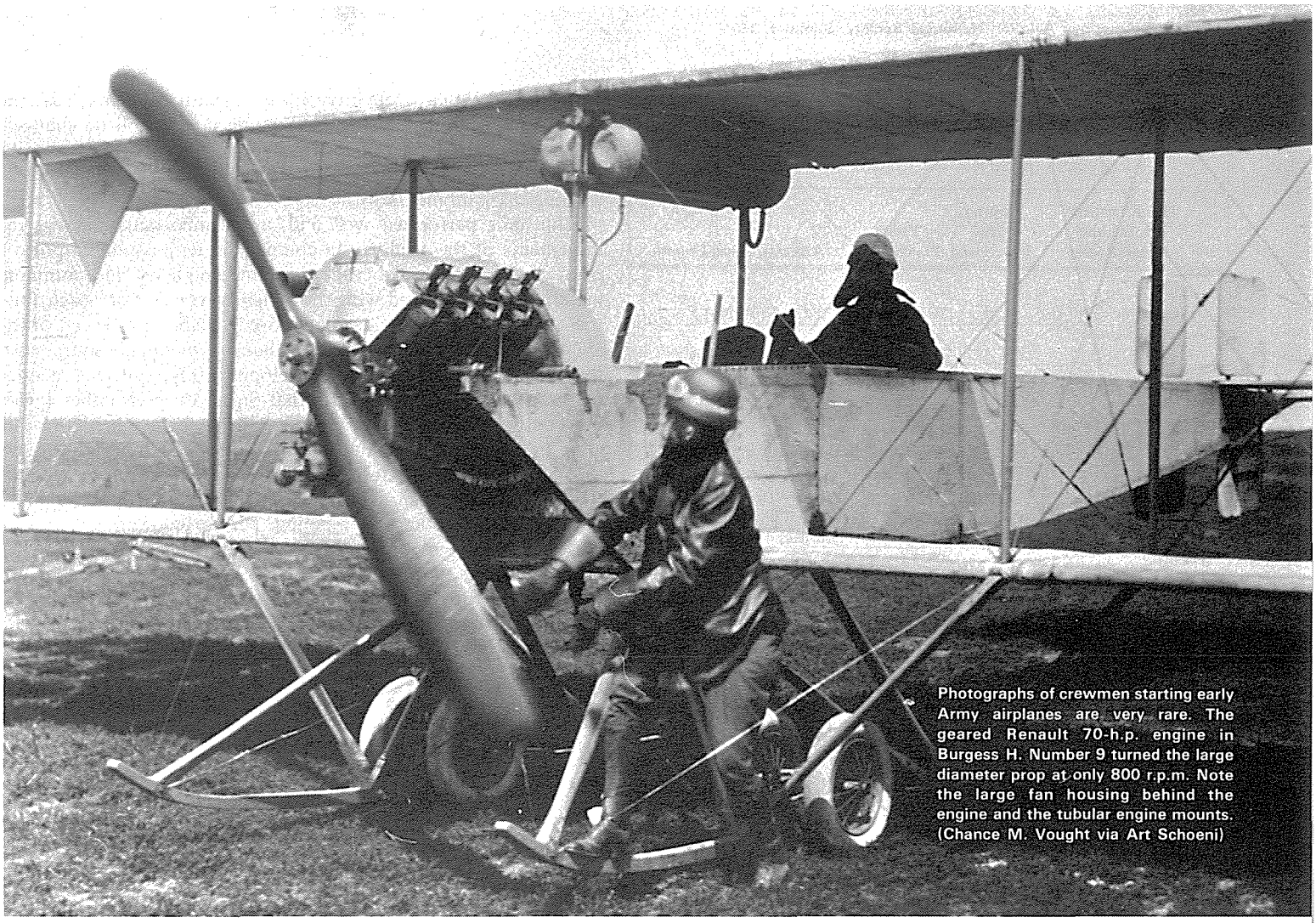


Photographs of crewmen starting early Army airplanes are very rare. The geared Renault 70-h.p. engine in Burgess H. Number 9 turned the large diameter prop at only 800 r.p.m. Note the large fan housing behind the engine and the tubular engine mounts. (Chance M. Vought via Art Schoeni)

Powering Army Aircraft Through 1915

By Robert B. Casari

The following account is not a definitive history of engines used in Army aircraft delivered between 1909 and 1915, but *is* intended to briefly record Air Service's experience with these units and the contribution they made to the initial development of Army aviation. The decision to stop with the machines that *entered service* in 1915 has been made, not because of significant technological changes occurring then, but simply because aircraft procurement expanded in the following year and ended that embryonic period when orders for one or two machines (and engines) were the norm. Within a year, individual contracts for as many as 50 engines and some semblance of standardization of types marked the beginning of a new era in Army aeronautics in which the early engines had no significant part.

Today, no official list of Army aircraft engines used between 1908 and 1915 exists and there is some doubt that the large number of serial numbers allocated to this period, in fact, represents a true indication of the quantities ordered. After considerable research, it has been possible to compile a listing of the models actually delivered and the approximate numbers of each that reached Army hands. The latter is based on examination of the history of each airplane, its service life, and known Signal Corps policy on ordering spare engines with the machines. During the latter part of the era being considered, 50 percent spare powerplants were usually specified on aircraft orders, though the policy for the period prior to about 1914 is not known. For this reason, extra units for the early years have been estimated (based principally on the length of time the individual airplanes were in service) and have been assumed ordered after the engines originally installed had seen considerable use. Some were purchased as late as 1916 for those earlier machines still in service.

The conclusion reached is that, even though about 300 serial numbers were allocated, no more than 100 engines were installed in the 55 Signal Corps aircraft placed in use through 1915; the 4 Martin Model S seaplanes, S.C. Numbers 56-59, have been excluded as they did not become operational until late spring of 1916. What is most surprising is the small number of manufacturers who supplied them. The following table covers the known engines by model.

ENGINES USED IN ARMY AIRCRAFT PLACED IN SERVICE FROM 1908 TO 1915

Manufacturer, Model and Rated Power	Approx. No. Purchased	Years Purchased	Aircraft Using Engine
Beardmore:			
6-cylinder (90 h.p.)	1	1913	Curtiss N, Wright F.
Canton and Unne:			
M-9 (120 h.p.)	1	1914	Burgess-Dunne pusher
Curtiss:			
4-cylinder (40 h.p.)	1	1911	Curtiss D and E
N (60 h.p.)	2	1911	Curtiss D and E
O (75 h.p.)	9	1911-1915	Curtiss E, F, and G; Martin TT
OX (90 h.p.)	25	1913-1915	Curtiss E, F, G, J, JN-2, and JN-3
OXX (100 h.p.)	12	1914-1915	Curtiss N, JN-2, and JN-3
S (60 h.p.)	1	1915	Burgess Trainer
Renault:			
8-cylinder (70 h.p.)	16	1912-1914	Burgess H; Martin TT
Sturtevant:			
4-cylinder (40 h.p.)	3	1911-1913	Burgess F and J
D-6 (60 h.p.)	2	1912-1914	Burgess I
Wright:			
4-cylinder (25 h.p.)	1	1909	Wright A
4-cylinder (30 h.p.)	5	1911-1912	Wright B and C
6-cylinder (50/60 h.p.)	13	1912-1913	Wright C and D
Total	92		

If the single Beardmore engine, the one from Canton and Unne, and the Sturtevant products (which powered but three Burgess airplanes) are ignored, it is evident that Signal Corps aircraft depended on only *three* engine manufacturers during the formative *first eight years* of Army aviation. Of these, Curtiss and Wright were both American firms, but the reliable Renault, built in France, made a major contribution, first as a service engine and later as a training unit. Almost all were better than the majority of their American contemporaries, though the officers who flew them regularly were often demanding and critical of them.

SIGNAL CORPS NUMBER ONE

The Wright brothers' first airplane for the United States government was delivered in 1908 and tested at Fort Myer, Virginia. During these trials, the tragic accident occurred that took the life of Lieutenant Thomas E. Selfridge and seriously injured Orville Wright who was piloting the biplane. It was many weeks before Orville was able to leave the hospital and not until the following spring that the brothers again shipped an airplane to Fort Myer to attempt the stringent tests.

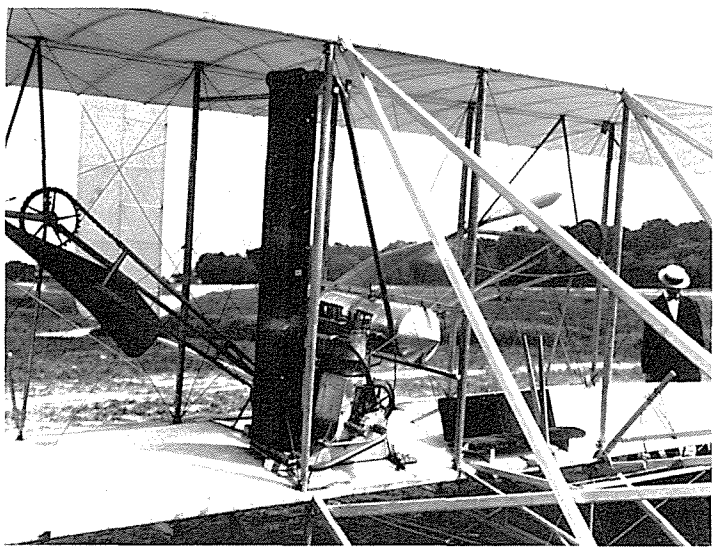
The flimsy Wright Model A was little more than a pair of wings with two elevators about 10 feet in front and a pair of rudders about eight feet to the rear. The pilot and passenger sat on seats on the leading edge of the lower wing to the left of the engine. Behind the wings at either side was a large, chain-driven, two-bladed propeller.

