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# AIRCRAFT

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Writers' program, Pennsylvania.

# AIRCRAFT




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## PREFACE

*Aircraft* is the eighth in the Children's Science Series. It was prepared by the Philadelphia Unit of the Pennsylvania Writers' Project, sponsored by the Pennsylvania Department of Public Instruction.

This booklet was written by Mark Bartman. It was edited by Katharine Britton of the State office staff.

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All illustrations are the work of Edward Giordano.

CONRAD C. LESLEY  
*Acting State Supervisor*

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THE BIRD WAS BORN WITH WINGS, BUT IT TOOK HUNDREDS OF YEARS OF EFFORT FOR MEN TO BUILD WINGS FOR THEMSELVES.



## AIRCRAFT

Sometimes as we look out of the window we see a robin or a pigeon flit from housetop to housetop.

Sometimes a humming noise draws our attention to the sky, and we glance up to see an airplane flying into a cloud.

The bird was born with wings, and it was easy for him to learn to fly. But it took hundreds of years of effort for men to build wings to carry them far and fast through the air.

Many men felt that they might find the secret of flying by watching the way the birds moved. Such a man was

Leonardo da Vinci, a great artist who lived in Italy in the days of Columbus. Leonardo would take a bird to the top of a hill and fling it into the air. Then he would watch carefully, and write down his ideas. Leonardo thought of making wings that would look like those of a bird. They would flap up and down as the man who wore them moved his legs. Leonardo never made a flying machine. But all the work that he did helped other men later when they tried to build airplanes.

### BALLOONS

As long as men could not figure out what kept the birds in the air, they could not build an airplane that would rise from the ground. But they were studying all the time, hoping to discover some other way of flying.

About one hundred and fifty years ago, in France, Joseph and Jacques Montgolfier, two brothers, had an idea. They had watched smoke and steam float up-

ward on a clear day. They knew that the smoke floated because it was warm. They knew that hot air was lighter than cold air and floated just as wood floats in water. Maybe this was the way.

Suppose, the brothers thought, that they could capture some hot air in a bag. Wouldn't it keep the bag up in the air?

They tested this idea at first without letting anyone know, and found that it worked. Then they were ready to let the world see their discovery.

On a day in June a big crowd gathered. A big linen bag was brought out and placed over a fire pot. Straw was put into the fire pot and lighted. Smoke and heated air rose and filled the balloon. The balloon began to tug at the ropes that held it, and the Montgolfiers let go.

Up, up went the balloon! A shout came from the crowd as the bag seemed to get smaller and smaller. But in a few minutes the hot air cooled and the balloon returned to earth.

News of the Montgolfiers' balloon spread quickly. Seeing their success, a man named Jacques A. C. Charles decided to try to raise a balloon in another way. He would use a gas that was very light. This gas was hydrogen.

His first balloon sailed for three-quarters of an hour overhead, while people watched below in the rain. It drifted fifteen miles out into the country and then floated toward the ground. Seeing it coming, the frightened farmers thought it was some harmful beast. They ripped it to pieces with their pitchforks.

A short time later, the Montgolfiers sent up another balloon. This time they used a larger bag, and fixed a basket to it. In the basket they put some passengers. Strange passengers they were — a duck, a sheep, and a rooster.

The balloon went up fifteen hundred feet and stayed there for eight minutes! How the rooster must have squawked and the sheep baa-ed and the duck



THE MONTGOLFIER BALLOON WAS BROUGHT OUT AND PLACED  
OVER A FIRE POT.

quacked when they all found themselves up among the clouds. We know they had a fight, for when they came down the rooster was bruised where the sheep had kicked him.

Montgolfier now thought of placing a fire pot in the basket under the balloon. If someone would ride in the basket, he could keep the fire burning by adding more straw. And so the balloon would stay up longer.

Pilatre de Rozier and the Marquis d'Arlandes were the first to try this new idea. As their Montgolfier balloon rose from the ground, they fed the fire pot with straw. Carefully, holding tight to the ropes, they peered over the basket. Down below everything looked small. The air was clear and fresh. The wind tossed their hair about. The sun beamed upon them. This was the life!

Now that these first two men had flown, others were ready to try. Jacques A. C. Charles went up afterwards in his

gas balloon. Charles was full of ideas for making better balloons, and he did more than anyone else to make balloons practical.

After a while balloons were so much better that men could make them go up and down as they wished. They could keep a balloon floating for a long time.

But that wasn't enough. Airmen were not satisfied. Why, ships were far ahead of balloons! A man could steer a ship wherever he wanted it to go. But a balloon would go only where the wind took it. If the wind should blow hard in a certain direction, goodness knows where the balloon might end.

Then somebody had a strange idea. Why not put oars on a balloon, and row it as we would a boat? But of course that didn't work. It must have been very funny to see men sitting way up there in a basket trying to row the balloon through the clouds.

