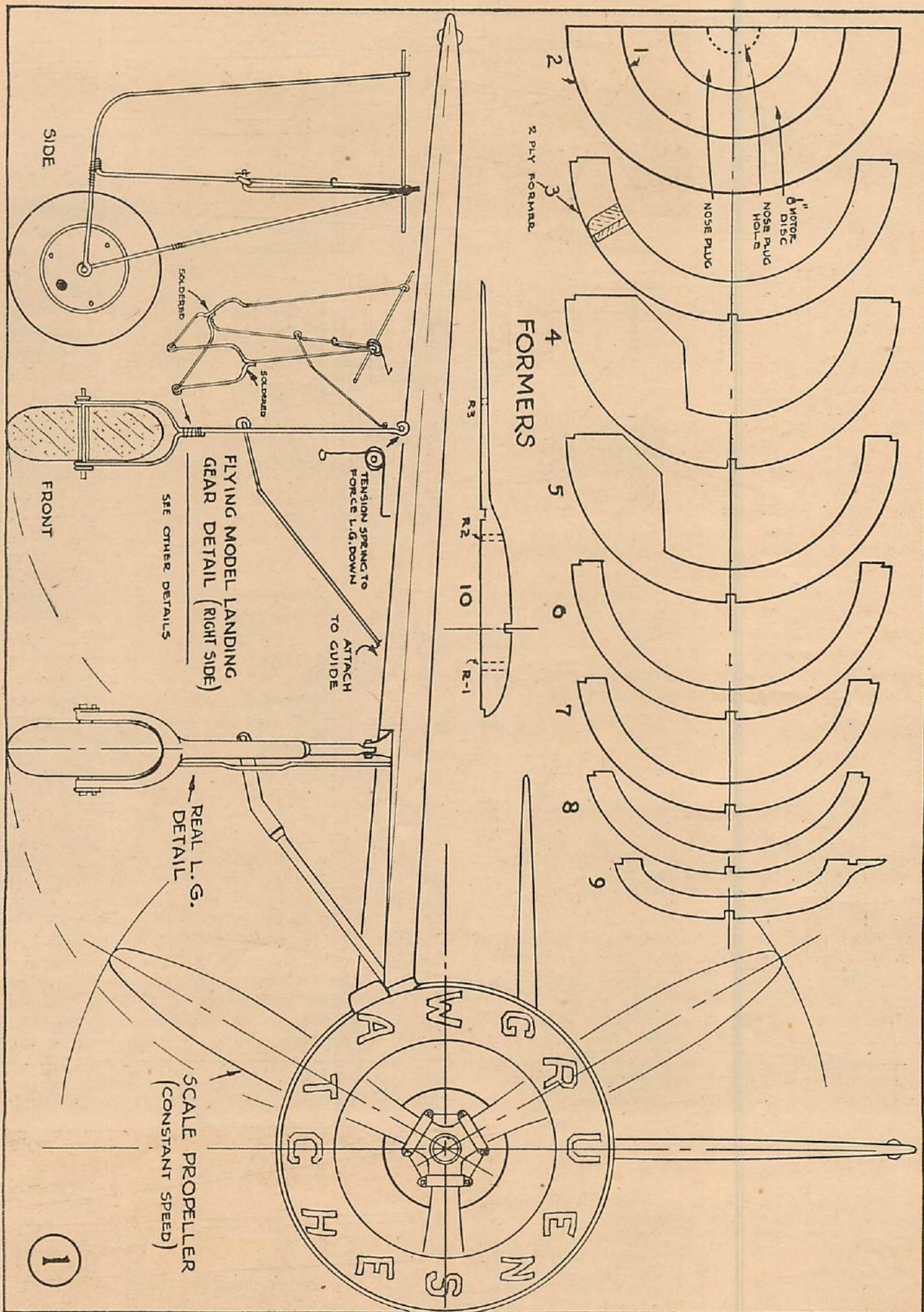
The rubber motor tension is what really operates the parts. The principle is the same as that used in the Folkerts Special model last month. A little study will make it clear.

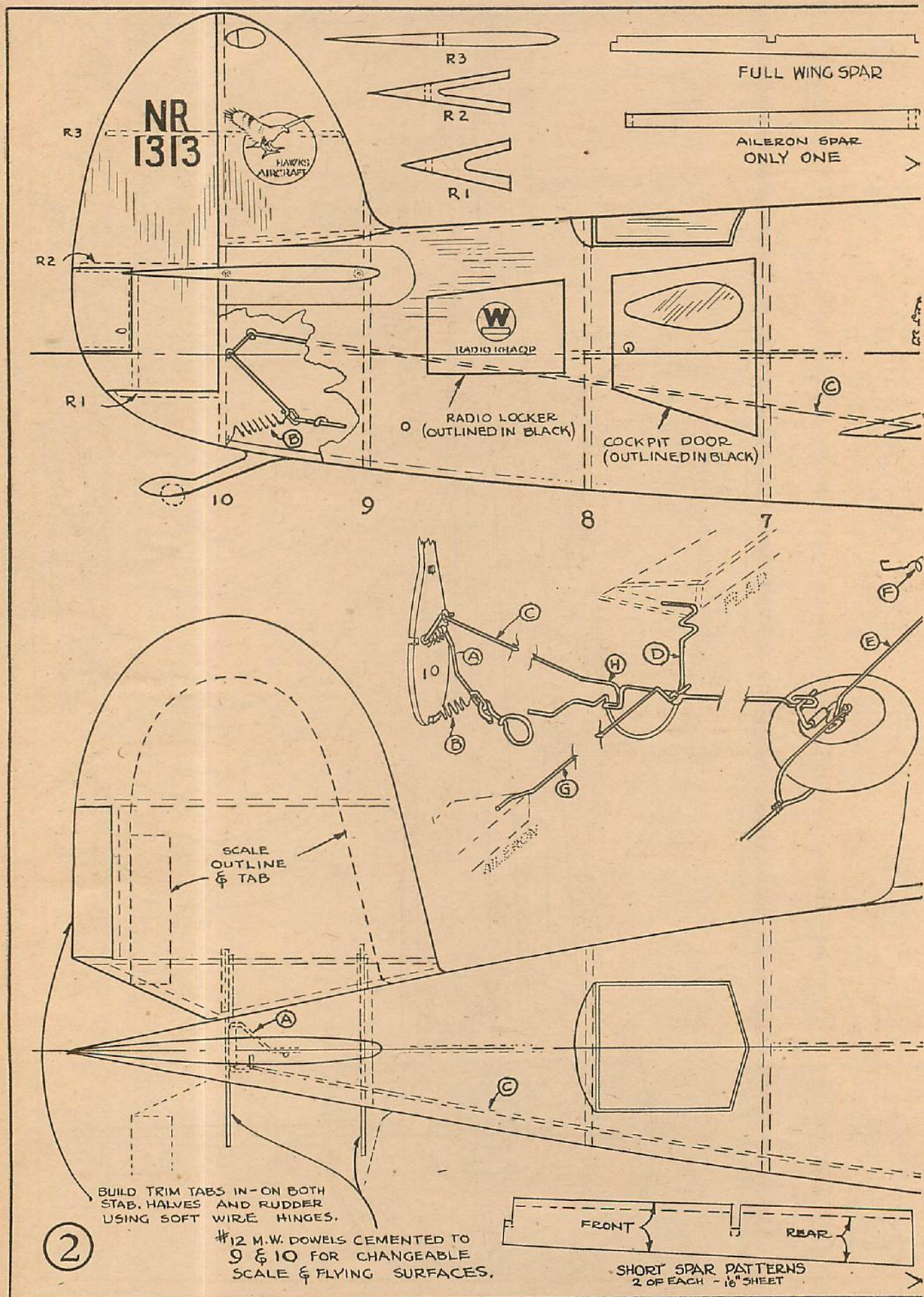
The tension of the motor being wound overcomes the tension of the spring B and the rear hook arm on A is drawn up in a horizontal position after the motor is about half wound; the crank on A is therefore drawn back, which pulls the control bar back about $\frac{1}{4}$ ". In this $\frac{1}{4}$ " movement the flap connecting wire D is caught by the reverse bend on the control bar, while the flaps are held up, and the control bar being directly connected to the aileron control G raises the aileron to its highest angle and holds the right wing down against the pull of the propeller torque, and lowers it as (Turn to page 94)

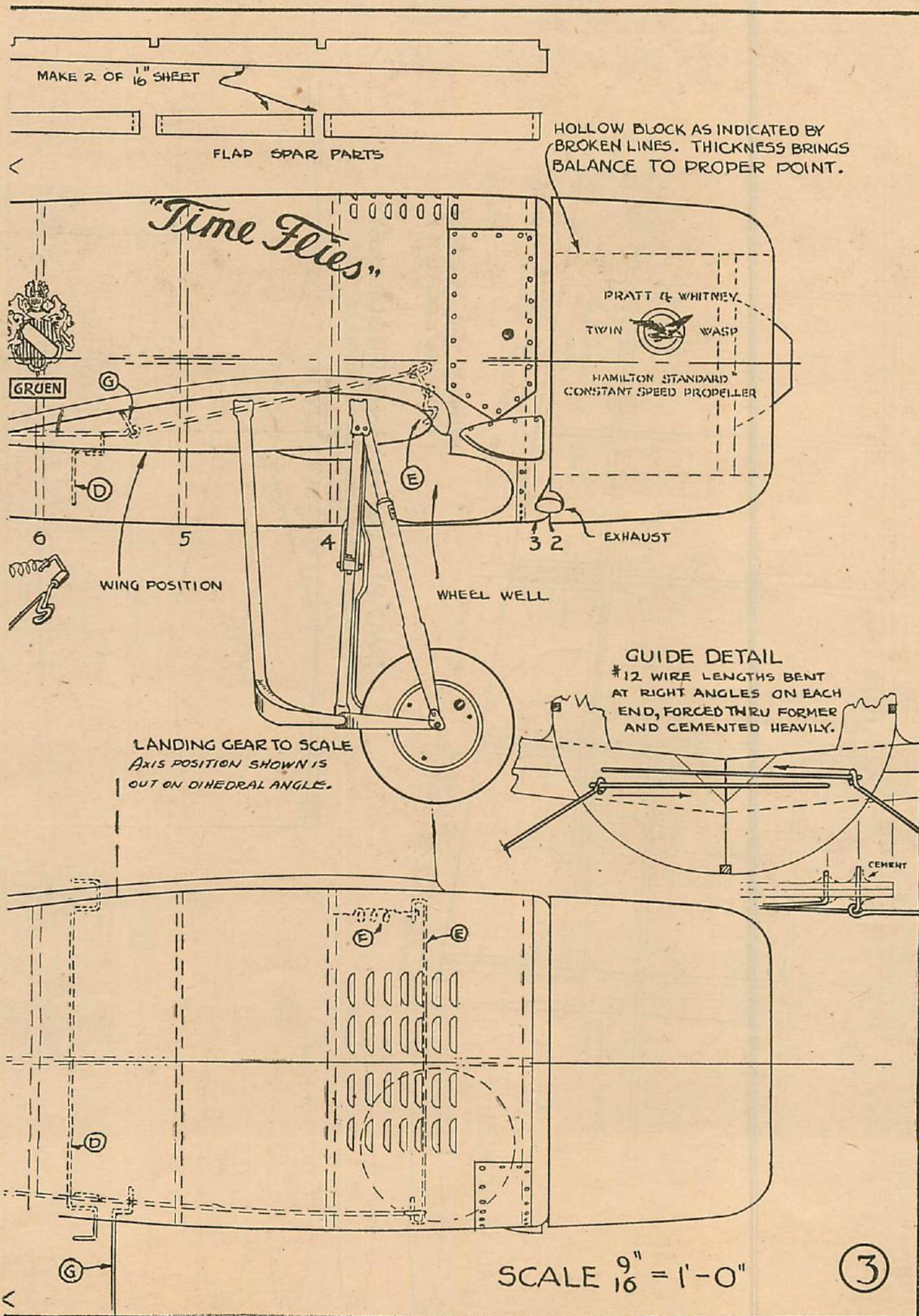
Performance, like size, is scaled down in this flying model, but it's all there.

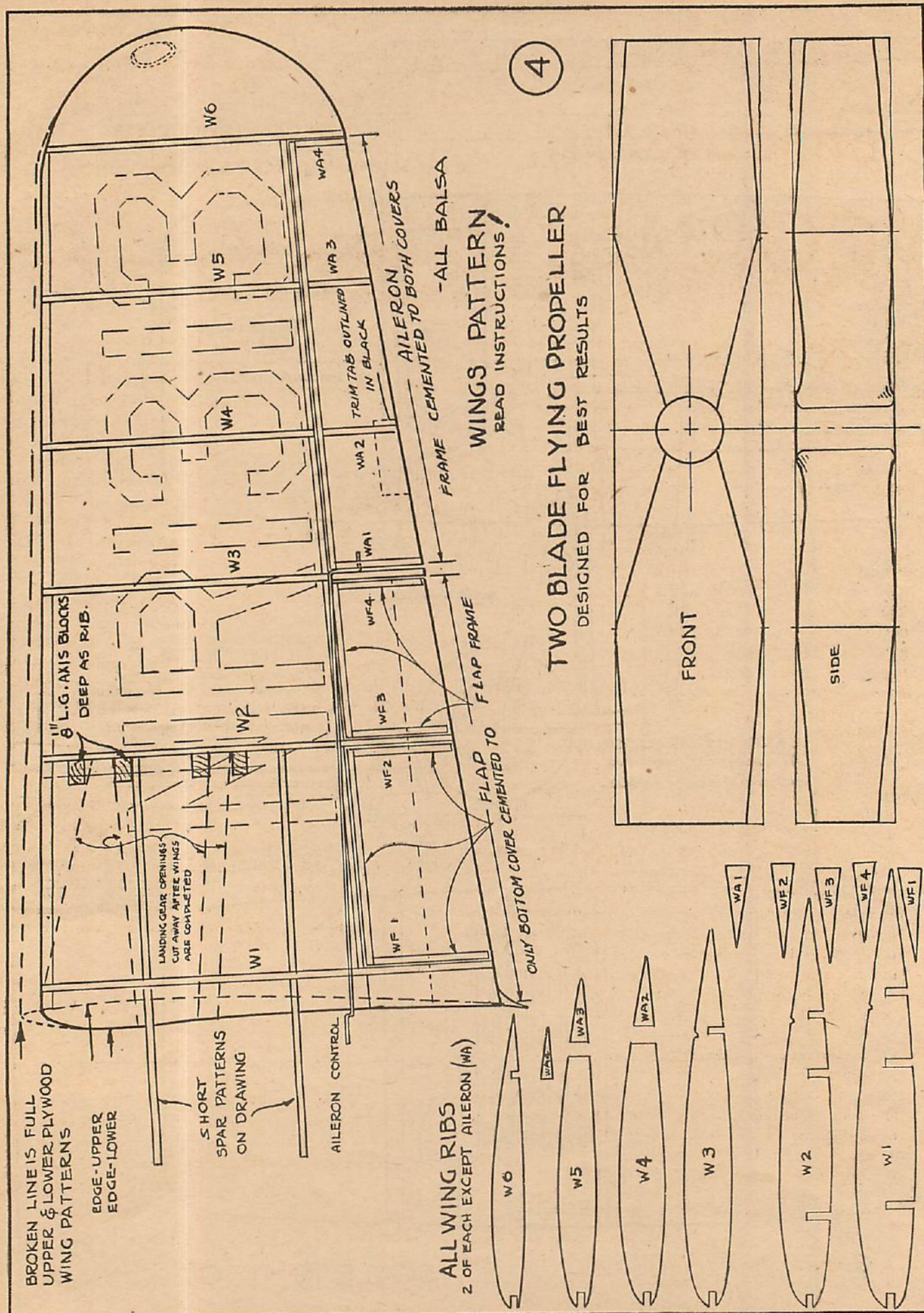
by Alan D. Booton











The Discussion CORNER

The model art progresses through exchange of ideas. The Discussion Corner is a monthly sounding board for your opinions. This month readers discuss gas rules. For March, the subject is streamlining. Other topics are listed below. Think about them, then write your opinion in 150 words or less and send it to The Discussion Corner. One dollar is paid for each answer printed.

THE ideal fuel allowance is $\frac{1}{16}$ ounce per pound. In an ordinary motor this is sufficient for about 2 minutes' run, which is plenty for a well-designed model. Minimum duration is the best way of measuring gas-model quality. However, this should be used with the $\frac{1}{16}$ -ounce rule. The virtues of the model are clearly demonstrated by its ability to soar after such a short motor run. Soaring 20 to 30 minutes after 2 minutes' power run proves that the model has something more than a good motor. Usually the model which is not properly designed will not even get off the ground for a minute's duration. The controlled flight idea should be used when flying area is limited by roads, buildings, etc., but it's well to remember that gusty air can ruin spot landings, and make three-point landings practically impossible.
—EDWARD MANULKIN, Philadelphia, Pa.

Gas used in a flying contest should depend on size and weight of the model. For example, a large, heavy model should have the benefit of higher gas-to-weight ratio than a lightweight model. This could be determined by a table of gas allotments drawn up before the contest. Maximum duration flying results in too many lost models, with damage to the builder's patience and pocketbook. Controllable flights are a comfort for builders, and both flying characteristics and appearance should count heavily in the awarding of prizes.—WALTER CARACIOLO, New York, N. Y.

I favor discarding present gas-model rules. The models built to get maximum efficiency with these rules are freaks; the recent 15-foot span $\frac{1}{8}$ h.p. job is an example. The timer idea would have fellows building ships only for maximum climb within the specified time. I have arrived at a formula of weight times horse power divided by wing area. Examples:

$$\frac{5 \times \frac{1}{8}}{7} = 1/7 \text{ oz. and, } \frac{5 \frac{1}{2} \times \frac{1}{8}}{15} = 1/16 \text{ oz.}$$

You can see that as soon as the wing loading or horse power decrease, less gas is allotted. My formula is not the best, but it might give some one a lead. Something must be done and I hope The Discussion Corner takes an active part in this argument.—CHESTER CHAPLASKIE, New York, N. Y.

This Month's Topic

How much gas should be allowed each model for contest flying? Or do you favor discarding the present idea of maximum duration and substituting controlled flight in which the model would be judged on ability to land near a designated spot plus flying characteristics and appearance?

It would be a great idea to drop maximum duration and substitute controlled flight. The plane should be required to take off, fly as close as possible, and land within a circle about 25 feet in diameter. By controlled flight we would reduce the luck element from favorable winds that so often prevails in duration contests. I don't mean that all contest winners have won just because they were lucky. They work mighty hard and deserve credit. But by limiting the flight to about five minutes, time is saved and more flights are possible. The best flight out of three should count.
—WARREN BARWELL, Washington, D. C.

I believe that present rules—providing a certain amount of gas according to weight—should be dropped. Models should be judged on ability to land in a circle of about 500 feet in diameter. In the present contest the winner usually wins by luck. Many times a heavy, well-built model is beaten by a flimsy model of no scientific value, because a light model can ride on the slightest breeze. Timers may be used. The present idea of radio-controlled models is also very good, but expensive. If all contests were held under changed rules, it would teach the entrants a lot about controlled flight.—BERNARD NATOV, San Francisco, Calif.

Gas-model winners should be determined by success of controlled flight. This will bring out the true quality of a well-built model and the careless, slipshod work of a poorly built job. Take-off, performance, and landing of the model will show the kind of work its builder is capable of doing. Models rated in this way will give the crowd more of a thrill by flying near the take-off spot, while models timed only for endurance in most cases lead the timers a wild chase over the surrounding country and eventually pass out of sight.—SHUNG LEE, New York, N. Y.

COMING UP are these topics:

For April—*What color combination is best on an all-weather outdoor model for greatest visibility?* Answers must reach us by February 1st.

For May—*Would adjustable-pitch propellers be of advantage in outdoor models? If so, how should the pitch vary?* Answers must reach us by March 1st.

Aerial Yacht

A solid model of the new stainless steel amphibian for the sportsman pilot.

by William Winter

SELECT a soft balsa block $6 \times 1\frac{1}{4} \times 1\frac{1}{8}$ " for the hull. On it draw the side view and cut away the excess wood. The top outline of the hull is then drawn on the top. Again shave away the surplus balsa. With a razor shape the semi-finished hull to the required cross sections given on the plan, and sand smooth. Force $\frac{3}{32}$ " round dowels through the block at the positions illustrated on the various views. The cavities for the retracing struts may be cut in with a pointed razor sliver.

Draw the tail patterns on $\frac{1}{8}$ " sheet balsa and cut out. Shape them to the required sections, sand the edges round and the surfaces smooth. To mount the fin, insert two headless pins in the block and force that part down on them, having applied cement to the joint. The stabilizer is cut in two halves, each of which is mounted in the same manner as the fin. Do not install thread bracing until painted.

FLEETWINGS SEA BIRD

section and sand. Drill small holes to receive the dowels and force the wing into position, using cement to make the fit permanent.

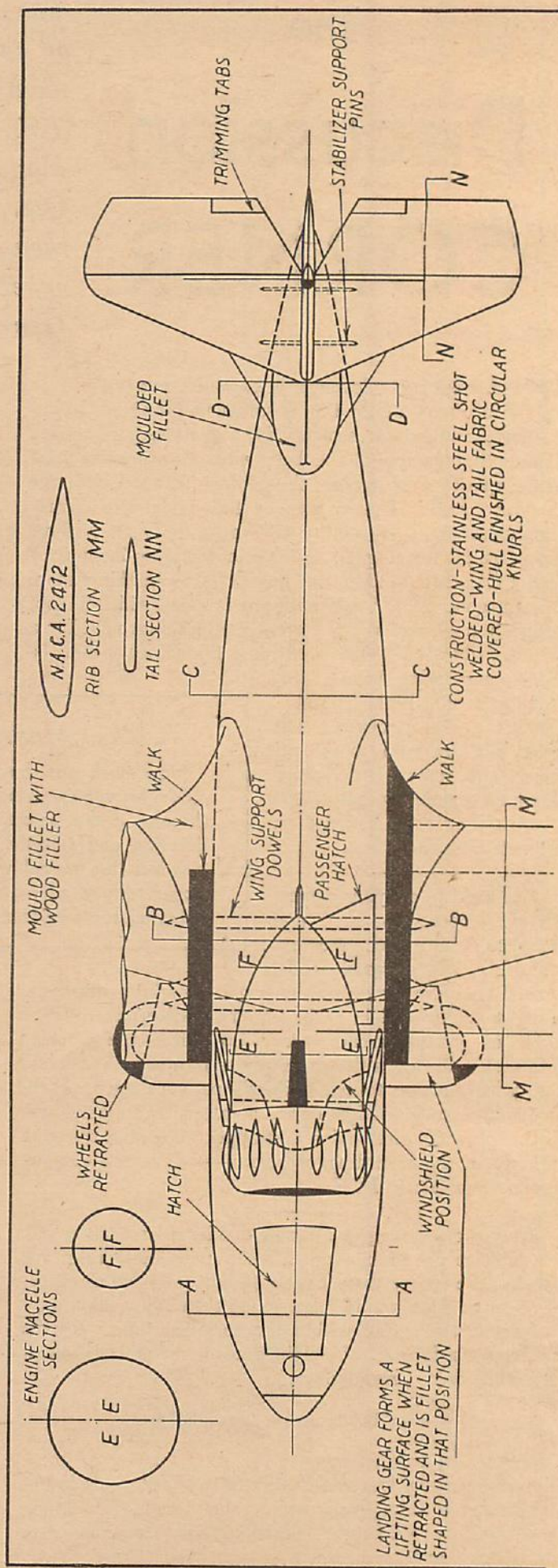
From a block 1" square, shape the engine nacelle in the same manner as the hull was done. The cowling is made integral in the same operation. Cut out the cowling face to receive small half-round cylinders, if desired. Mount the finished unit on round bamboo struts as shown on the plans.

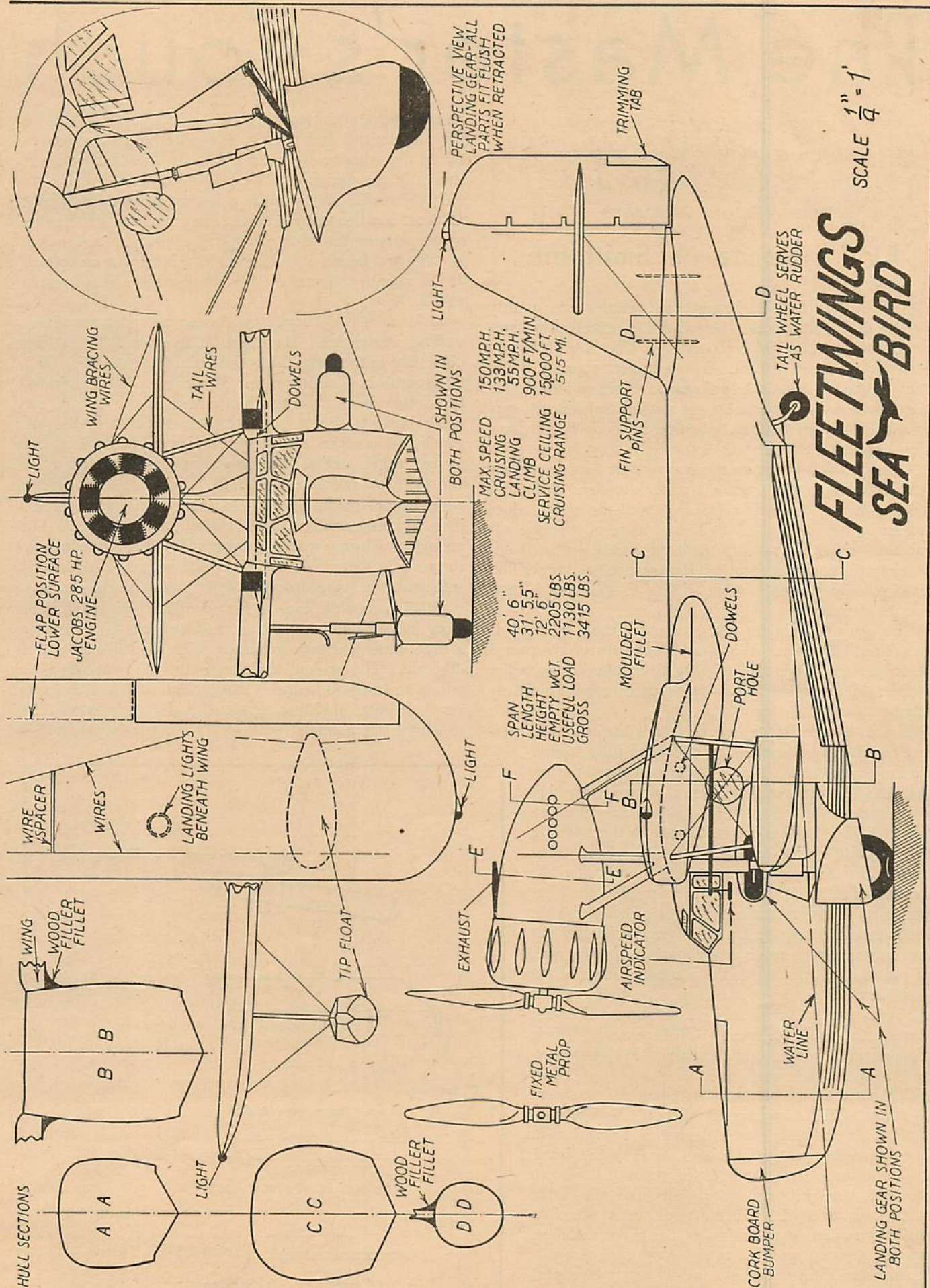
Mold the wing and fin fillets with wood filler or any similar substance.

Cut the tip floats to shape from $\frac{3}{8}$ " square stock, sand, and install on fine bamboo struts.

Carve the main landing-gear blocks from the remnants of the wing sheet. The remaining parts of this assembly are made from convenient scraps. Install the same in either the retracted or extended positions as desired.

Give the entire model a coat of white shellac or clear varnish to close the pores of the wood. For a high-grade finish, the model can be supported in various positions as the dried shellac or varnish finish is resanded, after which another coat may be given. (Turn to page 95)





The Master's Touch

It's the necessary link between a good indoor model and a good flight, and here's how to develop it.

by Lawrence N. Smithline

AT the last Lakehurst meet, a beginner was greatly disappointed in the way his excellently constructed model was flying. The model looked perfectly all right to him. To an expert near by, however, it needed certain adjustments. Two minutes after the expert got his hands on the model it pleasantly surprised the builder with a flight that anybody would have been proud to claim.

This situation is not an unusual one; it happens whenever a beginner has trouble with his model. Although the beginner often builds his ship well, he simply does not know how to fly it. It is by virtue of a single advantage—experience—that the expert can get such apparently phenomenal results. Experience has taught him what usually causes trouble, where to look for it, and how to correct it.

The greatest single annoyance to the beginner is "wash-out" trouble. Wash-out is the warping upward of the trailing edge of one wing to counteract propeller torque. Poor results may have their origin in many things.

The first case is the one in which the ship flies perfectly with only a few winds, but when fully wound climbs to about 20 feet, washes out, and dashes down. The most frequent cause is wing clips which slide around the motor stick. When the clips are free to slide, there is no resistance to the twisting moment of the wash-out and the wing will continue to stay in the washed-out condition to bring the model down. The cure for this is to bind the clips with silk, or else to make new clips of heavier wire. Another cause may be that the wing is washed out more than necessary to overcome the torque, and, of course, the proper cure is to remove some of the wash-out. Sometimes too deep a camber coupled with an already torsionally weak wing will cause wash-out at the high speeds of full power. This is rather rare, however, and is really a last-resort excuse for persistent wash-out.

The second case of wash-out trouble is wash-out in flight. This may happen when the model is 90 feet up and already has 10 minutes to its credit. There are three possible causes for it: weak wing, tail, or boom. Sometimes, if the seam of the boom opens, it loses its torsional rigidity and allows the tail to twist around. When a weak model flies into a slight, sudden gust, either of the three members may be twisted and the model may dive down.

Another disturbing flight incident may be a persistent diving tendency. The sensible thing to do when a model dives is to see if it has enough lift.

If not, move the wing forward. If the lift is all right, line up the tail and wing. The difference in angle between the wing and the tail should be less than 180° , as shown in the drawing.

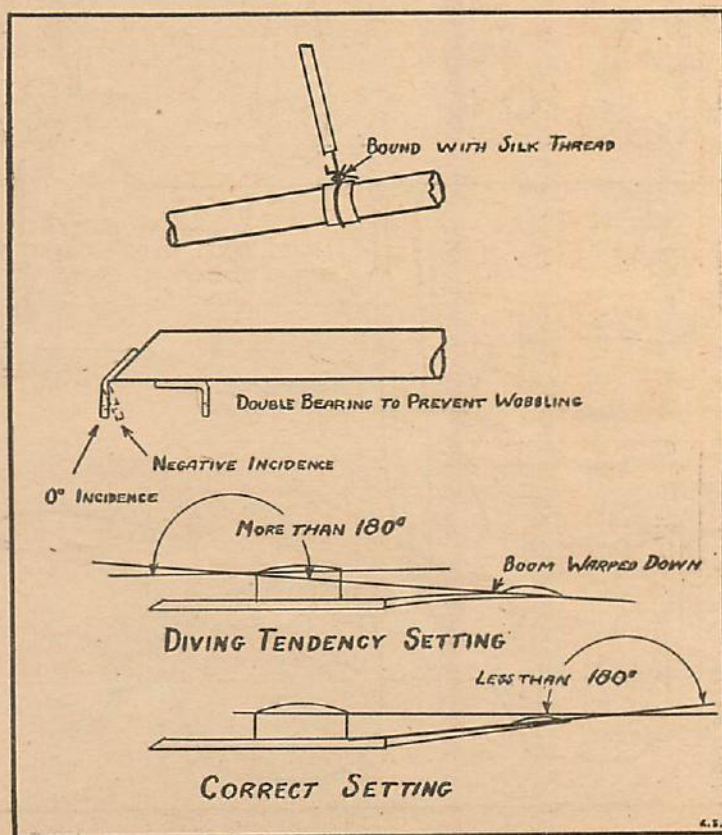
If the model flies well on a few turns, but has diving tendencies when fully wound, five times out of ten this trouble can be traced to a weak fuselage. If the fuselage is weak and bends, it puts a positive incidence on the tail and a negative thrust on the prop, which will dive the model.

In contrast to diving tendencies, a model may have stalling tendencies. Exclusive of too much lift (which obviously is the first thing the builder should look for) this condition is rather rare. There are two other possible causes for it: too much negative in the tail, or too much positive thrust. The excess negative in the tail can be reduced by removing and recementing it at the proper angle. How the thrust line should be adjusted will be explained later in detail.

An indoor model never looks more helpless than when it is skidding. The usual cause for skidding is not enough wash-in (warping upward of leading edge) in the torque wing. When the torque wing wash-in is insufficient, the wing droops and the model skids.