While the invention of the airplane itself had been a tremendous accomplishment, the 1909 Wright engine was equally noteworthy, for it was not only well engineered in terms of the standards of the time,[1] but was generally reliable and adequate in power—remarks that could not be made about most of its contemporaries. Whereas the brothers' first engines had been units with their four cylinders horizontal, the Army's machine was equipped with a completely new design originated in 1906 and under development since.[2] Its four water-cooled, cast-iron cylinders were vertical and individually mounted on the crankcase, rather than being a single integral casting with the crankcase as in the 1903 engine. The pistons and crankshaft were little changed and splash lubrication was retained.[3] While it had no throttle, its speed could be controlled by varying ignition timing and by cutting the spark momentarily.[1]

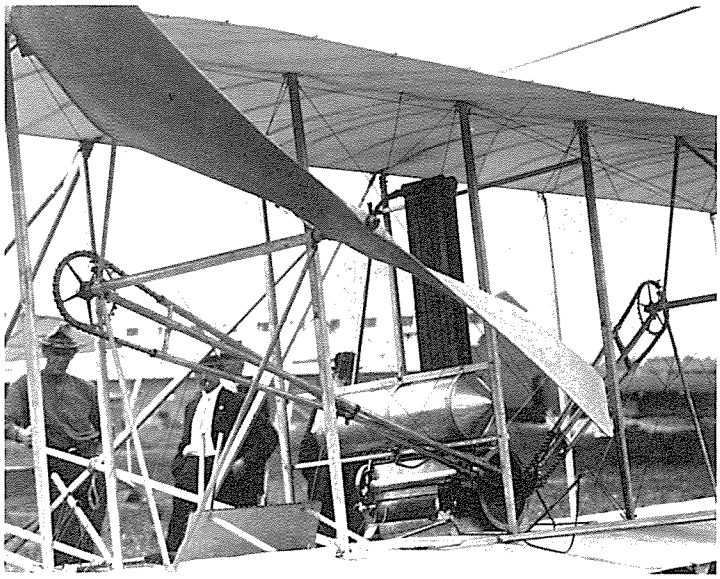
This unit performed well and, most important, met the requirements of the airplane. In comparison with a modern powerplant, it was hopelessly crude, but the simplicity and common materials used, coupled with the Wright's mechanical design abilities, resulted in an engine that proved reliable in use and probably ran for 20 hours between overhauls. While many sources list these early Wright products as developing 30 h.p., official records of the Army consistently state that Signal Corps Number 1 was powered by a 25-h.p. unit.[4] It should be remembered that no attempt was made by the Army to consistently test its early equipment for comparison purposes. This first military engine in the world weighed in at 165 pounds without radiator or magneto[4]—a little less than seven pounds per horsepower.

Beginning in early July of 1909, the airplane's designers made flights working towards completion of the Army's requirements of one hour duration and 40 m.p.h. speed. Initially, they had difficulties that limited their attempts to five or 10 minutes and they continued to both practice and make engine adjustments. On the 27th, Orville Wright with Lt. Frank P. Lahm took off late in the afternoon from the large field at Fort Myer and made over 70 circuits of the area, finally landing after one hour and 12 minutes before a cheering crowd. During the flight, the engine had "missed" on many occasions but still had demonstrated its reliability on what was a new world's duration record. Three days later, Orville flew the machine with Lt. Benjamin D. Foulois as a passenger over a 10-mile course during which they averaged over 42 m.p.h., again without difficulty. Several days later, the Army agreed that its requirements had been met and accepted the world's first military airplane which had accumulated perhaps five hours' flying time.

The Wright Model A was then moved to the leased field at College Park, Maryland, where Wilbur Wright began training three Army pilots to operate the machine. Lieutenants Frank P. Lahm and Frederic E. Humphreys began their instruction in early October and flying continued for another month. The flights varied from a few of less than a minute to one over an hour, Wilbur



The center section of the 1908 Wright machine at Fort Myer, Virginia. The 4-cylinder, 25-h.p. Wright engine is mounted between the tall radiator and the glistening fuel tank. Note the small padded seat to the right for two passengers and the Wright lever controls. This was the airplane in which Lt. Thomas E. Selfridge was killed and Orville Wright seriously injured on September 17, 1908. (Air Force Museum)



Another view of the Wright machine, from the left rear, at Fort Myer in 1908. The angular wooden propellers were chain-driven from the rear of the engine crankshaft, the chain on the left prop being crossed so they rotated in opposite directions. (Air Force Museum)

Wright being in the air most of the time, and by the end of the month both Lahm and Humphreys had soloed with another officer, Lt. Benjamin D. Foulois, only partly trained. These operations were almost daily occurrences and there is no indication of major difficulties with the engine as it accumulated another 14 hours up to November 5, 1909. On that date, Lahm and Humphreys had been in the air only nine minutes when the engine misfired (according to one source), leading to a forced landing in which the right wing and skid were damaged.[5]

While awaiting repair parts from the Wright factory, weather forced transfer of flying operations south to Fort Sam Houston at San Antonio, Texas, and both Humphreys and Lahm returned to their regular Army assignments, leaving only the inexperienced Foulois in charge of the Wright biplane. Since he had never completed his formal instruction under Wilbur Wright, the Lieutenant was forced into making his first solo flight when the machine was ready in early March, 1910. On his fourth trip of the day, the "gasoline feeder" broke and Foulois made his first forced landing, damaging the elevator.[6]

During March, the enlisted men overhauled the engine[8] which appears to have accumulated between 20 and 25 hours since first delivered to Fort Myer eight months before. The machine was in the air only three hours that month, two in April, and a total of seven hours up to June 7th when flying ended for the moment as the men were shifted to Leon Springs, Texas.[6]

Returning in July, Foulois continued as the only Army pilot, but accumulated very little time in the air over the next few months. Much of this period was spent in modifying the airplane, the principal change being to replace the skid landing gear with three wheels. Weather also interfered consistently as the gusty winds prevalent through the hot Texas days were a real danger to the low-powered airplane. Most flying was done early in the morning or in the evening when the air was usually calm. Between July and September, Foulois added only *two hours* flight time to his log and his record for October and November was not much different.[6] Flying activities were then suspended until early 1911.

In March, 1911, orders were placed for two additional machines which led to shipping Signal Corps Number 1 back to the Wright factory for repairs. After examination there, it was recommended that a number of airframe components be replaced and the engine was reported to be in fair condition.[7] As accurately as it can now be estimated, it appears that the 25-h.p., four-cylinder unit only had between 30 and 40 flying hours, about 10 of these since its overhaul a year before. This was an excellent record, considering the elementary level of design, metallurgical knowledge of the time, and particularly the fact that these hours were all at full throttle.

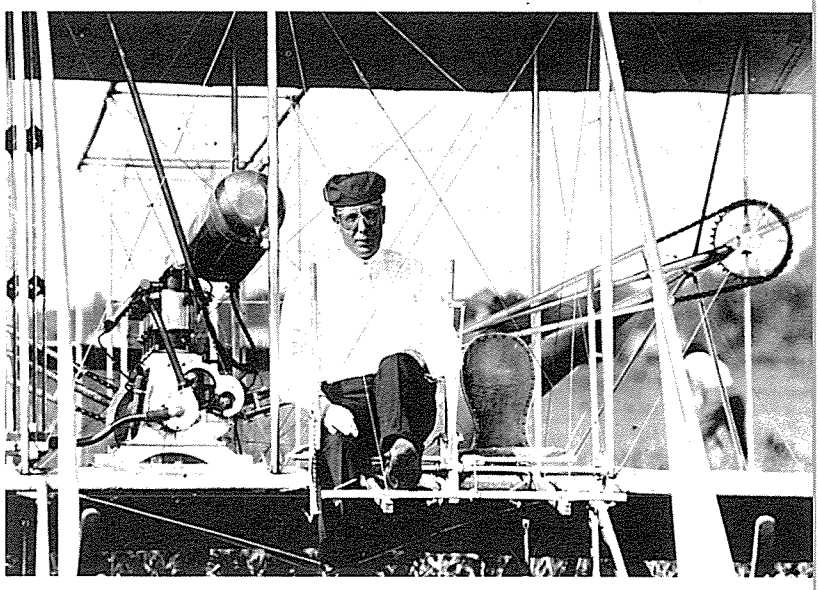
Since the machine was not of the current Wright design, it would be difficult to obtain spare parts, and the cost of repair would be excessive, it was finally decided that this historic machine with its original engine would be donated to Smithsonian Institution where it was accepted on October 20, 1911, after having been restored to its original configuration by the Wright factory. It is still on display there.

