From Harold E. Porter '07

THE AUTHOR

AËRIAL OBSERVATION

AERIAL OBSERVATION

The Airplane Observer
The Balloon Observer
and the Army Corps Pilot

By

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Illustrated

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AERIAL OBSERVATION

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DEDICATION

On February 11, 1912, there was held at the Sorbonne, in Paris, under the auspices of L'Association Générale Aéronautique, *a public meeting at which the destiny of France was taken out of the lap of the gods, and remolded according to the wishes of the people. It was a meeting which had for its object the adoption of a definite aerial policy as a foster-child of the commonwealth. Without this meeting, and the result of it, there would have been in 1914 no French Flying Corps, well-manned, well-trained, and well-equipped (according to the highest standards of that time) to guard the pathless ways above the nation, and to stand as the first, and eventually, after four years of constant and unrivalled achievement, to stand, late in 1917, as the last, bulwark of civilization.*

The development of aviation in France—which is to say, the development of modern military aeronautics—is due almost entirely to the little group of statesmen who, without ulterior motive, spoke the truth to France at that public meeting, and thereby nationalized a great ambition. Thenceforward, the French Republic knew—as ours has never known—that great policies, and great visions, are inevitable of success when the impulse springs from the whole citizenry, and not merely from that tiny fragment of it which is called the "government"

The impulse of France, a reaction from the logic and eloquence of a few who were trusted and believed, led to public subscriptions and public enthusiasm which in turn led to aeronautical research and experiment, aircraft production, the training of voluntary personnel, and all the manifold preparation which placed the Republic in a condition of readiness when readiness was unexpectedly demanded.

Again, this was no trick of politics, nor was it the coup of an Administration; it was a national movement, due to the prophets who foresaw its benefits.

There was one man who, regardless of the orders of his physician, rose from a sick-bed, and compelled his will to carry himself to the platform; compelled his voice to preach to his audience the doctrine that the history of France was literally to be written on the clouds. The world has never appreciated this man as a pioneer thinker in aeronautic matters; and perhaps it is because his later grandeur has overshadowed that courageous journey at the end of which there was no glory for him except the consciousness of having risked his health in order that he might loan his genius to his country.

To the distinguished sponsor of the early French program, then; to the prophet of a new world; and to the patriot who, thank God, was never a Cassandra to his fellow-people,

M. Georges Clemenceau

this book is respectfully dedicated.

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PREFACE

BY ELMER HASLETT

Major, Air Service, United States Army (Pilot and Observer). Distinguished Service Cross, Croix de Guerre. Two citations for conspicuous bravery. Operations Officer First Army Corps, Château Thierry, and First Army Observation Wing, St. Mihiel and the Argonne. Author of "Luck on the Wing."

WAR has never been fought successfully by "hunches." Information is the basis of every military action; it has ever been, and it will ever be. Without information, military decisions become a matter of guesswork; and with guesswork the fate of nations is just as safe in the hands of an ignorant plowboy as in the hands of the most highly trained general.

War has never been reduced to an exact basis. Every war, every battle, and every phase of every battle is a separate problem. Throughout the ages, military authorities have been able to do no more than to reduce their experience into a few simple principles which have a fair chance of weathering the revolutionary changes in successive wars. Consequently among military critics there has existed always a tendency toward conservatism.

On account of this conservatism, I predict that the views of Major Porter (which views I fully share) as to the future of aircraft in national defense will not be received by the high courts of military power without dissenting opinion. But conservatism has now reached the point of detriment, in that it has overshadowed and dimmed the perspective of many of our clearest thinkers. Regardless of the critics, whose views we naturally respect, it seems that no person of responsible intelligence (regardless of military training) can reflect upon the rapid development of aviation without realizing that a permanent change has come—not only in the methods of waging war, but also in the battleground in which it must be waged. Within the short space of four years this new arm of the service undertook to dominate, physically, a new element, and did actually dominate it. It provided a battleground which completely covered land and sea—the two grounds upon which all former wars were carried out. Moreover, this new ground is one in which only one arm can survive. As rational people, we must base our preparation upon its known advantages.

Major Porter presents the thesis that observation is the backbone of aviation. With this thesis I agree, and I submit that it is the main preliminary basis of military action. The tendency of modern warfare is toward mass formations; this principle has already been adopted in regard also to aviation by several first-class nations—upon a few hours' notice the entire air strength of these nations can be moved under one command and possibly in one mass. Deducting downward, the nation with a united air force will certainly gain and hold the supremacy of the air. Without air supremacy there is no successful aërial observation. Without successful observation, there is not sufficient military information. Without this, there is no forming an intelligent military decision. Without *this*—we guess. And for my part—and I believe that my opinion is shared by the vast majority of flyers—we want no more guesswork in regard to aviation. We have had enough of it, and of its results. The results were unnecessary casualties. And one must laugh to imagine the air services of our own army, navy, and post office, no matter how efficient individually, in an attempt to unravel enough red tape to meet the trained force of any foreign power which understands mass flying and mass action in the air. I firmly believe that a united Air Service, controlled by a separate Department of Air, is the only solution to our aviation problem.

Aërial Observation is a subject with many ramifications. No man may specialize in them all. Yet the education of the modern citizen is incomplete unless he has at least a conversational knowledge of the main branches. The ideal method of presenting the whole subject to a layman in order to furnish him with a conversational knowledge of these branches (and of presenting it to a prospective student of observation in order to furnish him with sound general principles) requires certain happy qualifications on the part of the originator of the method.

First, the book should be written by a man with perspective. Secondly, in addition to intensive study, the author should have made many flights, and actually practiced his theories in the air. He should have been a true *observer*—not merely an officer with the military rating of Observer—but one who, in addition to seeing, realizes what he has seen.

Major Porter fills the requirements better than any one I know, or know of. We have got the right man, and therefore we have got the right book.

ELMER HASLETT.

MEXICO CITY, MEXICO.

AËRIAL OBSERVATION

AËRIAL OBSERVATION

I

INTRODUCTORY

I

THERE are any number of unhappy methods of beginning a book, especially a book which promises to have something technical about it; but surely the unhappiest of all possible methods is to begin by explaining to the reader how ignorant he is, and how, if he will open his mouth and shut his eyes, the book will presently fill him with valuable information.

The present volume, however, is intended primarily for those who are unacquainted with the subject, and if there is any one military subject upon which the normal reader has been, and unfortunately still is, misinformed and underinformed, that subject is aërial observation. As Josh Billings sagely remarked, it's better not to know so much than to know so many things "that ain't true." Indeed, the Division of Military Aeronautics was, in the autumn of 1918, so frankly concerned about the lack of public regard for aërial observation that it detailed an eager young officer to the special duty of obtaining national publicity for the Observer, and shedding light upon his incalculable contribution to modern warfare. The armistice put an end to the detail; this book is an unofficial continuation of the work so tardily begun.

This is distinctly a book for the layman. Anyone else may buy it (or, more probably, borrow it, or pick it up in a library) and read it at his own peril; but he will find in it only the A B C of observation. To cover the subject thoroughly would require more shelf room than Mr. Eliot allows for a complete education. The best we can do is to point out a few of the most interesting phases, and to describe them without using words of more than six syllables.

This particular method of carpentering in words is broadly called, by contemptuous and technical critics, "writing down to the public," and it is supposed to be a literary misdemeanor of the deepest dye. But the mean height of the present subject is perhaps 12,000 feet, and from that altitude it is impossible not to write down to an audience. Of course, there is one other way of looking at it. You might with equal justice claim that the author is excessively haughty because he has written miles over the heads of his readers. You pay your money (or become a borrower) and you take your choice.

There is an ancient anecdote about a youth who was sent to inspect the sap buckets in sugar-maple time. After a considerable delay he reported that some of the buckets were empty, some were partly filled, and most of them were running over. "So I'd say," he reported, solemnly, "they *average* about full."

By the same analogy, we hope that this book will average about level, and side-slip not at all.

II

Let it be understood at the outset that the author has no desire to pose as the "I" of the Army, and that no further intrusion of personality is intended. Moreover, the author is keenly aware of the deficiencies and the absence of originality in the following pages. This is neither a textbook nor an encyclopedia, and it frankly disregards a number of phases of observation (as, for example, night observation and naval observation), and it owes, quite as frankly, a very large part of itself to the research and accomplishment of persons other than its careworn parent. But there are certain to be various individuals, both in the Air Service and out of it, who will question the motives which underlie this presentation. There are certain to be many who will disagree with what is written here, whether written as stable fact or as mere opinion, and perhaps they will even disagree with what has been left out. It seems pertinent, therefore (and it certainly saves effort), to quote from *The U. S. Air Service*, the official magazine of the Army and Navy Air Service Association, an interview between the editors and the author in 1919, an interview which, despite its flippancy, has a basis of dead seriousness:

"And why," we said to him, resting our four editorial elbows upon one of Mrs. Shoreham's best tablecloths—"and why are you writing a book on aërial observation? What makes you think you know anything about it, anyway? And even if you write a book, what makes you think that anybody will read it? Of course, you can always slam the Administration, and then Colonel George Harvey will read it, but except for that—what's the idea, what's the idea?"

Mr. Hall, or Mr. Porter, or Major Porter, whichever he happened to be at the moment—he glanced up from the grapefruit cocktail which we had ordered for him, and for which we afterward let him pay. He doesn't look very martial, because of his literary aspect; but, on the other hand, he looks too military for an author.

"The reason I'm writing it," he said, "is because I want to."

"But do you *know* anything about observation?" we persisted.

"And where did you acquire this thesaurus of priceless information; this fund of heterogeneous intelligence; this stupendous agglomeration of superincumbent wisdom; this—"

Mr. Porter, or Major Porter, or Mr. Hall—one or several of him, answered us.

"I was an Air Service officer, temporarily in the office of the Secretary of War when the Training Section sent up to find out if they could borrow me back for special duty. This special duty, as outlined, was to learn all that I could about observation, and then to act as a sort of official champion and chaperon of the Observer—to see that he got publicity, and to stimulate the recruiting of other Observers. They could, and it was, and I did."

"And what do you think of our American girls . . ." Here we paused, and blushed. Our newspaper experience had misled us; we had asked Question Number 12, for Distinguished Foreigners Only. "And what," we corrected ourselves, taking our oysters conservatively from the side of the spoon, "do you think about observation, in general, or in particular, or in your book?"

The subject of the interview gazed at us calmly. "In the first place, when we have another war, observation is going to be one of the answers. Any nation which is well and thoroughly prepared—*by* observation in advance, or *with* observation in action—is going to win hands down from any nation not so prepared. That's, of course, presupposing that the other arms of the service, including the combatant branch of the Air Service, are in some decent sort of condition. All right. We've got to have Observers. And here are the main points I rest my case on: the Observer must be a volunteer, and he must be as versatile with his brain as a combined reporter, detective, military strategist, and quail shooter. Ordinarily he will be seven or eight years older than the average graduate of our recent schools. He will learn from realities, and not from textbooks, all he can about Infantry, and then about Artillery, and then—and only then—go on to flying. Unless he grasps at least the fundamentals of major tactics, and has in him at least the germ of command, he won't be allowed to fly at all. In other words, the Observer of the future must be in temperament and ability a miniature major general, and not simply one who looks and reports. And he has got to be a Pilot before he can be an Observer.[1] That

[1] This is now the established system in England, and since the date of this interview it has been adopted by the United States.

is to say, the Pilot and the Observer must theoretically be interchangeable; and, practically, they must each be able, on an instant's notice, to make better than a fair stab at the other fellow's function. And the strong line of demarcation, both in the Service and in the public mind, between the *chasse* Pilot and the Observer has got to be broken down—and stay broken."

"Elucidate," we said, briefly, as we enfiladed our *filet mignon* with a fork.

"You break it down," he explained, "as soon as the Observer is also taught to be a Pilot, and the Pilot is also taught to be an Observer. Just now their points of view are as far apart as capital and labor. Instead of that, they ought to be as clubby as Haig and Haig. It's a matter of psychology, it's a matter of efficiency, and it's a matter of safety. At Langley, for instance, there were entire classes of busted R. M. A.'s [1] under instruction as Observers. They were disgruntled, and they didn't care very much whether they made progress or not. Why? Because they'd been brought up to believe that the Pilot is a human being and the Observer is a passenger. They thought they were disgraced by changing seats. I talked to a dozen of them, and every man was afraid of his reputation, first, with other Pilots, and, secondly, with the public. Now let those chaps learn *both* ends of the game and there won't be any trouble. The principal reason for our lack of good Observers in the war, and the difficulty of getting candidates was just that most men hated to wear a split wing.[2] But your Pilot-Observer would be as good as anybody. Give them duplicate training and equal rating, and you multiply efficiency and morale a thousand per cent. Aren't Observers people?"

"You interest us strangely," we said, appropriating his sugar. "But why should the Observer wear whiskers? Why should he be so old?"

"He should be from twenty-five to thirty-five," said our prey, "for the simple reason that the job requires more brains than we assumed. I would rather have an Observer with brains and a cork leg than a perfect physical specimen with normal intelligence.

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[1] These were officers who, even after qualifying as Pilots and "getting their wings," were regarded as insufficiently promising to warrant any further education in piloting.

[2] The Observer's insignia was an "O" and a single wing. The Pilot wore a device consisting of a shield, with a wing on either side of it.

'Normal intelligence' isn't half good enough. The Observer must be an expert, and not an apprentice, in military affairs. He must have the poise and the judgment of maturity. Courage isn't worth a whoop unless it has judgment back of it, and mere vision isn't worth having unless a lot of imagination is glued to it. I don't mean to say that we hadn't some few young Observers who did very well, but I do mean to say that the average ability of the younger crowd was pretty low. The best men in the business were French officers from twenty-six to forty."

"Suppose," we said, "you were running the Training Branch with full authority to do whatever you wanted. How would you go about making Observers for the next war?"

"I'd establish at least two aërial West Points.[1] Fields, that is, at which the whole subject, including real infantry and artillery work, could best be taught. Langley and Rockwell,[2] for choice. I'd offer regular courses, at government expense—courses long enough to train men *adequately* as Pilot-Observers—and I'd open these courses to three classes of men. First, civilian volunteers, all college graduates, who'd go through the course as at West Point, and be commissioned in the Reserve, or Regular Army, on graduation. Second, officers and enlisted men of the Regular Army or National Guard who might ask for this special training. Third, graduates of the school—from both of the other classes—who'd be called to active duty for four weeks a year to keep in touch with progress."

"On the basis of a unified Air Service?"

"Certainly. Unified in time of peace, and separated, but not divorced, in time of war. That's why I mentioned Langley and Rockwell. We don't see anything strange in teaching a man to fly an H and then a DH and then eventually, perhaps, a Spad—what's strange in teaching him airplane and seaplane work both? He can specialize later. And why shouldn't an Observer be as much at home over the water as he is over land? West Point doesn't simply teach a cadet one phase of warfare—it gives him a broad, general military education, and lets him specialize later. I'd do the same thing in the air."

[1] Present Air Service plans do actually include an air college with a four years' course, comparable to the courses at West Point and Annapolis.

[2] Both Langley and Rockwell fields are so situated as to permit training on both land and seaplanes under centralized supervision. Both of them are located where there is "good air"—a very important item in training—and also where there are safe harbors.

INTRODUCTORY

"Is all this in your book?"

The author reached for the sugar and looked blank. We drank our coffee unconcernedly. "Some of it is," he said, "but the book itself is rather amusing. And it was hard to write. I don't know whether it'll be hard to read, or not. The first edition may not be exhausted before publication, but the author is, anyway. You see, it's for people who don't know much about observation, and it's a little difficult to get them interested in a technical subject, so I've tried to make it light and joyous. Perhaps you can imagine *The Battery Commander's Handbook* used as the plot of a musical comedy. That's about the style."

"You don't expect to sell many, do you?"

"Hardly. But that isn't the point. It seemed to me that the public has been told so many untruths and half truths about the Air Service that unless everybody who *could* tell the truth upped and told it pretty soon, it might be hard to get a hearing when we need it. I've told the truth, that's all. And in some spots it's bewildering. My personal feeling about it is that when we went into the war and set up an Air Service of our own we'd entered a three-legged horse in a steeplechase. And before he finished he broke another leg. And then, just because the opposing horse quit at the finish, we not only think our horse ran a great race, but we also think he can keep on winning."

"Knocker!" we murmured.

Mr. Hall looked annoyed, and we judge that that was the way he intended to look. "Don't forget," he said, "that there's no money in this for *me*, and no glory, either. After the book comes out I'll be more knocked against than knocking. But I've had enough experience to get an idea or two, and enough study to get a perspective. I'm for the Air Service first, last, and all the time. Specifically, I'm for the Observer. But I've seen enough of the average student, his ground training, his flying, his later accomplishment, to believe that as long as we have a dud system we're going to have a dud job. And it won't be until the public learns a little about observation, and its value to the future, that there's going to be much of a chance to progress. Every civilized nation on earth has gained five years on us since last November. I know that Military Aeronautics will come through if Congress will let it. And Congress will let it if there's any public sentiment for it. But the public has lost its nerve. It put up an ante of $640,000,000 without a quiver, but now it refuses to pay $15,000,000 to draw cards.

That's why I did the book. And if you don't agree with my ideas, why, go write a book yourselves."

As we were buying our hat back from the goddess of the coat room, we ventured a final query.

"If the book isn't going to be published until next year, isn't that too late to do any good, anyway?"

"Sh-h-h!" said one of his personalities—the one with the sense of humor. "Sh-h-h! That's my subtitle—'The Late History of the Late Air Service of the Late War.'"

III

It is certainly not through lack of intrinsic merit that the science of aërial observation has attracted so little notice in America; it is solely on account of the dramatic news value of the *chasse*, or pursuit, Pilot. Say what you will, the public loves to read about a fight; the description of any sort of fight except possibly a bullfight or a cockfight will stir the blood of any reader who has a normal supply of bright red corpuscles under his skin. Even now, a retired Pilot is an object of adoration to the hard-headed business man, almost as much as he is to the soft-hearted débutante. The mere conception of two opposing flyers, each controlling, through the medium of a viciously high-speed engine, a little, flimsy spider-work of wood and linen, and fighting with machine guns two or three miles above the earth, is enough to flog the laziest imagination. In 1914, the newspapers were quick to see what possibilities of sensational writing lay in the field of aviation. The facts were ready; and the facts were born for headlines and the front page. Journalism had for once acquired an asset in the form of a reality which was almost literally immune to exaggeration. Heaven knows that the papers did try to exaggerate it, and tried nobly, but the facts caught up with the most bloated of reportorial visionings, and passed them. The very expression "fighting Pilot" was a mental intoxicant—not for your 2.75 minds, either—and the air services of all warring countries were positively embarrassed by the legions of young men who craved to learn how to fly.

The *chasse* Pilot caught the fancy of the world six years ago, and as the ultramodern crusader, the cavalier of the clouds, the revived exponent of the age of chivalry, he has continued to provide as much of the element of military romance as the American public seemed to require or to expect. And America was far enough distant from the front to look for romance, which is a quality that fades out of mind as soon as you approach the actual scene of battle. America read of the fighting Pilot, and took it for granted that he was the backbone of the service, instead of the ribs. This is not altogether true of the French public, nor of the British public, but in both France and Britain there has always been a far more intelligent general interest in military affairs, and a far more intimate knowledge of military details, than there has ever been, or possibly there ever will be, in America. We take our wars like so many cases of national indigestion; we neither anticipate them nor, after the attack is over, do we keep a supply of medicine in the house—or in the Senate, either. We act as though it were indelicate to be interested in military operations.

France honored with renown the Observer and the Pilot alike; Britain, approving of French ingenuity, but disapproving of French ingenuousness, suppressed the names of all her individual heroes, except those who were actually decorated; but both nations understood the indissoluble partnership, in purpose and glory, of the Pilot and the Observer, and their relative functions were a matter of popular comprehension. Naturally, Pilots like Guynemer, Fonck, Nungesser, Madon, Pinsard, Willy Coppens, the great Belgian Pilot, Piccio, the leading Italian ace, Ball, Bishop, Lufbery, and Rickenbacker come in for the largest share of glory, and this is right and proper; but the only reason why it is right and proper is that few individual Observers stood out from among their fellows as these few Pilots stood out among their fellow Pilots. Collectively, the Observers of France, Britain, and Germany received full recognition for their services.

To be sure, the recognition came slowly, even in France, because in the beginning of things, while the single-seater was pre-eminent for all military uses, the Pilot was the Observer, too. He was the only man in the boat, and so much of his attention was necessarily directed toward the management of his ship that his reconnaissance reports were liable to be a trifle sketchy. The potential value of observation, then, was minimized because of conditions which arbitrarily prevented it from more than a minimum of success—namely, the inability of the Pilot-Observer to observe for details. The immediate value of observation was indeed appreciated, but before the science had begun to expand, combats took place in the air, and from the first combat, the public was interested chiefly in the name and address of the winner.

With the advent of the two-seater, however, with the utilization of an officer for observation only, and with the vast improvement in both the quantity and the character of the information which could be gathered by this second man, France began to realize that although the Observer was sitting in the back seat, literally, he was not to be confined there figuratively. In Britain, despite the fact that Britain's first army was twice in thirty days saved by a single Observer, the recognition was still slower; so slow, indeed, that it was not until August 24, 1915, that the "R. F. C. doormat" was even authorized to wear any especial insignia as a badge of his calling. When this concession did come at last, it was extremely conservative, for the insignia proved to be the identical device which France bestowed upon the "Hun," or mere flying cadet—it was in the form of a half wing instead of a whole one. Yet at the end of the conflict Britain had decorated almost as many Observers as Pilots, and when the half wing was seen in Piccadilly, no inquisitive civilian had to inquire what it meant.

In Germany, the Observer was always a commissioned officer, and his Pilot was usually an enlisted man. This circumstance of itself is enough to show where the enemy emphasized brains and where he emphasized skill.

But here in America, the Observer has been almost entirely unobserved. He has not been exploited; his duties—those marvelously intricate, absorbing, supremely vital duties of his—have never been clearly comprehended. The very name of his occupation has suggested humor. Compared with the title of "fighting Pilot," the noun "Observer" has been taken to mean "spectator."

"Oh, I was an Observer!"

"Observer! Ha-ha-ha! That's *good!* What did you observe—sunsets?"

As a matter of fact, that particular fragment of dialogue was overheard in a hotel lobby (the name of the hotel will be furnished on application, but we caught, through a rift in the fog and smoke, the stained token of German gas, approximated his position, and come down through the fringe of that gas, "hedge-hopping" over the treetops, until he could almost identify his men by their tin hats and uniforms. Not willing to rely even upon this, because the visibility was so poor that he distrusted his own eyes, he had asked an imperative question from the air; he had fired from a Very pistol the star signal which requires the front line to reveal itself, and the line had answered by lighting flares to show its exact location. The Observer had sat right on top of a battle, made himself a very good sporting target for all the machine guns and small arms in the sector—and he particularly dreaded rifle fire, because when he flew lower than a thousand feet the good marksmen could come very close to him, while the bad ones, aiming at random, were very likely to hit him; he had flown so low that the slightest mishap meant death or capture; he had passed through the fire of his own barrage and the enemy's; and he ran a fresh barrage of enemy 155's while he was touching up a map to show the exact position of that battalion. Then he got himself lost in the fog for a minute or two, came out over a German position which opened upon him with machine guns, and he dived down to rake the trenches in reprisal as he turned for home. He dropped the map, together with a brief statement written in longhand at division Headquarters. And this statement was written out painfully, but with not a significant word omitted, after his left shoulder had stopped an explosive bullet. So—

"Observer! Ha-ha-ha! That's good! What did you observe—sunsets?"

Well, what *is* an Observer, anyhow?

He is the young man who watches the enemy's movements, strafes them with the help of artillery, photographs them, fights them in the air and sometimes dives to fight them on the ground,[1] bombs them on occasion, annoys them ever, and has little enough credit given to him even in this book.

IV

This is a paragraph of apology to statisticians, purists, rhetoricians, and literary critics, if any.

The World War taught us all we know about the practice of aërial observation. The war is over. But the same war gave us the basis of our current theories, which may or may not reflect our recent practice.

When we say that one thing or another "was" done in respect to observation, we are airing a fact which was firmly leashed to the war and may not reappear in any other war. Likewise, when we say that one thing or another "is" done, there is intended to be an implication that the same sort of thing will be done over again, later—in other words, that the precedent established overseas has become a part of our broad theoretical outlook.

When all of our present theory, as well as all of our former practice, depends upon one single set of battle circumstances, it is very difficult to be consistent in the matter of tenses.

Every statement in figures which appears in these pages is taken from an official report. That is why the majority of them will probably be disputed.

[1] The strafing of infantry was first thought to involve too great a risk, but eventually it was practiced by both sides. In the American forces the first exponent of this kind of low-altitude fighting was Maj. Elmer Haslett, who broke up a German soup fatigue in a communication trench. This, from a German point of view, was almost as tragic as the battle of Château Thierry.

II

THE HISTORICAL DEVELOPMENT OF AËRIAL OBSERVATION

V

BY the time this book is published, we may perhaps be suffering under a complete new set of military theories, for war, in these days, is very nearly as plastic as the law. We are almost in the position of the young attorney who specialized in a study of the statutes, and never stopped to realize that the next bucolic legislature could, if it so desired, repeal in twenty minutes everything he knew. At the present writing, however, in dealing with the three most closely correlated branches of the united service, let us rely upon to-day's authorities.

The function of the infantry is to win battles, and it seems like a simple thing to ask.

The function of the artillery is to support the advance (or, God forbid, the retreat!) and to insure the freedom of the infantry by demolishing or neutralizing the enemy's artillery. The maturity of the insurance depends, however, upon the co-operation of the beneficiary; and he pays his premium with information. Indeed, Colonel Rousset, speaking of Verdun, said: "Artillery fire checks any force and breaks its impetuosity, but causes only the pusillanimous to retreat. To win out over the others, to force them back in the offensive as in the defensive shock action, or at least the menace of shock, is necessary, and only infantry is capable of producing the one or the other."

The *basic* function of the Air Service is, by gathering information about the enemy, to provide additional safety for the infantry; and it does this partly by direct contact with the infantry, partly by direct contact with the artillery, and partly by very indirect methods which in the long run are for everybody's benefit. Incidentally, the Air Service spoils the morale of the enemy and improves our own, by virtue of its very existence. Some one has pointed out that if an enemy observation plane crosses the lines at any low altitude and continues on for ten minutes, it will have traveled possibly fifteen miles and been seen by many thousands of men. If a single enemy shell happens within the next quarter hour to burst near any one of those several thousands of men, he promptly blames it on the plane and lifts up his voice in a hymn of aggrieved resentment against his own Air Service for not protecting him, and chasing those enemy Observers out of the sky. Each man on the ground is permanently convinced that the enemy Obšerver is maliciously interested in him and him alone. It is a very personal feeling. Ludendorff says that at the Somme his infantry was demoralized by Allied aircraft. "Not so much by causing casualties as by making the troops feel that they had been discovered in places which heretofore they had thought afforded safe cover."

But when the Observer's ship floats over its own lines, moral is added to material benefit. Troops which realize that their position is known and understood by their good friends in the air have comparatively little uncertainty about their immediate future. They are sure that their reinforcements will arrive when needed. They are confident that they haven't been mislaid by the Staff.

And they derive this surety, in part, from the vast mass of information which they know the Air Service is helping to gather for them. They know that to-morrow morning, when all the ingredients of information have been picked over and selected and made into a tactical croquette, their commanders will know everything that the enemy has done during the previous day and night, what the effect of our own fire has been, and how this compares with the effect of the enemy's fire. They know that it is intended to make to-morrow a little more comfortable for them than to-day; and the very next hour a little more comfortable for them than the present moment.

And if, at about this time, an enemy reconnaissance plane comes over, and is driven smartly back by a *chasse* plane, then the morale of the troops is again infinitely uplifted, because they see that they are doubly safeguarded. Their own Observers are keeping watch over them; the enemy's are prevented from telling tales. This is what is really meant by "the mastery of the air." It is wholly different from the mastery of the sea. It consists in setting up a force which can observe the enemy and put to flight all enemy Observers.

In his testimony before the House Military Committee in November, 1919, General Pershing laid great stress upon the fundamental importance of infantry.

> The problem is to take a battalion, or other fighting unit, and support it with all that is needed to fight with, and to utilize all the auxiliary fighting arms in helping the infantry to get forward to the objective of his attack, which is the enemy's line,

and in that aviation plays a very large part that requires a very careful and close training in time of peace with the infantryman who carries the gun. You must protect him from attack by the enemy's aviation and from observation in order to save him from being the object of the enemy's artillery destruction. The problem is one that hinges absolutely on the accurate and careful training of all branches, including aviation, as the support of the infantry. We must not lose sight of the fact that aviation is not an independent arm, and it cannot be an independent arm for a long time to come, if ever.[1] The war has not changed in a thousand years the fact that the man who carries the spear or rifle or the bayonet or whatever weapon he uses, is the man who must be supported in order to win a victory.

Let us, therefore, be thoroughly persuaded that neither the artillery nor the tank corps, neither the chemical warfare service nor the cavalry, neither the *chasse* Pilot nor the Observer, is operating separately in purpose from the army as a whole—and the purpose of the army is to push that infantry ahead. The advance of the infantry, under proper guardianship, is the determining factor in war. That advance is the only actuality which can gain, or threaten to gain, any conceivable sort of decision, no matter how temporary. You may batter down the enemy's defenses, reduce his strongholds to ruin or to absurdity, cripple his guns, drive his airplanes out of the sky, blow up his ammunition dumps, scrap his depots, demolish his railroads, and tumble in his trenches, but all these damages can be repaired in time, so that until and unless the infantry has actually made progress forward there is no solid military advantage gained or even begun.

[1] In this one sentence General Pershing is at odds with every flying officer in every military air force in the world. The rest of the quotation, however, is in accordance with the beliefs of every military commander from Julius Cæsar to Joffre. General Pershing has consistently been blind to the fact that the air is a separate element from the ground.

The Observer makes that advance as safe as possible—and no individual does more to make it so. Therefore, although he doesn't insist on being called an "intrepid birdman," he certainly does hate to be called a "deuce."

Think for a moment in terms of man-power. Here are 50,000 infantrymen, ready for action, and worth, if you capitalize them on the basis of their war-risk insurance,,$500,000,000. To support and assist them, you have artillery, engineers, tanks, cavalry, chemical-warfare detachments, with a personnel of perhaps 15,000 altogether, valued, with equipment, at another 500,000,000 dollars. And one Observer in a twenty-thousand-dollar plane can save that billion-dollar investment for his nation, as Colonel Charlton saved it for Britain, or he can lose it. The Air Service is the only service in history in which a second lieutenant has the responsibility of an arbiter of fate.

VI

It must be clearly understood why combat is not the primary function of an Air Service. This is the paragraph which will offend most Pilots, and a good many domestic and foreign critics. So let us say that facts are facts and that no conclusion is ever more than an opinion. A tabloid history of aviation is now in order and will be supplied as briefly as possible.

The value of altitude for reconnaissance, or scouting, is self-evident. The higher you go the more you see. From a height of only 150 feet, your view extends about 15 miles; and from 1,500 feet, it is extended about 60 miles. A child often climbs upon a chair for precisely the same reason that a cat walks a board fence—to broaden out the perspective of the world and see farther. Anthropoid apes and prehistoric man alike were sensible of the advantage of height in spying on unwelcome visitors; they climbed instinctively to the tops of trees, and sometimes even carried rocks with them, to be used in prehistoric bombing operations. The value of hills, trees, fixed towers, and, presently, fabricated and movable towers, as observation posts, was recognized by the earliest of combatants and the earliest of military writers; and for thirty centuries there has never been a change in the one fundamental principle of strategy, so aptly put into words by Wellington—namely, that the most important thing for any general to know is "what the fellow is doing on the other side of the hill." Strategy is military genius, and not guesswork; you may be a very good guesser, but you can never be a strategist until your genius has been given actual facts about the enemy to feed on. You need to know how many men and guns he has, where they are, and as much more as you can find out about his intentions, before you can confidently go ahead with your plans. It goes without saying that if a man could stand in one high spot, on the ground, and see accurately for forty or fifty miles, his observations would be unsurpassed and there would be little need for aërial reconnaissance; but a man cannot see that far, even with the finest field glasses, and, and moreover, at a distance of even a mile or two he can't see through villages or forests, or down into trenches, or deep into distant valleys. So that for more than a hundred years the aim of all civilized nations has been to broaden out the perspective and to get a peep over the hill, by the use of some sort of aircraft. Until comparatively recent times, most of the effort of scientists was devoted to a study of balloons.

There is a persistent rumor to the effect that the balloon was invented in China in the fourteenth century, but credible witnesses have never come forward. There is interesting proof, however, in the form of several of his own papers and sketches, that no less a personage than Leonardo da Vinci was a dabster at aviation, and an experimenter and a research man, and held some very original ideas on the subject of parachutes, helicopters, and ornithopters.[1] Indeed, Da Vinci was in some degree the Langley of his age; his ideas in the year 1500 were perfectly sound at bottom, a little too highly ornamented on top, and might have worked out rather practically in another year or two of research and experiment. He devised both a propeller and a parachute, and he made many interesting researches in regard to the flight of birds and the resistance of the air. In 1742 the Marquis of Bacqueville flew a short distance from the Seine to the Tuileries on a sort of ornithopter, and retired to explain how he had done it, and why he didn't care to do it again. It was in 1783 that the Montgolfier brothers succeeded, in France, in persuading a small and uninhabited gas bag to stay in the air for a few excited minutes; but in the same year Rozier made the first actual ascension, and only two years later the English Channel was crossed, in a balloon (somehow the crossing of the Channel is always a sort of standard performance, whether done by swimming, submarine, or seaplane), and the Air Service became merely a matter of the calendar.

Those of us who have read *Rasselas* (few will admit it) remember that Doctor Johnson said, nearly two hundred years ago: "He that can swim needs not despair

[1] An ornithopter is a flying machine which flaps its wings, and a helicopter is one which doesn't.

to fly; to swim is to fly in a grosser fluid, and to fly is to swim in a subtler. You will necessarily be upborne by the air if you can renew any impulse upon it faster than the air can recede from the pressure."

In 1856 the first man-carrying kite was successfully demonstrated and caused a vast deal of enthusiasm, especially among the military soothsayers, and in 1866 Wenham built the first glider,[1] which was looked upon as an interesting toy, and an effective new type of fool killer. But in all these experiments, whether with balloons, kites, or gliders (for the glider was already admitted to be the chrysalis of self-propelled aircraft, even although it was doubted that self-propulsion would ever be practical), the military importance of the work was never far in the background, except in America, where military matters have seldom included foresight. Indeed, France made actual use of a funny little captive balloon, for observation purposes, at the battle of Fleurus against Austria in 1794, Napoleon had an observation balloon in Egypt in 1796, and there was a serious-minded balloon division in the French army before 1840. During the siege of Paris, sixty-six observation balloons went up from that city in four months—or one balloon went up sixty-six times—at any rate, that is the published record of ascensions. Balloons were used extensively by the Union army, and used occasionally by the Confederate forces, during the Civil War. Germany, always defective in originality, but abominably clever at stealing the world's thunder,

[1] It is claimed that Baptiste Dante made a glider flight near Lake Trasimene, Italy, in 1500, but like many other inventors, he seems to have achieved results only when no one was looking. Other claims for successful glider flights are made for Captain le Bris in 1855. But the glider failed, and the obvious pun on the captain's name holds good.

had a rather well-organized balloon section as long ago as 1884; and British balloons directed artillery fire against Cronje in the Boer War.

To be absolutely positive, however, of what the fellow is doing on the other side of the hill, it isn't sufficient to depend upon mere altitude, which furnishes at best an oblique, and therefore a distorted, view of everything which doesn't lie directly underneath. The ideal condition is, of course, to be able to go over there and look at the enemy either horizontally or vertically at close range; and since even free balloons can't travel over into the enemy's country except with a favoring wind—and this same wind will assuredly prevent them from coming home with the bacon of information—it was still the custom of all armies, up to the present war, to use cavalry for scouting, because cavalry, until the present war, was obviously the fastest on its feet of any known organization. It provided the surest method of getting over into the enemy's country, getting news, and getting back; and it had been used for this purpose ever since man first learned to sit a horse. Now, it is safe to say that virtually the only use for cavalry is for protecting the flanks of an army, and for charging against troops already exhausted and in the open. Richard III could never be written by a modern author.

The free balloon had no homing instinct, and only twelve years ago it was laid down as an incontrovertible dictum that cavalry would always be the accepted medium for scouting, and that aircraft, no matter what happened in the way of development, would never amount to more than a fascinating makeshift. Perhaps it was too much to expect that a world which had wept twenty centuries for Icarus, and used Darius Green as an epithet, should put any faith in a pair of bicycle menders from Dayton, Ohio.

The crossing of the English Channel by balloon in 1785 was a feat which not even the performances of the *R-34* and the Vickers-Vimy bomber can shadow; it required good balloon construction, skill, and unexampled courage on the part of its passengers, and a remarkable spirit of derring-do besides. By proving the efficiency of the balloon as a medium of gaining and maintaining altitude, it guaranteed at least one section of the future Air Service, and made way for the Balloon Observer; but from that autumn day in 1903 when the Wright brothers, the legitimate successors of Lilienthal in Germany and Chanute in America, demonstrated that a heavier-than-air machine could rise from the ground under its own power, and fly, the Airplane Observer was inevitable. The ideal of altitude plus locomotion was within reach, and at last there had appeared a method of getting over the hill and back again, at height. In the Balkan War the airplane appeared in action for the first time, and in 1911 Italy had made use of low-flying scouts against the Turkish armies, published no official reports whatsoever, and instantly multiplied its aviation service.

Nevertheless, in the first few months of the war the air forces of our allies lagged considerably behind the possibilities of that ideal. There was a strong tendency to assume that airplanes had come into the realm of military science merely to take over from the cavalry[1] the work of scouting, and, to some extent,

[1] Gen. Blaque Belair, in the *Revue du Cheval de Guerre*, for June, 1920, says: "If the cavalry did not fulfill its brilliant and glorious mission during the World War it is because it was given no opportunity"—due to the

to take over dangerous duties of those tactical spies who gave such color to old-fashioned melodramas and made William Gillette a matinée idol. The airplanes walked right in and looked around and walked right out again. They could do nothing else; they were single-seaters, and the Pilot-Observer couldn't stop for details. A very general report upon the situation and resources of the enemy—a report so general that a modern Observer would be disciplined for it—was considered fair enough for anybody; and because the speed of the airplane, as against the rate of travel of the enemy's army, tended to prevent surprise attacks and to alter the whole system of military strategy, the Allies thought that perfection was already reached. Britain, especially, if we may judge from the London newspapers during those early months, was rather smug about it. Germany was far worse; the German press declared ecstatically that war had been reduced to the science of chess, and that the great German General Staff could beat the universe at that particular game. It was as though Morse, when he had once succeeded in making his elementary telegraph operate for the distance of a hundred yards, had decided that he had reached his limit and that there was no use in trying to run a line from Baltimore to Washington.

These early reports of the Air Service were made direct to the General Staff, and it was only after the Staff was appeased, and the Air Service had a little extra time on its hands, that observation in its present aspect had a chance to develop. Fortunately, the

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trench warfare—"to maneuver. Marshal Foch has declared that on November 14, 1914, there was to have been initiated a great offensive, and forty thousand horsemen would have turned the slow withdrawal of the Germans into a rout."

Staff in those days was easy to satisfy. A squadron which was ordered to perform as many as four reconnaissances in one day was righteously proud, and it was also indignant, because it thought itself overworked.

As a sample of the warped information which has been fed to innocent readers, an article in the *Saturday Evening Post* is illuminating. It is stated that at the beginning of the war all nations were unanimously free from any ideas of offensive or defensive aërial action. "When two hostile flyers came to close quarters they shook their fists at each other, made faces, and flew away." Then the writer goes on to say that one morning a Scot took up a heavy revolver with him and brought down a Hun, and that subsequently the flyers of both sides proceeded to carry on a spasmodic and guerrilla warfare with rifles, revolvers, and shotguns. Eventually a German affixed a machine gun to his Fokker and found that his morning hate was unusually gratifying. "Immediately," says the critic, "the machine gun was recognized as the essential factor of the situation, but still the general aim was to cripple scouting and reconnaissance work, rather than to fight."

That last sentence contains a true statement of fact, and the fact endured until the end of the war, and is permanent; but the rest of the story gives a clear impression that aërial combat was appreciably delayed and was spontaneously inspired by conditions. In this connection it is interesting to recall that when the war first began to appear unavoidable, an editorial, printed in the issue of *Flight* (England) for July 31, 1914, said, in part:

> Naturally, reconnaissance will be the first and principal object. . . . But there will be interruption from hostile air fleets.

to it, will fight with crockery or two-by-fours rather than not fight at all. They couldn't help fighting, whether they had anything appropriate to fight with, or not. All of the original Pilots of the R. F. C. carried revolvers, and one officer actually brought down two Huns within five minutes. But this doesn't import the fundamental duty of combat.

A French communiqué of exactly the same date refers to a German ship armed with a fixed Browning "quick-firer," which was fastened to the upper wing, and fired over the propeller. This date hardly seems to justify the adverb "eventually," used by the writer above referred to; and there is another point which isn't to be overlooked. The German Fokker was a distinguished improvement of a captured French machine, the Morane-Saulnier. If the Fokker were in fact the first ship to be armed with a machine gun, this could not have taken place for several months. The *Post's* writer has confused the issue. The Fokker was one of the first German ships to use a machine gun *firing through the propeller.*

On November 21, 1914, the German Aviatik was definitely and authoritatively reported to have a Browning as a part of its regular equipment; and in January, when there was captured a German aërial double-barreled gun for firing chain shot, the last of the substitutes was out of the way. Indeed, the war was considerably less than six months old when Roland Garros had arranged a machine gun to fire through the propeller (it was not his own invention, although the press has very generally given him the credit for it); and the war was very little older when poor Garros was captured, gun and all. The Germans made good use of the idea, and this was where the Fokker came in. It so happened that the Fokker was the ship which gave Germany a long and devastating superiority in the air; and it is noteworthy that both the ship and the gun were second-hand inspirations.

Here are certainly all the means of combat, and the Air Services were slowly separating themselves into strictly combat and strictly observation flights, and yet the general aim was still to cripple scouting and reconnaissance work rather than to fight. Fighting was a matter of individuality rather than of organization. Some flyers spontaneously hunted for trouble, and others avoided it. It was only when aërial reconnaissance passed out of the adolescent stage and began to prove its extraordinary worth, that fighting in the air became habitual.

