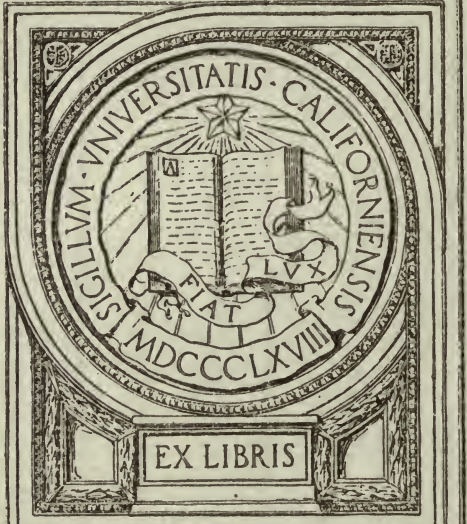

MILITARY AVIATION

PREPARED BY THE WAR COLLEGE DIVISION, GENERAL STAFF CORPS AS A SUPPLEMENT TO THE STATEMENT OF A PROPER MILITARY POLICY FOR THE UNITED STATES

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SYNOPSIS.

MILITARY AVIATION.

I. INTRODUCTION.

1. RELATION OF AVIATION TO THE MILITARY SERVICE.

In this paper it is proposed to consider various aeronautical appliances in regard to their practical value in campaign, as shown by such data as are now available from the theater of war in Europe.

In its relation to the military service, aviation to-day may be regarded as embracing all aerial appliances, such as heavier-than-air craft, dirigibles lighter-than-air craft, and nondirigibles or captive lighter-than-air balloons, together with the personnel necessary for their operation and management.

2. USE OF AIRCRAFT ON OUR COAST AND WITH OUR MOBILE LAND FORCES.

In considering this subject account should be taken, first, of the use of aircraft of various types along and beyond the coasts and frontiers of the United States upon the outbreak of war; second, the use of aircraft in the Army by the mobile forces; third, the use of aircraft by our over-sea garrisons.

In addition to the battle fleet and units of the Navy designed to take the offensive on the high seas, the waters contiguous to the coast line of the United States are organized into naval defense districts. These cover certain sections of the coast line and contain patrol vessels, both surface and subsurface, and aircraft for reconnoissance purposes. These are essentially for the purpose of finding out and locating hostile vessels which are approaching the coast and of determining their strength, dispositions, and probable intentions.

Added to the strictly naval formations included in the naval defense districts, in time of war the United States Coast Guard (in peace under the Treasury Department) passes to the control of the Navy.

The Coast Guard, in addition to its boats and revenue cutters which will be utilized as patrol vessels, embraces the Life-Saving Service. The latter has stations more or less regularly distributed along the coasts which are connected by telephone lines. They are also equipped with visual signaling appliances to communicate from shore to ships. The Navy maintains a chain of radio stations along our coasts and over-sea possessions.

The naval defense districts become of great importance in case that the main battle fleets are defeated or in case they are operating at a great distance. Therefore, when an enemy expedition breaks through the naval defense and approaches the coast with a view to forcing a landing the resistance to such an expedition becomes primarily a function of the Army.

The defensive formations of the Army consist of the harbor defenses and accessories and the mobile units. The harbor defenses consist of fixed and mobile gun defenses and mine defenses; also obstacles both on land and in the waters. The aircraft required in connection with the harbor defenses should consist of machines used for one or more of the following purposes:

(*a*) For reconnaissance—that is, to determine the strength, dispositions, and probable intentions of the enemy.

(*b*) For preventing hostile aerial reconnaissance.

(*c*) For destroying hostile aircraft and for offensive work against enemy submarines and other vessels, including the interruption of enemy mining or countermining operations.

(*d*) For aiding in spotting the fire of Coast Artillery, both against ships and against any invading force that may invest the seacoast fortifications.