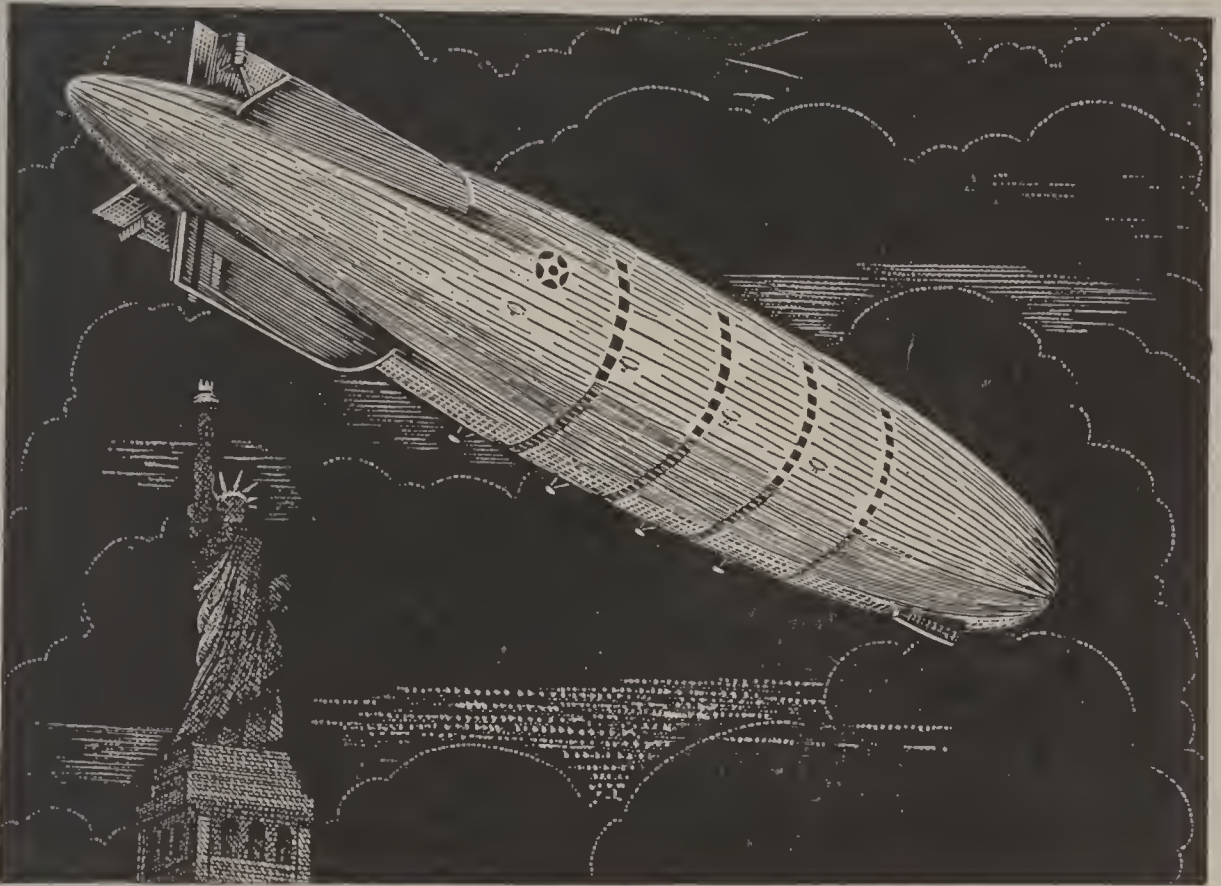
## DIRIGIBLES

When the oars didn't work, no one knew what to try next. For a long time there were very few changes in the balloon. But all the time men were working on other machines. They learned to make more powerful engines. And they learned to make a propeller.

The propeller was first invented for boats. It was a piece of wood or metal that turned like an electric fan, and was fastened to an engine. When the engine turned fast, the propeller turned very fast, and so it pushed the boat through the water. So, airmen thought, why couldn't we do the same thing with a balloon?

When propellers and engines were put on balloons, the shape of the balloon was changed. Instead of being like a ball, it now looked like a cigar. This is called streamlining. A cigar-shape is easier to push through the air. It is this same





THE DIRIGIBLE IS SHAPED LIKE A CIGAR AND HAS AN ENGINE AND PROPELLER.

shape that helps a shark or a submarine to slip through the water. A balloon shaped like a cigar, and having an engine and a propeller, is called a dirigible.

The first successful flight of a dirigible was in 1901. Alberto Santos-Dumont flew around the Eiffel Tower in Paris. His dirigible could be steered in any

direction and flew nineteen miles an hour. That was even faster than the early automobiles.

The dirigible of today is much larger than any of the early balloons. Some dirigibles are longer than a city block. They can carry heavy loads and can be used for long flights. Dirigibles have crossed the Atlantic Ocean many times. A dirigible from Germany, the *Graf Zeppelin*, flew around the world in 21 days in 1929.

### THE WRIGHT BROTHERS

Still the dirigible had many great faults. It could not travel fast enough, and it was clumsy. It could be used only in good weather. And it was not safe. Some of the best and most costly dirigibles blew up or crashed.

But airmen for a number of years had been working on another idea. Engines and propellers were used in dirigibles. Why could they not be used in another

kind of flying machine? At first the machines in which this was tried were no good, and there were many accidents. The airmen crashed into trees, into fences, into the ground. They broke arms and legs. Some of them were killed.

Among the men who were working on the new idea were two American brothers, Wilbur and Orville Wright. They studied the work of Leonardo da Vinci and other men. They studied the work of Otto and Gustav Lilienthal, who had thought, like Leonardo, that the secret of flying could be found only by watching the birds. The Lilienthals had learned a great deal about making machines that would float through the air, but their machines were gliders and had no engines.

The Wright brothers knew that there was much more to be learned about flying. They made large kites and flew them, trying to find out why the kites stayed up. They found out that the kite

was light, and so the push of the wind was enough to keep it in the air. When the wind stopped, the kite fell. It would fly properly only when the string was holding it against the wind.

Now these two airmen made glider kites, guided by strings. Like the Lilienthal gliders, these had wings that did not move up and down. They floated well. But the Wright brothers felt that they had still not found the best shape for the wings.