Visualize, if you can, the two embattled armies which first used artillery against each other. They were very much excited about it, and each side probably thought that the battle was going to be a walkover. Without doubt, the fire was originally directed against the opposing infantry, because of the very obvious menace of attack on the part of that infantry, and because, also, the results of fire against it were something which could be seen and valued. The gunners could actually see the enemy's troops keeling over, and it must have been a very encouraging sight. The gunners possibly told one another that future wars, now that such a diabolical weapon had been invented, were out of the question. They wondered why the enemy was so foolish as to go on with the war. But after a little time one commander, observing that in spite of the havoc created by his own irresistible guns, his own infantry was also being keeled over in much the same manner by the enemy's irresistible guns, and realizing that the war hadn't ended yet, probably took counsel with himself, got his senses together, and argued that if he could silence the other fellow's artillery he would do two things at once—he would save his own troops from the dangers of the enemy cannon, and leave himself free, after that, to harass the enemy infantry as before. This would certainly win the battle for him; there was no question about it. So that he craftily lengthened his range, and the enemy artillery, suddenly and unexpectedly assaulted in this fashion, obeyed its impulse to strike back, and so there ensued an artillery counterbattery duel. It continued to the point of a decision. But this duel, as you will surely have to admit, was never started for its own sake, was never defined as an end in itself, but was staged for the indirect assistance to the infantry, even if this assistance couldn't be given, now, until the artillery duel itself was finished and one side or the other had got the advantage.

Aërial combat developed along exactly the same lines, and although the analogy doesn't hold good throughout, because infantry and observation are not parallel services, yet the analogy of protection does hold good. At first, the reconnaissance of both sides was unhampered; wherefore each side promptly realized that if it were getting so much information itself, then the enemy was getting a lot, too, and that it would be a good thing to stop the enemy from getting it. Observation planes were then deliberately interrupted, in the hope of preventing the Observer from taking home his information and from ever coming back again. General Brancker anticipated this condition when he said, early in the proceedings:

"The first and foremost duty of the Royal Flying Corps is reconnaissance. Very soon a *second* duty will be allotted to us—the prevention of hostile reconnaissance."

For this purpose, fast single-seaters were employed exclusively, and were called *chasse*, or pursuit, planes, and flyers were set apart to do nothing but operate these planes, either as free lances or in organized squadrons. The object of a *chasse*, or fighting, plane was primarily to bring down enemy observation planes, of the new two-seater type, which were engaged in picking up valuable news or taking damning photographs. The nomenclature shows this; the pursuit planes were to pursue, and it stands to reason that one usually pursues a weaker force, and not an equal or a superior. But the enemy's *chasse* planes were out on a similar job; they were still-hunting for observation machines, too. So that the two *chasse* planes presently fought it out together, not for the sake of the fight, but for the later benefit of observation, and for nothing else in the whole wide world. And there never was a time, up to the end of the war, when a *chasse* plane, if it had the choice of attacking one of its own type, or an observation plane, didn't choose the latter. There never was a time when any air commander ordered differently. There never was a time when, if a fighting squadron met an enemy fighting squadron convoying an observation plane, or several of them, it didn't dive for the observation planes, and take the resultant skirmish with the convoy as an incident to the job of harassing observation.

Now aërial combat, purely as an expression of military power, is absurd. It has no greater significance, in itself, than the maneuvering of two wily snipers, each of whom hides in his own lines and tries to stop the other gentleman from sniping. A single fighting plane, from a tactical or a strategical standpoint, is of the least imaginable importance; and a battle between two opposing single-seaters would be of literally no consequence whatsoever unless the victory of the one and the defeat of the other had a bearing upon the great operations of the opposing armies, both preventing the loser from interfering with the gathering of information by the opposite side, and also from providing any assistance to the seekers after information from his own side. And there you have the one and only reason for the existence of the *chasse* Pilot. There are a few special pursuit flights which are released from every duty except to find the enemy's fighters and engage them, and are specifically not to trouble themselves about enemy observation; and yet these flights are just as certainly there for the benefit of observation, pro and con, as any other flights.

This is not in derogation of the *chasse* Pilot as an individual, or as the guardian angel of the Observer. There is a distinction here between the tactical and the individual importance of the fight. The *chasse* Pilot is absolutely essential to the Observer; observation without protection is an impossibility. The two duties now go side by side. No combatant in any other arm of the service has a more complicated task than that of the *chasse* Pilot, or one which involves greater personal hazard. No one—except the Observer, the Pilot who drives that Observer, and the infantryman. Gen. Sir David Henderson, testifying in the R. F. C. inquiry of 1916, declared that the least dangerous of all aërial work is fighting in a fighting machine; and perhaps this is sound, for the Observer's peril is certainly greater, and there are not many more kinds of aërial work, anyway. The *chasse* Pilot has a few short, sharp actions, and is through for the day; the Observer and the army corps Pilot fly for hours at a time, frequently under continuous fire from the ground, and always the attacked, and never the attacking party in a fight. Certainly the figures show that fewer *chasse* Pilots than Observers, or army corps Pilots, are killed or wounded. The infantryman is in greater peril than any of them.

But the main point is that no task is more *spectacular* than that of the *chasse* Pilot. His roving commission, or even his routine patrol, strikes a gorgeous chord of romance in the soul of every civilian, and every *embusqué*. He is a demigod to every person who has never been in the air, and he was first to catch the public attention. Hence his cumulative publicity, and hence the impression that the Air Service is built around him. In reality, he stands toward the Observer just as the artillery stands toward the infantry. He is there for protection. And protection is a secondary purpose.

General Pershing has pointed out that wars are won by infantry and that all else in the military organization exists only in relation to infantry. In the air, observation is similarly the crux of the matter, and pursuit squadrons exist only for the purpose of "chasing and bringing down enemy airplanes in order that the Observers . . . may continue their work unmolested."

One of the most natural, as well as one of the most curious, results of the development of combat is found in the lists of decorations awarded to flyers. In the autumn of 1914 French officers were made chevaliers of the Legion of Honor simply for having participated in an aërial fight. A Pilot who brought down a Hun was made an officer of the Legion. Six months later it took an exceptional performance to win even the *Croix de Guerre*, and in a year's time a Pilot rarely got his name in the papers until he became an Ace.

It is very generally supposed that the man who goes forth to do battle, single-handed, above the clouds, is *sui generis* in regard to bravery and skill. That is not true. It has been hinted by one cynical writer that aërial observation is hardly more dangerous than straight flying, to the admiration of all the girls in the neighborhood, at a local field. That is not true, either. But to debate the question of the relative bravery and skill of the *chasse* Pilot and the Observer is as fatuous as the subject of high-school freshman debates—"Resolved, that the hand is more useful than the eye."

We are not parties to that debate. Bravery and skill are common requirements—common requirements for every officer and every enlisted man in every army. We are dealing entirely with a demonstration of the principle that observation is the primary function of the Air Service. In Eddie Rickenbacker's book, *Fighting the Flying Circus*, he even goes so far as to say that "bombing, patrolling, and bringing down enemy airplanes are but trivial" compared with the importance of observation.

Perhaps he was in a position to know.

VII

In spite of almost universal public opinion, for which the front-page astigmatism of the typical war correspondent is largely responsible, an Air Service is not fundamentally a service of combat; it isn't even an auxiliary combat arm, as one leading and almost infallible American officer says it is. Indeed, the French authorities, who were studying military aviation before America even had a dozen Pilots, maintain that it happens to include combat only as an unavoidable necessity. The necessity grew up overnight, but only in relation to observation. Indeed, the German experts went so far as to claim that the duty of an actual fighting plane was not so much to fight as to threaten to fight. The service was frankly at its zenith of efficiency when it acted as a menace, and not as a headstrong belligerent.

As a matter of history, the air services of all nations spent a large portion of their activity in actual fighting, but observation planes fought in many more combats than *chasse* planes did. This is because an observation plane was by its very nature an object of attack by every enemy who saw it. But to use a ludicrous example—if a banker, through no overwhelming desire of his own, contracted a case of influenza, it would hardly be fair to say, simply because he spent twenty-four hours of the day in having influenza, and only eight hours in banking, that his basic existence was as an influenzist, and not as a banker. One occupation is accidental, the other is permanent. So with the Air Service. It fought, and it fought even more than it observed, but its main business was to observe and not to fight. Observation was a permanent duty; combat was fortuitous.

Please note that this applies to an Air Service *as a whole.* Pursuit squadrons, of course, had no other business than to fight. But fighting was absolutely the last motive of the consolidated service.

A modern Air Service is first and foremost a service of information, and secondarily a service of destruction. As a destructive power, it indulges in the isolated function of bomb dropping—another spectacular occupation which isn't half as important as most people believe. Haig, Foch, Ludendorff, and Pershing have agreed, independently, and without inviting each other to a conference, that bombing is an expensive and an erratic undertaking. The actual physical damage done to British property as a result of all the Zeppelin raids put together, for instance, is officially estimated at only seven and a half million dollars. It is a matter of terrifying the man in the street, and now and then getting in a lucky hit or two. If you balance the cost and the damage, bombardment groups would invariably have shown red ink on the wrong side of the ledger. Even so, bombing is entitled to second place in the list of Air Service duties, because its nature is inherently allied with that of the airplane. Observation missions and bombing raids are made possible only by altitude plus locomotion. The question of cost, or of chance, is utterly beyond the point. In March, 1915, it was said on good authority that France's only reason for keeping up her long-range bombing operations was her own scarcity of heavy-artillery ammunition. The obvious recourse was to bomb the German powder factories. (There is no particular reason for dragging this fact on to the stage by its hair; it merely adds bulk to the book.) We all concede, however, that in future wars bombing operations are likely to be of far greater importance than in the recent war. The bombs themselves will be improved in effectiveness, the bomb sights will be vastly improved in accuracy, and a greater load will be carried by every bombing plane.

As a source of information, an Air Service is merely one part of the great news-gathering bureau under the supervision of the chief of staff of an army corps. This bureau uses its Air Service as a cane, but not as a crutch, for there are five other sources of information which can also be leaned on. (1) Enemy deserters and prisoners, who are questioned by Intelligence officers, and sometimes are kind enough to reply, but usually stand up and lie like troopers for the glory of their fatherland. (2) Enemy documents found on these deserters or prisoners, or in captured positions. These vary from copies of important orders to love letters from Lena to Fritz, but it is a good principle to remember that anything written by an enemy, or to an enemy, generally tells something *about* the enemy. (3) Listening posts. (4) The Infantry Information Service. (5) The Artillery Information Service.

All this information is assembled and consolidated and predigested—the labor involved is brain-wearing, but necessary, because there is such a terrific jumble of it, concerning so many different subjects and objects, and because some sections of it are always contradictory—and from it are eventually made up the general bulletins, and the maps and firing charts, on the basis of which the war itself, and its subdivisions, the local battles, are planned and directed.

The inherent duties of an Air Service, then, are, in the order of their intrinsic importance—not in any sense in the order of their strategical importance, however, for they are glued together unyieldingly—the inherent duties are observation, bombing, and combat.

Sometimes a combat plane has two seats, in which case the officer in the rear cockpit is liable to be called an "Observer"; but as a matter of fact, since his work is specifically pugnacious and he is there to operate machine guns and nothing else, he is properly addressed as an "Aërial Gunner." Likewise, those men who work the releases of a bombing plane should be called "Aërial Bombers," and not Observers, because they are paid to bomb and not to observe. Combat and bombing are beyond the scope of this treatise, so that we shall not meet the aërial gunner or the aërial bomber again, but as they all wore the same kind of insignia, it is a good thing to know which is which.

Aërial Observation, broadly speaking, is divided between the two groups of lighter-than-air craft (balloons) and heavier-than-air craft (airplanes), and embodies four kinds of performance:

(a) Infantry Contact Patrol, which is limited to airplanes and consists in flying above the infantry during an attack, and keeping Headquarters advised of progress. It is also called "Infantry liaison."

(b) Artillery Reglage ("spotting artillery fire"), which is conducted both by airplanes and by balloons. The most important part of this work consists of firing upon the enemy's own artillery.

In July, 1918, the London *Mail* said:

> More and more, week by week, we see these counterbattery duels waged to the death; and if anyone has any doubts about our Air Service in France, he should see the daily list of batteries marked down and ranged upon by our Observers. The war is becoming more and more a counterbattery war, and this means that the Air Service takes a bigger and bigger part.
>
> The enemy is hiding his guns more and building heavier defenses for them; he surrounds them with smoke screens and roofs them with concrete and walls them with scene painting and divides them with sham batteries, but he has not yet dodged the eyes of our airmen with any general success.

Henry Woodhouse, in his *Text Book of Military Aeronautics*, says that artillery reglage has become an exact science, but that does seem like a rather strong statement, because it imports absolute perfection in the airplane, the Pilot, the Observer, the radio outfit, the gunners, and the guns. If all of these were perfect (which none of them ever will be, or can be) then it might be approximately exact.

(c) Reconnaissance (performed by airplanes) and Surveillance (performed by balloons), both functions sometimes including:

(d) Photography, with vertical, stereoscopic and oblique photographs taken from airplanes, and a few oblique photos taken from balloons. Photo missions, however, are usually quite independent of reconnaissance, and go out on schedule, like suburban trains, or else are special missions sent out for specific purposes.

All other forms of observation — and different authorities divide and subdivide them, like the school-teacher's apple, until the bad boy despises the picayune fractions and furnishes the age-old answer of "apple sauce"—are variations of one of these four types of missions. No two authorities agree exactly on their proper names or their proper definitions.

VIII

At the outbreak of the war our allies had few ships, few Pilots,[1] no Observers, no radio, no cameras, no suitable armament, and no idea of which way the cat was going to jump. England, for example, owned 7 airships, 45 seaplanes, and 166 airplanes which were chiefly antiquated Blériots and Farmans ("Henrys"), with a few Avros and Bristols. She had about 200 qualified Pilots, military and civilian. Italy had about 200 planes; of which about half were light fast ships of French or British design, and the remainder were big heavy ships of the pre-

[1] In the first month of the war Britain had fewer than 100 Pilots in service; they accomplished 87,000 miles of reconnaissance during the first 30 days.

Caproni type. Russia had 800 planes, but only 400 Pilots, and the planes were of so many different types that a Pilot was helpless, except in a machine in which he had flown a good deal. Belgium had the best *types* of military planes in the Allied armies, and began the war with 30 of them. France had more serviceable airplanes than any other nation, but French ships, like French automobiles and Swiss watches, were hand-made. They represented a score of different types, and their various parts weren't interchangeable, so that when a bus got into trouble it was necessary to get new parts which would fit that particular bus. When you remember that at least a few small replacements are usually demanded after even the shortest of air skirmishes, and that after 50 hours or so of flying an engine has to be completely overhauled anyway, you can easily imagine how few of the French machines were kept in uniformly good condition. But France took heroic measures—out of her 600 ships she scrapped 500, and then built up, on the basis of the 100 ships remaining, a policy of standardization which was a time saver and a life saver. She deliberately amputated five sixths of her aërial fleet in order to guarantee her later efficiency.

Germany had a good balloon service, and of course its famous fleet of dirigibles and over 1,000 airplanes ready for service. She also had a tremendous advantage in her number of trained Pilots; and she was wise enough to concentrate her personnel and her material in one place. At the start, then, Germany got away in the lead, and kept it for the first year of the war.

A large number of all the ships built before the war were monoplanes, for until the war the monoplane was considered the best type to build for all purposes. It was a faster climber than a biplane and it was faster in flight, and it was also a good deal easier to handle in bad weather. (As late as 1914 even a good Pilot was apprehensive about "bumps";[1] and a flyer who took the air in a stiff breeze was a bit of a martyr, in his own mind, almost before he had gathered flying speed.) It soon proved, however, that the only reason for this supposed leadership of the monoplane was because of the greater care used in designing it. As soon as equivalent care was bestowed upon the biplane there was simply no argument at all in favor of the older type.

Almost all of the early observation work was performed in single-seater biplanes, with the Pilot acting also as Observer. Try to drive an automobile (which is a much simpler task than flying a plane) while you make notes on the scenery, count the farm animals in a barnyard, and make a list of all the different flora along the way, and you will gather an indistinct impression of what the Pilot-Observer had to do. He could go out to examine the country for one particular condition of affairs—as, for instance, he could be sent to find out whether the enemy was advancing, or whether a certain village was occupied, or whether trains were running on a certain railroad—and make a categorical report, but there was no remote possibility of any finesse about it.

Now, in a monoplane, the "skipper" is seated above the wings; and if it happens to be a bi*place*, or two-seated monoplane, the Observer is seated above the wings also. Neither of them can see directly over the side, for the view of the ground is cut off by the

[1] In ordinary rough weather a single bump may change the altitude of a plane from 25 to 100 feet in an instant; and at the bases of clouds, especially cumulus clouds, there are often pockets which will drop a ship from 500 to 1,000 feet.

wings, and if you try to remedy the defect by slicing away a part of the wings, you also slice away a part of the efficiency of the plane. You can't very well build a monoplane without this disadvantage in visibility, but you can easily build a biplane without it. The fuselage, or body, of a biplane is longer, so that the Observer sits back where the wings can't interfere with his perfectly vertical vision of the ground. He can always look directly over the side.

A biplane can be built with a far greater variation in speed than a monoplane, and this is important, because it allows the ship to have a high flying speed and a low landing speed. Actual flying isn't a tenth as dangerous as coming down, but a man has to go home sometime—as the cheerful fellow in the story said to the reformer who remarked, "I'm sorry to see you coming out of a saloon"—and although high speed means safety in the air, yet it means exactly the opposite in landing.

Furthermore, a biplane can carry more weight than a monoplane, so that the weight of the Observer [1] is no handicap. Two men are better than one, not only in respect to their actual work, but also because of the moral support they give each other, and a two-seater carries enough weapons to make up for the greater speed and maneuverability of any enemy single-seater which might pounce down upon it. It was soon apparent, therefore, that the biplane was by far the better general type for all purposes; not simply observation, but pursuit work as well. Fast little biplanes were put into production at the same time that larger biplanes were planned for observation and bombing. By 1918 there were virtually only

[1] The allowance of weight was approximately 170 pounds. Nobody in the Air Service loved a fat man.

two types of monoplane which had endured the test; the other ninety-seven types in actual service were all biplanes.

There was a good deal of bickering, in those formative days, about the merits of the dirigible balloon, and the Allies, before pushing their aircraft plans too far forward, were eager to see what the Zeppelins[1] would accomplish. There was no single instrument of war which was so much feared and hated; the Allies swallowed everything they heard about it, and waited for the wolf to come and bite them. It was almost believed that one Zeppelin could carry out, at the same time, half a dozen different functions, as, for example, reconnaissance, artillery reglage, and bomb dropping; and the Allied estimate of Zeppelin efficiency was vastly higher than the later facts ever justified. But the dismal failure of a Zep. to aid very substantially in the reduction of Liège, the subsequent Zep. failures all over the theater of war, and the discovery that a Zep. was rather easy prey to a flight of armed airplanes, set the Allied audience to thinking and set some of them to doing. The experts tell us now that if Germany had made use of airplanes in Belgium, instead of trusting so implicitly in the dirigibles, the war might have ended in a swift victory and a table-d'hôte dinner in Paris, as advertised. As it was, Germany bet on the wrong horse.

Prior to the war, a number of well-minded and thoughtful citizens, both in Britain and on the Continent, had written some very interesting forecasts of aërial warfare, and outlined with uncanny skill the boundaries of observation, but no one beyond the

[1] German dirigibles are usually called Zeppelins on the analogy of the music-hall song which began, "Her name was Jane—that's why we called her Helen." The vast majority of all "Zeppelins" were Parsevals.

professional military critics had paid much attention to them. The professional critics themselves were not nearly as far-sighted as civilians like Claude Grahame White and R. P. Hearne. And the curious part of this situation is that the prophets were quite correct, but that their prophecies came true only after a period which neither the military people nor the prophets had ever imagined. This was the interlude during which bombing was so very fashionable, and was popularly supposed to be the *métier* of the Air Service, and it began when observation seemed to have reached its intensive limit of culture and before combat was regarded as a definite form of activity. This supposition was a newspaper affair, rather than a creation of the military theorists. British publications, in particular, uniformly disregarded the greater possibilities of aircraft, which concern observation, and laid strong emphasis upon the lesser, which include bombing. Ninety-nine per cent. of all the aërial news items in British newspapers and technical journals from August, 1914, to March, 1915, concern bombing operations only; and the greatest imaginable praise was given for very minor successes. This is not to imply that 99 per cent of the *air forces* were consecrated to bombing, but only that the press jumped to a swift conclusion. Now that the war is over, the Allies and the enemy have unanimously agreed that bombing was consistently overrated. It made a fine noise, and once in a great while a bomb did happen to hit something important, but over a period of four years the amount of damage done was much less than the cost of causing it.

To be sure, observation was in process of study, and now and then there was an isolated accomplishment [1] which showed what some day might be expected; but the press had not yet learned that the intangible results of a reconnaissance may be, and usually are, a thousand times more important than the effect of a few bombs dropped on an enemy field kitchen. And the press was perhaps excusable, because observation was in its immature stage. Field-Marshal Sir John French was quick to compliment the R. F. C. for "establishing effective communication with units in action," but this compliment must be construed with reference to its date. Any good bush-league pitcher is effective—in a bush league. Effective communication, in the winter of 1914-15, meant really little more than the barest communication at all; whereas the bursting of a bomb was something which every reader could picture to himself and gloat about. Moreover, no matter how many good targets the British Observers reported, the British artillery was unable to take much advantage of them. Britain had few guns, and no heavies at all, so that reglage was comparatively ignored until well into the spring of 1915. Germany, on the other hand, had practiced reglage before the war, and was capitalizing her resources. She hadn't as many airplanes as France, but she had three and a half times as many guns as France, so that her superiority in artillery over her two chief opponents was very pronounced and should have resulted in an easy

[1] Without aërial observation the British army would certainly have been enveloped at Mons, on August 23, 1914, and the war might have ended according to the German prophecies. Similarly, the cause of the Allies was saved perhaps half a dozen times by individual Observers, and certainly the first battle of the Marne would never have been won by France unless a flying officer had detected between two German armies the gap through which the French infantry poured. Moreover, the situation at Ypres at the beginning of the war was saved by a handful of Belgian planes.

victory. To a confirmed German, this war must seem like a golf match, which, after it has been lost outdoors, can be played over again as easily in the clubhouse grillroom, and the result entirely changed by the constant repetition of the small word "if." Germany got off some wonderful drives, but her approaching was unsteady, and she kept lifting her head to peek at the greens—on the Champs-Élysées.

Even France was inclined to think that day-bombing, superficial scouting, and the occasional locating of artillery targets was all that a reasonable Ally could expect, and the French Flying Corps was once actually complimented simply for having observed "the massing of the German legions." This, in the light of present achievement, sounds something like complimenting the vision of a rural stranger who has come to New York particularly to see the Woolworth Building, and then does notice it, when he goes past.

But we cannot afford to laugh at France. France showed us the way and provided the standard by which we shall be judged in aërial observation as well as in aërial combat. In the first five months of war, French flyers performed more than 10,000 reconnaissances, involving over 18,000 hours of flight and covering over a million and a quarter miles; and this is about as much as America did in the last five months, after all those years of boasting and preparation. It took only one phase of a single major offensive to teach France what could be seen from the air by trained Observers. The beginning of the attack, its progress, the gradual wearing down of the German artillery, and the new situation of the French troops—these items, considered by themselves, and then considered in relation to the evidence by which they might have been anticipated, furnished the starting point. From that point forward, observation became a specialty of France.

The only available ships were still the lumbering old "airscows," but even an airscow, over the lines, was in the best possible position to get fresh news about the enemy. This was conceded, for it was self-evident. Yet if that news were vitally important, and would lose its value if it lost its freshness, how could it be carried back to Headquarters unless the airplane itself carried it back and thereby prevented itself from getting just so much more information?

How could the airplane exchange signals with both the artillery and the infantry, so as to convey to the one an accurate expression of the needs of the other? The dogma was actually laid down that this co-operation was impossible.

We have already shown that one of the most imperative of all facts for a commander to know during an attack is the actual position of his front-line troops. As an elementary proposition, France worked out a theory that this position could be shown to the Observer if the infantry were furnished with little guidons, or flag markers, and in June, 1915, they tried this theory on the dogma. It appeared that an Observer flying as high as 6,000 feet could easily pick out his own troops, provided that they were in open country and not in motion. Unfortunately, however, the war was going into the trenches and the flag markers declined to be seen under those conditions. The troops also declined to remain at rest. It wasn't healthful.

In September they tried out Bengal fire in actual combat in Artois and Champagne. The troops carried this with them and showed the Observer very clearly where his front line was at any given moment.

But the Huns could also see the fire pots, and by the time the Observer had reported on the lines, the Hun had generally urged his artillery into action, and this promptly caused the lines to be located somewhere else. The use of Bengal fire was a good idea, in its way, but it gave Germany too many free shots.

Then France experimented with direct signaling from the ground to the plane with flags, on the ancient wigwag principle, but the flags—and the Observers—made too many mistakes. The plane simply couldn't keep in sight of the flags, and the Observer, bouncing from side to side, and occasionally standing on his head, invariably lost at least a part of the message. Since all messages were coded, this meant that to lose one letter lost the whole message. It was as bad as missing a step in the tango; you simply could not get it back.

Back in 1914 a certain Professor Donath of Berlin was struggling over a sort of aërial blinker, not unlike an automobile headlight, by which an Observer could flash signals in Morse to the ground. These signals were said to be visible for about four miles, but after they had once been tried out in action they were discarded in about four minutes. Both sides then hit upon the idea of message bags; and a French Pilot, Paul Fugairon, invented a metal cylinder in which a message could be placed and dropped. As it struck the ground its mechanism set off a flare of Bengal fire which called attention to it and made sure that it would be picked up. By the use of this scheme the Observer didn't have to land in order to make a report and he could be back at work in a very few minutes.

In the meantime, German ships called "range-checking" planes were trying to regulate artillery fire by dropping down to their batteries, now and then, little metal disks on which were scratched a few notes about the position of the Allied personnel and equipment which made good targets. They also set off smoke bombs directly over the target, or threw out handfuls of paper, or tinsel, which would gleam in the air and catch the attention of the batteries. The Allies were engaged in similar makeshifts, and at least they were better than nothing. The artillery, if it knew the altitude of the plane—and this was agreed upon in advance—could get the angle of sight, and then sit down with a cigarette and a manual of trigonometry and deduce within, say, an eighth of a mile, the location of the target. It is only necessary to add that unless a shell, no matter how big it is, falls within a very few rods of its objective, the men who are sitting on that objective won't even have to stop reading the morning newspaper. This meant, in turn, that if the airplane, whether by the carelessness of the Pilot or the inaccuracy of the altimeter, wasn't flying at the prearranged altitude when it went over the target and let off its smoke bombs, the artillery calculations might be as much as half a mile out of the way. If the liaison was perfect, however, some of this crude reglage was fairly satisfactory.

At Verdun and on the Somme the final inspirations came. Afterward there was no lack of communication between the airplanes and the ground. The infantry and the artillery signaled to the planes chiefly by *panneaux*, or ground panels, made of cloth, and arranged in different positions so as to deliver a message by code; and the airplane signaled to the infantry by Very pistols, Klaxon horns, or rockets, and to the artillery by radio. The ground panels stayed in sight and stayed still until the Observer had read them, so that all the previous trouble was obviated.

From the introduction of these methods of signaling, but more than ever when the aërial camera was brought into play, the Observer "spoke out even to commanding generals," and so will he continue to speak forever.

III

THE TRAINING OF THE AIRPLANE OBSERVER

IX

"THE Observer," said Captain Bachelier, who was attached to the French mission to America and knows perhaps more about observation than any living man, "must be volunteer—and a little bit crazy." This startling requirement means only that a man must have an overwhelming desire to fly, a beautiful willingness to fight, and a species of fatalism which will let him be as cool as a cucumber when the rest of the neighborhood is as hot as the hinges of by-and-by.

"The Observer," said Lieutenant Guye of the same mission, "must have a profound knowledge of military science, and an inexhaustible physical endurance."

"The requirements," said General Brancker, Director of Air Organization for Great Britain, "are the same as for horesmanship—good hands, a good head, steady nerves, and judgment."

"Good Observers," wrote a British authority, "are rather more rare than good Pilots, and it is remarkable that the Observer is much more conscious of strain than the Pilot. In all the war there is perhaps nothing quite so damaging to the nerves as the work of the Observer. A battle in the air is a less trying ordeal."

"For the Observer," said a captured official German document, "the chief essential is to see correctly. For this he requires natural aptitude, careful training, and constant practice. The Observer must have a good eye for country, must have a knowledge of the artillery's method of firing, as far as this affects aërial observation, and must be acquainted with the zones of dispersion of the different guns, the different kinds of ammunition, the possibilities of using them, and the time of flight of the projectiles. Further, he must possess a general tactical knowledge and must be able to form an opinion, based on sound judgment, as to the value of his reports to the higher command."

"The prime requisites for admission to a school of observation," said a bulletin from the War Department, "are good education, sound judgment, quick perception, quick action, and iron nerve." In addition, the flying officer must have normal vision in both eyes, correct color vision, normal hearing, positive equilibrium, perfect respiration and circulation, sound heart and lungs, a delicate sense of touch, and controlled emotions.

From these opinions, you may easily be prepared to know that the Observer, going into the air, is charged with attention over so many different items that he is somewhat comparable to the gentleman who plays the traps in a jazz orchestra. If his duty is routine, and not emergency, he should certainly be on the field a full half hour ahead of time, so as not to overlook any details of his equipment. It shouldn't be assumed that every Observer always carries the full outfit with him, for the paraphernalia depends on the type of mission which is to be performed. The list is inclusive.

In the first place, if the weather is cold the Observer has to determine between maneuverability and comfort. He can go up with electrically heated clothing,[1] helmet, hood, chin protector, and fleece-lined gauntlets, or he can freeze comfortably and have room to stir. There was a British Observer who once went up on emergency duty without so much as putting on a knitted sweater. He flew for two hours at 10,000 feet; and when he landed he thought that summer had come, for the temperature on the ground was about 35. In civil life he is doing very well with one artificial hand, and they say that if he continues to live in Bermuda he may keep the other one.

In any event, the Observer is probably standing upright—except on the take-off, when he makes things easier for the Pilot by getting his weight down—and he is getting all the wash of a propeller whose tip is going to travel, presently, at the rate of fifteen or so miles a minute. In many of the types of reconnaissance plane there is no place for him to sit. His heavy web safety belt is buckled fast; his feet rest on the almost paper-thin flooring of the fuselage; the walls of his cage are linen. On either side of his feet are control wires which he needn't bother to disturb unless he is tired of life. He has about as much radius of action as a large alligator in a small bathtub.

He has with him his two machine guns, which cost an appreciable effort to swing. He knows them better than he has probably known any piece of mechanism during his whole life. It was a very careless Observer who once was so heedless of his responsibilities that he failed to check up the work of a careless armorer. The armorer had forgotten to throw across the catch which holds the guns on their

[1] The ancient recipe beginning, "First catch your trout," is still good. The Observer can go up with electrically heated clothing—if he can get it.

pivot in the tourelle, so that the first dive threw them overboard. In American ships, the Observer carried 1,067 rounds of ammunition, and often it wasn't enough.

If he is to work on infantry liaison, he has his Very pistols, occasionally required for special signaling, and he mustn't make any mistake in the signals. A Very pistol is an ungainly contrivance, which looks as though a small boy had whittled it out of wood, and it fires stars like those from small rockets.

Whatever his mission may be, the Observer has his maps, which are priceless. Nor are they the flimsy commercial paper maps with which we are familiar, for the propeller wash is streaming past him at such a terrific rate that he needs maps either printed on linen, or pasted on linen, or on some substance which gives a firm backing, so as to be sure of having them at all after the first ten seconds and having them in condition to use.

He has his sketching outfit, which may be a couple of pencils or a rather elaborate set of crayons, depending on his duty and not on his artistic ability. Before aërial photography was popular, entire trench systems, every sap and angle of them, were sketched by Observers.

If he is on a photographic mission, he has his camera, using plates, and not films. Films are unsatisfactory. Plates are bulky and heavy, but they always worked out better than films. The plates are carried in 24-plate holders, of which there are usually at least three in the cockpit. Some one has said that if the airplane is the eye of the army, the camera is the retina.

Sometimes he has his field glasses, although there is little opportunity to use them.

He has his radio set. Our own sets would send 11 miles to another plane, and 47 miles to a ground station.[1] And for infantry and artillery missions he has a projector with which he can flash signals for short distances, if his radio resigns or if there are so many other ships in the sector that the use of radio is accompanied by confusion.

On certain types of missions he has caterpillar bombs[2] to drop on any chance target, and in this case he has both his bomb releases and his bomb sights to watch.

He has his rockets under the planes, to be released electrically. There are five principal rocket signals—one-star red, two-star red, two-star white, six-star white, and yellow smoke. These are for infantry work and are used instead of, or to supplement, the Very pistols.

He has his message containers—canvas, with long

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[1] The value of the American radio outfits is shown by the following German order:

"XIII. (Württemberg) Army corps, H. Q., Corps Headquarters, 5-6, 1918. Routine Order No. 30.

"1 (Ia) Captured aviation W. T. fittings.

"The enemy has found it possible to use wireless installations for undamped waves in his airplanes. So far few fittings of this type of apparatus have been captured by us, and in order to enable us to make use of this as soon as possible and also so as to save millions, which would have to be spent in experiments, it is everyone's duty to see that all W. T. fittings from captured airplanes are salved as completely as possible. Even the smallest pieces will be collected, as a tyro cannot recognize the value and importance of small parts to the expert.

"W. T. fittings which have been salved will be forwarded to the nearest aircraft unit, which is responsible that they are sent on immediately to the commander of aviation.

"In view of the importance of these fittings for our own wireless telegraphy, sums paid for salvage will be high."

[2] Aërial bombs are of three general types: one is designed to explode in tiny fragments which are effective against troops; one is for the demolition of heavy works or material; and the third is incendiary.

red streamers, to attract attention, or tins, which emit smoke when they land. These are also for infantry liaison, but they are used at any time when the Observer wants to get immediate and depictive information, or a written message, down to the ground.

In France each ship was also furnished with two gas masks (in case the ship landed near gas) and a first-aid packet.

This is a rather broad assortment of implements, but it contains no luxuries. The Observer was supposed, first of all, to enjoy continuous personal discomfort, and if he got any rest it came out of his pay. On practically no mission of any kind was the Observer free, from take-off to landing, to devote a single moment to calm, philosophical thought. He was like the owner of the country theater who volunteered to furnish "supers" for a transient production, and failed to get any recruits, so that he was forced to play the "supe" parts himself. He discovered that there were three of them—an Irishman, a Dutchman, and a policeman. The Irishman and the Dutchman got into a fight, and the policeman came in to arrest them. He spent a busy evening.

There was always the enemy's aircraft to look out for; there was usually Archie, and there was the unvarying rule that an Observer keeps both eyes open all the time, even when his own mission is accomplished and he is on the way home. There is always something to see or to try to see; there is almost always something to do or to try to do; and the Observer rarely knows at any moment what part of his kit of tools he will have to use next.

It is easy to see why the physical examinations were made so difficult. France, for example, fixed instru-

THE OBSERVER AND HIS ARMAMENT—A. E. F.

ments to register heart and lung reactions, and then suddenly gave the candidate a surprise, like a revolver shot close to his ear, or a bucket of ice water over his head, or a terrific glare of light. It wasn't enough for the man to remain outwardly calm; he had to remain inwardly calm also—or, at least "all symptoms of agitation should be at their maximum at the instant of disturbance." They put the candidate before a sort of pendulum, and told him to press an electric button as soon as he saw the pendulum move. If his reaction took more than nineteen one-hundredths of a second he was politely excused. They put him through a solid hour of pastimes like these, and only if he was absolutely perfect was he allowed to enter upon flying training.

X

The training of the American student, in spite of its brevity, was tremendously well done, considering that the majority of instructors were merely graduate students who had never had the slightest experience in actual warfare. They had been arbitrarily detailed to the duty, and their own disappointment was acute, because the detail meant that they would probably never get overseas. Aided by a few French and British officers, they instructed as well as they could, but they knew only theory, and they could teach only what they knew.

The complete course, as it was finally arranged, lasted about twenty-three weeks, and began with ground school instruction on general military matters, radio, machine guns, and the interpretation of aërial photographs. Satisfactory pupils were then shipped to a school of fire (the field artillery, at Fort Sill, Oklahoma, or the coast artillery, at Fort Monroe, Virginia) to learn how to co-operate with the artillery arm;[1] to Observers' school for six weeks, and finally to an aërial gunnery school for the final touches.

To take the Observers' course was to earn the privilege of playing with some of the most fascinating toys ever invented. Since the system used in America was practically the same as that in France and England a general description will serve to cover the whole subject.

Visualize, if you can, the forty-foot reproduction of a sector of the western front painted as a bird's-eye view on sturdy fabric and stretched flat on the floor of a large room. The sides of the room were filled with timbered spiderwork, surmounted, at the height of fifteen or twenty feet, by balconies on which the students sat to look down upon the panorama, as though they were looking down on the sector from an airplane at the height of perhaps 7,500 feet. The students were there to direct the imaginary fire of imaginary artillery upon an imaginary target. Forests, roads, fields, waterways, trenches, towns—every conceivable item of the terrain was depicted so as to make the game as realistic as possible.

Each student in the balcony had either a Morse key or buzzer, to represent the radio set in an airplane; and directly below him, at a desk, was another student with a sounder (unless the buzzer was used) and with a lot of tiny cardboard panels to represent the large cloth panels which the artillery sets out on the ground to identify itself, and to signal up to the Observer. By means of the radio and the panels, the Observer and his battery can carry on a pretty exhaustive con-

[1] At Langley, the student saw real guns fired not more than once or twice a week, and not more than a dozen shots at most. Artillery fire was simulated by puff targets.

versation, as long as they stick to military subjects; but there is no provision for chit-chat.

Field artillery identification panels, in service, are four meters square, and on them are fastened or painted one or more smaller black squares, in a distinctive design for each battery,[1] and these panels are laid out on the ground in plain sight, near the organization which they identify, so that the Observer can quickly pick out any particular unit. Heavy artillery identification panels are in the shape of diamonds, four meters to a side, with diamond insets in black. The little signal panels are four meters long and a meter wide; their position on the ground with respect to the large identification panel constitutes a code signal to the Observer. This is purely the French system, and every one, including Germany, borrowed it.

The instructors operated electric mechanisms, or hand devices, which caused tiny lights to flash briefly over or under various points on the bird's-eye view. These lights were make-believe shell bursts from the artillery,[2] and they were allowed to glow for only a second, so that the student had to be very alert, just as he would have to be in actual warfare, to spot a burst before the smoke of it had drifted away.

This toy is called a "miniature range."

Now you must remember that in the field the artillery almost never sees what it is shooting at. The Observer sends down by radio a series of symbols which describe a target on the firing map, and the

[1] Infantry organizations and Headquarters also have identification panels to help the Observer locate them.

[2] In England, on a miniature range built out of sand, a fascinating device which was operated pneumatically made a tiny area of sand puff up for an instant to represent a percussion burst.

artillery, having a duplicate map, lays its guns according to the description, and shoots away. The first shots are almost invariably wide of the mark, but the Observer sends back more and more information, correcting the range and deflection until the artillery has found its objective; and then he usually picks out something else for some other battery to shoot at.

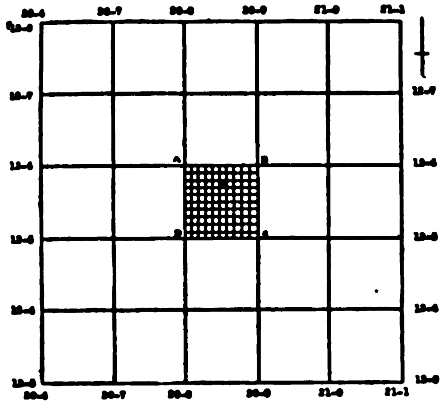
A firing map is marked off in squares, each side of which represents a kilometer, or five eighths of a mile, on the ground. This permits the Observer to describe the location of a target by co-ordinates[1]—*i.e.*, by describing the particular square, and the particular part of that square, in which the target lies. The cross lines on the map are numbered from the southwest corner, and the numbers run north and east. All the maps used in war are based on this principle, and all of the French maps were numbered from an extreme southwestern starting point taken arbitrarily at the beginning of the war. This meant that every single map, no matter how large or how small, fitted into the general topographical scheme, and that each map was co-ordinated in perfect harmony with all the others.

Take, for example, the accompanying sketch, and imagine that these are the lines ruled on a map—printed right over it. If you were given this map with the numerals 133 and 206 at the southwest corner of it, you would know that that corner was 133 kilometers north and 206 kilometers east of the original starting point for numbering these battle maps. The co-ordinates always remain the same, and any spot you described on this map could instantly be visualized

[1] There are several methods of describing a target, and some are simpler than this, but less interesting.

by anyone else who had a map of the same territory, whether his own map was on the same scale or not.

Suppose the Observer, flying over the lines, sees some enemy guns at the point marked X. He wants his artillery, which is ten miles behind him, and can't possibly see that point, to open fire on these enemy guns. He describes the big square ABCD by the co-ordinates of its southwest corner, D, and then, subdividing in his mind that big square into a hundred little squares, he describes the little square in which X is situated. These little squares are *not* shown on the firing map; there wouldn't be room for them, for they represent only a hundred and ten yards to a side. But the Observer can still let his artillery know just where those enemy guns are, within a hundred and ten yards, by doing the subdivision in his head.



Starting from the bottom of the page, the line which runs up to the southwest corner, D, of the big square is numbered 208. Then starting from that southwest corner D, and running east, the point X is in the sixth row of little imaginary squares. The "abscissa" of point X is therefore 208.6. But since the nearest north and south lines which have an 8 at the end of their numeral are 198 and 218, and each of them is ten kilometers, or more than six miles,

which this
confused if
are left off.
to fire at such
line 198 or 218.
upon. So that
to the artillery as
the abbreviation 86
and it also saves
sending the radio
chance of mistakes

corner D, and point
squares, going
"ordinate" of point
leaving off the first

the enemy guns at X,
that point as 86-58,
from its own map
he knows, incidentally,
and 125.8 kilometers
of the whole mapping

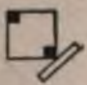
students sometimes had maps
with the miniature range, and
the range itself was ruled
and the students had to

on the miniature range and
so that the following ex-
will do very well as a permanent

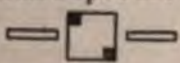
that the student Observer knows
field he will be helped by the

objective card, which has on it every bit of information ever gathered about this target), and that it is supposed to be an enemy battery firing upon our troops. He theoretically sees this enemy fire once or twice (or the instructor tells him where it is), he notes its position, and then calls up his artillery. Let us assume that the station call for a certain battery is C 3 X. (In the field, station calls always consisted of two letters and one figure.) He operates his Morse key, and the man below him responds by putting out panels, just as the artillery will put them out in an actual engagement.