The number and character of the aircraft required depends on the locality, number of harbor defenses, their organization, strength, and positions. Each harbor-defense area, therefore, needs to be studied with this specific end in view, and should have radio apparatus not only for communicating with the Navy but also for communicating with its aircraft and with the units of our mobile forces.

In addition to the aircraft required with the harbor defenses themselves, aircraft are required with modern movable coast-defense armament employed as an auxiliary element of the mobile forces in defending the intervals between our fortified harbors and with units of the mobile forces.

The use of aircraft with the mobile units is a definite matter; each division requires one squadron of 12 aeroplanes. These are divided into three companies of four aeroplanes each, two companies having reconnaissance and artillery observation machines and one company having two high-speed machines especially constructed for long-distance reconnaissance and for combating the enemy's aerial craft; two battle machines for the purpose of bomb dropping and offensive work against enemy material of all sorts. This is in keeping with the best practice that has been developed in the European war.

3. USE OF AIRCRAFT AT OVER-SEA STATIONS.

The use of aircraft with the Army in the over-sea possessions is analogous to that mentioned above with the harbor defenses; and in

addition, wherever mobile units of the Army happen to be, they must be provided with suitable aircraft. The defense of over-sea possessions constitutes a problem in itself, and these garrisons must be equipped not only with machines capable of reconnaissance over land but also with those capable of operations over water, with the power to alight in water—that is, hydroaeroplanes.

The type of machine to be used necessarily depends on the locality: for instance, in Hawaii practically all of the military machines would need to be hydroaeroplanes; in the Philippines and Panama a great proportion of them. To the Coast Artillery troops in the United States proper and in the districts around the Great Lakes the same considerations apply. It is believed that the main principles enunciated above should be followed, and that an estimate of actual machines and material, both heavier and lighter than air, should be made for all places.

II. GENERAL TYPES OF AIRCRAFT.

4. CAPTIVE BALLOONS.

For over a century captive balloons have been used by the armies of all the leading military nations. Their function has been one of observation; that is, to see what those on the ground were unable to see. They have therefore proved a useful means of observing and reporting the effects of artillery fire. Electrical means of communication greatly enhanced the utility of captive balloons, as it made communication instantaneous from car to ground instead of by the older way of raising and lowering written messages by ropes. In clear weather and on favorable terrain captive balloons are able to distinguish different branches of the service at a distance of 16,000 yards or about 9 miles. With the best glasses at the present time the field of observation is said to extend to 20,000 yards. In general, captive balloons of the "Sausage" or "Drachen" type are used by all the armies of the great nations. Along the French-German front in northern France these balloons are used in great numbers all along the lines. Their function is to observe the fire of artillery and keep watch of all movements of hostile parties within their field of view. They are connected by telephone directly with the batteries whose fire they are observing and with the headquarters to which they are attached. In many cases the captive balloons work in conjunction with aeroplanes. The aeroplanes by flying over the terrain where the hostile targets are located find out the exact position of those which the captive balloons have been unable to locate by themselves. When by means of signals the locations of the targets have been indicated to the observer in the captive balloon, the aeroplanes proceed to other duty. Aside from the use of the captive balloons

in conjunction with aeroplanes, their duties are practically the same as they have been for many years or were in our own Civil War. Free balloons such as were used from Paris, for instance, in 1870 are now a thing of the past, their place having been taken by the aeroplane or the dirigible airship. All military captive balloons are now so constructed that their undersurface acts like a kite, thereby making them steady in a strong wind. To keep the envelope distended properly in the face of the wind, a wind sail is provided so as to transmit pressure to the rear part of the envelope by means of the wind itself. Captive balloons are used not only with the field forces, but also are especially useful in fortress warfare. The organizations which handle these balloons consist ordinarily of some 4 officers, 72 men for each balloon section.