THE ERA OF THE TEN-MINUTE FLIGHTS, 1911-12

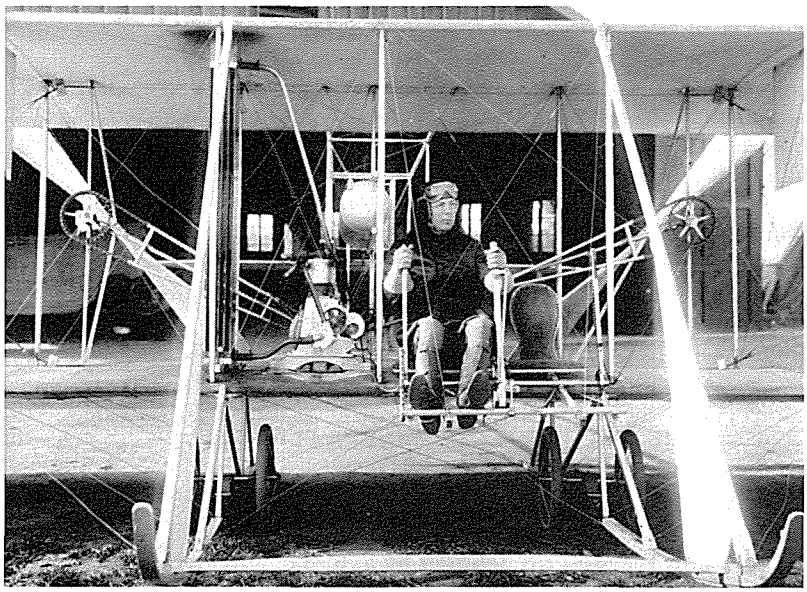
During 1911, the Signal Corps ordered seven new pusher airplanes of two basic types. The Wright Brothers' design had evolved into the Model B powered by a 30 h.p. development of the 4-cylinder unit used in Signal Corps Number 1 and three aircraft of this type (Numbers 3, 4, and 7) were purchased. A fourth Model B (Number 5) built under license was obtained from the Burgess Company & Curtis of Marblehead, Massachusetts, who designated it as their Model F; however, it was equipped with a Sturtevant 4-cylinder, water-cooled, inline engine of 40 h.p. (probably the Model D-4).

The other three machines came from the Curtiss Aeroplane Company of Hammondsport, New York. The first, a Model D assigned Number 2, was ordered as a high performance "Scout" and had a 60-h.p., 8-cylinder, Curtiss N engine. The other two Curtiss machines were Model E pushers, developed from the D---Number 6, ordered as a low-powered trainer, had an upright Curtiss 4-cylinder, water-cooled unit, probably the Curtiss H or K; while Number 8 was intended for scouting behind enemy lines and was fitted with the new 8-cylinder Curtiss Model O of 75 h.p. evolved from the Model N.

So, while it might appear that there was some standardization of aircraft types, the Army had five different engines in their seven 1911 machines. Surprisingly, these units were reasonably



Captain Charles D. Chandler in a Wright B at College Park, Maryland, in May 1911. The vertical flat tubes of the radiator reaching from the lower to upper wing are at the extreme left. On the front of the 30-h.p., 4-cylinder engine is the direct driven water pump with open gear drive for the magneto. The carburetion system concealed near the pilot's right elbow was extremely crude. Note the large dent in the fuel tank, possibly from a collision with a bird. (USAF)



This Wright B in May 1912 at College Park shows the excellent workmanship of the Wright Company, though some wires are slack. Cooling water piping to and from the radiator is discernible, the connections to the cylinders being on either side near the top. On the Wrights, the chains passing through tubular guides between the 30-h.p. engine and props created an unbelievable clattering and screeching noise. Captain Chandler occupies the pilot's seat.

reliable and certainly long-lived because, with the exception of two machines destroyed in accidents, the airplanes were still in service on February 24, 1914, when use of all pusher designs was discontinued by the Army.

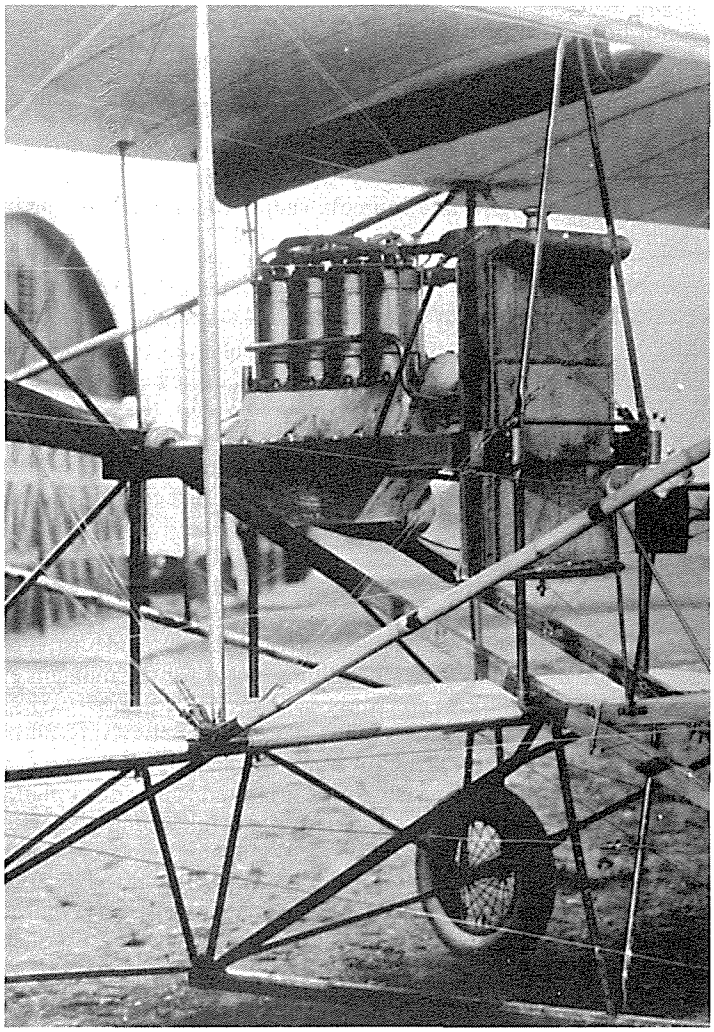
While the first military machine had been flown very little, this was not the case with the Wright B airplanes. Numbers 3, 4, and 5 at College Park, Maryland, in 1911 were in continuous service training and carrying out military flights, though records are not complete. Prospects of better weather led to the operation being transferred to Augusta, Georgia, in late November for the winter months. By the end of the year, the total number of flights each had made was impressive and had already exceeded those of Signal Corps Number 1. Number 3 had been in the air 409 times and had accumulated over 74 hours, and figures for Number 4 were almost identical.[9] It is interesting to note that the average duration of flights for several years was about 10 minutes, another indication of the training nature of early Army flying and the lack of any real military operations. Number 5 had not been accepted until late in the year, but even it had made nearly 200 trips of over 35 hours' total time.[10] Though there is no indication of the frequency of overhauls, the Wright and Sturtevant engines were clearly proving more reliable than that in the first machine.

There were occasional problems and the engine in Number 4 after the move to Augusta did not develop the power it formerly had. There in November, 1911, Lt. Henry H. Arnold complained that the Wright B did not have the climb necessary for military use, if two men were on board. This condition seems to have continued, for Arnold and Lt. Charles D. Chandler in January could not get the machine above 200 feet, regardless of the angle of attack. These early difficulties were often carried directly to the Wrights and, in this case, Orville replied that the powerplant must be out of adjustment.[9] Because Number 4 continued to be used for another eight months, it is evident that the 4-cylinder unit received major attention in early 1912.

During this same period up to the summer of 1912, only two Curtiss engines were in service because the third machine ordered the previous year was not accepted until May. Like the Wright powerplants, they also saw considerable operation and were involved in several accidents which they survived. When first delivered to Fort Sam Houston, Texas, in April, 1911, the Curtiss D (Number 2) had the powerful Curtiss N engine of 60 h.p., a rating not exceeded in Army airplanes for a year. Only two weeks later, Lt. G.E.M. Kelly smashed up the pusher in a landing accident in which he died.[11] The Model D was then rebuilt and shipped to College Park in July. After delivery of the slow Curtiss E, Number 6, the officers decided to convert it to a high-performance scout and Number 2 to a trainer, so the engines were interchanged, the new 4-cylinder unit being mounted in Number 2 and the 60-h.p. Model N going into Number 6.[12]

It was at Augusta that the N lived through at least one smashup when Lt. Frank M. Kennedy flipped Number 6 on its back on February 12, 1912, without serious injury. Two factors contributed to the survival of the powerplants in the early Wright and Curtiss pushers; the airplanes' low speed and the engines' well-protected location between the wings and behind the pilot. It would appear that another Model N engine was purchased because the Curtiss D airplane by early 1912 had this unit installed in place of the 4-cylinder powerplant. That spring, the machine was in at least four accidents and was rebuilt each time, apparently with the same engine.

Because of these incidents, during the first six months of 1912, Number 2 accumulated only 4 hours 41 minutes in the air



The Curtiss 4-cylinder 40-h.p. engine in Curtiss E Number 6 at College Park, Maryland, in 1911. Only one of these units was purchased by the Army and was later installed in the Curtiss D when it was converted to a slow trainer. Above the engine is a fuel tank, smaller than on the Wrights, but the radiator is generously sized.