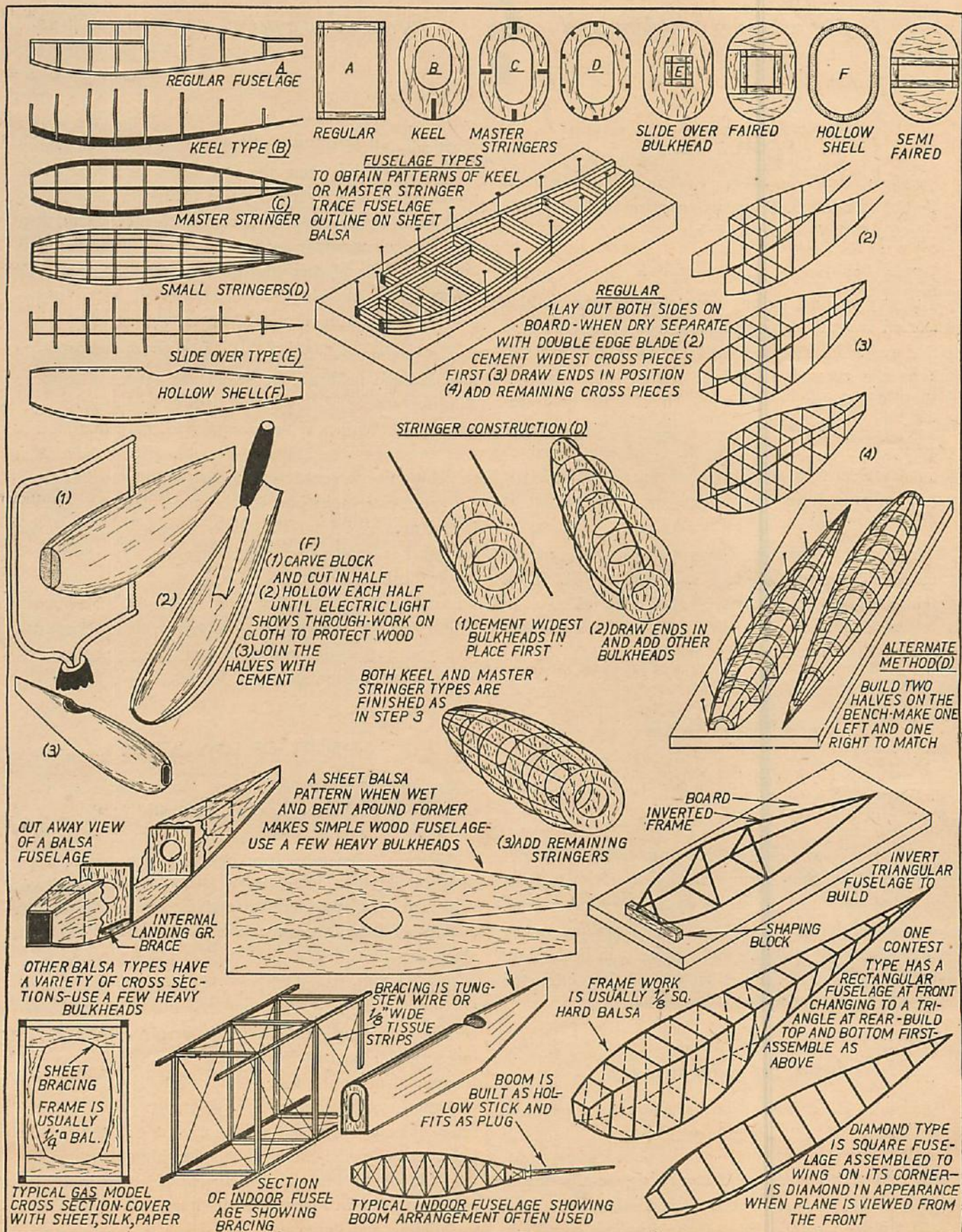
Other probable causes for skidding are insufficient wing dihedral and insufficient rudder area. If you have a high wing you may get away with a small amount of dihedral. The present tendency is toward relatively high wings and little dihedral. Insufficient rudder area gives very definite skidding tendencies in maneuvers due to gusts. If a model with

(Turn to page 93)



Builder's Guide

Fuselages
by William Winter



Have you a question on model building or flying that bothers you? Bring us your problem and



we'll answer it in the interest of readers everywhere. Replies by mail require return postage.

MODEL TYPES

Question: Will you please explain the abbreviation R. O. G.? Do R. O. G. models require landing gears? W. H. D., Grand Rapids, Mich.

Answer: R. O. G. means Rise Off Ground, and is a short way to refer to any type of model that is able to take off from the ground unassisted. Thus this type would have to be equipped with a landing gear and tail skid, as the take-off should be accomplished from a standstill without any assistance. H. L. is the abbreviation for Hand Launched, and designates such models as twin pushers, tractors, and other stick models which do not have landing gears. When the R. O. G. type model operates from the water, the abbreviation is changed to R. O. W.—Rise Off Water.

You should remember, however, that the type of model with a built-up fuselage is not always R. O. G. The built-up fuselage may resemble that of a cabin fuselage model, but until the wheels are added, it qualifies only as a hand-launched stick model.

GAS-MODEL PLANS

Question: Is there any book available with instructions and plans for building gas models? M. R., Mexico City, Mexico.

Answer: Gas-model plans and instructions have not yet appeared in book form. Design and construction methods of gas models change so quickly that a book is soon out of date. This rather discourages any author from collecting the material and editing it in book form. Magazine plans and articles on gas models offer the most reliable and up-to-date information.

CENTER OF LATERAL AREA

Question: What is the center of lateral area, and how is it found? W. F., Waterbury, Conn.

Answer: Lateral area of a model is generally understood to mean the surface seen from a side view. That is, the rudder and the side of the fuselage contribute

practically all of the lateral area. The center of lateral area is the point along the fuselage where there is as much lateral area to the front as to the rear. Locating it is done by first taking a reasonable guess and then checking the accuracy by measuring the areas forward and rearward and checking them against each other. A rough approximation of its location is all that is necessary in considering center of lateral area.

The fundamental requirement for the center-of-lateral-area location is that it be behind the center of gravity. The importance of this is not hard to realize. Imagine what would happen if the reverse was true; that is, if it was forward of the center of gravity. If the model was struck by a side gust it would turn away from the wind and eventually spin into the ground. If the center of lateral area is behind the center of gravity, the model has what is known as weather-vane stability—that is, it automatically noses into the side gust. This is necessary for stable flight. Making the fuselage of reasonable length, plus an ample-sized rudder, will be certain to give you a desirable center-of-lateral-area location and ample weather-vane stability.

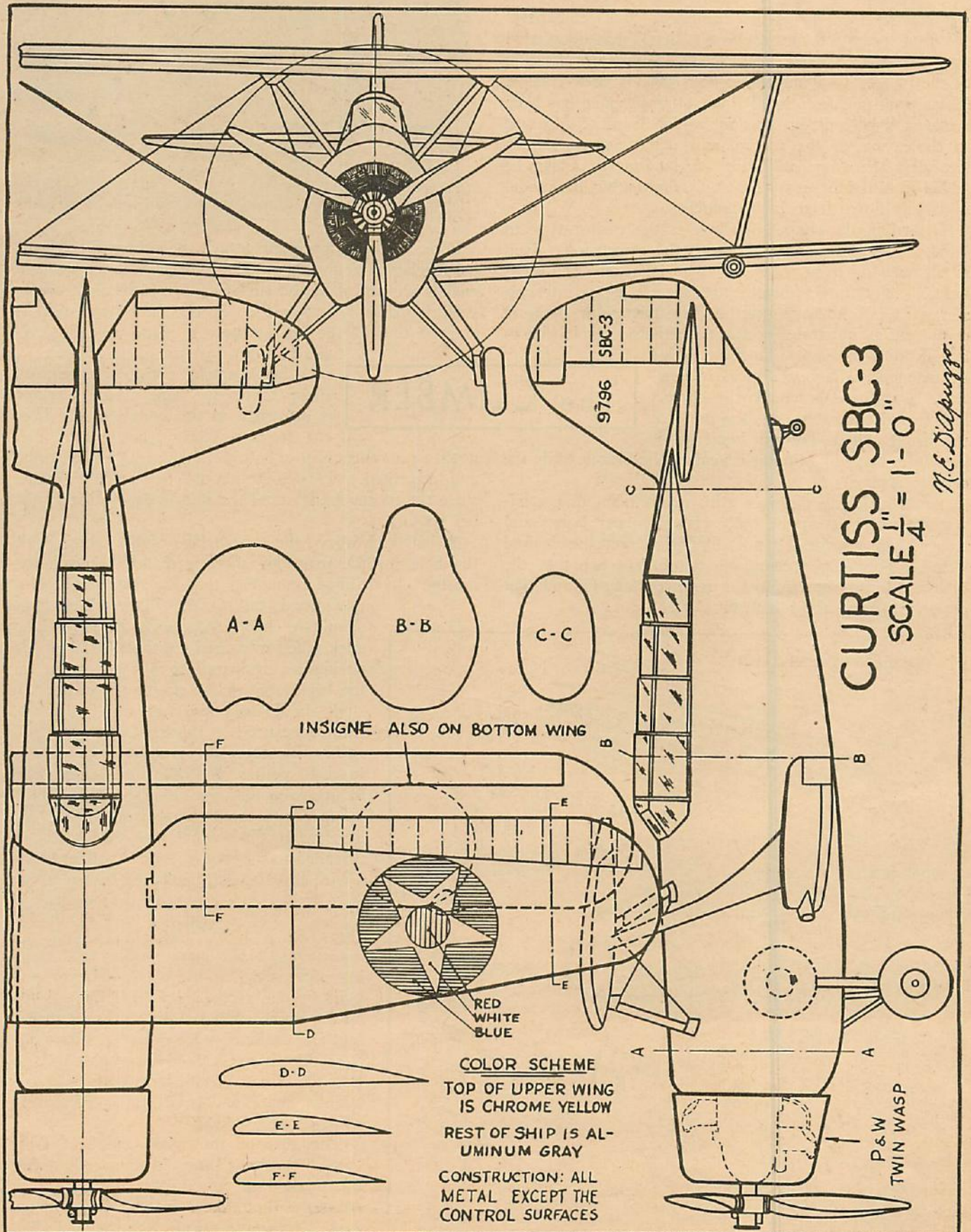
STABILITY OF LOW WINGS

Question: Which are more stable—high- or low-winged models? B. W., Crossfield, Alberta.

Answer: Generally speaking, high-wing models are more stable than low-wing models. However, a low wing can be given excellent stability by increasing the amount of dihedral; some fine models have been built along this line.

Poor stability should never discourage any one from building low-wing models, but it is unlikely they'll ever become very popular because it involves considerably more trouble to attach the wing to the bottom of the fuselage than to the top. If the wing is made to fare into the fuselage, then it is usually secured so that it is impossible to move the wing forward or backward to balance the model as is done with high-wing models. Thus it might be said the increased stability of the high wing ties in nicely with its increased conveniences in building and flying.

Navy Scout Bomber



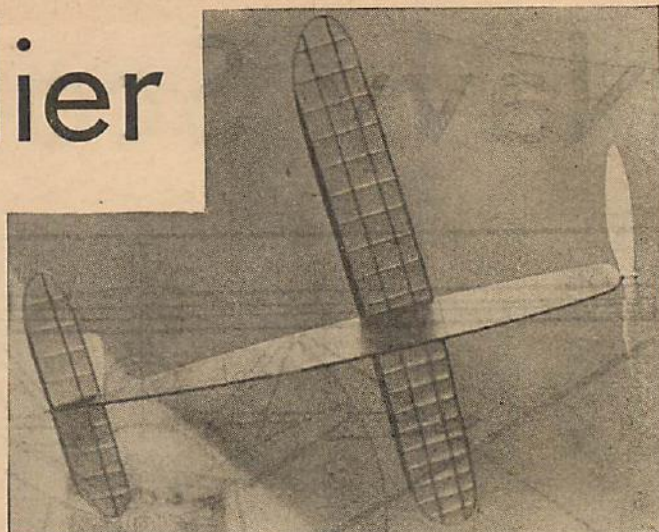
*Altitude yields
long glides for
contests with a*

High Flier

THIS month's contest model has the easy-to-build qualities that appeal to beginners, and yet experts find its type to be so efficient that it has dominated the three last national meets. The contest classification of this model is a hand-launched class B stick tractor. However, the conventional single-stick fuselage has been replaced by a built-up fuselage which is more resistant to the strain of the motor, and more convenient for attaching the wing and tail. A landing gear can be added if you want to try R. O. G. flights, but the model is usually flown from hand launches.

The triangular-shaped fuselage is the easiest type to build. The top panel is built to the dimensions given in the drawing from $\frac{3}{32} \times \frac{3}{32}$ " balsa longerons and cross braces. The fifteen braces are spaced at 2" intervals along the 30" fuselage length. The triangular shape is completed as illustrated. The top panel is pinned flat to a board and the bottom longeron added by fitting the diagonal braces in position. Cut these braces to the correct length and cement them, beginning at the front. The bottom longeron is bent into shape by pinning it against the braces while the cement is drying.

You'll probably discover with much relief that a triangular fuselage can be built without queer twists and warped curves, for it's not difficult to get the desired shape. The only precautions to observe are that the diagonal braces be cut to the required lengths and that opposite braces are identical.



Some modelers prefer to attach the rubber directly to the fuselage, but for this model as well as large fuselage models we find a motor stick is more convenient. The stick is balsa $\frac{5}{16} \times \frac{3}{8} \times 25$ ". Notice how the stick is tapered toward the rear, where a piano-wire hook is attached for fastening the rubber.

The CLIMBER

A balsa nosing cut to a triangular shape to fit the front of the fuselage is cemented to the motor stick. It is cut from a block $\frac{1}{2} \times 1\frac{1}{4} \times 1\frac{3}{4}$ ". A

notch is cut through the bottom and the stick is inserted and cemented. This joint should be carefully made, since the nosing must stand the pull of an 8-strand rubber motor.

A half inch above the top surface of the motor stick the hole for the propeller shaft is drilled through the nosing. In drilling, remember that the shaft must point downward and to the right. The shaft should be only $\frac{7}{16}$ " above the top of the stick when measured from the front of the nosing as compared to $\frac{1}{2}$ " measured on the back edge of the nosing; likewise, the shaft should be pointed about $\frac{1}{16}$ " to the right, measured on the front of the nosing.

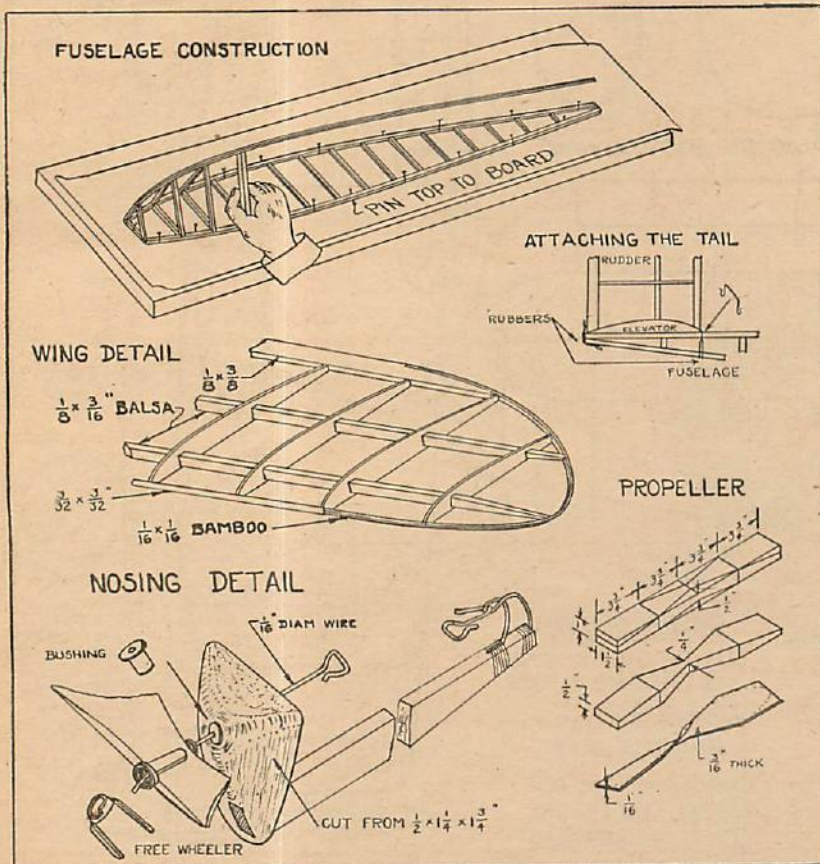
The motor stick is secured inside the fuselage with a wire clip at the rear and by grooving the edges of front nosing so it "plugs" into the fuselage front about $\frac{1}{8}$ ". The wire clip, which is cemented and threaded to the motor stick, fits underneath a wire clip fastened inside the fuselage.

WING

Generous-sized spars, leading and trailing edges make a solid wing. The wing is built in one piece. The ribs are slipped on the spars, spaced as shown in the drawing, and fastened with cement. The leading edge is $\frac{3}{32} \times \frac{3}{32}$ ", inserted edgewise into the ribs. The trailing edge is of triangular shape and is cut and sanded from a balsa piece $\frac{1}{8} \times \frac{3}{8}$ ".

The tips of the wing are bent from $\frac{1}{16} \times \frac{1}{16}$ " bamboo; their shape, together with the method of joining them to the wing structure, should be clear from the drawing.

A 2" center portion of the wing is flat,



while each tip is raised $3\frac{1}{2}$ ". In raising the tips, the balsa spars and leading and trailing edges are broken into shape and then cemented.

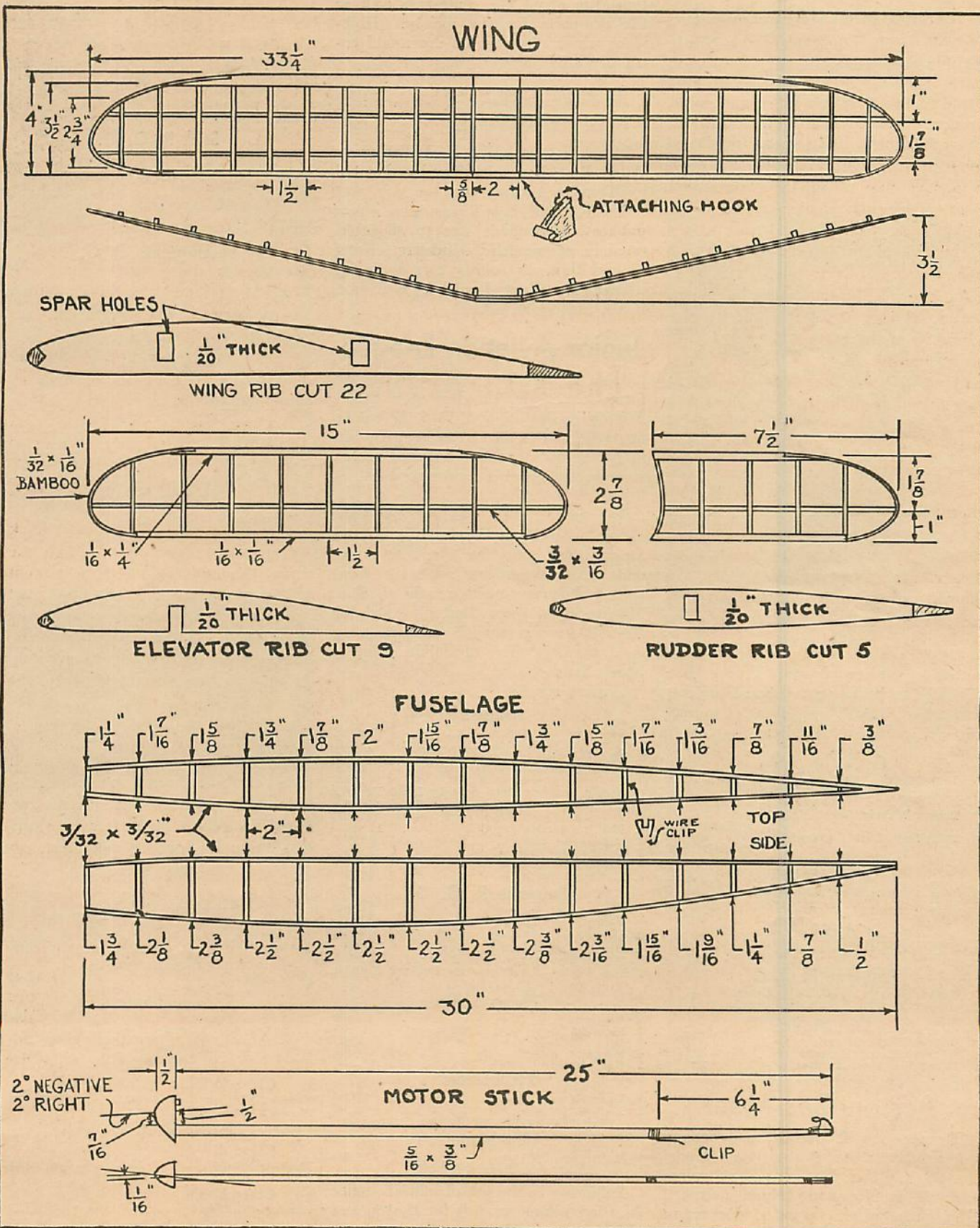
TAIL

Elevator construction is practically the same as the wing, except that there is only one spar. The rudder is half the elevator; the only difference is in the rib

shape. Special care should be taken to make sure the bottom rudder rib is curved so it fits over the top of the elevator rib. (After covering, the rudder is cemented rigidly atop the center of the elevator.)

PROPELLER

Much of the success of this model depends on the skill you show in carving the large propeller. (Turn to page 93)



Flight records
and contestants
in competitions.

Model Matters

Club notes and
news of model
organizations.

(In contest tabulations, results are to be read as minutes (to left of colon), seconds, and fractions.)

Ft. Lauderdale Meet

While chill winds blew up North, Florida opened her winter model season with the usual balmy weather at Fort Lauderdale's first annual model meet, held at Merle Fogg Municipal Airport, Nov. 28. AIR TRAILS was privileged to help in the arrangements, and subscriptions were among the prizes that



Harry Gilbert with the gas job that placed second at Ft. Lauderdale's first annual meet.

went to the place winners. Trevor Morris of Palm Beach proved to be the star contestant, taking two firsts, two seconds, and a third. Results:

Exhibition Scale

1. John Harrison, Miami Page navy racer
2. Albert Shultz, West Palm Beach Curtiss export Goshawk
3. Trevor Morris, West Palm Beach Monocoupe
4. John Day, Fort Lauderdale Stinson Reliant

Stick Models

1. Dick Combes, Fort Lauderdale
2. Bill Booth, Fort Lauderdale

Fuselage H. L.

1. Trevor Morris, West Palm Beach
2. Trevor Morris, West Palm Beach

Fuselage R. O. G.

1. Trevor Morris, West Palm Beach
2. Trevor Morris, West Palm Beach

Gas Models

1. Robert Hock, Miami 5:10
2. Harry Gilbert, Miami 3:14.4
3. Ernst Kolakowski, Miami 2:45.8
4. F. Mudd and H. McClain, Miami 1:21.8

Boston Gas Meet

Despite a stiff breeze and freezing temperatures, the Boston Gas Model Society held their first contest Saturday, Oct. 24 at Norwood (Mass.) airport. The gusty wind accounted for many crack-ups, but everybody seemed en-

thusiastic about the contest as well as the prospects for the society. High-place winners among the dozen-odd entrants were:

1. Marchi (Hurleman engine) 2:40
2. Phillips (Tluth engine) :22
3. Shea (Brown engine) :17.5
4. Cedrone (Brown engine) :14

Marchi was awarded the Will Rogers-Wiley Post Memorial Trophy donated by Tommy Atkins.

The B. G. M. S. will soon issue a new publication available free to all interested in gas models. Modelers seeking to join this new society can do so by writing to Albert Lewis, 7 Kenneson Road, Somerville, Mass.

Junior Aviation League

J. A. L. members turned out in full force Nov. 7 at the Irvington Street Armory in Boston, and when the smoke of battle had cleared away, two Boston indoor records and one national record were broken, and a new record established.

The new record was set by Paul Durup with his helicopter. It buzzed around the armory for 1 minute 4 seconds. Arthur Sampson set a new local class A glider mark with a flight of :30.8. Morris Sulkin's new Boston record for class C fuselage models is 6:04—very good time, in view of Sulkin being a junior builder.

Contest results:

Gliders

1. Sampson (jr.) class A * :30.8
2. Capo (sr.) class B :29.7
3. Marchi (open) class A :29.6
4. Oringer (sr.) class B :28.1
5. Phillips (sr.) class A :25.2

(*Equals Boston record held by Louis Young)

Stick H. L.

1. Phillips (sr.) class C 11:35
2. Capo (sr.) class C 7:38.4
3. Tyler (sr.) class C 7:33
4. Pappas (sr.) class B 6:52
5. R. Brown class B 6:25

Fuselage R. O. G.

1. Capo (sr.) class C 6:47
2. Sulkin (jr.) class C *6:04
3. Tyler (sr.) class C 5:07.4
4. Durup (sr.) class B 4:03
5. Wallerstein (sr.) class B 3:47

(*New Boston record; formerly Jack Golden, 3:25)

Flying Scale

1. Sampson :39
2. McLean :37
3. Elbefeld :37
4. Sherman :34
5. Robinson :22

Helicopters

1. Durup (sr.) *1:04
2. Marchi (sr.) :07

(*New national and Boston record)

Ornithopters

1. R. Brown (jr.) * :06

(*New Boston record)

Following is the list of official Junior Aviation League records for Boston and vicinity:

INDOORS

Stick H. L.

- Class B
Senior: Tyler 14:24.5
Junior: Durup 10:31.8

- Class C
Senior: Phillips 14:38.4
Junior: Bergman 9:43

Stick R. O. G.

- Class A
Senior: Marchi 9:12.2
Junior: Phillips 6:39.4

- Class B
Senior: Capo 12:02
Junior: Golden 8:10

Fuselage R. O. G.

- Class B
Senior: Cline 9:08
Junior: Phillips 5:12.6

- Class C
Senior: Stuart 8:09
Junior: Sulkin 6:04

Gliders

- Class A
Senior: Tasker :32
Junior: Young :30.8
Sampson :30.8

- Class B
Senior: Marchi :42.2
Junior: Young :27
Open: Marchi :30.6

Stick R. O. W.

- Class A
Senior: Pappas 1:10

- Class B
Senior: Phillips 2:35.5



Four exhibition scale contestants, in winning order from right to left: John Harrison, Albert Shultz, Trevor Morris, displaying his favorite magazine, and John Day.

Fuselage R. O. W.

- Class B
Senior: Marchi 3:11

- Helicopters
Senior: Durup 1:04

- Ornithopters
Junior: R. Brown :06

OUTDOORS

Stick H. L.

- Class D
Senior: Phillips 11:48
Junior: Wallerstein 3:33

Fuselage R. O. G.

- Class C
Senior: Shea 8:10.2
Junior: Sulkin 6:56

- Class D
Senior: Wallerstein 4:17

(Turn to page 95)

OFFICIAL MODEL RECORDS

APPROVED BY THE CONTEST BOARD OF THE N. A. A. THROUGH SEPT. 30, 1936

NOTE: Marks indicate following—*New record since listing of May 30, 1936 (published in AIR TRAILS, August, 1936).
†Bettered the record listed for this category as of May 30, but was later bettered by the performance indicated by *.

(Age divisions: Junior, to 16 years; Senior, 16 to 21; Open, over 21)

INDOORS

STICK MODELS, HAND-LAUNCHED

CLASS B			
*Junior: John S. Stokes, Jr.	Huntington Valley, Pa.	18m	12.2s
Senior: Wilbur F. Tyler	Boston, Mass.	20m	50.1s
†Open: Gordon Johnstone	Detroit, Mich.	16m	23s
*Open: Ernest A. Walen	Springfield, Mass.	18m	46.5s

CLASS C			
Junior: John S. Stokes, Jr.	Huntington Valley, Pa.	20m	53s
*Senior: Robert Jacobsen	Philadelphia, Pa.	25m	29s
Open: Carl Goldberg	Chicago, Ill.	23m	29.3s

STICK MODELS, R. O. G.

CLASS A			
Junior: William Wert	Philadelphia, Pa.	10m	26.4s
†Senior: Ervin Leshner	Philadelphia, Pa.	11m	50.8s
*Senior: Ervin Leshner	Philadelphia, Pa.	15m	47.4s
Open: Joseph Matulis	Chicago, Ill.	9m	59s

CLASS B			
*Junior: John S. Stokes, Jr.	Huntington Valley, Pa.	17m	19.3s
*Senior: Hyman Oslick	Philadelphia, Pa.	17m	03.8s
*Open: Ernest A. Walen	Springfield, Mass.	17m	42.8s

AUTOGIROS

Junior: Raymond Steinbacher	Ridgefield, N. J.	57.2s
Senior: Alton H. DuFlon, Jr.	Ridgefield, N. J.	2m 01.2s
Open: No record established		

ORNITHOPTERS (LAUNCHING OPTIONAL)

NO CLASSES FOR SIZE
Junior, Senior, Open: No records established

HELICOPTERS (LAUNCHING OPTIONAL)

NO CLASSES FOR SIZE
Junior, Senior, Open: No records established

(Indoor classifications: Class A, wing area up to 30 sq. in.; B, 30-100; C, 100-150)

GLIDERS, HAND-LAUNCHED

CLASS A		
Junior: M. Hugelot	Chicago, Ill.	34.6s
Senior: Wallace Simmers	New Lenox, Ill.	43.6s
Open: Joseph Matulis	Chicago, Ill.	38.8s

CLASS B		
Junior: Robert Gelbard	Chicago, Ill.	49.2s
Senior: Wallace Simmers	New Lenox, Ill.	58.4s
Open: Carl Goldberg	Chicago, Ill.	47.5s

STICK MODELS, R. O. W.

CLASS A			
Junior: William Wert	Philadelphia, Pa.	7m	19.4s
*Senior: Colman Zola	Brooklyn, N. Y.	7m	41.1s
Open: Georgevin Becksted	Chicago, Ill.	5m	38.2s

CLASS B			
Junior: William Wert	Philadelphia, Pa.	9m	27.6s
Senior: Mayhew Webster	Philadelphia, Pa.	11m	55s
Open: William Latour	Philadelphia, Pa.	13m	15s

CABIN FUSELAGE MODELS, R. O. G.

CLASS B			
*Junior: John S. Stokes, Jr.	Huntington Valley, Pa.	14m	15.3s
Senior: Charles Heintz	Philadelphia, Pa.	13m	12.2s
Open: Georgevin Becksted	Chicago, Ill.	11m	26s

CLASS C			
Junior: John S. Stokes, Jr.	Huntington Valley, Pa.	15m	05.6s
Senior: John Haw	Philadelphia, Pa.	17m	14.8s
Open: William Latour	Philadelphia, Pa.	12m	31.8s

CABIN FUSELAGE MODELS, R. O. W.

CLASS B			
Junior: John S. Stokes, Jr.	Huntington Valley, Pa.	3m	23s
Senior: Sidney Axelrod	Chicago, Ill.	6m	32.2s
Open: William Latour	Philadelphia, Pa.	5m	42s

OUTDOORS

STICK MODELS, HAND-LAUNCHED

CLASS C			
Junior: Junior Dague	Tulsa, Okla.	21m	04s
Senior: Harry Cornish	Denver, Col.	61m	09s
Open: Joseph Frady	Tulsa, Okla.	27m	07s

CLASS D			
Junior: Fred Skafec	Akron, O.	8m	21.6s
Senior: Daniel Clini	Springfield, Mass.	38m	50s
*Open: Chester Lanzo	Cleveland, O.	18m	10s

STICK MODELS, R. O. W.

