nate and biplane bracing will reappear, and no doubt for the largest of all, triplane construction will prove necessary.

Air Cooled Engines

The obvious advantages of air cooled engines in weight and simplicity have not been realized in the past because of high fuel consumption and unreliability. Progress has, however, been consistent. The development in the United States of the 3-cylinder air cooled 60 h.p. Lawrance engine is an important step. This engine compares well in economy with good water cooled engines. Larger engines using 9-cylinders of the 60 h.p. type are building by Lawrance and several experimental air cooled engines are under construction by others. The year 1921 should see American air cooled engines of high power.

High Altitudes

During the war there was a great demand for flight at extreme altitudes. Three methods were advocated to permit this:—excessively high compression engines, an engine excessively large and powerful for the plane, or a supercharger to supply air to the engine at ground pressure. All methods were used by all countries, but the perfection of the supercharger has come since the Armistice.

The "super compressed" engine is the cheapest and simplest means to preserve engine power as well as to gain in thermal efficiency, but requires a special fuel to prevent bad knocks. During the past year, experiments have brought out a suitable fuel.

The German B.M.W. engine is a striking example of both super compression and over size. The compression ratio is 6.4 and the engine is rated at 185 b.h.p. At ground level more than 230 b.h.p. can be developed, but at the expense of reliability. As installed, the engine is so adjusted that it will develop only 185 b.h.p., but will maintain this power beyond 8,000 feet.

The Moss supercharger used by Major Schroeder in his world record altitude flight of 33,114 feet is an outstanding accomplishment of the year and as a technical achievement is one the country may well feel satisfied with. Foreign superchargers seem to be still in the development stage.

When engines maintain their power to high altitudes by means of a supercharger, the torque remains constant. The propeller, however, due to the less dense air, is easier to turn. Consequently, the propeller should have a gear shift to increase its revolutions, or a variable pitch. The latter solution has been brought out in the Hart propeller perfected at McCook Field. Here again foreign variable pitch propellers appear to be still matters of speculation and experiment. The variable pitch propeller has been further developed to provide a complete reversal of pitch. This opens up new possibilities for brake effect on the ground and for use on airships in place of reverse gears. Variable pitch propellers have been tried on the Naval Airship C–10 and have proved very useful approaching a landing. One notable demonstration was made by the Army in California.

New Engines

New engines brought out in 1920 include improvements and refinements in existing standardized engines and a few entirely new designs. Under the first classification come the 180 and 300 h.p. Wright engines which virtually complete the Americanization of the Hispano-Suiza which has been going on for the last three years, and under the latter come the new Aeromarine 120, Aeromarine 180, Packard 300, and Packard 600 h.p. types. The Lawrance 60 and 200 h.p. air cooled engines have been mentioned.

The Wright 180 and 300 h.p. models are essentially developed engines, and the changes made from the French designs are in the nature of simplification to give longer operating life and easier maintenance: V magneto brackets, dry sump, gasoline gear pump, thicker heads, more accessible connections, etc.

The Packard 300 h.p. is a new engine of 12 small cylinders and has given a very good account of itself as an economical smooth running engine. The Packard 600 h.p., however, is still an experimental engine. It failed to run in the Gordon Bennett race, but won the Pulitzer Race running at reduced power. The engine, however, is of a type much needed for larger planes which are now equipped with two engines, and it is hoped that 1921 will show the development stage passed.

The Aeromarine six cylinder 120 and eight cylinder 180 h.p. types are among the first engines that appear to be designed for commercial use. Both have been thoroughly tested on the block and give every promise of being sturdy dependable engines as nearly fool-proof as possible. Removable heads are a feature that appeals to the man in the field.

New engines under construction which should be heard from in 1921 are an eighteen cylinder engine of 700 h.p. building at McCook Field, and a special six cylinder heavy duty airship engine of over 300 b.h.p., for which the Bureau of Engineering at the Navy Department has let contracts with three separate manufacturers. The same Bureau has a large number of Liberty engines being rebuilt to incorporate a reduction gear.

"Doped Fuel"

One of the outstanding technical accomplishments of the year is the culmination of the work of Kettering and Midgley on doped fuels. It has long been known that high compression engines knock badly on Pennsylvania gasoline, and that such engines knock less with California gasoline. It has now been determined that the addition of very small quantities of any one of several aniline derivatives to gasoline eliminates knock, that the pinking or knocking is not due to preignition but to detonation during combustion, and that higher compressions may be employed in aviation engines than were heretofore considered practicable.

A plausible and useful theory of knocking has been explained and practical use is already being made of it. If engines are run on benzol-gasoline mixtures, there is danger of freezing in cold weather and the benzol attacks rubber connections in the fuel leads. About 20% of benzol does stop knocking and makes a good fuel, but as little as 2% of aniline is claimed to be equally effective without the bad effects found in benzol. The Germans introduced blending with benzol during the war on account of the shortage of gasoline, but quickly discovered that with benzol-gasoline mixtures higher compression was permissible. The B.M.W. and later Maybach engines show the influence of this idea.