So they made a wind tunnel, a small tunnel through which air could be blown. Then they placed wings in the tunnel, blew wind through it, and found out which shape of wings had more lifting power. Then they were able to make a better glider.

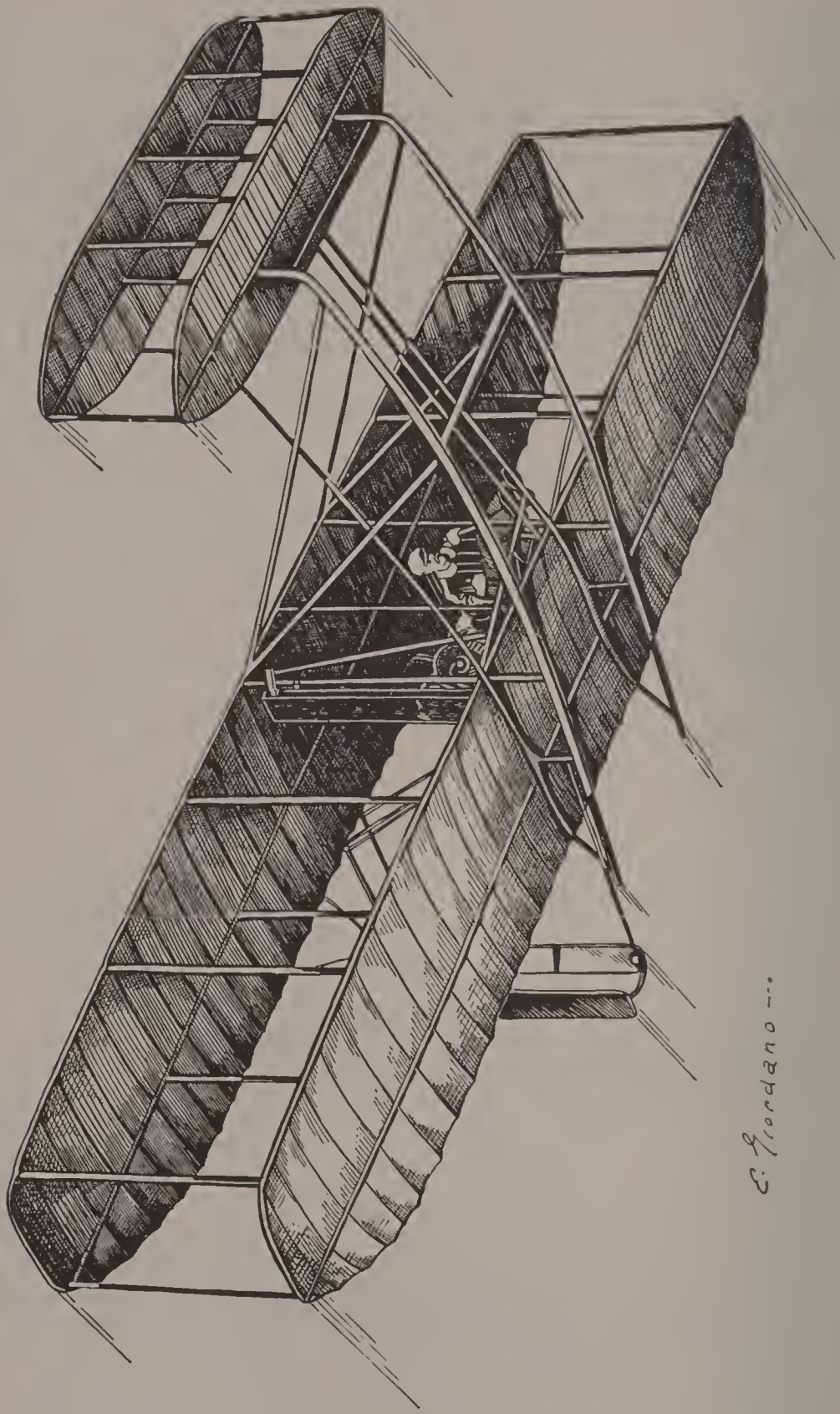
At last their glider was ready for an engine and a propeller. As the propeller pulled the glider forward, air would move over and under the wings to keep the machine in the air.

The Wright brothers tried to get the people who made automobiles to make an engine for them. But everyone laughed at the idea that an engine could be used in a flying machine. So the brothers made an engine of their own.

To the engine they fastened two propellers with blades like those of an electric fan. The engine turned the propellers. The faster the propellers turned, the harder they pulled. Then the engine



THE LILIENTHAL BROTHERS HAD MADE GLIDERS, LIKE THIS ONE, WHICH HAD NO ENGINES.



*C. Jordano ...*

THIS IS ONE OF THE FIRST AIRPLANES MADE BY THE WRIGHT BROTHERS.

and propellers were put in a glider, a strange-looking machine when we think of our newest planes.

In 1903 the Wright brothers went to a place called Kitty Hawk, in North Carolina. And here their machine made its first trip. This was the first flight in history of a winged machine driven by a motor and controlled by the man who flew in it. It went only one hundred and twenty feet, about as far as we can throw a stone.

But men had the secret now. Some day they would be able to fly to the ends of the world! The great dream had come true.

### BUILDING BETTER WINGS

The Wright brothers kept on working to make the airplane better. Other men were working, too. They put small wheels on the bottom of the plane so that it could roll along the ground and gather speed to rise into the air. And it







could roll slowly to a stop when it came back to the ground, instead of having to stop suddenly.

The Wright brothers' plane had two wings, and so it was called a biplane. Soon men were making planes with only one wing, and these were called monoplanes.