CLASS C			
Junior, Open: No records established			
*Senior: Larry Low	New York, N. Y.	2m	00s

CLASS D			
Junior, Open: No records established			
*Senior: Larry Low	New York, N. Y.	tie	{ 1m 12s
*Senior: Malcolm Abzug	New York, N. Y.		{ 1m 12s

GLIDERS, HAND-LAUNCHED

CLASS B			
<i>Junior:</i>	Walter Weitner	New York, N. Y.	46.5s
<i>*Senior:</i>	Harry D. Soper, Jr.	Rockford, Ill.	2m 52s
<i>*Open:</i>	Willis C. Brown	Arlington, Mass.	33.1s

CLASS C			
*Junior:	Horace Smith	Jacksonville, Fla.	36s
*Senior:	Colin Edwards	Oswego, N. Y.	6m 30.4s
Open:	James McPheat, Jr.	New York, N. Y.	31.5s

CLASS D		
Junior, Open: No records established		
*Senior: Edward L. Smith	Jacksonville, Fla.	38s

AUTOGIROS (LAUNCHING OPTIONAL)

NO CLASSES FOR SIZE
Junior, Open: No records established
Senior: Ralph Kummer St. Louis, Mo. 2m 06s

HELICOPTERS (LAUNCHING OPTIONAL)

NO CLASSES FOR SIZE
Junior, Senior, Open: No records established

(Outdoor classifications: Class B, wing area, 30-100 sq. in.; C, 100-150; D, 150-200; E, over 200)

GLIDERS, TOW-LAUNCHED

CLASS C			
*Junior: Ralph Brown	Arlington, Mass.	9m	32s
Senior: Bob File	Columbus, O.	23m	13s
*Open: Everett Tasker	Boston, Mass.	4m	25s

CLASS D		
Junior: Paul Durup	Boston, Mass.	57.8s
Senior: Dick Everett	Elm Grove, W. Va.	2m 38s
Open: Roland Buhrig	Canastota, N. Y.	1m 18s

CLASS E			
Junior, Open: No records established			
Senior: Jack Smith	Dayton, O.	1m	23.4s

CABIN FUSELAGE MODELS, R. O. G.

CLASS C			
Junior: Fred Smith	Denver, Col.	27m	40s
Senior: Robert Cahill	Indianapolis, Ind.	33m	00s
Open: Georgevin Becksted	Chicago, Ill.	39m	30s

CLASS D			
*Junior: Arthur Koslow	Philadelphia, Pa.	9m	47s
Senior: William Ying	New York, N. Y.	41m	19s
†Open: Roy Wriston	Tulsa, Okla.	41m	10s
*Open: Chester Lanzo	Cleveland, O.	48m	45s

CLASS E (GASOLINE ENGINE)			
Senior: Joseph Kovel	New York, N. Y.	64m	40s
†Open: Michael Kostich	Akron, O.	36m	52.2s
*Open: Don Spaulding	Denver, Col.	63m	07.4s

CABIN FUSELAGE MODELS, R. O. W.

CLASS C			
Junior, Open: No records established			
*Senior: Alan Orthoff	New York, N. Y.	1m	07s

CLASS D			
Junior, Open: No records established			
*Senior: Louis Milowitz	New York, N. Y.	1m	14.3s

ORNITHOPTERS (LAUNCHING OPTIONAL)

NO CLASSES FOR SIZE
Junior, Senior, Open: No records established

THE RING OF DEATH

(Continued from page 14)

MY DEAR BARNES: This is the only warning you will receive. If you survive this you will be fortunate. Don't take on an undertaking that will be presented to you under the plea of humanitarianism.

THE DEATH RING.

Bill crumpled the death note in his hand.

"What is it, Bill?" Sandy asked, his eyes wide, a worried frown creasing his forehead.

"It's nothing, kid," Bill said. "A letter from a crank. He tells me to mind my own business. You know, we get lots of those."

"You're sure it's nothing, Bill?" Sandy insisted.

"No!" Bill snapped at him. "Now get out of here. I have work to do."

"I wanted to tell you more about my idea," Sandy said.

"Scram!" Bill said, and pointed to the door.

When it closed behind Sandy, Bill straightened out the note he held in his hand and studied it for a moment, turning it from side to side. He noticed that little specks, tiny specks that were almost too small for the naked eye to perceive, studded the heavy paper. He ran his fingers over the surface. The paper was smooth. The little specks glistened like infinitesimal specks of quartz embedded in limestone.

After a moment he stood up and crushed the thing in his hand again. Then he threw it in the wastebasket so hard it bounced out and rolled across the floor. He picked it up and dropped it in this time.

He went back to his drafting board and climbed on his stool. He tried to concentrate on the design before him. But his mind kept wandering away.

"That's the trouble with you," he growled to himself. "A little thing like that letter bobs up and you begin to fret."

But deep down in his heart he knew why he was fretting. He was fretting because that letter wasn't like the usual crank letter.

He threw his pencil on his desk and began pacing the room. The more he paced, the more nervous he became. Then he knew there was only one thing for him to do—get in the air where he would lose his nervous tension. Take the Lancer into the air where he could think.

He opened a closet door and pulled out a white flying overall, kicked off the slippers that were on his feet and reached for some flying boots. He was muttering to himself as he threw open his door.

Then he stopped. One of the tele-

phones on his desk began to ring. And there was something about the sound that sent cold shivers up his back. He went back, lifted the receiver off the hook and spoke into the mouthpiece.

"It's Bev, Bill," Beverly Bates, one of Bill's crack fliers, said in his precise Harvard way of speaking. "I've got to talk to you, Bill. Will you be in your rooms for a few minutes?"

It wasn't what Bev Bates said, but the way he said it that made Bill's stomach turn over. He waited a second while he steadied his voice before he answered.

"Surest thing you know, fella," he said. "Come on over."

III—LIFE, OR DEATH

IT WAS a different Bev Bates than Bill had ever seen before who came into his living room a few minutes later. The tall, brown-eyed Bostonian was undoubtedly struggling to keep himself in hand. He smiled at Bill and spoke in his usual courteous manner, but Bill could feel the tension underneath. He studied Bev for one brief instant, and he knew that something was troubling Bev more than he would ever let him, Bill, know.

"I was just going to call Martin and have the Lancer warmed up," Bill said. "I want to get the cobwebs out of my mind and hair. What say we take her together? Or would you rather stay here and talk? We can plug in the intercockpit phones when we're in the air."

"That's an idea, Bill," Bev said, and Bill could tell that he was relieved.

Ten minutes later they stood on the apron before Hangar No. 1, while "Scotty" MacCloskey, the dour old Scot who was the major-domo at Barnes Field, warmed up the three thousand horses in the nose of the Silver Lancer.

Bill climbed into the forward cockpit, while Bev climbed into the rear. Bill idled down the powerful twin-Diesel engines and watched the two-iridescent disks that were triple-bladed, automatic-pitch propellers.

From the center of the propeller cap peeped the muzzle of the 37mm. automatic engine cannon that fired through the hollow prop shaft. From troughs along each side of the engine peeped the noses of two .50-caliber machine guns. They were equipped with automatic ammunition counters and engine-driven synchronizing gear. A dull, burnished metal telescopic sight gleamed in the sun, under Bill's nose.

Bill's eyes ran over the complete set of blind-flying instruments, including the Kruesi short-wave direction finder and his own adaptation of the Stark 1-2-3

instrument panel, with no little pride in his eyes. He glanced at the tachometer and shouted to Bev in the microphone before his lips:

"All set?" he asked.

"Let her ride," Bev answered.

Bill swung the Lancer lightly around and rolled down the center runway into the field. In the center of the field, where the main runways converged, he kicked the rudder to send the ship into the wind. The engines blasted as the three thousand horses in the nose snorted to be unleashed. The tail lifted, and a moment later the retractable landing gear slid up into the belly, making a monoplane of what had been a sesquiplane on the ground.

At five thousand feet Bill leveled off and pointed the nose of the speeding ship toward the end of Long Island. He cut his throttles to cruising speed and spoke into his microphone.

"All right, fella," he said to Bev, "what's on your mind? Let's have it." There was a silence for a few minutes, until Bill turned his head. "Let's have it, Bev. We'll straighten it out, whatever it is."

"I hardly know how to begin, old chap," Bev said, his voice betraying his embarrassment. "You see, there was a girl—" He broke for an instant and Bill groaned inwardly. That was one thing he had never had to contend with with his men—girl trouble.

"We—we haven't announced our engagement yet, Bill," Bev went on as Bill banked the big ship around in a sweeping turn. "And now, I don't know that we ever will."

"But let me begin at the beginning. Guy Emerson, the girl's brother, was my roommate at Harvard. We belonged to the same club and were like brothers. When we were graduated I took up flying, seriously, as you know. Guy was interested in flying, had a pilot's license. But he was more interested in bacteriology. He majored in it. During his last year in college his father died. The family, his mother and the sister I spoke of, decided that he should use what money they had left to finish his courses. He finished, and that summer, when their money was about gone, Guy could not get a job. You know what the year 1930 was for young men just coming out of college?"

"It was tough going for all of them," Bill said, sympathetically.

"Well," Bev said, "I heard of a job he might get in a roundabout way, through a friend of a friend—one of those things, I told Guy about it and they offered him a job, at a salary that nearly took his head off."

"He had to apply to a large international trading corporation in New York."

AIR TRAILS will be represented

at the

NATIONAL AVIATION SHOW

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JANUARY 28th to FEBRUARY 6th

The show is sponsored by Aviators' Post No. 743, THE AMERICAN LEGION.
Sanctioned by the Aeronautical Chamber of Commerce of America.

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Transcontinental & Western Air, Inc.
United Aircraft Corp.
United American Bosch
U. S. Bureau of Air Commerce
Waco Aircraft Co.
Walter Kidde & Company
O. J. Whitney, Inc.

If you live in or near New York—Don't Miss It. Flight Commander Carlson will be there.

They told him they did not know just where they would send him, but his salary, one that was beyond his most fervent dreams, would begin at once. They told him they were only acting as an agent for other parties in employing him. His job was to be the collecting and culturing of bacteria. They told him they would deposit any part of his salary he wished in a Boston bank for him.

"One day he received a wire ordering him to New York immediately, ready for service. He packed and took the first train. His mother and sister received a wire from him saying he was taking a fast transport plane to the West coast. They had a short letter from him from San Francisco. The letter was vague about where he was going or when.

"That was the last thing they ever heard from him. He dropped from sight completely. After a time they began to worry and tried to check on him through the trading corporation in New York. They professed to know nothing about him, said they had been acting as an agent for a man they could not, now, locate themselves. They said—"

"What about the salary that was to be deposited in the Boston bank?" Bill asked.

"That's the funny part of it," Bev said. "It is still being deposited. They

tried to trace back, with the aid of the bank, but came up against a stone wall. The money is still being deposited, but there is no trace of Guy.

"He meant a lot to me, Bill—more than I could ever convey to you in words. And his sister means even more. She blames me for his disappearance. She has even hinted that perhaps I know something about him I'm not telling. It's tough going for me because, well, because—" Bev's voice broke for an instant and Bill was quick to pick up the conversation and pretend he did not notice it.

"I know how you feel, fella," Bill said. "But don't worry about it. This bird Emerson has to be some place, or those checks wouldn't still be coming through. He may have gotten mixed up in something he doesn't want them to know about. If we still had prohibition, I would say it was that. We'll go into New York and take this trading corporation apart and find out what makes it tick. I'm glad you told me about it."

"Thanks, Bill," Bev said. "I feel better about it already."

"Well," Bill said, "I have the cobwebs out of my own head now. I'm going to spiral back to the field."

"O. K.," Bev said, as Bill stuck the control column forward and started a long, sweeping turn.

Bev noticed that as Bill came around in the turn he did not bank, but took it in a flat turn. It was the first time he had ever seen Bill make a turn close to the ground without banking. When Bev felt the Lancer glide off into a side slip, as the wing on the outer side of the turn began to point downward, he thought nothing much of it.

But when the nose of the Lancer dropped and he knew that they were going into a spin, he shouted into his microphone.

"Have you gone to sleep?" he bel-lowed at Bill.

When no answer came back to him he grabbed for the dual controls in the rear cockpit. He shouted Bill's name over and over, as he leveled the big ship off. He could feel a slight pull on the control column forward, and knew that Bill's hand was still wrapped around it. His breath was coming in short, sharp gasps as he continued to cry Bill's name. The hair rose at the base of his skull as a few whispered words came back to him.

"I'm out, Bev," he heard Bill whisper. "Something hit me. I can't see and I can't move my arms or legs. Listen close. I may go out again."

"I'll get it, Bill," Bev breathed.

"Get Tony and tell him to have the ambulance on the apron when we come in. And tell him"—Bill was gasping

horribly now—"tell him to have Dr. Humphrey get the note out of the wastebasket in the living room of my quarters. Tell him to tell doc to handle it carefully—with gloves. Tell him to go to work analyzing what was on it and checking on a serum. You got it, Bev?"

"I have it, Bill," Bev said, and he saw Bill's head drop forward on his chest. "Guts!" he said to himself, as he threw the radio key and began to chant the call letters of Barnes Field into the microphone.

"B. B. X. answering. B. B. X. answering," Tony Lamport's voice came back to him in a moment.

"This is Bev, Tony. Something has happened to Bill. He went out like a light as we started back for a landing. Get this right: Bill regained consciousness for a moment and gave me instructions. Are you ready?"

"Shoot it, Bev," Tony said, his voice calm and steady.

They slid Bill Barnes out of the front cockpit of the Silver Lancer and onto a stretcher, while a score of mechanics, ballistic engineers and his little band of fliers looked on. Dr. Humphrey climbed in beside him and the ambulance clanged away to the infirmary.

Any one would have thought that that hard-bitten band of men who saw Bill Barnes' lifeless form carried away to the hospital would have disbanded then. But they didn't. They moved across the field to stand outside the infirmary until Dr. Humphrey sent out word that he would live or that there was no use waiting longer.

And inside, in the waiting room of the infirmary, was a little knot of men who were closest to him. Young Sandy Sanders with tears welling in his eyes—tears he didn't try to hide. He couldn't see any world ahead for him without Bill. He couldn't imagine a world without him. He said as much to the stocky, tense "Shorty" Hassfurth, Bill's chief of staff, who sat beside him.

"Hey, Shorty," Sandy half whispered, "Bill's going to keep his nose out of the ground, isn't he?"

Shorty looked at him with those lead-blue eyes that had become hard and old and worn when he was only a kid of twenty, flying over the German lines in France. He intended, as he turned his head, to tell young Sandy to shut up. But when he saw the tears in Sandy's eyes, his own eyes softened and he gave the kid a pat on the back.

"He's never stuck his nose in the ground yet, has he?" he growled. It was both a question and an accusation.

"Red" Gleason, the carrot-topped, ex-War flier who had been Shorty's pal in War days, sat there with the mask on his face he had learned to wear so many years before. But when he heard Sandy's question and Shorty's answer, he reached in a pocket and brought out a

cigarette and bent over to light it in a way that might have made you believe that hard-boiled mask was only a mask after all.

Cy Hawkins, the leathery-faced Texan, with the slow drawl, the muscles and the mind that coördinated so fast he was a streak of lightning without any one knowing it, pretended to be studying one of his flying boots with an intensity that would have given you the idea he was immersed in a difficult problem in calculus.

Young Henderson, one of Bill's younger fliers, and the usually calm Bev Bates, didn't try to hide their feelings.

Martin, head mechanic on Barnes Field, and dour old Scotty MacCloskey, waiting, waiting, hoping and praying. And the nervous, efficient little Tony Lamport popped in and out of the room, his whole body a bundle of nerves.

They sat there breathless, afraid to breathe, when Dr. Humphrey opened the door two hours later.

The doctor nodded his head; he half smiled; and they knew. They knew that Bill Barnes had won one of the biggest fights of his life.

"He—he's all right, doc?" the irrepressible Sandy asked, breathlessly.

"He'll make it," Dr. Humphrey said. Then he held up a warning finger. "Remember, though, that a man is never well until he's out of bed. Only a man with Bill's fighting spirit would have made it. It was his will and his refusal to die that did it as much as anything we could do. Good old-fashioned guts some people call it.

"We made a quick analysis and took a slide of the deadly living bacteria that was attached to the note of warning Bill received this morning. Fortunately, we found it was something we know about. We used injections of a serum that has been recently developed for just such a purpose.

"Barring complications, Bill will live!"

IV—BEV'S MISSION

YOUNG SANDY sat beside Bill's bed in the infirmary two days later. There was no doubt of the intensity of the siege through which Bill had passed. His face was lined and pallid beneath his coat of tan and his eyes were sunken wells.

"A bunch of newspapermen came around," Sandy said. "The news of your being near death reached them in some way. I handled the matter the way we always handle those things. You've got to be hard-boiled with those newspaper guys. I took 'em into your office and I laughed at the idea that anything had happened to you. I told 'em you were up visiting your Aunt Minnie in the Adirondacks and were in the best of health."

"My Aunt Minnie up in the Adiron-

dacks would be surprised to hear that," Bill said, soberly.

"You got an Aunt Minnie up in the Adirondacks?" Sandy asked, his eyes wide.

"Sure," Bill said, "two of 'em. They're sisters. They both sing alto in the church choir."

Sandy peered at Bill's pallid face suspiciously, but Bill did not crack a smile. He said, "You got rid of the reporters O. K.?"

"Yeah," Sandy said, and then his forehead wrinkled in a frown. "You know, Bill, I wish you'd take my advice more often. The other day when that letter came I told you I had an idea it was important and that I had a funny feeling things were going to break wide open. Well, I still have that feeling, kinda as though I can't breathe. I wish you'd be more careful. I get worried about you sometimes. You take pretty big chances when it isn't necessary."

Bill thought of the thousand times he had roared that selfsame advice at Sandy during the past three years, since the kid had become one of his fliers. He couldn't entirely hide the grin that flashed across his face.

"Listen, kid," he said. "The thing you were talking about day before yesterday—laying odds on our chances of return when we go on a job—What odds would you have laid that I wouldn't come back the other day when Bev and I went up to get a little fresh air?"

"Gosh, Bill," Sandy said, and he looked startled, "I'd have laid a hundred to one that you wouldn't have any trouble and would come back all right."

"O. K., kid, let that be a lesson to you. You don't want to gamble on people's lives in this business. It's too risky."

"A lesson to him? A lesson to him?" Shorty Hassfurth's voice said behind Sandy. "He never learned a lesson in his life. They had to burn down the schoolhouse to get him out of the third grade."

"Yeah?" said Sandy, whirling to gaze into the faces of Shorty, Red, Bev Bates and Cy Hawkins. "Yeah? The first time I heard that joke was the day my crib caught on fire when I was two years old, you lug."

"How're you doin', fella?" Shorty asked Bill.

"Still have a few bugs in me," Bill grinned. "When the doc works those out I'll be O. K. Which reminds me, I wish you birds would go over in the living room of my quarters and look at a sketch on my drafting board. I've been working on a small crate for the Bureau of Air Commerce. Maybe you'll see a way to iron some of the bugs out of it."

"Right, Bill," Bev Bates said. "Anything else we can do for you?"

"Not a thing," Bill said. "I'm glad you came in, all of you. I wish you'd stick around for a few minutes, Bev. I want to talk to you. Sandy, you go along with Red and Shorty."

"I'll go along with 'em," Sandy said, "but if they start any of their funny stuff with me I'll move their noses over."

"Why, you big rough boy, you!" Shorty lisped. "I don't think we ought to trust ourselves with such a brute."

"See!" Sandy said to Bill. "They're beginning already. Some day I'll get something on you two chinless mugs, and when I do—" He stalked out of the room without finishing the sentence as Red and Shorty burst into laughter.

"You're really feeling better, Bill?" Bev asked when they had gone.

"Much," Bill said. "I'm all right now, but the doc thinks I ought to stay here for a few days. He says that sometimes there is a relapse to the particular kind of fever and poisoning I had. I don't think he knows much about it."

"Have you been able to figure any angle while you've been lying here?" Bev asked. "I mean, what is the Death Ring and why did they send you that letter?"

"That's what I wanted to talk to you about," Bill said. "I want you to tell me again the things you told me in the air the other day. I remember them, but I don't know how well. What is the name of the trading concern?"

"All-World Traders, Inc.," Bev said.

"You know, Bev—now don't laugh at me—but I think there is a tie-up between Emerson and that death note I received two days ago."

"You think what?" Bev gasped.

"Look," Bill said. "Emerson was a bacteriologist, wasn't he? That is the job he landed through the All-World Traders, Inc. Or, at least, that's all you know about it. Right?"

"Right," Bev said, but he was looking at Bill as though he thought Bill mad.

"All right," Bill said, and there was a new intense fire in his eyes that hadn't been there earlier in the morning. "Being a bacteriologist is not only a respectable profession but an honored one. Why would a man doing such work hide the fact from his family and friends?"

Bev didn't even bother to shake his head.

"Either because he isn't allowed to communicate with them or he is ashamed of the particular kind of work he is doing. What could he be ashamed of doing?"

"What?" Bev asked. "You'll have to tell me, Bill. I can't figure it."

"Maybe he's working for an organization that is capable of and wishes to make such letters as I received yesterday. Imagine what an easy way to kill a man? Merely mail him a letter! He opens it, contacts a deadly germ and in

a few hours he is dead. Dr. Humphrey told me the germs attached to that letter were still alive when he found the note. I noticed them when I read it but didn't pay any attention to them. Dr. Humphrey says that exploded glass and ground silicon dioxide were impregnated with germs and a food paste that would keep the germs alive for three or four days. Naturally, they were infinitesimal in size and were a part of the paper. The paper was especially heavy, probably made for just such a purpose. Do you get what I'm driving at?"

Bev nodded. "It makes me shudder to think of the possibilities of such a terrible thing," he said. "You think Emerson might be working for the people who developed this thing?"

"I think it is very possible," Bill said. "That would account for the large salary he is receiving and the fact his family haven't heard from him. He may be doing it against his will—held a captive."

"But why did they send you such a notice?" Bev asked.

"That," Bill said, grimly, "is what I'm going to find out. The note warned me



They were circling him. His face became tense in desperate concentration.

not to undertake a job under the plea of humanitarianism. I haven't been offered any such job."

"I see," Bev said. "I understand what you mean, but it seems too fantastic to contemplate. Suppose this job is offered to you—what are you going to do?"

"I'm going to take it," Bill said, and his face was as hard as granite now. "It may be funny to some people to send me poisonous germs that nearly kill me. It may be very funny to them. But I don't have that kind of a sense of humor. I can't laugh with them, but I'm going to laugh at them. You are not obligated to do what I am going to ask you to do. It will be dangerous, as dangerous as anything you've ever undertaken."

"I know, Bill," Bev said. "I'm beginning to put things together in my own mind. I'll go over there now. I'll come in to see you as soon as I get back."

"O. K., fella," Bill said and held out his hand. They shook hands silently and Bev went out the door.

Bill laid his head back on his pillow. There was a distinctly worried expression on his face as he saw Bev go. He knew that he might never see him again.

But he knew that if he was right in his suspicions about the horrible thing that was rearing its head some place in the world, the sacrifice of Bev's life, and his own, and the lives of all of his men, would not be too much if they could quell it.

V—MR. STITT

BEV BATES took his Snorter off Barnes Field with that easy deftness for which he was famous.

Twenty minutes later he was walking up Broad Street in New York toward the offices of All-World Traders, Inc. He asked for the general manager and vice president, a Mr. Stitt. The girl at the desk in the outer office acted like all girls in outer offices and asked him what he wanted to see Mr. Stitt about.

Bev flashed his best smile, the one he usually reserved for Elinor Emerson, and told her it was a personal matter. To his surprise Mr. Stitt said he would see him immediately.

Mr. Stitt was a man with a round face, a bald head and a pair of very shrewd eyes. He greeted Bev cordially, so cordially that Bev became suspicious, asked him to sit down and offered him a cigarette.

"You're one of Bill Barnes' men, aren't you?" he asked after he had lighted Bev's cigarette.

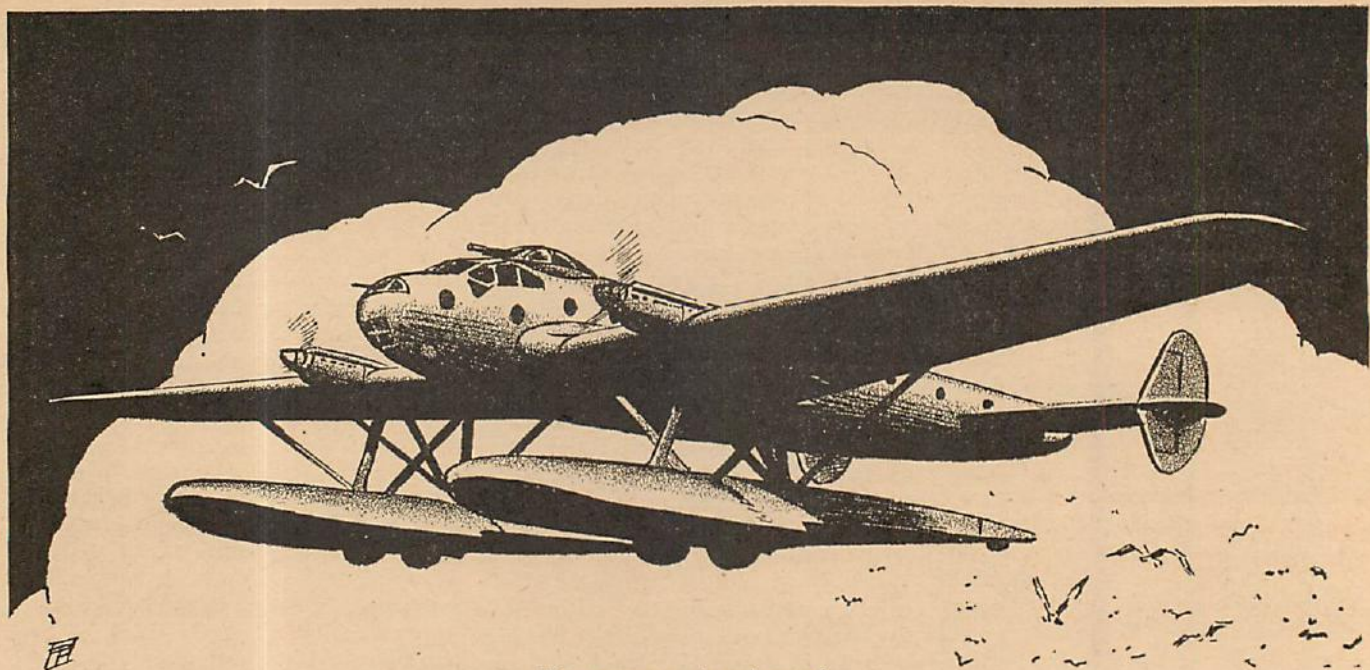
"How did you know that?" Bev asked him.

"Oh, all you fellows are famous," Mr. Stitt said, pleasantly. "I recognized your name and then, of course, your face. What can I do for you?"

"Tell me where I can locate Guy Emerson," Bev said, and he watched Mr. Stitt's face closely while he said it. For a moment Mr. Stitt looked puzzled, then he nodded his head.

"Oh, yes," he said. "I had another letter from his sister yesterday. I've been trying to help his family locate him. You see, we do a general international business as traders. We trade in everything—commission brokers, really. One of our customers out in Sumatra may write to us asking us to hire and send him a particular kind of engineer. We do it and that is the end of it."

"I've checked over the records concerning young Emerson and find that one of our customers in San Francisco wanted us to pick up a couple of well-trained bacteriologists and send them to him. We did. Emerson was one of them. I believe we received a letter saying he had reported for duty out there. Naturally, that ended our concern in the matter. When Emerson's



The transport heads south.

family asked us to locate the man who had hired Emerson we could not make contact with him. But"—Mr. Stitt's round face broke into a wide smile and he held up a finger—"I think I'm going to be able to put *you* in contact with Mr. Emerson."

"That," Bev said, "is real news. It's good of you to go to all this trouble. The Emersons will appreciate it more than I can tell you. And so will I. You know, Guy Emerson is my oldest and best friend. We roomed together at Harvard."

"Is that so?" Mr. Stitt said, politely. "Then, of course, you're as much interested as they are. Now I'll tell you what I'll do. I expect to hear from San Francisco within an hour or two. It's almost lunch time now. Suppose we step down the street and get a bite of luncheon and by the time we get back I'll probably have a wire. All right?"

"O-h-h," Bev said, "I don't want to impose on you to that extent. I—"

"You're not imposing on me," Mr. Stitt said. "I'd like to hear something about your experiences with Barnes. He must be a very amazing man."

"He is," Bev said stoutly, and he thought about Bill's suspicions of that morning. It was going to be one grand laugh on Bill.

Mr. Stitt rang for his secretary and told her he was going out for luncheon and probably wouldn't be back for a couple of hours. Then he guided Bev through the multitude of runners, messenger boys, stenographers, clerks and business men that were milling along Broad Street.

They crossed Beaver Street and kept on until they were almost down to the docks.

The Epicure was not the kind of place Bev would have picked as being worth investigating. It was a small

place with a bar in the front and a half dozen tables in a small room to the rear. Mr. Stitt spoke to the bartender and they went through and took a table.

"One thing I always order here," said Mr. Stitt, "is Wiener Schnitzel. It melts in your mouth."

"I'll try it," Bev said. He looked at the occupants of the other tables and didn't think they looked much like prosperous business men. Then, under Mr. Stitt's urging, he told him about Bill Barnes and Barnes Field and Bill's equipment.

It was about that time that Bev began to feel peculiar. He excused himself and went into the wash room for a moment, as he had done when they first entered the place. When he came out he was staggering a little.

"You know, I don't feel right," he said to Mr. Stitt.

"Don't worry about *that*," Mr. Stitt said. "You're going to feel much worse before you die."

Bev's head was whirling now so that he could hardly hold it erect. But the significance of that remark penetrated. He tried to reach into his consciousness, but the world was running away from him. Things flashed before his eyes that he had never seen before. He groped in the darkness with all his will power.

Then it came to him. Bill had been right!

He clenched his teeth, pushed himself to his feet and saw Mr. Stitt's laughing, mocking face for an instant. He gathered all the strength he could muster, struck at it. He felt his fist smash into something that gave like a rotten pumpkin. Then he got a last glance at Mr. Stitt's face—and it wasn't smiling any longer. It was the face of an animal—a snarling, wounded animal at bay.

With a supreme effort he whirled away

from the arms that were trying to hold him. He drove his left fist into Mr. Stitt's bloody face and followed it with a right that took all of his remaining strength. He felt something give under the force of the blow and knew that Mr. Stitt was on the floor. He laughed crazily, tried to strike out, as blows crashed on his body. He could dimly see a half dozen men around him. But they were like dancing puppets on wires.

And mercifully, before he struck the floor, the dope that had been given him took effect.

The world exploded into a great black void.

VI—THE MESSAGE

AT eight o'clock the next morning Dr. Humphrey went in to make his morning call on Bill Barnes. Bill had finished his breakfast early and was stewing when the doctor arrived. He didn't wait for Humphrey to speak.

"Got a telephone extension that will reach in here?" Bill asked.

"Why, no, Bill," the doctor said.

"O. K.," Bill said, grimly. "Get me a bath robe and some slippers."

"I don't want you to get out of bed, Bill," the doctor said. "I'll make any call you wish made."

Bill threw back the bedclothes.

He marched by the astonished doctor, out into the corridor and down the hall to the doctor's office. He grabbed the receiver off the hook and snapped the hook a couple of times. When he heard Tony Lamport's voice he said, "Tony, get me the All-World Traders, Inc., in New York. Get it? All-World Traders, Inc. They'll be in the book."

The muscles of his cheeks stood out like the jowls of a squirrel with a mouthful of nuts. When a voice came on the wire he asked for the person in charge of the office.

"I guess you want Mr. Stitt, the general manager," a girl's voice said. "Who is this and what do you wish to speak to him about?"

"The name is Barnes, Bill Barnes," Bill growled. The girl gasped and said, "Just a minute please, Mr. Barnes."

"Hello, Mr. Barnes," an oily voice said in Bill's ear a moment later. "This is Mr. Stitt."

"Did one of my men, Mr. Bates, call at your office yesterday?"

"No," the voice said, slowly. "I'm sure we'd have been honored to have met him."

"You're sure of that?" Bill insisted. "Now just a moment, I'll check—"

Mr. Stitt began.

"Never mind," Bill snapped. "I'll check it myself," and he snapped the receiver on the hook.

"Listen, Bill," Dr. Humphrey said, pompously. "I insist that you—"

Bill didn't stop to listen. He went back to his room, got into his clothes and tore out of the infirmary toward the administration building. He found Sandy, Shorty, Red Gleason, Cy Hawkins and Henderson sitting in his office. Their mouths fell open when they saw him.

"I thought—" Sandy stated.

"Don't try to think," Bill snapped at him. "I'm out of the hospital for good. There's going to be hell brewing around here within a short time." He turned to Shorty.

"Listen, Shorty," he said: "Bev went to New York yesterday morning to see some one in authority at the firm called All-World Traders, Inc., on Broad Street. I'm sure he went there. He probably saw a man named Stitt who is the general manager. Why he went doesn't make any difference now. Why he hasn't come back is the question."

"I want you to go over there and find out if he was there. I'm positive he was, but this man Stitt denied it over the telephone a few minutes ago. Don't go to Stitt; just nose around until you find out whether he was there. Talk to a phone girl, a reception clerk, any one. You know how to handle it. Take my car and take Sandy with you because Bev said he was going to fly over in his Snorter and leave it at the Battery. One of you will have to fly it back."

"But stick together and don't let any one get behind you. Put an automatic in your pocket in case you run into any trouble. I'm going to fly out to Minnesota and see some doctors out there. I'll be back to-night sometime."

Shorty got to his feet without a word, then said to Sandy, "Come on, kid."