5. DIRIGIBLES.

The term dirigible, as applied to aeronautical appliances, signifies a lighter-than-air craft, which is equipped with engines and propellers capable of moving it from place to place. Dirigibles may be roughly divided into three classes: Nonrigid, or those whose envelope can be entirely packed into a small space when deflated, and that have no rigid framework of any kind; semirigid, or those that have a stiffening for a part of their length in order to enable the envelopes to maintain their shape to better advantage than the nonrigid; the rigid, which have a framework for the whole envelope that maintains itself continuously. All have been tried for the last 15 years. The nonrigid types have not given very good results, as they are too much dependent on the weather, due to distortion of the envelopes; the semirigid have given some satisfaction and have been largely employed. The advantage of the semirigid types is that they may be packed for shipment and reassembled much more easily than the rigid types; they can be deflated quickly and, consequently, are not so subject to complete destruction as the rigid types when anchored to the earth. On the other hand, they are not able to develop the speed that the rigid types, such as the "Zeppelin," are capable of.

Dirigibles and aeroplanes are frequently compared with each other as to their utility in general. As a matter of fact, they are two entirely different military accessories and are as different in many ways as is a captive balloon from an aeroplane. Dirigibles are able to stay in the air at any height for long periods of time. They are capable of running at reduced speed, can hover over localities for minute observation and to take photographs. They are able to carry several tons weight in addition to their passengers and crew. From the fact that they are able to remain stationary over a given place

they are able to launch their projectiles with greater accuracy. Dirigibles in the present war have been used both over land and sea. At sea they have carried out reconnaissance, have acted offensively against hostile submarines, have accompanied transports in order to observe the approach of hostile craft, have been used in mine laying, stopping and examining hostile merchant vessels at sea, and for bombarding hostile localities. The airships which have made the longest trips and developed the greatest efficiency thus far are the German "Zeppelin" rigid-frame type. These have repeatedly flown over England at a distance of at least 300 miles from their base, and have nearly always returned in safety. Some have been lost, however. Aeroplanes appear to be unable to cope with them at night. While dirigibles have not proved themselves to be a determining factor in combat, either on land or sea, they are being developed to the greatest extent possible, especially by the Germans, who have dirigibles of very great size. The principal features of this type are a rigid framework of aluminum, a number of drum-shaped gas bags, and a thin outer cover. Although the details of construction are not definitely known up to date, their length is about 485 feet, their volume about 900,000 cubic feet, their total lift over 20 tons, and their useful lift about 5 tons. They are driven by four motors of a total horsepower of about 800, which is applied to four propellers. Their speed is from 50 to 60 or more miles per hour and a full-speed endurance of over 100 hours, or more than 4 days. It is therefore evident that in good weather these airships have a radius of action of from 5,000 to 6,000 miles. Moreover, they are being constantly improved, and are probably capable of crossing the Atlantic Ocean. Crews of from 10 to 20 men are required for their operation; they are armed with bombs of various sorts, light guns, and are equipped with searchlights. They carry very efficient radio apparati, which have equipments for determining the directions from which radio impulses are being sent. In this way they are able to locate themselves at night or in foggy weather when the ground is invisible. They require very large and expensive hangars, gas plants, and equipments for their operation. When forced to make landings outside of their hangars, on account of their bulk, they are very difficult to handle in hard winds, and are liable to destruction thereby.

The best of the nonrigid and semirigid airships have a capacity of more than 800,000 cubic feet, a maximum speed of 50 miles per hour or less, and a full speed endurance of about 24 hours. As mentioned above, their great asset is extreme portability and cheapness as compared with the rigid type.

6. AEROPLANES.

Heavier-than-air craft made their appearance as military agencies in 1908, when the Wright brothers demonstrated thoroughly their possibilities in this respect. While many of the salient features of heavier-than-air machines had been worked out years before, it remained for the internal-combustion engine to really make mechanical flight possible. The military possibilities of aircraft of this description were appreciated immediately by the great nations. Large appropriations were made at once, notably by France and Germany, for their development. At first England was slow to take up the matter, but in 1912 had gone at it thoroughly and was spending large amounts of money for their development. Italy, Russia, Japan, and the smaller nations of Europe and South America made liberal appropriations for obtaining the material and developing the personnel. Aeroplanes were used in a small way during the Italian campaign in Africa during the Balkan-Turkish War, and during the Balkan War. These nations had very little equipment and very few trained flyers. Wherever the aeroplanes were given the opportunity, under average conditions they rendered efficient service in reconnaissance.