Propellers

During the year further data for the design of propellers was furnished by the publication by the National Advisory Committee for Aeronautics of another report on Profs. Durand and Leslie's comprehensive research. So far as propeller performance in free air is concerned, the information available is now very complete. Unfortunately the mutual influence of a tractor propeller and a fuselage with a blunt entrance (or a nose radiator) is not known and evidence is accumulating that a good propeller design will give an abnormally poor performance when used with certain blunt fuselage forms.

Experiments during the year on the construction of propellers have led to improvements. The Forest Products Laboratory has developed improved methods of selecting, drying, and gluing propeller woods and an aluminum leaf coating to prevent change of moisture content.

Propellers have been covered with linen and with leather in efforts to reduce erosion from rain drops and molded propellers of a bakelite preparation have been used with success. Metal propellers have not yet been proved practical but there is great promise in future developments along this line.

Torpedo Planes

The problem of the torpedo plane has been active during the year. The first torpedo carrying plane was a makeshift made up at the Naval Aircraft Factory from a lot of old Curtiss R.–6 seaplanes rebuilt with a Liberty engine and larger pontoons. These were used for practice drops in the schools.

Next, Glenn L. Martin built his well known Bomber with a divided landing gear so that a torpedo could be carried under the fuselage. The useful load was not sufficient and a further change was made by adopting an "Albatross" profile for the wings. To make up for the greater drag of this high lift wing, streamline wires were introduced. The result is that with the same power the modified torpedo carrier, I.M.T., has a high speed one mile in excess of the standard bomber, carries 1,600 lbs. more load and has a landing speed 2 miles lower.

Ship Planes

During the year the Naval Aircraft Factory has fitted hydrovanes and flotation bags on a number of land planes to adapt them for shipboard work. Experiments have been carried out with Hanriot, Nieuport, Sopwith, Vought and Loening planes. Parnall ship planes have been imported for test purposes, as well as Fokker and Macchi types. The problem is to develop a handy plane which can fly from a ship's deck, land again upon the deck, or in case of engine trouble, alight on the water and remain afloat. Experiments will continue with the collier "Jupiter" converted into an airplane carrier and renamed "Langley."

The Helicopter

It can hardly be said that any great progress has been shown toward the development of a successful helicopter or direct lift machine, although there has been a surprising amount of interest evidenced. The technical journals have carried articles "proving" the practicability of direct lift with screws and several experimental machines have been built.

The Hewitt-Crocker scheme has been tested on the ground and showed a good lift from the screws. But it has not flown. The Damblanc machine in France has had similar tests, but again no flight is recorded. It is reported that during the war, a helicopter was tried in Austria by Prof. Karman which did attain a considerable altitude while attached to the ground by several wires. So long as the machine kept a good tension in the wires, the equilibrium was maintained, but no free flight was attempted, as no means were provided for steering and control. The idea was to replace the kite balloon at the front with a small direct lift machine. The advantages seem obvious but the experiments were abandoned.

A most interesting helicopter is that of Emile Berliner of Washington. With an 80 h.p. Le Rhone engine, H. A. Berliner has made several actual flights at an altitude of six feet or so. These were really sporting events, as the transverse motion was a crab-like scuttle in random directions depending on the inclination of the machine. A circle of swift footed friends assisted in the control of the machine at critical times. However, the problem of control has now been shown up clearly, and various devices are proposed to solve it.

Racing

The year 1920 has seen the revival of racing, with the Gordon Bennett contest in France and the Pulitzer Trophy Race in this country. Both competitions were purely speed affairs but, fortunately, were over courses long enough to require some degree of reliability.

The Gordon Bennett race was naturally a great disappointment to American aeronautical engineers on account of the failure of the three American entries, each of which possessed new features of obvious interest. However, if any lesson can be drawn it is that a speed race is a gamble on whether any given machine can start and hold together long enough to finish. The French could have won the Cup this year with a training plane.

Technically, the French winner showed no advance in design over their best of 1918, but that best is still an object lesson to the world in harmony of form and superb finish.

The Sopwith entry was to have shown the 450 h.p. Jupiter and the British Nieuport the 300 h.p. A.B.C., both air cooled engines. It is of the greatest technical interest to know whether the additional head resistance of such radial engines is made up for by the saving in weight over, say, the 300 Hispano as installed in the winning French entry.

The Curtiss and Dayton Wright entries were monoplanes in which every artifice had been resorted to in the effort to obtain aerodynamic efficiency. The Curtiss reduced the landing gear to a most rudimentary type without shock absorbers, while the Dayton Wright had mechanism completely to retract the landing gear into the fuselage. The Curtiss scheme is light and simple, but demands a perfect landing field. The Dayton Wright scheme obviously saves an important amount of resistance.