Bill picked up the telephone and asked for Martin, the head mechanic. "Roll the Lancer out and warm her up," he said. "Check the fuel, oil and guns."

"Yes, sir," Martin answered.

To Cy, Red and Henderson Bill said,

"You birds check your Snorters and the transport-carrier. I can't tell you what's on the fire. I don't know myself. But when it happens, it's going to happen fast. Tell Scotty to give every one a warning to be on guard and have him double the guards on the gates and the patrols."

Bill followed them out of the administration building and over to the apron where Martin was warming up the Lancer.

Bill shaded his eyes, gazed into the morning sun to locate the drone of the fast-moving plane that came to his ears from overhead. Far off to the southeast, it was a mere speck on the horizon. But it grew larger while he watched and he could tell by the sound of the motor that it was moving at a terrific speed.

Bill was about to withdraw his gaze when another speck appeared a little above and about a mile behind it. It, too, was traveling at a speed he estimated at over two hundred miles an hour. He saw the sun glittering on the coal-black finish of the second plane and saw that it was a sturdy biplane, not unlike the famous British "Interceptor" type.

The thing Bill saw next made him leap for the front cockpit of the Lancer and snatch a pair of binoculars from a side pocket.

He saw that the first ship was a fast, all-metal, low-winged monoplane and he could tell by its markings that it was a United States government ship. He saw the pilot bring it up and over in a flashing Immelmann turn as the black biplane dived on it.

Then Bill held his breath as the pilot stuck the nose of the monoplane toward the earth in a vertical power dive. He was probably at ten thousand feet when he went into his dive. Occasional flashes of sunlight played on the metal wings. Down and down he came, his motor roaring a high-pitched scream.

Martin and the half dozen grease monkeys, who had rushed out of the hangar at the sound of the screaming motors, watched with white faces.

"Pull her out!" Bill yelled at the pilot of the monoplane. "Pull her out or she'll never come out!"

But the ship came plummeting down and down, and Bill knew that the pilot must be standing almost bolt upright on the rudder bar with his hand wrapped around the stick and his heart in his mouth.

And then Bill saw that thin line of tracer smoke float through the air again as the pilot of the black biplane came within shooting range and he could hear the *tack-tack-tack* of a pair of machine guns.

The nose of the government monoplane came up slowly, higher and higher. For a moment it did not seem possible the little ship could hold together under the

terrific strain of that pull-out. But pull out it did, then zoomed upward as the black ship shot beneath it.

The monoplane streaked away only a thousand feet above Barnes Field, then came up and back in a chandelle. But the black biplane had nosed out now and it started up toward the monoplane.

For two minutes Bill stood there entranced, watched the two ships go through every maneuver known to airmen. Time after time, as the biplane went back to attack, the little monoplane rolled or slipped or skidded out of danger.

Then Bill realized that the government ship was not armed. It was fighting with nothing but the pilot's skill to keep it from annihilation. He shouted at Martin as he jumped for the cockpit of the Lancer.

"This is it," Bill said to himself. "That government ship is trying to get down to me. Why didn't I realize it sooner?"

Bill gunned the three thousand horses in the nose of the Lancer as he saw the biplane pouring bullets into the monoplane. He took the Lancer off at a terrific speed. When he had his landing gear tucked in the belly, he stuck the nose almost straight up, aimed at the circling black ship.

He saw that the monoplane was half fluttering, half falling to its destruction as his finger clamped down on the .50-caliber guns in the Lancer. But the pilot of the black ship had seen him coming and was straightening out now with his engine wide open. He didn't wait to see if the monoplane was helpless. He gave his motor all the juice it would take as he stuck the nose of his ship toward the east and sped away.

Bill looked over the side of the Lancer and saw the government ship pancake out on Barnes Field and almost nose over. For an instant he was undecided whether to go after the black ship and force it down or land. Then he fish-tailed the Lancer onto the runway and was over the side the moment he locked his wheel brakes.

Red Gleason and Cy Hawkins were running toward the wrecked plane. Martin and a half dozen mechanics were behind them. Bill heard the ambulance clang out of the garage; he heard the *ding dong* of the fire truck as it sped toward the wreck.

Bill jumped on the step of the little single-seater and saw that the pilot was slumped over the stick; he was unconscious and bleeding badly. Bill saw where at least a dozen bullets had cut their way through the fuselage and he cursed as he got his hands under the man's arms and lifted him up and out. Red and Cy eased him to the ground.

A groan came from the man's bloody lips; his eyes fluttered open. He saw Bill and spoke in a voice that was so

low Bill could not hear him. Bill leaned down closer and spoke in the man's ear. "Barnes!" the pilot whispered. "Send the rest of these people away. I have a message for you. Call Morton in Washington and confirm what I tell you. But don't say what I tell you over the telephone. He will tell you what I say is true."

"But there's an ambulance on the way," Bill said, "with a doctor."

"Tell them all to stay away while I talk to you. A doctor won't do me any good. I'm finished."

"Move back, all of you," Bill ordered. "Keep 'em back, Red."

"Listen carefully," the man said in a labored whisper. "There is a cruiser, the *Goodwill*, cruising back and forth fifty miles off the coast from New York. Morton will give you her position. You must go there to-day, immediately. The acting heads of the half dozen most powerful nations in the world are waiting there for you. They are depending on you to do a job for them."

Blood gushed from the man's mouth and he stopped talking for a minute.

"Tell Morton what happened to me. I'm a secret agent. You must not fail to find the cruiser. They will tell you what to do. The safety of the world depends on you, Barnes. Good luck!"

Bill stood up and shouted at Dr. Humphrey. But when he turned back to the man on the ground he knew Dr. Humphrey could do nothing. The man was dead.

"Red," Bill said, "will you take charge of things here? I've got to make a telephone call to Washington, fast. Get in touch with the police commissioner. Tell him, confidentially, this man is a secret agent. Morton will tell the commissioner what to do if he phones him."

Bill whirled, broke into a run, his long, powerful legs pumping up and down toward the administration building.

He went into his own office, got Tony Lamport on the telephone and told him to rush a call through to Morton, the chief of criminal investigation in Washington. He had worked with Morton a half dozen times before. They understood each other.

When the telephone finally rang he tried to keep his voice steady and natural. His heart was pumping furiously.

"This is Bill, Morton," he said into the mouthpiece.

"Did my man get through?" Morton asked. "You have his instructions?"

"I have them," Bill said. "He is dead."

There was a short pause. Bill waited until Morton spoke again.

"Get a piece of paper and a pencil," Morton said. "I'll give you that position. This is entirely out of my jurisdiction, you know. I am only a go-between."

"I understand," Bill said. He jotted

down the position Morton gave him.

"I think I have an idea about all this. I'll tell you about it another time," Bill said.

"I hope you live to tell me, Bill," Morton said. "You can get away immediately?"

"I'm on my way now. Good-by, Morton."

"Good luck, Bill."

He hung up the receiver, slipped a heavy automatic out of a desk drawer into his pocket and started on a run for the Lancer.

"Tell Tony," he shouted at Cy Hawkins as he swung into the cockpit, "I'll keep in touch with him. I'll be back in a few hours—if luck rides with me."

VII—ABOARD THE "GOODWILL"

THE LANCER was still warm when Bill kicked over the twin Diesels, checked his automatic ammunition counters, the 37mm. cannon and flicked his radio key on and off.

Two minutes later he whipped the Silver Lancer into the air and stuck the nose toward the end of Long Island. He carefully probed the air all about him when he had eight thousand feet under him.

There was not a plane in sight. After the tip of Long Island flashed under his wings, he carefully plotted and replotted his course. He didn't believe he would have any difficulty in picking up the *Goodwill*. It was a clear day and he couldn't very well miss the cruiser if it was anywhere near the position Morton had given him.

Twenty-five miles out over the Atlantic, Bill had an uneasy urge to turn and look back and up over both shoulders.

When he looked over his left shoulder and saw the black biplane, he simply grinned.

"All right, baby," he said. "If you want it, come and get it." He laughed grimly to himself. "Something tells me I'm going to see plenty of you before this thing is over."

He held the Lancer on its course while he studied the ship over his shoulder. It was not unlike the biplane that had been over his field that morning with its guns vomiting lead and death. But there was something different about it. It was more rugged and squat and was equipped with retractable landing gear.

Ten minutes later he sighted the *Goodwill*. She was steaming south at a speed of about fifteen knots an hour. As he sighted the ship, he eased the stick of the Lancer forward and sent it into a long glide, pointing the nose straight at the cruiser. The cruiser must have sighted him at about the same instant. Her speed was cut until the ship was practically still, rolling slightly. He skimmed the top of the cruiser and set the Lancer down on the waters of the

Atlantic a hundred yards away from her. They were already lowering and manning a dinghy when he taxied toward her.

Three minutes later the jig lieutenant at the helm of the little power boat brought her alongside the Lancer. He saluted and shouted above the roar of Bill's Diesels, "Mr. Barnes?"

Bill nodded. "Can you put a couple of men aboard my plane to throw out the sea anchor and man her while I'm aboard the *Goodwill*?"

The lieutenant nodded his head. Three sailors scrambled over the side of the dinghy onto the main float and made it fast. Bill slid out of the cockpit and down on the float beside them and gave them instructions. Then he probed the sky overhead in search of the black biplane. It was nowhere in sight.

He was greeted at the head of the gangplank by the officer of the deck. "You will follow me, please, Mr. Barnes," he said.

The officer stepped aside as he knocked on a door on the upper deck and opened it for Bill. Bill knew that he was entering the quarters of the captain of the *Goodwill*.

A tall, gentlemanly-appearing man rose to his feet and extended his hand. "Captain Shackleford, Mr. Barnes," he said. "Sit down a moment."

"Thank you," Bill said. "You were expecting me, of course?"

"I will announce to the gentlemen in conference that you are here," Shackleford said. "But first I must warn you. The six gentlemen with whom you are to confer are all incognito. They will all wear masks. This whole thing is being done in the strictest privacy, for reasons that are probably plain to you. Even though you recognize one of the gentlemen you must not speak his name or let it be known you recognize him. They are not admitting their identity to one another."

For an instant Bill wanted to scoff and ask why the childish procedure. Then it came over him like a flash. They were all afraid of the demoniac power of the common enemy they had banded together to fight! It made him realize more than he had ever realized before that this was going to be the most arduous and the most dangerous assignment he had ever had. He felt goose flesh creeping up on his skin and the palms of his hands were wet with perspiration. He nodded his head as Captain Shackleford got to his feet and knocked on a door off his own office. Then the captain stepped aside to let Bill enter.

Bill stepped over the sill of the doorway and into a half-dark room. A wave of apprehension engulfed him as he swept the grim, masked faces seated around the long, heavy table. For an

instant there was silence. Then it was broken by the youngish voice of the man at the head of the table facing Bill.

"This is an honor and a pleasure, Mr. Barnes," he said. He got to his feet, as did the others, and Bill shook their hands in turn as they expressed themselves to him in varying accents. Then the youngish man indicated a seat at the other end of the table.

"Have you any idea why we are here and why we have asked you here, Mr. Barnes?" the man with the youngish voice asked Bill.

"A very definite one," Bill answered. "But I am not sure my theory is correct. Will you please proceed as though I had formed no opinion?"

"Right. I'll begin at the beginning: Some place in the world there is a man named Armon Benedict. No one knows where he is now or where he came from, or his nationality. All we know about him is that he is an outcast, exiled and hated wherever he goes. During the World War he was a two-way spy. He sold information to both sides for what he could get for it. He is a human being in its lowest mental form.

"In the last few years there has been much talk of the next war and the possibility of civilian populations being bombed and gassed. But this man Benedict has developed an idea which is far more deadly and horrible. That is germ warfare, a thing that can truly wipe out civilization, a *Frankenstein* idea that can get beyond the control of the men who created it.

"Benedict attracted the attention of the huge international munitions ring during the War. They advanced him money for his first experiments. He got together a band of outcast scientists and promised them luxury and wealth beyond their greatest dreams if they would work with him. They have gathered deadly germs of little-known diseases, gathered them from the filth spots of the world, from sewers and jungles, from corpses of men who died of unknown diseases—even robbed graves to get them—and went back through the ages to recreate the germs of plagues long since forgotten.

"He has found blights and germs that will wipe out crops, cattle, spores of grain, and fruit diseases have been cultured to kill the food supply of the enemy.

"These various germs can be cultured and sold at a cost much less than the price of manufacturing shells, bullets and poison gases. They can be produced at ten dollars a pound and sold for a thousand. They can make a self-infecting powder that can be blown out through the exhaust of a plane. That powder will make its own minute cut and infection. It will filter through clothing and be breathed in with the

dust of the air. It can be carried in small bombs that weigh only a few ounces in place of bombs that weigh thousands of pounds, tons.

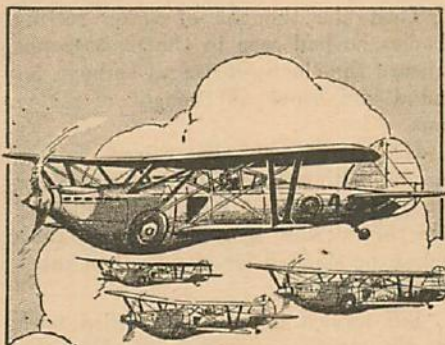
"A large plane, fitted with proper gas tanks, can fly thousands of miles, drop its cargo of death and return safely to its base. Long-range reconnaissance planes are being built to-day with an eye on germ warfare. It is the most horrible thing ever created by the mind of man.

"That is why we are here to-day. The great powers of the world have decided that this thing must be stopped in its infancy. Otherwise we will entirely destroy one another.

"Benedict is gaining confidence and power. He has one station, on some island unknown to us, where he is experimenting. He intends to create others all over the world to supply whatever section wishes to buy his product. I have some photographs here I want you to look at. They will give you an idea of what he can do.

"These photographs came into our hands in a roundabout way. They show a few pictures Benedict had taken when he was trying out his product on actual human beings deep within the interior of Sin-Kiang. It will give you an idea of what germ warfare can do."

Bill took the half dozen enlarged photographs and gazed at them with



Black biplanes.

mute horror. He saw what apparently was once a caravan. There were scattered groups of corpses. Bodies of cattle, men, women and children were rotting together. Even the vegetation was withered and dead. He handed them back without speaking.

"We don't know where Benedict is working," the man with the youngish voice went on. "We have asked you here to beg you to find out and exterminate him and all his workings. We have tried to find him, each with our own espionage system, but we have failed. We believe that you are the one man in the world who can find him and wipe him out. It will be a dangerous undertaking. The world at large must know nothing of this horrible thing. It would drive half of humanity insane, knowing

that such things lurked just around the corner. Civilization, all the world, will owe you a debt it can never pay if you succeed." He waited for Bill to speak.

"I've already started to find him," Bill said.

A gasp went around the room, followed by exclamations in a half dozen different languages.

Bill began with the poisoned note that was sent to him. He told them about Bev Bates. He went through the whole story, up to the present moment.

"My men," Bill said, "have a surprising capacity for avoiding the traps that are laid for them. That is why I have them with me. I am confident that Bates will find his way to Benedict and get the information to me in some way. If he doesn't, I will find a way to find him. Benedict is already after me. The plane that followed me to-day will report that I came here to meet you. Your plans must have leaked out in some manner. It will be open warfare between Benedict and myself from now on. It goes without saying that I am only too willing to accept the commission."

"You cannot expect help from any of us, Barnes," the youngish voice said.

"That," Bill said, smiling grimly, "will not be necessary. If you have no further instructions to give me, I will start back to Barnes Field now."

Each of the masked men got to his feet and shook Bill's hand. The man with the youngish voice was last. He said, "You know who I am, of course, Barnes?"

Bill nodded.

"I can't help you officially," he said. "But I can unofficially. If there is anything you need, Morton will let me know."

"Thank you, sir," Bill said. Wheeling, he opened the door, stepped over the sill and went out into the sunshine that played on the decks of the *Goodwill*.

After a short run, Bill lifted the Silver Lancer off the water and laid a course toward Barnes Field. A thousand thoughts were racing through his mind. He delved into his past experience to find ways to meet the present situation. He knew who the man with the youngish voice had been and he knew the identity of two or three of the other men. But he didn't admit them even to himself.

He was so deeply immersed in thought as the Lancer winged its way home at three hundred miles an hour, that he didn't hear the shrill scream of the motors of those six black biplanes until their bullets were tearing into the Lancer.

They came diving out of a wisp of fleecy cloud a thousand feet above him, and they were on him before he was aware of them. White streams of tracers floated through the air as the planes thundered down on him.

His mouth was a hard, firm line across his face as he took the Lancer skyward. The black ships had come out of their dive and were spiraling upward in his wake. They were converging on him from all sides.

For a moment Bill pondered on what he had better do. He knew he could run away from them without an effort.

Then another thing came to him. If he got some of them, perhaps the rest would turn tail and lead him back to their base. Or he might be able to shoot down one of the planes and then pick up the pilot and take him back to Barnes Field for a thorough going over and questioning.

He brought the Lancer up and over in a loop. At the top he centered his controls, then rolled right side up. Then he whipped up and back in a flashing chandelle.

He went, head on, into the black ships with the wild abandon and speed of lightning. His fingers were fastened down hard on his gun trips. He raked the black ship in the lead with a withering fire. He saw the pilot rise up in his seat as though he were on springs, then fall back with his arms swinging. The black biplane skidded off to the left, almost ramming another black ship. Then it stuck its nose down and went whirling into its watery grave in the Atlantic.

Bill gunned the Lancer again and came over in a normal loop on the tail of another black ship. His line of tracer smoke curled above the head of the pilot. He shifted his fingers and clamped down on the trigger of his 37mm cannon. The explosive shells struck the engine block of the black ship, detonated. Orange flame and black smoke and pieces of debris were one for a moment. Then the smoke blew away, and what had been a fast, rugged biplane was a hundred pieces of junk with a man's shattered body amidst it.

Then the air seemed to be choked with snarling, black wasps that roared and buzzed and darted in and out as they tried to circle their prey and get it in the vortex of their fire. But they were afraid of their prey, whereas to Bill, they were only four more pilots of black biplanes.

He cursed as he felt their bullets drumming through the monocoque-stressed skin of the Lancer. His controls told him that they had shot away the trimming tabs on his rudder. That added to his anger and he began to talk to himself as he fought.

"You asked for it," he said, viciously. "Now take it and like it!" He took the Lancer through the air with the speed and flaming fury of a meteor. He knew the Lancer was taking a terrific beating and was being riddled from wing tip to wing tip by those four black ships. His face became lined and tensed and terrible in his absolute concentration.

They were circling round and round him, trying to keep out of range of occasional bursts from his 37mm cannon and at the same time keep him under a withering fire that would tear the Lancer to shreds.

Then he got a black ship under his nose for that fleeting instant that is enough. His finger clamped down on the electric trigger of his .50-caliber machine guns and they drew a path from the nose to the tail as it flashed by his guns. The black ship yawed wildly, then plunged into a spin toward the waters below.

Bill's breath was coming in short, agonized gasps now. His hand wrapped around the control column like a band of steel. His eyes were mere slits in his pallid face. He used his guns only when he had a black ship dead under his sights. He was using all his natural ability as a flier and all the power and maneuverability of the Lancer to avoid the desperate charges that were being made at him.

He blasted another black ship out of the sky with his cannon and then tore the head off the pilot of still another with his powerful .50-caliber guns.

That left a single opponent. Bill expected to see him peel off and turn tail. But the pilot of that black ship had what it takes to make a great air fighter. Bill almost peeled off himself for an instant because he believed the man was no match for him.

Then the thought of those rotting bodies he had seen in the photographs aboard the *Goodwill* flashed through his mind and drove all thought of mercy out.

He chandelled the Silver Lancer around with the speed of light and dived at that last black ship. The pilot of the black ship seemed to read Bill's mind; he skidded his plane out of range of Bill's bullets.

Bill leveled off and chandelled back to the attack again, with the black biplane racing to meet him.

"So," Bill snarled, "you're good, are you? That's why you didn't peel off. You think you're going to be the murderer who sends Bill Barnes to his grave."

The two ships streaked and tumbled through the flaming heavens, firing burst after burst, without effect. Bill's teeth were clenched so tightly his jaws—in fact, his whole body—ached. He recognized the other man to be a master pilot and he was amazed at the speed and maneuverability of the black ship.

Again they came at one another at terrific speed. But this time Bill anticipated the man's change of direction. His finger clamped down on the trip of his 37mm cannon as he corrected his aim. One instant he could see the enemy's face behind the windshield of his ship; the next instant it dissolved

into black smoke and orange flame. Flames shot out from the ship in every direction as the gas tanks exploded. What was left of it tumbled over and over to the rolling waters of the Atlantic below.

Bill dived the Lancer toward the surface to comb it for a possible survivor of the battle. Nothing but floating debris came to his sight.

He threw his key as the light on his radio panel gleamed red. It was Tony Lamport chanting his call letters over and over.

"Bill speaking, Tony. Bill speaking, Tony," Bill said into his microphone. His voice was tired beyond words.

"Where are you, Bill?" Tony asked.

"About twenty miles out from the tip of Long Island," Bill said. "I've been having a tea party for some of my friends."

"I have word from Bev," Tony said.

"What is it?" Bill asked, sharply.

"I had better save it until you get here," Tony said. "There is danger of a cut-in."

"You won't have to save it long," Bill answered. "Signing off."

VIII—ARMON BENEDICT

BEV BATES first opened his eyes when two men with the faces of gargoyles pulled him out of the low-winged cabin job and tossed him on the ground. He had been conscious of only two things during the past few hours. First, that his face, his head, his whole body ached unmercifully. Second, of a sense of motion.

"The dope's wearing off," one of the two flat-faced men above him said.

"He'll have to have another shot before long," the second one said, "or we'll have a crazy man on our hands. We gotta get him fixed up by Doc McLaury because the chief will want to see him and talk to him."

"That guy McLaury will probably finish him. He'd rather use a saw and a knife than drink rum."

"Frank's all right," the other one said. "He just likes to cut inside people the way a small boy likes to take the cover off packages. It's just curiosity."

"I don't want him to get curious with me."

Bev strained again with all his will power to understand what those voices were talking about.

But his brain would not coordinate. He only knew that he was suffering as he had never suffered before. Dim memories flashed into his mind and flashed out again. He felt himself being lifted from the ground and heard voices cursing above him. Then he lost consciousness again.

The next time Bev opened his eyes he gazed at a twisted, scarred face such



Martin tore the belly out of one of the black ships as it went by.

as he had never seen before. He blinked and looked again to be sure it was true. Then he shuddered and closed his eyes.

"Sit him up and swing his feet down to the floor," a voice rasped. Bev felt himself being lifted again. As he opened his eyes once again he saw that horrible face. Something slapped him on one cheek, then the other. He tried to struggle to his feet and would have succeeded but for the hands that clung

to his shoulders. He knew that the man with the twisted face had struck him.

"Is he all right now, doc?" a voice said.

"He'll feel like a fighting cock in a couple of minutes," the raspy voice said.

Bev opened his eyes and found that his brain had cleared. He sat looking at the chuckling thing before him. He was aware of two or three men standing on each side of him. He gazed

slowly around the room and saw that he was in an ordinary doctor's office. For a moment he groped. Then everything began to dovetail like a jigsaw puzzle falling into place. He remembered everything in a hazy way.

"Where's Stitt?" he asked viciously of the warped thing standing before him.

"About three thousand miles away, as the crow, or anything else, flies," the voice rasped.

"I don't see how you do it, doctor," a rugged little Japanese hissed through large, even teeth. "An hour ago he was a very, very sick man."

"What the hell do you care how I do it?" Dr. Frank McLaury, a one-time famous London physician snarled. "What the hell difference does that make? There he is. Take him to the chief. He's waiting to see him."

They helped Bev to his feet and he made no effort to resist. His strength had been returned to him as though by magic. He walked in a square of four men led by the little Jap.

When he stepped out of the doctor's office into the open air he gazed about him with eyes wide with astonishment. Purple buginvillea and scarlet hibiscus bushes bloomed in the little yard. A hundred feet away was a white shell road that skirted a beach from which the heat rose like blasts from a fiery furnace. Beyond the beach were the soft green waters of a tropical sea that became purple and indigo near the horizon.

Bev didn't ask any questions as he was led around the doctor's building and up a sloping hill to a long, white house with a red, tiled roof.

Hoko, the Japanese, led Bev into the long, low living room off the front terrace. A thick Bokhara rug carpeted the room. Tapestries, books and maps lined the walls. It was sumptuously furnished.

The pleasant-faced, slightly bald man who sat at one end of the room raised his mild, blue eyes as Hoko entered with Bev.

"Welcome to the Island of the Damned, Mr. Bates," he said. "Won't you take a chair?"

Bev sat down in the chair closest to him because his legs would no longer support him.

"My name is Benedict, Mr. Bates." The man smiled. "Armon Benedict. I suppose you wonder where you are?"

Bev was conscious of a distinct wave of fear and revulsion as he heard the pleasant-faced man before him admit, even boast, that he was Armon Benedict. He thought of some of the horrible tales he had heard about the two-way spy of World War fame. He remembered the stories that were told of Benedict's guile and suave geniality. It was a part of his stock in trade. And he remembered the stories that had to do with the other side of the man's nature—the animal cunning and the merciless cruelty.

"I am a bit curious as to my whereabouts," Bev managed to say, calmly. "There isn't any use in telling you what I think about you and your cutthroats. I would like to know where I am."

"No," Benedict said, "it won't do you any good to call me names. You're on one of a number of islets which are known as the Martinets in the West In-

dies. They are mostly small islands, some of them are mere rocks protruding from the Caribbean, running between the British islands of St. Bartholomew and Samarra. There is no communication between us and the larger islands. We are off the steamship and air routes. In fact, we're lost to the world, Bates. Yet we're always in touch by radio."

"Just what do you do to keep busy here?" he asked Benedict. Then he became filled with outward admiration of the radio equipment on a long, heavy table.

He saw that the receiving equipment consisted of the regular receiver and complete vacuum tubes, an antistatic-damped diaphragm head set and a dynamotor for power supply. It was compact and lightweight, and operated on two frequency bands. One from 190 to 450 kilocycles for department of commerce broadcasts, and the other from 500 to 1500 kilocycles. A flip of a switch changed it from one band to another; a calibrated dial made tuning simple.

The transmitting equipment was a compact unit, employing only two tubes. It had crystal control and operated on two frequencies.

"Very neat," he said and turned to listen to the story Benedict was babbling with no little pride.

Bev could not believe his ears as he listened. Then it came to him that Bill had been right in linking the disappearance of Guy Emerson with the death note. He tried to keep the horror and loathing out of his eyes as he listened to Benedict. Finally, he broke in on him.

"You nearly got Bill Barnes with your death note," he said, as pleasantly as he could.

"I could have killed him," Benedict said and his face was not so bland now. "But I expect to have a report of his death almost any minute." He told Bev of the trap he had laid to catch Bill on his way back from the *Goodwill*.

"He is a fool to try to cross swords with Armon Benedict," the mild-mannered dealer in death replied, pompously. "I will take you out to see your friend Emerson now, if you wish. He is working in a laboratory connected with the other end of this house."

Bev's battered and bruised body was shaking as though he had the palsy when a guard threw open a door at the other end of the house a moment later. But in spite of the fact that he had keyed himself up to stand what he was going to see, he did not expect the horrible thing that came to his gaze.

In the long, low room, under the pitiless rays of a tropical sun he saw a dozen men working with test tubes and mortars and the other abracadabra of trained scientists. Bev saw with horror that they were chained to the benches at which they worked and three armed guards stood watch over them.

His eyes traveled down the row of hopelessly beaten men who worked there. He felt a rage burning in him as he studied the gray hair of a young-old man at the end of the table. For an instant he raised his eyes in Bev's direction, eyes that were deep-sunken and terrible to see. They flickered over Bev's face and darted to Benedict without a sign of recognition.

A low snarl, like the noise that a wounded animal might make, came from Bev's lips as he charged by the first guard and started toward his old friend, Guy Emerson. He could contain himself no longer. He knew now why Benedict had been so pleasant and affable. It was so that he could suddenly spring this living-dead man on him to cause him anguish beyond description.

Then he was engulfed by the three guards that swarmed over him. He fought with all the strength he had in his tortured body. But it was not enough. His head lolled back like the head of a dead man as they carried him back into Benedict's living room and deposited him on a davenport.

Benedict was the only person in the room when Bev groaned and opened his eyes. But it was not the same Benedict Bev had seen before. It was a madman who stood over him and taunted him. His lips curled back over his clenched teeth in a snarl. His fingers bent until his pudgy hands became two clutching talons.

Bev did not try to answer the ravings of the man who showered imprecations upon him. He knew that he had just one duty left which he must perform. As he sat up and put his feet down on the floor, he watched the two guards who passed back and forth on the terrace in front of the house.

For an instant he was almost overcome by a nausea that left him with great beads of perspiration on his forehead. He felt so weak it did not seem possible that he could get to his feet. But get to his feet he did. For a full minute he stood there, swaying back and forth like a reed in a gale. He did not pay any attention to Benedict's furious words as he paced back and forth in the room.

He leaned weakly against a chair, waiting for Benedict to come back down the room. When he was opposite him, Bev gathered all of his strength for this last great effort of his life.

He was leaning forward toward Benedict as he took his stance and drove his fist at Benedict's face with all his weight. His fist stifled Benedict's shout as he drove it into the man's teeth. Bev caught him with a left and then a right on the jaw as he started to fall. There had been only the noise of those three blows being struck. The guards continued to pace back and forth on the

terrace as Bev lowered Benedict's still form to the floor. Then he leaped for the radio transmitter and threw the switch. He clamped the ear phones over his ears and began to tune on the delicate dials while he chanted Barnes Field call letters into the microphone.

Then Tony Lamport's voice came to him, clear and distinct.

"B. B. X. answering," it said. "B. B. X. answering."

"This is Bev speaking, Tony," Bev chanted. "Can you hear me, Tony? This is Bev speaking, Tony. Can you hear me, Tony?"

"O. K., Bev," Tony said. "Where are you, Bev? Tony speaking, Bev."

Bev clenched his fists to keep from screaming. He gulped and began to tremble again as he saw Benedict stirring uneasily on the floor.

"Take this fast, Tony," Bev said. "I have only a minute."

"Shoot it, Bev," Tony said and his voice was like a sedative.

Bev rattled off the location of the island in the West Indies. He told Tony as much as he could tell him in those brief, few seconds.

But it was enough. He had done his work when Benedict sat up on the floor and shouted for the guards on the terrace. He pulled the ear phones off his head and tried to take a position to defend himself as the two guards rushed at him. But his strength was gone and he had done his job.

He slid to the floor with a smile on his bloody face as the butts of their automatics beat on his defenseless head.

IX—DOG FIGHT

WITHIN an hour after Bill fishtailed the Lancer down on Barnes Field it became a bedlam of feverish activity. Tony Lamport had met him on the apron and given him Bev's radio message. Shorty and Sandy were back with word that Bev had called at the offices of the All-World Traders, Inc., had gone out to luncheon with Stitt and disappeared.

Bill listened to them grimly, then he bellowed for Scotty MacCloskey.

"Plug up the Lancer," he barked at Scotty. "You've got to do it in an hour."

Bill Barnes was a flaming dynamo during that hour, lashing men to greater efforts.

The sixteen-foot props of the big carrier-transport gleamed dully as a mechanic blasted the two fifteen-hundred horse power, supercharged Diesel engines.

Above and behind the pilot's compartment was a circular platform in which was mounted a rapid-firing one-pounder that could throw one hundred one-inch shells in the space of a minute.

In the midships section of the big

bomber was the hangar of the Eaglet, Sandy's fast little fighter. Suspended by its landing hook from an overhead girder, the Eaglet was locked rigidly in place on the girders, and hung with its cockpit just above the level of the deck.

Behind the Eaglet's hangar was a retractable machine-gun turret that could be lowered below the bottom of the fuselage. Farther down on the port side were two lavatories, showers and wash basins. There was a dining saloon and the living room. In the tail was the galley, with an electric stove, ice box and a machine-gun turret where old Charlie, the cook, held forth.

On the bridge of the monster ship were dual controls and instruments, a Sperry automatic pilot under the pilot's seat, wireless equipment, a new Kreusi radio compass "homing device."

Steps led downward from the bridge and pilot's compartment to a machine gunner's cockpit in the nose, mounted with a .50-caliber gun. Beneath the gunner's feet were bomb sights and releases. In each of the wings, abaft the engine, were inclosed machine gunners' pits similar to the one in the nose. A runway connected these two cockpits with the main fuselage.

"Sandy!" Bill bellowed across the hangar. Sandy's head bobbed around the tail of a Snorter and he came toward Bill, sheepishly. Bill glared at him and said, "What are you doing?"