7. TYPES OF AEROPLANES.

We now find aeroplanes consisting of three principal classes: (*a*) Scout or speed machines; (*b*) reconnaissance aeroplanes; (*c*) battle machines. The first are used for distant reconnaissance and combating the enemy's aircraft, the second for ordinary reconnaissance and the observation of fire of artillery, and the third for the destruction of enemy's material, personnel, or equipment.

8. REQUIREMENTS OF VARIOUS TYPES OF MACHINES.

Great advances have been made since the war began in all these machines, all the details of which are not yet available. The following table, which appeared in the London Times of February 19, 1914, gives the approximate requirements of each type of machine at the beginning of the war. These general characteristics are still desired, but the radius of action and the speed have been considerably increased:

Performances required from various military types.

	Light scout.	Reconnaissance aeroplane. (*a*)	Reconnaissance aeroplane. (*b*)	Fighting aeroplane. (*a*)	Fighting aeroplane. (*b*)
Tankage to give an endurance of.	300 miles	300 miles	200 miles	200 miles	300 miles.
To carry	Pilot only	Pilot and observer plus 80 pounds for wireless equipment.	Pilot and observer plus 80 pounds for wireless equipment.	Pilot and gunner plus 300 pounds for gun and ammunition.	Pilot and gunner plus 100 pounds.
Range of speed	50 to 85 miles per hour	45 to 75 miles per hour	35 to 60 miles per hour	45 to 65 miles per hour	45 to 75 miles per hour.
To climb 3,500 feet in	5 minutes	7 minutes	10 minutes	10 minutes	8 minutes.
Miscellaneous qualities	Capable of being started by the pilot single-handed.		To land over a 30-foot vertical obstacle and pull up within a distance of 100 yards from that obstacle, the wind not being more than 15 miles per hour. A very good view essential.	A clear field of fire in every direction up to 30° from the line of flight.	A clear field of fire in every direction up to 30° from the line of flight.

Instructional aeroplanes with an endurance of 150 miles will also be tested under special conditions; safety and ease of handling will be of first importance in this type.

9. AEROPLANE ENGINES.

As to material, the most important consideration in aeroplane construction has been the engine. Without excellent engines the best aeroplanes otherwise are of no service; in fact, may be a source of danger. In the countries where aeroplane development has made the most progress large prizes have been given for the development of suitable engines. At the same time, research and experimentation have gone on along this line at Government plants. Engines require frequent replacement. In fact, it is reported that after 100 hours in the air engines are "scrapped" and new ones installed. The plan found to give excellent results for the development of material is for the Government to have stations where experimentation along all lines is carried on. On the data furnished by these establishments specifications are made up for the construction of aircraft by private individuals and civil manufactories. If any parts, such as the engines mentioned above, need additional development, prizes are offered to stimulate construction and progress.

III. FUNCTIONS OF AIRCRAFT.

10. HEIGHT AT WHICH AEROPLANES MUST FLY.

It was soon found out that to escape the fire of small arms a height of about 4,000 feet above the ground had to be maintained. As soon as balloon guns were created this height had to be increased to 6,000 feet, at which height it is now necessary to fly in order to be reasonably safe from being hit by hostile projectiles sufficient to bring the machine down. At this height, 6,000 feet, small details of the terrain and small detachments of troops or material are very difficult to distinguish. On the other hand, large columns of troops, trains, railways, bridges, artillery firing, and sometimes in position, defensive positions of large extent, and things of that nature can be readily distinguished. Whenever it becomes necessary for the aircraft to fly at a lower altitude than 6,000 feet the chance of destruction by gunfire must be considered.