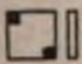
Observer: C 3 X C 3 X C 3 X C 3 X

Artillery:  ("Yes?"). The square identification panel, as already explained, is marked so as to show exactly what organization it belonged to. If the panel has *no* insets, it belongs to the divisional artillery post of command. The panel as illustrated would indicate the Sixth Field Artillery.

Observer: C 3 X C 3 X sn ("Your panel is understood." The battery always lets the panels stay in position until the Observer has seen and understood each signal). B T A ("Enemy battery in action"). 8658 (locating the battery on the map by co-ordinates). R E G ("I am in position to observe fire," or, "Shall I spot fire for you?").

Artillery:  ("Will adjust on objective you have reported").

Observer: C 3 X C 3 X sn 06 ("Is battery ready to fire?").

Artillery:  ("First battery is ready").

Observer: C 3 X C 3 X. *Fire!* (This, in the radio code, is a special character of three very long dashes.)

Artillery:  ("Battery has fired").

This might seem to be an unnecessary statement, but you will see later that the shell won't fall for several seconds, so that even if the Observer doesn't see the actual flash and smoke of the discharge, he will still have time to get into position to watch the burst.

The instructor now flashes lights for a second or two to indicate the bursting shells. The student watches these and notes whether they are too short or too far, or to one side or the other, and then he sends back his corrections.

Observer: C 3 X C 3 X. 025ii 055 ch ("25 meters to the right, 55 meters short").

Artillery:  and then  ("Correction made. Battery ready").

Observer: C 3 X C 3 X. *Fire!*

Artillery:  ("Battery has fired").

And so, with the Observer correcting and correcting until he has brought the battery squarely onto the target, he goes through a shoot which is a perfect example,[1] in miniature, of what he will later do in actual artillery adjustment with real guns firing at a "meat" enemy. Every conceivable situation is worked out, and every item of a vast code of signals is called into use. The Observer has to memorize

[1]The illustration is very much simplified. In practice, the Observer would also give the number which had been assigned to that particular objective on the firing maps, and he would specify the kind of fire he wanted, and he would repeat all these signals several times.

the entire code, both for the ground panels and for his own radio work, because he would never be allowed to take any part of it, on paper, over the lines with him; but as a matter of fact, his job is nearly half over, as far as the technical difficulties are concerned, when the first few shots have been fired.

Of the regular panel signals, there are about fifty in the artillery code. For radio, there are at least five "service signals" which the Observer has to memorize, eleven signals for reporting the actual fall of any one shell or salvo, and over forty two-number signals covering almost the entire field of gunnery endeavor from "C 7"("Has the battery fired?") to "95," ("Decrease the interval between shots of salvo by five seconds"). Next, there is a long list of miscellaneous three-letter signals, from A V I ("Hostile airplane") to R L V ("Have me relieved"). Is this all? Far from it. We now come to a list of some thirty miscellaneous ideas which have no permanent code equivalents, because they are left to the ingenuity of each army group to figure out for itself. The Staff will assign a code symbol to each idea, and perhaps change it in the next forty-eight hours. These intermittent orphans of thought include such messages as "Grenade combat taking place at" such and such a point; "Division command post at" such and such a point; "Friendly troops at," "Enemy barrage very dense at," "Hostile machine guns at," and so on.

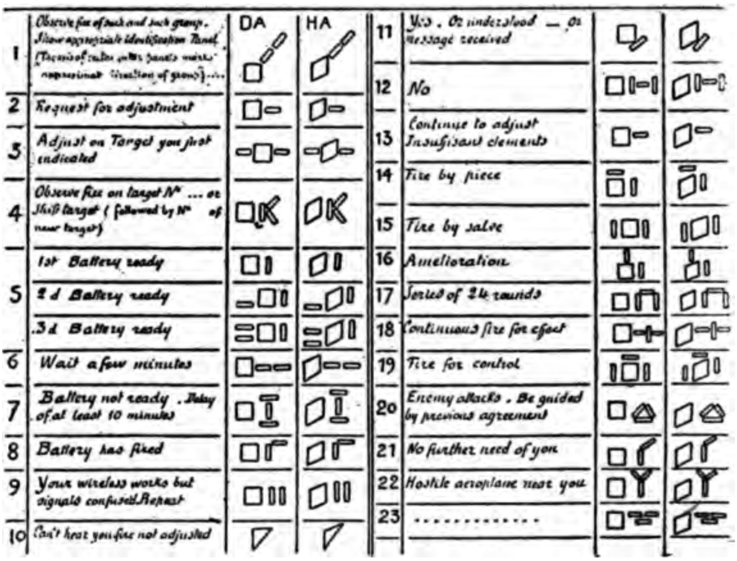
At the army balloon school at Lee Hall, Virginia, there was a beautifully contoured miniature range modeled out of native clay and painted to reproduce in proper tone and color every natural feature and every landmark in an active sector. The modeling was done from maps and photographs brought home by a Balloon Observer, and was so accurate that every

Signal Code

Execution	Repeat	Short	Target
Out	Fire	Over	Change target
Understood	Right	Deflection correct	Error
Unable to receive	Left	Range correct	Going to land

06	Is Battery ready?	23	Can't observe here	ART	Artillery	PRF	Depth
07	Has Battery fired?	24	Deflection irregular	AVI	Enemy Aeroplane	QUE	Tail at
08	Can't see Projectile	25	Will execute as requested	BAV	Anti-Aircraft Battery	RAS	Nothing to report
09	Aim on me	26	H. E. Shell	BTA	Battery in action	SUD	South of
11	Can't see Panels	27	Lost	BTO	Battery occupied	TAM	Friendly Troops
12	Auxiliary Target	28	Cease firing	CAV	Cavalry	TRA	Trenches
13	Supervising Fire	29	Result accomplished	COV	Convoy	TCF	Railway train
14	From the Right	31	Friendly shots falling on	DIR	Direction	REG	Adjust on
15		32	Continue the fire	EST	East from	RLV	Get relief for me
16		33	Too much distribution	FDF	Barbed wire	VRV	I am going to relieve
17		34	Shrapnel, time fire	FRO	Front	DRO	Right to
18	From the left	35	Zone Fire I cease observing	IFC	Infantry in column	GAU	Left to
19	How many guns fired?	36	Too much concentrated	IFD	Infantry deployed	IDI	Available aeroplane here
21	Observation impossible	37	By battery volleys	IFR	Infantry assembled	TET	Head at
22	Very irregular for range	38	With gas shells	NOR	North of		
		39	Repeat	OUS	West of		

With Panels



A VERY SMALL PERCENTAGE OF WHAT THE OBSERVER MEMORIZES last shell hole, every building, and every tree in the sector was in its place. Watercourses were fashioned out of glass, and trees were made of fragments of sponge, painted green, and set upon half-inch trunks.

The buildings were accurately scaled and stood an inch or two high, and wire entanglements were manufactured of the finest imaginable wire. The student Observers sat on bleachers at one end of the range, and the benches were so constructed that from the lowest row the Observer got a perspective as though his balloon were up a thousand feet; from the second step he got the effect of an elevation of two thousand feet, and so on to the topmost bench.

At Eberts Field, Lonoke, Arkansas, there was an ingenious system of teaching artillery co-operation by using stereopticon pictures instead of the miniature range.

"A squared map of Little Rock, Arkansas, and vicinity is taken as the range. It was possible to provide pictures of three different localities in the Little Rock area. Lantern slides were made of these pictures, which were taken from a plane at an altitude of 3,000 feet.

"When the picture is thrown on the screen it shows the area under fire even more clearly than it was possible to show on the original miniature range. The Observer has before him an exact reproduction of his target. The shots are fired by flashing a hand lamp held back of the screen, and this also provides the same effect as the flashing of lamps on the ranges used in ground schools. The ground strips (panels) are shown in front of a lamp at one side of, but off the screen. In short, the student starts out on his prearranged shoot and goes through the program with the same facility as on the built-up range, signaling and controlling fire by use of a loud-sounding buzzer on his desk. Every phase of artillery co-operation can be taught with this stereopticon system that is taught with an expensive miniature range.

"Another advantage of the stereopticon system is that the target and the range can be changed with much greater ease, requiring the mere shifting of a plate, whereas the change of paintings on the other miniature ranges was a matter of a day's work. The firing of shots by flashing hand lamps also makes the work faster and more fascinating for the student flyers."

But the Eastman camera gun is perhaps the most attractive plaything. This is somewhat of an improvement on the original British idea for practice in aërial marksmanship. The British gun was a single shooter, but the Eastman improvement was in the form of a small motion-picture camera attached directly to a Lewis machine gun in the Observer's cockpit of a training plane, aimed by aiming the gun itself, and operated by the same trigger. The Lewis gun, used normally, reloads itself by the recoil; but there isn't any recoil to a kodak, so that a spring had to be devised to "cock" the camera gun after each shot. On the film, there are either 47 or 97 exposures, just as in the drum of the machine gun there would be 47 or 97 cartridges.

Now the essential feature of a machine gun is that it keeps on firing as long as the trigger is depressed. So with the camera gun after the spring was installed; the gunner could fire one shot at a time, or a short burst of half a dozen exposures, or, by holding back steadily on the trigger, he could run off as many shots as he liked, even to the extent of the entire film. And since he would do this by precisely the same method that he would fire the actual machine gun—turning the gun on its Scarff mounting at any angle he desired, and swinging and aiming the actual gun itself—it was remarkably good practice.

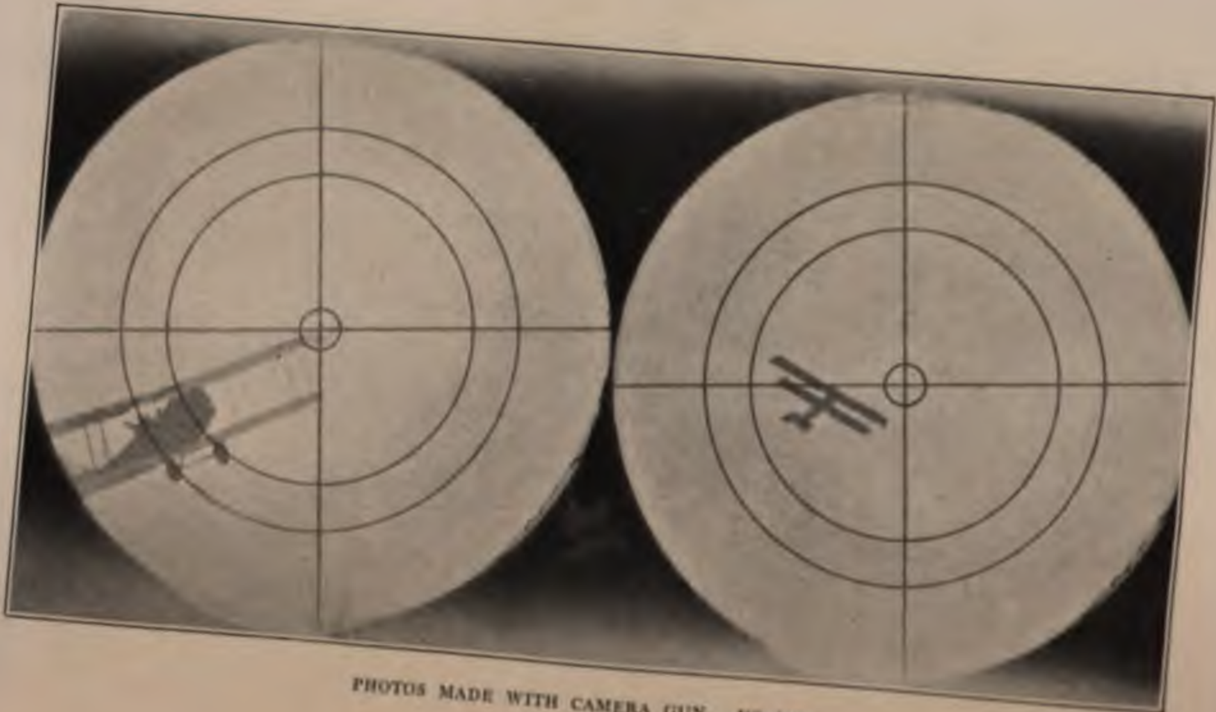
Each of the final prints is bisected by cross lines, and has two or three concentric circles on it, with the intersections of the cross lines as their center. These circles are placed in exactly the same relation to each other as the two ring sights of the gun. From the position of the "enemy" plane with regard to the lines and circles on the print—remembering always that the speed of the ships is so terrific that there is a distinct change in their relationship during the time of flight of a bullet or during the time of the fastest of snapshots; and remembering always that in determining the effect of a shot you would consider where the enemy *would* have been in another twentieth of a second—from all these things, it is a simple matter to determine whether or not the enemy would have been hit, and where he would have been hit, if the machine gun had fired bullets instead of taking pictures.

Few people realize what an accurate shot, or what a lucky shot, it takes to bring down an airplane. Take the dimensions, not of a pert little *chasse* plane, but of a good-sized two-seater built for reconnaissance—it will be somewhere in the neighborhood of twenty-six or twenty-seven feet long, with an upper wing span of perhaps forty feet. This looks like a pretty big target, but the fact remains that you can put dozens and dozens of bullet holes into it without doing more damage than can be repaired overnight. Bullet holes in the wings and fuselage mean little or nothing. Capt. Alan Bott, writing of one of his own first experiences, says: "The nearest Hun . . . was evidently unprepared, and . . . I raked his bus from stem to stern. I looked at him hopefully, for the range was very short, and I expected to see him drop . . . but he sailed on serenely. This is an annoying habit of enemy machines."

There are virtually only six ways to put an airplane out of commission by machine-gun fire. The most effective method is to shoot the Pilot, and this is the primary object in combat. The ship is twenty-seven feet long, or thereabouts, and the Pilot, seen sideways, takes up just about a foot and a half of that dimension. That means that to shoot wildly at an airplane is to leave the result to pure chance; and this explains why not one aërial skirmish in twenty ended in a casualty. Imagine yourself sitting in a railroad train going sixty miles an hour, and having another train pass you in the opposite direction, two tracks away, at the same rate of speed. There is one short blur of sound and that's all—and the average express train is twenty times as long as an airplane. Then imagine what luck you would have in trying to shoot one particular person in that other train. Then imagine the speed of the trains doubled. Then imagine them on different levels. Then imagine them traveling at different angles up or down into space. And if your imagination lasts this far you will have some idea of the number of bullets that every gunner wastes before he makes any sort of a good hit, even by sheer accident.

What it amounts to is that you have to hit, from your own highly uncertain station, a target about a foot square that is traveling at the rate of about forty yards a second, while you are going just as fast in a different direction.

The machine gun is sighted (and the camera gun with it) through two ring sights, and over a wind-



PHOTOS MADE WITH CAMERA GUN. NO HIT

[redacted]

vane sight whose "bead" varies with the direction and with the velocity of the wind. The idea is to aim so that the bullet will go, or, in camera-gun practice, so that the exposure will apparently be taken, just ahead of the Pilot. In warfare, the tracer bullets help the Observer to correct his aim, and a vast amount of shooting is done offhand, but the camera gun has to be sighted without this refinement of assistance. The Observer can only get the rings and the bead where he wants them, and let go, shooting enough ahead of the enemy Pilot to allow for the speed and direction of both planes. The object of the combat is to bring down the ship; the Pilot is the original target, but if you miss him there are still four chances of success.

The first of these fortuitous ways of downing a ship is to put an explosive or tracer bullet into the gas tank. These tanks are generally armored, or protected in one way or another—all but the tank of the DeHavilland 4—and they are invariably placed in front of the Pilot—except in the DeHavilland 4—so that, if the ship crashes, the Pilot won't get the full weight of it on his back. The right sort of bullet in the tank, however, will send the ship down in flames.

The other four ways are to crack the "prop" or one of the struts with a bullet; to cut a flying wire or a control wire; to shoot away part of the tail group, or the ailerons; or to cripple the engine. None of these achievements *necessarily* results, however, in anything more serious than forcing the Pilot to land. Often he remains in complete or part control of the machine, at least as far as making port is concerned.

In camera-gun fighting, therefore, it isn't considered an act of piety to bring back films which show that the enemy would have been hit in the fuselage, or anywhere else except the front end, where the Pilot sits, and so do the engine and the gas tank.

Two students, going up in different ships with camera guns and several extra magazines of film, can go through a mock battle in the air with all the ardor and skill they and their Pilots possess, and they can fight it out to a finish, too, although the result can't well be known until the films are developed and the split-second register (which is a photograph of a watch face made on the same film simultaneously with the "shot") is consulted. Unfortunately, this instrument was a late invention; the vast majority of our students were trained under conditions which made it impossible to tell which Observer had theoretically shot down the other first. But inasmuch as the machine guns themselves must be swung and sighted (it is no small trick, either, with the wind streaming past you so that you can almost lean against it as though it were a stone wall), and inasmuch as the ships are careening over the sky in all the dizzying maneuvers of combat, the camera-gun fight is quite as exhilarating as any normal student would like, and it puts a gloss on the efficiency of a man who is tired of shooting at tiny balloons towed by other planes, or at shadows in the water.

There isn't, in yachting, any sport more absorbing than, say, a three-hundred-mile problem in aërial navigation over unfamiliar country on a cloudy day. To estimate the prevailing winds, to plot the course on graph paper, allowing for the drift of the plane in the wind, and to hold to a compass course on every leg of the journey—changing the data on wind velocity every now and then, after brief occasional glimpses of the ground, where streamers of smoke and the appearance of the wind on water tell much to a trained intelligence, and changing the course accordingly—this is something to live for. There are few sensations more delightfully acute than that of arriving, just at dusk, at the point you were supposed to reach an hour sooner. And if the Observer realizes that often he may be called upon to travel over unknown country after dark, and if he learns of the incredible number of British Pilots who became casualties after losing their direction, he regards navigation as worth studying—also to live for. It will be no less important for him to be able to tell instantly, sometime when he is flying on a cloudy day, by just the briefest peep at the ground, whereabouts he is. Often, on reconnaissance duty, he will find the weather conditions execrable, but he will still be obliged to go ahead and perform as much of his mission as he can; and unless he is pretty well posted in navigation these occasional peeps of the ground will be of mighty little value to him. Even a good aviator, like a good woodsman, will get lost at times, but a good aviator, like a good woodsman, will find himself again when the novice would have to give up in despair.

To work out one's salvation at infantry contact patrol, with live troops underneath, appearing and disappearing just as they do in action, and with puffs of smoke suddenly springing up to mark the bursting of enemy shells—to make military maps from one's own photographs—to hunt for camouflaged guns and pin-point them on photographic negatives—to adjust make-believe artillery, not indoors, now, but out in a ship, through the medium of puff targets, which simply discharge smoke to indicate the simulated bursting of a shell—to adjust the fire of real guns, and see at last the shells bursting in direct hits as a result of one's own eye on the ground and one's own hand on the radio key—

It was sport than which—as the extremist puts it—there was none such.

Observation requires a good deal of imagination, and it is rather a wonder that every imaginative youth in the land didn't apply for admission to an Observers' school. It was the most absorbing, the most thoroughly interesting, and the most stimulating of any form of military education.

XI

There are only two kinds of markmanship, aërial and otherwise, and until a man has qualified as an aërial gunner he simply doesn't know what difficult shooting is. A crack trap shooter will average ninety-four or ninety-five clay pigeons out of a hundred during a whole season; a crack rifle shot will score possibles at thousand-yard ranges; a superb aërial gunner may possibly hit the bull's-eye—*i.e.*, the enemy Pilot—once in two or three or four or five thousand shots, and still be a superb marksman.

Take a very capable ground-trained machine gunner, put him for the first time in a cockpit with a Lewis gun, his own weapon, fly him at 120 miles an hour, and let him shoot at another ship flying equally fast in the opposite direction, at a different level, and at a different angle. Or even let him sit in the Empire State Express and fire at the lady on the Spearmint signs as he passes by them. His record of bull's-eyes will be just about .00001.

The American student began by learning his gun from the inside out, and from the outside back again, and he learned, among other useful tricks, to assemble it, blindfolded, in seventy seconds. It wasn't supposed that he would ever play ostrich and blindfold himself in the air, but he might have oil on his goggles, or a cinder in his eye, or, more likely, he might want to keep watching his enemy some time while he tinkered with a refractory gun. If he could pass this blindfold test, which no professional gunsmith ever had to, he was presumably competent to make minor repairs to the gun if anything went wrong in the air. Another of the curious little tricks he mastered, in connection with the gun, was to change magazines at his waist level, and to do it in about five seconds and in three motions. The speed and deftness of this trick is as important to the Observer as speed and deftness in getting the ball into play is important to a quarterback. One motion too many, taken by the quarterback, lets the opposing side get into its charge, break through and spoil the play; one motion too many taken by the Observer gives the enemy, likewise, a second's leeway—and in that second the enemy's gun can fire seven or eight shots. Furthermore, a drum of cartridges, if balanced on the hand where the propeller wash can get at it, will turn a man's wrist into a bunch of splintered bones in something less than half a twinkling. There is good form and bad form for this maneuver, and good form is to keep the drum at waist level. Bad form is to go to the hospital for surgical treatment.

The student spent fifty-two hours on the technique of the gun, and seventy-six hours in firing, including a lot of clay-pigeon shooting for variety, and the use of the camera gun. In the early courses students were put on a platform at a considerable height and allowed to shoot at clay pigeons with a machine gun. This was supposed to be good practice for the aërial gunner, but it was only a makeshift. With the introduction of the camera gun the simulated combat came into favor; but ordinary trap shooting was still encouraged and made a part of the regular course. It was good general training and good fun, it kept the students' eyes in constant focus, and the students never had to be urged to it. On the contrary, they had to be dragged away from it.

At Fairfield, Ohio, there was presently instituted an armorers' school for the instruction of the men whose duty it is to keep the machine guns in good condition. An observation squadron has, normally, fifteen of these armorers, but a good Observer begins where the armorer leaves off, just as a good Pilot begins where the mechanics leave off.

There was one British squadron which fired 70,000 rounds in the air with only two jams; and this record is just about four hundred times as good as any ordinary squadron achieved. But in this case, each Observer tested every cartridge he intended to take up into the air with him; he calibrated them, and examined them for split cases, rims too thick or too thin, length, and deep-set or protruding caps; he took out the hammers of his guns and passed every single shell through the breech. He lined up his sights, tried the trigger action, and made sure that the spring had exactly the right tension. But this thoroughness was an outstanding exception. The recipe is sound, but it presupposes British patience. Machine guns, especially the belt-fed type, are invariably eager to jam if they can, and a jam which happens during the course of a lively fight is a fairly serious matter, because the gunner is absolutely helpless until he has cleared it. Still, the majority of the Observers left the responsibility to the armorer.

The aërial gunnery schools at Ellington, Selfridge, Taliaferro, and Rockwell fields graduated 2,295 men; the majority of these, of course, were Pilots. Pilots and Observers got the same instruction.

Up to the end of the war, the Hun had a marked advantage in aërial gunnery, due to the greater average number of shots he could fire without reloading. That is, he could fire so steadily that he was very effective even if he weren't a good shot. The German Parabellum, which was the most remarkable gun in this respect, could fire an even thousand rounds before it had to be reloaded.

The two best Allied guns were the Lewis and the Vickers. The famous Lewis machine gun, which weighs less than twenty pounds without the water jacket (the Lewis was designed to be water-cooled, but high altitude experience proved that the difficulty is not in cooling the gun, but to keep it from freezing), is a magazine-fed gun, and after forty-seven or ninety-seven shots, depending on the size of the drum, the empty magazine has to be removed and a fresh one substituted. Still, this is a very light and hard-hitting weapon, and a good part of its efficiency is due to its very lightness. The Observer, swinging a machine gun around the compass, and having no very stable foundation of balance, is working against such a terrific pressure of wind that a few pounds more or less weight in the gun makes a vast difference to him. There are moments when centrifugal force gets hold of him, and he couldn't exert power enough to turn a door knob to save his life. The less weight to the gun the better.

The Vickers is fed from a belt of 500 cartridges, and is therefore much more liable to jam whenever it is used where the wind can get at the belt. Both

France and Britain, however, mounted the Vickers up forward as a fixed gun, to be operated by the Pilot, and thereby got the advantage of a big cartridge capacity without the danger of excessive jamming. American ships had a fixed Marlin gun for the Pilot, and two flexible Lewis guns for the Observer. German Pilots used a fixed Maxim, and a movable Parabellum; sometimes a Wirst, which had a capacity of 250 shots without reloading. Italy had a Fiat gun, and this and the Maxim were both on the order of the Vickers.

Both the Lewis and Vickers had a slight margin of speed over other guns, and could fire at the rate of about nine shots per second. Their ammunition was practically the same—.30 and .303 caliber, respectively. This ammunition consisted partly of steel-nosed armor-piercing bullets, partly of tracer bullets whose phosphorescent cone of fire told the gunner whether his aim were good (and tracer bullets, spitting and crackling, could kill a man as expeditiously as any other kind), and partly of explosive bullets—in which last type the Hun was a distinguished specialist. Then sometimes they used just plain lead. Each Observer chose his ammunition to suit himself, and prescribed the proportions he wanted. And there were as many different prescriptions as there are for cocktails or salad dressing. The only general practice was to have about each fifth bullet a tracer bullet, for with that arrangement the gunner could always have a fiery pathway in the air to use in correcting his aim.

XII

Examples of school problems in reconnaissance may perhaps be pertinent, because they furnish a very good idea of what sort of details the Observer may be sent to look for in the field. At the Observers' School at Langley Field, Virginia, there were sixty-three of these problems to be solved during the course, and each one of them was based upon a fundamental condition which might very easily appear in actual warfare.

1. The enemy has been shelling Norfolk from the coast north of Old Point. His only means of observation has been a balloon located north of his batteries. Observer's orders: Sketch and report on the balloon field, co-ordinates, activities, buildings, transportation facilities, cover adjacent, etc. Is it protected by antiaircraft batteries?

2. The enemy is using the railroad yards of Hampton to load and unload supplies. Observer's orders: Report on depot; size, character and number of warehouses, side tracks, switching facilities, and anything else of military value. Sketch the problem.

3. The enemy has a battery of three large guns which has been causing us great trouble. Observer's orders: Locate and sketch them and report on the kinds of guns they contain, tents, buildings, facilities for moving munitions, and anything else of military value. Photo six overlaps for mosaics of the following: pin-point battery and flying northwardly so as to get all the batteries along the coast.

4. There are a number of reservoirs about twelve or fifteen miles northwest of this field. Observer's orders: Report on and make a sketch to accompany reports. From what source does the water seem to come? Is the watershed large or small? Are the reservoirs protected by troops? Is there a pumping station near? Report on all roads and other lines of communication in the vicinity. Photo six overlaps

for mosaics of the following: 1. Pin-point where C. & O. Railroad crosses the railroad at southernmost field, and fly in a northwestern direction along the southern line of the reservoirs, including as many of them as possible on mosaic.

5. Our army is camped near Richmond and nothing is known of the country between our camp and Old Point Comfort, except that there is an aviation camp near. Observer's orders: Sketch this field, showing on this sketch topography concerning same. Report anything that to your mind would be of interest to commander of troops.

IV

AËRIAL OBSERVATION

A.—*General*

XIII

BEFORE going farther we had better fix in mind what we mean by "lines" and "positions," because we are often going to come across these expressions. In the modern trench system there are four positions —fire position (or, in the British idea, the observation position); cover position (about 25 to 50 meters behind the fire position); support (about 150 to 300 meters behind the cover trenches); and reserve (800 to 1,200 meters behind that).[1] Each of these positions is made up of from two to five intercommunicating lines of trenches; and between the consecutive positions there is a sort of halfway position not put there for a permanent station of defense, but merely for the purpose of offering a military rest-room, and giving the men from the fire trenches a chance to retreat, in case they need to, to the cover trenches. The expression "front line," used as the great majority of newspapers used it, generally meant the first of the three or four rows of *fire trenches*. The "second line" has similarly been the name applied by laymen to the second line of fire trenches, and not to the second

[1] In the "Hindenburg Line" the distance between lines varied from 150 to 300 yards, but this was unusual; and it was a two-line position for the most part.

position. But this is not the correct military terminology and leads to a lot of confusion. If you mean "lines" you ought to say "lines," and if you mean "positions" you ought to say "positions."

The arrangement of positions in the modern trench system was worked out to prevent the enemy artillery from firing at more than one position without readjusting his guns. Ordinarily, only a small fraction of the active force—say a quarter of it—is supposed to be in the first three lines. The rest of the defenders are taking life easy, but are ready to dash to their posts of combat as soon as they are needed. On the German side, the strongest trenches were farthest from the front—the enemy found increasingly greater resistance if he tried to advance.

The popular fancy seems to be that trench warfare began spontaneously, and that when the opposing armies deadlocked they simply dug in where they happened to be, each unit digging a trench to suit itself and then tying them together at the ends. This is not quite correct. There is as much science in the construction of a good trench system as there is in any other engineering work, and perhaps more so. The systems were laid out by the engineers, and then everybody dug.

One of the vital points always to be considered in building a first-class trench system is the location of good observation and listening posts. A trench in itself isn't very much of a stronghold; its strength lies in the weapons that are in it; so that the prime requirements are strategic rather than tactical. Another factor is the presence of shell holes, embankments, gullies, culverts, stone, wood, and all sorts of natural features which make the job of construction any easier. You want to snatch at any of these features and incorporate them in your works. The location of towns or railroads or waterways is fundamentally a part of the problem, because they are either very easy to defend or very hard, and it makes a great difference how much you intend to cherish them. The first thing to do is to get a general idea of where the line is going to be and put a sketch down on paper, and then shift the plans around so as to take in all the principal points of interest and use all the natural advantages. The lay of the land is mightily important. You can't see uphill as well as you can see downhill, nor can you attack uphill as well, so that it is a good thing to have your trench system arranged on a reverse slope if you can. But you can't always do it, and sometimes you have to build your trenches as much as a half mile farther back than you would like them, so as to avoid the certainty of very clever sniping from the other side.

In laying out the lines, you also have to consider what are the best places for guns, which must not be either too close to you or too far back, and what places are inherently weak, and what places have got to be most carefully protected; and you juggle your lines accordingly, always remembering that gas has a bad habit of sitting down in depressions, and sticking close to trees and bushes. You don't want to get your troops into a series of sink holes.

Finally, you have to determine which of several styles of trench you are going to dig. The rectangular scheme wastes material; the semicircular design makes easy walking in the trench, but the walls are perpetually caving in; the 135-degree type is the best all-around trench and is the type with which the world is most familiar. In any event, trenches are always narrow and deep; for shallow ones are worse than useless, and wide ones give too much latitude to enemy shrapnel in addition to wasting energy in shovel practice.

Trenches are built on the ratio of 20 per cent shovel and 80 per cent brain, and after they are built the infantry spends about ten hours in repairing them for every ten minutes of actual fighting. The idea is to plan the defense so that here and there the enemy, if he attacks, is bound to come to some place where the defense is so strong that he will be stopped for a little while, and while he is stopped he is enfiladed. This usually means that you have placed machine guns to bear on these places and that the guns will take the enemy on his flank, which is both inconvenient and dangerous for him, and while he is thus annoyed your reinforcements are coming up.

The estimate of the Royal Engineers for the material to intrench one mile of front, including the first and second lines and communicating trenches, include 900 miles of barbed wire, 12,000 six-foot standards for wire, 12,000 small pickets for wire, 6,250,000 sand bags, 36,000 feet of corrugated iron, 1,125,000 feet of timber, averaging 3 by 3 inches, and a miscellaneous lot of material which would require the services of the bookkeeper of a bargain basement to prepare a detailed account.

B.—*Infantry Contact Patrol*

XIV

Probably the least complicated of all forms of aërial observation, as well as the least frequent, because it is employed only in formal attack or defense, and the most dangerous because of its character, is what is known as infantry contact patrol. This, in brief, consists of watching the infantry in action and reporting upon its progress, both with relation to the troops at the actual battle front, and to the columns [1] of reinforcement moving up to it. From the moment that the main action begins the infantry is sure to be lost in the smoke, so that the airplane is the only means of communication between the troops and the rear; it is to all intents and purposes an aërial observation post for the benefit of higher command. It reports back to Headquarters on the status of the troops, and it delivers to the troops any information or warnings which may be necessary. It is the hyphen which joins together the infantry and the artillery.

Infantry, having set out to attack, first passes through the enemy defenses which have been hammered down by the earlier gunfire, and then goes forward, halting every now and then, on schedule, to re-form, and to let the "moppers-up" scout over the captured territory and collect Fritzes. This checkmated the early German trick of permitting large numbers of troops to hide in dugouts until the first wave had passed over them, and then bob out to take the attackers from the rear. At a definite time, or signal, the infantry goes on again, still with the guns protecting it (an impossibility, of course, without airplane observation), until presently, exhausted, it falls into the next trenches, and the reserves, who have been following along to clinch a success or beat off a counterattack, then come right through and continue

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[1] Reinforcements march generally in small columns, arranged in a sort of checker-board pattern, so that no single shell or shrapnel burst can touch two of these little units at the same time. That is, each column is at least 150 yards away from the nearest columns to its front and rear, and perhaps 50 yards from the columns on its left and right.

the drive. You must never make the mistake of supposing that one group of infantrymen is weak or cowardly if it falls by the wayside and lets another body push through, because this is not the fact. From the instant that the advance begins, even if it is a successful attack, the infantry suffers both by loss of men and by loss of morale. These losses are slow, steady, and persistent. As the *Journal des Sciences Militaires* has it, "an engaged unit has an absolutely limited offensive capacity, and inevitably there arises a moment when it is incapable of advancing farther."

Sometimes the "leap-frog" system of attack is used; and this means simply that the first troops take one objective, and then deliberately stay where they are, and put the captured trench in order, while other troops go on to the second objective, after which the first troops or the third troops can push on still farther.

Now, the experience of the French has proved that the best Observer is an artillery officer, or at least an officer who has had considerable artillery training; and the experience of the British, and of ourselves, has demonstrated that you can't send up an inexperienced officer, and simply by giving him the title of Observer make him one. There is hardly any expression in the English language more trite than "the psychological moment," but that moment is, nevertheless, the turning point of battle. Nobody knows the cause of it; nobody knows the precise clock-beat on which to expect it; nobody knows whether it will favor one side or the other. At one instant it doesn't exist; at the next instant it does exist; and in another instant it may have disappeared again. It is simply that point of time at which somebody is off his balance, mentally or physically. The touch of a finger will knock him down. Let him recover his poise, however, and again he will offer resistance even to a bludgeon.

The Observer who brings back the proper information in time for that moment to be capitalized is a good Observer; and the Observer who best understands the art of war is naturally able to furnish the most reliable reports. Any Observer who can independently analyze any given situation from the artilleryman's viewpoint is of paramount value, and it never does to cry, "Wolf!"

In so little an incident as this:

Down below, the world was slate gray, dotted with scars of flame which blinked out and came again, incessantly, in a jagged line. Small areas of solid earth dissolved, disintegrated, and fled skyward in shapeless bulbs of brown and gray. Behind that creeping barrage an infantry battalion was going forward. On the ground behind it lay a row of white panels in groups, each of which consisted of a triangle and two thin rectangles. These signal panels, eighteen inches square, are carried by every squad of infantrymen, so that no group, however small, is without the power to make its location known. In important situations, rows of panels are spread out over the whole front, marking the line. Their relative position in this case shrieked aloud to the Observer a message that the barrage was short—that it must be lengthened—that it was blotting out the very men it was supposed to protect. And the infantry is never supposed voluntarily to disclose its position unless it is held up, or cut off, or unless the barrage is dangerously short.

The Observer happened to be a former artillery officer. And he ignored the panels. For the guns can't be absolutely perfect and the charges do vary slightly, and now and then a shell or two drops far behind the others. To lengthen the barrage would render it nugatory; would take away the greater protection. And an Observer who was impatient of artillery and had seen those one or two shells wipe out a fraction of the advance might forget the French philosophy: "The infantry keep close to the creeping barrage, which they see and from which they receive a few fragments, causing a few casualties; these casualties are very small compared with those the hostile fire would inflict if our barrage did not prevent it, and the infantry submits to it as the very condition of success."

So that even in so small a thing as this, the infantry feels safer with an artilleryman overhead.

Now the Observer is supposed to know at all times where his troops are, but even if he flies as low as four or five hundred feet, which he does very often, it is quite possible that weather conditions will prevent him from being absolutely sure of the positions in question. He therefore asks his troops, by a six-star rocket from a Very pistol (the British I. C. P. ships carried Klaxon horns to ask this question), "Where are you?" and the front-line troops, recognizing the ship by the distinctive cloth streamers attached to it, are supposed to respond either by panels or by flares, generally in the shape of torches made of oil-soaked rags, whose flame can be seen through any sort of smoke. They are supposed to indicate the line in this manner, and they realize the importance of it, but inexperienced troops hate to do it, just the same, because they feel that it also gives free information to any enemy planes which may happen to be hanging around that neighborhood. But the Observer has

INFANTRY CONTACT PATROL. NOTE METHOD BY WHICH INFANTRY IS DEFINING THE LINE OF ADVANCE

simply got to get the information, and if he can't get it any other way (and during a really big engagement there is not much time to set out ground panels), he flies low enough to tell his troops by their complexions. In open warfare, especially, it is mighty hard to keep in touch with your own troops. One British squadron, in 1917, had to perform ninety-six I. C. P.'s within a week.[1]

When we speak of "waves" of troops, the layman may perhaps get a picture of units advancing in a more or less regular formation in echelon, keeping some decent semblance of a connected line. In reality they are "waves" only because they start one after the other; they generally finish like a pile of leaves blown by the wind. A few units in the extreme front may be half a mile ahead of the units in the extreme rear; they are all over the lot; some are stopped almost at once, others find no more resistance than a

[1] "The infantry airplanes (contact patrol machines) should appear a few minutes after the commencement of the assault; they should follow the forward movement of the infantry, report any interruptions of its methodical progress, especially noting strong points which remain uncaptured and require a renewed artillery preparation and call for identification of the front line as soon as the objective is reached. Premature demands for contact patrol signals are always unsuccessful and make the infantry uneasy; time must be given it to settle in the new positions and overcome the resistance of small hostile detachments. When an infantry airplane has observed that the objective ordered has not been reached, it should report at once by wireless the points attained. Doubtful points must be reported as such, and subsequently cleared up by further reconnaissance. To supplement reports, sketches should subsequently be made and dropped.

"In the case of an attack with distant objectives the front lines must be fixed in the course of the attack during the periods laid down for barrage halts. In no circumstances, however, should the attack be checked for this purpose. Besides following the advance, the infantry airplanes must watch the general activity of the enemy, in order to report counter-attacks, and the assembly and the pushing forward of reserves and to ask for artillery fire at the proper time." (*German secret manual for Air Service.*)

piece of burlap would offer to a needle. When the bulk of the attack is stopped the consolidation of units is a matter of stupendous importance. Some may not even dare to remain in the positions they have gained; they may not have any support. A "wave" is purely a figure of speech, and after the first few minutes it is remarkably inappropriate.

The manual says, "Try to follow the battle—get interested in it," but this seems a bit unnecessary. The Observer is near enough to the ground to get hit by anything from a high explosive shell to a brickbat. He is in the way of thousands of shells from both sides, and there are thousands of rifle and machine-gun bullets zipping around him. He can't hear himself think. He is sitting right on top of the battle, and everybody sees him. If he isn't actively interested he must at least be temporarily diverted. It certainly is not a rest cure.

Sometimes, instead of signaling to him by panels or by flares, his infantry will use one of the various shutter devices, of which the most common is a sort of window blind with all the slats painted white on one side and black on the other. A string is fastened to the slats, so that the operator can make them all turn over at once and thereby make the shutters show solid white or solid black, at will. With this suburban sort of contraption the infantry can send brief messages in code, some of them to be passed on by the Observer to higher command.

The ordinary ground panels, already explained, are very simple for infantry. The identification panel for a battalion is a triangle, for a regiment a half circle, and for a brigade or division a whole circle. There are practically only eleven messages which the infantry will ever need to send to an Observer—"Message understood," "We're ready to attack," "We will not be ready to attack at time set," "Request barrage fire," "Request fire to prepare for attack," "We want to advance; increase the range," "Our field artillery is firing on us," "Our heavy artillery is firing on us," "Send us cartridges," "Send us grenades," and "Objective attained." One battalion of American troops, recruited from the East Side of New York, suggested a twelfth message, "Did the Giants win?"

The Observer gets his information, marks a map to show the position of the troops, dodges his barrage, and perhaps with a preliminary report in radio (although on the offensive this is too rare to be considered as a normal requirement), drops the map and a few words of longhand comment in a message bag at Headquarters. When it is acknowledged—by panels—he goes back on the job. Practically the only circumstances in which the Observer needs to use his radio is in case he sees a counterattack in preparation or on the move.

The artillery barrage is regulated by the messages and maps of the Observer. He may not dare to make a mistake, because a mistake might result in the planting of the barrage squarely among his own friends. His friends, as we have seen, are spread out all over the map like the points of a broken comb. Nor, as we have seen, can he trust entirely to the signals he gets from the infantry. It is quite possible that flares might even be lighted by troops which imagine that they are the front line and really aren't. The Observer has to see correctly and use perfect judgment. This is why the job is not one for a young and inexperienced man, no matter how eager and how courageous, but for a sane, balanced, highly skilled officer with military brains in his head and the sang-froid of a Lucifer in his veins.

Infantry contact patrol is the most dangerous of all aërial work and calls for wonderful teamwork between the Pilot and the Observer. Low flying is risky enough, even in peace time. Add to it the barrage from both sides (and a ship under four thousand feet is right in the trajectory of its own big guns), the enemy fire from the ground, and the menace of enemy airplanes, and it becomes a task for a cast-iron volunteer; a man who is absolutely sure of himself and one who can orient himself a half dozen times a minute if necessary.