"Well, you see, Bill, I'm trying to lay a few odds on this trip. I got it pretty well figured out, I think. I'm figuring on percentages. You see, it has been quite some time since Cy stopped a bullet and—"

"Shut up and forget that stuff!" Bill snapped. "Get up in the transport. We'll take her. Shorty is going to fly the Lancer."

"O. K., Bill, but—"

"Scram!" Bill said.

Early in the afternoon the props of the three Snorters, the Silver Lancer, and the monster transport were ticking over slowly on the apron. The goggled, white-helmeted heads of Bill's men jutted above the rim of the fast amphibians. They were waiting impatiently for Bill to signal the dispatch tower.

The motor of Red Gleason's Snorter roared. A signal flashed. The Snorter rolled forward as the brakes were released. Red Gleason grinned and began to sing as he gunned his engine. The tail came up. The concrete faded away beneath it. Red took it swiftly upward in tight spirals, to be joined a minute later by Cy Hawkins and then Henderson.

As the three thousand horses in the Silver Lancer snorted, Shorty Hassfurth flipped a hand of farewell into the air. His flaps came down and the wheels in the wing-tip pontoons left the concrete. The retractable gear rose

smoothly to disappear beneath the fuselage. The Silver Lancer joined the circling Snorters overhead as Bill climbed into the starboard pilot's seat of the transport-carrier.

He slipped his boots into the rudder stirrups and gunned the twin, supercharged engines. He flipped a switch on the intercockpit telephone and checked his crew: Old Charlie, the cook, in the tail; Miles, who operated the landing and loading trapeze of the little Eaglet and the retractable machine-gun turret; Martin up in the nose, who could knock a gnat off a church steeple with his bombs at two hundred m.p.h.; McCoy and Neely in the two machine-gun cockpits abaft the engines. Above and behind Bill's head, young Sandy rode in the circular, glass-inclosed one-pounder turret.

The five ships fell into a tight formation, the three Snorters on each side and behind the transport. Two thousand feet above and a little in front rode the Silver Lancer with Shorty's hand wrapped around the control column.

"We'll be seeing you, Mr. Benedict," Bill said, grimly, as he threw his radio key. He made contact with the other four ships, gave them their cruising speed and course and called Sandy down to take over the controls.

A solid mass of cumulus clouds came racing toward them as the State of Delaware spread out beneath the speeding formation. Skirting the eastern shore of Maryland, they flew above the choppy waves of the Chesapeake Bay and over Virginia. Off Cape Hatteras, Bill took back the controls and checked his bearings carefully. The formation was flying blind now, checking position with Bill every five minutes.

South of Charlestown, South Carolina Bill began to worry. Things were going too smooth. Everything was clicking too nicely. He knew it couldn't last. He threw his radio key to warn his men to keep their eyes open. Twenty minutes later it happened.

The light on his radio panel gleamed red. It was Shorty, riding the Lancer high above and in front of them.

"Formation of twelve planes," he said, briefly. "Flying at about fifteen thousand, keeping a parallel course. Black biplanes with amphibian gear. They're fast. In the sun."

"Calling all planes! Calling all planes!" Bill chanted into his microphone. "Shorty reports formation of twelve planes at fifteen thousand. Keep your eyes open and be extra careful if they attack. We're going to need every ship when we get down in the West Indies. I'll hold the carrier steady on her course if they attack. They—"

"They're coming, Bill!" Shorty shouted into the microphone.

"Come back fast, Shorty!" Bill roared.

He threw the radio switch and connected the interplane telephone. "Battle stations!" he barked. "We're being attacked!"

Old Charlie, the cook, leaped to his station in the tail cockpit as Miles let himself down below the fuselage in the cylindrical turret, his machine gun ready for action. McCoy and Neely were thumbing the sun, their guns ready for action.

The three Snorters closed in, to cut the formation of twelve biplanes in half as they dived on the carrier with their guns streaming tracers and lead. Bullets thudded through her wings and her tail surfaces as they dived by. Martin tore the belly out of one of the black ships as it went by. It kept straight on toward the waters of the Atlantic as the eleven ships came up and around in a sweeping bank.

As the eleven black planes swung back to the attack a silver bullet came out of nowhere. It tore their carefully aligned formation apart like a chaff before a gale. They dived, zoomed and rolled to get out of the path of mad fury that swerved neither to left nor right, its guns belching death. Shorty's hand was wrapped around the control column of that comet with the grip of a python around its prey.

As three of the black ships whipped back to pounce on him, he flipped over like an eagle and dived across their rear. His fingers clamped down on his triggers as he caught one of them under his hair sights. The burst of fire lasted a mere second and a half, but his aim was deadly. The pilot crashed over his stick and the ship plunged to its grave.

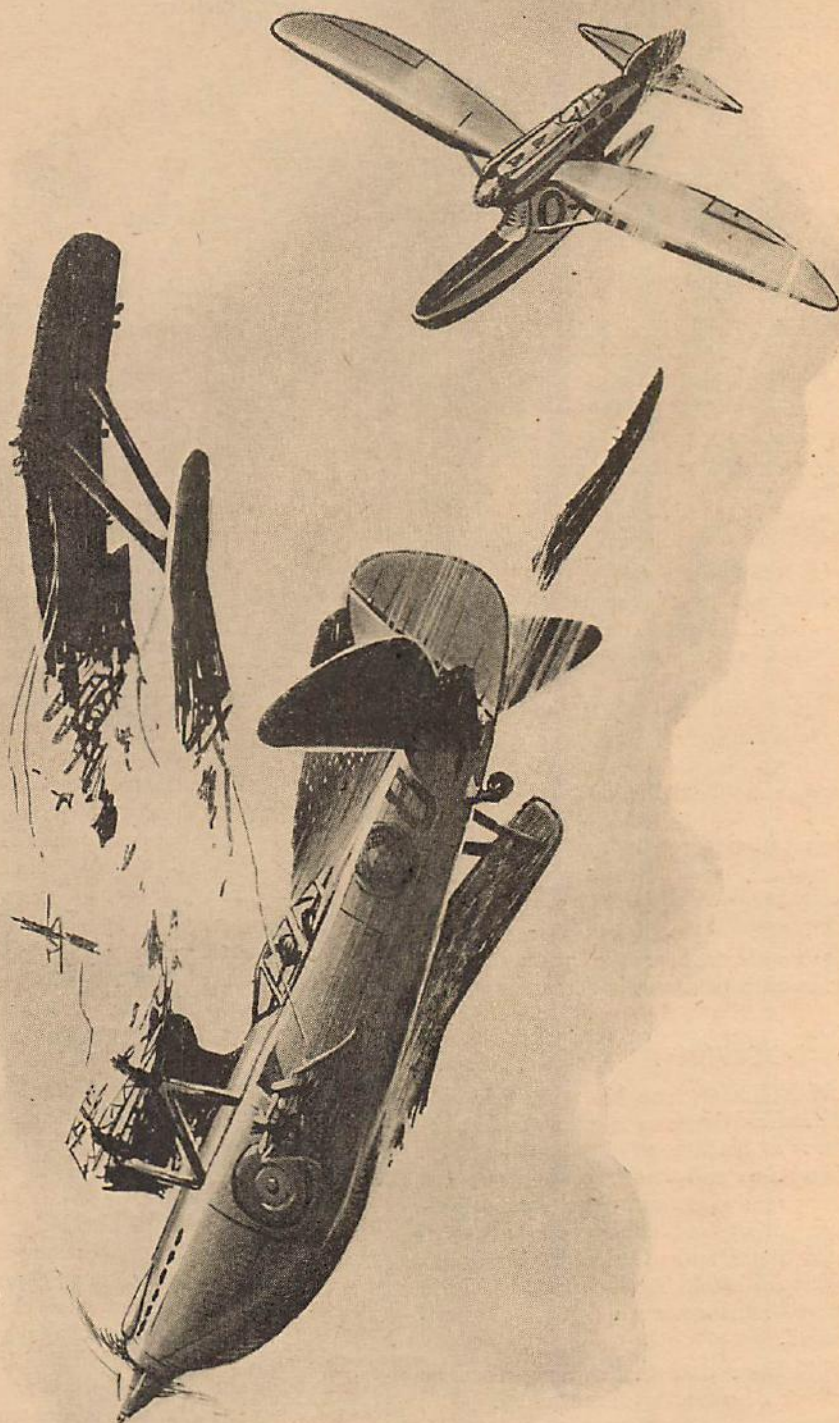
"Give it to 'em!" Bill roared into the microphone while he held the carrier steady on its course. The three Snorters broke away from their position around the carrier. Red Gleason was leading them. He followed a black ship as it pulled steeply up into the sky, went over in a half loop, rolled right side up and came tearing back with its guns bellowing. Bullets ripped across the Snorter's right wing, chopping through the metal skin.

Red cursed as he pushed the stick forward and went into a dive. He felt his machine shudder and tremble as the bullets from the black plane drilled through his tail assembly.

The next second he jerked the stick back into his stomach to zoom vertically up and over on his back. Neutralizing the controls, he opened the throttle and was on the biplane's tail. Hanging head downward, he lined up the black ship in his hair sights and tripped his triggers. Fire and smoke belched from the biplane's engine housing as Red went by it, hanging head down. He threw the stick to the left, rolled right side up and came around in a swirling, vertical bank. He held his fire as the black ship became a whirling ball of red smoke.

Three thousand feet above Red, the remaining biplanes were fighting for their lives in a mad whirlpool of spitting, snarling death. They were not able to get back into formation because each time they tried to maneuver into position a silver bullet ripped their alignment apart.

Far ahead, the carrier-transport kept steadily on its course. In the pilot house, Bill, his eyes glued to a pair of binoculars, alternately cursed and prayed. His eyes glittered with pride as he saw his men outflying, outsmarting and outmaneuvering the black ships that were three to one against them.



Suddenly the wings folded back. The plane plunged.

He saw Cy Hawkins flash over in a dazzling inverted loop to come up under the tail of a black ship. The biplane staggered like a thing mortally wounded. It came up until it stalled, then the nose fell away and it went into a vertical dive that soon became a spin. Cy followed it, his guns pouring lead and tracers into it as it dived. Suddenly, both wings folded back against the fuselage and it plunged like a diving gannet into the Atlantic.

Then Bill became aware that four of the black ships had peeled off from the slashing, ripping dog fight and were trying to overtake the transport.

"Four of 'em have peeled off and are coming after us, kid!" Bill shouted as he jumped for the starboard pilot's chair. He opened the throttles of the twin Diesels and pulled back on the wheel. "The other four are keeping Shorty and the Snorters busy."

The muscles in Bill's cheeks stood out like knots of rawhide as he looked back over his shoulder and saw that the four black ships were preparing to attack.

"Get up and handle the rapid-firer, kid," Bill shouted. "Try to keep 'em away from us."

Sandy raced up the steps and swung the rapid-firer around as the first of the black planes dived on them. Before it was within range of the wing machine guns, Sandy had the ship under his sights. The breech of the one-pounder burned against his cheeks as he clamped down on its trigger. A half dozen savage barks sounded above the throbbing roar of motors. Sandy could almost follow the course of the projectiles as they sped toward their target.

Suddenly the target became a great cloud of black smoke, streaked with dabs of saffron and crimson. Ribbons of bright orange shot out of it as it broke in all directions. The three ships behind it zoomed upward to get away from the bits of wreckage that flew in all directions. Then they dived out of range of the rapid-firer and came up underneath the belly of the transport.

But Miles was there in that smoke-house that was a retractable machine-gun turret. The first black ship took the full force of the shattering impact of those powerful .50-caliber bullets. They tore the prop into a hundred pieces and drove back through the windshield. The face of the pilot disappeared as they tore his head from his shoulders. The nose of the pilotless plane dropped and it went plummeting into the sea.

The two remaining black ships beneath the transport suddenly stuck their noses down in a vertical dive, as they were joined by the two that had survived the dog fight to the rear. The three Snorters and Shorty, in the Lancer, were after them, their guns sending burst after burst into the retreating ships.

"Calling all planes! Calling all planes!" Bill bellowed into his microphone. "Let 'em go! Come back and take your positions. Is every one all right?" They all checked in and answered in the affirmative.

"That was nice going," Bill said. "But continue to keep your eyes open. That was just the beginning. We have plenty of trouble coming our way."

"You're right, Barnes," a strange voice broke in, a voice that made the hair creep at the base of their skulls. "That is the second time you've won, but it is only the beginning. Your real trouble is yet to come. I have another way of fighting your kind of man, Barnes. I'll destroy you and you'll all rot where you fall."

"But you'll die an easier death than Bates is going to die, Barnes," the voice went on. "I'm sorry you can't see him now. You'd never recognize him. He has courage, but we'll break it before we're through with him. I'm going to let him speak to you, let him warn you to turn back while you still have a chance. I think you will still recognize his voice."

None of Bill's men could have spoken if their lives had depended upon it, as they heard Bev's voice come to them through the ether.

"He wants—me—to—tell you—to—turn—back, Bill," Bev gasped, as though his very soul was being tortured. Then, suddenly, his voice gathered strength. "But don't turn back, Bill! Come and get this fiend; destroy him and everything about him! He's—"

There was a scream that chilled the very marrow of their bones as Bev's voice died away. Then silence.

"Bev! Bev! Bev!" Bill shouted into the microphone. No answer came back to him. Bill's hands were off the wheel, clenched in front of him. "Benedict!" he shouted. "Benedict! I'll take you apart with my two hands if you touch him again. I'll—"

A high-pitched burst of laughter answered him. Then there was silence.

X—ISLAND OF THE DAMNED

FOR the next two hours Bill busied himself with checking his position and keeping in constant communication with his fleet. There was no conversation about Bev over the radiophone. Bill knew how his men felt and he raised their cruising speed to three hundred miles an hour. He knew that they would answer Benedict in their own way when they had a chance.

As a wrench and twist suddenly dropped the big transport three hundred feet, little furrows of anxiety formed between Bill's eyes. He made contact with Tony Lamport on Barnes Field and asked him what he had on the weather in the West Indies.

"The barometer is falling," Tony told him. "Storm warnings are being broadcast from South America to Cape Hatteras. If you can find a place to sit down you'd better do it. Are you going to refuel at San Juan?"

"No," Bill said, grimly. "We're going through to St. Bartholomew. I'll keep in contact with you as long as I can."

Bill made contact with his four ships. Clouds had appeared again from nowhere. Fog began to lick at the coated windows as great drops of rain spattered against them. Another air pocket dropped the big ship down seven hundred feet. Bill worked quietly to regain balance, his eyes anxiously scanning the instrument panel.

After the three Snorters and the Lancer had checked in, he spoke to them for a moment.

"Drop back and down, Shorty," he said. "The rest of you stay in as close as possible to me." He gave them his bearings and compass readings. "Check in every five minutes. If any of you don't want to go on through, drop out and land at San Juan or try to make Kingston. It's up to you."

"Nuts!" Shorty Hassfurther growled at him.

Great banks of angry clouds raced by them as darkness settled down. Rain beat against their windshields and hatches like the constant drum of machine-gun bullets. As the wind increased in fury, it bobbed them about like corks on an angry sea. Rain seeped down through the hatches and trickled across the decks and down their necks. They were all flying blind and could not make contact on the radio.

It was three o'clock in the morning when Bill finally got through to his ships again. They had all survived that night of horror and were still holding the course he had given them. He took their positions every few minutes after that.

At four o'clock Bill threw his radio key and spoke to his men again. "I figure we're almost dead above St. Bartholomew," he said. "Nose down and we'll make a landing on the roads. You go in first, Shorty, then Red, Cy, Henderson, in that order. It will be easy to get down when you get out of the clouds."

The five ships nosed down cautiously through the fog and rain. They located the lights of the little coast town on St. Bartholomew and Bill gave them instructions about the harbor, or roads.

A few minutes later they taxied their thundering motors in close to the shore and threw out their sea anchors.

"I want you all to stand by," Bill said. "Shorty, you come over into the transport. I'm going to take the Lancer and find the island where Bev is being held."

They made the transfer in the little

rubber boat Miles inflated aboard the transport.

"Hurry back, will you, Bill?" Sandy said as Shorty came onto the bridge of the carrier. "I don't want to spend any more time with this Pennsylvania Dutch kraut than I have to."

Shorty didn't answer. And when Shorty didn't answer one of Sandy's cracks, Bill knew that he was more than a little worried. Bill dropped one hand on Shorty's shoulder.

"I'll be back in a little bit," he said, "and I'll either bring Bev with me or I'll know how to get him, if——" He stopped.

"If!" Shorty said, softly.

They shook hands and Bill went down the steps and out the port door to the rubber boat. The twin Diesels in the nose of the Lancer were still warm when he worked the electric starter. Three minutes later he lifted the nose of the ship off the waters of the Caribbean and pointed it into the streaks of light that were breaking above the horizon to the east.

He climbed to fifteen thousand feet, to lessen the chance of his motor being heard on the surrounding islands, and began to study the map he pulled out of his chart drawer. He went over the things Bev had told Tony over the radio and picked out the island he imagined it to be.

Just as the sun stuck its nose over the surface of the sea, Bill saw an isolated bit of land surrounded in each direction by shoal water from which jagged bits of volcanic rock rose above the surface.

When he saw the two radio masts and the cluster of white buildings along the shore he knew that was the island Bev had described. It was not more than six miles long and a mile wide at the broadest part. He studied it from an altitude of fifteen thousand feet and decided the only way he could get in was to land the Lancer on the far side of the island from the buildings and fight his way over the ridge of jungle. It was only a quarter to five and he could see no sign of life.

Cutting the Lancer's engines as much as possible, he glided in to a precarious landing among the jutting rocks. He was panting and breathless after he had thrown out his anchor and waded ashore. He knew that he must work fast if he was going to be successful. He held his two fully loaded automatics over his head as the water came up around his chest.

Wading ashore was an easy matter compared to fighting his way through the moderately dense jungle and over that ridge. Bill fought and cursed as he broke his way through lianas and thick bush with mimosa thorns tearing at his face and hands and even penetrating his clothing. When he reached

the top he threw himself down in the lush vegetation, tried to regain his breath.

He looked at his watch and saw that a half hour had passed since he climbed over the side of the Lancer. He forced himself to his feet and began the last half of his journey. He knew he must be more careful going down this side, in case life had begun to stir on the island.

Almost before he knew it he was at the edge of the jungle and only fifty feet from the long, rambling white house that stood on the side of the hill. He watched it carefully for five minutes before he moved.

Then he moved in a manner characteristic of him. He remembered that Tony had told him Bev was being held captive in a long, rambling white house in which Benedict lived. He knew the house would be guarded. So he depended on the element of surprise.

He broke out of the jungle on the run and headed straight for the closest door of the house.

No sound came from inside the house. Bill turned the knob carefully and noiselessly. The door yielded to the slight push he gave it. He slipped inside and stood motionless. After a moment dim voices came to him from the other side of the house. He glided across the room as silently as a jungle cat, slipped through the doorway on the other side. An automatic was in his right hand, ready for anything that awaited him there.

The voices became more distinct now and a peal of laughter that came from the big room across the hall made Bill's blood run cold. It was the laughter of a man gone insane.

Bill moved down the hallway, inches at a time. When he reached the doorway he heard a voice droning on and on in a tone of deadly monotony.

"—and that's the end of that, Bates, my boy," the voice said. "I hope you're not uncomfortable."

All of Bill's senses became alert. His whole body tingled. He forgot that he had flown all night without any sleep and that his face and hands were covered with blood. He forgot that his clothes were sodden from perspiration and sea water and that his whole body ached. He forgot everything but the fact that Bev was in that room.

He stuck his head cautiously around the corner. The sight that met his eye sent such a surge of anger through him that he held himself in check only by closing his eyes and using all the power of his will.

He saw Bev's battered, gaunt face slumped forward on his chest. But there was a sneering smile of defiance on his lips. He was tied to the chair in which he sat, to keep him from falling out of it. In front of him sat a man with a

rather pleasant face and a bald head. Bill knew, instinctively, that this was Benedict. Beside him sat a man with a scarred, twisted face—McLaury, the doctor. Behind Bev stood a surly-looking guard with an automatic strapped to his hip.

"You'd better give him something to bring him around a little more, doctor," Benedict said. "I know he'll enjoy hearing how we're going to pull his toe nails and finger nails out."

The doctor reached for a little bag that sat before him, opened it. He pulled out a bottle, removed the cork.

It was then that Bill stepped into the room. Benedict and the doctor did not see him at first because their backs were toward him. But the guard did, and went for his gun.

Bill shot it out of his hand, then shot the bottle the doctor held out of his hand.

And when Benedict whirled around, he saw certain death in Bill's eyes. He made no motion to reach for the little automatic he always carried in his pocket.

"Unfasten those ropes!" Bill snarled at the wounded guard who stood holding his hand. He had made no effort to retrieve his gun. Bill walked over and picked it up and stuck it in his pocket. The guard leaped to the task.

"You'd better hurry up, Benedict," Bill said, "if you're going to cause me to rot where I fall."

"Barnes!" Benedict gasped and his face turned a shade paler.

"Barnes!" Bill mimicked. "I ought to do what I said I would do over the radio. I ought to take you apart the way a butcher fixes a chicken for fricasseeing. But I won't. It would be too good for you. I'm going to take you where you'll rot for the rest of your life. If any of your men heard that shot and try to get in here you'll be the first one to die."

Bill lifted the half-conscious Bev out of his chair and carried him over to a davenport. He looked at the doctor. "Do you have anything that will bring him around so that he can walk?" he asked.

"I think so," McLaury said. His scarred face was rigid with fear. "I—I am not responsible for this. I——" His tense voice trailed off.

Bill didn't answer him. He bent over Bev and tried to get a word from him. That's when Benedict made his mistake. When Bill's back was half turned, he jabbed a hand in his pocket to get the little automatic. Bill saw him from the corner of his eye and his movements were so fast no one in the room could follow them.

He swung around, took two long steps with the speed of lightning. He caught Benedict's wrist, jammed the arm up and behind him with all his strength.

Benedict screamed as the bone snapped with the noise of a cracking timber. Bill threw him across the room so that he landed on his face.

"That'll give you an idea of how I feel about you," he said, viciously. He turned back to Bev. Bev's eyes were open and he was breathing deeply.

"Where is Emerson?" Bill asked him.

Bev pointed at Benedict as he was getting to his knees. "He killed himself yesterday after he saw me. They had him chained to a worktable in the laboratory, like a slave or an animal. Kill Benedict, Bill. He isn't fit to live."

Bill had never seen such hatred in any man's eyes as he saw in Bev's at that moment. He shook his head, slowly.

"Barnes," Benedict cried, "twelve of my planes are on the way here to wipe you and your men off the face of the earth. I'll countermand my orders and let you live if you'll give up this job and not go any further with it. I'll never bother you again. I——"

"You're going to rot!" Bill snarled. "I'll take my chances with your men. Get up on your feet. You're going up over that ridge back of your house and down the other side to my plane."

"I can't make it, Bill," Bev said. "I haven't an ounce of strength yet."

"You," Bill said to the doctor, "and that plug-ugly over there, are going to carry him. Tie that kit of yours around your neck. You may need it. Bind up his hand first. He has a job in front of him and will need all his blood."

Bill circled the room, looking out of all the windows. It was only six o'clock. He saw but one man and he was down near the water front.

"You go first, Benedict, and if you try to make a break I'll make a sieve of you. You two form a seat with your hands. That'll be the easiest way."

He knew that only a miracle could get them across that fifty feet of open land without being seen. But they got across and they fought their way up over the ridge and down the other side with Bill kicking them to keep them moving. He made them carry Bev out to the rear cockpit of the Lancer and put him in it. He bound Benedict's hands and feet after he forced him in beside Bev. Then he told McLaury, the doctor, to get every one out of the buildings on the island as he was going to level them with bombs.

Bill took the Lancer through that gantlet of jagged rocks, missing some of them by only inches, and lifted it off the water.

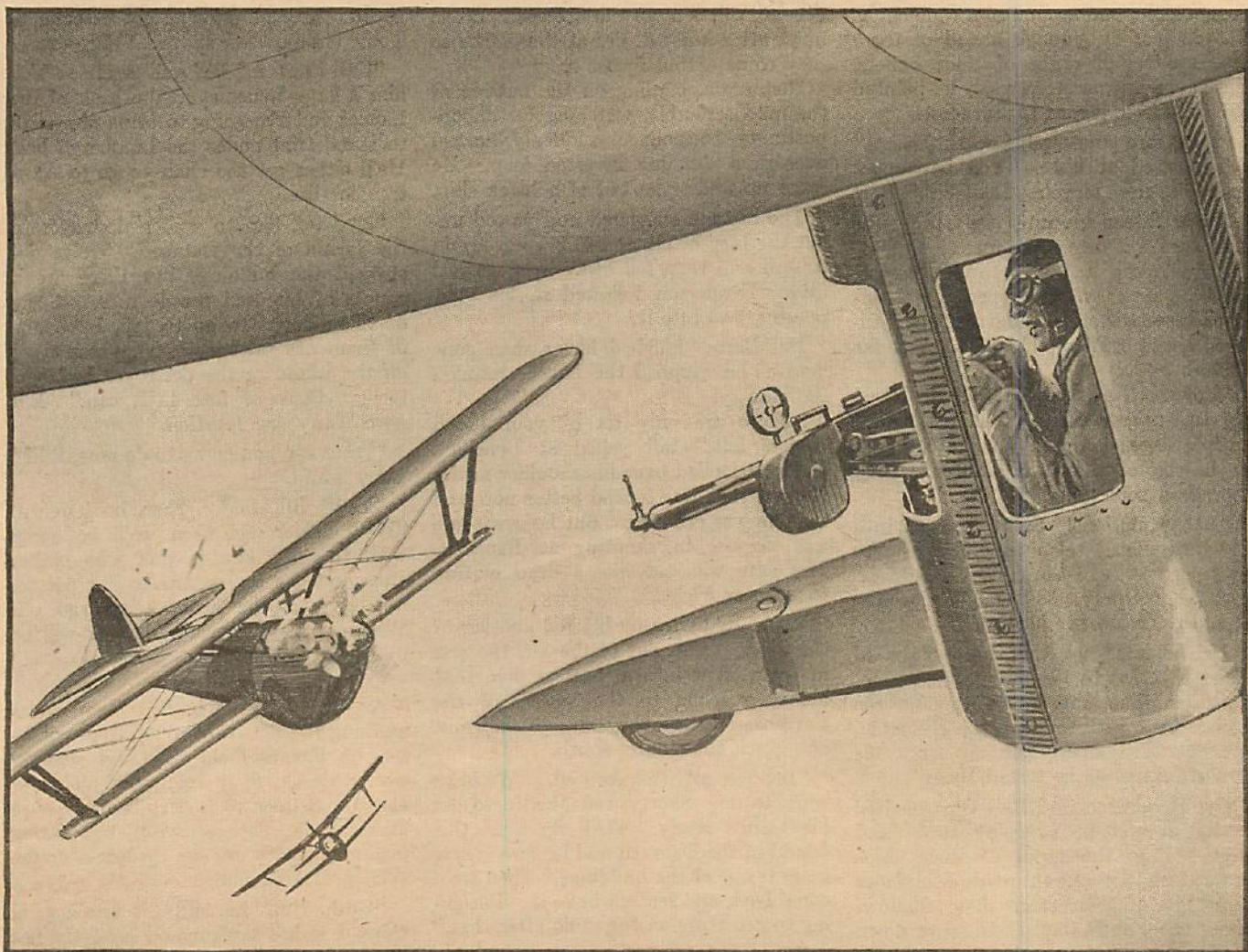
He was only a hundred feet off the water when the twelve black ships Benedict had mentioned appeared a mile away at an altitude of five thousand feet.

XI—DECORATIONS

THE FAST little single-seaters were on Bill before he could get any altitude. They dived at him from all sides, their guns blazing. Fire streaked from their cowled noses as they converged on the Silver Lancer.

Bill's coördination was perfect. He knew it was utterly impossible for him to escape being hit by more than one stream of bullets. He smiled grimly as he thought of Benedict in the rear cockpit. Then his mouth became a savage slash across his face as he opened the Lancer up until all her horses became a deep, mighty roar, and yanked the stick back into his stomach.

The nose of the big ship swung upward as the main float and wing-tip pontoons snuggled up into the belly. It hurtled vertically toward the sky. Bill felt the ship tremble and balk as the first hail of lead struck it. He tried to get one of the ships under his own sights as his finger caressed the electric trigger



Miles, in the retractable turret, met the first ships with the full force of the .50-caliber bullets.

of his guns. Then, in a blurred image, one of the black biplanes tore across his sights. It was gone in a split fraction of a second, but in that time Bill's finger tightened on his gun trip and he drew a line the length of the fuselage. The ship yawed wildly and flames billowed out from its engine almost immediately.

Bill glanced back over his shoulder after that first terrific onslaught and the ships had passed beneath him. He saw that both Benedict and Bev were untouched. But the look of fear on Benedict's face gave him a thrill of pleasure.

As soon as Bill was clear he flipped his radio key and began to chant Shorty's call letters into the microphone. When Shorty answered he told him he had Bev and Benedict in the rear cockpit. Then he told him to order the other ships into the air immediately and join him.

"Twelve of those black biplanes are sweeping around to come back and get me," he said. "I'm going to lead them away from St. Bartholomew until you get your engines warmed up and get into the air. Then we'll take them apart."

Bill couldn't help laughing at the desperate attempts of the eleven remaining biplanes to shoot him down. He led them around and around in a wide circle, staying just far enough ahead of them to keep out of range of their bullets. He laughed some more when he pointed out the black planes to Benedict.

"There are your twelve death dealers," Bill shouted at him. "You better get 'em some new bicycles, Benedict."

After fifteen minutes he stuck the nose of the Lancer northeast. He saw the transport and his three Snorters spiraling upward. He opened the engines of the Lancer wide and sped toward them, leaving the black ships far behind.

"Protect the transport!" he bellowed into the microphone. "I have the bird who is responsible for all the attacks on us in the back of the Lancer. Let's show him something!"

"Battle stations!" Shorty roared into the interplane telephone aboard the transport. "Take the controls, kid," he shouted at Sandy. "I'll handle the one-pounder. Hold her steady."

He bounded up the short flight of stairs that led to the circular platform. He saw that Bill was bringing the Lancer back with the throttles still wide. Tracers were lacing the air from his powerful guns as he tested them.

Cy, Henderson and Red Gleason had swung around in sweeping turns and were pulling the noses of their ships upward as the eleven roaring biplanes came out of their steep dive, shallow-dived once, and stuck their noses down barely two hundred yards away from the carrier-transport.

Shorty could feel the big bomber tremble as the lead from their guns drummed into her. He swung the revolving gun turret around so that he would catch them in his fire when they raced past.

Bullets beat a tattoo on the nonbreakable glass of the circular turret, spread themselves out in little masses of white powder, with touches of black to show where they had struck the bulletproof glass. They thudded through the wings and tail surfaces as the biplanes dived by.

As the planes streaked downward, Shorty held his hand wrapped around the grip of the one-pounder and his eyes glued to the telescopic sight. For one brief instant one of the black biplanes came under his sights, then another.

His fingers closed down on the trips as the first one passed. The breech of the one-pounder burned against his cheek as it throbbed and roared in quick, staccato bursts. The powerful projectiles sped true to their mark.

The two black planes became two clouds of black smoke, streaked with dabs of flame. Débris flew in all directions as their two engines plunged toward the sea.

Martin, in the forward gunner's cockpit, and Miles, in the cylindrical turret beneath the belly of the transport, drove burst after burst of fire at the planes as they came within focus.

Henderson, circling on the outside of the mad scramble, watching for an opportunity to pounce, suddenly flashed over in a dazzling inverted loop. He came up under the tail of a black ship.

The biplane staggered and yawed under the fury of his guns. It spun up on its tail and then fell away in a vertical dive. Henderson followed it, his guns pouring lead into it.

Bill Barnes laughed like a man gone mad as he whipped the Lancer through the air.

"There are only six of your death dealers left," Bill yelled at Benedict. Then he looked over his shoulder again. He saw that Bev looked better now and that he was grinning. But he saw there was no use in shouting at Benedict. The man was out like a dead herring from sheer fright.

When Red Gleason blasted another of the black planes out of the air, the rest of them went into a vertical dive that almost reached to the waters of the Caribbean before they straightened out and stuck their noses south.

"Let 'em go!" Bill shouted. "We have work to do. Shorty, tell Martin to get his bombs ready. We'll fly over this Island of the Damned and be sure everybody is out of the buildings. Then we'll come back and let 'em have it. I'm going to get Tony on the radio after that."

They circled back over the Island of the Damned and saw that all of the in-

habitants were clustered a mile away from any of the buildings.

"Tell Martin to let 'em have it," Bill said to Shorty.

Three times the big transport circled above the buildings along the water front, and each time it laid two of its thousand-pound eggs. The transport bounced upward as each of those powerful bombs drove into the ground. Black smoke welled out of the buildings as they caught fire. Orange flames welled out of the smoke and shot skyward.