11. STRATEGICAL RECONNAISSANCE.

Reconnaissance of this kind is strategical in its nature, the tactical reconnaissance of particular localities is still carried out by troops or captive balloons. In fact, it may be said that all strategical reconnaissance is now carried on by aircraft. The reconnaissance is carried out by an officer who requires considerable experience in order to be able to distinguish objects on the earth and assign to them their true military value. The pilot is either an officer or noncommissioned officer. The observer is always a trained tactical officer, because in reconnaissance of this nature an untrained person can not interpret the military significance of what he sees.

12. PHOTOGRAPHY FROM AEROPLANES.

Photography is utilized to the greatest extent possible in aerial reconnaissance. The devices are so arranged that they are capable of taking one or a series of views of a particular locality. The plates or films thus made are rapidly developed and are thrown on a screen by means of a stereopticon, when all details are magnified to any extent desired and details invisible to the naked eye are brought out plainly. These details are then entered on the maps of the officers concerned. As the height at which an aeroplane is flying can be taken from the barograph, and as the focal angle of the lens of the camera is known, a scale can easily be worked out and the views form good maps of the terrain photographed.

13. AEROPLANES AND ARTILLERY.

In addition to reconnaissance in general, aeroplanes have taken their place as a fixture for observing the fire of artillery. Due to the degree of concealment which artillery is now given, it is impossible to determine its location from the ground. The aeroplanes first pick up the targets, report their location to the field artillery, and then observe the fire of the batteries. By means of prearranged visual signals or radiotelegraphy the aeroplanes are able to indicate to the artillery where their fire is making itself felt. If artillery is insufficiently provided with aeroplanes, it is well established that an enemy so provided has an overwhelming advantage.

14. CONTROL OF THE AIR.

For this reason, among others, attempts to gain "control of the air" are made by belligerents at the inception of hostilities. This takes the form of offensive action by aeroplane against aeroplane. For this purpose machines known as "speed scouts" and "battle aeroplanes" have been developed. All the great European nations are now equipped with them. The only way in which enemy aeroplanes can be effectively dealt with is by aeroplanes, because they are difficult targets for gunfire from the ground. To gain control of the air a great preponderance in number and efficiency of aircraft is necessary. So far in the European war, unless one side had a greatly preponderating number and quality of aeroplanes, they have been unable to obtain and keep control of the air. An excellent instance of obtaining control of the air seems to be furnished by the Austro-Germans when they initiated the campaign against the Russians in May, 1915. In this instance complete control of the air appears to have been obtained. The results to the Russians were disastrous because the Austro-Germans were able to fly at will wherever they wanted to, could pick up the location of the Russian

masses, and make their movements accordingly, entirely unobserved by the Russians. In the fire of their artillery they had the advantage of being able to locate the Russian guns and observe their own fire, while the Russians were powerless to do so.

In an article on "Recent progress in military aeronautics," published in the Journal of the Franklin Institute for October, 1915, Lieut. Col. Samuel Reber, Signal Corps, United States Army, sums up the question of machines for control of the air as follows:

> Experience has developed three types of aeroplanes for military purposes: The first, the speed scout, for strategical reconnaissance, a one seater, with a speed up to 85 miles per hour and radius of action of 300 miles and a fast climber, about 700 feet per minute; the second for general reconnaissance purposes with the same radius of action, carrying both pilot and observer and equipped with radiotelegraphy, slower in speed, about 70 miles per hour, and climbing about 500 feet per minute, and in some cases protected by armor; the third, or fighting craft, armored, and carries in addition to the pilot a rapid-fire gun and ammunition and so arranged as to have a clear field of view and fire in either direction up to 30 degrees from the line of flight, the speed to run from 45 to 65 miles per hour, and the machine to climb about 350 feet per minute.

15. SURPRISE MOVEMENTS.

It is often said that due to the use of aeroplanes surprises are no longer possible. Generally speaking, this is so, providing both sides are equally well equipped with machines and weather conditions are favorable. If, however, complete "command of the air" is obtained by one side, the chances of surprising the enemy are greater than they have ever been before.