But can you imagine what would happen to two great armies, or two great nations, at war, if one side had plenty of trained Observers and the other didn't?

As we have already noted, I. C. P. was developed by France, and although the British made progress with it at the Somme in the early summer of 1916, France continued to improve the system, and before the end of the year had brought it to comparative perfection. It was here that Ludendorff began to waver in his confidence, and, as he has admitted in his memoirs, he never recovered his original certainty of success. French aviation had disturbed his equilibrium.

> The way this new device has worked is simply marvelous [wrote Captain Millet from Paris to the London *Observer*]. It is mainly to this scientific system that the troops owe the fact that they have been able to advance under a curtain of shells which moved continuously ahead of them. . . . Everyone acquainted with trench warfare knows what the root difficulty was before the present advance. It had been quite rightly assumed that the attacking troops must only advance under a

protective curtain of shells. On the other hand, as all the wires are cut as soon as a battle begins, one did not see how to make sure that the moving curtain of shells would precede the attacking infantry without going too fast or—which was a more ominous danger—too slow. The difficulty seemed so insuperable that some of the best artillery officers suggested that the only way out was to time exactly beforehand the movements of the attacking troops with the lengthening of the range. Any advance under such a system would have had to proceed according to a sort of railway time-table.

But France invented I. C. P.; and at Verdun, on the 24th of October and 15th of December, 1916, after good artillery preparation, the barrage was so regulated by observation that the German artillery was vastly hampered and the German infantry was sadly demoralized. Thereafter, all armies followed suit and infantry liaison became an integral part of routine observation.

A letter written home by one young Observer has in it a good deal of sound comment on I. C. P.

Infantry liaison is contact between the advancing infantry and the supporting artillery and Headquarters. This kind of work does not happen very often, fortunately for us, as the mortality rate is very high indeed. It happens only when an assault is being undertaken, and it calls for the most experienced Observers and the most skilled Pilots. It is often necessary to fly very low, so low that the enemy *chasse* planes make no attempt to bother the ships, depending on their machine guns on the ground to bring them down. These planes are the means of communication for the advancing infantry, which is sometimes so isolated as to have no other method of sending back word to the artillery in the rear and to Headquarters. They also keep Headquarters informed of any new and unexpected developments.

This class of flying in clear weather is very interesting indeed, as one can see the whole battle being waged below. In foggy weather or rain it is just plain hell. It is then the most nerve-straining of all flying. Aĕrial observation is very complicated, and in a group can be found many specialists, so that the commanding officer must be a flying encyclopedia. He must be a man of open mind, with an intimate knowledge of all phases of the work, but first of all he must be a Pilot and he must be able and willing to go out and fly any mission that comes under that class of work. One of the best commanders on the western front says, "I never send a Pilot on a mission that I am not willing to undertake myself." Naturally, he never has to ask for volunteers for a perilous mission, for every man in his outfit is always a volunteer.

XV

The mention of antiaircraft batteries brings up afresh the subject of "Archie," and this is as good a time as any to speak of him; and also to smile, without prejudice, at a statement made by Wilbur Wright to a reporter from the Kansas City *Star* in 1909, when the Wrights had just returned from their English invasion.

"How high can you go?" asked the reporter.

"As high as I want to," said Wright, "but there will never be any need to go higher than a thousand feet. At that height no known gun could reach you."

And in modern warfare, a man flying below 4,000 feet is liable not so much to be hit by A. A. as by a barrage.

The name itself is said (in an article in *Popular Mechanics*) to have originated from the character of the bad boy Archibald in the comedy of "Mamma's Boy," produced in London in 1915.[1] The mother of this character constantly had to reproach him, and her reproach was always good for a laugh. A little later, when the Germans were first trying out the antiaircraft guns and not doing very well with them,

[1] *Flight* for October 30, 1914, has however, this paragraph: "The 'Archibald' is . . . uncomfortable. The aviator has thus christened the small shell fired by the antiaircraft guns of the enemy."

an officer on the ground regarded a peculiarly ineffectual shot, and exclaimed: "Now, Archibald!" It was the catch line of the comedy and it stuck. And presently it ceased to be funny.

At the outbreak of the war it was generally supposed that reconnaissance height was about 4,000 feet, which seemed to provide enough protection from ground fire. As a matter of fact, 4,000 feet was quite safe enough until Archie was born. The first Archies (and the Hun was using them in September, 1914) were 7.5's mounted on motor trucks, and at 3,000 feet a Pilot was entitled to feel contemptuous. The next improvement brought shrapnel, which, however, hadn't much value above 2,500 meters—and, as one historian wrote even in 1916, was practically "disregardable" as a means of defense—but presently it gained altitude and began to cause trouble. The simile of snowballing butterflies went out of vogue. A shrapnel shell bursting within a few dozen meters of a plane—and in the air the burst sounded more like a horrible clash of cymbals than a normal, workmanlike explosion—would make a sieve out of it, and in addition knock it about most perilously, as though a healthy cyclone had taken a passing fling at it. As one British flyer wrote (Starward): "I've been in plenty of bad weather at sea, and it's worse than anything I ever suffered in a boat. It makes me downright sick, just like a bad attack of seasickness." And shrapnel was then generally fired in bursts of from four to eight shells simultaneously, after a couple of range-finding shots. One of the 1916 Krupp 104-mm. guns could fire 15 shells a minute, and each shell burst into 625 fragments, with a range as high as 13,000 feet. A burst directly under a plane would toss it like a leaf in a whirlwind.

Furthermore, new inventions were coming rapidly into use, and each was a trifle more obnoxious than the last. One was a gas shell which was rarely harmful in itself, but put up a small, dense, colored cloud for several minutes, and permitted very accurate range-finding, as the shots were timed at fixed variations of a few hundred feet. Another was the German "flaming onion," which consisted of bulbs of chemical compound, which exploded, or ignited, at a high level in short rectangles of compressed flame, "sizzling and sputtering," as one man put it, "like so many little bits of hell." Originally these were fired several at a time from a fixed gun aimed to cover a definite air area; and as they exploded they scattered fire in a wide circle. Naturally, if one of them grazed a plane, no matter how delicately, casualties were promptly indicated. But later the Hun took to stringing the onions on a wire, and this gave the Pilots the task not only of dodging the onions themselves, which they could see, but also of dodging the wire, which, of course, they couldn't see at all. If any part of the plane touched a wire, the onions were neatly folded around the ship and there was nothing to do but repent.

Germany also tested out a poison-gas shell, but without success.

The *Journal of the Royal Artillery* gives proper credit for our own Archie effectiveness by stating that "the French antiaircraft service possesses apparatus and methods which are being copied by all the countries of the Entente."

There are three main points of cheerfulness about the modern Archie, which is good for 5,000 to 6,000 meters. One of them is that his bark, which sounds like that of a large, coarse dog with a chest cold, is harmless, and that any good Pilot can easily counteract the sudden loss of control of his ship when the bursts come close. The second is that Archie has to sight by trigonometry and try to outguess a very fast-moving object. If he is firing a shell which travels 2,000 feet per second, any respectable plane flying at 15,000 feet will travel more than half a mile during the time of flight of the projectile. The third is that he can't overcome clouds; he loses much of his viciousness in bad weather, but when a day is clear, save for a background of light clouds at, say, 25,000 feet, so that a plane is silhouetted against it, his aim is at its best. Of course, there is comparatively little chance of actually hitting a ship, anyway—that is, the hits are few in number compared with the enormous quantity of ammunition wasted. The idea is merely to annoy the Pilot as much as possible and to prevent him from flying in a straight line—and whatever annoys the Pilot also annoys the Observer. Archie is to hinder rather than to stay. Direct hits are almost unknown, but when a single gun will fire 10 shots a minute, the danger from fragments is acute.

New, young Observers find Archie a gentleman of rude and uninterrupted habits, and there are many instances of precipitate retreat, or wild calls for artillery aid, when Mamma's Boy begins to misbehave himself. There was an English code radio signal, "LL" which called for every gun of every caliber within range to concentrate on a given spot for several minutes. It was intended to be kept for rare occasions,[1] such as the unexpected massing of German

[1] The American "LL" was limited to use against columns of troops, or transports, over half a mile in length; infantry in mass, not less than a battalion; artillery limbered up, or transports parked, strength not less than forty vehicles.

infantry, when the diversion of all these guns from their previous objectives would be well worth while. But the youthful Observer who had just been rocked out of his senses by a burst a few meters distant, and who saw bulbous cloudlets of black and white smoke drifting around him, and heard the banging and yelping of innumerable shrapnel shells, some of which sent bullets through the fuselage—this young man was abruptly minded that linen and plywood are thin protection, and he generally clutched his radio key and sent back hasty co-ordinates and "LL." Afterward, when he had explained why he ordered the expenditure of many, many thousand dollars, and when his superiors learned that despite the efficiency of the artillery they hadn't destroyed any Crown Princes or ruined a surprise attack, they said things.

Nor did they follow the ready-made analogy and reproach that Observer with merely a "Now, Archibald!"

Antiaircraft machine guns are usually found very close behind the troops, with the antiaircraft *artillery* just back of that. One of the common tricks of the trade is for one or two planes to decoy a larger force of the enemy over the A. A. batteries at a previously arranged height, so that the guns can make that particular part of the heavens all angry with shrapnel.

France had the best antiaircraft guns, and the best trained personnel, but their official records aren't available. The British, however, from January 1 to November 11, 1918, inclusive, officially destroyed or brought down 271 German airplanes, to say nothing of balloons. Germany stood third in markmanship; but her standing mustn't be taken to mean that her gunnery lacked merit. The common belief is that the German marksmanship was poor, but Guynemer him-

ONE OF OUR OWN "ARCHIES" IN ACTION

self nonchalantly disposes of this error. "The Boche cannon shoot straight," he said, "but we have to show them that they do not frighten us." This was after a photographic mission on which his partner reported over 1,000 shells fired at them, "during which Guynemer did not make a single turn. . . . He went straight toward his objective." American A. A. units, according to the *Army and Navy Journal*, brought down a total of 59 hostile planes, of which 18 were shot down by A. A. artillery, and 41 by two different A. A. machine-gun battalions, which had, between them, 96 guns. We had 1,500 other such guns at the front, but they brought down, all put together, only 2 Huns. The average number of shots fired per plane brought down was 1,050.

Archie himself, of course, is not immune to punishment. The *Daily Telegraph* correspondent wrote home in 1917:

> Our planes are so many and so daring that the enemy Archies are chary even of trying to shell them, because if they only shell long enough, one or another of the wheeling shapes will spot the flashes, dot down their positions on the map, talk for a little while with the wireless to their friends the gunners, and then wait, circling around, to watch the wrath come to visit the Archies.

C.—*Reconnaissance*

XVI

In a lecture at Fort Sill, Oklahoma, on November 6, 1917, Lieut. R. Michel of the French flying corps gave a synopsis of observation which was later used in all the schools and is well worth quoting here. It chiefly concerns reconnaissance, which, after infantry contact patrol, is the simplest form of observation, certainly the most common, admittedly the most valuable, and perhaps no more and no less dangerous than any other form.

"The Observer and the Pilot only spend a few moments in the air, and so they should accomplish a great deal during the flight. Every measure should be adopted, therefore, to make their work while in the air as easy as possible. That is to say, the Pilot and Observer should take all possible precautions before the flight. It is cold in the air, and you have to wear heavy clothing; but this clothing is apt to be uncomfortable, and before starting you should take every precaution against being made uncomfortable by the clothing. You should be able to turn your head easily in every direction in order to see that no German airplane is coming; you should also be able to turn in your seat, to write, and to look at your map. So do not be in a hurry before you go up, but try and arrange your clothes, helmet (knitted), and goggles so as to be quite comfortable. Don't get your scarf tight around your neck. Pull a woolen helmet over your collar, and mittens over your sleeves. Flying gloves are not sufficient themselves, as the draught works up your sleeves and your fingers soon get cold. Remember that in some cases your usefulness as an Observer is bounded by the time it takes your fingers to work. So try and not let your fingers lose all feeling by continuing rubbing them before you start to write or sketch. Never wear puttees in cold weather.

"You also look at your machine gun and make sure that it is working exactly right, that it turns in every direction and has enough reserve ammunition. If you are able to use a camera or wireless set, you must make sure these appliances are working correctly, and in the case of a [illegible] are enough plates.

"Above all, you must prepare your reconnaissance in advance before going up. As soon as a mission is assigned to a Pilot or Observer, he should take all the maps and all recent photographs of the sector over which he is to fly, and get to know the topography of the country perfectly in the least of its details.

"Different maps[1] will be chosen according to the mission you are to accomplish. For extensive reconnaissance you will need a map on a smaller scale than for a reconnaissance close to the lines; for this last kind of work the map must show the very smallest details on the ground. You should be very sure of the scale of the map you are using, be accustomed to estimating distances by a glance of the eye at different altitudes, and know how to represent this distance on your map.

"You should study your map well before leaving on a reconnaissance. The map should show all German lines and all the new works, and should be folded so that you can have before you all the country covered by this reconnaissance without having to unfold your map in the air, for to do so would lose considerable time and would often be impossible. Your map should be fastened to a map holder, either with rubber bands or mucilage, for you cannot trust thumb tacks, which the wind will tear out. Your map can even be inclosed in a large mica envelope. However, you cannot write on this.

[1] There has been a movement to map the entire United States, as France mapped France. Even the smallest practical scale, however, would require so many separate sections of the plan that a complete set would cost, according to an official estimate, over a billion dollars for field work and the lithographing before the printers even had a chance to submit a bill. Incidentally, a complete set, with each map properly backed, would stack up as high as a thirty-story building.

"The following articles should be taken on reconnaissance:

1. Liquid compass.
2. Watch.
3. Pencils — black, red, and blue — with point protectors.
4. Spare ammunition.
5. Note pad.
6. Penknife, where you can get at it and not under your leather clothes.
7. India rubber.
8. Glasses or telescopes.

"The most efficient way to write notes is to use a cavalry sketching board which can be strapped on your arm. Have a good, real liquid compass fitting to it, and when you have put the paper on the rollers strap your wrist watch on top of one of the rollers. Then you have compass, time, and notes strapped to your left forearm, with both hands free. Use every possible means to put down your information rapidly and accurately. Make out a code of your own, such as M. T. for motor transport; H. T. for horse transport; I. for infantry; C. for cavalry; G. for guns; A. for ambulance; B. for barrage, etc., according to your own plan.

"Do not start to write a full description of the exact position and the roads taken up by a column or transport of troops. Time is much too valuable, and you may have missed something very important while writing. Just draw a firm line the exact length of your column on your map with your red or blue pencil, with an arrowhead to show the direction, and one of your pet codes to remind you what it is when you come down.

"During the reconnaissance the Observer should know just where he is, just what trench or village he is flying over, and which is the shortest route to get to the aviation field quickly. To know where he is, the Observer should pay attention to the great landmarks—forests, towns, rivers, etc. Know their relative positions perfectly.

"It is good to use field glasses, but don't hold them to your eyes all the time. Their field is too small; only use them in order to see details you cannot see distinctly with your naked eye.

"Never trust anything worth reporting to memory; always mark it down clearly, and don't forget to rub out all the pretty pictures you have drawn on the map before going up the next time."

There are five [1] principal kinds of reconnaissance:

1. Strategical.
2. Battery zone.
3. Tactical.
4. Special.
5. Flash.

Aërial observation is aptly said, by the French experts, to be both expensive and sensitive; and from this truth we derive the axiom that no aërial reconnaissance is ever made for the purpose of gathering information which could possibly be gathered in any other way. That is something to bear in mind. No mission, however simple it may seem, is undertaken unless it is truly necessary. And reconnaissance missions are undertaken daily. The conclusion is obvious.

At one time, it was a pretty general impression

[1] No two writers ever agree on this point, either. There are all sorts of divisions and all sorts of definitions. One set, however, is quite as good as another, and perhaps better.

that the use of airplanes was going to shorten the war. On the contrary, they lengthened it. Reconnaissance from the air made any surprise attack, in force, impossible.

XVII

As Lieutenant Michel said, the Pilot and the Observer, no matter how much they have flown together and no matter how well they understand each other's methods, go over their reconnaissance problem with care, so that each is sure of proper co-operation from the other. There is mighty little time for bickering in the air.

And yet the very nature of observation requires that all work be carried on with the very minimum of prearrangement; the one thing that always does have to be prearranged is the course to be followed. The problem of navigation is never absent.

"Eyewitness," in an official communication from British G. H. Q. in France in 1915, wrote that psychology also comes in, and the temperament of an Observer is of the greatest importance. "He must be cool, and capable of the greatest concentration, in order to keep his attention fixed upon his objective in spite of all his distractions. He must withstand the temptation to make conjectures, or to think that he has seen something when he is not absolutely sure of the fact. . . . Even trained Observers vary in their power of reconnaissance. Some have a special aptitude for strategical work, the wide field of action and the chance of gaining, as it were, an insight into the working of the enemy's mind appealing to their imagination and to their taste for discovery. The spirit of adventure also enters, for long reconnaissances are hazardous."

In every army, practically the same routine was followed—reconnaissance was a Staff project. The Staff sent orders to aviation headquarters, aviation passed them on to sector or division headquarters, the sector passed them on to the squadrons, and finally a couple of second lieutenants, having nobody else to boss, went out and performed the mission.

Now and then, for certain missions, one-seaters were sent out because of their greater speed. As an illustration, Eddie Rickenbacker was once sent to confirm a report that eleven troop trains had left Metz and were carrying the Prussian Guard to attack some American troops which had been trapped near Montfaucon. This narrow sort of assignment, however, demands no particular observation skill or training, and it is the only sort of assignment which any but an experienced Observer could complete.

XVIII

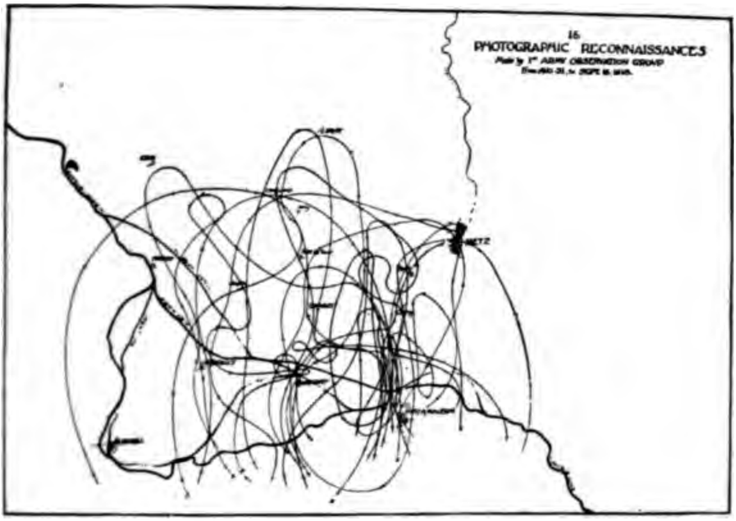
Strategic reconnaissance, which is simply the work of an aërial policeman on his beat, is a daily routine, considerably more inevitable than breakfast. In each sector, several ships may be flying simultaneously on this sort of mission, although in the early days it was thought a distinct hardship that one British squadron had to arrange for four reconnaissances daily. The difference between strategic scouting and tactical scouting is simply that in the first case you want information which will help the Staff to work out a big broad plan of action, which may take months to put into full effect, while in the second case you want the sort of news which will help in arranging plans for a definite, limited, and immediate action, which may take place to-morrow, and all be over in half an hour.

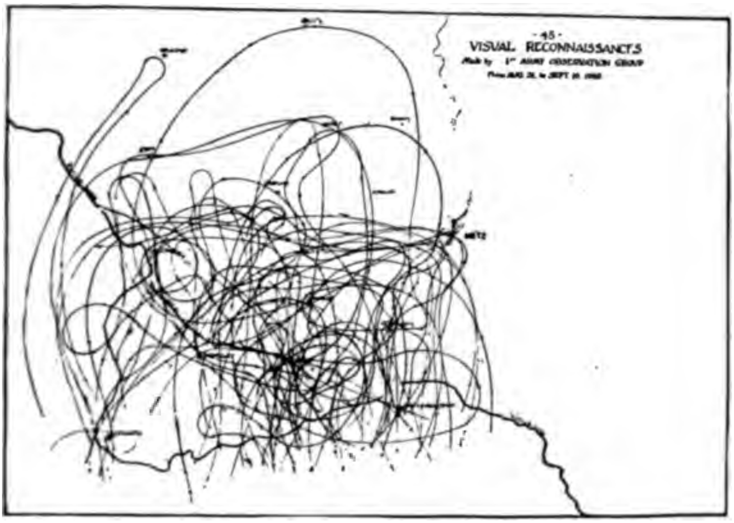
First and foremost, the daily movements of the enemy have to be checked up, and we must get the very latest and most reliable information about his scheme of relieving troops, his method of bringing up his supplies, his general conduct and disposition, and what he seems to have up his sleeve, besides muscle. Reconnaissance information is like a newly laid egg—it is at its very best on the day it is brought in, and it loses merit every day it is in storage. The flight is either along a prescribed line or over a prescribed area, and it generally lasts for a considerable time, even as long as three or four hours.[1]

[1] This depends entirely on the fuel capacity of the ship, on its speed, and on the wind. For instance, suppose that the first part of the flight is to be made dead against a wind which is blowing 25 miles an hour, that the speed of the plane is 75 miles an hour, and the gasoline capacity would be enough to last 4½ hours if there weren't any wind at all. In the first place, the ship would use up at least that half hour's worth of gas in climbing up to a reasonable height, and circling over the points which have to be studied, and not getting anywhere in particular. So there are really only four hours to count on.

Now going against that wind the ship will make only 50 miles an hour net, and coming home with the wind behind it it will do 100. The relationship of these mileages is 5 to 10 or 1 to 2; so that on the outward leg the ship will use up two thirds of its four hours, or two hours and forty minutes; and on the run home it will take only one third of four hours, or an hour and twenty minutes. In going against the wind, at a net speed of 50 miles an hour for two hours and forty minutes, the ship will go 133⅓ miles. This is the "radius of action"—133⅓ miles and back again. Naturally, few flights are ever made straight into a wind and back again; and even in a four-hour reconnaissance the Observer might not go more than twenty or thirty miles into the enemy's country. He would be circling a good deal, and dodging Archies. But the principle of the radius of action remains true.

It is fairly important to figure these things out before you start. One point which is interesting is that the speed of the ship is several times as significant as it seems to be. Suppose, for example, that two ships are available for a 90-mile flight, with a 60-mile head wind at the start. One ship has a maximum speed of 100 miles an hour, with a 3-hour fuel capacity; the second ship has a speed of 70 miles an hour, with an 8-hour fuel capacity. Offhand, you might figure that the second ship could do the work as easily as the first. You would do a simple problem in





PHOTOGRAPHIC AND VISUAL RECONNAISSANCES

Many ships are sent out at the same time on this sort of reconnaissance, and the sum total of their observations is made the basis of the current estimate of what precise type of hating the enemy will do next.

It requires no Sherlock Holmes to deduce what the enemy is going to do next. The chief essential is plain, ordinary common sense. Convoys on a road aren't out for a pleasant hike, like a troop of Boy Scouts, but they are out to protect provision or ammunition trains, which may or may not happen to be in sight at the time. A flock of newly dug communicating trenches, with nice new paths running into them at their starting point, far behind the lines, would bring up a suspicion of an attack over that part of the front which can be fed with reserves along those new trenches. If there are little parallel trenches along the front and heading toward it—the suspicion can be crystallized into a certainty, for these are for "jumping-off places," to get the troops out of the trenches in quick time. New railroad tracks, or spur tracks, hint at a new position to be constructed, or at the site of a new battery, for you can't bring up heavy guns and material by hand. Unusual signs of life at a railroad center are always interesting; back in Jones's Corners, Vermont, they mean that the mail

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multiplication, and say that the second ship had a 560-mile capacity, while the first had only a 300-mile capacity. But the second ship couldn't even reach the objective, to say nothing of coming home again. It would run out of gas at the 80-mile mark because the resistance of a 60-mile wind, against a 70-mile ground speed, would let the ship travel only 10 miles an hour, and in 8 hours it would go only 80 miles. The faster ship could make the round trip without a quiver.

It is interesting to note that in France, as in America, the prevailing winds are from west to east. That meant that at the front the Allied ships were always fighting the wind home, and slowly running out of gas while they were far in enemy country, with enemy ships trying to block them off.

train is coming in, and at the front they mean that new troops are probably coming in. "On ordinary days a German train always shut off steam when we approached"—for obvious reasons. It is a safe conjecture that any sudden increase in railway material usually means trouble ahead for somebody. Contrariwise, the negative fact that there is *no* rolling stock at a junction is something to ponder over, and it starts a prompt search for the missing cars to find out if troops or guns have been moved out of this place to be used somewhere else.

Away back in October, 1914, the *Telegraph* told how French Observers, seeing a vast quantity of rolling stock at one or two stations which had until then been quite neglected, figured out a hitherto unexpected assault—which came. The French, however, were waiting for it with all the confidence in the world, all the infantry and artillery they needed, and all the ammunition they could lay their hands on. In 1915 the German respect for French observation was so great that an entire German army corps was marched into a forest near Arras by night for the purpose of reorganizing under cover. In other words, Germany preferred a tremendously complicated task at a tremendous expenditure of time rather than to permit the French Observers to guess at the object of the reorganization of a single corps.

The increase or decrease of building operations is significant to the last degree. Construction work takes time, money, and personnel, so that when the enemy begins to rebuild any of his damaged defenses, or quarters, or to set up new ones, it means that he is going to be obstinate about holding that position. On the contrary, if he doesn't bother much about repairs or try to strengthen a position, it shows a quiescent willingness to go away from there if sufficiently prodded.

The troop movements of the enemy are obviously of prime interest to the Staff (although most of these are made at night, or in foggy weather, when observation is impossible), and the establishment of headquarters, camps, hangars, and flying fields is worth more than a single observation, and get more.

Incidentally, an airdrome is one of the very easiest points to spot from the air, no matter how well it may have been camouflaged. The great, bare landing space with its huge hangars marking the boundaries, and the smaller buildings grouped around them, stands out with great clearness, and an Observer would have to be blind in both eyes to miss such an objective. Germany used to build fake airplanes and put dozens of them in a flying field, so as to give the impression of several times as many ships as she really had. (See photograph opposite page 185.)

Machines on strategic reconnaissance sometimes go as far as forty or fifty miles into the enemy's province —it's all right as long as it's all right, but it's hard luck if you "lose the prop" and have to land in Germany— and they fly higher than any other observation ships do. An altitude of 20,000 feet isn't uncommon. The Observer has been told—if necessary—what he is to expect to find; and he checks off on his map, item by item, the various things he is supposed to account for, noting in each case the exact time of the observation. This isn't simply to make the job harder for him, but to help, in the later consolidation of several different reports, in making sense of any items which may have been reported in contradictory form by the several different Observers. Often an apparent contradiction will smooth out nicely as soon as the time of the reports is compared. A few minutes' variation can easily change a whole situation.

Writing in the *World's Work*, General Mitchell says that high-altitude reconnaissance is one of the hardest things to prevent in all air work. And he reports an interesting occasion on which a Hun flew over General Headquarters, just before the Meuse-Argonne offensive. General Mitchell was in the act of guiding General Pershing to a conference of the higher air commanders.

"We had proceeded about halfway, during which time General Pershing had commented on the fact that we had been remarkably successful in preventing enemy reconnaissance and that he had thereby been able to insure great secrecy as to the concentration of the army. Hardly had this been said when I noticed high up in the sky, and coming toward us, the explosions of our antiaircraft artillery. It meant only one thing, and that was that a German ship had slipped through our barrage and would photograph the place where we were standing. The antiaircraft fire was splendid, but the German ship, a Rumpler, was so high (about 6,000 meters—20,000 feet) and so well handled that it easily avoided the shots, which, as a matter of fact, could not reach it. I knew that our high-pursuit patrols were in place, because I had inspected them myself that morning, and that the Rumpler had come along with the sun until he had gotten to the desired point, and then had made a break across the salient in which we were. I thought to myself that he would run squarely into one of our formations to the east, but I said nothing about it. The general made no particular comment, spoke to the assembled air officers about their former work and what was to be done in the coming battle, and then went back to his headquarters.

"I walked down with him, thinking of the Rumpler and what his reconnaissance would show if he were able to get back with it, and what more we could do to guard against a recurrence. As I returned to my headquarters I had decided that, with the force we had, it was impossible to do more and that it would be very difficult for the Rumpler to get away from the pursuit patrols that lay in his path. Imagine my satisfaction when, as I stepped into my headquarters on my return, the information officer reported that the Rumpler had been shot down in flames by a patrol from the first pursuit group, and that he had fallen on our side of the line and all his plates were in our hands."

Comparatively little radio work is done on any sort of reconnaissance, for the simple reason that it is bulk information which is wanted by the old folks at home. But when radio is used messages are always sent twice, to take care of any difficulty of the receiving operator in getting the code. This brings to mind another item for the Observer. It is peculiarly important for him to have the latest code in his mind before he starts out. Once in a great while an Observer went up, found something which demanded a radio report, and sent home a message quite as intelligible to Headquarters as a chapter out of a Chinese novel. He was not one of those who received swift promotion and a letter from the general, to keep framed, on his mantelpiece.

XIX

Battery zone, or artillery, reconnaissance, doesn't pry so deeply into the enemy's back yard. The batteries are a comparatively short distance behind the lines, and the purpose of this sort of reconnaissance is simply to scout around for new gun emplacements and to see if the enemy has moved out of any old ones. Even the French concede that this is a very difficult assignment, for usually the signs are as hard to read as the tracks of a light-weight animal on dry ground. Observers are taught to judge from the color tone of gun pits whether they are occupied or not; the difference is merely a shade in favor of the one that's occupied. But any appreciable change in the countenance of a forest gives an immediate idea that a battery is playing hide-and-seek, and certain kinds of construction work are almost positive evidence as to the occupation of any battery position; the condition of the paths from the near-by dugouts to the emplacements gives another clue. In the winter time, a dark smudge on the ground shows up the melted snow under the muzzle of a gun, and sometimes, even in fine weather, the earth itself will show a burned streak, especially if the gun is close behind an old pathway or road, which, being light in tone, shows up the "blast marks." Still, this doesn't necessarily prove that the battery is *now* active; it only shows that it was active recently. You get the best real proof of guns in place, whether they are firing or not, by the shelters near them, the roads leading to them, and the teams or trucks on the road or standing around.

Guns in action, of course, are mighty easy to find and to classify. A field gun, as seen from the air, spits out a yellowish-white flash which jumps out as though some one had suddenly kicked it from behind. A small howitzer has a larger and yellower flash, and sends up a sprightly puff of smoke, without the kick. A big "how." shows more flash yet, with reddish tints in it, and lets loose a huge cloud of yellow smoke.

But a battery seldom fires if an airplane is overhead, unless the occasion is worth the risk. It means prompt strafing and there is always a chance that if the guns remain quiet they may be overlooked.

The Observer has previously studied photographs to see what the terrain is going to look like, and he presumably has some prints of these with him. He also has with him a firing map, corrected up to date. If he does happen to come across an enemy battery in action then, and has authority to call for fire on it, his photographs will help him out considerably, because he can draw the battery-target line right on the photograph and mark down the shots a great deal more accurately than he could ever do on a map.

XX

A tactical reconnaissance is a painstaking examination of the country immediately in front of an army or army corps. If strategic reconnaissance is police work, then tactical reconnaissance is detective work. The Observer goes into it as meticulously as though he were a prize housekeeper bent on discovering germs in the ice box. Field glasses are more generally used in this type of work, partly because the report has to be made out much more in detail, and partly because ships on tactical reconnaissance fly at lower heights, which make the use of the glasses feasible. Besides, the Hun always worked as though he were trying to get through in time to go to the ball game, so that whatever news was gained had to be very accurate, and then had to be reported with the utmost haste, or it would be too late. Strategic news is important enough, but tactical news is ten times as important, in that it loses its value in a much shorter space of time.

Tactical information is wanted chiefly by corps and division commanders, to tell them about the local conditions on the other side of the lines; strategical information is rather the basis for large campaigns or operations.

XXI

A special reconnaissance[1] is just like that. A ship is sent out, either during a battle or because something suspicious is going on over in the enemy trenches or behind them, and on this mission it cruises as low as it has to, down to a very few hundred feet, often making wide circles over the same spot until the Observer can tell exactly what is happening. Two ships in each division are generally held in reserve for special flights only, and go out only under orders of the division commander.

The Observer on this sort of special mission wants to give back a quick report on what the enemy seems to be cooking up for use in the very immediate future. He makes sketches on his maps of all changes of which he is *sure*, and if he is an Ally he marks the German lines in red (for danger), and the Allied lines in blue (for temperance). These sketches he later traces neatly in such form that they can be laid down over one of the current strategic maps and instantly show the commanders what is going on in the way of

[1] In the first year of the war, before the Germans had spread out over the whole front, France sent out frequent ships on special reconnaissance of the most dangerous type. A landing was made behind the German lines, and the reconnaissance carried out on the ground. Vedrines and Guynemer were both decorated for remarkable service on these special missions, which became impossible as soon as the country was thoroughly occupied.

changes. The probabilities are that these changes will have to do with the bringing up of troops, or some rearrangement of the trenches.

The term "special reconnaissance" covers everything which isn't a regular or semiregular duty. An infantry intelligence ship, or "airplane of command," is often sent out by the commanding general of a division during an attack, to cruise around directly behind the front advance and report the situation to the general personally. This differs from I. C. P. in that the Observer is not responsible to the infantry for any help, nor to the artillery for advice. He is a messenger boy of the air.

In this connection, an early "Order of the Day" of the Germans is interesting:

> According to the report of a squadron of Airplane Observers, our troops are very easy to mark in fighting, in spite of their gray uniforms, because of the density of their formation, while the French know apparently how to protect themselves perfectly against aërial reconnaissance. During a fight it is necessary that our troops should make the task of aërial reconnaissance more difficult by more careful use of the country—making use of narrow files along trees, edges of villages, shelter of houses, avoiding mass formations. . . . At the approach of an airplane all movements ought to cease. . . . Upon the approach of an enemy airplane there should be no firing, for the flash of the gun betrays the position from afar.

The danger in all special reconnaissances is from the ground. The Observer must fly low enough to see things clearly with his naked eyes, and this inevitably brings him within range of small arms, in addition to the persistent Archies.

XXII

A flash reconnaissance is almost as difficult a task as it would be to map the position of a firefly seen through an opera glass. A ship goes up at dusk, or occasionally on cloudy days, to try to locate active enemy batteries by marking down the flash of their guns. If the Observer can see the battery actually firing, he can make a fairly accurate guess at the caliber of the guns. He notes, with the aid of a stop watch, the exact time of the flash, and reports this, together with the co-ordinates of the battery position, the number of guns which fired, and their caliber, to the Intelligence Office.

The Intelligence Office has nothing to do with hired help and worries not at all over the servant problem. One of its duties is to keep a minute record of every known enemy battery, its activities, and its efficiency; and this record is filled in daily according to four kinds of reports.

(a) Sound ranging, which consists in picking up, by means of instruments second cousin to the aneroid and son-in-law to the ordinary microphone, the sound of a gun, and locating it, on the principle that sound travels 340 meters a second. The sound of an enemy gun is recorded, photographically, or in chart fashion, on instruments at several different points, whose distance from one another was measured with infinite care. Five minutes after the arrival of this sound, all the necessary calculations can be made (unless there are so many guns firing at once that the sounds are hopelessly confused) and the enemy gun can often be placed with an error of only a few yards; indeed, the probability was that it could be located within 25 meters, and furthermore, its target and caliber be discovered. Obviously, the bad weather which spoils aërial observation has little or no effect on sound ranging. Germany was far inferior to the

Allies[1] in sound ranging; indeed, the editor of the *International Military Digest* says that Germany owed its entire knowledge of the process to the capture of a wagon containing the apparatus.

There are several methods of recording the information thus plucked from the air, but one of the best was the French method of using a photographic recorder of sensitized paper, which moved steadily along in its container, and received tiny flashes of light reflected by small mirrors attached to the galvanometers, which do the bookkeeping. The machine wasn't kept on duty at all times, but was started up whenever there was need for it, and stopped as soon as a few shots were recorded.

The difference in time reported by two different stations, multiplied by the velocity of sound, gives us (if we can swallow it) "a distance which establishes a branch of an hyperbola of which the foci are the positions of the two microphones, and the axis is the line joining them." By simple trigonometry, which was soon reduced to formula, the enemy gun is spotted.

(b) Aërial observation during the day, and flash reconnaissance. Camouflage might deceive even the photographer, however, and puffs of smoke are sometimes fired from fake emplacements to cheat the Observer. Dovetail all four sorts of information, and there is only a small loophole for deceit.

[1] As a sample of our national assumption of perfection, a New York newspaper printed, on December 7, 1917, a statement that France experimented with sound ranging in 1914, Britain developed it to a certain degree, and America made it practical. The truth of the matter is that France had an accurate and efficient system of sound ranging over the whole western front, and that Britain borrowed the idea from France, and America borrowed it from England. France began to experiment with it in October, 1914.

(c) Balloon observation, chiefly valuable in this connection for spotting the flashes of enemy guns, bursts of enemy fire within our bailiwick, and the probable number and caliber of the guns firing.

(d) Ground information, coming sometimes in the form of agonized protests from the unit under fire, and sometimes in the form of blasé comment and routine reports. You can tell from a very small piece of shell fragment what was the caliber of the gun that fired it. Each organization reports to Intelligence each day what sort of projectiles, and how many of them, have been fired at it.

Each one of these varieties of information has its defects. Sound ranging is spoiled if there are too many enemy guns shooting at the same time; aërial observation is bad in bad weather; flash observation can be cheated by a simple trick, and balloons can't fly in a heavy wind or shift their position so as to avoid every cloud. So that if the enemy guns are firing only at night—and this is often the case—all four types of information will often be needed before we can turn our own guns on the enemy's and thoroughly annoy him. On other occasions the mass of information at hand is simply incredible; you almost know the enemy gunners by their first names.

There are some interesting British figures to show how many German batteries were located in 1917 by these four different methods. Thirty-seven and a half per cent of all batteries located were detected by sound ranging (8,578 batteries were reported by sound ranges alone), 28 per cent by observation groups, 26½ per cent by R. F. C. squadrons, and 7½ per cent by balloons. In other words, no one method would have detected more than a small percentage of this total.

XXIII

Reconnaissance in general has two main aspects, of which one is offensive, and the other is defensive.

The French routine of offensive reconnaissance, as we have already said, was worked out at the Somme, where France made her greatest strides in observation and put the fear of defeat into Ludendorff. This routine may safely be taken as a model, since it includes all forms of scouting theory and practice and has to do both with airplane and with balloon observation.

As soon as the Staff had once decided to go ahead with an offensive,[1] the ground in front of the French army was most carefully studied and mapped and

[1] "Principles to be observed when reinforcing the front—The appearance of strong air forces (airplanes, balloons, and antiaircraft guns) is for the enemy one of the surest signs of an impending attack. *The activity of the forces must, therefore, be moderated during preparations.*

"It is very difficult to insure an adequate engagement of airplanes while still observing the demands of secrecy, as reinforcements cannot be brought up till very late. By frequently exchanging aircraft units, by attaching aviators to the reconnaissance and protective flights already present on the front of attack, and by forming instructional centers behind the front, an attempt must be made to insure that the flying personnel possesses the necessary knowledge of the country on the front of attack without premature transference of forces. Flying at the front must be co-ordinated so that, on the one hand, it will be difficult for the enemy to detect reinforcement, and that, on the other, the aviators are given sufficient opportunity for learning the country.

"In any case, *complete photographic reconnaissance*, with no gaps, must be insured. This is of decisive importance. Next in importance is the necessity of familiarizing artillery, infantry, and battle aviators with the ground. The main reinforcements in pursuit and protective flights can be brought up last.

"*The bringing up, housing, and work of balloons and antiaircraft guns* are governed by the same principles." (*German secret manual for air forces.*)

photographed, not simply for a short distance, but far back over the lines. A major offensive, you see, includes both a strategical and a tactical performance; strategy is the genius which conceives and executes the broad plan of movement, and tactics is the scientific application of genius in a single instance of action. Every German trench, every path, every approach, every dugout—the barbed-wire entanglements, machine guns, trench mortars, headquarters—all these were repeatedly examined and studied and recorded on countless photographs taken at different times of day from different levels, at different angles and in different lights. Oblique photographs turned up a number of dugouts which no one had ever suspected, and the size of them gave a very clear idea of how many reserves they could accommodate normally and at a pinch. All these data were carefully consolidated and boiled down, and presently, when the time of the attack drew near, an exhaustive series of photographs, maps, and plans was made, and issued confidentially to commanding officers. A broad summary of this information appeared in the *Plan Directeur*, a printed, contoured, co-ordinated map showing the general organization of the enemy in the greatest detail.

Furthermore, there was prepared every night, in very active districts, maps which showed all the enemy batteries which had been seen in action, or were known to have been in action, during the previous twenty-four hours, and all the aero squadrons and balloon companies received copies of these maps every morning. And since the *Plan Directeur*, whether on a small scale of 1/120,000 or on the largest scale of 1/5,000, was primarily topographical, and showed the layout of the whole country without too great emphasis on the military side, *objective* maps were also made, indicating in different colors every foot of enemy intrenchment, every weapon of defense, every tiniest item of military value. All these maps were made after long preparation, and had been constantly revised and re-edited and reissued, so that the final five-star extras were marvels of precision. They were so accurate that the advancing infantry knew exactly where they should have to dodge the fire of machine guns; the artillery knew, well in advance, where barrages would be wanted, and where the enemy reserves would necessarily have to crowd up in the cover trenches and provide good covey shooting. Even the troops which hadn't previously been fighting in this neighborhood, but had been brought up especially for this attack, understood, by the maps and photographs handed out to them, what they were to do, how they were to do it, who was going to help them, and when and where, and what the enemy had put in the road to hold them back.

Moreover, the style of the Hun defenses—and these were also photographed obliquely from their own rear, but looking toward their front, so that the pictures brought out the internal workings of the enemy—the character of these defenses indicated how much of a fight he was really willing and able to put up, and this enabled the infantry and the artillery to work out their highly delectable plot with some certainty of its reception. "The Observer alone had seen the strong points and the weak points on the German side; his word and his lens saved an incredible amount of time in feeling out the Hun; the artillery could decide, long in advance, where to drop its shells of various caliber, in order to do the most damage; and since it knew where the enemy reserves would probably be waiting for orders, it also knew from just what point any counterattacks would have to start," and it was all ready to spill shrapnel on them. And the infantry knew where it would find every ridge and slope and road within the enemy lines, and where it was liable to be defiladed. It was reconnaissance to delight the heart of a Raffles.