Bill dived the Lancer low and destroyed the pier and boathouse on the water's edge. Then he dropped two twenty-five-pound bombs on the hangar and saw the two planes inside catch fire as their gas tanks exploded.

"That's the end of your laboratories, Benedict," Bill yelled. It was the first time he had ever had an enemy in his plane while he destroyed his property; Bill was enjoying it. Bev spoke to him through the intercockpit phone.

"There isn't any use in talking to him, Bill," Bev said. "He's so frightened he's in a comatose condition. If any one said 'boo!' to him now his heart would stop."

"The big dealer in death," Bill sneered. He reached for the radio key and flipped it. In three minutes he got through to Tony Lamport on Barnes Field.

"Call Morton," Bill said to him. "Tell him I have Benedict in the back of the Lancer and I'm going to bring him back to stand trial under the Lindbergh law. He'll either get the chair or go to Alcatraz for life."

"And tell him to send a destroyer to the Island of the Damned. We've destroyed the buildings but there are a couple of hundred people there. Some of them ought to go to jail, but some of them are prisoners. They can't get off the island so the destroyer had better get there as fast as it can." Bill gave Tony the location.

"What are you going to do now, Bill?" Tony asked.

"Me?" Bill said. Then he laughed. "We'll refuel and then we'll be home with this big kewpie doll who makes guns and gas and germs to kill people, but faints if he hears a gun go off. Whatever they have at Alcatraz will be too good for him."

A WEEK LATER Bill Barnes was working in the living room of his quarters on Barnes Field. He was working over a design for a fool-proof plane for the Department of Air Commerce in Washington. Young Sandy was sitting in a chair, with one leg thrown over the side, bothering him.

"Gosh, Bill," he said, "it was a good thing I didn't lay any odds on Cy not getting back from that last trip. I sure would have lost my pants."

Bill didn't answer him. When the telephone rang a moment later, he scowled and pointed at it. Sandy spoke into the mouthpiece and then hung up.

"It's Morton, Bill," Sandy said. "He just landed in a plane from Washington."

Bill groaned.

Sandy answered the knock at the door a few minutes later.

Bill shook hands with James Morton and wondered what was coming now.

He made up his mind that he wouldn't help under any circumstances.

But after talking a few minutes, Morton shot his hand into a side pocket and drew out a small package. He unwrapped it and a half dozen little leather boxes came to view.

"I came all the way from Washington to bring you these, Bill," Morton said. "It's all very hush-hush. No publicity or anything."

"What's in 'em?" Sandy asked.

"Decorations," Morton said, and he flipped the tops open. "The six most powerful nations in the world have sent you their highest decoration through me, Bill."

"Is that all that brought you here from Washington?" Bill asked.

"That's all," Morton said.

"Well," Bill said, "at last I get a break. Give 'em all to Sandy—he's saving 'em."

"DEAR HARRY—"

(Continued from page 34)

out. Then I wouldn't get a chance to wash you out," he snarls.

I don't understand what he's talking about, so I look down again. We're not fifty feet high and coming down very fast. We're heading for the pond.

Whoosh!

We hit the water—and the mud. It seems that the pond is made up of mud and water in equal parts. Mud rains down on me. When the shower stops I look at Easton and have great difficulty in recognizing him. Getting the worst of the mud bath, he is covered completely. But even as I watch he lets out a war whoop.

"Now!" he shrieks. "I'll fix you!"

He lunges at me, but his safety belt, which he has forgotten to unfasten, holds him back. In the split second it takes him to loosen the belt I'm out of the cockpit and floundering through the "aquamud" for the shore. Easton is after me in no time, but once on solid ground I break into a sprint which leaves him far, far behind.

I do not return to the airport that day, in fact not until next morning. By then my dear instructor has cooled off somewhat and my life is safe. By the way, though, Easton is no longer my instructor, having turned me over to another pilot.

Can you beat it? Norwood has the nerve to ground me for a week. Just because Easton landed the plane in the mud. As though that was my fault. And not only that, but he makes me clean every last speck of mud off the ship. This, in addition to my job as helper to the mechanics, which job he assigned to me so I could work out the repair bill on the previous crack-up.

Well, time drags along slowly the first few days of my enforced confinement to the ground. I occupy myself, on the few occasions when the mechanics do not need my inexperienced help, watching the other students take off and land and wishing I was doing the same.

Then one day at the noon hour, when all the planes are down, a student named Kelvin approaches me. He looks around carefully before speaking.

"Say, want to go for a ride?" he inquires.

"I'm not supposed to get into a ship for a week," I answer.

"Aw, forget it," he says. "Come along with me. I've never carried a passenger yet and I want to see how it feels."

I hesitate.

"It's O. K.," he goes on hastily, mistaking my hesitation. "I can fly as good as anybody on this field, even if I have had only nine hours' instruction."

"All right, I'll go," I say. And we arrange the details.

Five minutes later Kelvin taxis slowly by the hangar. Nobody seems to be looking so I run and jump into the front cockpit.

"Stop!" comes a bellow to my ear. Norwood's voice! Of all people, he is the one who must happen to walk out of the hangar at just that moment.

Kelvin doesn't stop. He slams open the throttle and roars the plane down the field. Up we go, come down, bounce off again and tear away, almost carrying some telephone wires with us.

We circle the field. All is confusion below. Plane after plane is run out. Motors are started.

"They're going to chase us!" Kelvin yells. "We'll fool 'em."

He levels out our plane and opens the throttle. We fly away from the airport, low and fast. When it is out of sight, Kelvin sends the ship down for a landing. I brace myself. The wheels hit hard. We lurch, bounce, and skid and finally come to a stop on a farm field.

"Now watch," Kelvin shouts.

The humming of many motors comes out of the south. A minute or two later eight ships roar by overhead, high and fast. They fade into the distance. It not occurring to them to scan the ground, Norwood and his gang have passed us by.

We climb to the clouds and drift along lazily for a while. Suddenly Kelvin cuts the motor.

"How about an ice-cream soda?" he asks.

"Sure," I reply.

Down goes the nose of the ship. We dive to a low altitude, spot a town and glide down to a small field. Kelvin

makes a two-point landing in the center of the field, kills the motor, and we roll straight for a barbed-wire fence.

"We're going to hit it!" Kelvin yells.

But we don't.

Thud! The wheels drop into a ditch. The ship rises up on its nose and stays there. Luckily, the prop stopped in a straight-across position and thus escaped injury.

"Well, well, we nosed over," Kelvin says cheerily.

"Yeah, we did," I agree. "Now how are we going to get the plane out of the ditch?"

The problem is soon solved. From every direction kids come running to see the "crashed" airplane. When about fifty have arrived, I go into action.

"Some of you climb up on the tail," I command.

They swarm up the fuselage and their weight does the trick. Down comes the tail.

"Now grab the wing and help push," I order.

Kids of all ages line up along the lower wing and heave. The ship rolls out of the ditch.

"Good work," I commend my army of small helpers. "For that you'll all be treated to ice-cream cones."

What a cheer greets those words! And then it's a case of forward march to town and the nearest drug store.

All is swell. Kelvin and me—our finances somewhat reduced—are devouring ice-cream sodas when in walks Trouble—Trouble in the form of the town policeman.

"I just got a telephone call to be on the lookout for two student fliers, same if located to be held until called for," the town policeman orates. "You two answer the descriptions. What have you got to say for yourself?"

Kelvin can think of nothing to say, but I can think of plenty.

"Why, officer," I say, "surely you don't believe that we look like student pilots. It's incredible. My friend and I have been flying since the beginning of aviation. In fact, we piloted the original Wright biplane on a number of occasions."

The town policeman cracks a grin at that.

"Well, well, well," he says. "At that

rate you must have started flying very young, yes indeed, very young. But come along. We'll ride out to your plane and I'll see if it fits the description I have. If it does, you're the two I want all right."

We walk out to a car. On the way I manage to whisper a few words to Kelvin.

A short drive takes us to the field where the plane stands waiting.

"Hm-m-m," muses our friend the policeman, "that looks like the plane—"

At this point I leap from the car, Kelvin following. We vault the high barbed-wire fence, dash to the ship. The town policeman is after us in a second, but barbed-wire-fence jumping is not for him and he loses time crawling through.

We fall into the cockpits; Kelvin shoves the starter. The motor catches on the second turn. We sweep down the field and fly away—very happily indeed.

"Let's go home," suggests Kelvin. "I've had enough excitement for one day."

I'm agreeable, so we set sail for the airport.

"Want to handle the ship a while?" Kelvin asks.

I do, and take over the controls just as the motor goes dead. I swallow hard and look at the gas gauge. Empty.

I look over the side. The country below looks very poor for forced landings. I suddenly discover that the plane with motor dead feels heavy, lifeless and seems to be falling like a stone.

The ground is rising up to meet us with terrific speed.

"Better take the controls," I call to Kelvin. He having had nine hours of flying instruction to my five, I figure he is the man for the job of making the forced landing.

"No, no, no," Kelvin says very politely. "You can make the landing. Go ahead."

I am surprised at this courtesy.

"But you've had more experience than me," I remind him.

For some reason there is a strained expression on Kelvin's face.

"That's all right. I'll bet you can fly as good as me any day," he replies with politeness supreme.

I look over the side again. I do not feel at all confident about making a forced landing. For that matter I can see no place to land.

"Listen"—I turn back again—"I don't think I can manage a landing. You'd really better do it."

Oddly, little drops of perspiration are coursing down Kelvin's brow.

"I couldn't think of it," he protests. "I wouldn't deprive you of the chance of getting some experience in forced landings."

I give up at this unbounded generosity, and, with a sinking heart, turn around, prepared to do my best and expecting the worst.

I find a huge haystack staring me in the face.

Whump!

We hit the hay. The plane tries to force its way through the stack, gives

up and falls back on its tail with a crumpling sound.

I give a great sigh of relief and climb out of the cockpit. Kelvin does likewise. Strangely, his legs are weak, for he holds to the plane for support.

Arriving back at the airport an hour later—on foot—we receive a scorching bawling out from Norwood and learn that we are both grounded for two weeks. And, furthermore, we are told that we are going to spend just about all our spare time helping the mechanics, until we have earned sufficient to cover the cost of rebuilding the tail of the plane. And that is not so hot. The mechanics are a jolly lot to work with, but it gets awful tiresome running around fetching tools, etc.

Next day, I accompany a gang of mechanics to the scene of the crash.

"Who was at the controls when the ship came down?" Brant, the head mechanic, inquires of me.

"I was," I answer, and while I'm about it, tell him of Kelvin's politeness in letting me have the job of making the landing.

Brant listens with interest.

"More than polite, wasn't he?" he says at the finish, with a half smile. "Much more."

I don't know yet what Brant meant by that. But somehow I feel it has some connection with the fact that Kelvin is now known far and wide by the nickname, "Politeness."

Well, keep an eye peeled for my next letter. In two weeks I'll be in the air again and then—

Yours,

STEVE.

NOSE DIVE

(Continued from page 22)

She didn't move. She kept looking at him. "You're not being archaic, are you? You're not going to tell me you won't admit women are as good as men, in the air?"

"I'm not going to tell you that," he said. "But—"

"But you think it!" Her trim little head nodded incredulously. "The masculine ego is an amazing thing!" she said. "Smug! That you, Larry Oliver, holder of the men's transcontinental record—holder of most of the air records—should refuse to take a chance of being beaten by a woman! It strikes me as pretty poor sportsmanship."

The hollows in his cheeks worked. "Whether or not I fly the race," he said quietly, "it's a man's race. I wouldn't put you in it, if I could. But," he added significantly, "the air is wide open."

"Meaning?"

"I'm only a man, of course," he said bitingly, "but—if there was any sky-

running I wanted to get into, and I had a ship, I don't know of anything that could keep me out of it."

She considered him thoughtfully a moment. "But if you were not officially qualified, it wouldn't count if you did win."

"Not officially perhaps"—he shrugged—"but that wouldn't make much difference to me. However, as I said, I'm merely a man."

Her lips narrowed. After a moment she said: "What did you mean by 'whether you fly the race or not?'"

"Things happen," he said carelessly. "What are you flying in the derby?" she asked suddenly.

His glance followed hers toward the clipped ship. "Not that," he said.

"But you were considering it?" she asked, shocked.

He made light of it. "A man can't ignore speed."

Her eyes reproached him painfully. "To think you'd let yourself slip so far!" Her head wagged sadly. "Anybody with your ability and accomplishments—it's really criminal, you know.

Why, with all the opportunities you've had, you should be so firmly entrenched in aviation—the commercial side of it—that manufacturers wouldn't dare try to freeze you out!"

"Who said they're trying to freeze me out?" he said testily.

She merely glanced at him. "I don't suppose," she said, after a moment, "you'd consider flying a Manley?"

He met her eyes squarely. Something deep within him smarted. "Thanks," he said grimly, "I wouldn't. Not even yours."

"All Manleys look alike," she said, coloring.

"And fly alike," he said brutally. "Nice motors for sewing machines. Dandy for ladies." He was hating himself. "Sporting of you, though, to offer."

Even her upturned chin went red. "I would scarcely have dared offer you *The Swallow*. Your masculine pride is so easily outraged. And *The Swallow* is rather conspicuously a lady's ship."

"Your feminine insight," he said caustically, "probably tells you, too, why.

If I fly the race at all, it won't be in a lady's ship."

"It does," she said with finality. "And I can only say of you that as a flier I think you're utterly stupid."

"And I can only say of you that as a lady you're utterly lovely."

"Interesting!" She sniffed. "Good morning."

He grinned at her retreating back.

NEAR THE HANGAR, Runt stopped Larry. "What are you going to do about her?"

"Who?" Larry turned on him, glaring.

"The ship!" Runt said, backing off.

Larry relaxed. "That egg beater of yours? Nothing. And if I were you, I'd give it to the bakery."

They walked on a few steps in silence. When Runt spoke again, it was in a different tone, lower, disconsolate. "Larry, the nut's waitin' for you again."

"What nut?"

"The cracked one—the guy with the pipe dream about the motor that's goin' to revolutionize aviation!"

"Oh, Stephens!" Larry grinned. "I'm in a swell mood to see him right now—for the last time!"

Joseph Stephens, grayer, more bent than usual, was studying the silver-and-black Benton on the line. His hands were crossed behind his shabby coat and his pointed, parchment face was twisted over his frayed collar at an inquisitive, rapt angle.

Somehow, Larry didn't have the heart to insult him.

IN THE chill, dark moments before dawn, the airport was a hive of activity and a blaze of floodlights under a hood of black. Dark figures scurried everywhere; motor cars raced back and forth from hangar to hangar; men with fluttering white satin badges were all over the place. The fence surrounding the field was surrounded by restless, expectant faces fading into the black. The transcontinental air derby for men would be starting any minute now.

Inside the administration building, in the dimly lighted corridor, Larry stood staring out the window at the preparations for the take-off. His face was drawn and tense from lack of sleep, and his hand shook with nervous fatigue as he fingered his cigarette.

The ships were moving up to the line leisurely, one by one. They glistened and glowed in the bright, false light. There were planes of every design: rakish, low planes; high, snooty planes, sturdy biplanes, bulletlike monoplanes with thick wings. They came forward like great, fantastic birds, to prescribed places in the line. Eight in all were lined up in the glare.

Larry glanced at his wrist watch. Minutes, merely, before they'd be get-

ting the starting signal. Something went to pieces inside him. He flung his cigarette at the floor. He whirled toward the door marked "Private."

What were the officials taking so long about? Couldn't they say yes or no? What difference did it make to them what type of motor Stephens designed? What difference did it make to anybody—except Stephens. Poor Stephens! What had become of the eccentric little man? He had been out of his head with excitement at midnight. He must be a raving maniac by now. It meant such a lot to Stephens! The realization of his life's dream. Dream? To Larry the whole thing was more like a nightmare. It was too fantastic, too unbelievable.

From the moment the little man unlocked the door to his barn laboratory and uncovered his motor, everything seemed screwy. Even Runt had acted screwy at sight of that motor! It was a radial of a sort, but that metal, conelike thing pointing backward—

Runt had even forgotten to be profane when he asked about that. Runt knew his internal combustion motors, but he didn't know turbines, nor what a combination of the two might do. But he was curious, and he was quick. Runt had never worked so fast. He had the motor out of the Manley in nothing flat. Before Emily's butler made it pretty apparent that she couldn't be reached by telephone, Runt had the new motor installed. Then, there was the test flight, the agreement with Stephens, and this—this waiting business.

Larry walked over and kicked the door marked "Private."

It opened.

Mr. Leonard Wingate, with a bunch of papers in his hand, looked over the rim of his glasses. "You'd better get your ship on the line, Oliver, if you're flying in this race."

"Is the ship qualified?" said Larry.

The glasses came up at him curiously. "Where have you been? We sent word to your hangar that it was qualified."

Larry went through the door of the administration building on the run.

The starting flag was coming up as he taxied onto the field. It faltered. When he was wing and wing with the outside ship, he adjusted his goggles and peeked down the line.

Propellers were spinning and idling in the brightness; heads bobbed in cockpits; a few were stationary, alert. The noise was deafening. Clouds of dust sped along the ground behind the ships, spreading loose gravel.

Mechanics and officials leaned against the blasts and ran, tilting through them, when they had to. The air was thrashed with snorting bursts and impatient churnings. The fences bulged inward under the press of eager faces in the darkness. Shouts were coming from

some of the faces. But what they shouted was lost in the conglomerate roar. The flag came up—

Larry locked his safety belt. Something caught his eye in Hangar No. 3: Emily Featherstone's white *Swallow* glistened vacantly near the great doors. But, from behind it, a ship was being run hurriedly. Silver and black. Cyril Porter! What the— And Porter was already in it. Probably couldn't even walk, the crazy fool. They'd rushed him to the hospital yesterday with appendicitis. He must have talked them into postponing the operation until after the race. Foolish of him, chancing the long grind. All the same, that was the stuff fliers were made of. Catch a woman doing that! He glanced at the vacant white ship again. Well, she'd win the women's derby. That was as it should be.

The silver-and-black ship swung into the line at the other end. The flag came up, steadily now. Motors roared one more last swelling clean-out. Chucks were pulled from under wheels. Motion-picture cameras, press cameras and broadcasting announcers were busy on all sides. Figures scurried. Shouting was general, unheeded. Larry signaled his thanks to his line crew. He looked for Stephens. There was no sign of him in the commotion. There was a tense lull. The flag dropped.

The roar was spontaneous. There was a dash of ships forward. They sped onward and upward like a flock of birds frightened to flight. The air throbbed with battling concussions. The swarm lifted above the field's whiteness into the dark heavens.

Larry watched the dark space behind him, full of wing-tip lights. He had got a good start. He hoped he could hold it. It would be terrible back there in the thick of that drove, watching all sides and top and bottom, watching speed and position, too. They would stick pretty close together, for a while, most of them. He knew almost all the ships, and most of the pilots. It would be some time before they would start stringing out.

He wished he knew his own motor as well as he did many of those trailing him. All he knew of his motor was from that brief test flight. It had performed then with a baffling lack of vibration and sound, and turned up a good speed—as far as he dared push a new motor. It might develop real speed, once it was properly broken in, or it might not. He could only fly and keep hoping. He settled down into his seat for the long grill. As lead ship, he had to watch his course. He knew the course. He tuned in his directional radio.

"Weather fair. Visibility unlimited. Light rain over the Alleghenies."

He dialed an all-night broadcasting

station. Music was good company in the air.

He watched the dawn break over his shoulder. It was a clear, cool-looking dawn, filled with scattered ships. He saw the pale, new sun casting long shadows on the filmy earth. That moment, the birth of day, always gave him a strange, peaceful feeling in the air.

He looked behind again. The ship nearest him was familiar. Silver and black? Yes, it certainly was Cyril Porter's ship! He'd have to give Porter credit, appendix and all! He'd never considered Porter much of a flier, even if Emily Featherstone did. But, in a Benton—

Larry eased his throttle forward a touch. He frowned. He didn't like driving the new motor too hard, especially not this early in the game.

He tuned in for reports. A head wind was slowing the field noticeably. Two ships had dropped out; one crashed in Pennsylvania. "One fatality. Pilot is—"

Larry dialed music.

Near Cincinnati his oil pressure began running up and his motor started heating. He throttled down a bit. Before he realized it, the silver-and-black ship was upon him, beside him. He looked at the pilot, puzzled. That was not Cyril Porter! He looked closer. The chin under the goggles broke into a smile. Larry stared. Emily Featherstone!

Larry worked at his telephone. "F C 7 calling K 7-2," he kept repeating. "F C 7 calling K 7-2."

Finally, a disguised voice answered: "Yes? This is K 7-2."

"What are you doing here?"

Her amused laugh answered him. "Taking your advice."

"Mine?" he howled.

"You said if there was any sky-running going on that you wanted to get into you didn't know what could keep you out of it—if you had a ship."

"Oh," Larry said lamely. "But—that ship?"

"Careful!" she warned. "The air has ears, you know. And it was your suggestion. Besides, this ship is entered. Friend of mine—at the hospital, you know—did me a favor."

Larry got it then. Cyril Porter let her take his ship, helmet and all. And Porter's ship was qualified. The nerve of her! But he grinned across the space at her. Into the telephone he said: "Since you're with us, I might as well wish you luck!"

He fancied he saw her light-blue eyes blink tauntingly behind Cyril Porter's goggles. "Thanks," she said. "Same to you—so you can make my check good."

"Oh," he said. He'd forgotten about that damned check. He'd made it out to her for the Manley, when he couldn't reach her by telephone. He'd left it for

her with Runt. It wouldn't be any good, of course, unless he won the race. There was a fat purse for the winner, and then there were other revenues— She might expect some explanation from him, though, for running off with her ship without warning her. "Did Runt tell you—"

But the connection was dead. She had switched off.

He opened his motor a little more after that. It would not do to let her stay too close. You couldn't trust these women. Slowly, he pulled away from her.

At St. Louis, his first refueling stop, he was better than fifteen minutes ahead of his own former record. There was a big crowd at the field and the usual fanfare of cameras, pressmen and a lot of irritating nonsense. Larry looked his motor over carefully. It was using an incredible amount of oil. And he didn't like the pressure running up so high. He found nothing he could fix. He hurried his take-off.

In the air, he determined to make time on this long leg of the race to Albuquerque, engine permitting. His oil pressure was high, but the temperature was normal. He worked his speed up higher than was prudent, and held it there. The monotony of straight flying, the flat, waste country, the heat and his lack of sleep made him drowsy. In spite of all he could do, his head nodded and his eyes kept closing. Several times he caught the ship slipping toward the baked ground. He gritted his teeth and slapped the back of his head. But it was agony to keep going.

Over Oklahoma his oil pressure shot up dangerously and his motor began acting strangely, making noises. That woke him. He throttled down, but the oil pressure and temperature remained too high for comfort.

He dialed for news of the race. Two more ships were down somewhere. The six remaining in the race were stretched over a wide area. He learned he was leading by a long margin. Cyril Porter's ship was still second. They were a good distance ahead of the others. "Headwinds increasing. Temperature on the ground: 97. Moisture—"

Larry switched off and flew silent.

The motor grew hotter and noisier. His nerves got edgy. Lives relived themselves in his memory, before he landed at Albuquerque. There was a crowd at that field, too, excited and curious. But he had no time for their silly questions. His motor was practically out of oil. That was a bad sign.

He was nineteen minutes ahead of Emily Featherstone. The worst leg of the race was before him, over the mountains. Unless something could be done to clear up that motor trouble his chances of even reaching Los Angeles

were none too healthy. He decided to risk a little time.

With a mechanic who was not much good to him, who understood less about the new-type motor than he did, he went to work cleaning the oil lines where he could. If it was merely foreign matter lodged in there, steel filings or whatnot, he might, with luck, clear the stoppage. Under the circumstances, there was little more he could do.

The silver-and-black ship made a landing while Larry was still struggling to reassemble the unfamiliar parts. He hurried more than ever. He saw Emily taxi up close and cut her switch. She was immediately surrounded by the throng. Her eyes were sparkling behind Cyril Porter's goggles. She held a red bandanna to her mouth as if she were laughing into it. She had on Cyril Porter's leather coat and Cyril Porter's blue-and-white scarf at her neck.

She did not get out, but called across the short space in a muffled voice: "Having trouble?"

He looked at her noncommittally. He was perspiring. "Nothing serious," he said. "Be leaving in a minute."

"Good," she said. Her ship was ready. She wasted no time taking off. She waved to Larry from the air.

He cursed. It was another seven minutes before he took off—the longest seven minutes he ever lived through. Other ships were due to land.

Aloft, his face was set. He would have to step on it now to even catch her. This was the shortest leg of the race—from Albuquerque on in—and the toughest. Every second counted. If the motor was going to conk on him, it was going to. No use babying it any longer. He watched his air-speedometer climb: three hundred forty, forty-one, two— The oil pressure mounted steadily, and the temperature. The motor got hotter and hotter. It made an awful noise. He swore, but he kept her set at that speed.

He sighted a dark dot in the distance. He opened the throttle wide and jockeyed with his body. He was taking an interminable time, but finally he nosed up alongside of Emily. She glanced across the flying gap at him. He grinned a grim grin. Now, if he went down, it would not be from second place.

His motor was clanking and clapping furiously. The exhaust outlet on her ship was almost transparent from heat. A black vapor was streaming from it. His own motor might go at any minute, or it might keep on like that a good while yet. He didn't know—but he did know her motor, and that it couldn't stand the pace much longer. It wasn't constructed for such constant high speed. And she had been crowding it hard throughout most of the race—wide open this last part. It was

a matter of minutes now to trouble, and they were already over the mountains, nearing the most hazardous stretch—

He throttled down slightly to keep abreast of her and got a telephone connection through to her: "Hey!" he shouted. "You're burning your motor up!"

"So are you!" she flung back.

"It's suicide to take such a chance!" he barked.

"I'm not afraid, if you're not!" She switched off.

They streaked on like a pair of mad hornets in a dash to death.

Then it happened. His ship lurched wildly. He touched back the throttle. He watched her ship. He saw her motor splutter and spit heavy, black bursts. Then the nose of her ship dipped. He throttled lower. He watched her drop beneath him; watched her snake her way down for a landing. It was bad country down there, mountainous, rocky, scrub growth everywhere.

He saw her flatten her glide dangerously toward a small, clear space walled in by cliff rock. He didn't see how she could make it. She slipped down between trees, through what must have been a ravine. Her ship disappeared for an instant, then came clear again, drifting lower, slower. Suddenly, her wing caught; her ship cart-wheeled, and piled up in a black cloud.

His brain locked. He dived.

Power on and nose straight down, he was at the entrance of the ravine in no time. But he had too much speed. He'd hit that rock wall ahead— He zoomed over it. He came around again, throttled. He fish-tailed down the canyon. He pancaked, landing with a jolt. He cut the switch, jumped out and ran for the wreck.

Then he saw her standing there beside it, eying him calmly, almost coldly.

"You're—all right?" he asked foolishly.

"Quite," she said. "I signaled you to go on. Didn't you see me?"

He shook his head. "Too busy."

"I appreciate your intention," she said gravely. "It was fine and sporting of you, needless as it was. But it will cost you the race! You shouldn't have landed."

"Had to," he said. "Out of oil."

Her eyes widened. "You were forced down? For want of oil?"

"I could have kept going a few more minutes, perhaps, but—" He shrugged.

A faint droning overhead pulled her look upward. Three ships, high in the blue, were streaking westward. They were close together.

"Larry!" she said suddenly. "Use my oil! You might still place in the race!"

"I'd like to," he said quickly. "I want to put this new motor across. It's

a honey, and I've got a half interest in the concern."

"You precious idiot!" she cried fondly, seizing his hand and rushing him toward the wreck. "Why didn't you tell me before that you're building motors?"

"Only learned it last night myself."

"Hurry!" she urged.

Aloft again, Larry tore westward. Only now there were three ships ahead of him that he knew of— There might be others. He kept squinting through that vast blue for them. He was flying wide open.

He spotted a dot ahead, far ahead, on the right. It grew slowly. When he got close enough to recognize the ship, red and green, he knew it was not one of the three lead ships. He pounded the throttle handle to be sure it was home. He rocked forward with his body, pushing. He passed the red-and-green ship. He gave the surprised pilot a hand wave.

Larry cleared the San Bernardino Mountains at a high altitude. He nosed down gently, increasing his speed somewhat. The air-speed meter wasn't working; hadn't been since he pancaked. He stuck his head out to the left over the cowl. The wind in his face told

him he was making good time—best he'd ever made! But there was no sign of the three lead ships.

The tiny squares below—houses, lawns, buildings—were becoming denser, and that pile of towered structures to the right, nestling in the hills, was Los Angeles. Not far to the field now. Not far enough.

The blue ahead began to whiten with mist from the Pacific. In the whitest of it he spied a small gray spot. Then another, and another.

Larry could see the landing field clearly now, beyond and below those three slowly growing ships. Their noses were pointed right on the field—on that long, clear, rectangle of brown with its line of hangars and its frame of waiting motor cars and people, extending back into the hills.

The three ships ahead were considerably below him. They were flying wide open, right for the white line. They were fast single-seaters, and they were being driven mercilessly.

Larry kept straining forward with his body, helping, dropping the nose lower. There was scant chance, but he would be close—

Over Inglewood, he reached the trail—



"You're—all right?" he asked foolishly.

ing ship; over the eastern boundary of the landing field, the second. There was only that red lead ship streaking below him for the white line. Larry pushed his ship's nose down deep. He dived for the white line. He leveled off practically on it. He touched lightly and fast, bounded gently. He chanced a sidelong glance. The red ship was just touching the line, dusting up tiny white clouds with its wheels. A close squeak, but he had made it!

Motor throttled and settling, he could hear the noise on all sides swelling. Shouts, cries, screams were drowned in the mounting blare of motor horns. Things fluttered in the air: papers, hats, handkerchiefs. The crowd broke through the police lines.

Larry cut his switch. Joseph Stephens, unshaven, wild-eyed, climbed on the wing. His coat was torn, but he was

not to be stopped. He grabbed Larry's hand, pressed it, wetly. He was panting.

"We're made, boy!" he shrieked, gasping.

He must have read Larry's question. "Flew out—last night!" he panted. "On the *Special*." He was screaming above the uproar. "Couldn't stand it there another minute. Isn't it the motor I said it was?"

"It's greased lightning! Only it needs grease!" Larry shouted. "Got to double the oil capacity! Wire Runt!"

The crowd was ganging the ship, rocking it. News-reel cameras jostled—and microphones, and officials. Larry turned to the rear cockpit and grinned.

Emily was smiling. Her blue eyes behind Cyril Porter's goggles sparkled with approval. She kept signaling to the ship's telephone.

Larry crowded his ear into the ear phone, against the noise.

"Brilliant!" she said heartily. "I couldn't have done better myself! I'm thrilled for you!"

"For us!" he said. "Right." Then his grin broadened. "You can cash that check now!"

He saw that that hurt her. He hadn't meant it quite that way.

Her eyes scolded him. "You've won," she said. "You could be a little more—gracious. You've won both your race and your argument!"

The noise was fierce.

"That flying is a man's game?" He crowded still closer to the ear phone to catch her answer. He looked straight into her eyes then, warmly. Into the phone he said seriously: "But, lady mine, I'll give the Devil his due: You fly like a man!"

ROCKET SHIPS

(Continued from page 27)

the nozzle is connected to a telegraph key placed in the trench and a cord attached to the tank and motor valves led to another safe point. At two short toots the key is thumbed down, igniting the fusee, whereupon the cord is pulled, releasing the fuels.

As the liquids ignite, the nozzle gushes, a terrifying sound which resembles the blast of a giant steam whistle with the roaring obbligate of Niagara Falls. The ground shakes like a miniature earthquake, and the eyes of the experimenters squint and widened with mingled incredulity and pride. Sometimes neighbors rush from their homes, thinking they are being blown up, and call police. The work is hazardous, and one or two very serious accidents have resulted.

There is every thrill of the regular rocket flight except the flight of the contraption itself. The society, however, is soon going to stage one of these. As in the past, it will hitch a motor to a 7-foot long, 3-inch-diameter rocket, the motor being fixed about two thirds from the tail. Launching is done on a 30-foot rack.

Dr. Goddard, in his experiments near Roswell, N. M., uses a 60-foot launching rack. His rockets are 12 feet long, 9 inches in diameter, and weigh 80 pounds. To propel them he uses 50 pounds of gasoline and liquid oxygen. The white gases rush out of the blast chamber for a duration of 20 seconds. Steering the rocket skyward is a delicate gyroscope whose spinning wheels, affected by any change in direction, control vanes guiding the course of the exhaust flames.

His "highest up" mark is a mile and a half, compared to the American Rocket Society's one mile. To him goes the credit, too, of shooting up the world's

first liquid rocket, which has been claimed by the Germans. One of his earliest contrivances contained a turbine and propellers, rocket-powered, whose purpose was to get the rocket outside the earth's atmosphere gradually.