The 75-h.p. Curtiss O powered many different early Army airplanes including this Model E Number 8, shown at San Diego, California. The carburetor is visible just below the lower corner of the radiator and large "saddle" fuel tanks on each side conceal the crankcase. Lt. Harold Geiger is the pilot.

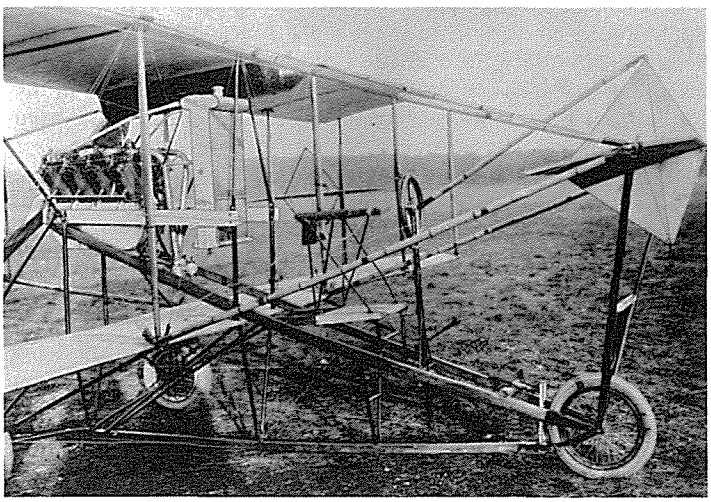
on 31 flights, but Curtiss E Number 6 flew 21 hours 2 minutes on 162 occasions.[13] Based on these figures, it appears that major overhauls of Army engines in 1911-12 were necessary no more often than six months to a year, though minor repairs were commonplace.

THE WRIGHT 50 H.P. AND THE END OF THE PUSHERS

While the Wright and Curtiss companies had shared equally in the seven machines delivered between the spring of 1911 and the summer of 1912, Wright designs predominated for the next 12 months. However, these Model C airplanes, which by the following summer resulted in two-thirds of the Air Service complement being Wright pushers, were also to prove failures and their faults caused removal from service of *all* pusher designs in February, 1914. Though the Wright airframes were deficient, the company's engines were not involved in the decision.

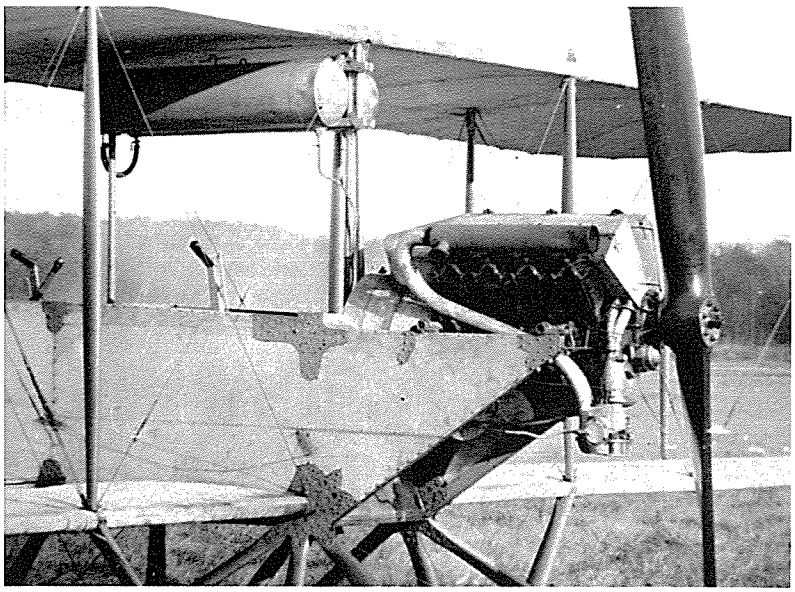
At about the same time as the first of the new Wrights was delivered, two other powerplants were received that were to become very important in Army aviation, though only one or two of each were available in the 1912-13 era when the pusher types were at their peak. These engines were the Curtiss Model O and the French Renault. The O was based on the earlier Model N and was a V-8 with water cooling and individual cylinders developing 75 h.p. at 1100 r.p.m.—15 h.p. more than the N. It was installed in airplane Number 8, the Curtiss E mentioned above that was belatedly delivered in the spring of 1912. This engine remained the most powerful of any in Army service for more than a year when another of the same type was installed in the single Curtiss G machine.

Number 8 was a very successful airplane and operated with and without floats, its powerful engine providing the margin necessary for water takeoffs. It saw service on the East Coast, at San Diego, and eventually in Hawaii, its Model O continuing the reputation of the earlier Curtiss engines as it powered the pusher for two years before the airplane was sold. Even then, the powerplant was returned to the mainland for further use.



When Curtiss E Number 6 was converted to a high-speed scout in late 1911, the powerful 60-h.p. Curtiss N engine was installed. This 8-cylinder unit has its carburetor just below oil sump level with dual intake manifolds extending upward and between the cylinder banks. No exhaust pipes were used. Because of the increased power, a larger fuel tank replaced the earlier one.

The most unusual of the new units was the Renault built in France and imported to the United States. One came into Army hands in Signal Corps Number 9, a Burgess Model H tractor type (the first Air Service machine to have the engine in front of its crew members) accepted in the summer of 1912. The Renault was a V-8 of 70 h.p. but was air-cooled with finned, cast-iron cylinders mounted individually on the engine block. Because of the slow speeds of the day, it was not possible to obtain sufficient



The French-built, air-cooled, Renault 70-h.p. engine was first used by the Army in Burgess H Number 9 in 1912 and had an enviable reputation that kept the unit in service until about 1917. Intake air followed a tortuous route, entering the open end of the large pipe above the left cylinders, was heated by exhaust gases, traveled downward and forward to the carburetor just behind the prop, and then upward through a divided pipe to each cylinder bank. Because of the machine's low air speed, adequate engine cooling could only be obtained by using a fan, whose housing is visible just behind the engine, which blew air into the sheet metal shroud between the cylinder banks and out through the cylinder's cooling fins.

cooling and a blower was mounted on the rear of the engine which forced air through a sheet metal housing into the Vee of the engine and outward over the cylinders. This particular design was about the only really successful, fixed, air-cooled type in the world, though a number of rotary air-cooled engines had been developed, principally in France.

The Army apparently did not specify the Renault for the new tractor and it was installed solely at the company's option, probably because it offered a lower weight-to-horsepower ratio than obtainable at the time with domestic water-cooled engines. The choice was excellent and introduced the French product to the Army which later used the type in quantity, though this first engine was the only one available for about 14 months until deliveries began on five additional Burgess H airplanes. In the meantime, Number 9 saw service at nearly every installation where Army airplanes were used and was the only tractor type available through most of the pusher era.[14]

This engine survived a dunking in the waters of the bay at Duxbury, Massachusetts, in August 1912 when Lt. Henry H. Arnold stalled the biplane during an attempted long-distance flight. However, on March 28, 1913, in Texas, the Renault powered the Burgess on a new American two-man endurance record when Lt. Thomas D. Milling flew Lt. William C. Sherman from Texas City to San Antonio in a flight lasting 4 hours and 22 minutes, only 15 minutes under the world's record.[14] It was later used at San Diego, California, until finally wrecked there in May, 1914 and, even then, it is believed the Renault was still retained by the Army as a spare for the later Burgess H machines.

While these early Curtiss Model O and Renault engines were successfully powering two Army airplanes, the Wright 50-h.p. engine entered service in late 1912 in the Wright Model C machine. The first, Number 10, had been accepted in July with five more (Numbers 11-14 and 16) following through November and another (Number 18) built by Burgess as its Model J, delivered in January, 1913. By that time, of the 16 airplanes on hand, 10 were Wright B and C models and the Signal Corps was clearly dependent on that company's products.

The new Wright Model C pushers were similar to the earlier B, but differed in detail. The radiator was moved to the rear and left of the engine and there were changes in the control surfaces. The company had relied heavily on the design of its 4-cylinder, 30-h.p. powerplant, as used in the Model B, in developing a unit of increased output. Apparent concern over the rough running early engine led to selection of a 6-cylinder configuration and the stroke was increased ½-inch with the bore unchanged. Construction of the unit was altered considerably with the crankcase now split and the cylinders made in three parts. However, these were more assembly and manufacturing changes, the technology of the engine retaining the essentially proven features of the 4-cylinder unit. Delivering 50 h.p. at about 1400 r.p.m., it gave the Wright airframe a boost in performance to about 50 m.p.h.

The first five C machines used this engine and Army experience with it showed it did not measure up to the 4-cylinder model.[16] Plane Numbers 10 and 11 were shipped to Fort Riley, Kansas, in October, 1912, with a spare engine for tests with air-to-ground signaling devices. The engine in Number 11 had numerous defects and was replaced with the spare. That in Number 10 experienced repeated pushrod failures, carburetion was not satisfactory, and poor fuel caused a loss in power. Early the next month, Number 10 made a forced landing after a water leak caused the magneto to fail. When the trials were over, the Wright engines were severely criticized. They missed constantly when

Captain Benjamin D. Foulois with a Burgess H in July 1914. Installation of the 70-h.p. Renault is essentially identical to that in Number 9 of 1912.