The most novel and interesting feature of any entry was the variable camber device in the wing of the Dayton Wright. The theoretical advantages of variable camber are well recognized and its adoption has been deferred only by mechanical difficulties. With regard to the Dayton Wright design, the question remains to be answered from experience: Does the aerodynamic advantage compensate for the mechanical complication and risk of breakdown? The resistance of operating mechanism on top of the wing does not seem to be inherent in such gear and should be eliminated in a perfected design.

The U. S. Army entry mounted for the first time the new Packard 600 h.p. engine and was by far the most powerful machine in the competition. The design of the plane was clean, but conventional.

The American entries in the Gordon Bennett Race failed from an excess of optimism. Each was frankly experimental and untried. The Curtiss plane smashed up in landing before the race, the Dayton Wright entry quit because of control or stability troubles and the big Packard engine of the Verville Army plane misbehaved. There was no real race, as the only British starter quit with a broken oil pump and two French entries also had oil troubles.

The Pulitzer Race

The Pulitzer Race was really a race, with 37 planes to start and 24 to finish. Again, it was demonstrated that experimental planes and engines have small chance to keep up a long grind at full power. True, the Verville Packard won the race, but the engine had to be run at less than 500 b.h.p. instead of its rated 600 b.h.p., and finished but two and one-half minutes ahead of the Thomas-Morse which had but 320 h.p. The experimental engines in the Curtiss-Kirkham triplanes both failed. Both Loenings failed because of cooling system troubles, known to exist in the type and thought to be taken care of. In all there were 13 unlucky planes which failed to finish.

It appears that only one plane quit because of a defect in the airplane proper, while ten had power plant trouble. Two contestants were disqualified for reasons of piloting and have no bearing in a technical discussion.

Of the ten planes in power plant trouble, only two broke a main engine part: a Liberty and a Curtiss-Kirkham engine. The rest were forced to abandon the race because of defects in engine accessories, cooling, ignition, oiling, etc. It is discouraging to have the lesson repeated time and time again that it is the accessories that let the plane down.

However, there was not one single propeller failure or gasoline fire, no case of loss of control, no burst wing fabric, and best of all nobody was hurt. This is certainly encouraging and no such record could have been expected two years ago.

Of the thirteen "lame ducks" that abandoned the race, there were but five forced landings and only two planes damaged. Credit for this is due less to good luck than to the good management of the Contest Committee in laying out a course over excellent country.

The following table is of some significance:

Engine	Liberty	S. P. A.	180 Wright	300 Wright
Started	16	3	10	5
Finished	13	2	6	2
Ratio	81%	67%	60%	40%

Which is simply interpreted to mean that the Liberty is a fully developed engine flown in the D.H. plane, also fully developed. A return of 81% may be taken as standard. The S.P.A. engine in the Ansaldo plane is another developed combination. The 180 Wright in S.E.-5 and Vought planes is not at all experimental, but has not had the benefit of extensive service experience. The S.E.-5 and Vought were originally designed and used with the 150 Hispano engine. The 180 Wright seems to be a little too much for the cooling system provided.

The 300 Wright as installed in Thomas-Morse, Ordnance and Loening planes is still somewhat unfamiliar. The engine itself has had thorough block tests, the planes have had extensive test flights, but the installed engine in the planes has not been subjected to severe duty. This engine at ground level is too strong for the cooling system provided. Even the Thomas-Morse, which won second prize, and the Ordnance, fourth prize winner, ran the race under a handicap of cooling trouble.

The winner of the race, strangely enough, was a disappointment because it did not show more speed with its stupendous engine. The engine, however, never developed its rated power. Technically, the greatest interest lies in the Thomas-Morse, the Ansaldo, and the Vought.

The Thomas-Morse ran away from the Ordnance with the same engine, which might be accounted for from the fact that it is a somewhat lighter and smaller plane. However, there is a suspicion that the blunt ended fuselage and nose radiator of the Ordnance may have been largely responsible.

This suspicion is strengthened by the discrepancy between the times made by the Vought and S.E.-5, each equipped with the 180 Wright engine and identical propellers. The Vought is a two-seater training plane, flown as a single-seater for the race, with large wings of 30 ft. span and eight struts. The S.E.-5 is a single combat plane with wings of 27 ft. span and only four struts. Yet the Vought beat the S.E.-5 by over four minutes. Obviously, the Vought has more wing drag to overcome. But it is significant that the Vought fuselage has an easy entrance and the circular nose radiator is symmetrical round the propeller axis, while the S.E.-5 has a blunt fuselage with a nose radiator projecting high above the propeller axis into the slip stream.

On the other hand, the Ansaldo made a fine record and its nose radiator resembles the S.E.-5. However, this plane is smaller than S.E.-5, has greater power, and can hardly serve for comparison.

The evidence is accumulating that blunt bodies shaped like S.E.-5, D.H.-4, and even the Ordnance and Verville to some degree, choke the propeller. If nose radiators are used in spite of many objections, it would seem desirable to use a small deep circular radiator and, if possible, a geared down propeller of large diameter. The combination of a large nose radiator and a small diameter propeller as in D.H.-4 has nothing to recommend it.