Six years after the first flight, airplanes were so much better and safer that a Frenchman named Bleriot was able to fly in a monoplane all the way across the English Channel, which separates England from France. Not long after that Glenn H. Curtiss, an American, flew an airplane from Albany to New York City, about 150 miles.

By this time governments of many countries had begun to buy airplanes for their armies. When the World War came in 1914 many ways were discovered of using planes to fight the enemy. Then planes became very important.

One thing the War showed was that

wooden planes were not so strong as planes should be. Metal was tried in place of wood, and was found to be much better. Today most planes are made of a material containing mostly aluminum, the metal used for many kitchen pots and pans.

By the end of the War many new things had been discovered about flying. Men were ready now to use planes for something besides stunt flights and fighting. Our Government began to use its planes to carry mail. And the more the airplane was used, the more men worked to improve it. Flying machines were getting better by leaps and bounds.

As airplanes became better, men began to make longer and faster flights in them. But the airplane was not yet so safe as it is today. Many people thought that pilots were fools to risk their lives, because the airplane would never be of any real use to men. But the pilots kept on flying. A number of American and

British pilots flew across the Atlantic Ocean.

One clear day in 1927, a young man named Charles A. Lindbergh left New York, winging his way eastward over the sea. And he took no one with him! Before this flight no one had ever gone alone. Newspapers called Lindbergh the Flying Fool.

A day and a half later he landed in Paris. He had traveled 3,600 miles alone to reach his goal. And he had made the trip in one-quarter the time of the fastest ships.

When people saw that one man had come safely through a non-stop ocean flight they knew that airplanes could become useful to many people. Other men began to fly across the ocean. And soon it seemed as safe to make a trip like that as to cross the country by train.

Ocean air travel was made safer, too, by improving the seaplane, or flying boat. In place of wheels, seaplanes have small

boats fastened under their bodies. These keep the planes floating on the water. The small boats are known as pontoons, or floats. In most seaplanes today, the whole body is built as a float. If anything goes wrong with the seaplane while it is flying over the ocean, it can land right on the water. And it can take off from the water.

Seaplanes hold many of the world speed records. This is because the water gives them a large space in which to take off and land at very high speeds.

Some planes are made with both wheels and floats. So they can take off from either land or water. These are called amphibian planes.

When airmen test new planes and new ideas for planes, the pilots carry parachutes in case the plane should not work right. A parachute is like a very big umbrella. It is usually strapped in a square pack on the back or under the body as a cushion. There is a little ring

on the outside. When the ring is pulled, the parachute unfolds. The person who has jumped from the plane goes sailing down to the ground without being hurt. So the race to build better wings does not cost lives as it did among early air-men.

### AIRPLANES IN WAR

Since the World War all countries have been building fleets of airplanes to be used as powerful fighting machines. Airplanes in war are now more dangerous in some ways than armies and navies.

The biggest war plane is the bombing plane, or bomber. It may be large enough to hold at least 20 men. The bomber is really a small battleship of the air. Besides bombs, it carries machine guns and small cannon. Its cannon are used against enemy planes. The bombs are dropped, and blow up when they hit something, often doing much damage.



A BOMBER, BATTLESHIP OF THE AIR, WITH PURSUIT PLANES PROTECTING IT.

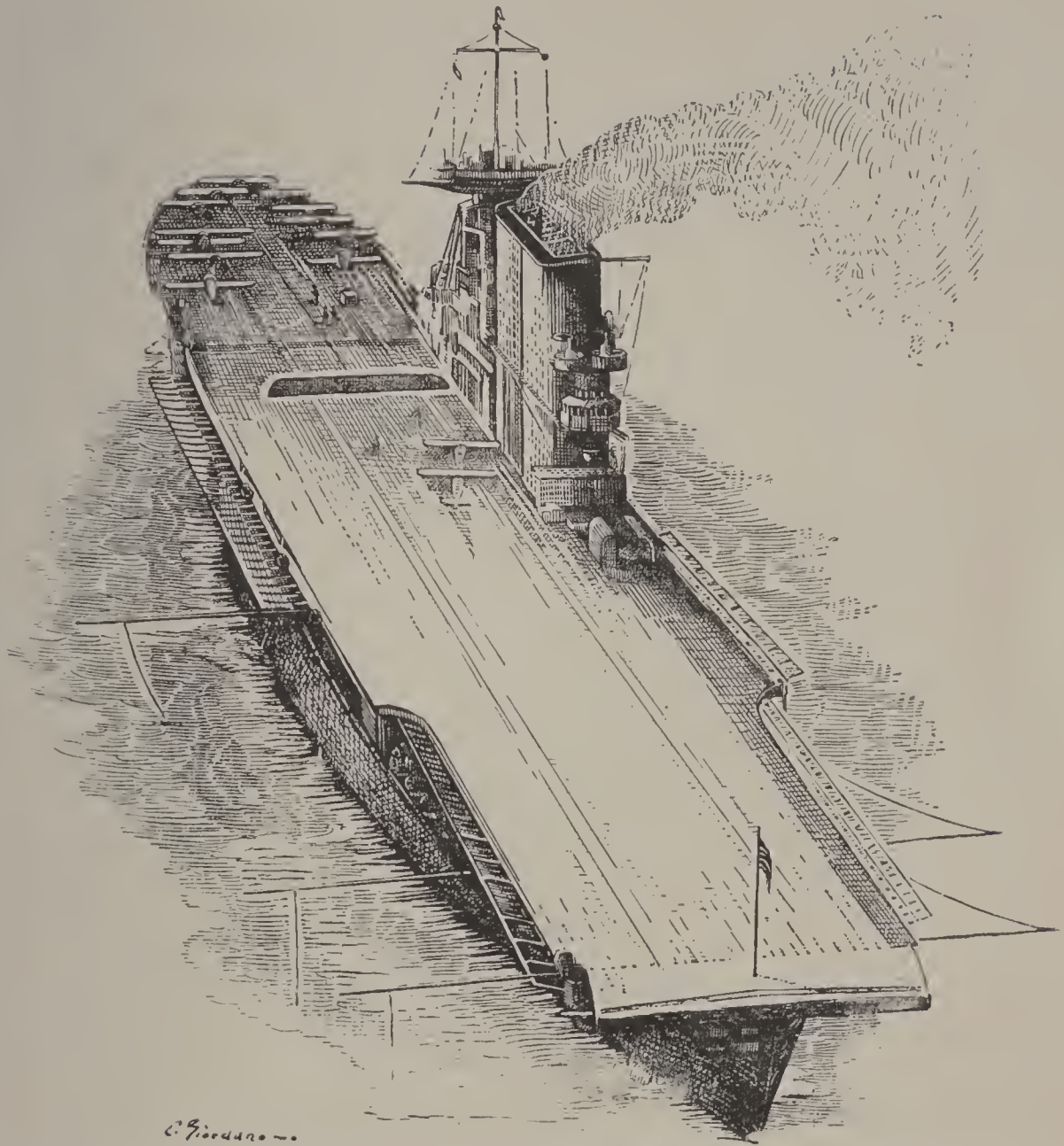
To fight the bombers, men built small planes that could fly through the air at breath-taking speed. These pursuit planes carry only one or two men, and two or more machine guns. They dart and dive and twist and pester the enemy plane, like hornets buzzing around the head of a man.