Rocket theory is that the longer it fires (provided it has sufficient fuel power) at a given acceleration, the higher it will go. As pointed out in *Astronautics*, the American Rocket Society's official publication, a 20-pound rocket completely loaded for flight, with a motor capable of a thrust of 40 pounds, will have a net upward thrust of 20 pounds. Exactly equal to its weight, this will permit it to move with an acceleration of one gravity, or 32 feet per second per second. At the end of the first second it will be going at the rate of 32 feet per second; and at the end of the second, 64; the third, 96. Hence, at the end of the first minute our rocket will be whistling through the cosmos at 1,920 feet a second and will have traveled 28,800 feet, or almost $5\frac{1}{2}$ miles. If the power is now shut off, the rocket will continue through its own momentum, on the free-wheeling principle, gaining, in so doing, an extra 10 miles. Allowing for the retarding effect of atmospheric resistance, the total flight of this "shot" would be a hypothetical 10 or 12 miles.

This is one of the reasons why the rocket is the ideal vehicle for reaching great distances beyond the earth. Another is its ability to function in a vacuum, as hitherto mentioned. No airplane has yet ascended a mere 10 miles—only the "floor" of the stratosphere. Airplanes doubtless will go higher, but not much higher. A study of the cosmic regions shows why. It is estimated that the oxygen-nitrogen atmosphere in which we live ends at 40 to 50 miles up; another 100 to 150 miles up exists a highly rarified region consisting of such lighter gases as hydrogen and helium.

This extends to the "ether" of pure space.

An airplane operating in such regions would find that its propeller, no matter how much power was behind it, would have no useful tractive effect; moreover, an internal-combustion engine relies upon an air intake rich in oxygen. Even in climbing to high altitudes to-day, airplanes are equipped with superchargers and reduction-gear propellers.

Hence an airplane cannot attain the outer fringe of the earth's atmosphere—estimated at approximately 200 miles up—the point where the pull of gravity would lessen and the machine would be able to coast off to the moon, 238,000 miles away, or to the planets, vaster distances beyond.

A principle of ballistics is that a shell given a velocity of about 25,000 miles an hour (6.94 miles a second) would zoom off into space, overcome the earth's attraction and never return. It would either crash into another planet or become, like the moon, a satellite forever circling its cosmic captor.

Captivated by this idea, Jules Verne built an imaginary projectile car and shot it from a 300-meter gun to the moon, as every schoolboy knows. What every schoolboy does not know is that this car could never have been shot up. At the velocity necessary to project it, the moon ship would either have been wrecked or would have burst into flame from the friction; certainly its passengers would have perished.

Rocketeers in the present century advanced the theory that a rocket-propelled car could overcome this initial problem by a gradual upward flight. After it was once out of the earth's atmosphere, they argued, their rocket could coast practically all of the way to the moon. The rest of the distance would be taken care of by the moon's own gravitational force.

But their problem was to find a fuel

FRANK HAWKS

(Continued from page 33)

A glance at this new device tells the pilot whether the mixture coming from the carburetor to the motor is too rich or too lean.

Westinghouse has provided a set of radio equipment that includes the latest contributions of science in that particular field. Among them is a 50-watt, two-way set through which Commander Hawks can communicate with airports or other ships either by code or radio-telephone. The receiver is designed to pick up beacon signals as well as messages on

the communications band. No matter where the receiver may be tuned, the pilot can, upon coming within range of an airport, throw a switch which tunes the set immediately to the regulation airport frequency. The plane's transmitter is provided with two frequencies, 3,105 and 3,120 kilocycles, for convenience in case of heavy traffic on either of the bands.

For research and experimentation, Commander Hawks also has had built into the ship an ultra-high-frequency transmitter and receiver to operate on a 1-to-5-meter wave band. The antennae for this set are built into the wing, while the regular transmission aerial is of the

conventional trailing type, lowered through an opening in the tail of the fuselage just below the rudder. The receiving antenna of the standard set is built into the outer edge of the vertical fin.

In designing ships like the *Silver Lancer* for Bill Barnes' fiction fleet, presented last year, we have attempted, while remaining well within the bounds of possibility, to keep at least five years ahead of current practice. It is interesting to note that, in the rapid advance of aviation, Commander Frank Hawks has already produced a plane which begins to approximate the high performance we predict for the future.

PHANTOM FLIER

(Continued from page 30)

O. K. And this time," he added with what sounded to Doc Mallory like a queer remark, "Ryder hadn't been around that plane."

Doc saw Mallory whirl on the little, stocky mechanic. The tip of his cigar shot up. His clipped mustache stood out on his curled upper lip, stiff as a toothbrush.

"Cut that, Zinke!" snapped Mallory. "You make one more dirty crack like that about Ryder and, by heavens, I'll have a new hangar chief!"

"I didn't mean it that way, sir," was Zinke's quick response. He fell back a step under the baleful glare of Mallory's threatening eyes. "I'll get the other ship ready, sir."

"Step on it!" Mallory ordered. "Ryder'll be here in five minutes!"

Doc Stevens heard the mechanic's sharply indrawn breath whistle through his teeth as he brushed past. It revealed to him that Whitehead's forced landing was still a pretty sore subject. He thought it had blown over. As he turned his head to watch Zinke dash out of the office, eyes down and back arched as if slinking away under the stinging rebuke of Mallory, a white-hot idea flashed into his mind.

Even more odd was the message in Mallory's smoldering eyes as their glances met. Doc knew instantly that the same idea had come to Mallory that occurred to him. The common thought was: there was the culprit who had spread that poison talk!

Before Doc could voice his suspicion, Fred Ryder and a girl stood before Mallory.

"Got here as fast as I could, Ted," Ryder said. There was a quiver in his voice. "Peg and I were at a party," he went on, "when your call was relayed to me." He looked at Doc somewhat strained. Finally he said, "'Lo, Doc," and stuck out his hand. He added awkwardly: "You've met Miss Ormsby?"

Doc bowed, and the girl nodded

coldly. He saw she was a pocket-sized blond beauty with the regulation blue eyes, a slightly uptilted nose and a strong mouth and chin. Her squirrel coat was partly open, showing underneath a blue satin party dress. Her right silver slipper beat a nervous tattoo. He knew she detested him because he had grounded Ryder.

"What's up?" Ryder asked Mallory.

"Whitey is down! No radio report from him. Within ten minutes after he took off his motor must have conked."

"That's a tough break," said Ryder, "on a night like this."

Doc heard the girl exclaim: "Oh! That Whitehead again!" He saw her bite her under lip until a globule of blood popped through the skin. Her face around the mouth and nose suddenly drained of color and became tense. Whitehead, it was clear, was the one name, not excepting his own, that was anathema to her.

Ryder, however, expressed the true spirit of the brotherhood of the men who fly. It impressed Doc immensely. "We must lose no time searching for him," the youngster said.

Mallory flung out an airways map upon his desk. Ryder quickly stepped up and followed Mallory's forefinger along the red line. Doc came close, also, for he was quite familiar with the course. He had flown dozens of times with Whitehead, both by day and by night, and knew how treacherous were those hills and the currents that swirled above them.

"The ship," said Mallory, "cruised at a hundred and twenty miles an hour. There was a stiff thirty-mile head wind which cut his ground speed to ninety. The greatest distance he could have covered was up to the end of ten minutes, when we should have received his first radio report. At ninety miles an hour that would be fifteen miles. But chances are that what happened, happened before the last second of the ten-minute period. Say seven or eight minutes—ten or twelve miles."

Mallory fumbled under the map. Doc saw one end of the foot ruler under the

engine report Zinke had brought in. He handed it to him. Mallory slid it along the red line on the map.

"At five miles to the inch," Mallory continued, "fifteen miles, or three inches, would be here." He made a pencil mark. "And ten miles is here." He drew a swift circle passing through the two points. "Somewhere in here Whitey sat down."

"Why," said Ryder, "that's right on the ridge. The elevation is 2,600 feet, and not a space level enough for a picnic. He's—" He straightened suddenly, hands clenched at his sides.

A fierce, stubborn desire came to Doc, also, to tell Mallory that Whitehead was dead, but he held it in check.

Outside, a motor roared out full blast. Mallory swiveled back in his chair and jumped to his feet. "Zinke," he said, "is warming up a plane for the search."

Doc saw Ryder's jaw drop and his face flush a deep red.

"I'm grounded," he said. He stabbed a cigarette into his mouth.

"You're the only pilot available tonight," Mallory glared at the surgeon. He clamped his cigar like a bulldog. "How about it, Doc?"

Doc Stevens saw he was on the spot. It was the old challenge of authority between Mallory and himself over flying personnel. To see that pilots were in condition and to keep them so was his job. Grounding a pilot for a day or so who had a severe head cold or was feeling low because of an extra large time disrupted the schedule. Mallory blew off steam like a geyser. The boys didn't like it, either. It meant loss in mileage pay. But the practice served to regulate their personal habits and curb excesses. It reduced to the absolute minimum the human element in the hazard of flying. To-night Doc saw the situation was particularly awkward. Mallory was in a bad temper. Besides, it was for his friend Whitehead.

"Well?" demanded Mallory.

Doc said: "That's all right, Ryder. This is an emergency."

"Stay under the clouds, Fred," Mallory began his instructions. "You've got

a 3,000-foot ceiling. Fly the course for ten minutes, then circle as you come back. Whitey must be on this side of the ridge. He will hear you and fire a red flare."

"Yes, sir," replied Ryder. To the girl he said: "Peg, you wait here. I'll be back in a half hour."

From a steel locker, Mallory brought out helmet, goggles, flying suit and parachute. Ryder got into the togs, and they went out to the line. Doc saw the girl's hand in Ryder's, and she walked close to him.

"Fred," Doc overheard the girl say, "you must find him! It will clear you as nothing else could."

The field suddenly became a great white way as the floodlights were turned on. Ryder lost no time adjusting himself in the cockpit. He taxied down to the runway and spun into the wind. Then he opened his motor to a thundering roar and swept off the ground into the howling black sky.

It always made Doc's spine creep to watch a plane take off at night. In the white glare he saw the girl's lips move as if in prayer. He glanced at his wrist watch. It was 12:23. Mallory certainly worked fast, he thought.

Doc went back to his office. He didn't even turn on the lights. He preferred to sit in the darkness. Strange, it occurred to him, how those last words Whitehead had spoken to him should persist in his mind.

"I've a hunch," Whitehead had said, "something is going to happen. It's been growing on me for days. Sticks to me like a nightmare. Seems as if some phantom flier is riding my tail. And to-night's the night."

"Nonsense," Doc had replied. "Just a touch of anxiety neurosis. Once you're in the air you'll forget all about it." He could still see Whitehead's careless shrug and see him climb aboard.

Lately there had been no way that he could check on Whitehead's flying in the single-seater mail planes. He reasoned, though, that if the pilot's flying was as ragged as his golf with him the last few games, he was, indeed, in a bad way. He couldn't account for it.

Somewhat similar to the peculiar case of Fowler. Pilot Fowler was a fine, stable, conscientious chap. Doc noticed that he was worried quite a bit. As a flight surgeon's job is a combination of dictator, an unorthodox doctor and father confessor, he finally got it out of Fowler. And it wasn't about his flying or his job, or anything like that. Fowler married a rather dominating, aggressive lady, and the big question in his household was—who wore the pants? Doc found that to be, among married pilots, a common source of friction. It preyed upon pilots' minds, undermined their confidence, cut down their efficiency. So he had a private talk with

the spirited Mrs. Fowler, and that settled that.

Now, Whitehead wasn't married. And he wasn't a ladies' man. So that angle was eliminated from Doc's psychoanalysis. If he could have cut Whitehead's head open and looked inside he might have been able to find the seat of the trouble.

Overhead, a motor snarled. It brought Doc to his feet. He was talking to himself as he dashed outside, for a hand grasped him by the shoulder and whirled him around to a breathless stop.

"Steady, Doc! What you need is a drink. We'll all have one as soon as Ryder lands. He's found Whitey, I believe."

Doc didn't answer Mallory. Miss Ormsby was with the manager, and she was staring queerly. They approached the ground crew waiting on the line.

Doc saw Ryder glide in deliberate and slow. If he had found Whitehead, Doc knew he'd have slammed down to a furious landing. The youngster seemed to drag his feet as he left the plane. The girl ran to meet him.

"Not a trace, Ted," Ryder reported to Mallory. "Black as a pit under the clouds. I swept the hilltops with my wing lights. There wasn't a sign of him."

Mallory's shoulders sagged. Then he straightened. He started to give orders. "Get the light truck ready, Zinke. Take three of the crew along. Be ready to start in ten minutes. Ryder, you come along. You know the ground pretty well."

Miss Ormsby spoke up: "I'm going, too."

"Nix, Peg," said Ryder. "This hike'll be too tough for a girl."

Mallory was a married man, so he took no sides in the argument. He turned to Doc. "We'll need you with us."

"Wait until dawn," Doc suggested. "We can't see a thing up there at night."

"It'll be daylight by the time we get up to the ridge," said Mallory. "Let's go!"

Doc realized it was useless to argue with Mallory. The manager would laugh if he told him what he felt about White-

head. He rode with Mallory in the roadster. Behind them came the truck with the ground crew. Ryder, in his flivver, brought up the rear. The girl was along. Doc got a great kick out of that.

Soon they left the main highway and hit the winding dirt road that lay over the hills rising before them. It wasn't much of a road, more of a fire trail.

"This takes us near that flashing beacon on the ridge," said Mallory. "Almost direct with the air route. Ought to meet Whitey walking back with the registered mail."

"You mean his ghost," Doc said. He didn't think Mallory heard him, because at that moment the car lurched violently in a deep, rain-washed rut.

From then on it was mostly low-gear work. The sky was a solid overcast. The yellow beams of the headlights bored through the blackness. Trees assumed uncanny shapes. Mile after mile they crawled on.

"I've made no report outside," Mallory finally broke the silence. His cigar had gone out, and he chewed it. "If the morning newspapers had got hold of it they'd have smeared it across the front page. By morning it will all blow over. Maybe there will be a little item in the afternoon papers, on the shipping page, about Whitey having a forced landing and the mail being undamaged."

Doc said nothing. Whitehead's face bobbed before him in the windshield. He just couldn't shake the pilot out of his eyes. All that evening, from the time they had dinner together, Whitehead talked so much at random that Doc knew he wasn't himself. That was the reason he had stayed until after the take-off. He remembered how Whitehead had tried to hide his emotions. He had searched the gray face closely and had seen fear. He could have grounded Whitehead by saying he was running a temperature. His eyes looked plenty feverish. But the fact that Whitehead was afraid convinced him that the pilot would be more on his guard—fly a little tighter—that he'd get through and conquer the great fear. He sensed it was the climax of Whitehead's flying career. The veteran flier was physically fit for another five years. And if he didn't take off, Doc knew he'd never make another flight. He honestly believed his friend would get squared around. So he had let him go.

Mallory suddenly shouted: "There's Whitey!"

Mallory jammed on the brakes. Doc scrambled to the ground. Then he laughed dryly at Mallory. "You're seeing things," he told the manager.

"Looks just like a man walking," Mallory said, "and dragging a mail sack after him."

Mallory was a fine executive, Doc Stevens decided, but he had no sense of

October Contest

The following readers were winners in the October "Gullible's Travels" contest with the indicated number of allowable, correctly picked errors:

First prize, \$5—Joe Bloom, Roxbury, Mass., 100.

Five prizes of \$2—Thomas Stewart, Hewlett, N. Y., 86; Frank Drugos, New Brunswick, N. J., 86; John Sisler, East Akron, O., 81; Ray Meyer, Louisville, Ky., 72; Albert Kramer, Philadelphia, Pa., 72.

Five prizes of \$1—William Tuerck, Jr., Laurelton, N. Y., 71; M. F. Thomas, Dwale, Ky., 64; John Dennin, New York, N. Y., 63; Francis Watyka, Johnstown, Pa., 56; Don Stamny, Royal Oak, Mich., 55.

humor. They rounded the turn in the road where a dead tree, snapped off close to the ground, had produced the illusion of a man walking with head bent low and the brush behind looked like he might be dragging something.

Presently Mallory stopped again. He switched off the boiling engine. "We've traveled eleven miles," he said, tapping the speedometer dial. "I think from here we better continue the search up to the ridge on foot. It's only a short way."

The truck and flivver pulled up. Zinke and his crew approached, then Ryder and his girl. The clouds had begun to break up, and the sky was turning from a wet gray to the pinkish-white of first dawn. The wind was raw, cold.

"There's the beacon," Mallory pointed to the flicker ahead. "Somewhere between here and there, according to our calculations, Whitey must have sat down. We'll spread out and push through to the top. You take the left-hand side of the road with your gang, Zinke. Take intervals of about two hundred yards. The rest of us will comb the right-hand side. Holler when you find him. Let's go!"

Doc Stevens glanced at the girl. In her silver party slippers she looked out of place. She'd turn an ankle in those high heels, the thought occurred to him, and that would be a job for him. So he said to Mallory: "I suggest that Miss Ormsby continue driving the car." He saw her eyes snap at the implication that she couldn't make the grade. Game kid. He added quickly: "We'll need the car for Whitey."

"That's an idea," Mallory agreed. Ryder put in a word and led Miss Ormsby back and got her started.

It was tough going through the brush. Each step Doc knew was bringing him closer to what he dreaded to find. He kept looking for the swath in the scattered trees that a plunging plane always leaves, unless it comes straight down like a plummet. Even then the wreckage would scatter over a wide area. Torn wing fabric fluttering in treetops. The tail assembly sticking up like a headstone. He forgot about his fatigue.

On the ridge, the sun popped up on the eastern horizon like a red-hot disk. The wind died down. Doc turned slowly on his heels, scanning the slopes as far as he could see details. He saw the others coming up. Mallory was trudging with head swinging from side to side like an elephant. He saw the girl's car about a quarter of a mile away to the south, where the hilltop was a couple of hundred feet higher.

Presently Mallory reached him. "Funny," Mallory said, "not a sign of him." His face showed the strain of the night's search. Pouches were under his eyes.

"The thing to do," Doc suggested, "is to follow along this ridge in both directions."

Mallory nodded. He took the field glasses out of their carrying case, slung across his shoulders. Doc saw him stiffen.

"The girl!" Mallory cried. "What the devil's she doing so far away from the car? She's waving! She's found Whitey!"

Mallory handed Doc the glasses. Doc saw the girl frantically waving her coat. Her mouth was open, but she was too far off to catch her voice. Ryder came up then. Zinke and his crew had also reached the top on the north side. They didn't wait for Zinke. At a fast jog, they raced ahead.

Miss Ormsby's first words were: "Quick, get Whitehead out! He may be hurt only a little."

Doc knew different. He saw the plane was bottom-side up, a mass of twisted metal, wires and fabric. The mail compartment had burst open. Pouches were scattered about. He dropped to his knees and reached under into the cockpit. His fingers tingled unpleasantly at the thought of what he would touch. He reached farther in—up to his shoulder.

"He's dead?" Mallory whispered over Doc's shoulder. Doc stood up. "What's the matter?" Mallory asked.

"He isn't in there," Doc answered. "Only one of his gloves—for the right hand."

A big smile spread over Mallory's face. "Then he's alive! He bailed out. Took his glove off first so he could grab the parachute rip-cord ring quickly."

"But the bus struck in level flight," Ryder pointed out. "The engine was full on. Look at the curled prop tips."

Zinke had come running up. Now he paced around the wreckage like a panther. "Five more feet altitude," said the mechanic, "and the plane would have cleared the hill. You can see where the wheels hit first and folded up. Both tires exploded and the crate slammed over on its back. Whitehead must have had his head down under the cowl, maybe getting ready to report in. Maybe he tried to stay under the clouds and the beacon was blanketed. Lucky there was no fire."

"He bailed out," Mallory insisted. "He's around here, with a busted leg, maybe."

Zinke crawled under the crushed cockpit and promptly came out. "The switches are still on, Mr. Mallory," he said. "Doesn't look to me like he jumped. I think he was thrown out. He took off in an awful big hurry and forgot to buckle his safety belt. We ought to find him on the other side."

Doc followed Zinke down the opposite slope. Before a large, thorny bush the mechanic dug his heels into the

ground. Doc saw his face turn to a ghastly color. He hurried around.

There he saw Whitehead. Both the pilot's arms were outstretched. Doc saw the crystal of the watch on the left wrist was broken. The hands had stopped at one minute of midnight. The right hand was bare. The stub of a pencil was gripped in the stiffened fingers, and the point was broken off. Held fast with a rubber band to the right thigh was a pad of paper. Doc was surprised. The note was addressed to him. He read:

DEAR DOC:

The hunch still rides with me. It's strong. I glance back now and then. There's only a tail light on my rudder post. But I'm expecting to see that phantom flier there. And I've got a big load to get off my chest.

Say, Doc, first thing I'd like you to do is put Ryder back on flying duty. Tell Mallory I said the kid is a sweet transport flier.

Here's why. The day Mallory brought Ryder to the field I knew the kid was gunning for my job. As my co-pilot, I made life hell for him. When Mallory took me off transports and put me on the night mail it was the same as slipping the skids under me. You didn't think so. I got busy. Remember the day I sat down in the pasture? Well, the motor quit because I turned off the gas. And I broke the gas line myself so I could—

That was all on the first page. As Doc turned it over to finish the note, the words blurred and he couldn't believe his eyes. Quickly he tore off the two sheets, folded and put them in his vest pocket. He looked up. Mallory was standing by Zinke. He was crossing himself. Doc said: "His watch stopped at 11:59."

"One more minute," said Mallory, "and he'd have radioed O. K. That's the way it always happens."

"Here comes Miss Ormsby," Doc said. "Better keep her away."

Mallory started back with the girl. Doc took off his topcoat and covered Whitehead.

With all together on the ridge again, Ryder said: "The way I dope it out is that Whitehead was flying blind and following the radio range beacon. According to the chart, the beam should pass right over the beacon. But under rainy conditions, over this broken sector, the beam shifts as much as thirteen degrees. I proved this to be a fact, Ted, because on my test flight I followed it, and it brought me out right at about this point. And the ridge here is two hundred feet higher than over the beacon. Whitehead generally flew by compass, even when he had to go

on instruments to get through thick stuff—except last night. That's how it happened."

To Doc Stevens the theory, from a flier's point of view, was perfect. To him, as a flight surgeon, it meant nothing. He knew he was the one who had blundered.

Mallory said: "Sounds plausible, Fred. We'll tell that to the inspector. In the meantime, you rush the mail back in your car. Take Zinke and one of the boys so they can bring up the big truck and my machine."

"And Ryder," said Doc, "I'm putting you back on flying duty. Your physical is O. K. But come to my office this afternoon for a routine check."

The youngster stared. The mail sack he had picked up dropped from his hands. And for the first time the girl smiled at Doc. He turned away. He wanted to finish Whitehead's note. Those last words that had blurred he couldn't yet believe.

On a near-by flat rock, Doc sat down. He smoothed out the second sheet. The words fairly jumped at him:

—I broke the gas line myself so I could report it as a forced landing.

Next day I spread the rumor among the greaseballs that Ryder had tampered with my plane. I figured that would wash him out.

Well, it did. Then it started to bother me, because you know, Doc, all my life I've shot pretty square with everybody. You can't fly and have a bug whispering in your ear that you're riding for a fall. Not after you've passed forty and started to slip. That always means a crash. And I couldn't give up flying. It's in my blood. Square it for me, will you?

You've been a real pal to me, Doc. You kidded me along when you had an idea I was getting stale as an old crust. If anything happens I want you to know the truth—

Here the pencil dug in deep. Doc Stevens remembered the broken point. The phantom flier that Whitehead was afraid of, he guessed, was Whitehead himself. His conscience had taken such possession of him in writing the redeeming confession that he forgot he was in the air, and the last word in his mind was "truth."

MOTORS

(Continued from page 18)

chamber through a nozzle where it is mixed with air and becomes a vapor. The same suction or intake stroke draws this vapor through the intake system and into the cylinder for the compression stroke.

A third portion of the modern carburetor, and probably the most important where aero engines are concerned, is the economizer well marked D on our illustration. It is often desirable to have a lean mixture for maximum economy at part throttle or what we will call cruising speed, and a far richer mixture for maximum power. In order to obtain this change in mixture ratio as the throttle is opened, various forms of economizer systems are used. Actually, these are enriching devices and our drawing shows a needle valve which is opened by the throttle at a predetermined throttle position and permits a quantity of fuel, in addition to that furnished by the main metering system, to mix with air in the carburetor.

The lower piston M acts as a fuel valve, preventing any flow of fuel through the system at cruising speeds, while the upper piston L acts as an air valve and permits air to flow through the separate economizer discharge nozzle at part throttle. As the throttle is opened wider, the lower piston uncovers the fuel port so that the fuel is drawn through the system and out the discharge nozzle, and the upper piston cuts

off the air-bleed to the economizer nozzle, thus increasing the suction on the fuel jet.

"Air-bleed" in this instance means a system incorporating a venturi tube in which a certain amount of air is "bled" into the jet so that a finely divided emulsion of air and liquid is formed in the tube.

A careful study of our drawing of the modern Stromberg carburetor will perhaps help clear up this mystery.

The fuel enters the economizer from the float chamber through the economizer metering jet A, which serves to meter the fuel passing through the economizer system. By changing the size of this jet, the amount of economizer action is regulated.

After passing this jet, the fuel flows up the passage B and into the economizer well. It enters the economizer through the port C, filling up the economizer well space D and the passage E so that the level of E is the same as that in the float chamber.

The upper piston L works to regulate the air-bleed to the economizer, while the lower piston M operates on the fuel flow. The air-bleed at practically atmospheric pressure enters the passage J from behind the venturi, and through the ports K passes to the interior of the economizer. It goes to the discharge nozzle P through the common fuel and air passage O. This air-bleed serves to relieve the suction existing at part throttle so that fuel will not be drawn past the piston M or through the passage E.

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3. 3 sheets silver tissue
4. 1 skein 1/4 flat rubber. Add 15c packing charge for offer No. 4

18" Balsa	THRUST BEARINGS	CAMEL'S HAIR BRUSHES
1/16x1/16, 100, 5c	Small, .002, 10c	Small 3c, Lge. 5c
1/16x1/16, 35 for 5c	Large, .004, 15c	Extra large, .8c
1/16x1/16, 18, 5c	PROPELLER BLOCKS	DUMMY RAD. ENGINE
1/16x1/16, 15 for 5c	1/4x 1/4x 5 8-5c	1 1/2" d. 18c; 2" d. 23c; 3" d. 33c
1/16x1/16, 5 for 5c	1/4x 1/4x 6 6-5c	ENGINE AND COWL ATTACHED
3/32x3/32, 30, 5c	1/4x 1/4x 7 4-5c	1 1/2" dia.18c
1/4x1/4, 30 for 5c	1/4x 1/4x 8 3-5c	2" dia.23c
1/4x1/4, 12 for 5c	1/4x 1/4x 10 2-5c	3" dia.33c
1/4x1/4, 10 for 5c	1/4x 1/4x 12 3-5c	CELLULOID PANTS, per pair
3/16x3/16, 8, 5c	1/4x 1/4x 15 1-5c	1/2" to 1 1/2" .18c
1/4x1/4, 6 for 5c	1/4x 1/4x 18 1-5c	1 1/2" to 1 3/4" .33c
1/4x1/4, 3 for 5c	1/4x 1/4x 21 1-5c	METAL PROPELLERS
1/4x1/4, 2 for 5c	1/4x 1/4x 24 1-5c	2 blades 3 blades
1/16x1/16, 8 for 10c	1/4x 1/4x 27 1-5c	1 1/2" .5c08
3/32x2, 7 for 10c	1/4x 1/4x 30 1-5c	2 1/2" .10c10
3/32x2, 6 for 10c	1/4x 1/4x 33 1-5c	3 1/2" .15c20
3/16x2, 3 for 10c	1/4x 1/4x 36 1-5c	4 1/2" .20c25
1/4x2, 3 for 10c	1/4x 1/4x 39 1-5c	ALUM. TUBING
3 sheets or 36" lengths, double above prices; add 10c packing charge for 36" lengths.	1/4x 1/4x 42 1-5c	1/16, 3/32, or 1/4
18" PLANKS	1/4x 1/4x 45 1-5c	3/16 or 1/4, ft. 7c
1x1 5c; 1/2x2 6c	1/4x 1/4x 48 1-5c	ALUM. COWLINGS
1x1 1/2 5c; 1x2 10c	1/4x 1/4x 51 1-5c	1 1/2" 15c 2" 18c
1x2 15c; 2x2 13c	1/4x 1/4x 54 1-5c	3" 25c
2x3 23c; 2x6 39c	1/4x 1/4x 57 1-5c	Specify whether anti-drag, closed, or open.
3x3 40c; 3x6 75c	1/4x 1/4x 60 1-5c	GUNS WITH RING MOUNT
TISSUE, AA	1/4x 1/4x 63 1-5c	1 1/2" 10c 1 3/4" 15c
All col. doz. 19c	1/4x 1/4x 66 1-5c	PURSUIT MACH. GUNS
Silver ...ea. 5c	1/4x 1/4x 69 1-5c	1/4", 1 1/4", or 1 3/4", each 5c
Superfine, wh. 5c	1/4x 1/4x 72 1-5c	BUSHINGS
WHEELS per pr.	1/4x 1/4x 75 1-5c	1/16 ...4 for 1c
Brch. Balsa Cel.	1/4x 1/4x 78 1-5c	WOND. WATER SPRAYER 15c
1/2 .01 .03	1/4x 1/4x 81 1-5c	MODEL PINS
1/4 .02 .04 .05	1/4x 1/4x 84 1-5c	1/2" or 1" pkg. 5c
1 .03 .05 .07	1/4x 1/4x 87 1-5c	SANDPAPER
1 1/4 .04 .08 .10	1/4x 1/4x 90 1-5c	Doz. sheets, .5c
1 1/2 .07 .10 .16	1/4x 1/4x 93 1-5c	PROP. SHAFTS
3 .15 .30	1/4x 1/4x 96 1-5c	REAR HOOKS
PINEWHLs, pr.	1/4x 1/4x 99 1-5c	doz.8c
Both sides alike	1/4x 1/4x 102 1-5c	MODEL STANDS
1/4" 4c; 1" 6c	1/4x 1/4x 105 1-5c	Sm. 15c; Lge. 25c
1 1/2" 8c; 1 3/4" 12c	1/4x 1/4x 108 1-5c	REED
NOSE BLOCKS	1/4x 1/4x 111 1-5c	1/32-1/16-1/8, .2 for 1c
1x2x11c	1/4x 1/4x 114 1-5c	NOSE PLUGS
2x2x12c	1/4x 1/4x 117 1-5c	1/2" doz. 8c
2x2 1/2x13c	1/4x 1/4x 120 1-5c	
3x3x15c	1/4x 1/4x 123 1-5c	
3x3x28c	1/4x 1/4x 126 1-5c	
3x3x310c	1/4x 1/4x 129 1-5c	
INSIGNIA	1/4x 1/4x 132 1-5c	
24 and stripes 5c	1/4x 1/4x 135 1-5c	
WASHERS	1/4x 1/4x 138 1-5c	
1 doz. 1/2 or 1 1/4	1/4x 1/4x 141 1-5c	
20 IN. FLYING PLANS 10c-3 for 25c	1/4x 1/4x 144 1-5c	
Sparrow Hawk, Boeing Trans. 247, Spad Chass., Vought Corsair, Curtiss Swift L. W., Waco Cabin Biplane, Douglas Dolphin, Boeing P12F, Fokker D.VII, S.E.5, Goshawk, Gee Bee, Boeing P26A, Monocoupe, Northrop Gamma, Fairchild 24 Cabin, Carben Super-Ace.	1/4x 1/4x 147 1-5c	
SELECT ANY 2 OF THE ABOVE PLANS in 2-in-one FLYING KIT Postpaid 75c	1/4x 1/4x 150 1-5c	
SEND FOR FREE CATALOG	1/4x 1/4x 153 1-5c	
Send For Wholesale Price List	1/4x 1/4x 156 1-5c	
IMPERIAL MODEL AERO SUPPLY	1/4x 1/4x 159 1-5c	
416E McDONALD AVENUE BROOKLYN, N. Y.	1/4x 1/4x 162 1-5c	

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As the throttle is opened, the economizer moves downward, being actuated by the cam-lever F which is pivoted at G and operated by a lever and roller H directly connected to the throttle valve stem. At intermediate throttle points, the piston M has moved downward until it covers the port C and in this position the throttle is open sufficiently to admit a No. 51 drill between the throttle edge and the barrel. It will also be noted that the piston L has not moved downward enough to close off the flow of air to the economizer.

As the throttle is opened, the economizer is moved further downward until at wide-open throttle the piston M will be all the way down the chamber. The fuel flows through the hole C straight up the economizer and out the discharge nozzle. The piston L now covers the air ports K so that the suction on the economizer system is at a maximum.

Also indicated on the drawing are Q, the clearance post screw, and R, the bushing of the economizer piston.