Another interesting point about the race is the use of benzol-gasoline blends by several of the prize winners. No power was gained but the knocking feared from running full power at ground level was eliminated and the engine eased. It seems reasonable to believe that the blended fuel permitted engines to run wide open which otherwise would have come to grief.

CHAPTER XIV

FOREIGN AERONAUTICS; REVIEW OF ACTIVITY, NATION BY NATION, THROUGHOUT THE WORLD

SUBSTANTIAL progress in the development of aeronautics was made by many nations in 1920. The greatest development was attained in those countries having centralized government control. This national support, whether moral or financial, or both, is establishing commercial aeronautics on a firm and permanent basis. The respective governments following out a definite aeronautical policy are doing so with the avowed purpose of securing a peace-time position in the air which will be their chief defense in war.

. Through the courtesy of European air attachés and diplomatic representatives in Washington, and through the co-operation of the Air Service and the Bureau of Foreign and Domestic Commerce, as well as by direct investigation abroad, the Manufacturers' Aircraft Association is able to present the following review of aeronautical activity, nation by nation, throughout the world:

ARGENTINA

Argentina is officially interested in developing its aeronautical resources, and the government is studying the regulations of the International Aerial Convention with the idea of formulating an aerial code. Meanwhile Federal aviation is under jurisdiction of the military. The Curtiss Aeroplane & Motor Corporation is demonstrating American built aircraft and maintains an aerial taxi service at San Fernando, 15 miles from Buenos Aires. There are also French and British companies co-operating with local financial interests.

AUSTRALIA

Australia is organizing an air force which, with civilian aviation activities, will be under the control of a board including in its personnel representatives of the Army, Navy and commercial interests. During 1921 the government hopes to map all possible air routes, make appropriations to encourage civil aviation and provide in this a civilian reserve and assure an operating aircraft industry, able to supply planes and motors in case of war. For this the budget appropriates £500,000 (about $2,500,000 at normal exchange) for military and £100,000 for civilian aviation in 1921. An air mail service is being operated by the government between Lismore and Tenterfield, 101 miles apart.

Austria

Austria has an aeronautics department under the State Secretary of Transport. Provisional regulations for aerial navigation, pending the publication of Austria's signature to the International Aerial Convention, have been issued.

Belgium

Belgian aeronautical activity is under the jurisdiction of the premier group of the Minister of National Defense, who has under his supervision a department headed by a Director of Aeronautics. The development of civil aviation is under this Director. Commercial, passenger, freight and mail lines are being operated between Brussels and Paris and Brussels and London. Belgium has assigned air attachés to all important capitals of the world. Their duties are to aeronautics what those of the military and naval attachés are to the military and naval branches of the government.

Bolivia

When Bolivia completes government and civil aviation plans, both branches will be under the jurisdiction of the Minister of the Interior. Bolivia presents a problem for aeronautical engineers. The extremely high altitude of the country makes it imperative that high-powered special high-altitude planes be employed. Bolivia first saw an airplane flight in June, 1920, when a Curtiss triplane purchased by the War Department was placed in operation.

Brazil

Brazil is developing an air force, and has formulated certain rules and regulations concerning civilian flying. Representatives of the Curtiss corporation, continually flying over Rio de Janeiro and other cities, created much enthusiasm in aeronautics. Practically the only restriction on flying to date has been the rule that a pilot must have a government permit.

Canada

Canada has an Air Board which supervises all federal and civilian aeronautics. It was established by an act of Parliament, June 6,

1919. A chairman and advisory officers were appointed immediately. They, in turn, divided the work of the Air Board into three branches, each under a Superintendent: flying operations, certificate branch and a secretariat. The superintendent of flying operations controls all government flying. The certificate branch conducts that part of the administration relating to the public, such as licensing of pilots and personnel, inspection of aircraft and air harbors. The secretary has charge of the office organization.

The Canadian Air Board at once issued orders against dangerous flying and then set to work on regulations. The rules were established by 1920. They conform to the Air Board Act and the International Aerial Convention.

Preliminary surveys have formed the basis for a network of aerial routes and landing fields designed to facilitate the development of commercial aviation in time of peace and the transportation of aerial troops, supplies and munitions from one end of the Dominion to the other in time of war.

The Board is also gathering meteorological data.

There are two aerial mail routes being laid out; one, the "All Red Route," connects St. Johns, Newfoundland, the gateway of the transatlantic air lines, with Victoria, B. C., the Canadian port of entry on the Pacific. This route, which has been charted and flown over in many sections, includes Quebec, Montreal and Ottawa, follows the line of the Canadian Pacific Railway through the Canadian national parks and makes many depot stops, also junction points whence, it is planned, branch routes will divert aerial traffic to Toronto, Sydney, Ont., across to Detroit, Mich., and from Winnipeg to Hudson Bay, Edmonton to Peace River, and Vancouver to Yukon. Under this system Halifax will be forty hours, by air, from Vancouver, while Winnipeg and Montreal will be separated by only 15 hours. The "Sunset Route" connects with all the principal cities and towns between St. Johns, N. F., and Vancouver, B. C., including Sydney, Halifax, Frederickton, Rivierre du Loupe, Quebec, Montreal, Three Rivers, Toronto, Brockville, Camp Borden, Port Arthur, Winnipeg, etc.