There are some planes used in war only for spying on the enemy. These are observation planes. They carry cameras, so they can take pictures of the enemy country.

For their warplanes, some countries have built floating airplane garages. These are large ships with flat decks on the top. They are called aircraft carriers. The aircraft carrier can be moved anywhere on the ocean, and so the planes always have a place to return to for rest, fuel, and repairs.

Even parachutes are important in war today. They can be used to land soldiers right in an enemy's country! Airplanes





THE AIRCRAFT CARRIER IS A FLOATING GARAGE FOR AIRPLANES.

fly the soldiers to the right spot, and the soldiers jump. The parachutes open and the men float to the ground, to help their own army by scouting, or even by blowing up railroads and bridges.

Parachutes are also used to drop mines. Mines are bombs that float in the ocean. As soon as a ship touches them, they blow up and damage the ship.

### AIRPLANES IN PEACE

But men use their wings to do good things too. Today planes can spread poison over fields where insects are eating crops. They are sent out over our forests every day to look for fires. They have been used in exploring the North Pole and the South Pole.

Many times an airplane has been the hero of a story. There was a plane that made a flight over the ice fields to Nome, Alaska, to bring medicine to sick people who were caught there in the snow. Not long ago our Navy sent airplanes across the Mississippi floodlands to drop food to stranded people.

But the greatest amount of useful work is in mail and passenger service. In the early days of air travel, only mail

was carried. But soon passengers and express were being carried too.

When commercial air transportation started, in 1919, the air roads, or airways, of all the world covered only 3,200 miles. By 1939 there were more than 71,000 miles of airways in the United States alone.

The airlines of the United States cover more miles and carry more passengers than the airlines of all other countries together. There are almost 300 big transport planes making regular flights on our airlines. They carry about two million passengers a year now, and the number is growing all the time. They carry thousands of tons of mail and express. They flew almost seventy million miles in 1938.

But the airlines do not carry all the air traffic by any means. In 1938 there were almost 11,000 private planes in our country. Many of these are used to carry sightseers or people on pleasure rides,

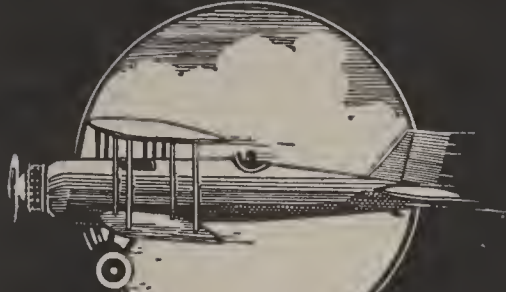
or even business men on long trips. In 1938 they carried more than half as many paying passengers as the airlines. Some private planes are used for carrying small express loads. Altogether private planes carried more than a million and a half passengers in 1938. They flew almost twice as many miles as all the airlines put together.

With all this flying we might expect many accidents. But there have been fewer accidents year by year. In 1929 a pilot on the airlines could expect an accident of some sort every two hundred thousand miles. But in 1939, accidents happened only every two million miles of flight. Most of these accidents were not serious. On the four biggest airlines there were no accidents of any sort.

But safety in the air has been won only by hard work. In the first place, airplanes had to be made better. The airplane in which we fly today is very



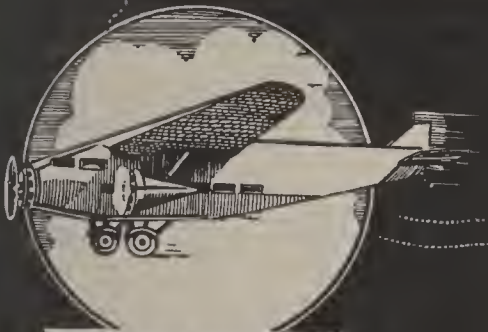
1 MAIL PLANE 1919.