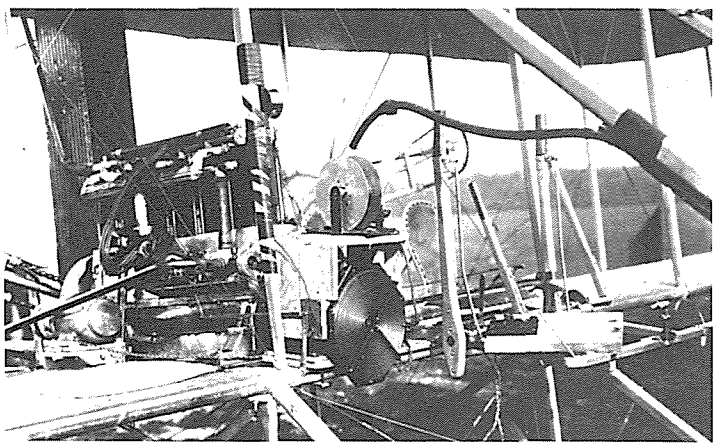
Perhaps the most unusual engine installation in any early Army airplane was the Curtiss O of 75 h.p. in Curtiss G Number 21 in 1913. The powerplant is completely hidden in the wide fuselage, but drove an exposed front chain that turned a rare three-blade prop mounted on an idler shaft above the engine. It was converted to a conventional direct drive, two-bladed arrangement early in its career. (USAF)

throttled and minor parts broke regularly.[9]

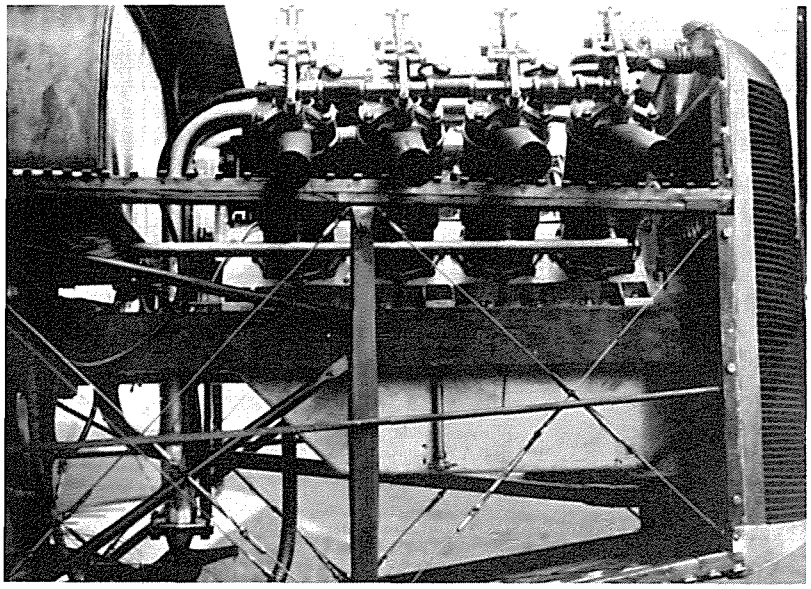
Two of the machines received different engines. Number 16 was ordered without a powerplant and a Wright 30 h.p. built from spare parts was installed, resulting in a low-powered trainer very similar to the old Model B machines in performance. This engine proved very unreliable, failing in the air after only one minute and causing constant problems after each repair. It was finally properly assembled and then regularly used until the fall of 1913. The Burgess company in Number 18 continued the practice of installing Sturtevant engines and a 4-cylinder, 40-h.p. type was used. It proved very reliable and its success led to another being installed in Number 16 in late 1913, replacing the Wright 4-cylinder model.

The quality of the 4-cylinder Sturtevant engines in airplanes Numbers 5 and 18 carried through the company's other products and a Sturtevant D-6 of 60 h.p. was used in an odd coast defense machine purchased from Burgess in 1912. This Model I, a pusher design with chain-driven twin-pusher props, was flown extensively over a two-year period, mostly in the Philippine Islands. The 6-cylinder engine operated reliably and the only recorded difficulty was a stub propeller shaft twisting off.[17] This machine was the last Army airplane to use a Sturtevant engine until 1917.

During 1913, the Army's opinion of the Wright 50 h.p. engine did not change materially. Two of the units were at San Diego late in the year where the commanding officer suggested they be returned to the factory to be rebuilt into the latest model for $1,000 each (as with most powerplants of this period, there was little standardization and later units of the same type contained improvements over the early ones).



This Wright 50-h.p. engine in the Wright C of 1912 is partially obscured by the radio equipment installed in front. However, the larger radiator required over the earlier 30-h.p. unit used in the Model B is evident and the water piping to the bottom of the radiator locates the geared water pump adjacent to the front cylinder.



Installation of a Curtiss O in a Martin T trainer of 1914. The carburetor is in the usual low position used on most early aircraft where fuel could reach it by gravity from the fuselage tank at the upper left. Though obscured by shadows, the carburetor is attached to the flanged connection on the bottom of the intake manifolds below and behind the engine. (National Archives)

During the summer of 1913, the Army had accepted its last two Wright pushers without fuselages. These were the Model D and each had a 60-h.p. engine, essentially identical to the 50-h.p. unit but developing a higher rating.[18] This pair had been so troublesome that their trials had taken *eight months* and they made very few flights before being discarded. The engines were not considered satisfactory.

While the Wright powerplants were now proving unreliable, the Wright C airframe was not even a safe design, tending to nose over if improperly flown. Number 11 crashed at Texas City, Texas, on July 8, 1913, killing Lt. Loren H. Call.[19] During the next seven months, *five others* suffered similar accidents, leaving only one of the type still on hand in February, 1914. The investigation conducted led to condemnation of the Wright C and removal of *all* pusher types (except the Burgess I in the Philippines) from service on the 24th of that month, reducing the Air Service strength from 15 airplanes to only seven. With this decision, the Sturtevant 4-cylinder engines, the Curtiss N, and all Wright powerplants were relegated to non-flying status, used principally for training of mechanics at the Signal Corps Aviation School, San Diego, California.

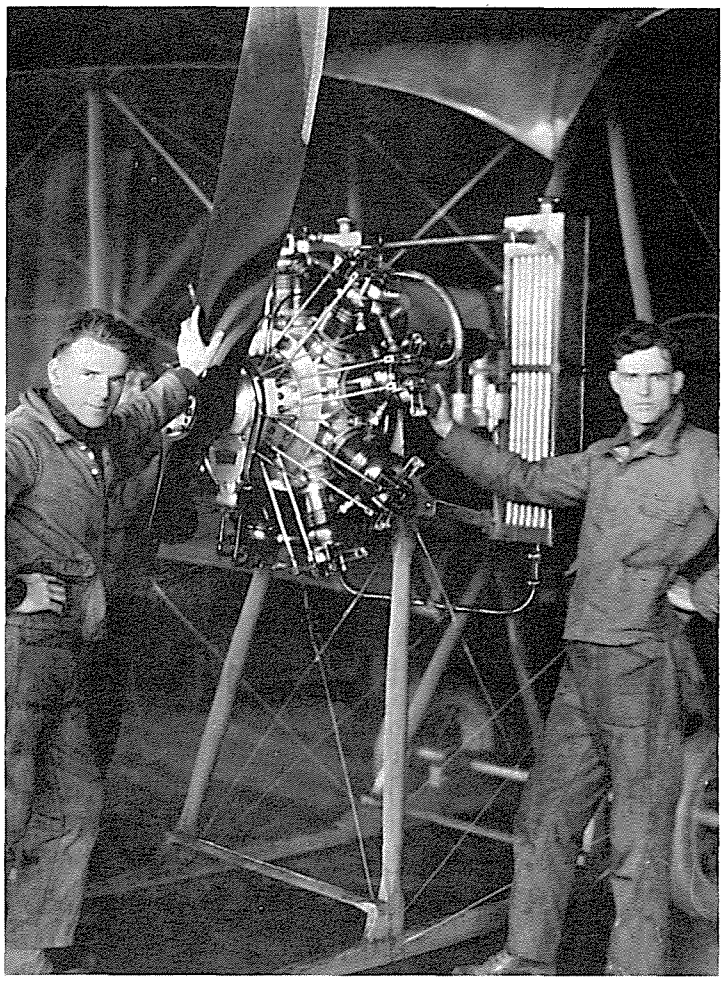
RENAULT AND CURTISS ENGINES IN 1914 TRACTOR AIRPLANES

While the Sturtevant D-6 engine continued to power the old Burgess Model I in the Philippine Islands through 1914, it was probably the remote location of this small Army contingent that prevented its replacement. With this one exception, Army airplanes used during 1914 were confined to only three engines: the geared French Renault of 70 h.p., the 75-h.p. Curtiss Model O, and the Curtiss OX of 90 h.p. All were 8-cylinder types arranged in a Vee, with the Renault air cooled and the closely related Curtiss units using water. The principal change in the OX over the O was introduction of a new valve operating mechanism using concentric pushrods that contributed to the increase in output to 90 h.p. at 1400 r.p.m.[20]