Now the purpose of an attack is really for the infantry to gain ground, and to gain enough ground, if it can, to capture the hostile artillery, and to prevent the enemy from putting up a further defense. At the Somme, France attacked on a very wide front, so that the enemy couldn't very well concentrate his forces to stop the rush. And the plan was to have several successive assaults, one quickly following the other, so that the enemy would get no breathing spell. This was the "wave" formation.

The first actual operation in the big offensive was the "artillery preparation," based on and conducted by aërial observation. The idea of this work was fivefold—to cripple the enemy artillery, to smash up their machine-gun emplacements, to destroy the wire entanglements, to injure the personnel in the enemy trenches as much as possible, and to hinder the reserves from coming up to those trenches. The *primary* object of this preparation is against the enemy artillery, and, although it prefaced the attack, it didn't stop with it, but continued throughout the whole fight. The preparation itself continued for several days, until the German organization was supposedly crippled, its artillery damaged, its infantry apprehensive, impatient, and tense with the severe ordeal. Perhaps the greatest nerve strain in war is for infantry to remain under bombardment for a long time without being able to leave the trenches. It is a cruel hardship; and the only strain which is in any way comparable with it is the strain of the troops which know, several hours ahead of time, the moment when they will be ordered to advance. It is worse than waiting for a dentist to find a new burr.

On the lengthening of the range and the beginning of the infantry attack (and, by the way, it begins now at "H" hour instead of the journalistic "zero") special reconnaissance ships, representing the commanding generals, flew very low over the lines, to see and follow the progress of the troops, each unit of which had been given a specific direction to follow and a list of objectives which they were to take if they could. In the meantime I. C. P. ships were acting as middlemen between the infantry and the artillery, making constant reports by radio to all divisions and army corps [1] and all artillery which held membership in the fight. Every now and then, whenever an Observer dared to leave his post for five or ten minutes, he hurried back to his own divisional headquarters and dropped a message bag containing his professional opinion of the battle—without a prescription—and maps or sketches of it. In acute emergencies, such as counterattacks just getting into their stride, he dropped messages to subdivisions as small as regiments. And throughout this duty he was unceasingly harassed by enemy fire, and he knew that

[1] Indeed, listen to the *Morning Post*, of London: "How different from the scout of old days, dropping road-stained and exhausted from his trembling horse. The contrast indeed was greater, for this scout had really brought only himself home; his news he had thrown out into the air from the front, and long before the scout himself arrived its purport had already been discussed at Headquarters. But the romance of the thing was richer for that dripping horseman who had thrown soul and body into the scale against Fate."

the slightest bit of incorrect information, or an enemy position wrongly located on a map, might be a truly fatal blunder. But the attack had to be co-ordinated. As the French put it, "for infantry, order is above rapidity," and each unit of infantry was supposed to go right ahead, no matter what other units were doing, until it was stopped and couldn't go ahead another step.

If any ship were driven higher by Archie, or by rifle fire, the Observer stayed on the job just the same, for he was still able to discover by the shape of the various trenches, the side on which the earth was shoveled up, and the position of the troops, who was in possession of various points, so that his reports continued to be trustworthy.

At the same time, ships on reglage duty were out in front, spotting artillery fire for destruction only.[1] And Observers watched, catlike, every action and reaction of the enemy's infantry, either detecting newly occupied trenches by their darker color or going down low enough to distinguish the enemy's tin hats. The artillery was supposed to prevent the enemy from bringing up troops in support; the Observers were there to check up the facts and pass bulletins on to the batteries. They circled over and over the lines. They dived down, now and then, and strafed the trenches with vicious sprays of machine-gun bullets.[2]

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[1] "Artillery airplanes, besides reconnoitering targets, must not be employed solely for the registration of single batteries. They are peculiarly adapted by their mobility and wide field of observation to check periodically, during short flights, a whole series of shoots for effect, and to insure that there are no gaps in the fire. A temporary increase in the rate of fire greatly assists them in this task. This is specially important when dense smoke impairs visibility for other means of observation. The effect of the fire should be tested during intervals in the firing." (*German secret manual.*)

[2] Before the machine gun was adapted to aërial purposes, the French

German orders say that infantry mustn't hide from a low-flying airplane; infantry must drive it off with rifle fire; but it was a general who wrote those orders, and very few German generals knew from personal experience what it was like to be strafed by a Frenchman.

When the attack had slowed down, and finally stopped, and the French troops were busily reorganizing and repairing the positions they had captured, the Observers still stayed up to regulate the artillery fire which protected the troops in their work. They were also alert to give warning of any counterattack, and to call for the guns to stop it; and they were further engaged in making maps and photographs of the new front lines. New maps were needed, for the old ones, representing the labor of weeks and weeks, had served their purpose, and were useless as soon as the attack was done. The whole situation on both sides had altered in almost every detail. It was necessary to have fresh information about the French positions, and also to have views and sketches of the places which the enemy would probably strengthen or was already strengthening, and photos to show up any new machine guns, new diggings, and any new "means of access" by which the enemy could deliver a counterattack.

It might be—and is—added that in the meantime

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had used against infantry a sort of steel dart, or *flechette*. These were simply tossed out over the side, and although they weighed hardly an ounce, and were only a few inches long, yet one of them falling from five or six hundred feet was deadly. Any ship could easily carry thousands of them, and they were most effective, but of course they couldn't compete with the accuracy and power of the machine gun. They had the advantage, however, of gaining vicious power from high altitudes, where the ship itself was safe, whereas to strafe infantry with a machine gun you have to come down pretty close to the ground.

the French pursuit planes were charged with spoiling the enemy's observation, and that bombers were charged with worrying the enemy at all his headquarters, stations, and depots.

One of the facts which few people seem to visualize is that at any one time, in any one region, there may be in the air a vast number of planes working on a dozen different general schemes and on an infinite number of separate missions. The great majority of laymen (and General Mitchell tells us that, also, the great majority of officers, when they first arrived overseas) imagined that an airplane was nothing but an airplane and could be used for all the different services of the air, as chance or the commanding officer dictated. This is far from the truth; every plane and every flying officer had a specialty. This was not primarily to gain greater efficiency of personnel—it was to gain greater efficiency of material, for you may put it down as an unalterable fact that no one type of plane can do more than one thing well. A ship may have great speed, or it may have great stability, or it may be able to carry great weights, but it can't possibly have two of these attributes at the same time. Take the St. Mihiel offensive; there were 1,481 Allied planes engaged in this, and each one had its own private duty, which was given to it in correlation to the duties of all the others.

First, please imagine the front line. Nearest to that line, on the ground, was, of course, the infantry, and over the infantry, at a very low altitude, the I. C. P. ships. On almost the same level, but generally to be found over in the enemy's country, was a special attack flight, patrolling the level and ready to swoop down and worry any clusters of enemy soldiers; and still at about the same level were a few courier planes, on special flights, darting back and forth with urgent information.

Nearest to the lines are the antiaircraft machine guns and the antiaircraft artillery. Back from the lines, perhaps five kilometers, were the 75-mm. guns; back another five kilos were the 155 shorts; still farther back were the 155 longs; and back of those were the heaviest guns of all. To observe for the little 75's and the 155 shorts, artillery planes were flying at about 7,500 feet over the targets at which these guns were shooting. For the 155 longs other ships were flying at perhaps 10,000 feet, and for the heavy army artillery there were planes at possibly 15,000 feet. All of these flew various distances into Germany, because the 75's carried only five kilometers over the lines, and the heavies carried as far as twenty-five kilometers. The Observer flew into Germany as far as he found necessary to get a clear view of the shells falling on the target.

Meanwhile, low-pursuit flights were busy at from 1,000 to 1,500 feet; photographic missions were busy at 7,500 feet, a corps surveillance ship or two for fugitive targets at 10,000, and an army surveillance ship at 15,000. Up toward the ceiling, after a pursuit barrage at 9,000 feet, there were day bombardment and pursuit groups cruising into Germany at 12,000 feet, high pursuit details at 18,000 feet, and above them all, at possibly 20,000 feet, the army reconnaissance planes.

XXIV

On the defensive, the Observer is like the rest of the army—he is more apt to be nervous and uncertain of himself because, of course, he hasn't any clear conception of what is about to happen. He has no carefully learned plan of battle to guide him; he has to take conditions as they come. He can't always decide whether some enemy movement is a genuine assault or only a feint. He is bothered physically by hostile planes, and he is bothered mentally because the enemy always seems to have the jump on him.

From the time when the enemy begins to prepare for action and it is certain that he means business, the Observer's work becomes absolutely continuous. If he gets any sleep, that's sheer velvet. Every bit of information he can gather must be brought home with all possible speed, whether it is possible or not. No matter what the difficulties are, he has simply got to learn the direction from which the enemy is going to attack. He can tell something about that from the enemy's artillery preparation, because the preparation is supposedly aimed against that part of the front which is going to be attacked; but there is always the dire possibility that the enemy is only fooling and will finally aim its assaults at some other point entirely, where reserves aren't waiting for them.

Just before an attack gets under way, the side which is attacking always lengthens the range of its guns, and the Observer seized this instance to call for a barrage of his own. From then on his duty was to follow the battle with every sense peeled down to the raw, and to keep his commanders advised of every little change in the situation which needs to be met with a change of plans. His own infantry was, of course, in its trenches, and not advancing, so that it would probably not need to communicate with him except to ask him for one thing—more barrage.

It is well to remember, here, that a barrage isn't by any means an impenetrable wall of fire; it merely makes progress costly. Of course it is itself expensive —prodigally expensive—and the reason for Germany's development of the gas shell, and for the use of gas in general, was originally to make an effective barrage which at the same time would be more economical than a curtain of artillery fire.

When the enemy is finally halted the Observer goes right on with his work, just as he did on the offensive. The first thing to discover now is whether the enemy intends to try another rush. If not, the Observer sketches on his map the new front lines, and their relationship to the old ones, and their strength and weakness in comparison with the old ones. When the French infantry was stopped, the French usually dug in at once; but in a similar situation the German infantry almost always scampered for the nearest shell holes and used them as the basis of their new system of defense. Photographs show up these matters very quickly and clearly, and they also show how the lines will have to be oriented (faced), and strengthened, in order to keep them at least as powerful as the old lines were; so that whole new sets of photographs are wanted as soon as they can be obtained.

XXV

One of the common methods of trying to blind the enemy is by the use of the smoke screen. This happy thought was borrowed from the British navy in 1917, and thereafter it was used by both sides with good effect, as far as cutting off the view of the enemy on the ground was concerned. But the same screen which would spoil the view on the ground, and prevent the other side from seeing what was going on, might not necessarily blind the Observer, who was in a position to cruise around the smoke and see what was behind it. Still, it was likely to bother him, and it was a perfect shield against the Balloon Observer, anyway.

Smoke was used to cover up genuine attacks, and it was also used very frequently as bait. That is, one side would put up a smoke screen, plus a lot of gas, at a place where it didn't intend to attack at all, so that the other side would play safe, waste its artillery in a useless barrage, and keep a large number of troops ready to beat back the expected advance. The clever idea in smoke deception is invariably to make the other side think you are planning to do something which you don't expect to do at all. The rule is to "mix 'em up."

For straight concealment, smoke was put up to hide guns or troops or building operations; and again to lead the enemy to imagine such a condition and to throw away ammunition on nothing but a cloud.

The Germans rested a great deal of confidence in these smoke-screens, and invented a large number of devices, in the form of misshapen tanks, which emitted smoke enough to make a good protection. Four of these devices were tested in this country by the Chemical Warfare Service, which reported as follows:

> The "N. T.," or "Nebel Trommel," which has a capacity of 253 pounds, was first set off. It gave an effective cloud for about thirty minutes. The "N. L.," or "Nebel Topf," much smaller in size, was next demonstrated. This machine has a capacity of 150 pounds and operated for about ten minutes with smoke about one half as effective as the larger machine.
>
> Next in size at the demonstration was the "N. K.," or "Nebel Kasten," which has a capacity of 75 pounds and gave off smoke for about fifteen minutes. This one is about one third as effective as the "N. T." The fourth and last was the "N. B.," or "Nebel

Buchse," of only 25 pounds capacity. This one smoked for fully three minutes. It is only one tenth as efficient as the big "N. T.," but it is about six times more effective than the ordinary smoke grenade.

The Observer, having the advantage of seeing behind the screen, was naturally able to save many a situation which, without his assistance, would have been a far more serious proposition.

D.—*Artillery Reglage*

XXVI

Artillery reglage, or "spotting artillery fire," consists in watching the fall of shells upon a target and sending back to the battery whatever information it needs to improve its aim. Theoretically, artillery is always either firing or getting ready to fire, and Henry Woodhouse says, pertinently, that the Observer is the man behind the man behind the gun. As we have shown already, Observers first attempted to point out a target to its artillery by flying over it in circles or in figures of eight, or by tossing out paper or tinsel, or by letting off smoke bombs, and it is no wonder that a good many artillery officers were contemptuous of the value of airplanes and of their future value. In 1915 France had adopted a slow but accurate method in which the Observer dropped at the battery, after each salvo, a card which showed graphically where the shots fell. These *ad interim* methods, however, were soon replaced by radio, and if the war had lasted much longer the chances are that radio would have been replaced by wireless telephone.

There is simply no question at all that the wireless telephone would be as far superior to radio as radio was superior to the Christmas-tree exhibition of tinsel. In the spring of 1919, tests made in the United States showed conclusively that even a green man could adjust fire by telephone, and do it with remarkable precision. The general officer who filed a report on this test said, in part:

> The aviator received the first lesson in adjusting fire by me fifteen minutes before he went up, and that is all he knew about artillery fire. The first problem was twenty-two rounds, and lasted nineteen minutes from the time he left the ground until the last shot. . . . This morning he went up, adjusted two guns of a platoon separately, brought in the whole platoon to fire for effect, making his corrections properly, and the total time from his leaving the ground to the last shot was twenty-one minutes, with forty-seven rounds fired. There was none of the long, tiresome delay such as I have been used to under our old system, when, as you know, it took us about an hour or an hour and a half to adjust one gun by airplane.

But during the war we all used radio as soon as it was ready to use. It may be wise to insert here a reminder that the best Observer on two legs is helpless unless there is a first-rate radio officer back on the ground, seeing that the apparatus is kept in shape, seeing that the messages are taken accurately, and seeing that they get to the artillery commanders without any delay. A voice is a beautiful voice only when there is an ear to hear it.

Now the average range of modern guns is so great that a very small error of the gunner means a very large error in the fall of the shell. The 75-[1] and

[1] The French 75, the idol of the Allied armies, is a distinguished exception to the rule that Germany invents nothing and perfects everything. The long recoil principle of this gun was conceived by a German engineer named Haussner, in 1890. A French officer, one Colonel Deport, elaborated the principle, which was then further studied and developed until, in 1898, the gun was finally adopted by the army. It is said that General Deloyé, who was in charge of the final tests, wanted to prevent

ARTILLERY FIRING AT A TARGET WHICH IT HAS NEVER SEEN

155-mm. pieces fire at about 5,000 yards, or three miles; the heavy army-corps 155's at about 12,000 yards, and the really heavy guns at 25,000 yards or more.

Howitzers, which are squat, fat pieces, fire in a very high trajectory, like a slightly bent hairpin; they have a much slower velocity, and cover a great deal less territory than guns. They fire very heavy projectiles, and are used only when the final and permanent destruction of the objective is the sole result that is wanted and when there is comparatively no hurry. Nothing but howitzers, for instance, can smash down to a really well-built dugout.

Now the sighting of a gun or of a howitzer is affected by pretty nearly everything on earth except the stock market. The gun itself has plenty of temperament, and, as the comic song said about women, you never find two alike at any one time, and you never find one alike twice. Each piece has a "probable error" all its own, and this is figured right into its range tables. Obviously, each piece has to have a range table to suit its particular eccentricities. In addition, the sighting of the piece is affected by the temperature of the air, the temperature of the charge, the barometric pressure, and the wind. And the wind is peculiarly naughty to howitzer shells, with their high trajectory and slow flight. These four factors, taken together, give us the "error of the day," which is figured into the range tables, too, each morning, and has to be altered during the day as often as the factors themselves alter. And then, finally, a gun which is fired rapidly half a dozen times

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Germany from perceiving how its thunder had been stolen, and so established a press bureau which carefully misrepresented both the character and the efficiency of this wonderful weapon.

will show a further variation from its own habits because of the changing temperature of the gun itself. It gets tired, and shows it. The inner surface begins to crack from the terrific expansion and contraction of the metal, and this, in time, spoils the accuracy of the piece.

Two points we must never forget: one is that it is virtually impossible for two shells fired from the same gun ever to hit the same spot; and the other is, that unless even a big shell lands and bursts within a few yards of its target, it will not disturb that target for half a second. Men in the neighborhood may be deafened and may be knocked over by concussion, but a man who is a hundred yards from the burst isn't in any vast danger, any more than the target is in danger from flying fragments. Of course, he isn't exactly *safe*, but on the theory of chances he is all right. This is one of the reasons why artillery costs so much. To manage the complete destruction of a single enemy gun pit costs, on the average, a hundred rounds from a 6-inch "how.," or sixty rounds from the heavier 9.2. And every time one of these pieces is fired everybody has to pay some more on his income tax, because big shells cost a lot of money. Counting the cost of the shells and the depreciation of the weapon, that gun pit may be written off at a price of eight to fifteen thousand dollars.

Now the Observer, in order to carry on his work properly, has got to know a good deal about artillery practice. He mustn't cause his artillery to lose confidence in him, as in the case of a British Observer who called frantically for shrapnel fire from an 8-inch howitzer—quite as hopeless a request as though he had demanded BB shot to be fired from a coast-defense gun. He must understand all the troubles of the artilleryman, and not expect the impossible. And therefore, when he is assigned to reglage he must keep at least on speaking terms with the commander of the battalion or battery for which he is going to work. But the Observer should know enough to carry out a shoot without any preliminary conference at all.

XXVII

When a battery comes up to a new position its first job is to establish its radio receiving station, get out its panels, and then "register" on a number of prominent points over in the enemy's country. That is, it actually fires at these points and has the effect watched by its own ground observation officers, if possible, until it gets a few direct hits; and then it saves all the data about these shots—the elevation of the gun, the fuse and timing, and all that—for further use, so that when it is ordered to fire in earnest at some other point near by, it can use those registration data as a basis of its fresh calculations of range, and so on, and thereby economize both time and ammunition. It will need fewer shots to find the new target.[1]

To register a gun you do not simply aim it at something and let drive. That would be about as certain of success as a woman trying to throw a baseball from deep center field to the home plate. It is a problem in higher mathematics. The "line of sight" is simple enough, because it is an imaginary

[1] A German officer wrote officially: "Time and time again the captured French instructions for firing have given me something to think about. . . . Preparations must be made so that fire for effect, without previous trial firing, could be begun at H hour and that the fire could be continued, if required, without (ground) observation."

straight line between the gun sights and the target. That is, it is simple unless the target is *out* of sight, in which case it has to be calculated. The "line of fire" is still simple, because it is the curved line joining the target and the elevated muzzle of the gun. But the "line of departure" is a sticker. When the gun is fired it makes a jump backward, so that the shell travels neither on the line of sight nor on the line of fire, but on the line of departure, which never existed at all, except in the imagination, until that precise instant. But all these three lines have to enter into the mathematics, for each one is figured from the one previous.

As soon as the shell starts bravely off, one force tries to keep it traveling in a straight line, while two other forces promptly form a partnership to pull it down. These forces, in order, are projection, which wants the shell to keep on going; the force of gravity, which wants the shell to come down to earth; and the resistance of the air, which would stop the shell dead if it could. The result of this little struggle for control of the flight is the familiar curved trajectory. The three forces compromise to bring it about.

Now even if there were no wind at all, the shell would nevertheless want to drift away from the line a little, on account of its rapid rotation. It is spinning on its own axis at a terrific rate, and it curves in its flight in the same direction as it is revolving. It has to. This "drift" is generally allowed for in the sights of the gun. Then if the gun platform is the least unsteady, the gun will jump differently each time it is fired, so that the line of departure will be a trifle changed on each shot. These things you have to consider in addition to all the different factors included in the "error of the day."

Because no two shells from the same gun fall in exactly the same spot, the exploding shells from any one piece will carve out an elliptical or oval-shaped design on the ground. If the "pattern" is fairly small, the gun is a good one; if it is large, there is something wrong with either the gun or the battery commander—probably the gun.

The little region on the ground in which at least half of the shells burst is called the "50-per-cent zone," and the Main Point of Impact, or M. P. I., is the center of population of the 50-per-cent zones of a whole battery. The 50-per-cent zone of a 6-inch howitzer at 9,000 yards, for instance, is about 100 feet by 15 feet. The M. P. I., however, might be in the middle of an area two or three times as large, if the several pieces can't manage to get together. The job of the battery commander is to bring the M. P. I. right on to the target, and that is the best that he can possibly do. It doesn't by any means follow that even if the M. P. I. and the target do actually coincide, there are going to be repeated hits on the target itself. All it can ever mean is that the target is being surrounded by shell-bursts, of which some are close enough to drive off the enemy's men; and fewer yet are landing near enough to damage the target; and a very few indeed—1 or 2 per cent at the extreme—are actually hitting some part of the target.

The oval-shaped design of the shell-bursts has one of its ends toward the gun which is firing; that is to say, in the language of the manual, there is always more error in the range than there is in the deflection. It stands to reason, then, that if you can enfilade your target by shooting at its side instead of its nose, you have a far better chance of putting it out of commission, because you are always surer of the line of your fire than you are of the distance. Like putting, in golf—if you are sure of the line you are bound to drop some difficult putts, even if your judgment of distance is a bit uncertain and you are alternately short and over. The difference is that the artillery can try all its putts over again and have them all count in the score.

With a howitzer, however, exactly the opposite story holds true. The "how." is very trustworthy indeed for range, but very uncertain in deflection; and in damp or rainy weather it is fearfully erratic all around, because the heavy charges cause a remarkably rapid change in the temperature of the piece, and the temperature of the charges themselves is constantly decreasing. As the temperature of the charge is lowered, the propelling power and the muzzle velocity drop back also, and when you try to tie up these facts to a weather bureau, and shoot straight with a howitzer in the rain, you get brainstorm.

The Observer has to be familiar with artillery practice, because otherwise he would often be at a loss to know what to look for. A gun fires a fixed charge, but the "how." has a variable charge, which seriously affects the time of flight. We shall see later that the time of flight is important enough, so that this variation is important also. The guns fire several different kinds of shells—the common shell, filled entirely with gunpowder; the shrapnel shell, which is a thin steel case full of shrapnel bullets, with a bursting charge of gunpowder in the base; and the H. E., or high-explosive shell, with a thick case. The H. E. case also contains a supply of dope which makes a thick smoke, in order that the Observer can see the burst more easily from the air and get a better idea of where the shell took effect. Incidentally, a high-explosive shell does a most terrific amount of damage where it actually lands, but it has to land closer to its target than any other sort of shell to damage it at all.

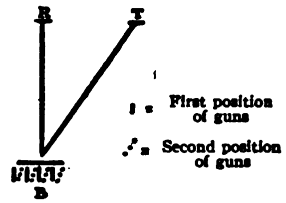
Our battery, which recently came up to a new position, has now registered on several points in the enemy's country near by, and has all the data on them. An Observer sees a target—let's say it's enemy artillery in action, and asks our battery if it would like to shoot a few rounds. Our battery would. The Observer sends down the co-ordinates of the enemy position, or describes it by any of the other recognized systems,[1] and asks if we are ready to fire. We say, "Wait a few minutes," and if the Observer is young and excited he swears.

But this is what happens before the battery can fire.

Let us say that one of our registration points was R, and that the target discovered by our Observer is at T, a place just about as far away from us as R, but in a different direction. First, we swing all the guns so as to aim more or less in common on the point T, but after that we have to aim them separately so as to concentrate them. The lines of fire don't all arrive at the same point, but are pretty nearly parallel, so that we shall be hitting along the whole front of the target, and not wasting effort by all of us trying to hit the same individual gun in that enemy position. You can see now that each gun of our battery is a problem

[1] All the important targets have numbers assigned to them on the firing maps, so that in many cases the Observer would simply flash back this number. Otherwise, if he didn't use co-ordinates, he could probably use a system in which the map is marked off into squares, each of which, and each subdivision of which, can be described by a series of letters and numbers arbitrarily chosen in advance.

to itself, and that on account of the individuality of each one of those guns, fifteen minutes isn't too long to ask that Observer to wait.



If we are firing a piece which has a variable charge, we have first to decide on what that charge is going to be, for this is what regulates the angle of descent of the shell. We next decide on the fuse to be used, whether a time fuse or a percussion fuse; and if it is going to be a time fuse we have to decide on the timing. Shrapnel ought to burst fairly high and short, so that the mass of three hundred odd bullets will be blown squarely into the target—but then, you don't use shrapnel against an enemy battery. You use it against troops. H. E. ought to land and burst right on the target, or else the taxpayers have spent something for nothing.

The battery commander then works out the angle of sight, finds the range according to the map, and makes corrections for all the variable errors. Yesterday's registration saves him a whole lot of time in this calculation. The range tables of each gun are based on a normal barometric pressure of thirty inches and a charge temperature of 60° Fahrenheit. Corrections are now made in accordance with the actual temperatures at this particular moment. The direction and velocity of the wind has to be figured next, and the loss of muzzle velocity, due to the wear of the gun, has to be put in somewhere, if not figured in already. These last three elements might conceivably affect the fall of a shell by as much as 100 yards at even as short a range as 3,000 yards. The necessary angle of elevation is found from the range tables, and the combined angles of sight and elevation put on the gun. Our registration data on point R help every step of the way.

The gun is now loaded and ready.

Merely the loading of a 6-inch gun, whose projectile weighs a hundred pounds, takes from three to four minutes. The ordinary range of this gun is 12,000 yards, or about seven miles, and the time of flight of the shell is about twenty-five seconds. The 15-inch "how.," firing a projectile weighing three-quarters of a ton, uses a few seconds more than this to deposit its burden only 9,000 yards away. The little 13-pounder can be loaded in twenty seconds, and takes another twenty seconds to drop a shell 6,000 yards distant. Between the different guns of a battery the interval of shots is perhaps ten seconds for small calibers, and fifteen seconds for large calibers. The Observer can always regulate this to suit his own ability to observe the shots. A simple adjustment, however, may take from an hour to two hours and a half.

Even when the war was well under way, a good many officers misunderstood the conditions, and the Operations Officer of the 12th Aëro Squadron once received from a full-blooded general the simple order: "German artillery firing on my post of command. Stop it."

If the artillery is not used to reglage by airplane, the fire will be correspondingly slower.

Laymen often wonder why so many different kinds of artillery are used and why one good type wouldn't do for all purposes. But it is physically impossible for any one gun to perform several functions. Some duties require heavy projectiles, and others demand quick changes of objective; and as Heywood Broun says of Charlie Chaplin, you can't throw your pie and have it too. The same gun won't do for destroying wire and demolishing distant batteries. You don't want to waste a big gun on an enemy machine-gun nest, nor do you want to fire a light field piece at an enemy headquarters. So that the general scheme is to use guns like the 75's against enemy machine guns, troops at close range, wire entanglements, and for barrages. Medium guns are used to destroy wire and to destroy guns smaller than themselves. Heavy guns are for strong defenses and long-range targets. All howitzers and mortars are for heavily protected or subterranean targets which take very hard hitting.

Observers are often sent out specifically to spot fire for certain batteries on certain objectives; and at other times an Observer will discover a good target, by accident or design, and ask his battery whether it wants to try a shot.

Usually the Observer who first happens on a good target will spot the fire upon it. A good target is anything from an enemy battery to a train of motor trucks—anything which is worth our while to demolish or to damage or to annoy. Of course, provision is made for difference of opinion between the Observer and his battery. Neither is particularly mercurial, but the battery may not care to fire at the first target offered to it, or it may have picked out its own target, which it thinks is more important. Or the Observer may see a better target than the one he first named, and change his mind. But when the battery has once decided to go ahead and fire, the procedure is absolutely controlled by the battery commander, and the Observer is charged simply with observation. To be sure, he gives the word for the firing of each shot or salvo, and he is at perfect liberty to ask for any particular method of firing, but this is only in order that he will be in a good position to see the result. As we noted in the school problem, the Observer goes through the shoot by signaling with radio, or by projector if there is any reason for discarding radio, and receiving answering signals from the ground panels; and he corrects each shot or salvo until the battery has found the target, after which he can go off and do something else. A clever Observer can handle at least two shoots at once, and sometimes he can handle more than that, especially when big, slow guns are firing.

XXVIII

Generally speaking, there are two kinds of artillery fire—precision fire and zone fire.

Precision fire starts off with trial fire, generally by salvo—meaning that the whole battery of four guns is in the game—with a five-second interval between the different guns, which ordinarily shoot in order from right to left. The Observer reports the deflection and the range of each gun in terms of meters, except that if the first shots show an error of less than 25 meters in deflection, or 50 in range, he simply reports "left" or "short," or whatever the case actually is, and the battery understands. This report is made in one continuous message after the salvo is complete; for example, "065 left, 055 over—040 right, over—over (implying that the deflection is all right)—025 right, short." The interval of five seconds between the guns allows him to judge the record of each gun separately, and also to know if he has missed seeing any of the bursts. If he has, the battery takes its putt over again. It is unusual for a battery to fire in volleys during this method of procedure.

After trial fire comes improvement fire, one gun at a time, until each piece has fired eight shots, the Observer still reporting errors. Fire for effect comes next, and since by this time the battery ought to be pretty well informed, continuous and rapid fire for effect can go ahead, and the Observer can look for something else to shoot at.

Zone fire is by salvo, and is supposed to get the battery into action very quickly. A whole battery fires at once and the Observer reports on each salvo, giving simply the average of the errors of deflection and range. He is dealing, that is, only with the Main Point of Impact. As soon as the battery has got its bracket on the target—that is, as soon as the guns are firing between two imaginary and near-by points which contain the target between them—fire for effect is taken up and put through rapidly, "probably by volleys at a series of ranges through the bracket." The Observer can report only in general terms, but that is all that is wanted. Incidentally, it was shrapnel zone fire which made the quick and lasting reputation of the French 75.

If the target is small the fire is always directed toward the middle of it, but if it is large, or has a wide frontage, the Observer will divide it up among his guns and let each gun nibble away at its own particular section of it, from right to left.

It may astonish some people to learn of the extraordinary appetite of a modern gun. The early Russian estimates of 1914 called for 200 shells per gun per day. The French General Langlois in 1915 wanted 300. The German estimate was 2,000 shells per battery per day, with 2,000 more in reserve for the next day. A field piece retains its accuracy for perhaps 4,000 shots, but the heavier guns don't last so long. The Germans, for example, concede that

150 shots meant the complete loss of usefulness of their 30.5-cm. gun.

Another way of looking at this question, academically, is to estimate the "life" of a gun on the basis of the time it actually takes for a shell to pass through it. The life of the British naval 305 was 3 seconds; of the French 75-mm., 25 seconds; of an average howitzer, 1 minute, and of the average mortar, 5 minutes.

An article in the *Sweiz Zeitschrift f. Art u. Genie* for August, 1918, states that the British at Arras in April, 1917, used 140 guns per kilometer of front, firing 343 shots per minute. The Italians on the Isonzo in 1917 used 100 guns per kilometer of front, and fired 152 shots per minute for 14 hours. But in a single sector north of Arras, the French are said to have used in their *rideau de fer*, or "iron curtain," a quarter of a million shells on a single spring day of 1915. This, however, was about the number that the combined Allies regarded as a day's expenditure at that time. In the reduction of the St. Mihiel salient, September 12–16, 1918, over 700,000 rounds were fired, of which the 75's fired more than half a million. Each of these 75's fired about 250 rounds per day.

Destructive fire, or "hammering," calls for very methodical and continuous work. Before and during an attack, especially, it is important to keep smashing away at every defensive item on the enemy's side; to spoil his protective works, to open up a path for the infantry, and to stun, if possible, the enemy's morale by never letting him rest.

The importance of artillery is obvious; but Colonel Meyler, in the *Revue Militaire Suisse* for August, 1919, points out that it was the Allied superiority in gunnery which proved to be the last straw on the enemy's back. Four months before the war ended, Germany had 20,360 guns of all calibers. On November 10th, Germany had about 13,500 guns in condition; and "barrage fire had been suppressed as too expensive."

XXIX

From the time the Observer is ready and able to spot fire, until his job is done and the battery is firing for effect, he is subject to one of those penalties which invariably seems to accompany a triumph. The airplane has one prime defect. If it could fly to an appointed spot and then stay there, artillery reglage would invariably be fatal to the target and Mr. Woodhouse would have some justification for calling reglage an exact science. But the airplane, which is the only possible vehicle to take the Observer into the enemy's country, can't come to anchor. It is always either approaching or leaving the most interesting spot on the map, which is the target. Or, in other words, "our view is interrupted always by our pace." In modern artillery work, a steep bank is required every thirty to forty-five seconds; and frequently the Observer has to send back a signal which sounds very slangy, "23" ("I was not in a position to see"). He is doing so many circles and figure 8's for Archie's sake, and watching for hostile planes for his own sake, that he does have to miss a good many shots. Frequently an artillery Observer will fly for two or three hours under the most intense bombardment from Archie, and without any chance of getting away from it. Pilots and Observers have landed after a long reglage, and found themselves utterly unable to speak without stuttering.

Radio is slow and reglage takes time; even when the objective is known in advance, and since "the human element is not good for more than, say, three and a half hours,"[1] and a heavy ship carries only enough "sauce" in the gas tank for that amount of flying, it is important not to waste any part of the flying period. The artillery must help by keeping its panels clean and putting them where they will be easy to see—on dark ground, where the sun will strike them. These panels, by the way, are never placed so near to the battery that they would help an enemy Observer to locate the guns.

The Observer has established radio communication with his battery, or larger unit [2]—he did this as soon as he took the air—and he has named the target, asked if the battery wants to fire on it, and received word that it does. From now on it is necessary for the Pilot to help in the teamwork, and unless the Pilot does his share the Observer is helpless. The ship must so maneuver for position that when the order "Fire" is given, the Observer can see the battery, if possible, and see the actual flame of the discharges. As the gun is fired—or the first of the series, or a salvo, as the case may be—he starts his stop watch, turns, and flies directly for the target. Now comes into play his knowledge of times of flight. He must have arranged his maneuver so that he is almost squarely over the target when the shot is due, so that he can observe it (not mistaking the smoke of the enemy's Archies for the burst of one of his own shells) and immediately turn toward home and send

[1] It is a fact, however, that Lieutenant de Brichambaut, of the French army, once flew seven continuous hours on artillery work, and flew 1,100 hours in two years on reglage duty alone.

[2] Each artillery brigade, regiment, and battalion, and sometimes each individual battery, had its own receiving station. In the infantry, receiving stations usually existed only at divisional and brigade headquarters.

back his corrections. His problem is to get a "bracket" on that target—*i.e.*, to get the artillery firing accurately between two points which have the target in the middle, and then narrow down the bracket until the artillery can simply "walk through" the enemy position, or keep banging away at the most sensitive point. The artillery, meanwhile, must try to fire as rapidly as it can, because the Observer is liable to be interrupted at any second by an enemy, or by clouds or bad weather.

The Observer keeps turning all the time, because, first, he wants to see the guns fire; second, he wants to see the shells burst; and finally, he has to send back his corrections while he is flying toward his battery. The reason for this last requirement is the nature of radio impulses. The familiar service illustration is the sole of a boot, with the ship in the center of the heel, flying toward the toe. The strength of the wireless signals is equally strong in all directions for a very short distance only—say, to the edge of the heel—and then it "peaks off" forward and is much stronger in that direction than in any other.

Communication between the plane and the ground is none too good,[1] anyhow; so that the rules of radio are very strict. No ship has any business to send radio within a mile of its own receiving station, or any other station, except under the most extraordinary circumstances; for at this short range it would set up such an electrical disturbance in the air that it would "jam" every ship in the whole sector.

To read the radio signals from any one ship the

[1] The universal testimony is that the American ground radio service was grossly inefficient, due to a lack of appreciation of the value of reglage by airplane.

receiving operator depends principally on the difference in wave lengths. The "wave" is the electrical hysteria which is kicked up in the air by the whole apparatus, and when this wave is interrupted by the Observer, who breaks into it by opening and closing an electrical circuit with his key, the resulting disturbance in the air comes definitely to the receiver in the form of short and long buzzing sounds, or dots and dashes. Each ship has a wave length of its own, but the receiving operator has to "tune out" on his receiving apparatus all the other ships in order to hear distinctly the one whose message he is interested in getting. But since the difference in wave lengths has no effect at all at short range, and a heavy radio impulse drowns weak ones, one ship coming in too close to a receiving station cannot only jam all his friends, but also buzz out all the other receiving stations in the same neighborhood. Five or six ships will get along together very decently in one kilometer of front, provided only that they behave themselves. Otherwise they will have to dispense with the radio and use their projectors.

Furthermore, you get the best results when the antennæ which trail from the plane are parallel to or in a line with the antennæ on the ground. So that the Observer has to attend to his knitting, and fly in his own narrow little alley, and not trespass on anybody else's sector. This explains why, as we have said before, you can afford to leave off the first two figures of your co-ordinates.

Just imagine one army with 10,000 guns and 25 Airplane Observers. Imagine the opposing army with 5,000 guns and 250 Observers. Which side would you choose?

Incidentally, the enemy has receiving stations which are constantly trying to tune in with our ships[1] and steal their messages, so that nothing is ever sent "in clear," but always in code. And when the enemy gets tired of listening at the keyhole he often turns on some of his high-powered juice, in the hope of jamming our whole artillery reglage force out of commission. Here is another reason for carrying projectors.

Sometimes, instead of correcting fire by calling the shots a certain number of meters left or right, short or over, the Observer uses the clock code, which is very simple to send and to read. Assume that the target is the center of a clock face, and is also the center of concentric circles of 50, 100, 200, 300, 400, and 500-meter radii. These circles are called A, B, C, D, E, F. If the Observer reports a shell falling at A2, or C7 (the numbers referring to the relative position of numbers on the dial of a clock) you can see how clearly the battery understands its errors.

Once in a great while the Observer communicates with his battery by means of dropped messages, but this is oftenest done when the battery is inexperienced, and the radio communication is wabbly. The message is written out and put into a container, which has a long cloth streamer hitched to it to attract attention, or sets up a flare when it strikes the ground, and it is dropped as near as possible to the place where it belongs. A message tin never ought to be dropped

[1] The German secret manual for air service said, in reference to the use of radio before a carefully concealed attack: "The allotment of wave lengths and call signs for airplanes and wireless stations requires very careful handling, as the enemy will necessarily have his attention attracted at once to an increase in strength by the use of new call signs. If it is impossible to avoid introducing new call signs, they must be allotted to the stations which are least in use or more difficult for the enemy to overhear."

over one thousand feet. From any higher point it is not blessed to receive. It is more of a bomb than a message. And the Observer has to send word that he intends to drop a message, so that batteries very near the post of command can stop firing—otherwise, he might get in the way of a shell, and his family would have to be content with his War Risk Insurance.

There is one amusing procedure used in open warfare when the Observer hasn't time to send back a routine message. It may be a sudden opportunity too good to miss, and rather than miss it altogether the Observer sends "OG," meaning "Lay on me," and flies along the line of fire toward the objective. The battery simply takes a chance, and the odds are a hundred to one on the target.

XXX

Fugitive targets, or, as Britain more aptly called them, "fleeting opportunities," are not only important, but also intensely exciting. They consist of targets which, whether they are in motion or not, open the door to a sudden and unexpected bombardment; they are opportunities which must be seized immediately, or never. If the Observer sees, for example, a convoy proceeding along a road (this will probably not be in a very advanced position), he tries to get a battery to fire at it; and ordinarily he will be successful, for one 75-mm. and one 155-mm. gun in each division are supposed to be kept free for fugitive targets and supposed already to be registered on a large number of points on the other side. The Observer, in this case, wouldn't ask for fire at the place where the convoy actually is, but he would give the co-ordinate of a piece of road so far ahead, and he would give the command to fire at such an instant, that the shells will fall among the convoy. Big guns like the 155's have a long enough time of flight to allow for rather close calculation and excellent success at a considerable range.

Against a good-sized convoy, or perhaps an enemy battery going calmly along a road, the Observer will send back not only the co-ordinates of the place where he wants the first shells to fall, but also the place where he thinks the convoy ought to be by the time of the second salvo. This should always be a near-by place which the target has to pass—such as the next crossroad, or bridge; for if any point more distant is selected, the enemy might turn off at the first crossroad and spoil the plan. Then the Observer saves several minutes of mathematics by watching the first shell-bursts, judging the second point from them, and rereporting that next point as though it were a deviation from the first. That is, he reports it as so far left or right, short or over. The 75's fire twelve shots as fast as they possibly can, and the Observer sends back simply the M. P. I. In this manner it is possible, once in a while, to chase a fugitive target all over a sector, which is a very sporting proposition—if you happen to be the Observer, and not the target.

Supply trains are splendid fugitive targets, and so are masses of infantry, although the infantry can get itself rather well scattered after the first surprise. In 1915 the British journalists were very much excited about one of their batteries near Ypres, which got a direct hit on a moving railway train eight miles distant.

To give a broad idea of the scope of reglage, you have only to consider the record of the 2d Wing, R. F. C., at the battle of Vimy Ridge. This wing worked with 38 heavy-artillery groups, 55 divisional artillery, and 187 heavy- and siege-battery stations, and its record was: 256 enemy batteries destroyed, 86 gun pits demolished and 240 actually hit, 103 explosions caused, 229 destructive trench shoots, 117 successful registration shoots, 2,843 fugitive-target calls, 406 artillery observation flights—and all this with only 30 machines working on a 7-mile front.

Airplane observation for fugitive targets will be a frequent occurrence in any future war; but reglage on fixed targets will probably not be common in wars of movement, but only in wars of position. Indeed, from July, 1918, reglage on the western front diminished considerably.