The Canadian Air Force was organized by the Air Board early in the summer of 1920. Since then seaplane stations at Halifax and Sydney have been taken over, and the flying field at Camp Borden has been obtained from the Department of Militia and Defence. Aerial maps are being made up as rapidly as possible. A bureau of aeronautic intelligence has been organized for gathering and disseminating information.

A trans-Canada flight was conducted by the Air Board in September and October, 1920. (See Chronology.)

The Certificates Branch, which has charge of all federal and civilian flying personnel, inspection of machines and examination and licensing of planes and pilots, laid out the groundwork for the flight, co-operating with the Naval Service and the Meterological Department.

During the eleven months in 1920 the Air Board reported the following: Private air pilots certificates, 60 applied for and 51 issued; Commercial air pilots certificates, 118 applied for and 59 issued; Certificates of aircraft registration, 137 applied for and 96 issued; Air Harbor certificates, 47 applied for and 6 permanent and 28 temporary issued, pending per-improvement of facilities.

All civilian and commercial flying organizations are required to make monthly reports detailing the number of machines in operation, number of flying hours, accidents, etc.

Chile

Chile has been interested in aviation since 1912, when foreign aviators arrived in the country and interested the people in developing the art of flight. A military school of aeronautics was founded by the War Department in 1913.

China

Chinese aviation is confined to the military air service, students of which are receiving training at the Curtiss Flying Station in Manila, Philippine Islands.

Colombia

Under its War Department, Colombia is endeavoring to organize both military and commercial aviation sections.

Czecho-Slovakia

Three operating airplane factories located near Prague, the capital of Czecho-Slovakia, indicate considerable interest on the part of both the government and civilians. The Czecho-Slovak Aero Club, on October 23rd, 1920, held the first international aeronautic exposition at Prague.

Denmark

The Navy and Army Departments have respective jurisdiction over aviation in Denmark. Regular air service, carrying mail and passengers, has been established between the three Scandinavian countries. These countries, with Copenhagen as a center, are in direct regular air service communication with west and south Europe, by the following routes: Copenhagen to Warnemunde, Berlin and Copenhagen; Hamburg-Amsterdam-London. This air service is conducted by private Danish firms, but the government assists in every way possible.

Ecuador

All aviation in Ecuador is under the jurisdiction of the War Department. Late in 1920 it was planned to establish a military aviation school.

France

French aviation is divided into three branches: military, naval and civilian, the last under the Under Secretary of State for Aeronautics. It is a branch of the Ministry of Public Works. The common point between these three branches of French aviation lies in the technical section of aeronautics. During 1920 it was found that a great deal of money was saved, by having in the same organization all the aeronautical engineers of the Army and Navy. This was based on the experience that any improvement in the mechanical branch of the art necessarily must be of benefit to all aviation activities.

The Under Secretary of State for Aeronautics is M. Flandin. Late in 1920 General Dumesnil was Chief of Military Aeronautics and Captain Valdenaire, Chief of Naval Aviation. M. Fortante was Chief of the Technical Section, involving the other three branches. Aerial attachés have been appointed to the important countries of the world. The French Aerial Attaché in Washington is Captain de Lavergne. France has sent temporary or permanent aviation missions to other countries, including those in South America and Asia, for the purposes of supporting French manufacturers, surveying markets, establishing air transportation under the respective governments and in some cases acting as temporary military missions, instructing foreign governments in organizing their aviation departments.

Late in 1920 there was a project to establish an aerial arm of national defense, which was to be brought before the Chamber of Deputies for ratification. This aerial arm would be similar in operation to infantry, artillery and cavalry. It would double the flying pay, promotions would be more rapid and retirement after twenty years of service, with the same pay as in the others after thirty years. A special school of aeronautics was to have been organized at Fontainebleau. A scientific school for aeronautical engineering has already been created at Versailles.

France has established an air mail service through civilian companies. The organizations operating the mail lines include: Messageries Aeriennes, between Paris and London; Grands Express

Aeriens, Paris and London and Paris and Brussels; Latezoere and Company, between Toulouse, Spain, Morocco, Rabat; Franco-Roumaine, between Paris and Bucharest, and also the Company Paris-Pragen, between Warsaw, Poland and Paris. Approximately 40,000 letters a month have been carried by the French lines operating between Paris and London. The air mail postage in Europe is slightly in excess of ordinary postage. All landing fields are in charge of the Office of Aerial Navigation. These fields are bought, established and equipped at the expense of the government. The civil plane finds there a shelter as well as gasoline, oil, repair facilities and mechanics, all for a small fee. All communications, wireless stations, meteorological posts, are installed by the government Office of Communications.