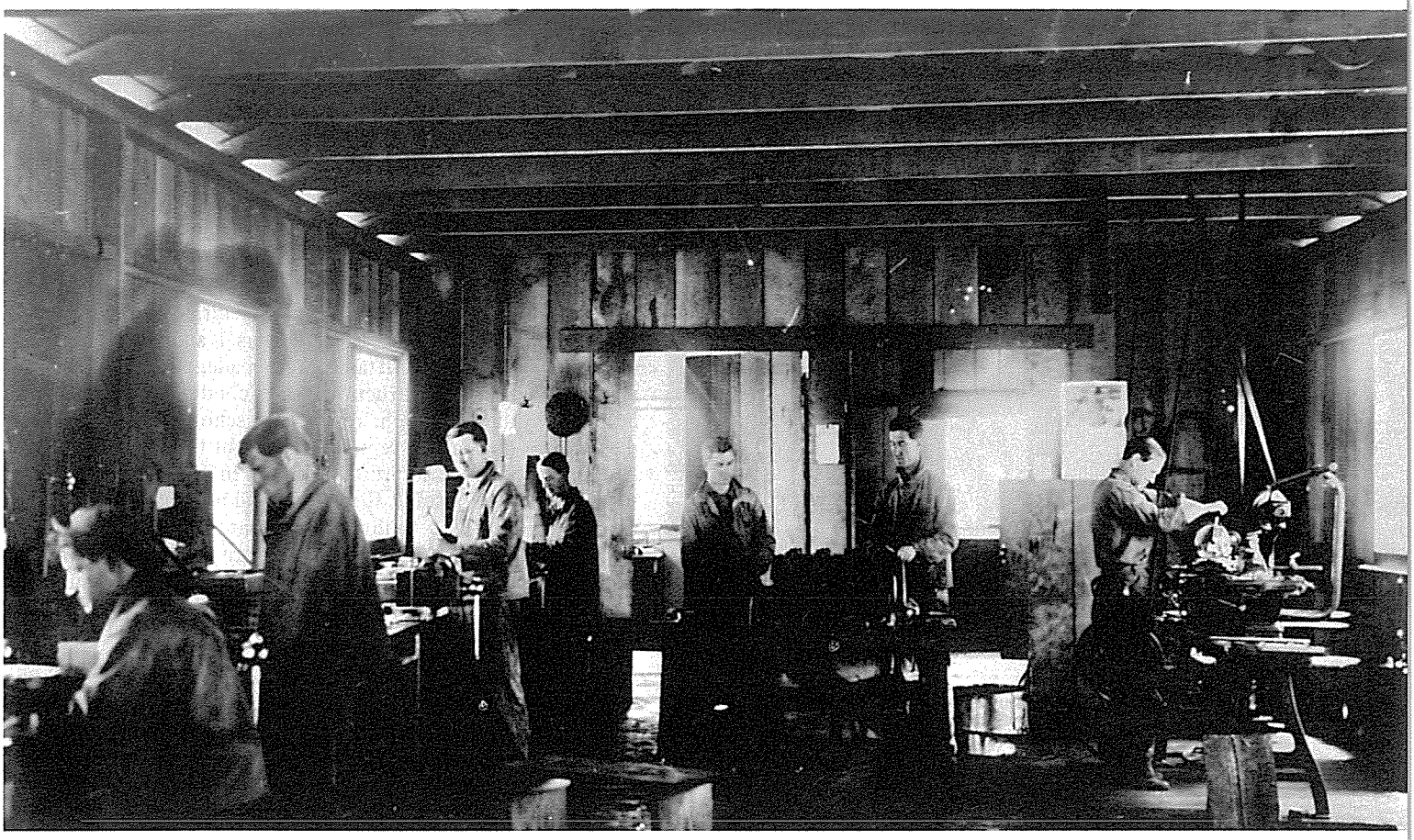
Three Burgess Model H tractor airplanes (Numbers 24-26 and similar to Number 9 delivered in 1912) had been ordered in May, 1913, on the recommendation of officers at Texas City, Texas, where the first Burgess enjoyed a high reputation. These three were delivered with three spare Renault engines just prior to the demise of the pusher designs and were placed in service by the First Aero Squadron at San Diego, California. The engine in Number 26, oddly, was in such poor condition, it had to be immediately overhauled,[14] but it was then used to set an American duration and endurance record on February 14th in a 4-hour, 43-minute flight from San Diego to Los Angeles, California, and return.

The Renault was a geared engine with the propeller operating at a fraction of engine speed, resulting in its being of larger diameter and generating excessive takeoff torque. While usable, the Burgess H airframes were not efficiently designed and the airplane's performance was low, particularly its ceiling. This brought criticisms from the pilots that somewhat limited the machine's effectiveness,[21] but they were the only squadron type available and were joined by two others (Numbers 27 and 28) in July, 1914, five now being on hand. (Number 9 had been taken out of commission in May, though its engine was retained for further use.) The last two machines had been ordered *without* engines[21] and presumably received a spare plus the one from Number 9, another indication of the quality of the Renault.

When the war in Europe began in August, there were undoubtedly delays in obtaining spare parts but, as we shall see, the French engines were used by the Army for *three more years,* so this problem was evidently overcome.



Burgess-Dunne Number 36 had a Salmson (Canton and Unne) M-9 engine of 120 h.p. installed as a pusher behind its swept-back wings. This unusual 9-cylinder radial unit was water-cooled with a radiator on each side of the short fuselage. Only the one was purchased, but it was used for many years in the engine mechanic's school at San Diego after the airplane was dropped from use. (National Archives)



The engine repair shop and mechanic's school at the Signal Corps Aviation School, North Island, San Diego, California, in about 1915. Excellent work came out of this crude facility where powerplants were completely rebuilt under the trained eyes of instructor George E.A. Hallett. (USAF)

Late in the year, Grover C. Loening, Signal Corps aeronautical engineer at San Diego, redesigned the Burgess H airframe to eliminate its cumbersome undercarriage, shorten the wingspan, and revise the odd tail. The lightened airplane with much lower drag could now reach 70 m.p.h., a drastic increase from the sluggish 58 possible before, and the rate of climb nearly doubled.

As 1915 arrived, Numbers 24 and 25 were lost in accidents, though the engines probably survived. The remaining three Burgess H biplanes remained in service with the First Aero Squadron until August, 1915, when they were finally dropped after the squadron's new Curtiss JN-2 machines became available. During this period, the Renault continued its reliable performance as Number 28 set a world's duration record at San Diego on March 12, 1915, of 7 hours 5 minutes. Significantly, when two of the last airframes were sold by the Army in 1916, the Renault engines were again retained.[22] We will return later to the story of their continued use in the last Martin TT trainers in 1916.

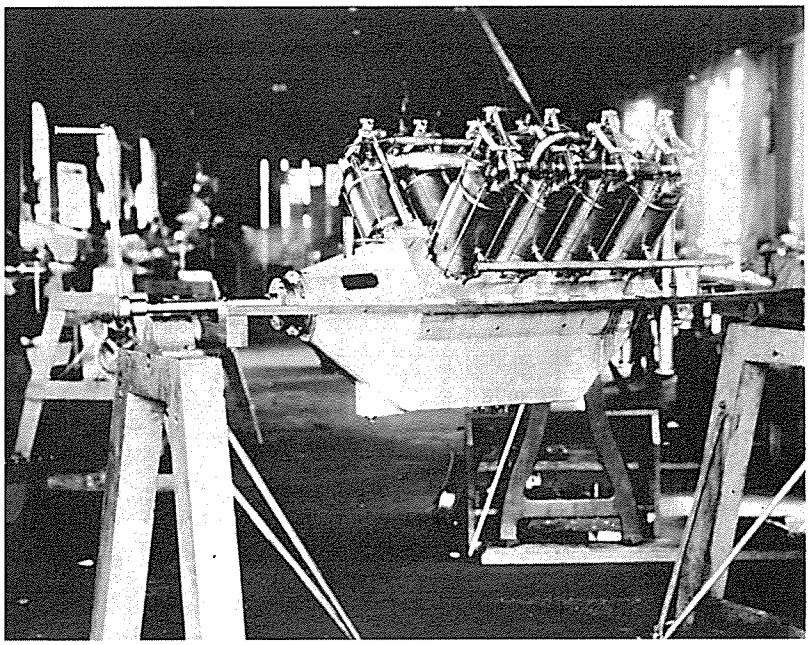
All other Army airplanes seeing significant service in 1914 used the Curtiss Model O or its closely related successor, the Model OX. Both of these engines were respected types and complaints were few from Army officers. The number of airplanes delivered to the aviation section that year was very small and experience with the Curtiss engines limited, but they still established a reputation that insured future orders from the military.

Two obscure experimental tractors had been delivered by Curtiss in 1913, the company's first attempt to design one of the type for the Signal Corps, and neither was too successful. The first, Number 21, was a Model G and had the Curtiss Model O engine fitted. In its unusual installation, a three-bladed propeller was mounted on a shaft suspended over the engine and was connected to it by a heavy chain drive. A large diameter metal flywheel was attached in front of the drive sprocket, giving the installation a high drag.