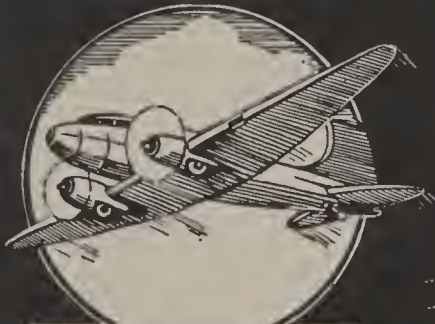
2 EARLY MAIL-PASSENGER PLANE



4 TRI-MOTOR BIPLANE 1930



3 TRI-MOTOR MONOPLANE 1928



5 TWIN-MOTORED DAY PLANE 1934



6 TWIN-MOTORED SLEEPER TRANSPORT PLANE 1939



7 FOUR-MOTORED SLEEPER TRANSPORT PLANE 1940

E. C. G.

THE AIRPLANES IN WHICH WE FLY TODAY ARE VERY DIFFERENT FROM THOSE WHICH CARRIED THE MAIL IN 1919.

different from the one which carried mail in 1919. That was a small biplane with room only for mail and pilot. The place where the pilot sat, the cockpit, was open and not protected. The plane traveled about 100 miles an hour.

The airplanes in which we first began to fly passengers were not much better than the first mail plane. The airlines were still using an open cockpit biplane, which could carry only one or two passengers.

But by 1930 big transport planes were being made. Each had three motors, with three propellers, and carried many people. Some of them were monoplanes, though biplane transports were still built. The monoplane was a slim, powerful machine. People must have thought it would be a long time before there would be a better plane than this one.

But in three years there were other great changes. The wing of the transport monoplanes was carried under the body,

instead of above or on a level with it. They were low-wing monoplanes. Instead of three engines, they now had two. These two engines had more power, but were less noisy than three engines. They were faster, and they worked together better. The propellers had three blades, for men had discovered that three blades gave more power.

But the greatest change was that the new planes were like small floating hotels. When meal time came, there was a good dinner served. When night came, there were comfortable beds. The passengers slept quietly while the plane swept through the skies.

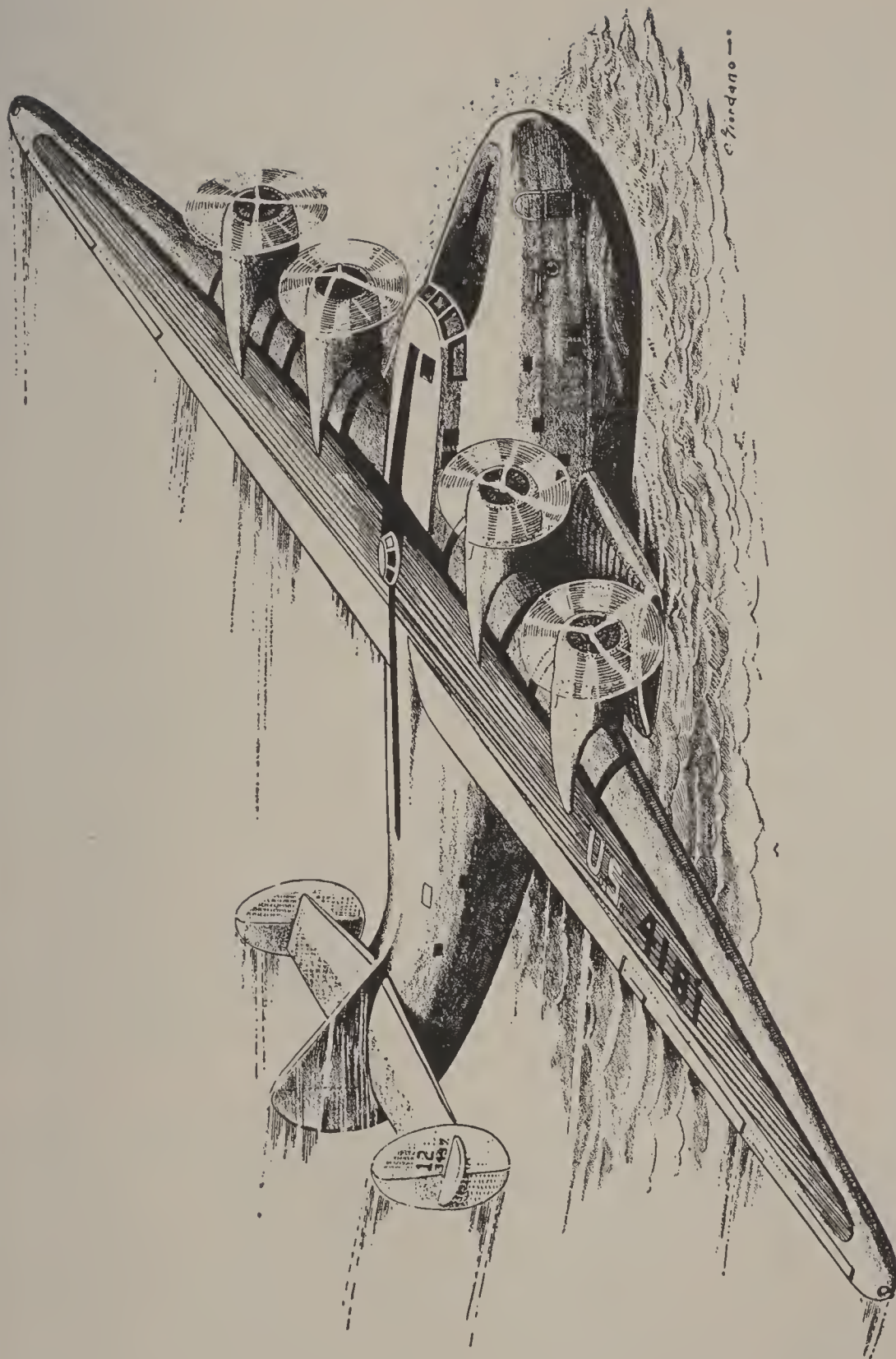
The new transports carried 21 passengers, and a crew of three. They flew three miles a minute on a long trip. That is 180 miles an hour!