16. BOMB DROPPING.

In addition to their functions of reconnaissance, the observation of the fire of artillery, and the combat of hostile machines, both heavier and lighter than air, much time, thought, and ingenuity have been given to the subject of dropping projectiles. Bombs of various sorts weighing from a couple of pounds to 50 pounds have been tried. The most common ones weigh from 15 to 35 pounds. At the height at which aeroplanes are required to fly it is extremely difficult to hit an object with any certainty. Various devices have been used and tried for this purpose. The factors of height, speed, and wind, are almost impossible to compensate for entirely, up to the present time, so that consequently bomb dropping in general or the launching of projectiles of all kinds from aeroplanes has not attained great results in so far as the actual destruction of material or personnel is concerned. Advances along this line are constantly being made, however, but progress is slow. A special type of aeroplane has been developed for dropping bombs and battle purposes.

For bomb attacks on any locality these machines are sent in flotillas of from 30 to 60 machines, each of which is provided with from 5 to 10 bombs. They go to the locality and circle over it, dropping their projectiles. Against railways, roads, bridges, and hostile parks of various kinds, this method of attack has given considerable success.

IV. ORGANIZATION OF AEROPLANE UNITS.

17. TACTICS OF AEROPLANES.

As to tactical use aeroplanes seem to be approaching methods similar to those used by a navy. That is, first the speed machines reconnoiter to the front; they are followed by the battle machines, which in their turn clear the way for the reconnaissance aeroplanes; those assigned to the artillery stay right with their guns. Fortresses, harbor-defense works, and naval formations require special organizations of aeroplanes, some or all of which may be operated from the water. The organization, kind, and number of the machines and personnel required for this particular service depend on the special locality and mission of whatever formation the aircraft are to be attached to.

18. DEVELOPMENT DURING EUROPEAN WAR.

The use of aeroplanes is gradually being developed from experience in the European war. Organization has been found to be one of the most important considerations; in general the organization has been into squadrons. The squadron is a tactical and administrative unit. It has a personnel consisting of pilots, observers, bomb droppers, mechanicians, chauffeurs, and drivers. Flying personnel has to be developed in the military service. Unlike chauffeurs, for instance, there are few in the civil population who can be drawn on. The few who fly are demonstrators, exhibition flyers, or sportsmen. They are very few in number and scarcely a military asset. In France the squadrons usually have six machines and two spares. They have the same organization of depots of resupply that other units of the armies possess. The squadrons usually consist of complete units of one kind of machine; that is, speed, reconnaissance, or fighting. These squadrons are usually assigned to an army, or more if the machines and personnel are available.

In general an aeroplane requires for its operation a personnel of 1 pilot, 1 observer, and 2 enlisted men, mechanicians, chauffeurs, etc.

In England 12 machines of different classes are assigned to a squadron.

19. ASSIGNMENT OF AEROPLANES TO ARTILLERY.

Many are of the opinion that machines with the personnel to operate them should be assigned permanently to artillery regiments, so that they would be immediately available whenever action is required by the artillery. If they have to be obtained from a higher headquarters valuable time is often lost. It is believed that before long aeroplanes will be assigned permanently to regiments of artillery.

V. DEVELOPMENT OF AERONAUTIC PERSONNEL.

20. GENERAL LINE OF DEVELOPMENT IN EUROPE.

In the development of their aeronautical personnel all nations have worked more or less along similar lines. At first these detachments were attached to the engineers. All the pilots and observers were officers, while the mechanicians and others were enlisted men. As the science developed and more and more machines becames necessary the importance of this branch constantly increased until eventually it formed a separate arm of the service.

Instead of officers only being employed in the flying of the machines noncommissioned officers began to be used as the pilots.