The Model G was flown at San Diego for many months by the company and the Army (both shared North Island facilities at this time) and the impractical prop installation gradually modified. First, the three-bladed unit was replaced with a two-bladed type and, finally, the chain drive was abandoned and the propeller mounted directly on the engine. Shortly after its acceptance by the Army in June 1913, it had been shipped to Hawaii where conditions were not suitable at the site chosen and comparatively little use was made of it. Taken out of service during the winter of 1913-14, it was flown by Lt. Harold Geiger for a while in the following spring before being sold, its engine shipped back to San Diego for further use there.[23]

The second Model G (Number 22) had been received at San Diego in December 1913 equipped with the later OX engine and was an ungainly four-wheeler which most pilots disliked. However, it was a dependable machine and, when the pushers were discarded in February, it was shifted from the First Aero Squadron to the Signal Corps Aviation School, becoming the most important single trainer in use there during the critical period until the Martin TT trainers were received late that summer. At some time in 1914, the Model OX was replaced with an earlier Model O believed recovered from the wreck of Curtiss D Number 2 in July 1913.[24] In general, the 75-h.p. Model O by 1914 was considered a trainer engine, while the 90-h.p. OX was for high performance service types.

While these two Curtiss tractors were not of great significance, other types accepted in 1914 assumed considerable importance. A pair of Curtiss Model J machines (Numbers 29 and 30) became forerunners of the entire Jenny series of trainers of World War I,



A Curtiss OX 90-h.p. engine being rebuilt at the Army's mechanics school at San Diego, California. (USAF)

though they were service airplanes used by the First Aero Squadron at San Diego during their careers. These also made use of the reputable Curtiss OX engine and reports are notable in making no mention of any problems with the powerplants. The first machine was lost on December 21, 1914, when less than six months old it crashed in the Pacific Ocean during the Mackay Trophy competition. Its engine was salvaged from the wreck and made available at North Island for further use, perhaps as a spare for Number 30.

During the third quarter of 1914, three Martin T trainers (Numbers 31-33) were received. These were all ordered without engines[25] and Curtiss Model O units were installed, probably at North Island after their arrival. This unusual method of purchase must have been to utilize available engines on hand at San Diego. The source of these powerplants is not positively known, but three were returned from Hawaii in mid-1914 where they had been used in Curtiss E Number 8 and Curtiss G Number 21. The crash of Curtiss F Number 15 the previous year had also brought another into the inventory, so it is likely that at least three spare used Model O engines existed. At this time, new 8-cylinder engines cost between 2,500 and 3,000 dollars and represented a tremendous investment in terms of the paltry appropriations made for the Aviation Section. What is most surprising is that these crude engines could be kept in operating condition for the years that some of them served.

The three Martin T biplanes rapidly became the standard trainer at North Island and were in constant use, rapidly adding hours on the Curtiss units. The last two were each in several minor and at least one major accidents, but the engines always survived.[26] The training school with its novice pilots made rough landings commonplace and the airframes were constantly strained. As the spring of 1915 ended, Numbers 32 and 33 were condemned as unsafe after 151 and 156 hours respectively in the air[26] and their engines perhaps again entered the North Island spares stock.

The original machine had an exceptional career, a tribute to both the Martin design and the Model O engine. In April 1915, it was transferred to Brownsville, Texas, to serve on the Mexican border during problems there, was damaged, and returned to San Diego for repairs. In September, it set an unofficial American endurance record of 9 hours 48 minutes, landing after a leak developed in the fuel system.[26]

While these early powerplants often were long-lived, this was not because their construction was particularly outstanding or that the materials were unusually durable. The North Island school had, in addition to the pilot training program, a school for mechanics, the only one the Army operated for several years. The classes were small but were in charge of an extremely competent civilian instructor, George E.A. Hallett, hired in December 1914 from Curtiss. During the next 20 months, Hallett directed this operation which devoted considerable time to classroom instruction on airplane engines as well as actual repair of these units.

A machine shop and engine repair facilities were provided in a small wooden building between Hangars 1 and 2. Here, parts for motors and fittings for airframes were made, engines disassembled and overhauled, and instruction classes conducted. Because of the limited facilities, research, repair, and school operations merged until it was difficult to separate them, but the results were excellent. During the 12 months beginning in July 1914, 69 engines were overhauled, a stand for testing and balancing propellers was completed, and test facilities for radiators built. Some idea of engine life can be gained from a comparison of total hours flown at San Diego during that year (1400 hours) and the number of engines sent through the shops, indicating approximately 20 hours average between overhauls.[27]

THE CURTISS ENGINES PREDOMINATE IN 1915

During 1915, Curtiss engines equipped nearly all new aircraft purchased by the Signal Corps and only the 70-h.p. Renault in the remaining Burgess H biplanes made a significant contribution. Part of the reason was the past performance of the Curtiss products, but the company did furnish over half the aircraft delivered that year to the Army and, with rare exception, always fitted its own powerplants in its airplanes. Further, the major training type of 1915, the Martin TT, was designed around the Curtiss O of 75 h.p.

Two exceptions were single French and British powerplants used in a pair of armored machines intended for reconnaissance use by the Signal Corps. The reasons for specifying foreign engines are not entirely clear, but were probably to obtain better units than could be purchased domestically to equip these first Army types intended for service in the combat area and to benefit from European advances in engine design.

A Burgess-Dunne tailless airplane with sharply swept wings was ordered with a 100-h.p. French Renault engine of 12 cylinders, reflecting Army satisfaction with the earlier 70-h.p. units. This air-cooled powerplant had been ordered separately by the military, was tested at the Engineering Experimental Station at the U.S. Naval Academy because the Army lacked suitable facilities, and was shipped to the Burgess Company and Curtis, Marblehead, Massachusetts, for installation in the Burgess-Dunne (Number 36). However, before the Renault could be installed, the failure of a third armored design ordered from Curtiss with a Salmson (Canton and Unne) M-9 engine led to installation of the Salmson in the Burgess-Dunne.[28] What became of the 100 h.p. Renault is not known, but it was not used in any Army airplane.

The Salmson was a 9-cylinder, water-cooled, *radial* unit of 120 h.p. built by the Canton and Unne firm in France and was probably installed in Number 36 because of its higher rating. The machine was delivered to San Diego in December 1914 where it was soon shifted to experimental work with the Coast Artillery and its original purpose forgotten. The machine was inherently stable, but answered the controls very slowly. It was flown very little between mid-1915 and October 1916 when it was condemned.[28] Its unusual powerplant ended up in the mechanics

Only one 6-cylinder Curtiss S engine was purchased by the Army. This 60-h.p. unit was installed in the Curtiss Tractor trainer of 1915 shown above which was rejected by the Army. The powerplant was then used in the nearly identical Burgess Tractor Trainer Number 40, being turned over to the Army mechanic's school at San Diego, California, after this short-lived machine was dropped. (National Archives)

school at North Island with many earlier models.

The second armored type was the Wright F (Number 39) which was one of the last designs of the Wright company while Orville Wright was still in charge. This odd attempt to install a fuselage on the basic Wright pusher airframe resulted in a flying monstrosity that was dropped as soon as it was received by the Army. However, its 90-h.p. Beardmore engine, a 6-cylinder water-cooled unit manufactured by Beardmore in England, was an extremely efficient and reliable type and was subsequently installed in the contemporary Curtiss N airframe (Number 35) where it was used for over a year.[29] While these two foreign powerplants did acquaint the Army with developments in Europe at the start of World War I, there is little indication this technology was either available to or absorbed by American industry.

Adding to the three earlier Martin T trainers were two Model TT developments delivered in January 1915 and another pair accepted in July. The first two (Numbers 37 and 38) were ordered with Curtiss Model O engines. However, the last ones (Numbers 50 and 51) were specified without powerplants and two Curtiss O units were installed from Army stock. It is likely that removal from service in June of Martin T's Numbers 32 and 33 led to the engines from these airframes being placed in the last two Martins when they were accepted in July. At this time, the Model O had been out of production for several years and was considered strictly for training use.

Another pair of Martins (Numbers 54 and 55) were placed in service late in 1915 and this order also reflected the availability of rebuilt engines in the Army inventory. Both received the old 70-h.p. air-cooled Renaults which were still on hand at North Island following their removal from the Burgess H machines.

The Martin TT's were the standard trainers at North Island from mid-1914 to 1916 when the first Curtiss JN-4 airplanes arrived. Even then, those with the Model O engines were in regular use until late that year, extending the life of the 75-h.p. Curtiss powerplant over a four-year period in Army aircraft. Similarly, the Renault air-cooled engines originally ordered for squadron use served their last hours in the air in two trainers, one lasting until late 1917 and the other into early 1918, nearly six years after the first Renault had entered service.

The last odd engine that entered Army service in 1915 was a 6-cylinder, water-cooled, Curtiss Model S rated at 60 h.p. Because of shortcomings of existing trainers at the Signal Corps Aviation School at North Island in 1914, Grover Loening and Lt. Thomas D. Milling prepared a design late that year and the Curtiss flying school there built the machine using the Model S engine. This airframe proved unacceptable and the Burgess Company at Marblehead, Massachusetts, built a near duplicate that became Signal Corps Number 40 when delivered to San Diego. Unfortunately, it suffered from poor lateral control and was taken out of service five months later, the engine becoming another in the mechanics

Curtiss N Number 35 was modified to use the odd Beardmore 90-h.p. engine originally installed in the Wright F catastrophe. Built in England, this excellent 6-cylinder engine is barely visible, though the light-colored upper cowl identifies one of the alterations made to accommodate the unit. Lt. Clinton W. Russell is the pilot. (National Archives)

training program.[30] It is strikingly evident that the operational life of many Army aircraft engines of the era was dictated, not by the powerplants themselves, but by the airframes in which they were installed.