This mixture problem becomes more acute at high altitudes where the air becomes lighter, and that is where the necessity for supercharging comes in—a point we shall bring up later in this series.

In general then, the carburetor is a device which takes liquid fuel, mixes it with a quantity of air and delivers the vapor to the combustion chamber of the cylinder, where it is compressed and fired.

TYPES of aircraft engines during late years, have dwindled to a few. Before and during the World War there were so many types that aircraft manufacturers and aviation enthusiasts were bitterly divided into about a dozen groups, each swearing by their particular type of power plant.

There was the heavy water-cooled in-line. There was the very inefficient air-cooled V type. There were Monosoupape rotaries, Anzani radials, Siemens-Schuckert rotary-radials and air-cooled horizontal opposed. To-day, manufacturers have come to agreement and we find only radials, water-cooled V's, horizontal and inverted in-line, and

a few light horizontally opposed twins for light-plane work. There are, of course, one or two types outside this general field, such as the Junkers Diesel and the H-type air-cooled engines that are being tried out by the Halford-Napier firm in England.

But let us take a modern light-power engine of a type in general use by amateur pilots in their private planes. If you are going to fly your own craft, you will no doubt be interested in a motor that comes nearest the plant that is found under the hood of your automobile. We refer to the inverted in-line air-cooled motor such as the Menasco and the Ranger, to refer to American types, or the British Gipsy and Cirrus; the Czechoslovakian Walter Minor, the French Renault Bengali or the Regnier R-6.

This type of motor is reasonably cheap to buy, run and service. It is generally dependable and outside of the inverted feature of its construction offers no particular point in appearance to frighten off the prospective aviation enthusiast. In other words, it appears to be a reasonably simple power plant with no special gadgets or mysterious component parts to give it a phony look of "aviation."

The inverted business does worry the average reader of aviation features, for he cannot fully understand how it is lubricated. In the ordinary automobile motor, he knows that the oil lies in the bottom of the crankcase whence it is forced to practically all moving parts, the general splashing around of the connecting-rod big ends in the lubricant and by a pump-feed system drawing it from a "sump" or pit in the crankcase.

In the inverted engine—which has been inverted to give a more convenient mounting arrangement and to allow efficient streamlining about the cowl—the lubrication system has been worked out as follows.

The oil for lubrication is carried in a separate tank and is pump-fed to necessary moving parts by pipes and internal passages in the parts themselves. As the oil runs clear through the bearings, it is caught in a trap, scavenged through filters and returned to the tank, whence it is forced around again.

In our drawing of a typical inverted in-line air-cooled motor, we have created something of a "No-type," in which we have attempted to show the main working parts of an average modern job. It will be seen on the arrow marked (12) that the oil-supply pipe runs along through the walls of the crankcase and supplies the main bearings by pipes. It will also be noticed that the open ends of the hollow crankshaft are sealed up with oil-proof disks to retain the oil, which is fed at a pressure of between 40 and 60 lbs. per square inch. Thus, there is no free sloshing around of lubricating oil anywhere in the engine, but it is under full control all the time in suitable ducts and leaders until it gets back to the separate tank.

In the Menasco, the oil is supplied to the general system by a gear-driven pump at a 40-lb. pressure. The oil is returned to the tank by two scavenger pumps. The rocker-arm mechanism is lubricated through the hollow push-rods. In the Ranger, the same system is used except that the underhead camshaft and the rocker arms are lubricated by a flood of oil carried in the cast aluminum housing. This system is shown in our composite drawing. In the French Regnier, the pump-force system is used and the cylinder walls are lubricated through holes in the ends of the crank pins.

In the De Havilland Gipsy 6, oil collected in the crankcase drains down to two large openings, one at the front end and one at the back of the engine, and thence by gravity to the oil tank at the rear of the motor or somewhere aboard the plane.

The rest of our drawing shows the gears that run the camshaft, and the rods at the top of the valve rods. The details of the propeller boss and streamlined spinner are also shown. The rocker arms and valves of No. 1 cylinder are explained in the cutaway drawing and a few minutes spent carefully inspecting the illustration should offer a fair idea of the general layout of a modern inverted in-line air-cooled engine.

Next month the authors will explain the principles and operation of the famous rotary radial engines.

CONTACT!

(Continued from page 47)

screws used to draw up the ends are $\frac{1}{8}$ " outside diameter and $\frac{1}{2}$ " long.

Hardwood blocks fit against both faces of the hub. These blocks are grooved on the curved side to accommodate the tubing, and flat on the other side to fit against the back plate and the face plate of the motor. Make these hardwood pieces just thin enough

so the nut can be screwed onto the propeller shaft. The method of shaping the blade ends so they fit snugly into the hub without danger of slipping is shown in the drawing.

COWLING

The cowl may be carved from a single block or may be built up from several joined blocks. The total overall depth should be $6\frac{3}{8}$ ", width 5", and length 4". See drawing #5. Draw the shape of the back of the cowl first and

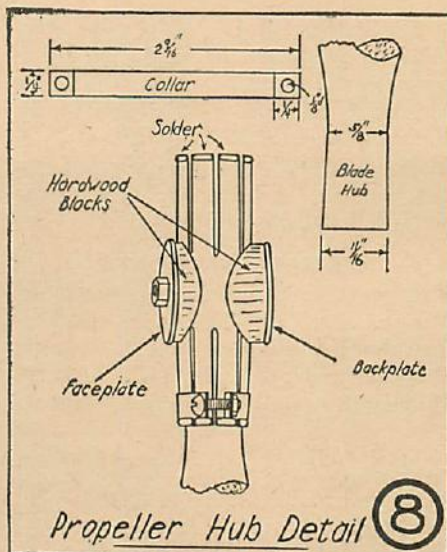
carve the block to fit it. Then draw the front of the cowl on the block and carve the block to it. Cut the rounded shape of the front and then smooth the outside completely. Do it carefully, as the appearance of the cowl when finished depends on this.

Split the block horizontally $2\frac{1}{2}$ " from the bottom and start to hollow the inside. A round gouge should be used; however, if you do not have one, you can use a knife, which makes it a somewhat more tedious job. Thickness at

the trailing edge should be $\frac{1}{16}$ " and at the thickest point near the front $\frac{1}{4}$ ". It may be necessary to gouge a small cavity for the spark plug. Smooth off the inside with sandpaper and paint it with spar varnish. Two small holes should be drilled in the bottom to accommodate the screws which hold the cowl on.

Cement only the left side (looking from the rear) of the split cowl together, leaving the right—which will be the hinged section—uncemented. Then cut the cowl through the center at the top only and cement a piece of silk about $2\frac{1}{2}$ " long over the cut. The silk acts as a hinge. Make two wire hooks, one with an open end, the other closed. Through the closed hook thread a loop of rubber 1" long, on the end of which is an "S" hook. Insert the open hook on the movable part and the closed on the stationary part beneath it.

NEXT MONTH we'll complete the plans and instructions for the model, along with some suggestions for flying operations. Included also will be details of the automatic wing flaps.



Propeller Hub Detail ⑧

MATERIALS

Fuselage

- 5 hard balsa $\frac{3}{8}$ "x $\frac{3}{8}$ "x5" for longerons and braces
- 9 hard balsa $\frac{1}{4}$ "x $\frac{1}{4}$ "x36" for braces
- 3 pine $\frac{3}{8}$ "x $\frac{3}{8}$ "x36" for strengtheners
- 1 spruce $\frac{1}{4}$ "x $\frac{3}{8}$ "x5" for strengtheners
- 2 bass $\frac{3}{8}$ "x $\frac{1}{2}$ "x3 $\frac{1}{2}$ " for motor mountings
- $\frac{3}{8}$ " flat pine about 1" wide for corner gussets
- 12 balsa $\frac{1}{8}$ "x $\frac{3}{8}$ "x36" for fairing stringers

- 15 balsa $\frac{3}{32}$ "x $\frac{3}{8}$ "x24" for front covering
- 1 balsa 4 "x $5\frac{1}{2}$ "x $\frac{3}{8}$ " for cowl, or built up from smaller pieces
- 2 dural L pieces $\frac{1}{2}$ "x $\frac{1}{2}$ "x12"
- 1 piece celluloid 6 "x18" for windshield
- 6 yards silk
- 1 pint clear dope
- 12 machine screws $\frac{1}{8}$ " outside diameter, 1" length
- .040 piano wire for tail skid
- Scrap of tin-can metal for fire wall

Landing Gear

- 8 ft. $\frac{1}{8}$ " dia. piano wire.
- Fine copper wire for wrapping landing-gear wires
- 2 pine $\frac{3}{4}$ "x2 $\frac{1}{2}$ "x9" for filling struts
- 2 soft balsa $\frac{1}{4}$ "x3 $\frac{1}{2}$ "x10" for fairings
- 2 soft balsa 1 "x2 $\frac{1}{4}$ "x2 $\frac{1}{4}$ " for tire cuffs
- 1 pair 3 $\frac{1}{2}$ " dia. rubber-tired wheels
- 10 ft. $\frac{1}{8}$ " rubber for binding
- Several square inches of balloon rubber

Ignition System

- 1 pine $\frac{1}{4}$ "x4x6 $\frac{1}{2}$ " for battery base
- 1 pine $\frac{1}{8}$ "x2x4" for timer base
- 2 bamboo $1/16$ "x $\frac{1}{4}$ "x15" for groove mounting
- Small throw switch for mounting outside fuselage
- Small camera timer
- 1 bolt 3/16" dia. $1\frac{1}{2}$ " long, with wing nut
- 8 ft. aircraft cable
- Several bolts, screw eyes, and scrap pieces of stiff metal (the material used in mechanical toy building sets is ideal)

Adjustable Propeller

- 1 piece seamless brass tubing $\frac{3}{4}$ " dia., 1/32" wall, 2 $\frac{3}{4}$ " length
- Short length of sheet metal for collars
- Small block hardwood for inserting in brass hub
- 2 pieces hardwood $\frac{1}{4}$ "x1x1" for face plates
- 2 pieces blade material (pine, bass, mahogany) $\frac{3}{4}$ "x1 $\frac{1}{2}$ "x7"

—G. S. L.

MASTER TOUCH

(Continued from page 56)

insufficient rudder area is displaced from ordinary flight by a gust, it seems to falter and take quite a long time to return to its proper flight condition. The reason why low rudders are almost universally used on indoor models is because they are more effective. When the rudder is below, it is not blanketed by the tail, as the relative wind strikes the rudder directly. If the rudder is above, it must be larger, because some of it is ineffective. Next time you are at an indoor meet, see if the models with rudders on top do not have larger areas than those with the rudder below.

For consistently long flights a model must be smooth. No one has ever seen a model fly 20 minutes with a prop off balance. When the model bounces around, energy is being wasted to keep it flying which might be later used to keep it up. Unbalanced props may be corrected by sanding the heavier blade with a #10-0 sandpaper until both blades weigh the same. If it does not track, (that is, if both tips of the propeller do not cross at the same place)

bend the shaft at the hub till it does. Often a prop will not track because the rubber creeps up the shaft. The cure for this is to pull the knots off the shaft and then hold the rubber about $\frac{1}{2}$ " back of the shaft and allow the prop to wind out that $\frac{1}{2}$ " of rubber. This procedure usually kills the tendency to climb the shaft. A wobbling propeller sometimes indicates that both blades are not at the same angles. This is usually caused by sanding the blades on a flat surface. Cure it by heating the blade with your breath and bend the correct angle into the blade with your fingers.

All four of these causes for erratic flight occur with equal frequency. Very often propeller troubles occur in combination and require quite a bit of time to iron out properly.

The proper way to adjust the thrust line of the model is rather vague in the minds of even some of the more experienced builders. Some consider the proper thrust line unimportant. They are mistaken, however, as a properly adjusted thrust line will use all the rubber energy and add minutes to a flight. The procedure is as follows: Adjust the model so it flies well with 500 winds; then, starting at 800 winds, increase the

number of turns in increments of about 200 per flight until the model stalls. When it does, put in negative thrust until the stall disappears. Keep on making flights with increased winds until the model stalls again, and again add negative incidence. Continue this treatment until the model is fully wound, when it may dive under full power because the motor stick will be bent to give you an increase in negative thrust. Remove some of the negative angle from the propeller until the ship no longer stalls and twist the bearing very slightly in the direction in which the model turns.

A correctly adjusted thrust line will give you the utmost from your rubber. No power will be lost in pulling your model out of stalls, and no winds will be wasted by having to send your model up again if it dives on the take-off.

Long flights are not merely a function of a well-built ship. Some of the record-holders have not been well constructed even by the greatest stretch of the imagination, but they have been well flown. A sensible diagnosis of the symptoms of an ailing model and the application of the correct remedies as described above will make any ship perform.

HIGH FLIER

(Continued from page 61)

Select a block of soft balsa 1 "x $1\frac{1}{2}$ "x15". Mark off the block accurately with a sharp pencil and a ruler. Punch the center hole for the shaft, using a needle. Do this accurately before you begin carving. A sharp jig-saw may prove helpful in cutting out the shape of the

propeller blank, but for actual carving a straight knife blade will be the best.

Leave the hub of the propeller about $\frac{1}{4}$ " thick and gradually taper the blades to $\frac{1}{16}$ " at the tips. A free-wheeler is cemented to the front of the hub. It is nothing more than a piece of tubing with a notch filed in it. The end of the prop shaft, bent at right angles, catches the notch in the free-wheeler in one direction, but slips over it in the other.

Small metal eyelets or bushings are inserted into the front and the rear of the nose block. These bushings serve as bearings for the propeller.

COVERING

The propeller as well as the other parts of the model are covered with superfine tissue and doped. The wing, tail and fuselage are water-sprayed and then treated with one or two coats of

light colorless dope. Better use brilliantly colored tissue in covering the wing and tail, since it will help you to keep your model in sight during a long flight.

FLYING

The propeller duration is limited to slightly less than a minute. This means that the model must climb steeply and steadily so that it has gained considerable altitude by the time the motor is dead. The model should turn in tight right circles. In launching your model when the motor is tightly wound, point the nose upward and launch the model upward and to the right. If properly adjusted, the model will climb right out of your hands and practically straight upward.

Eight strands of $1/30 \times 1/4$ " rubber are used to swing the propeller. A few inches of slack put in give it a length of about 26".

The flatness of the glide will determine the length of the flight. Negative propeller thrust will improve the glide, but most influence will be exerted by the wing and the tail adjustments. A block about $1/8$ " should be inserted under the wing leading edge. The elevator is left flat on the fuselage.

WEIGHTS AND DATA

Fuselage336 oz.
Wing550 "
Elevator and Rudder144 "
Propeller and Stick600 "
Rubber (8 strands $1/30 \times 1/4$ " ..	1.030 "
Total Weight	2.660 oz.
Wing area	125 sq. in.
Elevator area	40 " "
Rudder area	20 " "
Over-all length	31 in.
Span	33 1/4 in.
Loading per 50 sq. in.	1.06 oz.

MATERIAL

(Balsa, unless otherwise stated)
 3 fuselage longerons $3/32 \times 3/32 \times 31$ "
 Several pieces $3/32 \times 3/32$ " for braces
 1 motor stick $5/16 \times 3/8 \times 25$ "
 1 nosing block $1/2 \times 1 1/4 \times 1 3/4$ "
 1 propeller block $1 \times 1 1/2 \times 15$ "
 $1/20$ " sheet balsa for ribs
 1 trailing edge $1/8 \times 3/8 \times 27$ "
 1 leading edge $3/32 \times 3/32 \times 27 1/2$ "
 2 spars $1/8 \times 3/16 \times 33$ "
 1 trailing edge $1/16 \times 1 1/2 \times 15$ "
 1 leading edge $1/16 \times 1 1/2 \times 18$ "
 1 spar $3/32 \times 3/16 \times 23$ "
 Bamboo for tips
 $1/16$ " dia. piano wire for hooks, etc.
 2 small bushings, 1 free-wheeler, washers, etc.
 17 ft. $1/30 \times 1/4$ " brown rubber
 Large sheet of superfine tissue; dope, cement, banana oil.
 —G. S. L.

TIME FLIES

(Continued from page 48)

the torque diminishes, making an ideal anti-torque control. Then, at the front end of the control bar is an elongated loop that engages the releasing latch E for the landing gear. The loop permits the engagement of the landing gear and yet the rear end of the loop forces the latch open when the power runs out. A small #4 wire spring is attached to the latch to hold it in locked position at all times, except when the control bar overcomes it to release the landing gear.

The exact dimensions for all the various wire parts are not given, because any deviation in your model would make them useless. The best plan is to fit your model with the parts so that they will work unerringly before covering the fuselage. All of the main parts are #12 music wire. The rear spring B is ten turns of #10 wire, on a $1/8$ " drill shank.

The scale landing gear is provided for those who would rather make a scale model. The wire landing gear for the flying model should be closely followed. Unhappily, several soldered joints have to be made. Cut out the spaces shown in the wing bottoms for the landing gear and force a 2" length of #12 wire through the blocks and landing gear axis, in one wing and then the other. Cement the guides to former 4 as shown on the guide detail and attach the brace wires, so they stop the landing gear in the right position. After testing the movement, remove the axis pins, add the tension springs that force the landing gear down, and replace the pins.

Cut the aileron free and cement a tissue hinge on. Cut the flaps loose from the bottom and cement tissue hinges to them. The aileron hinge goes

on top and the flap hinges go on the bottom. After all of the wire parts are fitted to the model, test them all before covering. Make sure of them.

COVERING FUSELAGE

Cover the fuselage with $1/64$ " sheet. Do this carefully and see that all seams are flush and well butted. Do not get blobs of cement on the panels between the formers. The fillets are $1/64$ " strips $1/4$ " wide and work very well. Cement the rudder ribs to the post, and frame for the trim tab. Trace the rudder outline on two $1/64$ " pieces and cut out, the grain running vertically. Cement these to the ribs and to the edges of each other.

HORIZONTAL TAIL

Cut four of the half patterns from $1/64$ " sheet and cement them together around the edges, with $1/8$ " streamlined ribs between, to make the two halves. Provision has been made on the drawing to have interchangeable scale and flying surfaces, by showing wire dowel rods and aluminum tubing sleeves.

PROPELLERS

A three-bladed propeller is shown for scale models. The propeller for the flying model is a two-bladed high-speed type designed especially for this model. It is carved from a $3/4 \times 1 1/8 \times 6$ " medium balsa block and is left fairly thick at the boss. Sand and balance and dope several times.

COWL AND NOSE

The cowl block is carved from medium balsa and left fairly thick in order to balance the model. The hollowed cowl is fitted with a $1/8$ " sheet disk and a conventional removable nose plug. Base-relief cylinders and additional detail can be added to the motor disk if desired. When installing the prop shaft, a loop for stretching and winding the motor will provide for longer flights.

FINISHING

Cement the tail skid on. It can be fashioned out of hard balsa. Cement the cowl on, and when set, sand the whole model with fine sandpaper and give it a coat of thinned clear lacquer. The use of dopes on all-balsa models is very discouraging, because it sags the sheet balsa between the formers and ribs. Mix aluminum powder with some thinned clear lacquer and coat the whole model. The lettering is "bold" blue. The background of the coat-of-arms is gold. Outline the door, radio compartment, and glass panels with a ruling pen and black ink. It is suggested that the glass panels be painted black instead of cutting them out. The tires, motor, and exhaust stack are also black.

Cut a $3/4$ " door where the rear hook is. Power the model with 8 or 10 strands of $1/8$ " lubricated rubber and lightly cement the "door" back in place. Cut the wheel wells in the fuselage barely large enough for the wheels to clear.

Cross Winds

Answers for January

F	I	S	H	A	S	S	A	I	L	
S	A	S	H	E	S	N	U	R	S	E
T	I	E	N	T	R	A	N	T	P	I
O	R	B	D	E	E	R	S	A	E	R
M	E	A	D	O	W	L	E	V	E	R
P	Y	L	O	N	S	S	T	I	R	S
S	L	O						D	O	N
C	A	R	A	T	A	R	A	B	I	A
C	E	S	S	N	A	V	O	L	A	N
A	N	T	G	N	A	R	L	T	W	A
S	T	G	O	N	D	O	L	A	I	N
T	E	N	U	R	E	S	E	C	A	N
R	O	T	A	R	Y	R	E	N	D	

FLYING

Do not glide the model, unless it can be done in tall grass. The gliding speed is about 15 m.p.h. and one must become accustomed to launching models with that speed. Pin the flaps up and be sure the aileron is down in neutral position before gliding. Adjust the glide with the trim tabs after the model will balance at the center of the tips.

If tall grass is not available, pin the flaps up and let the model take off with the wheels down, using only enough turns on the motor for the model to clear the ground. After the adjustments are perfected, cement the tabs.

- 1 $1\frac{3}{4} \times 2\frac{1}{2} \times 2\frac{1}{2}$ " nose block
- 1 $\frac{3}{4} \times 1\frac{1}{8} \times 6$ " prop block
- 1 $1\frac{1}{4} \times 1\frac{1}{4} \times 1$ " wheels block
- 2 $1\frac{1}{16} \times \frac{1}{8} \times 12$ " leading edges
- 4 $1\frac{1}{16} \times 1\frac{1}{16} \times 12$ " longerons
- 1 $\frac{1}{8} \times 2 \times 8$ " sheet 3 $1\frac{1}{32} \times 2 \times 18$ " sheet
- 1 $1\frac{1}{16} \times 2 \times 18$ " " 12 $1\frac{1}{64} \times 2 \times 18$ " "
- 3 #12 music wire x 24"
- 1 #10 " " x 12"
- 1 #14 " " x 12"
- 1 #4 " " x 6"
- 1 oz. tube cement
- 1 oz. clear lacquer 1 oz. thinner
- 1 dram fine aluminum powder
- 1 dram blue lacquer pack of pins

MODEL MATTERS

(Continued from page 62)

Gliders H. L.

Class B	
Senior: Tasker	4:34
Junior: Durup	:44
Open: W. Brown	:33.1

Gliders, Tow Line

Class C	
Senior: Shea	3:15
Junior: R. Brown	9:32
Open: Tasker	4:25

Gasoline-engine Powered

Open: Marchi	2:40
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Australian News

Australia is planning to hold an international championship model meet in March, 1938. The prizes for this event will total more than \$1,000. Tentative plans call for gas-powered, outdoor rubber-powered, and indoor events. Teams

from all parts of Australia will participate, along with as many foreign modelers as care to enter. The United States has been especially urged to send a team "Down Under" for this contest, where a fine reception has been already planned.

During the American representatives' stay in New South Wales, they will be the guests of the Australia Model Club. Well-equipped workrooms, entertainment, and inspection of airports are a few of the items in the reception program. Ivor Freshman, for many years the director of Australian model activities, has charge of the international contest.

The \$1,000 prize-money announcement proves to be especially interesting, since the national contest scheduled for Detroit next summer also includes \$1,000 in cash prizes.

AERIAL YACHT

(Continued from page 54)

For a lustrous metallic fuselage finish worthy of the large ship, one method is to obtain silver or aluminum paint of the type which comes in a two-portion can, one part containing the metallic paste and the other an oil mixing fluid. For best results, mix only the quantity to be used at the time.

A good method, but somewhat more expensive, is to use pure silver leaf, which comes in a little booklet like postage stamps. Apply a coat of the special sizing for the purpose; pick up and lay on the fragile silver leaf with a camel-hair brush; apply a coat of white shellac; rub with graphite and polish. This method gives a realistic metallic sheen. The materials can be procured at your local paint store.

If you are willing to experiment, you may also try a carefully fitted tinfoil covering.

The windows are painted white, outlined with fine black striping. The wing and tail, fabric-covered on the large

plane, may be any color. If the control surfaces are to be indicated, score the wood lightly before painting. Install the various wires, etc., after which any minute touching-up may be done. As this is written, the Sea Bird had an X license, but an NC number will probably soon be available.

Carve the propeller from a scrap of sheet balsa and after sanding and painting, mount on a pin so that it will be free to revolve.

If you choose to construct the landing gear in the up position, the hull may be set on a shaped pedestal for exhibition, or the bottom may be cut off flat at the water line (shown on the drawing) and the model mounted on a sheet of glass.

List of materials:

- 1 block $6 \times 1\frac{1}{4} \times 1\frac{1}{8}$ "
- 1 1" sq. $1\frac{1}{4}$ " 1 $\frac{3}{8}$ " sq. 2 "
- 1 $\frac{1}{8} \times 2 \times 6$ " full cut sheet balsa
- 1 $\frac{1}{4} \times 2 \times 12$ " sheet balsa
- split bamboo pair $\frac{1}{2}$ " wheels
- small vial cement
- white shellac, clear varnish or clear dope
- silver paint, silver leaf, or tinfoil
- 1 $\frac{3}{32}$ " dowel heavy pins
- wood filler #60 black thread

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COLT 45 Cal. "FRONTIER" model kit, 7" barrel.....\$1.70

COLT 45 Automatic Pistol Kit.....1.00

COLT 25 Cal. automatic pistol kit......50

THOMPSON SUB MACHINE GUN model kit.....3.00

Savage Cal. 32 automatic pistol kit......75

LUGER 9 M/M auto. pistol kit w/4" barrel.....1.75

LUGER 9 M/M auto. pistol kit w/6" barrel.....1.90

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AIR TRAILS Model Index

Outstanding examples of every type of model design have appeared in plan form in this magazine. For your convenience, if you have missed any issues, if you are looking for modern scale plans, or if you need a contest design, we have indexed our model material. The lists below include all published up to and including the issue of December, 1936.

ORIGINAL AND CONTEST DESIGNS

	Weight, oz.	Wing area, sq. in.	Wing load, oz. @ 100 sq. in.	Span, in.	Issue
BANTAM, high-wing rectangular fuselage	2.02	100	2.02	26 $\frac{1}{8}$	July, 1936
BUG, beginner's h. l. stick pusher	.43	44	.98	15	Aug., 1936
BUZZER, beginner's r. o. g. stick tractor	.95	78	1.20	24	Sept., 1936
CLOUD-DUSTER, contest midwing, elliptical fuselage	2.66	130	2.04	36	Nov., 1934
DUCKY-WUCKY, hydro parasol oval fuselage (as land plane)	2.61 1.96	130	2.00 1.50	31	Oct., 1935
GULL, experimental rectangular fuselage, high gull wing	3.20	186	1.72	43 $\frac{3}{8}$	Dec., 1936
HUMDINGER, parasol pentagonal fuselage	2.40	135	1.78	30	April, 1935
LITTLE STUNTER, beginner's high-wing fuselage	.28	25	1.10	14	Mar., 1935
OLD FAITHFUL, twin stick tractor	2.28	157	1.43	30 $\frac{1}{4}$	Dec., 1935
OLD-TIMER, biplane, rectangular fuselage	3.68	265	1.40	36 $\frac{5}{8}$	Sept., 1936
PERFORMER, high-wing rectangular fuselage	3.60	180	2.00	39	Sept., 1935
RANGER, contest, high-wing rectangular fuselage	3.20	131	2.50	36 $\frac{1}{2}$	Jan., 1936
SOCKDOLAGER, high-wing rectangular fuselage	2.10	180	1.17	42	Nov., 1935
THERMAL FINDER, low-wing oval fuselage	3.54	174	2.00	44 $\frac{1}{2}$	Mar., 1936
TRAINER, high-wing rectangular fuselage	1.70	100	1.70	29 $\frac{3}{4}$	May, 1936
WAKEFIELD WINNER, 1935 (Light) high-wing rect. fuselage	4.07	197	2.06	39 $\frac{7}{8}$	April, 1936
WAKEFIELD WINNER, 1936 (Judge) high-wing rect. fuselage	4.25	195	2.20	44	Oct., 1936
WANDERER, contest, twin stick pusher	3.20	160	2.00	33	Sept., 1934
ZEPHYR, beginner's high-wing rectangular fuselage	.52	82	.64	24 $\frac{1}{4}$	Nov., 1936

SOLID SCALE

	Span, in.	Scale, in./ft.	Issue
BILL BARNES Silver Lancer	6 $\frac{1}{4}$	$\frac{1}{8}$ "	July, 1936
BILL BARNES Snorter BF-4D	6 $\frac{1}{2}$	$\frac{1}{8}$ "	Feb., 1936
BOEING F7B-1	6 $\frac{3}{4}$	$\frac{1}{4}$ "	July, 1936
BOEING P-26A	5 $\frac{15}{16}$	$\frac{7}{32}$ "	Mar., 1936
CESSNA C-34	8 $\frac{1}{2}$	$\frac{1}{4}$ "	Sept., 1936
CURTISS III Hawk	5 $\frac{13}{16}$	$\frac{3}{16}$ "	June, 1936
DOUGLAS DST	23 $\frac{3}{4}$	$\frac{1}{4}$ "	Oct., 1936
FAIRCHILD 45	10	$\frac{1}{4}$ "	July, 1936
GRUMMAN F3F-2	7 $\frac{1}{8}$	$\frac{1}{4}$ "	Dec., 1936
GRUMMAN JF-3	9 $\frac{3}{4}$	$\frac{1}{4}$ "	Aug., 1936
HAMMOND Y (ATC)	10	$\frac{1}{4}$ "	Nov., 1936
HEINKEL He70	12 $\frac{1}{8}$	$\frac{1}{4}$ "	Nov., 1936
HOWARD "Mr. Mulligan"	6	$\frac{3}{16}$ "	April, 1936
LOCKHEED 12	12 $\frac{3}{8}$	$\frac{1}{4}$ "	Dec., 1936
MARTIN "China Clipper"	12 $\frac{1}{8}$	$\frac{3}{32}$ "	May, 1936
MILES Falcon	6	—	Aug., 1936
SEVERSKY BT-8	9	$\frac{1}{4}$ "	Sept., 1936
VOUGHT SBU-1	8 $\frac{1}{4}$	$\frac{1}{4}$ "	Oct., 1936

GLIDERS

	Weight, oz.	Wing area, sq. in.	Wing load, oz. @ 100 sq. in.	Span, in.	Issue
DART	.74	52	1.42	21 $\frac{1}{4}$	Dec., 1936
SCOOTER	.40	33	1.20	16	July, 1936
SOARER	5.50	225	2.45	48	Aug., 1936

FLYING SCALE

	Span, in.	Scale, in./ft.	Issue
A. N. T. 25	36 $\frac{1}{2}$	$\frac{7}{16}$ "	Dec., 1936
BROWN B-3	22	$\frac{11}{16}$ "	Sept., 1936
CURTISS III Hawk	21	$\frac{11}{16}$ "	Nov., 1936
FAHLIN Plymacoupe	24	$\frac{3}{4}$ "	Aug., 1936
FAIRCHILD 24 (1936)	22 $\frac{7}{8}$	$\frac{5}{8}$ "	Oct., 1936
MIGNET Sky Flea	24	1 $\frac{1}{4}$ "	June, 1936
NORTHROP A-17	22 $\frac{5}{8}$	$\frac{1}{2}$ "	July, 1936

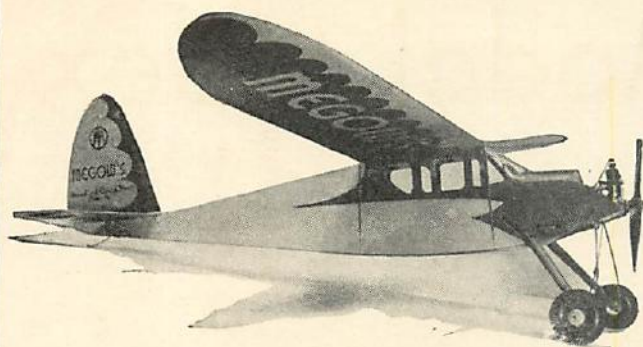
INDOOR CONTEST

	Wing area, sq. in.	Span, in.	Weight, oz.	Issue
CLASS B tractor h.l.	95	28	.058	Sept., 1936
CLASS B fuselage r.o.g.	99.1	26	.106	Nov., 1936

CONSTRUCTION ARTICLES

Weighing scale (to 5 oz.), sliding-weight suspended	Dec., 1935
" " (to 2 $\frac{1}{2}$ oz.), direct-reading platform	July, 1936
Pneumatic tires, rubber-powered models	Aug., 1936
" " gas models	Oct., 1936
Hollow sticks for indoor models	Oct., 1936
Floats, small-model	Oct., 1936
" large-model	Nov., 1936
Propellers for indoor models	Dec., 1936
Free-wheeling prop device, Garami method	April, 1936
Finishing solid models	Nov., 1936

Any back issue, except those for 1934, which are no longer available, can be secured for 15¢ each, in stamps or coin, from the Circulation Department, Street & Smith, 79 7th Ave., New York, N. Y.



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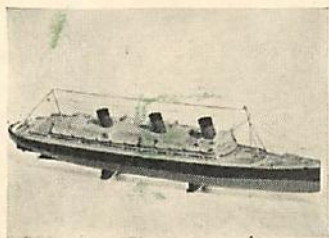


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