21. OFFICER-OBSERVERS AND NONCOMMISSIONED OFFICER-PILOTS.

The observers were either trained staff officers or officers of particular branches when the reconnaissance being made especially concerned a certain branch. For instance, in the observation of artillery fire an artillery officer, for the inspection of a demolished bridge over a great river an engineer officer, or for the observation of the tactical or strategical dispositions of an enemy's troops a staff officer. Noncommissioned officers are now very generally used as pilots. All countries now at war have found that they have places for all the trained pilots they can possibly obtain. In general the units are commanded by officers and a certain number of the pilots are officers, but the bulk of the piloting is done by enlisted men while the officers are carried as observers.

22. LOSSES TO AERO PERSONNEL IN WAR.

The losses to the flying personnel in war, when equipped with proper machines, seems to be less than that of infantry, cavalry, and artillery in the order named.

23. DEVELOPMENT OF AERONAUTIC PERSONNEL IN THE UNITED STATES.

In the United States the development has been along similar lines to those employed in Europe, with the difference that here a branch of the service existed that did not formerly exist in the European armies. It was a development of the Civil War, i. e., the Signal Corps. This corps is charged with the transmission of information between the various units of an army; the captive balloons had formerly been assigned to it, and when the aeroplanes made their appearance they naturally fitted in. In this way all the agencies for the transmission of information are kept under one head, which should give not only the maximum amount of efficiency in such transmission but also obviate the necessity of creating a new arm of the service. The development of aero units in the United States has been slow for various reasons: First, on account of the fact that very little money has been appropriated compared to the sums appropriated in Europe. Second, the selection of the flying personnel has been limited to lieutenants of the Regular Army, unmarried, and below 30 years of age. This reduces the number of eligibles to a very small compass and does not give the results that are necessary. In the development of a flying personnel it is thought that, in addition to a certain number of officers obtained from the Regular Army as now provided for by law, pilots should be obtained both from among the enlisted men and from suitable civilians who enlist for that purpose. When they have proved their ability to be efficient pilots they should be placed in a special grade to be designated by a suitable name, such as "aero pilot, Signal Corps," for instance. This grade should be analogous to the grade of warrant officer in the Navy. When such men leave the service for any cause which does not interfere with the performance of the duties of pilot, arrangements should be made to obtain their services at once at the outbreak of war. The observers should be tactical officers who have received training. The present organization authorized for the aero squadrons in the United States provides that each one have 12 aeroplanes—8 of the reconnaissance type, 2 of the speed type, and 2 of the battle type. The personnel numbers 20 officers, 18 of whom are pilots. It is intended that staff and Artillery officers be used as observers. The United States squadron appears to be a well-balanced unit for work in this country, judging by the experiences obtained in Europe. It should be perfected as soon as possible and every effort made to give our Army the aircraft of all types needed for its use. Lieut. Col. Reber, in this connection, says:

We who in the beginning started the movement are now at the tail of the procession. We have no dirigibles, but very few trained men, and fewer machines.

The manufacturing industry is moribund from the lack of business, and there is no future for it. We have no aerodynamical laboratories in which to study the problems, and no engineering courses, except one, in which to develop our constructors. The Government has not stimulated any advance in the design of machines or motors by competition for substantial reward. We have no national league, as in France and Germany, to assist the Government by private subscription and by public demand for the development of air power. The interest of our people in aeronautics at large is dead, and has been perhaps so lulled by a sense of false security and the belief that war will not come to such a vast and powerful Nation as ours; that it will not heed an oft-quoted maxim of the Father of our Country, "In time of peace prepare for war." In no particular is it more impossible to make up deficiencies after the outbreak of hostilities than in aeronautics. What is to be done?

Evidently a strong appeal should be made to Congress for suitable legislation.

24. SCOPE OF NEEDED LEGISLATION.

What is needed is legislation that will give means of obtaining a sufficient personnel of pilots, enough money to buy suitable machines including excellent engines, and the training of a suitable number of officer-observers. Provision should be made for the creation of captive-balloon units, and dirigibles of various types should be developed.

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