All the time airplanes were becoming more and more streamlined. The twin-motored sleeper transport of 1939 was a beautiful thing to see. But airmen were

still not satisfied. They planned a giant transport that would carry from 30 to 40 passengers, and a crew of five. This giant will look much like the twin-motored planes, except that it will have four motors. An extra wheel, placed in the front, will give added safety, for it will guard against the plane's tipping over when it lands. The plane will fly at 225 miles an hour!

Meanwhile, airmen had been working on seaplanes, too, and in 1935 these began to make regular flights over the Pacific. These flying boats are the greatest giants of them all. Like the newest of the land planes, they are four-motored monoplanes. But the wing is carried over the body, instead of under it. The biggest of these can carry 50 to 70 passengers, a crew of eight, and tons of mail. They can fly almost 5,000 miles without landing, and passengers eat well and sleep well.





THE FLYING BOATS ARE THE GREATEST GIANTS OF THEM ALL.

Large planes have replaced small ones on the airlines, though some ten-passenger planes are still used. But for private flying people want smaller planes. They cannot afford to buy the large ones, or to fly them.

There are small, safe planes that a person can buy without a great deal of money. Some of these have come to be known as flivver planes, because they cost so much less to buy and to run, just as the flivver auto did. The flivver biplanes seat only one or two persons.

The private flyer may also get a plane for three people, or five. These larger planes are usually monoplanes. For the monoplane is replacing the biplane, and there are fewer biplanes made each year.

Men have built certain planes that would be safe for special uses. One of these, the autogiro, looks very different from an ordinary plane. Extending outward above its body are long thin blades

that turn like a windmill. These lift the autogiro, and so they are actually moving wings. The old autogiros had four moving wings, and one small wing like the wing of an ordinary monoplane. The new autogiros have only three moving wings and no other wing at all.

The moving windmill wings permit the autogiro to fly up and down at a very steep angle, and to land on a small space. If the engine which drives the front propeller stops, the windmill wings bring the autogiro safely to the ground. An autogiro can be used for landing freight or mail on large roofs of city buildings. In some places autogiros are used to carry light loads into cities from nearby landing fields.

A man can buy any one of the thousands of planes made yearly — biplanes or monoplanes with open cockpit or closed, land or sea planes — and know that it will carry him safely wherever he wants to go. Our Government takes

care of that. It will not let any planes be flown until they are tested for safety.

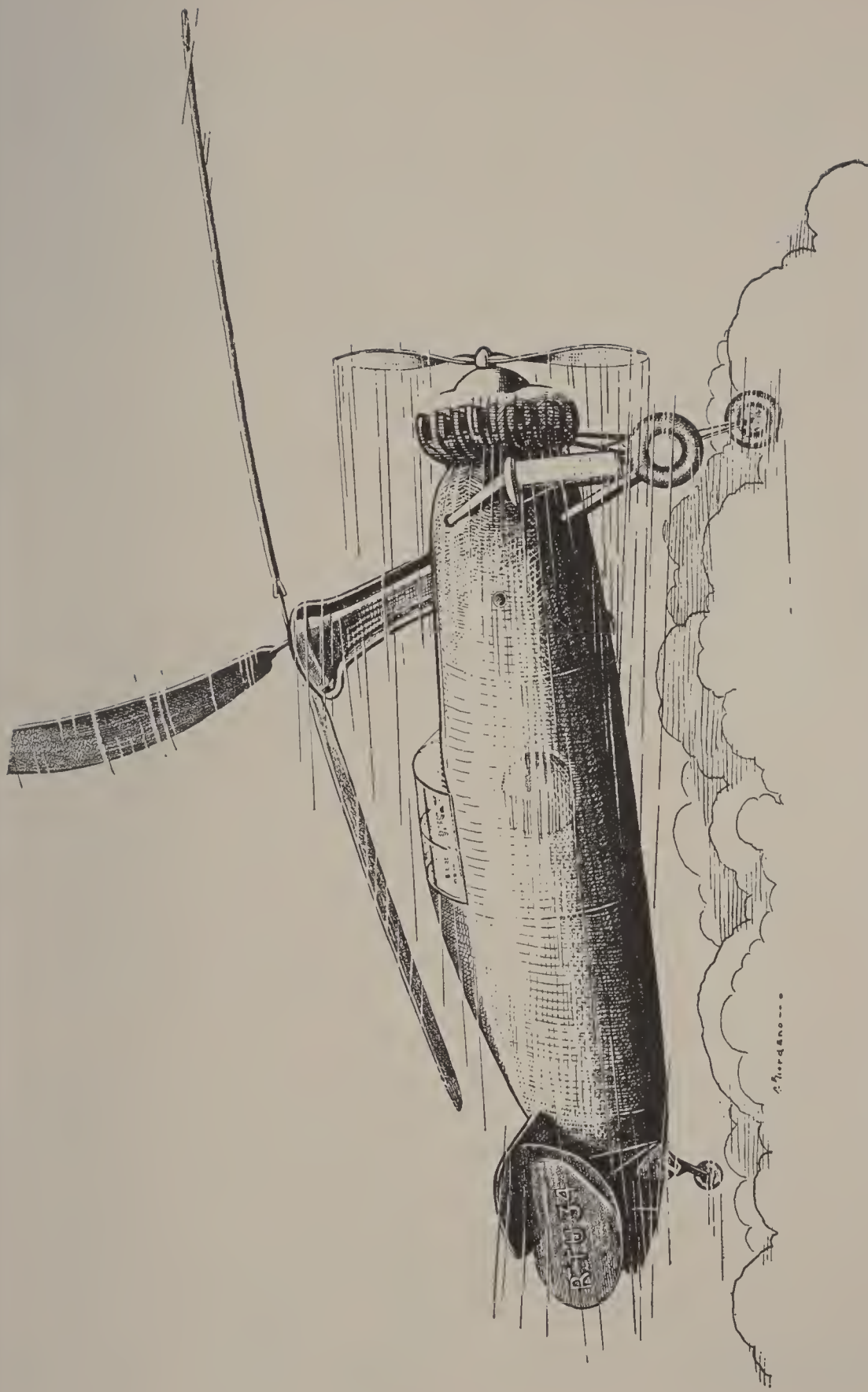
The work of the Government is the second important thing that helps to make flying safe. The Government not only sees that planes are safe. It also sees that the people who fly them know how to fly.