For each trip undertaken by a company recognized by the government, certain bonuses are given. The sum of various bonuses covers, for instance, for the trip from Paris to London a total of almost 700 francs or $140. During the next ten years the government will continue to award these bonuses in order to support civilian aeronautics and to help develop it. The budget for the next fiscal year includes 60,000,000 francs for civilian aeronautics alone. In return for this government assistance, private companies are required to accept the control and supervision of the government, according to the rules and regulations laid down. The planes must have certain characteristics, which permit of their being transformed immediately into war craft. They must be kept in perfect condition and the government may have a plane condemned and discarded.

French aviation officials are convinced that within ten years the public will use aircraft as much as the railways. More than 1,000 persons have flown from Paris to London. With the opening of the new lines, the government has planned to create another aerial landing field at Orly, 60 kilometres from Paris. At Nice will be located the official junction point between Paris and Rome and Paris and Bucharest. Strasburg will be the junction of all lines coming from Germany, Czecho-Slovakia, Poland, and in the future from Russia. Radio stations have been erected, special telephoning posts built and meteorological observations are sent every hour to every landing field.

Germany

Germany has a Ministry of Air and Transport. Immediately after its creation early in 1920 several new transport and aerial manufacturing companies were formed. Liberal subsidies have been granted to manufacturing and passenger carrying companies.

Great Britain

All aviation in the United Kingdom of Great Britain and Ireland is under the Air Ministry. Military and naval aviation is included in the Royal Air Force operating under the Air Ministry, as does the American Air Service under the War Department. The Ministry also has jurisdiction over civilian aviation — control of fields, inspection and licensing of machines and pilots. Many air lines operate daily between Great Britain and the Continent. While the Royal Air Force is the dominating scheme of the government organization, the Air Council of the Ministry includes Winston Spencer Churchill, Secretary of State for Air, the Marquis of Londonderry, under-Secretary of State for Air, Air Marshal Sir Hugh M. Trenchard, Chief of the Air Staff, Major General Sir Frederick H. Sykes, Controller-General of Civil Aviation, Air Vice-Marshal Sir E. L. Ellington, Director-General of Supply and Research, W. F. Nicholson, Secretary of the Air Ministry.

The ministry is divided into departments, the Department of the Secretary including the air historical branch, a directorate of contracts, a finance department and a directorate of lands. The Department of the Chief of the Air Staff handles all operations and intelligence, training and organization, personnel, equipment, medical services, works and buildings. The department of the Controller General of Civil Aviation has charge of all commercial aerial navigation and enforcement of aerial laws, information, communications, licensing of airdromes and pilots and meteorological data, all co-operating with officials assigned from the Royal Air Force. The Department of the Director-General of Supply and Research has charge of all research, designs, armament, instruments, aircraft supplies and aeronautical inspection.

Active committees include those on airdromes, advisory committee on civil aviation, research, awards to inventors and patents, medical advisory board, meteorology, industrials, etc.

Then there are these inter-departmental committees on which the Air Ministry is represented: cadets' regulations, navy and army canteen board, ex-service organizations, radio research, etc.

The United Kingdom is divided into area commands—the inland area, in which is also included the Irish wing; the Coastal area, which includes all airships and seaplane stations and flying craft operating with the Fleet.

Royal Air Force Headquarters for cadet and boy training are located at Cranwell and at Halton, England.

Late in 1920 Great Britain had air attachés in all important capitals. Air Commodore L. E. O. Charlton is air attaché at Washington.

The Air Council has established a prize fund for improvements in design and performance of both commercial and military aircraft. The government also assumes responsibility for organization of airdromes, wireless and meteorological services, adjustment of international questions, research and experiments. At the Air Conference held in October, 1920, under the auspices of the Air Council, and in which all aeronautical interests, commercial and military, participated, reports on all angles of aviation were distributed. Preliminary work is under way toward linking all Colonies with England by means of commercial aerial routes. The Air Council is co-operating with the Canadian, Indian and New Zealand Air Boards.

In response to an interpolation in Parliament November 24th, the Prime Minister stated that there was a distinct separate future for the Air Service, apart from its co-operation with either sea or land forces. He stated that the expense of the Royal Air Force, as at present constituted, had been justified by results.

On November 23rd, the Secretary of State for Air, Mr. Churchill, in response to interpellations, gave the following facts: The Air Force in Constantinople is maintained at a monthly expenditure of approximately £4,000. The Air Force in Egypt is maintained at a monthly expenditure of approximately £80,500. The Air Force in Palestine is maintained at a monthly expenditure of approximately £18,250.

Mr. Churchill stated that on October 1st, 1920, the total strength of the Royal Air Force was: officers, 2,812; other ranks, 23,862. The numbers authorized in the Air Estimates for the year 1920–1921 were as follows: officers 3,059; other ranks, 26,519.

Three commercial air routes are operating between England and the Continent — London to Paris, 223 miles; London to Brussels, 210 miles; London to Amsterdam, 258 miles. The Government grants a bonus equal to about 25% of the operating receipts of companies engaged in commercial flying.