The function of artillery reglage in actual battle is well outlined in a paragraph from Ludendorff's manual:

> Action of artillery airplanes after the assault—Only the artillery airplanes remain continuously over the battlefield before, during, and after the assault.
>
> There action in the battle is concerned less with obtaining a large number of observations at the moment of the assault *than* with the *uninterrupted watching of our own and enemy's activity during the whole battle and with rapid and timely reporting to our batteries concerned.* It is of the greatest importance to report the hostile batteries which are most active, batteries successfully engaged, well and badly directed fire, good targets which are not fired on, etc. The artillery airplanes must be given definite orders for such observation, which they must carry out in addition to general supervision of the battlefield. They must know exactly what orders have been given to their own artillery, so that they may suit their action to the course of the battle. Their work will only be successful if they have been thoroughly instructed.

In the London *Times* there was an attractive story which illustrates some of the distractions of a photo Observer. It was a letter from a Pilot, but it is none the less convincing on that account.

AERIAL OBSERVATION

Yesterday, being the first fine day, I had instructions to go up in an F. E. with "P—" as Observer, to take some photographs over ——. It was about the most unpleasant job going, as the numerous woods about there are literally bristling with Archies of no mean prowess, as I can testify, having had, perforce, to sample some of their wares on many a reconnaissance of late.

It took us roughly an hour to get up to 9,000 feet. . . . The air was pretty full of machines. . . . We saw no Huns, though we afterward heard that there were three hanging about behind their lines and worrying a number of our fellows doing photography. . . .

A biplane and a monoplane appeared east of us, the biplane leading, with ample evidence of being in a hurry, with the monoplane—which appeared to be one of our Morane type—overhauling it hands over fists. We were about 2,500 feet over the buses, and when within about a mile I got a glimpse of the monoplane's top wing. Black cross on a white base. Good enough!

Down went the F. E.'s nose almost vertically; 2,000 feet we came down, while the air-speed indicator went up to 160 m. p. h. and then stuck, not having been designed for the purpose of exceeding recognized limits. I expected the F. E. to fold up under the strain any moment, but she stood it like a rock. By this time the other two machines were almost vertically below us—the Hun had caught up with the biplane and was emptying his gun into it at fifty yards range. It subsequently transpired that just at this moment he had put three bullets into the Observer's arm and one through the main petrol tank, with the result that the precious fluid was pouring all over the Pilot, Observer, and fuselage.

I started pulling the F. E. out of her nose-dive about 200 feet above the Hun, as too sudden a shock would inevitably have crumpled her up. The consequence was that we found ourselves above and behind the unfortunate Teuton and within twenty yards of him.

To my mind, he never saw us until we opened fire. Twenty rounds of lead were planted into the back of his neck, though apparently they did not hit him. He then turned his attention to us, turning left-handed and passing directly below us. This necessitated our getting on to a perpendicular bank and doing a complete circuit to see where he'd go to. The little beggar was describing circuits around us, while we did a sort of inner circle, conducted, of course, with a perpendicular bank; but owing to the fact that our speed was so great and that we were doing complete turns in about twice the length of our machine, the centrifugal force was so great that "P." couldn't hold the machine gun on its mounting; it swung down, and—though the whole gun only weighs twenty-eight pounds, he could not pull it up square.

Things being at the moment distinctly unsatisfactory, we were not sorry to see the Hun head for home. After him we went, both diving lustily. . . . I was beginning to get a little anxious, as we were getting very low and expecting Archie to get us any minute, when we got him. The evolutions that machine described falling 7,000 feet, with no man at the wheel, were extraordinary, viewed from above—first, wheels up, then right way again, a loop, several cart wheels, a nose-dive, more loops, and several turns on to and off its back, until it was lost to sight almost on the ground. . . .

The incident over, we started climbing again, as those infernal photographs had to be done. . . .

E.—*Photography*

XXXI

Back in 1859 Napoleon III, at the battle of Solferino, took photographs of the Austrians from the air; in the Civil War photographs were taken from balloons on the line between Richmond and Petersburg; and in 1882 an Englishman named Shadbolt took photographs of London from a balloon; but no specialized aërial camera was ever perfected, even comparatively, until 1913, when Germany officially adopted a Goerz product for her balloon service. This camera was improved by Austrian experts, and still further improved by Russians.

At the outbreak of the war Austria, of all the nations engaged, was well equipped for photographic work; none of our allies were prepared even in an elementary sense; Germany stood next to Austria. The first British aërial photograph was taken in November, 1914, at Neuve Chapelle; and during the first month of operation of a British photo section in France only forty negatives were made. France did not establish her system of allotting one photo section to each army until December, 1914; and Britain was a month later in putting the photographic service on an efficiency basis. The enemy was first to learn, therefore, what sort of aërial photographs have the greatest value. The enemy was first to realize that while 6,000 feet was high altitude for visual reconnaissance, and anything lower was dangerous, the telephoto lens meant that pictures could be taken with utter safety beyond the best range of anti-aircraft guns. The enemy knew, long before anyone else did, that a pretty, conventional black-and-white or sepia print is absolutely valueless for military uses, no matter how popular it is at summer resorts; and that the aërial photograph must be a flat, gray, even-toned print with plenty of detail both in high light and shadow. And the enemy wasn't handicapped, as the rest of us were, in the manufacture of optical glass for lenses. Indeed, Germany and Austria had supplied the world. Britain, in order to establish her first few sections, had to advertise for privately owned lenses, and to pay top prices for them, too.

Yet within a very brief period France demonstrated that a photograph could be taken over the enemy's lines, brought home, developed, printed, interpreted, and passed on to the artillery in as short a time as fifteen minutes. This, of course, was a special stunt, but two hours is a fair latitude for anybody. By the end of the war one ship out of every four on the western front was there for photographic service alone. France and Germany were both getting beautiful photos from 18,000 feet—better pictures than

A TYPICAL OBLIQUE PHOTOGRAPH. NOTE HOW THIS COULD BE USED BY INFANTRY, WHEREAS A VERTICAL PHOTO OF THE SAME TERRAIN WOULD BE HARD TO INTERPRET

any American equipment could get from 12,000. If the war had only stopped and waited for us, we should very likely have done something worth bragging about.

Aërial cameras have little in common with the kind which are advertised to make a summer vacation pleasanter. You couldn't use them to kodak as you go, unless you had a trailer truck to carry the equipment. One familiar type is about six feet long and takes very charming pictures, clear and detailed, from an altitude of over three miles. The more usual varieties are crude-looking contrivances with no style at all and plenty of weight, and they are operated either by a thumb release, something like a telegraph key (or, in one model, like the plunger of a slot machine), or by a cord or chain which offers about as much resistance to the touch as the handle of a healthy cash register; but even so, they took beautiful pictures with 1/500 second exposure,[1] and they could actually take pictures through fog or smoke so dense that the human eye could hardly see what was underneath. Moreover, that wonderful utilization of the panchromatic ray and filter toward the end of the war made it possible to show color gradations on the ground, and this was close to the millennium in photography.

One curious phase of aërial photography is that the extraordinary conditions of the work made it necessary to use a plate shutter instead of a lens shutter. That is, in the ordinary camera the plate or film receives the impression when a shutter placed directly behind the lens is temporarily removed, and allows the light to come in through the lens. In aërial cameras the shutter was placed just in front of the

[1] On account of the speed of the ship, 1/100 second is the *slowest* exposure which can safely be made.

plate, and was as big as the plate itself. It was practically a curtain to be drawn aside at the proper moment.

The French insisted, to the end, that the Observer on photo missions should have his own private ship, with all the attachments and adjustments which best suited his own particular methods.

Aërial cameras are attached to the ship either in the floor of the fuselage or in a wooden rack over the side. In "pin-pointing" an object, the Observer looks through a sort of peephole sight and makes the exposure so that the object will show up reasonably near the center of the negative. Plainly, an aërial photograph isn't worth the danger and expense of taking it unless it shows up the exact object which is wanted.

It isn't much of a trick to take, from a hand camera on the ground, a good picture of a rapidly moving object, and with a graflex you can easily get pictures of automobiles breaking speed records, with no blurs to speak of except those made by the wheels, which often look egg-shaped; but to take from the air, while the plane is in rapid motion, a good picture of any stationary object requires a considerable amount of skill and a considerable amount of practice. Just as on the ground, the important thing is to know exactly when to release the shutter. Any novice can make a good showing if the ship is quite level, but at any other time the photograph will be a trifle distorted; it will turn out slightly oblique instead of vertical, and it will probably be quite useless, because the focus will be different at the points nearest to and farthest from the camera lens. The result will be somewhat like the result of looking into a concave or convex mirror in a dime

MOSAIC MAP OF THE CITY OF WASHINGTON, D. C. PHOTOGRAPHED FROM AN AIRPLANE IN TWO HOURS AND FIFTEEN MINUTES. BY ORDINARY METHOD OF SURVEYING AND MAPPING THIS MAP WOULD TAKE AT LEAST A YEAR TO DUPLICATE

museum. The reflection might indeed be recognized by those who have learned to know and love the subject, but strangers wouldn't see the point. The Observer must learn by experience when he can safely release the shutter, and when he can't. And in action, since the ship must fly level[1] in order to insure good photographs, and since all the opposition of the enemy tends to compel the Pilot to do anything in the world *except* to fly level, the problem is frequently very pretty and very complicated. Fortunately, it demands no technical skill to take aërial photographs. The photo section looks after that, and says to the Observer, in the words of the famous old advertisement: "You press the button—we do the rest."

The greatest trouble in aërial photography is caused by two sources, which can't very well be removed—light and vibration. Just as on the ground, the shutter has to be adjusted with reference to existing light conditions, and if these change while the Observer is en route, he's out of luck, because there is no chance to make a readjustment in the air. Vibration is almost impossible to eliminate, when you have a feather-weight craft attached to a high-powered engine; indeed, the vibration is so great that many of the tiny metal screws become loosened, and sometimes lenses actually drop out of the cameras. The main objection to vibration, however, is that too much of it blurs the photograph.

The actual area covered by a vertical aërial photograph is amazing. From only 4,000 feet, for example, with a 10-inch lens and a 4x5 plate, the longer side of the plate covers about 2,000 feet of ground, and the shorter side covers about 1,600 feet, with a total area

[1] "Level" is at best an approximation. A ship which in five minutes doesn't vary fifteen degrees, even on the calmest day, is achieving a miracle.

of 450,000 square yards, or about 175 acres. At 7,000 feet, the area shown is over 1,000,000 square yards. At 10,000 feet it is nearly 2,250,000 square yards, and it then increases with disproportionate rapidity. The majority of the French photographs, toward the end of the war, were taken from around 18,000 feet, and of course were on much larger plates than 4x5, so that the area shown could be figured in terms of Texas counties.

The vertical photo, which is taken straight downward and has no distortion, is used for general information and for making mosaics and military maps. The oblique photo, taken slanting—not straight down, but from an angle—gives a sort of panoramic view, which isn't of much importance in making war maps, but is very good for showing up contours and other topographical details,[1] which the vertical photo doesn't. Its greatest value is when it is read in connection with a vertical photo of the same object. An article in the *Illustrated World* says that oblique photography was developed because in the early days of the war the infantry in attack were given vertical photos to help them identify their objectives; but when it appeared that the infantry couldn't translate them properly, for lack of experience in interpretation, the oblique photo was thought of, and taken for this purpose. But the fact is that oblique photos, as taken by the Allies for the use of their infantry, are purely incidental; they were taken to secure an idea of contours, for use on maps. The infantry does much better with drafted sketches made from the photos themselves. Germany, however, specialized

[1] One of the most valuable obliques, from a historical standpoint, was taken at Ypres, when an Observer happened to be behind the German lines just as the first gas attack was launched.

in obliques, which they took from hand cameras and "rectified" the prints afterward; for the Germans believed that the advantage of using a hand camera, and dispensing with the nuisance of the awkward over-the-side or in-the-floor mounting, more than made up for the difficulty of rectifying the pictures. A typical hand camera looked like a revolver with elephantiasis; the operator simply aimed it at the objective and pulled the trigger. The first aërial cameras were *all* hand held, and all took obliques, because these were so much more familiar to laymen.

The stereoscopic photo brings out relief, and helps the interpreter to estimate the height and depth of things. The two eyes of the Observer tell him nothing about the relief of objects—for example, the depth of trenches—unless he is only a very few hundred meters high—nor does the single eye of the camera tell the interpreter much about depth, but stereoscopic photos—two pictures of the same object taken side by side—taken from the same altitude bring out the missing facts; and it is even possible to get a stereo effect by mounting two ordinary prints of the same area on a card, as in the old-fashioned method of viewing Niagara Falls with the parlor stereo outfit. The stereo helped to translate little items on the ground which previously had been puzzles, because no one could possibly estimate whether they were one foot or twenty feet tall or deep.

A recent article in *Popular Mechanics* terms the stereoscope "the deadliest weapon of the war," but that does seem to be a little bit extravagant.

Since the vertical photograph is taken either for general information or for keeping up to date the military maps, all important areas are photographed every day and even several times every day; and by this method the smallest changes in the situation show up clearly by a comparison of prints. The military map is made direct from a "mosaic," which is a set of photographs taken in a continuous series so that the same ground which appears as the last inch or so on one plate will also appear as the first inch or so on the next plate. Photographs for mosaics have to be taken while the ship is flying on a dead level. The exposures have to be made at absolutely regular intervals, according to the altitude and flying speed, and according, also, to any "drift" due to crosswinds. If the ship is "crabbing"—*i.e.*, flying across the grain of the wind—the job of fitting all the prints together is naturally more difficult. The Observer sights by various points on the ground, and flies in a straight line over one of the boundaries of the area to be photographed; turns and flies back just inside the boundary; turns again and takes another strip; and so on, covering the entire area in successive strips which overlap both lengthwise and sidewise. The prints are then scaled—and if necessary to bring them to scale, some are enlarged or reduced—and then they are pasted together, generally over an outline map on the same scale, so that the overlapping parts of them *coincide*, and then the whole mosaic, looking like a grotesquely completed jig-saw puzzle, is itself photographed, to make one comprehensive picture. The time and energy saved by this process is enormous. A whole county can be photographed in an hour or two, and a mosaic and map made of it in a few days; whereas to do the same work by an ordinary survey might take a couple of months. Besides, there are no surveying gangs in the front-line trenches.

The information brought out by photographs is amazing. A tiny new-made path may crop up in a photo, and eventually be proved to lead to an unsuspected, underground post of command. Guns are located, organizations are located; intentions are forecasted by dots and spots which would be utterly meaningless to an untrained man.

But although photographic information is the most perfect of all news about the enemy, and although the acquisition of it is a dangerous art, the interpretation of aërial photographs is a safe and an exact science. Strictly speaking, the Observer himself has nothing to do with it; all he does is to take the pictures. The camera is all set for him, and is virtually foolproof. The later work, which has to be done on the ground, is the most delicate and serious and informative of all observation procedure. The vital duty of the Observer is to know exactly what his objective is and how to get it on the plate. He is not responsible for the condition of the camera, or what happens to the pictures after they are developed, except that he ought always to find from the photo section how his pictures have turned out, in order that he can improve his work later. But he ought not to make the mistake of the amateur kodak fiend and use the same magazine of plates twice. The worst of his bugbears is that he can't possibly know, when he is flying, whether his camera is out of order, or not.

America, last in the war, was also last in aërial photography—a difficult thing to understand when you recall not only that the airplane is an American invention, but also that photographs were taken from captive balloons in the Civil War. In the *Century Magazine* for September, 1886, there is an article on aërial photography based on the experiences of the author, an amateur balloonist, in July, 1885, and the theory set forth is quite as modern as anything we could put forward in 1916, and the photographs taken from about 6,000 feet are very good, too. From a single glance, any army officer should have seen the point. The author almost shrieks it. "The stone and rail fences, bounding the fields of all sizes and shapes, are shown with great sharpness. The pasture, meadow, and cultivated land are clearly indicated. . . . The maplike effect is very striking. The course of streams, with the different railroads and highways, may be traced for many miles. . . ."

And so on.

The first American school of aërial photography was opened at Langley Field in October, 1917. Capt. M. A. Kinney, Jr., writing in *Flying*, says that the school had one camera, of foreign make, and was delighted if 50 per cent of the pictures taken at 6,000 feet turned out well. This was while France was photographing beautifully from three times the height, at 99-per-cent efficiency.

XXXII

The habitat of the enemy, his employment, his ambitions, and the state of his health are best and most clearly shown by aërial photography, which is perhaps the most imaginative of all subjects having to do with observation, and certainly is the most vital, although it gets more credit from the enemy than from anybody else. The best Observer who ever lived—or the best thousand of them working in concert—couldn't compete for a moment with the naked eye against the camera lens. The lens catches, in a large area, details as minute as the footprints of a single soldier in the dewy grass of a spring morning, even from an altitude of 15,000 feet. The camera has no personal imagination, no nerves, no prejudices, and doesn't need, for instance, the instructions given to Observers on visual reconnaissance: "German troops march with intervals between sections. Don't mistake the shadows cast by poplar trees across roads for troops in column of route." The camera is a faithful servant, and what it does it does with unapproachable precision.

Because, fifty years ago, the French topographical maps were marvels of accuracy, and perhaps the best in the world, it was expected that during the war France would have a certain tactical advantage over the invader, who was fighting on French soil. But by the time that all the combatants had settled down to trench warfare the topographical landmarks had all disappeared. The forests were blasted into kindling wood and were totally unrecognizable. Church steeples which had been used as bench-marks by the surveyors had simply ceased to exist. The maps were still marvels, for historic purposes, but for military operations they weren't worth the paper they were printed on. They were maps of a land which had become foreign even to itself.

So that from the air France mapped herself anew, and not a blade of grass escaped. Germany did the same. It was indeed, as Rex Beach said, a war of lenses; and as a British officer said, more specifically, "Photography is the *basis* of good artillery."

Just as an illustration of the uncanny uses of aërial photography, in April, 1916, an Observer noted some rather suspicious activity in a forest about twenty-five kilometers from Chalons. The Germans were cutting out a small clearing and the Observer knew what that meant. It was exactly the sort of place in which any artillerist would like to put a big gun emplacement.

Photographs were taken from altitudes so high that the enemy couldn't see the planes and didn't know that their labors had been discovered. From time to time more photographs were taken, until finally one of them disclosed the little circular blot which represented a gun platform.

Six months later, in October, 1916, a quartet of high-explosive shells from this gun fell in Chalons, and the range of about sixteen miles was a long-distance record for artillery at the time. In other words, this was the first of the German superguns, a pet of the Empire, and it was expected to mark the beginning of the Allied downfall. But after the fourth shot the gun fired no more. Heavy naval cannon had been mounted on barges in the Chalons Canal about twelve miles from the forest, the co-ordinates of the German position had been figured out on the map from the photographs, the naval guns had registered very carefully on several different witness points at the same range, and a tremendous rain of shells proceeded to destroy six months of German labor and to nullify the expenditure of a huge amount of money and a large assortment of hopes and anticipations. Of course, the position could have been destroyed by the naval guns long since, but it was good policy to wait until the German gun was set up and could be destroyed also.

Similarly, "the long-range gun which fired on Paris"[1]—which happened, incidentally, to be two

[1] The value of artillery intelligence is nowhere shown more clearly than in the facts which were learned about these guns before they were seen or their positions known. By carefully kept statistics, and by fragments of the shells, the time of flight was calculated, and also the probable characteristics of the gun, the load, and the trajectory, so that France was able to state, long in advance, that the weapon was a Krupp naval 380 mm. tubed down to 220 mm.

guns already firing and a third gun in reserve—was put out of business as a result of photography. Unfortunately, this position in the forest of St. Gobain at Crêpy-en-Laonnois, a village about seventy-five miles northeast of Paris, wasn't detected until it was complete and Paris had been startled, in spite of all that Jules Verne had once predicted. In October, 1917, however, photographs had disclosed a new branch line of the Laon–La Fère Railway; the purpose of the branch was temporarily unguessed. During February, 1918, however, the Observers who went out to hunt for trouble in this neighborhood struck an unexpected air barrage at 3,000 meters, and when they climbed up out of it they found another at 5,000 meters which proved circumstantially that they were on the trail of something important, for air barrages aren't cheap and aren't put up for amusement. As soon as the bombardment of Paris began, the French experts put two and two together and made five, and the only thing left to do was to verify the fact that the spur track ran to St. Gobain and then try to demolish the big guns. They succeeded in putting two of them out of business in short order.

Artillery reglage by photography is very slow, but devilishly accurate, provided always that the weather is good and the ground hasn't previously been torn up so much by shells that the fresh shell holes can't be counted. Photographs are taken in advance, and trial fire is then made late in the afternoon or early in the morning. As soon as the plates are developed the artillery can see for itself exactly where its shells hit and what corrections are necessary; and it can go on firing twice a day, with more photos taken in between times, until it has found the target.

In Champagne in September, 1917, photography discovered a very important telephone central, with more than 150 wires leading out from it. Again it was the part of wisdom to wait until the destruction of the exchange would leave the enemy in dire straits, instead of ruining it at a time when it could easily be rebuilt. The information was quietly salted away for weeks. Then, just ten minutes before an Allied attack, four 270-mm. guns were turned loose on that exchange, putting it completely out of repair, without the slightest chance of its being rebuilt, and preventing any communication between the enemy infantry and artillery. The attack was highly successful, and no wonder.

XXXIII

The Photographic Section at an American air park consisted, theoretically, of 30 men, in command of a sergeant, first class, who was in complete charge of the photographic hut. He was assisted by 3 sergeants, a supply sergeant, a chief draftsman who assembles the panoramic pictures (mosaics), and a chief printer and enlarger. There were 9 corporals, one to repair wooden parts of cameras, one in charge of plate developing, 1 draftsman, 3 printers, 1 print developer, 2 camera repairers and installers, and 2 chauffeurs. Then there were 15 privates, first class—2 draftsmen to correct and retouch prints, 3 print developers, 2 men to wash and dry the plates (they were dried quickly in alcohol), 4 men to wash and dry the prints, 1 plate developer, 1 printer, and 2 motorcycle riders. Forty of these sections were overseas when the war ended, and 49 were in this country, awaiting orders.

The majority of these men were trained first at

INSTRUCTION IN MOSAICS

Madison Barracks, New York (and some at Langley Field), and then by the Eastman Kodak Company in Rochester, New York, and, regardless of the previous commercial or amateur experience which was a basic requirement, they needed anywhere from three to six months of special instruction to fit them for army photographic work, even when this work was simply darkroom practice or retouching. A few students who showed a little more intelligence or ability than the others were sent on to Cornell to be further trained and later commissioned as Photographic Intelligence Officers.

It is a curious thing that films can't be used in the air with any consistent success. The center of a film photograph is almost invariably always out of focus. The aërial photo covers so much ground that a film is never flat enough, and apparently can't be stretched flat enough, to preserve the focus. Britain and France discovered this after unwearying investigation and a constant succession of failures, and America was wise enough, for once, to profit by somebody else's experience. And since an aërial photograph is worthless unless it is clear and full of detail, the question of bulk and weight was also set aside and plate cameras were universally adopted. This meant a lot of extra fuss and bother, for, to be on the safe side, the photographic Observer has to shift every plate through the magazine at least once before it is taken into the air, to make sure that it fits—and plates are mean things to handle, anyway. But they had to be used. The French Observers shifted the plates to make sure; ours didn't.

From Lieutenant Michel we learn how France conducted her photographic work during the first three years of the war:

"Aërial cameras may be automatics,[1] semi-automatics, etc. Automatic cameras are proper for one-seaters, for the Pilot cannot let go of his controls to take the photographs, but they are not needed on airplanes with two seats.

"The best thing on two-seaters is a good plate camera such as the French and English use. Automatic cameras have complicated, fragile mechanisms, which get out of order easily, and in France, where the temperature is often very low in the air, we run the risk of having the oil in the mechanism freeze and the machine refuse to work at all; besides, the operator cannot tell during the flight whether or not his camera is working, and this causes a great deal of trouble. For this reason we should positively not use an automatic camera on an airplane with two seats. Such a course would have bad points and no good points at all.

"There are good points in cameras with telephoto lenses.[2]

"The French cameras have a focus of 10 inches, 20 inches, and 48 inches;[3] the 20-inch and the 48-inch cameras have to be fastened to the airplane; the 10-inch can be worked by hand. For one-seaters the

[1] Automatic cameras are driven by mechanism which makes the exposures regularly at fixed intervals without attention from the Observer. The U. S. Air Service had an automatic camera which made exposures at the rate of 24 per minute. This, however, saw little or no service at the front. We secured from France 87½ per cent of all cameras and photo equipment used by American Observers.

[2] Germany specialized in these, but the point was that Germany preferred to have poorer pictures rather than to have the Observers fly low when there was danger. Rickenbacker describes with much humor his attempts, in a Nieuport with a ceiling of 18,000 feet, to get at a German photo machine which wouldn't come lower than 20,000.

[3] The largest American camera had a 50-inch focal length and took pictures 8x10.

French use an automatic camera with 50 plates and a focus of 10 inches, and have given up films.

"All aërial photographs should be taken vertically; otherwise we would have distortion which makes the reading difficult and inexact. However, once in a while we should take oblique photographs (which cover more ground than the vertical ones) in order to get an idea of the whole sector and in order to get an idea of the contour of the country. Oblique photographs have to be taken at the same height and should overlap one another a little—this in order to join them in making photographic maps or mosaics.

"A good way to get the effect of relief and to see distinctly all the details of a system of defense is to take two photographs of the same object from two points near each other, but separated just the right distance, and then to mount them stereoscopically. Stereoscopic photographs are much used throughout the army in France and have proved very valuable.

"The whole sector to which the aërial photo section has been assigned should be photographed daily; sometimes it is even worth while to do this twice daily, morning and evening; the pictures should be developed very quickly. Two hours after the Observer photographer has returned to the aviation camp all the pictures he has taken should be sent in all directions, to all departments, regiments, batteries, and the Staffs that need them. In the French army they make about 80 copies of each picture, and each Observer always brings in 20 to 30 pictures.

"It is not uncommon for a squadron photographic section to make 1,000 prints a day;[1] to accomplish this

[1] During the Meuse-Argonne offensive, which lasted nine days, one American photographic section alone made 52,000 prints from 860 negatives. British official reports state that British photographers took

rapid development and printing, each French squadron has a photographic section composed of specially trained men.[1] Automatic machines develop and print the photographs."

The automatic camera of which Lieutenant Michel speaks is the French De Ram, which makes its exposures at regular intervals, according to a timing device which may be set as desired, and this is the only complete and practicable automatic which was used during the war. Many other types were tried out, but never passed the experimental stage.

"In some cases, for example with contact patrols, we have to get out our photographic intelligence with the greatest speed. The French photographic service uses a process of developing, printing, and drying which produces one or two prints on paper, completely dried, ten minutes after the photographic airplane has come down.

"The reading and interpretation of the photographs has to be done immediately, for it is of the greatest importance that the information given by the photographs be obtained quickly.

"The photographic work is done in motor laboratories, comprising darkrooms and drawing-rooms. In addition, each photographic section is provided with a wooden portable laboratory.[2] In the sectors of attack several sections are brought together and

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501,116 separate photographs between July, 1916, and November, 1918; and that during the entire war, 5,287,826 prints of aërial photographs were issued by the Air Service in the field.

[1] French photographic methods were studied overseas by picked men from each American section, and the French system was followed throughout.

[2] At Château Thierry one American section spent six days and nights in a suffocating inferno made by bottling up a tent with tar paper and opaque curtains, and in this airless, lightless "hut" they toiled as bravely and as doggedly as any organization which ever took the field.

assigned to a large photographic barracks where the automatic machines are installed.

"The photographic officers should call attention to the new and important details on the face of photographs. These comments are reproduced photographically on the prints for the departments who are not used to reading aërial photographs—infantry, for example. The draftsmen also make photographic maps, intelligence maps, etc., which are reproduced photographically and which give at a glance all the new and important information.

"All the work in a photographic reconnaissance should be done on the same day the reconnaissance is made. The officer should take no rest until everything is finished and the prints sent off, for example, by motorcyclists. It is not uncommon for photographic officers to go several nights without sleeping. What difference does it make? They know the importance of their work and should perform their duties with devotion. When rain comes (and it comes often in France) they will rest."[1]

This mention of rain in France is peculiarly important, and it is noteworthy that special sensitizing of plates was required there, for the French light at its best isn't good. It is often cloudy and almost always hazy. It was really this haze which hurried on the improvement of a marvelous system of panchromatic plates and filtration of light through color-filters which permitted the photography of the ground through all sorts of dust, cloud,[2] and fog, and also

[1] But from a later French authority, "We must be thoroughly convinced of this principle; photographs must be taken at all hours and in all kinds of weather"; and from General Brancker, "The war has taught us to laugh at weather."

[2] Filters can cut through haze, but not through actual cloud banks. Without the filter a photograph might be too indistinct to have any

killed almost every known kind of camouflage. A plate which is rendered susceptible to greens, for example, will show up green foliage and grass very distinctly, but everything else in the picture which has been camouflaged to *look* green will be blurred, if any paint, or painted substance, is used as part of the hoax. Series of photographs can thus be taken of any one region, and they can show up almost everything except what the enemy is actually thinking about. There is no rest for the wicked.

XXXIV

A photographic mission is generally assigned to the Observer in a two-seater, but France was very successful, early in the war, in utilizing the services of photographer Pilots, who flew Spads or Nieuports equipped with automatic cameras on missions far into German territory. This saved the necessity of any teamwork, for the Pilot could work out his plans without having to argue with an Observer, and he could change them on the spur of the moment to suit whatever flying or tactical conditions he found. Many of the French oblique photos were taken from one-seaters; and there was a good reason for this. The best obliques are taken from very low altitudes, and the obliques most valued are those which show the *rear* of enemy works, and therefore have to be taken from behind the enemy lines, aiming toward our own front. It is no idle pastime for a slow two-seater to dive down to 200 or 300 meters over the enemy's head. There is danger from ground fire, and this danger is increased by the fact that a two-seater can't climb out of range again very speedily. A fast plane

value at all, while with it the print would be merely blurred a little, as though the ground had been seen through amber glasses.

can do this and get away in a hurry; but especially during an attack, when obliques are wanted to show the progress of enemy troops, even a one-seater finds it risky enough business to dive so low.

Photographic missions go out regularly, on schedule, are almost invariably furnished (and reconnaissance missions are often furnished) with flying protection; which means that a group of fighting planes precedes the mission to clear a path, or follows it at a few hundred meters' greater altitude, ready to dive upon any enemy which may appear. Curiously enough, *Flight* (England) at the outbreak of the war guessed exactly wrong on this point. "Will slow craft be used as a covering force to retard the movements of the enemy's craft while the faster machines urge their way back with the information that has been secured?" The answer is, "No."

F.—*Photographic Interpretation*

XXXV

"To interpret an aërial photograph is to reverse the habits of a lifetime." On the ground we photograph objects as they really are, and if we stand with the sun behind us we have none of the shadow in the pictures; from the air, we photograph only the top of the object, but in addition we get all of the shadow, and then when we come to interpret the print, we re-create the object partly from the top of it, but principally from the shadow. The Washington Monument, if you turn a Brownie on it from the park near by, will turn out to be the familiar white shaft; but if you photograph it from the air, it will be a tiny dot of white, which is the top of the monument, attached to a considerable pencil of black, which is the shadow.

An inexperienced person, given a set of prints to interpret, is absolutely helpless. The science is one which has to be studied and mastered academically; in the end it becomes remarkably exact. The interpreter is trained to know how things *ought* to look under all sorts of different conditions in a vertical photo. Hence it is that camouflage, even before the introduction of the panchromatic ray and filter, was sometimes ridiculously easy to spot from the air. A battery might have been camouflaged with an overhead screen of chicken wire covered with branches, or a trench may have been concealed by straw piled on a netting, and hidden so well that from 5,000 feet the naked eye would have accepted the deceit; but the texture of the camouflaging material won't cast the same shadow that a thicket or a cluster of trees would; so that the trick won't stand examination by a clever interpreter who knows what the tops of trees *plus* shadow should look like. The camouflage might show up in a photograph like a blot of gray ink—just as camouflaged trenches are often indicated by grayish blurs.

There are other interesting tricks about aërial photography, too. Objects which are really light-colored can turn out dark in a photo, and vice versa, so that the interpreter has to have a well-developed judgment. Take a very faint path across a meadow. From the air, as well as from the ground, the grass itself looks dark, but when a few men walk across it they kick the blades of grass away from the sun, and when the shadow of countless blades along that particular way is removed there appears a faint whitish line. Naturally, there are many instances of mistakes by even the best interpreters. One of them concerned onions. In northeastern France it is customary to dry onions on a surface made by putting straw matting over a framework supported by poles. These were reported as wagon trains. Think it over.

To interpret an aërial photograph you first have to orient it—you have to place it with reference to the points of compass and the map, and then you have to turn it until you get the light to fall upon it just as the light actually fell upon that area which was photographed. In practice, this means that you want the shadows to fall toward you. Otherwise the interpreter would be figuratively standing on his head and he would see mounds where there should be holes, and walls where there should be trenches. Then the scale of distances must be determined, and this is done simply by taking the known distance between any two points as shown on your map and applying it to the same two points as shown on the photo. When you have once obtained your scale you can measure distances accurately on the photograph. After this there are only two steps—to see what is on the photograph, and to make your conclusions. Sherlock Holmes would have adored it.

In a recent issue of a highly technical magazine published in Chicago there is a story regarding photo interpretation which is amusing and instructive, whether it is true or not. This story relates that a certain Brazilian Pilot was sent to Belgium to learn aërial photography. He "spent a week in the air," and was then assigned to a photo hut to learn interpretation. One fatal day when he was alone in the laboratory new plates were rushed in, together with orders to locate some German "pill boxes," which are small, round structures of concrete, accommodating two dozen men, more or less, and at least one machine gun.

The Brazilian quickly found them on the print, some five of them grouped haphazard about three shell holes, marked the location on the map, and within ten minutes the big guns were dropping shells on the Hun positions. So much faith did the artillery officer have in the photographic information that he fired but a few shots, preferring to waste no ammunition.

At the crack of dawn the next morning a photographer flew over and took a picture of the result. Winging back, he attached his plates to a parachute trailing bright red streamers, and dropped it near the hut. Since the Brazilian officer had handled this "case" the day before, the new print was given to him. Studying it, he found that the pill boxes were unhurt, and that by a miracle a dozen new ones had sprung up during the night. He sent this word to the artillery officer. This individual swore that his guns never missed, and came dashing over to photographic headquarters to curse the camera man for blindness.

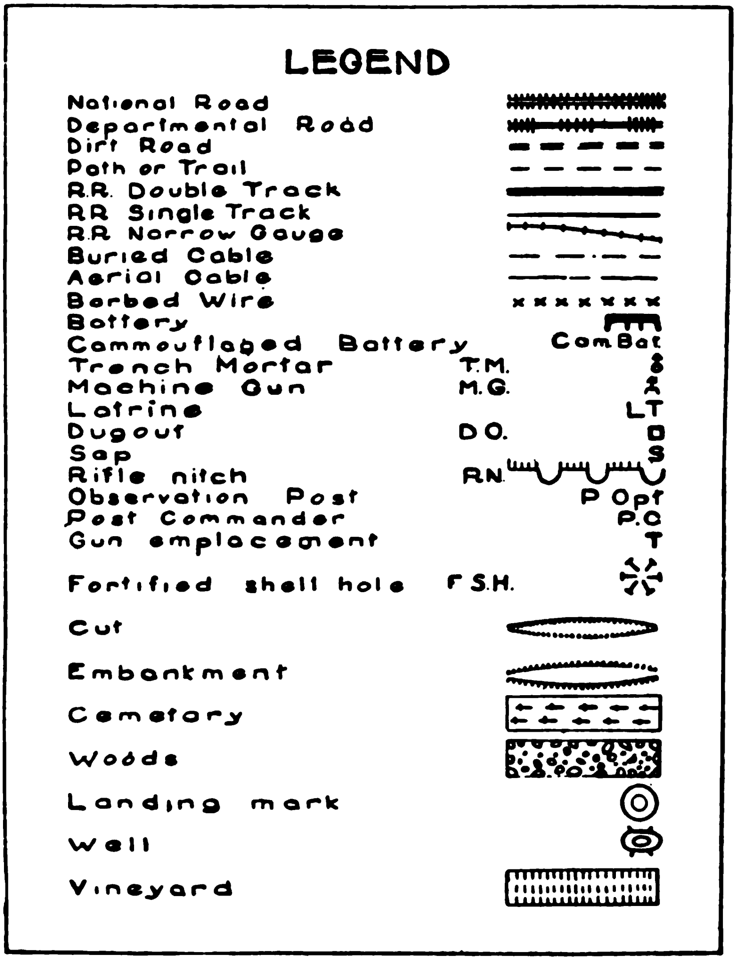
The Brazilian produced the photographs and pointed out the three shell holes and the surrounding pill boxes. The artilleryman was bewildered; the picture didn't "look right" somehow, and yet there were the pill boxes and the shell holes!

At that moment the British expert in charge of the hut came up and glanced at the photograph. With a laugh he turned it end for end.

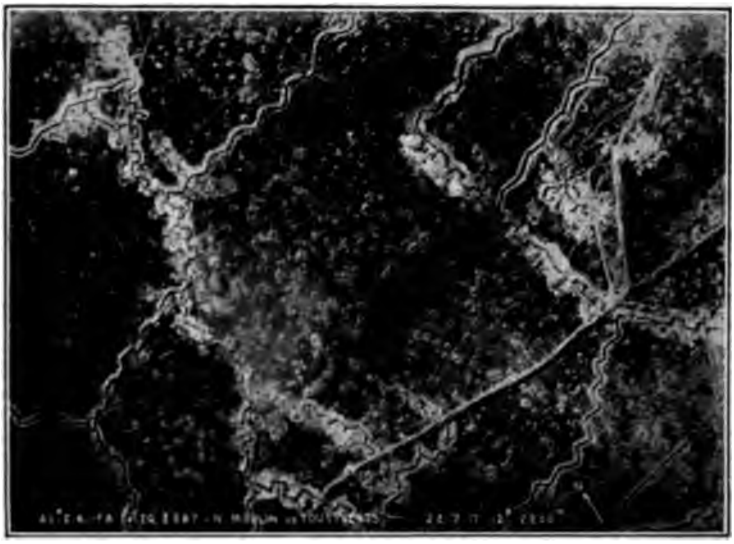
Now there were three pill boxes surrounded by circling shell holes! The Brazilian was crestfallen, as well he might be, for he had been directing the artillery to "strafe" holes in the ground.

Then the article goes on:

The secret of the mystery is this: You, like the British photographers, have been reared in the northern hemisphere and have always seen shadows of objects fall to the north because the sun is always south of you. When you look at these new things, aërial photographs, the only way you have of making them look "natural" is to hunt for shadows. You take your bearings by the direction in which they fall. You know that the sun shining into a hole will light up the northern lip and cast a shadow on the southern side. You also know that the sun shining on a mound will illumine the southern half and leave the northern side in shade.



LEGEND FOR TRENCH PHOTOGRAPHS



PHOTOGRAPH OF THE MOULIN DE TOUS VENTS TRENCHES

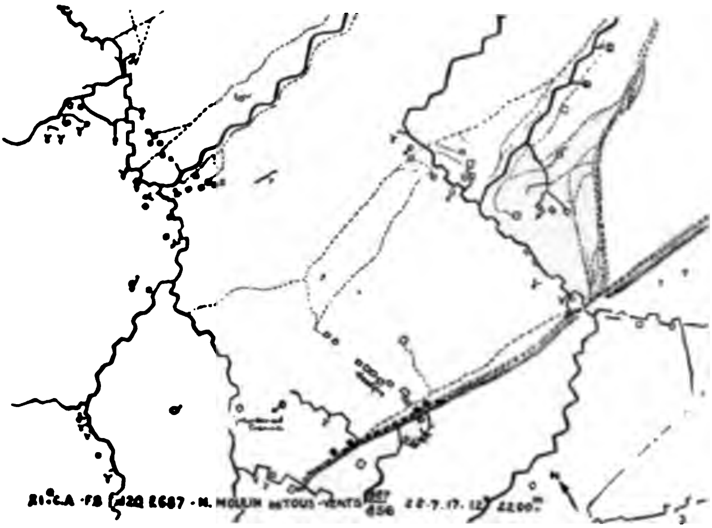


DIAGRAM MADE FROM THE ABOVE PHOTOGRAPH

(See Legend facing page 180)

The Brazilian aviator was reared of course in the southern hemisphere where the sun is always north and where the shadows fall to the south. He saw in the picture just the reverse of what the Britishers saw, and he had not received enough training to know that he might always adjust his mind to the difference.

Now, although this reads very smoothly, it has more loopholes than the pill boxes did. This artillery officer whose guns never missed was *sui generis*—there were never any guns like those in this war or any other (even although one modern textbook does say, fatuously, that "the gunner seldom has to fire more than three shots without hitting the target." If this were true, the war would have ended in 1914). Without correction of fire by an Observer either on the ground (impossible in this case, for "big guns" have rather too long range) or in the air, he would have been lucky to hit within a hundred meters of the objective, even if he had previously registered on witness points in the vicinity. Interpretation, even in emergency, was rarely left to a beginner; and even if it had been, he would probably have remembered that the first thing to do is to set the photo on the map, and then to turn map and all so that the shadows fall toward him, regardless of the points of the compass. That is rule 1, on page 1. It would have been the very first thing he learned.

Moreover, the artillery officer, if he had ever previously studied as many as one aërial photograph, would have known instantly that the print was upside down. The story is too good to be true, but it demonstrates the point perfectly. First, orient your photograph.

Speaking of pill boxes, Lieut.-Col. J. E. Cassidy, C.E., in *Professional Memoirs* for May and June 1919, gives a good description of the last of this type of

German defensive work, as found in the lower Argonne on the Hindenburg-Wotan Line:

The thickness of walls and roof, and heavy reinforcement of the concrete, as well as the openings for machine guns to provide flank and frontal fire, are especially noteworthy The complete system was laid out so as to provide for the area directly in front of any one unit to be swept with fire from the adjoining pill boxes on each flank. Paths were cut entirely across the plateau so that roads and other positions were commanded by the fire from this unit. The gallery leading from the interior of this pill box to the deep shelter was concreted to a distance of 37 feet from the floor, the remainder of the gallery being cased with standard wood casing. The ingenious arrangement of hoods over each machine-gun opening was to protect the gunners from the flare of bursting shells. A fireplace was constructed in the wall. The two machine guns were arranged so that one man operated each pair of guns. This pill box was heavily mined and the wires ran back 150 yards, so that the structure could be blown up if the gunners were forced to withdraw. The roof camouflage consisted in the actual transplanting of some of the surrounding shrubbery The steel reinforcement consisted of round rods about .75 inch in diameter, bent and shaped in various ways. The deep gallery shelter contained four bunks, though the manning of all the guns required five men. For some reason, the right flank wall was but 3 feet 5 inches thick as against 5 feet for the other walls and roof. The entrance to the pill box was from ground level, about 3x3 feet, being protected by a hood also. This entrance during active operation was protected by an armor-plate shield with machine-gun ports for two guns in same.