## PILOTS

In order to fly a plane, a pilot must get a license from the Government. The kind of license he gets depends on the kind of flying he is able to do.

If a pilot does more than his license permits, he is breaking the rules. Then he will not be permitted to fly at all for a certain length of time.

To get any kind of airplane license a person must be 16 years old and have his parents' consent. He must be 21 years old to get a license without his parents' consent. He must have a good



THE NEW AUTOGIRO HAS ONLY THREE MOVING WINGS AND  
NO ORDINARY AIRPLANE WINGS AT ALL.

character, and he must pass a physical test. He must know the air traffic rules made by the Government.

Besides these things, for each license the pilot must have done a certain number of hours of flying. He must pass a written test and a flying test. For each higher grade of license, tests get harder and more hours of flying time are needed.

For a Student Pilot license, the student must have done eight hours of flying with a teacher. For a Solo Pilot license, with which he can fly alone, he must have done five hours of solo flying. For a Private Pilot license, which permits him to fly friends without pay, 35 hours of solo flying are needed.

The pilot needs 60 hours of solo flying for a Limited Commercial license, which permits him to fly passengers for pay within an area named on the license. And he must have 200 hours to be a Commercial Pilot. Then he can fly

passengers all over the country, but he cannot be chief pilot on an airline.

The Airline Pilot must be 23 years old and a high school graduate. He must know all the air traffic rules. He must know all about why planes fly and how to fly them, how to tell what the weather will be, how to fly at night or in bad weather with instruments, and many other things. His tests are the hardest of all. He must already have a Commercial Pilot's license, and he must have had 1,200 hours of solo flight. He is a pilot that we can trust, and the biggest transport plane is safe in his hands.

A pilot can also get a license to teach, or to fly by instruments. And a man who is interested in planes can learn to do some of the other work connected with them, such as taking care of the engines or running the airlines.

There are schools in all parts of the country which teach about planes and flying. And every year the Government

picks out a number of young men who will make good pilots, and teaches them free.

Even to fly a glider a license is needed. But for this a person must be only 14 years old, and strong and well. Then he must make a certain number of glider flights and pass tests on air traffic rules for gliders.

#### AIRWAYS AND AIRPORTS

With all these rules about pilots, and air traffic, and plane strength, our Government protects the people who fly. But the airlines, too, are helping to make flying safe. They know that they can get large numbers of passengers only by making it safe and comfortable to travel by air.

Every air route is planned carefully to travel the safest way. The planes do not always fly in a straight line from one place to another. Sometimes they



must turn to detour bad storms and very high winds.

We might think a pilot would have a hard time following a road through the air. But the whole air route is marked for him. All the time there are many radio stations sending out signals which the pilot hears. These radio beams guide him along the airway, just as a white line guides us along a road in our automobile. Even if the weather is cloudy and he cannot see the ground, the pilot can find his way by the radio beam.

On clear nights the pilot also sees lights flashing every ten or fifteen miles,



ONE OF OUR GREAT AIRPORTS LOOKS LIKE THIS AT NIGHT.

to help to keep him on the right route. These are called beacon lights.

Along the airway there are certain places where passengers can get on or off the plane. These are called terminals, or airports. An airport is a busy place. All day long at a big airport there may be planes coming in from many distant places.

A good airport has to be near roads and railroads. It must be level and the ground must be firm so that the planes can take off easily. There should be no poles, fences, buildings, or trees to keep the pilots from having a clear view. And so that there will be no accidents as planes take off and land, a large airport must have towers from which traffic may be controlled.

The airport must have a weather station, too, so that the pilots may be warned of storms, high winds, rain and snow. If the weather is bad, the planes will not fly.

Less than forty years have passed since men first began to fly. Yet today there are thousands of airports in the United States.

As America goes ahead, she will go on wings, swiftly and surely, to the hum of a motor, the roar of a propeller.







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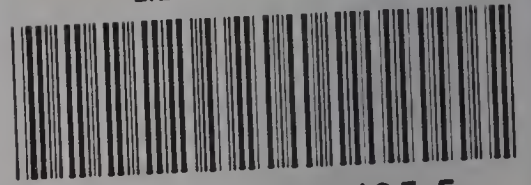
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