The Government airdrome at Croydon and the private commercial airdrome at Cricklewood are arrival and departure stations for aircraft from abroad. Pilots arriving from a place outside the United Kingdom take their airplane to the examination station, where a report is made and the prescribed form filled out. Log books, manifests and declaration of goods on board the aircraft are turned over for inspection.

Strict rules are enforced regarding importations into the United Kingdom. From May 1, 1919, till October 1, 1920, 100,285 passengers and 266,000 pounds of freight were carried in aircraft flying approximately 1,381,500 miles. Imports worth £512,722 were flown into the United Kingdom in twelve months. Exports for the year aggregated £235,045 in value. Aircraft departing for the Continent in twelve months totalled 1,455, and 1,325 arrived in England; 51,535 letters left the United Kingdom for Paris, Brussels and Amsterdam, and 45,077 letters arrived from those cities between November, 1919, and October, 1920. Unlike the U. S. Air Mail Service which transports mail thousands of miles at ordinary rates of 2¢ an ounce, European air mail costs more.

The three commercial air routes from England to the Continent connect with other air lines running all over Europe and to Africa. Train service is augmented, and international travel facilitated by simplified customs regulations. On the London-Brussels air-line, passengers can transfer to craft flying between Antwerp and Brussels, Spa and Brussels, or Paris and Brussels.

On the London-Amsterdam route, connections can be made to Hamburg, Berlin, Bremen and Copenhagen.

Passengers flying from London to Paris may connect with air-lines running from Paris to Bordeaux, Toulouse, Rabat (Casa blanca), Tangier, Montpellier, Bayonne, Bilboa, Nimes and Nice, via Avignon.

Italy

Since July 1st, 1920, commercial aviation in Italy has been under the jurisdiction of the Permanent Board of Aeronautics, which, broadly speaking, controls the development of both military and naval aviation. Army Air Service operations are controlled by the Inspector of Army Aeronautics, and naval aerial operations by an Inspector of Naval Aeronautics. These are Gen. Moris and Admiral Orsini, respectively, while Professors Volterra and Panetti comprise the other members of the Board.

All military and naval aircraft are developed and produced by the Army Air Service, assisted by technical officers from Naval Aviation when the planes are to be used by the latter branch. Operations are conducted separately by both land and sea aerial forces, while the aviators are trained in separately conducted schools.

The Army Air Service, beginning January 1, 1921, will include four divisions, that dealing with commercial aeronautics, the operating division, the technical and administrative divisions. Technical sections under the jurisdiction of the War Department include experimental branches for both heavier and lighter than air craft all in the technical division, also an ordnance bureau, radio office, aerological and photographic services.

The chief of the Army Air Service is Major Gen. Amedeo de Siebert. Lt. Col. Ferrari commands the technical division, Col. Rossi the planning division, Lt. Col. Lapolla, operations; Lt. Col. Verduzio, experimental.

Italy has assigned aerial attachés to France, England, the United States and Sweden. Lt. Col. A. Guidoni is attaché at Washington.

The commercial aeronautics branch of the Army Air Service is continuing the work of preparing aerial routes and establishing landing fields throughout the kingdom.

Several commercial companies are endeavoring to maintain regular services. They are assisted by the Government, which maintains the landing fields and defrays the expenses incident to charting air routes. The Government also nourishes the industry by buying all its machines from manufacturers with two results: machines and equipment can be secured more economically from private factories operating on a competitive basis than if built in Government owned and operated factories; also, the maintenance of a civilian industry provides the country with a nucleus for quantity production in case of war.

Aerial laws have been made in accordance with the International Aerial Convention and local regulations are based on those provisions.

Japan

Aviation in Japan is under the supervision of the government, military and naval aviation being part of the army and navy establishments and the air mail service now being organized under the supervision of the Department of Communications — all, however, co-operating in conferences for the development of machines, routes and the training of pilots.

Norway

Norway has an Air Force under direct government supervision, which is co-operating with commercial companies in establishing routes and air terminals throughout the country. Under the War Department operations are divided by the Army and Navy directorates.

Peru

All aviation in Peru is under the War Department. Air mail lines have been established from Lima to Callao, Ancon, Huaclio, Trujillo, Supe, Chorrillos, Lurin and Pisco.

Poland

The Polish Government is encouraging the establishment of air mail services between Warsaw, Prague, Strasburg and Paris. Military Aviation is under direction of the general staff and consists of aviators recruited from many countries, including the United States.

Roumania

All aviation in Roumania is under Government supervision, the civilian flying being handled by a directorate of aviation in the Ministry of Communications. This bureau is now organizing airways and helping to organize factories, at the same time regulating aerial navigation. Plans have been made to organize permanent aerial passenger routes in 1922.

All public aircraft facilities, such as air ports, radio telegraph, radio direction finding, supplies and repairs, are being organized under the direct supervision of the Government. These facilities are let to private companies obtaining State contracts. The Government also has tendered to all sports and touring activities assistance similar to that given the commercial services.