It is too bad to spoil a good aviation story by dragging in all this ponderous description of a concrete bungalow, but we draw the line right here—and the Hindenburg Line is a very good place to go ahead from.

XXXVI

In the military sense, nothing is of independent value. Nothing exists except in its relation to something else—a doctrine which is halfway between Christian Science and Unitarianism. Even the clearest and most detailed of aërial photographs may require other data—such as other photographs, or balloon reports, or the testimony of sour prisoners—to make it truly illuminating.

The interpreter, above all, must have a very lively mental vision. He should be imaginative, not as a writer of fiction is imaginative, but rather as a reader of it ought to be. That is, he ought always to be wondering about the outcome, and trying to guess it before he has finished with the story. He must know just how any given object on the ground will look when seen from above. He must have learned his business from the ground up, and then with equal thoroughness from the air down. He must put himself in the enemy's frame of mind, and know how the enemy applies himself to the arduous duty of thinking. He must know, by constant study, every inch of the country which has been and is to be photographed, so that he won't be misled by the absence of contours from the photographs.

There is a rather improbable story about a German railroad which, in a photo, disappeared for a mile or so into a field and then reappeared; the mystery remained unsolved until somebody "guessed" that it was a tunneled mountain. The theory, however, is correct, for all the world looks flat in an aërial photograph. The interpreter must even know a little bit about geology, because "works will not present the same aspect, and, in consequence, will not have the same value when they are in the marshes of the Somme, the sandy clay top soil of Artois, as in the chalk of Champagne, the rocks of the Vosges, or in the sand dunes. The possibilities of excavations will not be the same." Trenches in the Champagne district, for example, were strikingly outlined in white, and the untouched ground was almost black by comparison, so that the smaller details were very hard to pick out.

The interpreter must know shadows not as an artist knows them, but rather as a scientist knows them. The shadow is his best friend; and by its length and shape he not only pictures to himself the object which cast it, but he can also judge the size and shape of other objects close by, whose own shadows are perhaps indistinct or misshaped. Without the shadow, he could hardly tell an embankment from a trench; and he certainly couldn't hope to distinguish between a gun emplacement and a haystack, unless somebody told him that one of them was shooting at us.

As soon as you pick up any aërial photograph, even if it is your first trial of skill in interpretation, you will instantly recognize certain landmarks, which by their very shape, or general appearance, fairly leap out at you, and introduce themselves. These are the items which your innate common sense interprets for you; there are only a few of them, but such as they are, they are unmistakable. A trench system with its familiar irregularities is recognizable on sight, whether you have seen one before or not, and so is the snakelike image of a watercourse, and so is a road. And since a road—or its legitimate offspring, a path—is probably the easiest landmark to get acquainted with, and assuredly the commonest in aërial photographs, we may as well get it out of the way at once.

Railroads, as seen from above, make dark lines, (and will be discussed later), but highways and paths are either fine, white or gray lines, or wider ribbons, depending upon their actual width. Perhaps you can discern the poplar hedges of a national highway, which also is very wide and straight, and you know that this type of road is supposedly the best there is, but the supposition doesn't prove that it is now in first-rate condition. Far from it. You cannot put your finger on a road and call it a good road, or a bad one, or an indifferent one; but in the war zone it was fairly safe to reason that most of them were bad, but passable. They may have been good before the war, but so were some of the conscientious objectors. In practice, since the war was fought on soil whose every inch was known to the topographers, it was possible to guess at the quality of a roadbed from its pre-war condition; but in general, one had to see first what the road was used for, and form an opinion on that basis. If it could stand a lot of traffic, it was a good enough road to warrant a little shell fire to make it worse. If it were being neglected, it wasn't worth bothering about, anyway.

Paths are faint and narrow markings, many of them rather distant from any other means of traffic, and many of them leading into regular roads.

Now to the average traveler, or to one who reads a map in preparation for a motor trip, a road is simply an artery of passage from one place to another. What lies beside it, or on the crossroads, is inconsequential; only the road itself, and the terminals, and the tearooms, and gift shops and garages matter very much. But in an aërial photograph, a road or a path is important not only on account of the traffic which goes over it, but also on account of all the various items of construction along the wayside, and upon the branch roads which lead away from it.

It is its own clearest signboard. For you must always remember that in active service nothing visible is made for fun or allowed to be visible if there is any way of hiding it, and that the things which are transported along a road are going to be used somewhere near it, although not necessarily on it. Furthermore, the soldiers who travel along any thoroughfare are going somewhere besides to the movies. The conclusive terminal of a road and the terminal of any path is almost always a thing of portent. We therefore watch both sides of any thoroughfare for dugouts, machine guns, mortars, and, in short, any implement or incident of warfare for which the materials could have been, or might later be, transported along that particular passageway. And we follow a path to the bitter end to see if it leads to any new construction work, or to a post of command, or to anything else of interest.

Now, in the first place, you can tell something about the amount of traffic over a road, or path, by the surface appearance of it. An abandoned road, whether it happens to be in France or in the backwoods of Arkansas, tries to revert to nature. Weeds and grass spring up; and day by day the road grows fainter and fainter, and in time, if nothing came along to disturb it, would disappear entirely from a photograph. Then the number of tributary roads, and their own condition, tell a little more about the amount of the traffic over a main artery. One of the tricks of the trade, by the way, is to wait until the enemy's traffic gets congested, and then bombard the road.

It stands to reason that if, on an aërial photograph, you follow any man-made track, no matter whether

PHOTOGRAPH OF THE ST. ÉTIENNE TRENCHES

(Note flying field)

DIAGRAM MADE FROM THE ABOVE PHOTOGRAPH

(See Legend facing page 180)

it is a broad-gauge railway or a simple upland trail, you are sure to discover either the purpose for which the tracks were made, or some use to which the enemy has put the asset which he found already made and waiting for him. For instance, a brand-new path to a battery which has supposedly been put out of commission, or is still under fire, is a sure proof that the enemy is hiding near that place or plans to come back as soon as the storm is over. It proves, that is, that the position isn't quite demolished and that somebody is interested in its welfare. You can take it for granted that there are still some habitable dugouts in the neighborhood, because the enemy isn't going to wander about and make fresh paths for the pleasure of mere exercise while a bombardment is going on, unless there is some place for him to dodge into at a moment's notice. Similarly, you can watch the construction of new roads and gather impressions without end.

Nothing, however carefully camouflaged it is, can long escape notice if there is the faintest sort of path leading to it. And often we follow the reasoning of the boy who found the lost cow when everyone else had failed. He sat down and figured out where he would go if he were a cow, and he did, and she had. We know what we—if we were the enemy—would establish at a certain point where a path ends, and he usually has.

It is said that once a clever interpreter noticed through a long succession of daily photographs the gradual, delicate darkening of a highway, beginning at some enemy headquarters and running as far as a certain forest. The road was so important that there was practically no chance at all of its being abandoned, so that obviously it was growing dark for some other reason. He guessed that the darkening effect was due to crushed stone put on the road to strengthen it. The stone, being loosely packed, caught the light differently. He decided that the road had probably been prepared for the heavy traffic of artillery; he caused new negatives to be taken of the woods where the dark part of the road showed, and he found a battery in the woods. And this story, unlike the other, isn't in the least improbable.

XXXVII

You cannot have a battery position, or an ammunition dump, or any other place where heavy merchandise is stored or used, without some fairly easy way of getting to it, by either light railways or motor trucks, because heavy materials can't be transported by hand. Nor can you have battery positions, or dumps, or headquarters, or billets, without a good many man tracks[1] leading to them. These headquarters and dumps and so on are what you naturally expect to find at the end of wide paths, behind the lines. But similar tracks in the front lines, or ahead of them, beckon us on to far less noticeable points—to observation posts and occupied shell holes. And when there is a barbed-wire entanglement with a tiny whitish line across it, we have discovered a gap in the wire through which patrols, or working parties, go out into No Man's Land. The whitish line is the path through the wire.

Within the range of our guns the troops of the

[1] To cheat the camera, all sorts of devices were used to prevent making paths which would show up from the air. See pages 214–5.

enemy travel up to the front, by daylight, through communicating trenches; at night, when there isn't so much need of concealment, they go up by paths, or by light railroads. These particular paths tell us nearly everything we need to know about the procedure of distributing men on the other side. We can form, by the size and freshness of any road or path, a decent estimate of its importance; and so we can distinguish between a path which is wide enough only for men in single file, and a road on which bodies of men may move in close column, and a road which is wide enough for trucks to pass each other comfortably. And, of course, we have probably seen these arteries in actual use. But suppose we haven't. Suppose we see, then, starting from a base, far behind the lines, a good, wide road which presently divides in a fork, and each tine of the fork presently divides again, and keeps on dividing into almost as many other forks as the 1847 Rogers Brothers ever built, and then into numerous paths leading into the communicating trenches. These are the ways by which the enemy, bringing up fresh troops for relief, saves congestion by splitting a division into brigades at the first fork, then into regiments at the second set of forks, then into battalions, and finally into companies or platoons, each with its own predetermined quarters in the trenches and its own especial schedule and route for getting there. We know, as clearly as though the enemy had written us a letter about it, just how he distributes his troops in that region; we know by what routes he brings up his supplies and reinforcements, and we make good use of the knowledge. If we can find out when he is relieving his front-line troops, we drop shells, at moments most inopportune for him, at the most important forks; and if these paths come together again, by necessity, at any obstacle which has to be crossed (a wire entanglement, for example, or a trench in the line of march) we drop shells there, too. The enemy can't afford to make too many cuttings in his wire; he doesn't want to bridge a trench too many times; he can't afford to have a main road crossed, and blocked, in a hundred different places by troops. Therefore he establishes fixed crossings, where the troops may have to come together again for a little while. These are beautiful little places to bombard.

Trained interpreters can judge, by the condition and the size of these paths leading up to the front, and also by the number of dugouts in a given area, how many troops can probably be sent up into the region without crowding. This judgment, backed up by visual observation and confirmed by any prisoners who show an inclination to discuss the affairs of their commanders, betrays the real strength of the enemy in that locality; and when you know his strength you also know something about his plan. Because later, if you discover that he is sending up more men than the dugouts will conveniently hold, you know that he plans to make up the deficit by coming over and capturing some of yours. Likewise, if his transportation begins to fall off, it may be just the time to send over a sharp and unsuspected attack of your own.

XXXVIII

We have already noted how the Observer regulates artillery fire by watching the fall of shells, and sending back to the batteries by radio the information by which the range, and the deflection, is corrected.

But the Observer, no matter how lynx-eyed, can never hope to report accurately upon the actual amount of destruction done by the guns. He can tell about the hits, but not about the damage. Once again the photograph is necessary.

Now an aërial photograph is often called a "paper target," because it shows the result of gun-fire as clearly as though it were a standard target in an indoor shooting gallery. There are, of course, occasional shoots which last for only a brief period; but there are also bombardments which go on for several days at a time; and it is the photographs, taken at frequent intervals, which finally record the success or the failure of the undertaking.

The essential function of artillery fire, except in barrages, is to demolish the enemy's works, not simply to silence or "neutralize" a battery, and to chase a few squads of frightened soldiers into a dug-out, but to ruin completely both the offensive and defensive value of the target. To do less than this is to waste both time and ammunition, unless the occasion is purely momentary. Neutralizing an enemy battery simply keeps it out of business for a short time; it can start firing again as soon as the opposing guns let up. The object, then, is to spoil the whole works and everything connected with it, and to make such a thorough job of it that the enemy will have little enthusiasm for reconstruction. We have said that it takes perhaps a hundred shots from a 6-inch howitzer to destroy a single gun pit. It takes about six hundred shells, however, to demolish any large and well-built position; even a dozen or so of good plump hits do not necessarily spoil the entire value of it; and we therefore take plenty of vertical and stereo photographs to show just when the destruction is completed and when we can call off the expenditure of the people's money and save taxes.

In demolition photographs, a battery is marked down as demolished only when there is nothing of the battery left—no guns, no casements, no dugouts, "nothing but a thick spatter of shell holes, and the more the better."

A demolished trench is easy to interpret, because at each end of the wreck there shows the unharmed continuation of trench, which furnishes a good basis of comparison. In the demolished part, the characteristic curves or angles are all bashed in, and nothing is left but a welter of torn and scattered earth, making a blurred and irregular wide gray ribbon on the print.[1] And since the object of a trench is to give shelter to the men who live in it, a trench isn't truly demolished until the last little element of protection is blasted away. To be sure, the enemy can rebuild the trench if he wants to, but our daily photographs will show up the new paths to it, and the materials, and the beginnings of the construction itself, and we can open fire again if we care to, and annoy him exceedingly. One of the axioms of artillery is that sufficient fire will positively destroy any trench; and that, if the result is worth the cost, the enemy can be kept perpetually at the work of rebuilding, and be condemned to a life of labor as unproductive as that of the pin-boy in a bowling alley.

Wire appears normally in a photograph as a black or a gray ribbon; and can be set down as demolished when the ribbonlike appearance is quite gone, and not until then. As in the case of fire against batteries,

[1] This sentence is from the author's notebook; it sounds too exotic to be original, but there is no annotation of credit to anyone else.

a few good hits or even a huge number of hits don't mean absolute destruction, and there will always, in any case, be a few isolated pieces of wire left standing. If only a few gashes are made, the enemy can easily train machine guns upon them, so that any attempt of ours to attack through these gateways would mean that our men would suddenly be caught in a death trap. The whole entanglement, then, must be shot away as much as possible; and dozens of photographs are required for proof. In general, no attack is ever made until the Air Service reports, both by photos and by visual observation, that the enemy's wire is down. You can imagine what a task this is when you know that the wire entanglements on the Hindenburg Line were as wide as thirty feet, a mass of loosely strung metal from two and a half to four feet high, and there were miles and miles of it. Obviously, wire like this can't be blown out of existence even by the fiercest of bombardments. Parts of it will always be left; the point is simply to do away with enough of it to make passage possible. It takes about twenty thousand shells from field guns to smash the enemy wire on a fifty-mile front.

In the matter of demolished dugouts we have a trifle more difficulty in saying when the job is finished, for the ordinary dugout is described as a whitish, squarish spot, and a shell hole is honored by the same description. There is always one good clue, however, and that is the shadow of the entrance of the dugout. This shadow is a tiny black dot, almost square. A shell hole, on the other hand, has no formal entrance, for if anybody wants to get into it in a hurry he goes in by the nearer door. An ordinary shell hole may be described, briefly, as a shelter consisting entirely of entrance and exit. But if this shadow of the dugout entrance has vanished, it is probably by the magic touch of an exploding shell. No dugout is safe for autocracy if the entrance is blocked up, no matter whether the enemy is inside or out. Again, our daily photographs will tell us what the enemy is doing with his ruined sanctuary—whether he is remodeling it for new tenants, or whether he has decided that he is permanently evicted.

Finally, the demolition of buildings, whether they are isolated, semidetached, in an exclusive suburb, or even in a town—this must be perfect, for even a wall or a cellar is a good refuge, and a better place for a machine gun. Villages used to be considered bad medicine, and generals avoided them, but now they are regarded as priceless. And it often happens that a partly destroyed building makes a better defensive position than a new one, because the material is all jolted down in a mass until it's almost solid. But a building is so regularly formed, and the characteristics of it are so easily marked, that there is hardly any difficulty (especially with oblique photos) in telling whether or not the occupants have gone to Ostend for the season.

XXXIX

As we have shown before, the German defensive system was based upon successive *positions*, each of them made up of several lines of trenches, and we also found that between the successive pairs of *positions* there was an intermediate position, to be used as a temporary waiting room. Theoretically this intermediate position was a trench, but practically it was almost always a ridge, or a vale, or a wall, or any sort of elevation or depression which furnished as much protection as the Hun thought necessary—and this was generally a good deal. Organized shell holes were popular, but anything was acceptable.

The *lines* are made up of trenches which are built around a few strongly fortified places called "centers of resistance," or, as the British terminology quaintly has it, "keeps." The lines were like a system of veins running out from the center of resistance, as a heart.

Centers of resistance follow the generally accepted principle of labor saving, for it is always easier to take advantage of the work of somebody else, or of the convolutions of nature, than to manufacture something from the ground up. These centers, therefore, were customarily built up in villages and forests, or on small hills. Their main purpose is to furnish a stumbling block for the troops who attack them. The idea is to make them so strong that, no matter how violent an attack is made, the attackers will be held up for a while at these centers, and in the meantime the supporting troops farther in the rear will have a chance to come up and start something. Villages, especially when a large number of the houses have cellars, are particularly attractive, for they contain a large amount of building materials which, although the architect never intended to use them for protection against anything but weather, make good protection from bullets. Woods are splendid for concealment and also offer building material in its original state, but there is ever present the annoying fact that to make use of too much of the material takes just so much away from the concealment. You can't make a tree occupy two places at the same time.

From these centers trenches were dug in all directions; and the trenches were filled with machine guns and trench mortars, for which the Germans usually provided rather elaborate concrete settings. Throughout the German system they acted as though they expected to stay in one place for a long time. On the Allied side, everything was built as though the Allies expected to move forward at any moment. As many of the guns and mortars as possible were planted at crossroads and in communicating trenches so as to enfilade anybody who ever came over to investigate. To enfilade the enemy is to get a line of fire on his flank instead of his front. A single bullet fired from in front is likely to hit one man or go for nothing, but a single bullet fired from an enfilading position has a chance of hitting almost anybody in the whole detachment.

In front of these trenches, barbed-wire entanglements were put up; and finally, a very large number of dugouts were built so deeply and solidly as to be practically immune to bombardment. These dugouts were there for two reasons—to hold the reserves and to provide a welcome home for any front-line troops which had been driven back to them.

Trenches are almost never built in anything like a straight line; but alternate fire bays and traverses. The crookedness of them is primarily to prevent enfilading. The average German trench was about ten feet wide. All trenches include the "fire step," which is merely an elevated step on the side of the trench toward the enemy. One has to stand on this to shoot over the parapet.

XL

In an aërial photograph, trenches are distinguished by the black lines caused by the shadow of the trench within itself, and by the shadows of the piles of earth, and sandbags, in front and behind it. That is, if a trench is built from north to south, and the light is coming into it from the east, then the eastern wall of that trench will show up in the picture as a perfectly black line. On one side or the other, or even on both sides of the trench, there will be a pile of dirt and sandbags perhaps as much as eight or ten feet wide, and this is naturally very much lighter than the black line of the trench itself and makes a sharp contrast with it. The appearance of the parapet and the parados depends partly upon the newness of the work and partly on the natural color value of the soil, and this is one of the reasons why the interpreter needs to have more than a slight knowledge of all the peculiarities of the country in which he is working. He must know what the soil looks like under different conditions, and whether it ought to show up as light or dark. Even half an hour's drizzle will change the whole appearance of a parapet.

"Every now and then, in a trench photograph, you will see tiny black notches, like little saw teeth, and these are rifle niches; and then, every now and then, you will discover a shadow on a parapet at a considerable angle from the trench proper, and this is a loophole for fire."

When a trench has been covered over, either to protect it from aërial observation or from actual fire, or perhaps for no more serious purpose than to protect men from the depressing effects of rain, it is sometimes easy, and sometimes very difficult, to discover it. But if such a trench has been fully completed and covers any considerable distance, it will have to have some means of ventilation, even for Germans, and ventilating chimneys show up as tiny black points on top of it. It is the easiest thing in the world to spot a covered trench in process of construction, because there are always cross bars over the trench, put there for the purpose of holding up the roof.

Except from stereos, it is hard to estimate the depth of a trench. Some are only 8 or 9 feet deep, and others, such as the Germans dug in Artois and Champagne, may be 25 or 30 feet deep.

XLI

When the old-fashioned war of movement merged in the modern war of position, and armies for the first time locked themselves into trenches, the abatis was generally constructed according to old-fashioned military principles out of trees, stakes, and pits. In a very short time, however, it developed that barbed wire was easier to set up and a great deal more effective as a defense. Moreover, it could be obtained in large quantities.

If an amateur is given an aërial photograph and asked to point to a line of barbed wire, the chances are a thousand to one that he will never discover it. He won't know what he ought to look for, but he won't dream of looking for what the wire actually looks like. Wire appears on a photograph as a broad ribbon varying in tone from gray to black. When it is gray, it has been set up rather recently. This lighter tone is caused partly by the wire itself, and partly by the fact that the men who set it up have trampled the ground and changed the color tone of it from dark to light. When the line of the wire is dark, it is because the set-up has been there for some time, and the vegetation has had a chance to recover from the large feet of the wiring party.

These ribbons of barbed wire are not, by any means, all parallel to the course of the trenches, but wander all over the landscape. Photographs will often show gaps in the wire through which parties may pass. It is usually a good thing, however, for a force which intends to take advantage of the gaps in the enemy's barbed wire to make sure—as they can very easily do from the photographs—that the enemy hasn't a lot of machine guns bearing on these same gaps.

Toward the end of the war the Germans, who had the best wire, anyway, developed a brand which threw so little shadow that it showed up very faintly or not at all in an ordinary vertical photograph. Here was where the advantage of the oblique photograph came in. We have already shown that the best plan is to take many vertical and oblique photographs of the same point. Wire which was shadowless in one picture showed perfectly clear and distinct in the other.

In ordinary interpretation, wire is good circumstantial evidence of something which the enemy thinks is worth while defending. A new set-up of wire is the very first sign that the enemy has decided to protect something else, and he used wire, not only to protect his trenches, but also to protect batteries, small villages, and anything else which is especially precious in his sight.

There is practically only one way in which wire can be set up to cheat the aërial photograph; and that is to set it up below the surface of the ground in a ditch or right through a hedge. But inasmuch as we never trust a ditch or a hedge for friendship, it is merely the photograph and not the interpreter who is cheated.

XLII

Communicating trenches tie together the whole trench system and also provide an exit in case of fire. They are sometimes straight, but usually zigzag, although they seldom display any of the wayward designs found in other kinds of trenches. When they are exposed they are naturally very easy to detect, but if they chance to be covered there is little hope of locating them, unless previous photographs caught them under construction. They have to have their ventilating chimneys, too, but there is a great difference between spotting a chimney when the general scheme of the rest of the trenches gives rise to a suspicion that one exists, and also some idea of where to look for it, and spotting one when it might be anywhere in the whole area of the photograph, and when no suspicion of its existence has previously been raised. There is no way of guessing where a communicating trench ought to begin; you have to examine the print with the most concentrated and petty care. It is the frequent and regular taking of photographs which catches these infinitesimal points, and sometimes, even after a trench has been carefully covered, a print shows up the grayish appearance of moved earth beside it, and sets the interpreter to hunting, like Santa Claus, for the missing chimney.

Incidentally, communicating trenches are planned as thoughtfully as the main trenches, and not laid out, as one might imagine, by a stencil design. A whole trench system is a bewildering maze which may be anywhere from two to four miles in depth.

XLIII

As soon as aërial photography taught us that the slightest irritation of the soil registers itself as either white or gray on the plate, working parties got their instructions to distribute all over the landscape the earth from excavations, and not to leave it piled where it would amount to a price tag on the defensive system. And again, the laborer was compelled to take an interest in agriculture and to realize that the growth of vegetation is the best joke on the enemy's photo interpreter.

Now the presence of dugouts is marked chiefly by the "spoil" cast up in the process. If dugouts are caught when they are young or half grown, they appear as square or rectangular excavations, and they can later be spotted by the material used for roofing. But when a dugout is once built, the appearance of the earth on it or near it is made to blend as closely as possible with the surrounding soil; it is camouflaged with artificial vegetation or furnished with something more genuine, and after this it is a trifle safer from discovery. The fact that ventilation chimneys are necessary helps a little; and sometimes the entrance appears as a black dot, which may be square, and may be not.

Dugouts are built not merely for "funk holes," or for purposes of official rest and recreation, but also for mine-throwers and machine guns. The Germans, who had more time on their hands than the Allies, made some very massive dugouts, in concrete and masonry, and hid them almost as well as they built them. The largest dugouts were usually placed so as to permit the personnel to reach important near-by points with the greatest speed; and the deepest were usually for high officers. Ordinarily, they held from fifteen to forty men apiece.

The interpreter who has located a dugout isn't supposed to stop there. He is expected to deduce the size of it and the purpose of it. An oblique photograph will tell him a good deal about the size, but the purpose is ferreted out by common sense. Paths or telephone lines leading to a dugout imply the probable headquarters, or hindquarters, of an enemy. The location with reference to the rest of the trench system supplies all the other needed information.

Interpreters are told to hunt for dugouts in the rear of the front lines and in all natural or artificial banks, such as quarries or railroad cuts; and they are also told that a row of new dugouts, outside the actual lines, means the probable establishment of new lines along this base.

XLIV

Early in the war the Germans built some very solid and supposedly permanent machine-gun[1] emplace-

[1] The incredible number of machine guns at the front may be faintly imagined by taking American statistics only. In 1912 we allotted 4 machine guns to each infantry regiment; in 1919 we allotted 336. Modern "Emma-Gees" fire perhaps 900 shots a minute, and each gun certainly has the effectiveness of at least 100 rifles. And on the French front Germany averaged one machine gun to every ten yards. Even when our First Division went into action on July 18, 1918, however, our comprehension of machine-gun methods was so faulty that in four days we lost 80 per cent of our machine-gun personnel and 85 per cent of our material. "It might have been justifiable if we had inflicted fearful execution upon the enemy, but not a single gun team in the division could claim to have fired more than two hundred rounds."—Capt. A. M. PATCH, Jr., *U. S. Inf. Jour.*, A

ments, but as time went on, and the element of permanency was changed a little, the Germans changed, too.

Even in solid emplacements, machine guns are pretty difficult to locate exactly. It is easier to camouflage a machine gun than almost any item of attack or defense; the gun takes up mighty little space; it seldom fires except during an attack or at night, and then it always fires at an angle, against a position not directly opposite. As a matter of fact, the majority of them are discovered by deduction. For example, a machine-gun emplacement may reasonably be expected in any angle of a trench. The machine gun itself may not be there, and probably isn't; for if the sector is fairly quiet, the gun will usually be in a dugout for safety. It stands to reason, then, that an emplacement isn't built for one particular gun, but that a great many emplacements are built in order that the guns can be shuffled around from day to day, to the best advantage. A V-shaped nick in the front of the parapet is the sign of a machine-gun emplacement, for this shows where the earth has been cut away so that the gun can "traverse," or change its aim along the front. The interpreter also looks for machine guns near the communication trenches, and at the same time he looks for the dugouts where the machine gun and the gun crew may rest and play pinochle in betweentimes. The interpreter must go over a photograph very carefully, taking into consideration everything he knows about the nature of the ground, and by his acquaintance with modern tactics he must be able to put his finger on the points at which an intelligent enemy would naturally have machine guns, and then he must examine these points to see if the enemy is as intelligent as we have given him credit for.

"An emplacement which has been carefully prepared is fairly easy to recognize. There is a whitish blur made by the earth which covers the shelter, and in the rear of it there is a tiny black line which represents the entrance. Sometimes the emplacement is shoved out in front of a trench, in which case the shelter is joined to the trench by a little line. If the shelter is casemated, there will be a very small square in the center of the discoloration. Sometimes in the forward part of a shelter there is a little black dot to show the loophole through which the gun will fire.

"It must always be understood that the appearance of all these works varies according to the light upon them, and that their color tone ranges from almost white to almost black. In any event, they are distinguished chiefly by their differentiation from the surrounding soil."

Out of the trenches, machine guns are hidden between the different positions, in cellars, shell holes, hedges, ruins, and other strategical points where there is a good chance of firing at short range. (Machine guns are rarely used at ranges over a half mile.) When they are placed up ahead of the front lines there are invariably paths leading to them, and sometimes there are trenches dug especially, and in most cases they are also protected in a strong little nook of wire.

Interpreters are also taught to regard as suspicious any little cranny or pocket in a wire entanglement—not that there is a machine gun or an emplacement in this nest, but because it is exactly the sort of place in which a gun might later be placed; and this suspicion is doubled if there is any sign of a path leading out to the angle or pocket. A very few machine guns, carefully placed and protected, can hold up a whole division of attacking infantry.

Trench artillery, including the well-known German "Minnie," or *Minenwerfer*, or mine-throwers, are easier to see than machine-gun emplacements, unless they are better camouflaged. "The heavier mortars are casemated, and show up a distinct loophole inclosed in the whitish or grayish blot of the casemate, and sometimes marked in addition by the platform on which the mortar rests. Contrary to general opinion, trench mortars are very rarely located in the trenches themselves, except in trenches which are not ordinarily occupied by troops. They are found more generally along communication trenches and along the lines of the narrow-gauge railways which the Germans like to run through their trench systems. The importance of the mine-throwers to the German led him to treat them with great consideration, and often to establish telephone connections, which are fairly visible. Then, paths sometimes lead to them also. But as a general thing the German concealed them with such zeal that their discovery was often first reported from the ground, after which their exact location might be determined from photographs which previously had not betrayed them."

Trench mortars are really short-range high-explosive bomb-throwers, and were used in great numbers because they were comparatively cheap to make, simple to keep in order, light to transport, and satisfactory in operation.

XLV

A great deal has been written in the current histories of the war about listening posts, and to some readers a listening post implies anything from an old-fashioned sentry box to the mere ground on which the listener crawls. But listening posts are a good deal more important than this, and a good deal more formal. They were located close to the most advanced wire entanglements, and sometimes they were pushed out even into No Man's Land; but wherever they were they were strongly protected by wire, and sometimes guarded by machine guns. Often they were fortified with concrete or masonry.

There is no particularly accurate description of a listening post. They were built where they would be of most service, and built according to the material at hand. But paths or trenches running away from the trench system, especially if they lead toward higher ground or to any natural features which would give a fair amount of concealment, and at the same time a convenient place for listening or observation, must be carefully examined. You hunt for the places where you wouldn't like to have an enemy listening post, and the odds are in favor of his having them in those same places.

Observation posts are a vitally important part of the line, and some of the German O. P.'s were built very strongly of concrete, "set flush in the ground, covered by a steel plate provided with a hole about twelve inches in diameter, through which the head of the observer, or a periscope, could be thrust." The periscope seems preferable.

XLVI

In the first months of the war, before aërial observation had advanced very far, batteries were placed, just as they always had been placed in other wars, more or less in the open or behind some natural protection, with the usual and minor defense of breastworks. "Footpaths and railroads led to them without any camouflage and showed clearly their positions, as well as the communicating trench, communicating the battery with the observer's station." But as the war developed, and it became an axiom that "a battery seen is a battery lost," the guns were camouflaged, and so were the communicating trenches and paths. Sometimes the guns themselves were painted, and sometimes they were concealed under large nettings erected on poles and covered with leaves, grass, and twigs.

During the later years of the war a good many battery emplacements were built not simply for immediate use, but also in places to which batteries might have to retreat, or might want to use temporarily, if their original position had been spotted. Near almost all of these emplacements, whether the guns are in place or not, there will be dugouts for the protection both of men and of ammunition. The Germans used to build at least three or four emplacements for each field battery, and move the guns constantly, sometimes firing flares from the emplacements where the guns *weren't*, in order that flash reconnaissances would be inefficient.

Batteries are protected either by breastworks or by casemates, sometimes built of trees and sometimes of concrete. Because these are so easy to see, they are usually very well camouflaged, but it is almost impossible to prevent discovery by what are known as "blast marks." These are the marks on the ground that show where the earth has been disturbed by the violence of the explosion. Sometimes these marks were partly neutralized by crude oil, mats, and tarpaulins.

The other unavoidable signs of batteries are paths, railroads, and telephone systems. The battery commander and the battery observers on the ground[1] are seriously dependent upon telephones, which run to field exchanges, for connection with balloons, landing fields, and headquarters, sometimes by overhead lines, and sometimes by buried cables.

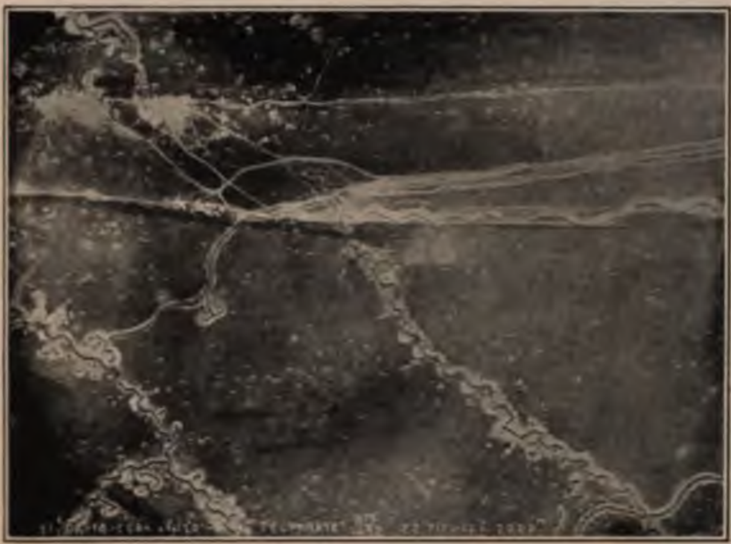
Once in a while it is hard to tell whether or not a battery position is occupied, because the "blast marks" don't necessarily prove that a position is occupied, but merely that at some time or other it *has* been occupied.

"Archies" show up as a circle with a dot in the center, representing the circular emplacement and the gun.

Big guns need broad-gauge railroads to transport both guns and ammunition, and since these guns are best located in forests, the mere fact that a spur track enters a forest is good preliminary evidence either that a big gun is in there somewhere or that one is going to be placed there.

Dummy batteries, which were very frequently used in earlier wars, had little position in this war. Brady's photographs of the Civil War show many "Quaker guns" with straw or wooden figures to deceive the enemy. What would do for the Civil War, however, when observation was all on the ground, wouldn't do for a minute in modern warfare, and if a dummy battery is constructed at all, it must be constructed so that an aërial photograph won't disclose its character at the first glance. France used to trick the Germans before photography was really under way, and watched with joy the waste of imperial ammuni-

[1] The artillery ground observers are commonly in or near the infantry trenches, because their duty is to give the infantry what artillery assistance it wants. It is only in real attack or defense that I. C. P. is practiced.



PHOTOGRAPH OF THE EUPHRATES TRENCHES

DIAGRAM MADE FROM THE ABOVE PHOTOGRAPH

(See Legend facing page 180)

tion; but at the end a dummy battery had to be as carefully placed and camouflaged as a real gun if anyone but the builder was going to be fooled. As a matter of fact, it was a futile sort of proceeding. The rear areas are always pretty well filled with personnel, and if the enemy opened fire on the dummies some one was certain to get hurt.

Batteries were innumerable along the front. The Germans had one field gun for every 19 yards of front, a light field howitzer for every 57 yards, a heavy field howitzer and a 6-inch gun for every 128 yards, a medium siege howitzer for every 256 yards, and a heavy siege gun for every 512 yards. These guns, if placed end to end, would reach from Berlin to almost any given point—except Paris.

XLVII

Railroads show up on an aērial photograph like a sore thumb. Both broad- and narrow-gauge[1] railways are used and are easy to tell apart, the broad-gauge railway by the size of the track, and the light railway by the fact that it has so many tangents and so few wide curves—which, of course, the smaller engines can't take at any speed. All railroads look very dark, in contrast to roads and paths, which are white.

Waterways are quite black in an aērial photograph, and their snakelike wiggles are probably the easiest natural features of all to discover.

It is a curious thing that telephone lines, whether

[1] These narrow-gauge railways, which by the end of the war were in operation to the extent of thousands and thousands of miles, were developed to save congestion of traffic, to furnish transportation over shell-torn areas, and to save labor. The usual light road had a gauge of about 21 inches, and gasoline for motive power. It was a single-track, ungraded road, and could be built at the rate of 6 to 10 miles in 24 hours

they are buried or not, show up with particular clearness. An ordinary line strung on poles appears as a perfectly regular succession of white dots. These are not the poles themselves, but show where the earth has been disturbed in digging the post holes. When trenches have been dug to hold underground wires or cables they are very straight and very narrow, and even when they are filled in so that the cable is entirely underground the long vague outline of the filled-in ditch is very noticeable. Telephones, as Georges Blanchon said in the *Revue des Deux Mondes*, form the nervous system of the trenches.

G.—*Ground Camouflage*

XLVIII

Speaking of camouflage, the subject has never been so well handled in brief space as by Representative A. T. Fuller of Massachusetts, in the *Army and Navy Register* of August 16, 1919, and there is no sense in trying to be original when such a splendid article can be quoted verbatim.

Before I had been on French soil a week I heard so much and saw so much which was strange and new that I felt like a farmer on his first visit to a city.

Take camouflage,[1] for example.

Though there is scarcely a word in the language which has been more used (and misused) since we first heard it during the early days of the war, I found, upon talking with the camofleurs themselves, that, to make use of an English colloquialism, we

[1] France began the art of camouflage in December, 1914, and the originators of the idea were some artists then serving with the artillery. They succeeded in painting, or covering, the big French guns, which were gray-blue in tint, and stood out sharply against the horizon. The work was so successful that a corps was immediately formed to experiment over the whole Picardy front.

had been largely "fed up" on misinformation. Though scores of camouflage stories have been published in our newspapers and magazines, I discovered that of the real work of the Camouflage Corps the public in America was permitted to know next to nothing. Certain of the camouflage operations on our front were of such vital importance that it was necessary to envelop them in the deepest mystery.

When the war ended the American Camouflage Corps consisted of a battalion of engineers, which was on the point of being expanded to a regiment,[1] under the command of Maj. Evarts Tracy, one of the foremost of American architects.

Figures are, as a rule, dry reading, but they provide the best means I know of giving some idea of the magnitude of the operations of our Camouflage Corps. During the summer of 1918 the battalion used materials per month in the following quantities:

Four million three hundred and twenty-eight thousand square yards of burlap.

Two hundred thousand gallons of paint.

Seven thousand seven hundred fish nets.

Fifty thousand pounds of wire.

Two million one hundred and sixty thousand square yards of poultry netting.

These figures will suffice to give you some idea of the importance attached to camouflage in the army.

So important, indeed, was camouflage regarded by the German high command that during the last year of the war there was attached to every German division a "security officer," whose duty it was to enforce the rigid observance of camouflage discipline by the various units of the division to which he was attached.

In many instances these security officers watched their respective divisions from observation balloons. They were answerable only to great headquarters, and were empowered, I understand, to recommend the removal of even divisional commanders for disregarding the rules for camouflage discipline laid down by Ludendorff.

Camouflage, it should be kept in mind, is of two kinds: negative and positive. Negative camouflage consists in the concealment of troops, trenches, mine-shafts, battery positions, ammunition dumps, hangars, and other objects whose location it is necessary to hide from the enemy.

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[1] Each large unit of the French army had at least a squad of camoufleurs.

Positive camouflage, on the contrary, consists in the imitation or suggestion of troops, trenches, batteries, etc., in certain locations, when in reality there was nothing of the sort there. This deceives and bewilders the enemy.

It occasionally becomes necessary, for example, to convince the Germans that a large troop movement was in progress behind a certain sector of the front, whereas the real movement was taking place scores of miles away. If it was desired to suggest a movement by rail, smoke pots with clouds of dense black smoke belching from them were placed on flatcars and moved about from point to point on the military railways. German aviators, observing these columns of smoke at numerous points along the railways, naturally assumed that they came from locomotives hauling troop-laden trains, and promptly reported that large bodies of troops were apparently being moved by rail behind the American lines.

Thereupon the German commander would rush up his reserves to resist the attack which he believed to be impending.

Or if it was desired to imitate a troop movement by road, the camouflage officer would requisition large numbers of Fords, which would be driven madly along the road, dragging bundles of brush behind them. The great clouds of dust which thus suddenly appeared on the highways convinced the German aërial observers that the *verdammte* Yankees were rushing large bodies of troops to the front by bus or motor truck. Fooling Fritz was an amusing and an exciting game while it lasted.

I might say that the Americans won battles on the western front because they were able to anticipate the German plans as a result of aviation photographs,[1] which disclosed the fact that trains were bringing troops and supplies up to a certain point preparatory to an attack. To simplify the work of the aviators maps were furnished them illustrating the country and all its fortifications, artillery, and so forth, as of the day before. The work of the aviator was to note any change on the map.

It has frequently been said that the camera does not lie, but such assertions did not hold good after the Camouflage Corps commenced operations. Thereafter the negatives brought in by the German airmen began to prove so unreliable that the

[1] But as late as May, 1918, the German camouflage was better in some respects than that of France, and often cheated the Observers.

officers whose business it was to interpret them never knew whether they were telling the truth or not.

For example, it frequently became necessary after heavy bombardments, in which long stretches of our entanglements had been destroyed, to convince the enemy that the wire had been repaired. This illusion was accomplished by the simple stratagem of driving stakes into the ground and festooning them with fish nets (hence the 7,700 fish nets used monthly by the Camouflage Corps), for, in a photograph taken from the sky, fish nets thus arranged are indistinguishable from wire. If such ruses are to deceive the enemy, however, as much attention must be paid to detail in their execution as David Belasco pays to detail in the production of a play.

On a certain British sector a not overintelligent subaltern was ordered by his battalion commander to take a working party and put out some 500 yards of this imitation wire, as there was reason to believe that the Huns, thinking the sector unprotected by entanglements, were preparing to make an attack. Now it is some job, even for a large and well-trained working party, to put out 500 yards of wire in much under a day. Heedless of such minor details, however, the lieutenant gayly slammed in his stakes and spread his fish nets as fast as his men could work, "wiring" the 500 yards of front in little more than an hour. From high in the blue the German airmen photographed the proceeding.

When one set of photographs showed a sector destitute of wire and another set of pictures, taken an hour later, showed the same area with a complete set of wire entanglements, the suspicions of Von Hindenburg's intelligence officers naturally were aroused, and the next morning at dawn the Germans launched the attack. In camouflage work, one can't afford to be slipshod.

The most elaborate camouflage works can be rendered utterly useless, moreover, by the carelessness of a single soldier, for there is little that escapes the eye of the airmen's camera, particularly when it is fitted, as during the latter days of the war, with a stereoscopic attachment.