As mentioned above, in 1915 the Curtiss O of 75 h.p. was considered an engine for trainers and it was the later OX of 90 h.p. that was specified for squadron airplanes. The First Aero Squadron at San Diego was in poor condition because the Burgess H with which it was equipped was not suitable and steps had been taken early in 1915 to replace that type with Curtiss JN-2 biplanes. Eight were received early that summer with 12 OX engines, but these powerplants were not up to the manufacturer's usual standard, so six were rejected by the Army and returned to the factory, a seventh being overhauled by the Signal Corps before being placed in use.[31] After all engines were installed, the squadron was transferred to Fort Sill, Oklahoma, where the JN-2s were extensively tested and used to develop artillery spotting tactics. Two similar Curtiss JN-3s with modified wings joined the squadron in September.

The JNs were not stable and were all underpowered, though the OX engines performed satisfactorily in the hot southwest. A fatal accident and several non-fatal ones generated extensive criticism of the JN design and they were all re-engined with 100-h.p. Curtiss OXX units plus revised wings of increased area and new tail assemblies.[31] As with the earlier powerplants, the new units showed the same poor factory inspection. The first OXX received in October 1915 had a defective magneto, the drive was loose, etc. After a new magneto was received and installed, it was discovered that the camshaft was improperly manufactured and the lobes had to be reground. Crankcase pressure was so high that oil was blown out of the engine. After repair, it was installed in JN-3 Number 52 where it operated only 49 minutes before having to be removed for an overhaul in which the main bearings were relined and scraped. However, the engines which followed were apparently in better condition and were finally installed in the other JNs shortly after the First Aero Squadron transferred to San Antonio, Texas.[31] The original OX engines were probably returned to the school at San Diego for further use as spares or as mechanics' training equipment.

In March 1916, with the OXX powerplants, the Curtiss machines (now designated JN-3s) were shifted to the Mexican border and participated in the Punitive Expedition under Brigadier General John J. Pershing that crossed the border in pursuit of the Mexican bandit Francisco "Pancho" Villa. Conditions there were severe and taxed the airplanes to their limits. Weather particularly was bad and the altitude meant the squadron had to fly near the airplane's ceiling much of the time.

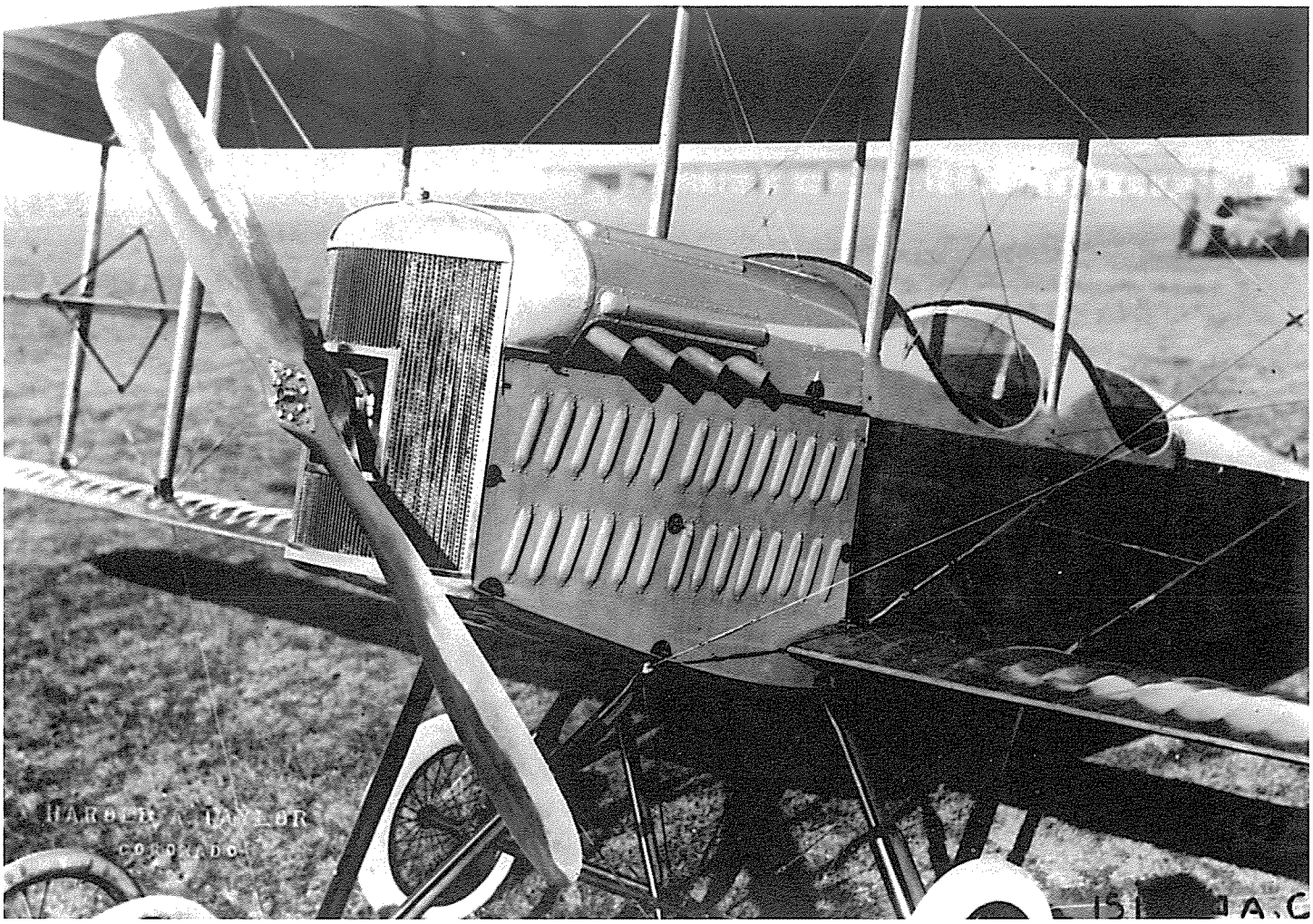
Within weeks, all but two were lost, many of the engines not recovered from the hostile Mexican territory. Any problems with the OXX units had apparently been solved by this time, for only one of the JNs was lost in Mexico because of engine failure, Number 43 on April 19, 1916. On that date, Lt. Herbert A. Dargue and Captain Robert H. Willis made a reconnaissance flight from San Antonio, Mexico, to Chihuahua early in the morning. When the engine began to miss, they were forced to land on the steep side of a mountain where the airplane flipped over. After burning the machine, the slightly injured pair walked 65 miles back to their base.[32] The last two remaining airplanes were then moved back to the United States where the engines were probably removed for other uses and the airframes discarded.

While the quality of workmanship at the Curtiss Hammondsport engine factory was occasionally poor, there is little doubt that most of its products were of good quality, as demonstrated by the reliability of the OXX units in Mexico. It is impossible to precisely determine the operating hours of these engines, but it is obvious that many flights across the border exceeded an hour and that the machines probably averaged no less than one flight per day. Based on this and the unlikelihood of repeated engine changes in the field, it is estimated that the Curtiss engines probably each accumulated 30 hours in Mexico.

EPILOGUE

Crude as they were by today's standards, the Army's aircraft powerplants of the 1909 to 1915 era were well engineered and possessed a reliability acceptable for the time. The very few types operational at any given time indicate that the service selected the best available from the industry and restricted its major procurement to those engines.

With deliveries of the JN-4 and R-2 airplanes beginning in 1916, most of the earlier machines were rapidly phased out, the notable exceptions being the Martin TT trainers. The Signal Corps continued to retain many of the old engines for instruction purposes and some of these even survived World War I. Lists of engines on hand at Rockwell Field (formerly the Army's North Island field), San Diego, California, indicate that a Curtiss O, the old Salmson, two Renaults, and a Curtiss S were among these. Unfortunately, they were not recognized as having historical value at the time and no attempt was made to retain them.



The neatly cowled Martin TT of 1915 hides its Curtiss O of 75 h.p. except for the exhaust pipes. The reliability of this engine is indicated by the fact it had been out of production for two years when it was installed in this brand new trainer. (USAF via Paul R. Matt)

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Robert B. Casari's works are well known to readers of the JOURNAL as an authority on pre-World War I airplanes, a consistent observer and contributor to the News and Comments section, and for his frequent and excellent book reviews. Among his outstanding articles are: "Significant Foreign Literature," Volume 5, Winter 1960; "The First Fifty-Nine," Volume 16, Spring 1971; "The McCormick-Romme Umbrellaplane, 1911," Volume 17, Fall 1972, and "The Dayton-Wright First Shot," Volume 19, Winter 1974. Newer members of the AAHS may know him as the author of an excellent series of books on pre-World War I airplanes, "Encyclopedia of U.S. Military Aircraft," now numbering seven volumes, with another in the works.