Spain

The Spanish Government late in 1920 announced its plans to maintain jurisdiction over all aerial traffic, according to the regulations of the International Aerial Convention. Mail and passenger lines have been organized for operation in Spain, France and Northern Africa.

Switzerland

Two directing bureaus, operating under the Swiss Federal Council, control all aviation, military and commercial, respectively. Many training schools for pilots have been established and private companies have been encouraged by law and government support to establish air lines, which are now operating between Dubendorf, Zurich, Berne, Lausanne and Geneva.

Sweden

Sweden is reorganizing her army air service which heretofore has been under the jurisdiction of one of the three aeronautical heads — the army, navy and waterpower administration. The last named has established aerial routes from Porjus to the electrical waterpower sites in Northern Lapland. Daily service is maintained, with seaplanes in summer and land machines mounted on skiis in winter. The Postoffice Department in 1920 started air mail services to Malmo-Copenhagen, Warnemunde and Berlin. The government has granted a liberal subsidy to the Swedish Air Traffic Company for 1921. The Aero Club of Sweden also receives a subsidy from the government.

Uruguay

Military aviation is under the authority of the Minister of War and Marine. There is a military aviation school at Montevideo, which also has an aviation club. The capital city is the western terminal of a civilian airplane line from Buenos Aires.

HISTORICAL DESIGN SECTION

HISTORICAL DESIGN SECTION

IN the following pages the progress of American aircraft design is illustrated.

It has been the aim to trace significant phases in the development of the art from the time the Wright Brothers made the first flight.

Even in so new an industry, records of early achievements have been scattered, but with the assistance of Orville Wright, Glenn H. Curtiss, Glen L. Martin, Edson Gallaudet and other pioneers, the compilers of this volume are able to present what is believed to be a fair graphic history of our development.

The gliders built and demonstrated by the Wrights are illustrated as the final steps preparatory to the historic flights at Kitty Hawk, N. C.

Langley's "Aerodrome" is given a place of honor, as it was built the same year the Wrights flew, but was not demonstrated until eleven years later, when Mr. Curtiss attached pontoons and took it up at Lake Keuka. Prof. Samuel Pierpont Longley, the designer, who died amid the ridicule of the undiscerning mind of his day, was thus vindicated.

But nothing, of course, can diminish the obligations which the art owes to Wilbur and Orville Wright. It was Orville Wright who made the first flight on the morning of December 17, 1903. He describes it as follows:

"The course of the flight up and down was exceedingly erratic, partly due to the irregularity of the air, and partly to lack of experience in handling this machine. The control of the front rudder was difficult on account of its being balanced too near the center. This gave it a tendency to turn itself when started, so that it turned too far on one side and then too far on the other. As a result, the machine would rise suddenly to about ten feet and then as suddenly dart for the ground. A sudden dart when a little over a hundred feet from the end of the track or a little over 120 feet from the point at which it rose into the air, ended the flight. As the velocity of the wind was over 35 feet per second and the speed of the machine over the ground against this wind ten feet per second, the speed of the machine relative to the air was over 45 feet per second, and the length of the flight was equivalent to a flight of 540 feet made in the calm air. The flight lasted only twelve seconds, but it was nevertheless the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward without reduction of speed, and had finally landed at a point as high as that from which it started."

It was not until five or six years afterward that the United States government became sufficiently interested to call for the design and construction of an airplane. The one thus built was flown, as the first American military machine, at Fort Myer, near Washington, Sept. 9, 1909.

In the meantime Glenn H. Curtiss, alone and through the Aerial Experiment Association, had been carrying on his work with airplanes and engines, and on July 4, 1908, made the first publicly announced flight in the history of the art. This was made at Hammondsport, N. Y., in the "June Bug," which was destined to be the first of a long line of practical machines bearing Mr. Curtiss' name, one of which made the first flight across the Atlantic. Mr. Curtiss describes this famous flight as follows:

"The 'June Bug' was brought out of its tent and the motor given a try-out. It worked all right. The course was measured and a flag put up to mark the end. Everything was ready and about seven o'clock in the evening the motor was started and I climbed into the seat. When I gave the word to 'let go' the 'June Bug' skimmed along over the old race track for perhaps two hundred feet and then rose gracefully into the air. The crowd set up a hearty cheer, as I was told later — for I could hear nothing but the roar of the motor and I saw nothing except the course and the flag marking a distance of one kilometer. The flag was quickly reached and passed and still I kept the airplane up, flying as far as the open fields would permit, and finally coming down safely in a meadow, fully a mile from the starting place. I had thus exceeded the requirements and had won the *Scientific American* Trophy for the first time. I might have gone a great deal farther, as the motor was working beautifully and I had the machine under perfect control, but to have prolonged the flight would have meant to turn in the air or passing over a number of large trees. The speed of this first official flight was closely computed at thirty-nine miles an hour."