It was told that in one of the sectors in Champagne the Germans had installed a battery of heavy guns which were so ingeniously concealed that we were unable to locate them. It was believed that they were hidden somewhere in a fringe of woods along a stream; but, though there was a considerable area of cultivated land beyond the woods, the aëro photographs of it showed nothing which would suggest a path such as would be made by artillerymen going to and from their guns. One day, however, a new batch of plates, upon being developed, showed a tiny row of dots, no larger than pin points, stretching across this cultivated zone.

Upon studying an enlargement of the picture the intelligence officers became convinced that the line of pin points was really the trail left by a soldier crossing the field, and they led straight to a small wood on the bank of the stream, within which a battery might easily be hidden.

Working on this surmise, the American gunners registered on that particular patch of woods the following morning, whereupon the fire from the concealed battery abruptly ceased. German prisoners captured a few days later explained how the secret of the battery's position had been kept so long. The German security officer had issued orders that the artillerymen must under no consideration walk across the fields in order to reach their guns, but that they must instead follow a much-used highroad until they reached a bridge over the stream, drop from the bridge into the water; and wade up the stream until opposite their position. But one night, an artilleryman, in a hurry to reach his battery, and confident that the tracks left by a single man could do no harm, took a chance and a short cut across the forbidden field.

I have told you what happened to his battery as a result of his carelessness. Knowing something of German discipline, I can imagine what happened to him.

But it was not often that the Germans were caught napping, and so ingenious were some of their stratagems and ruses that it required an intelligence officer with the imagination and deductive powers of a Sherlock Holmes to keep up with them.

During the operations last summer on the Flanders front a British aviator brought in some photographs of a certain area behind the German lines. The intelligence officer whose duty it was to scrutinize them detected on the prints a suspicious something which he was convinced was a cleverly camouflaged German battery, but, though it was in the midst of open country, there was no suggestion of a path leading to it. After studying the photographs under a magnifying glass for several hours, he suddenly exclaimed:

"I have it! They get up to the guns on the covers of biscuit boxes."

"What do you mean?" his chief asked, curiously.

"It's as plain as the nose on your face, sir," explained the youngster. "The Boche knows jolly well that if he walked across that open ground his tracks would show up in our air photos. So when he wants to get up to his battery he gets a couple of wooden biscuit-box covers and ties strings to them. He stands on one cover and throws the other ahead of him, then jumps to that and drags up the first cover by means of the string and repeats the operation. Deuced clever of the beggars, I call it."

And as subsequent events proved, the intelligence officer was right in his deduction.

The demands of the armies frequently affected the people of far-off regions in the most extraordinary fashion. Last summer, for example, there was some danger of the women of Madagascar having to go naked because their only article of clothing was purchased in such extraordinary quantities by the American Camouflage Corps. The costume of a Malagasy woman consists of nothing more than a three-yard length of native-woven, earth-colored matting. It was discovered that this matting, when laid upon the ground, imitated a path such as would be made by the feet of soldiers, to perfection. So, in order to bewilder and deceive the Germans, a veritable network of imitation paths was laid down behind the American lines, 10,000 miles of women's dress goods being imported for the purpose from Madagascar.

Should you feel like raising your eyes at these figures, let me remind you that the American Camouflage Section used more than four and one quarter million square yards of burlap every month. This burlap, much of which was "slashed" after the fashion of foliage props in theaters, was dyed in a great variety of colors, all of which were standardized and could be ordered by number. There were burlaps dyed and slashed to imitate plowed fields, grain fields, roads, lawns, quarries, water, rocks, and spring, summer, autumn, and winter foliage; in short, every phase of nature as found in eastern France.[1]

By far the most important work of the camouflage section

[1] The dyes had to be carefully watched, however, because a slight variation of tint might cause suspicion and discovery. A literal earth shade, for example, would be fatal—to simulate earth the proper color was medium yellow-green. Light yellow was impossible. Undyed raffia from the air looks like chalk.

was the construction of "false contours" for the concealment of troops, gun positions, ammunition dumps, and the like. A "false contour" can best be described as the prolongation, by means of burlap spread over a sort of trellis made of poultry netting, of a ridge, promontory, or hill, the space beneath this burlap tent, which was dyed to the exact shade of the hill itself, providing perfect concealment for a battery of a battalion. So closely would nature be imitated in the shaping and coloring of these "false contours" that photographs taken by enemy flyers showed only an innocent hillside, with not enough vegetation to provide cover for a sniper.

One of the "false contours" erected by the Camouflage Corps was so cleverly executed that a peasant's cow, grazing on the hillside, strayed out on to the burlap surface, broke through, and was extricated only with considerable difficulty. When her pasture suddenly gave way I imagine that the cow had the surprise of her life.

Another development of the war, of which, for obvious reasons, nothing has been said in the press dispatches, was the silhouettes made of painted canvas, mounted on light wooden frames, which were used in the so-called "Chinese attacks," an idea which we borrowed from the British. When it was necessary to ascertain how quickly the enemy could switch on his artillery fire in a certain sector, or the location of his batteries or machine guns, a hundred or more of these silhouettes, painted to represent American soldiers charging with fixed bayonets, were laid down in front of our wire in such a manner that they could be pulled upright by means of cords running back to our trenches.

Just at daybreak, at that hour when objects are still indistinct and when the nerves of the men are at the greatest tension, a signal would be given, the cords pulled, and a long line of what appeared to the startled Germans to be charging Yankees would suddenly appear in the mists overhanging No Man's Land.

Instantly the German trenches would crackle and blaze with musketry, the concealed batteries and machine-gun nests would betray their position by going into action, and by the time the Huns discovered the hoax which had been played upon them our Observers had obtained the information which they desired. Sometimes, in order further to chagrin the Boches, the silhouettes would be left standing.

Then there were soldiers' heads beautifully executed by skilled sculptors in papier-mâché. These were of great service in locating snipers. When a German sniper became particularly obnoxious and defied all attempts to locate him a papier-mâché head, crowned by a steel helmet, and made so as to move up and down in wooden guides, would be set up in that part of the trench which the sniper had been annoying.

At intervals the head would be slowly raised and lowered, so that from the outside of the trench it looked for all the world like a soldier peering cautiously over the parapet. Sooner or later the hidden marksman would send a bullet through the careless Yankee's brain. The neat hole drilled through the papier-mâché showed the exact direction from which the bullet came, and by inserting in the hole a tiny telescope no larger than a pencil, and looking through it by means of a periscope, the loophole from which the sniper was firing could be located—in one case such a loophole was cleverly concealed by an old boot apparently thrown carelessly on to the glacis, the sniper firing through a hole bored in its heel—and his occupation abruptly ended.

Though I have described at some length the use of these silhouettes and papier-mâché heads, because they are picturesque and interesting phases of modern war, it should be borne in mind that they were designed to meet exceptional conditions, that they were used infrequently, and that they were in no way typical of the enormously important work of the Camouflage Corps.

V

THE ARMY CORPS PILOT

XLIX

THE public has already heard so much about the chasse Pilot that his training and his duties are familiar to the great majority of readers. We shall touch then only upon a few neglected phases of piloting in general, and upon those phases of piloting which have to do with the army corps Pilot alone.

The army corps Pilot[1] is the Pilot who drives the Observer. Originally, the Pilot graduates of American schools were allowed to elect, or to decline, an army corps berth, but this proved to be a fatal, or at least a futile, system. The public loved the *chasse* Pilot, and gave him all the glory and all the publicity, so that few graduates of the schools had courage enough to express a preference for army corps work, even when they preferred it. Later on, Pilots were assigned arbitrarily, and this was a very good thing for the service.

In January 1919, a lady historian, writing in the *Saturday Evening Post*, reported a conversation be-

[1] Observation squadrons are broadly divided into Army Observation Squadrons, Corps Observation Squadrons, and Night Observation Squadrons. To speak with utter accuracy, all Pilots connected with these squadrons aren't Army Corps Pilots. This, however, was their original title, and we use it to avoid the otherwise wearisome repetition of "observation pilot." We want to save that word "observation" to apply to the Observer alone.

tween herself and an unnamed officer at A——, a flying center in France. "What is the difference," she asked, "in the training for a *chasse* Pilot and that for the bombing and reconnaissance Pilot? Why does a man go in for one rather than for the other? Is there any guiding principle?"

"It is largely a matter of temperament," he replied, "temperament and youth. That is what it really boils down to in the end—youth. Youth means speed. Youth means taking long shots, shaving close margins, a certain buoyancy, recklessness, dare-devil dash. An older man won't take such risks. He may be a fine flyer, he may have plenty of courage, plenty of nerve, but he is not apt to take twenty-to-one shots in the air. And it is these very qualities—speed, dash, confidence in himself, ignorance of fear[1]—which the *chasse* Pilot must possess if he is going to survive . . . "

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[1] The following philosophy from *Speedway Dope* conclusively shows that fear is unnecessary:

If you fly straight,
There is no need to worry;
If you fly improperly,
Of two things one is certain—
Either you spin or you don't.
If you don't spin,
There is no need to worry;
If you do spin,
Of two things one is certain—
Either you crash or you don't.
If you do not crash,
There is no need to worry;
If you do crash,
Of two things one is certain—
Either you are hurt slightly or seriously.
If you are hurt slightly,
There is no need to worry;
If you are hurt seriously,
Of two things one is certain—
Either you recover or you die.
If you recover,
There is no need to worry;
If you die, you cannot worry.

This dialogue is not imaginary. It is not satirical. It is not intentionally humorous. But if the lady historian correctly understood the officer, he is responsible for the implication, retailed to the two million buyers and four million readers of America's greatest periodical (counting those who are always looking over somebody's shoulder in the train), that there is some especial brand of courage and initiative sacred to the personality of the *chasse* Pilot. And it is overstatements of this nature which have fogged the judgment of the public.

As a matter of fact, the differences between Pilots are partly mental, but chiefly physical. It is a reality, perhaps astonishing to those without experience in the air, that mental and physical abilities of Pilots vary in proportion to the altitude at which they work. Even such an apparently trivial defect as a small lung capacity is of prime importance in rating a Pilot for service.[1] There are Pilots of the first grade, technically, whose reaction to altitude is such that they may very well prove available for single combat not oftener than once or twice a week, but nevertheless capable of daily and long-continued flying periods at lower levels, regardless of the fact that these are infinitely more dangerous—as shown, for example, by the fact that the Hun used a telephoto lens on his camera, and held strictly to "the long view and the lesser risk." Indeed, the Allied records of combat show that observation machines actually participated in more fights than pursuit planes did.

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[1] The Royal Air Force claims that the length of time a man can hold his breath is a good indication of his ability to fly at high altitudes, because when a man holds his breath, the oxygen in his lungs gradually diminishes, just as the oxygen in the air grows less at increasing heights.

To a considerable extent, it is requisite that the Observer's Pilot be a man of even more delicate and sensitive nervous organization than the *chasse* Pilot; and this for the reason that in the French system, based on known psychology, he is "married" to his Observer. Pilot and Observer bunk together, mess together, play together, fly together, fight together, and if they chance to run out of luck, they generally die together also. When one is on leave, the other is on leave also. When one is ill, the other generally has a vacation. They constitute a team for which the most superb of all known forms of teamwork is demanded. Their reactions, their judgments, their decisions, their casual thoughts, must be synchronized as carefully as the fixed machine gun is synchronized with the propeller; for, in the air, a man must trust his partner as himself, and perhaps a trifle beyond. Each carries the life of the other in the hollow of his hand, in the corner of his eye, in the most remote little convolution of his brain cells, in his reflex reactions, and in his instinct. The *chasse* Pilot rides alone,[1] fights alone, and in case of mishap has no one to think about and no one to blame but himself. To be sure, all three types of flyers must be men of quick reaction, but it is only in observation work that there is any prominent altruistic responsibility.

Nor are they, either army corps Pilot or Observer, gray-whiskered conservatives who have "gone in" for a pleasant form of recreation, for it is in no sense a paradox that the average observation machine is exposed to many times the amount of direct fire, and often goes through many times the amount of actual

[1] There are a very few biplace pursuit squadrons—not enough to dispute a generality.

combat experience which the average single-seater has; and more than this, the observation machine flies frequently and continuously at altitudes so low that they have no attraction whatsoever for the *chasse* Pilot; and, finally, the observation machine flies regularly under weather conditions which keep *chasse* Pilots on the ground. A crack fighter is allowed some latitude for temperament, but the Observer and his partner are expected to leave their temperaments at home.

We grant you that the observation machine is slower and less maneuverable than the little battle plane which loops if you breathe on the controls, but it is a complicated mechanism of wonderful power, nevertheless. We grant you that the Ace is an accredited expert at his trade, and a remarkably splendid figure in modern warfare. But it is highly significant that England prohibited the announcement of the names of individual victors in aërial combats, so as "to suppress the fervent imagination of press correspondents." When you recall—or learn for the first time—that no less a personage than Mr. H. G. Wells once wrote that "every man who goes up and destroys an airplane . . . should have a knighthood," this censorship doesn't seem so unnecessary.

Jacques Mortane, in his book *Guynemer, the Ace of Aces*, reports this statement from the greatest of all fighting Pilots:

"What I must tell you is the courage of the Observers. When we stop to think that those officers deliver up their lives to a Pilot who may make one mistake, be the victim of a moment of dizziness, or of a fainting fit, or even of a mortal wound . . . we cannot admire them too much. I admit that I would not like their profession. I am not afraid, but I accept that danger against which I can fight, while the Observer has to have blind confidence in his Pilot. I assure you that an Observer . . . has deserved well of his country."

Finally, to quote Mr. Bonar-Law in the House of Commons: "Although it is not the intention of those who direct the Air Service that men on reconnaissance machines should fight, yet you could not prevent them from fighting. They tucked up their wireless and went for the enemy wherever they found him."

Again, this is no argument and no debate. We are not here to attempt to belittle the *chasse* Pilot, or to overpraise the army corps Pilot. The point is simply that if they have performed their duty well, neither of them is entitled to a single degree more glory than the other.

It may be illuminating, however, to demonstrate the combat requirements of observation. The two American pursuit squadrons which fought the greatest number of combats were the 94th (to which Eddie Rickenbacker, Douglass Campbell, and Jimmy Meissner belonged), and the 13th. They averaged 102 combats apiece. The two leading observation squadrons, the 1st and the 91st, averaged 97 combats apiece.

L

It would be manifestly unfair to the lady historian, however, to omit from mention the single paragraph she devoted to the army corps Pilot and the Observer:

Taking photographs of enemy positions, bombing back areas at low altitude, regulating our own battery fire—all these duties require great courage and endurance and a certain inattention to peril. But because such exploits are not fascinating, romantic, spectacular, they do not get the public eye.

For example, suppose an aviator was sent out to correct the fire of one of our guns which had been trying to get a hostile battery whose shells were harrying our troops. Naturally, the Huns did not want their battery knocked out, so they tried to scare the intruder away. Antiaircraft guns popped away at him; his planes were perforated with bits of shrapnel; flaming "onions" burst around him; and a gang of Hun combat planes probably dived down from "upstairs" to wipe him out. From this menace his own patrols may have protected him—provided they were not pulling off a little fight of their own. Under such conditions he might either have cut it or stuck. Usually he stuck. For, getting that hostile battery meant the saving of scores of lives on the ground. Perhaps he made a safe get-away. But if not, did the newspapers acclaim him a hero, give his age, state, and proud college, and the number of Huns brought down? I'll say they did not! His epitaph, if he achieved one, was merely a brief line in the *communiqué:* "One of our reconnaissance machines did not return."

A certain inattention to peril!

Let us quote—since the lady is kind enough to mention photography, what a French instructor says on the subject: "Few Pilots are fitted to drive an Observer photographer, and . . . these require particular qualities and skill. The Pilot . . . must take the Observer over the precise point where the picture is to be taken, and . . . allow him to make a perfectly vertical aim at this point . . . taking account of hostile airplanes and artillery."

Perhaps, when you do take those enemy manifestations into account, there *is* a little romance in it. Then consider, if you will, another statement made to a French reporter by the young man named Georges Guynemer, who began his career as an army corps Pilot and transferred to the pursuit branch because of his supreme fanaticism for the kill. "In order to make a reconnaissance, a man must put his whole heart in it. . . . It is at the risk, and many perils. . . . On June 17th, notably, I came back with eight wounds, another time with nine." At this time, Guynemer was doing scouting, artillery reglage, and photographic work with great success.

Finally, let us add the opinion of one who, while he was not an army corps Pilot himself, but a pursuit Pilot, nevertheless felt that there was something worth remembering out of *Gunga Din*. He wrote home to his mother:

> Flying a photo machine is the most difficult and "brainy" flying of all. The conditions are such that it demands the most of a Pilot, while it is of such importance that the enemy spares no expense or trouble to bring him down. His machine is always the objective of all enemy *chasse* machines who can reach him, and a target for the antiaircraft batteries, for he has to fly a straight and even course, always. He cannot vary his line of flight to avoid the inferno of antiaircraft shells that are belching forth from dozens of guns. The only time a Pilot on a photo mission will leave his course is when the enemy machines attack him, and then he fights on the defensive. If he can drive off the attacking enemy planes, he sticks to his aërial post and continues his mission.
>
> Nothing matters to him except those pictures which must be taken and delivered to the home station behind the lines.

Indeed, the duty requires more than a certain inattention to peril. If peril, and nothing else, were the standard of publicity, then the relative positions of these men, in the eyes of the world, would have to be exactly reversed.

LI

It has never been set down in any available authority that the Pilot is also by way of being an engineer, and only those who have peered into the cockpit of a service plane have any conception of the number and variety of instruments over which he broods. The Pilot, let us say, is on a photographic mission, under the necessity of flying level at the same time that he is being strafed by Archie and looking out for hostile aircraft.

All he has to do, besides, is to pay occasional attention to the following furnishings of his "office."

(1) The tachometer, or engine-speed indicator, which is important because the lifting power of the plane varies in proportion to its speed. If the engine begins to lose power, there is a bad session ahead for the Pilot.

(2) Oil and gas gauges. There are no roadside garages in the air, and to go dry means something even more annoying than a long walk home.

(3) Motometer, to show the engine temperature and give advance warning of overheating.

(4) Ammeter, as on an automobile.

These are the instruments which apply principally to the power plant. But there is an equally serious set of contraptions to record the various playful antics of the plane itself. Under fair conditions, the Pilot drives by the horizon; he tells his position, both vertical and lateral, by the way the nose of his radiator bears on the horizon. But as soon as he runs into clouds, or bad weather, and the visibility becomes so poor that the horizon can't be used as a guide, he has to rely on his instruments. Otherwise, he might be climbing, or nosing slightly down, or flying in a wide circle, without knowing it.

Probably the first instrument to be used [says Mr. Charles H. Colvin, M.E., in the *Aircraft Journal*] was a combination banking indicator and incidence indicator, which some Pilots used on the old Wright machines. It consisted of a small piece of cloth tied to one of the forward outriggers. If it blew back approximately level, it indicated a small angle of incidence;

if it blew up at an angle, a large angle of incidence. If it blew to one side or the other it showed a slip or skip, or an incorrect bank. This simple device served very well on the old pusher-type machines, but of course cannot be employed on a modern tractor plane.

The reason for this last statement is of course the presênt position of the propeller, which would take full charge of the indicator and not let the motion of the plane have anything to do with it.

The modern Pilot, however, has these acceptable substitutes:

(5) Banking indicator, made on the pendulum principle. Whenever the ship is banked, the pendulum swings a corresponding distance off center; so that the instrument is very easy to read and understand.

(6) Air-speed indicator. Air speed isn't the same as engine speed, nor is it the speed of the plane in relation to the ground; it is speed in relation to the air only. Unhappily, this particular instrument goes cranky at high altitudes.

(7) Air-distance recorder. This is like the odometer of an automobile.

(8) Altimeter. This is an aneroid barometer, with an adjustable zero, so that the flight can be measured either by the height of the plane above sea level, or above the starting point.

(9) Compass. This is always a bad actor in an airplane, on account of vibration and heavy magnetic attraction. The highest American authority makes the statement that never has he seen an aërial compass, except in a captured Boche plane, which "even pretended to point north." Long-range reconnaissance becomes a more or less religious ceremony when the compass goes wrong.

(10) Drift indicator. This is necessary because although the nose of the ship may be pointed north, the wind may be crosswise, thereby blowing it in a sidelong direction, so that it is actually traveling northeast or northwest. Mr. T. A. Morgan, writing in the *Aerial Age Weekly*, says that a Pilot flying at 120 miles an hour from New York to Chicago in only a ten-mile north wind, would be blown 60 miles off his course unless he had a drift indicator. Without such an instrument, the Pilot simply has to estimate his drift by comparing the actual course steered and the actual course made—which last he gets from compass bearings on the ground. In the war zone this is risky business. A good navigator is an encouragement to his Observer, and vice versa.

(11) Turn indicator. This is chiefly to prevent flying in circles in the darkness; for if a Pilot is lost he will automatically do what a man lost in the woods without a compass will do—keep bearing to the right.

(12) Inclinometer. This is to show the angle of climb, or descent. A good Pilot knows perfectly the angles of normal climb and glide, and knows how far he can crowd his plane before it either stalls or goes into a spin; but since he needs the horizon to confirm his sense of hearing (for the wind in the wires is a guide to him) an inclinometer is pleasant to have in the dark or a heavy cloud bank.

The Pilot has learned his engine thoroughly, and he has also learned gunnery, and is in charge of two machine guns which fire through the propeller, in the ratio of about 3 to 7—that is, if the propeller is revolving at 1,400 revolutions per minute, the gun will shoot about 600 bullets a minute. He also has Very pistols for use in emergency.

In another sense, however, war-time flying consists entirely of emergencies; and in *any* sense, the army corps Pilot has no time for wool-gathering among the fleecy clouds.

LII

The obvious and logical reason for compelling the Observer to take the same physical examination as that prescribed for the Pilot is that both men are subject to exactly the same reactions in the air. The mere question of suddenly acquired altitude, and the equally swift drop back to earth, make a very great drain upon the nervous reservoir, to say nothing of the demands upon the heart and lungs. The pulse and the blood pressure of any flyer are subject to such extreme and rapid changes that the strain of high altitude alone may perfectly well spoil a man for flying, after a very little experience, and not very much combat. A man whose normal blood pressure is 120 will average a pressure of 200 at only six or seven thousand feet.

As a matter of fact, a Pilot generally managed to teach his Observer to fly as soon as possible,[1] for self-protection in case of disaster. The dangers

[1] Mr. Pemberton-Billing in the House of Commons on March 28, 1916 spoke hotly of the failure of the British government to understand that no machine should fly under any circumstances unless equipped with dual control. If the Pilot were shot, the Observer could take charge. "Any man who had flown for ten minutes in a dual-controlled machine could bring it back to earth—perhaps with a little crash, but he could guide it back again. Not only would valuable information be saved, but perhaps the life of the Pilot, and certainly of the Observer—and the machine itself might be saved from total loss." A few months later the Committee on the Administration and Command of the R. F. C. recommended the Pilots and Observers should be so trained as to be interchangeable. The plans of our own Air Service now happily include this provision.

and difficulties of the two are precisely the same. There is, however, one degree of surprise which the Observer sometimes gets, and the Pilot doesn't. The Observer doesn't know, from one minute to the next, what the Pilot is going to do to the ship. An enemy may have appeared, the Observer's finger may be all but squeezing the trigger, and of a sudden he is sidewise, or lengthwise, or upside down; with the interesting task of relocating the enemy, when convenient, through goggles now drenched with engine oil, and drawing a bead on him through a double ring sight and over an additional vane sight which acts like a bit of mercury harnessed to a weather vane and bobs cheerfully about to compensate for the breeze of a hundred and thirty or forty miles an hour. Incidentally, a Pilot is always happy when his Observer is a big, powerful chap, for this means that he can swing his guns easily, and won't mind the propeller wash.

In his *Physiology of Flying*, Mr. W. Guy Ruggles (inventor of the Ruggles Orientator) explains that in addition to the five senses we all know about, and the sixth sense which fiction writers all agree is the prerogative of woman and should be called "intuition," there is still another sense which nobody discovered until the war. It was always there, but no one seemed to have suspected it; so that when the experts found it they were as pleased as though they had found a quarter in the pocket of a last winter's suit. This sense is that of orientation and equilibration. Put an experienced woodsman in a dark forest, and he can *feel* the points of the compass, and come home as confidently as a horse. And some people can walk a tight rope blindfolded, and some can't.

Those who haven't read of this subject may be interested to know that the seat of this genuine sixth sense is in the inner ear. Animals have an inner ear, too, and need it. Remove one of the internal ears of a cat, says Mr. Ruggles, and it loses its entire sense of balance. And those humans in whom the sense is abnormally acute become trick bicycle riders, and acrobats, and drivers of racing automobiles. It is a question of instantaneous adjustment to the world, no matter what the world is doing.

Now in the air a man is constantly reacting to sudden and very pronounced shocks to his poise, or equilibrium. We all know the dizzy, sickening feeling which comes from turning swiftly around several times in the same direction, and then stopping suddenly. Children do it for fun and flyers do it because they have to. The illusion of motion continues, and if you are on the ground, you can't walk straight for a minute or two. But a flyer is subject not only to illusions of the plane (not the *air*plane, now, but the geometric plane) in which he is traveling level, but also to illusions concerning either of the other two dimensions in which he may travel. After a *vrille*, for example, the flyer may come out perfectly flat, and yet feel the same spinning sensation, and actually seem to see the horizon where it isn't. After a long fight, both Pilot and Observer are pretty certain to be lost. As soon as either one of them realizes that he is lost, he instantly confides in his partner, for this is nothing to joke about. There is no disgrace in it, either.

The Ruggles Orientator was invented to train flying cadets, and is an apparatus containing a seat into which the student is strapped, and a stick which electrically operates a set of controls, just as the stick in an airplane mechanically operates them. This simulated cockpit can be moved in any direction, or in two directions simultaneously, by means of its suspension from a metal crossbar by a sort of loop of metal which revolves horizontally. Fastened to the sides of this loop is a smaller framework which revolves vertically. To the ends of this, and actually supporting the cockpit, is yet another framework, which revolves laterally. And by practice in this machine the student Pilot learns how not to get too dizzy, and how to operate his ship even although he cannot see the ground and is lying on his ribs or is upside down, spinning like a merry-go-round which has gone hysterical.

The Observer is subject to the same reactions. His failure of orientation or of equilibrium won't wreck the ship, but it will certainly bring him out of a maneuver too dizzy to know where the enemy is, and to aim at him. It is the quick recovery of equilibrium which gives the Observer one of his prime assets in a combat; the man who shoots first has a considerable advantage.

Acrobatics are a result, and not a cause, and acrobatics are taught in the schools for two reasons; first, to simulate all the difficulties into which a Pilot may get his ship by accident, and, secondly, because in combat it is a mighty desirable thing to keep out of the enemy's line of fire. To do this means to disconcert the enemy, to dodge and twist and turn, with the additional hope of coming out on the enemy's tail, and catching him at a disadvantage. But as a Pilot once said to Rex Beach, "When you're hanging by your belt, with everything loose in the fuselage falling into your face, and with your goggles so oily you can't see, it makes you feel—well, utterly unnecessary."

When Pegoud first looped the loop, there were a good many people who compared him with Blondin and the late lamented Stephen Brodie. The performance seemed, to the man in the street, quite as maniacal as the exploits of the late Lieut. Locklear seemed to some of us. And yet, in view of the fact that "stunts" turned out to be the strongest safeguards of both the Pilot and the Observer, it is fully possible that Locklear was a pioneer as praiseworthy as Pegoud, and that in time to come many lives will be saved by the transfer of a passenger from one plane to another in flight.

Certain it is that countless lives were saved, and countless victories won, by stunt flying. Indeed, a Pilot unskilled in acrobatics wouldn't last through the first five seconds of his first fight. A combat in the air isn't a long-drawn-out duel, with the guns spitting fire incessantly; it consists of a very large amount of jockeying and a very few shots. The whole thing may be finished, with the loser either falling out of control or scooting for home, in less than a minute. The game isn't to blaze away at long range, but to come to close quarters, to get into a first-class firing position, and then to fire. Stunts are absolutely necessary here, just as they are necessary afterward, when one ship or the other wants to get away. It would be suicidal simply to turn off and fly straight toward home. One acts, instead, like a bit of drunken thistledown in a hurricane, shakes off the pursuer by sheer strategy, and then runs with the throttle wide open.

The loop was the first stunt to be generally learned; it is the easiest to learn, and the least valuable in war. Now and then a Pilot who was pursued might loop so as to come back on the other fellow's tail and become the pursuer, but it was a risky venture, because from the instant that the nose goes up until it is pointing down again the ship is utterly defenseless. In 1916, it was announced that any Pilot of the Royal Flying Corps who was caught looping would instantly be dismissed from the service.

Combat acrobatics, however, are all based upon the loop, the ordinary bank, and the *vrille*. The loop itself is rarely a good thing to bring into combat, but it is the godfather of the *renversement*, the *retournement*, and the famous "Immelmann turn." Each of these three maneuvers aims to bring about the quickest possible change of direction, and each starts out as though for a loop; but the ship changes its mind at the top, slides over in a half *vrille*, and in the *renversement* and the Immelmann, goes back in the opposite direction whence it came—and in the *retournement* it has yet another change of mind, and picks up the original direction again.

From the gentle bank, always used in turning, we get the vertical bank for a swift veering from one side to the other. An airplane, in turning, can't stay level any more than a sprinting bicyclist, riding a race, could make fast turns on a flat track. Centrifugal force is father to the skid. But the more you bank a plane the sharper corner you can make, even to the perfectly vertical bank "in which the machine seems fairly to spin around, using the tip of the low wing as pivot." And if the plane is permitted to fall sidelong from a banking position, you have the "side slip," which is excellent when you want to dodge away from an enemy, for it takes you out of range, earthward, at absolutely unhittable speed.

The *vrille*, or "tail spin," or "spinning nose dive," is a stunt in which the ship tumbles headlong down an imaginary spiral staircase, or, as Eddie Rickenbacker thinks, goes down like a match in a whirlpool. This is the way a ship usually acts when it is out of control, so that the *vrille* was often used to delude an enemy into thinking he had won a battle—and at a lower level the Pilot would flatten out and scamper. After a while it became an invariable custom to follow down an enemy plane which had gone into a *vrille*, and, if he crashed, to let him crash as hard as he liked, but, if he flattened out, to dive for him and start the fight over again. Still, if you were in Germany, you couldn't afford to follow your suspect down too far. He might be decoying you down for his antiaircraft batteries.

There are at least a score of variations of these playful performances, but they all work out of the same principle and all aim toward the same result—to change the course, or to change the altitude, with the least possible delay. And both Pilot and Observer must be able to come out of one of these stunts, or out of a succession of them, with unimpaired nerves, and no loss of fighting instinct.

In the authorized treatise on acrobatics which Capt. K. G. Pulliam, Jr., wrote for the Air Service Headquarters, A. E. F., he began the description of each trick by stipulating that the Pilot should first climb to at least 1,200 meters (3,600 feet); and he concluded by saying:

> Acrobacy at low altitudes . . . should never be done . . . except in cases of emergency and actual combat. A Pilot cannot at all times be sure of the condition of the atmosphere, which he cannot see, and fatal falls often result when overconfidence meets with bad air conditions near the ground.

Yet the observation machine is very often flying at an altitude of a very few hundred feet. If suddenly attacked—and it is hardly worth attacking such a machine at *any* altitude except with the advantage of surprise—the ship will usually attempt to escape; it is supposed to place the completion of its mission before voluntary combat. To escape will probably require acrobatics; and the characteristic of almost every "stunt" is a quick loss of altitude. Here is where the Observer, and the army corps Pilot, are in greater danger than any pursuit Pilot; they are between the devil and the deep sea. At high altitudes they can be quite nonchalant about it.

There are plenty of occasions when the Observer, although unharassed by the enemy, must work regardless of the perpendicular; and he is supposed to continue such peaceful pursuits as counting box cars even although he may be lying ninety degrees over on a vertical virage "with not even the fabric of a wing between his eyes and the crust of the world." There are other occasions on which the work is done at a dead level, with both Pilot and Observer realizing that to fly level is to deal the best hand to Archie, and yet to fly otherwise is to nullify the mission.

The danger of flying is one thing, and the danger of aërial observation in actual warfare is another. The broad general principle is clear—if anything happens to the ship, there isn't much to do about it. In the recent war there was seldom a parachute, such as the balloonist has, to drop with.[1] Experi-

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[1] Germany was the first nation to provide the flyer with a parachute. Compulsory fitting of life-saving parachutes to all airplanes of the Royal Air Force has been decided upon by the government. Whether this will be applicable also to commercial aircraft has not yet been settled.

ments have been made with this, but so far only one efficient type has been produced, and it was demonstrated at the air carnival at Atlantic City half a year after the war ended. The 'chute weighed only twelve pounds, and the harness one and a half; it worked perfectly, and made its descent, with passenger, at the rate of only eight miles per hour, landing him with the same jolt he would have received if he had jumped to the ground from a height of twelve feet. Most people, even if tender of anatomy, would prefer a twelve-foot bump to one of twelve thousand.

The main risks of aviation in war time are three: accidents to the ship through the agency of nature, accidents through the failure of power, or from a backfire which destroys the ship, and accidents through the skill of the enemy.[1] In any case, the job of landing often becomes a serious problem; it is no trick at all to land a plane on good terrain even if the engine is dead, but to land on bad ground with a dead engine is flirting with the undertaker. At 2,000 feet you can't tell what you are getting into, and at 1,000 feet, with the ship out of control, you have a peculiar interest in the terrain. You recall cheerfully that "the presence of stock indicates a good meadow," and you are perhaps more interested in the lowing kine than ever before. And since the Observer and the Pilot share equally these dangers, as well as those of actual combat, a few American citations for the Distinguished Service Cross will illustrate something of what they endured

[1] In the first year of the war the actual losses in the R. A. F. were 12 per cent from enemy bullets, 18 per cent from defects of the plane, and 70 per cent from defects of the Pilot. In the second year this last figure was reduced to 30 per cent and in the third year to 12 per cent.

together—something for which the mention is a pitiably inadequate valediction.

Second Lieut. Guy E. Morse (deceased), Observer, 135th Aēro Squadron. For extraordinary heroism in action near Vilcey-sur-Trey, France, September 12, 1918. Lieutenant Morse, with First Lieut. Wilbur C. Suiter, Pilot, fearlessly volunteered for the perilous mission of locating the enemy's advance unit in the rear of the Hindenburg Line. Disregarding the hail of machine-gun fire and bursting of antiaircraft shells, they invaded the enemy's territory at low altitude and accomplished their mission, securing for our Staff information of the greatest importance. These two gallant officers at once returned to the lines and undertook another reconnaissance mission, from which they failed to return. Lieutenant Morse's body was found and buried by an artillery unit.

Second Lieut. Elmore K. McKay, Observer, 96th Aēro Squadron. For extraordinary heroism in action near Dun-sur-Meuse, France, October 23, 1918. Lieutenant McKay, with First Lieut. Harry O. McDougall, Pilot, while on a bombing mission displayed exceptional courage by leaving a comparatively secure position in the center of the formation during a combat with five enemy planes and going to the protection of two other officers whose plane had been disabled and forced out of the formation. While his Pilot skillfully maneuvered the machine Lieutenant McKay shot down one of the adverseries and fought off the others, thereby saving the lives of the officers in the disabled American plane.

Lieut. Kingman Douglass, Pilot, 91st Aēro Squadron. For extraordinary heroism in action near Longuyon, October 31, 1918. While on a photographic mission Lieutenant Douglass encountered a superior number of enemy pursuit planes. Notwithstanding the odds against him, he turned and dived on the hostile formation, destroying one plane and damaging another. He then continued on his mission and returned with photographs of great military value.

First Lieut. Harvey Conover (deceased), Pilot, 3d Observation Group. For extraordinary heroism in action near Consenvoye, France, October 27, 1918. Flying at an altitude of less than fifty meters over enemy artillery and machine guns, which were constantly firing on him, Lieutenant Conover and his Observer staked the American front lines and gave valuable information and assistance to the advancing infantry. Although suffering from two severe wounds, and with a seriously damaged plane, he delivered a harassing fire on six enemy machine-gun nests which were checking the advance of the ground troops, and successfully drove off the crews of four guns and silenced the other two. He then made a safe landing and forwarded his information to division headquarters before seeking medical aid.

First Lieut. William T. Badham, Observer, 91st Aëro Squadron. For extraordinary heroism in action near Nuzancy, France, October 23, 1918. This officer gave proof of exceptional bravery while on a photographic mission twenty-five kilometers within the enemy lines. His plane was attacked by a formation of 30 enemy aircraft; by skillful work with his machine gun Lieutenant Badham successfully repelled the attack and destroyed two German planes. At the same time he manipulated his camera and obtained photographs of great military value.

First Lieut. George R. Phillips, Pilot, 50th Aëro Squadron. For extraordinary heroism in action near Beffu at La Morthomme, France, October 23, 1918. Lieutenant Phillips, Pilot, accompanied by Lieut. M. B. Brown, Observer, while on a reconnaissance for the 78th Division attacked an enemy balloon and forced it to descend and was in turn attacked by three enemy planes (Fokker type). The incendiary bullets from the enemy's machines set the signal rockets in the Observer's cockpit afire. Disregarding the possibility of going down in flames, Lieutenant Phillips maneuvered his plane so that his Observer was able to fire on and destroy one enemy plane and drive the others away. He then handed his fire extinguisher to Lieutenant Brown, who extinguished the flames. They completed their mission and secured other valuable information.

First Lieut. Raymond P. Dillon, Pilot, 24th Aëro Squadron. For extraordinary heroism in action near Mezières, France, November 3, 1918. Lieutenant Dillon exhibited courage in the course of a long and dangerous photographic and visual reconnaissance in the region of Mezières with two other planes of the 24th Aëro Squadron. Their formation was broken by the attack of ten enemy pursuit planes; five enemy planes attacked Lieutenant Dillon and his Observer, who succeeded in shooting down two of these out of control. They then had a clear passage to their own lines, but turned back into Germany to assist a friendly plane with several hostile aircraft attacking it. They succeeded in shooting down one more of the enemy.

AËRIAL OBSERVATION

Second Lieut. Dogan H. Arthur, Pilot. The bronze oak leaf is awarded Lieutenant Arthur for the following acts of heroism in action October 18 and 30, 1918, to be worn on the Distinguished Service Cross awarded him October 3, 1918. On October 18, 1918, while on Artillery reglage, Lieutenant Arthur and his Observer were attacked by four enemy planes. His Observer's guns jammed, but Lieutenant Arthur with splendid courage and coolness outmaneuvered the hostile aircraft and escaped, although they followed his plane to within twenty-five meters of the ground, badly damaging it by machine-gun fire. On October 30, 1918, Lieutenant Arthur was one of a formation of nine planes which were to take photographs in German territory. Before the lines were reached six planes dropped out, but the remaining three entered the German lines, although they observed several large formations of enemy planes in the near vicinity. When they were twelve kilometers within the German lines they were attacked by eighteen enemy Fokkers. Regardless of his own safety, Lieutenant Arthur engaged these planes in order to allow his companions to escape, and turned toward his own lines only when he saw them shot down. Then he fought his way home, and in the fight which ensued his Observer shot down two enemy planes.

First Lieut. Thomas M. Jervey, Ordnance, 1st Army Observation Group. For extraordinary heroism in action near Longuyon, France. Assigned to the 1st Army Observation Group, Air Service, armament officer, Lieutenant Jervey volunteered as Observer on a photographic mission from Ontedy to Longuyon, twenty-five kilometers into the enemy lines. In combat with fourteen enemy aircraft which followed, one enemy aircraft was destroyed. Lieutenant Jervey, regardless of the fact that his plane was badly shot up and that his hands were badly frozen, continued on the mission, returning only upon its successful conclusion.

First Lieut. William P. Erwin, 1st Aëro Squadron. For extraordinary heroism in action in the Château Thierry and St. Mihiel salients, France. Lieutenant Erwin, with Second Lieut. Byrne E. Baucom, Observer, by a long period of faithful and heroic operations set an inspiring example of courage and devotion to duty to his entire squadron. Throughout the Château Thierry actions, in June and July, 1918, he flew under the worst weather conditions, and successfully carried out his missions in the face of heavy odds. In the St. Mihiel sector, September 12-15, 1918, he repeated his previous courageous work. He flew as low as fifty feet from the ground behind the enemy's lines, harassing German troops with machine-gun fire, and subjecting himself to attack from ground batteries, machine guns, and rifles. He twice drove off enemy planes which were attempting to destroy an American observation balloon. On September 12th and 13th he flew at extremely low altitudes and carried out infantry contact patrols successfully. Again, on September 12th he attacked a German battery, forced the crew to abandon it, shot off of his horse a German officer who was trying to escape, drove the cannoneers to their dugouts, and kept them there until the infantry could come up and capture them.

This last officer, always an army corps Pilot, ranked in the first fifteen of American aces.[1] Compare his record with those of the handful of Pilots who stood ahead of him in the list. Their sole duty was to fight. To him fighting was incidental. His entire record is very well worth quoting:

Lieut. William P. Erwin is the Premier Ace of Observation Aviation.

He came on front with 1st Aëro Squadron, July 18, 1918. Officially credited with destruction in aërial combat of nine enemy airplanes. Decorated with Distinguished Service Cross, French *Croix de Guerre*, War Medal Aëro Club of America, three times cited in orders for gallantry in action, and twice recommended for Congressional Medal of Honor. Had three Observers shot while flying over the lines with him—one instantly killed, the others seriously wounded.

On July 20, 1918, while doing an infantry liaison with a French division which went "over the top" very late in the afternoon, Lieutenant Erwin and his Observer, Lieutenant Boldt, were keeping contact with our infantry and machine-gunning the German troops ahead of them when Lieutenant Boldt was shot through the head and Erwin's place riddled with bullets. Erwin completed the mission and returned with the dead Observer. For this exploit he was decorated with the *Croix de Guerre*.

August 1st. Went for some pictures in the Château Thierry section about five miles inside the German lines. In performing

[1] The term "ace" has never been officially recognized by the United States army, and, indeed, the official use of it is prohibited.

this mission was cut off by ten Fokkers. They were flying at about 3,500 meters when the Fokkers attacked. Seeing no way of escaping, Erwin headed his Salmson biplane straight into the enemy formation, aiming for the leader. They came head-on at terrific speed, both opening fire with the machine guns at about 250 yards range. When it seemed as though a collision was almost unavoidable, some of Erwin's bullets reached their mark, for the German machine plunged into a nose dive, passing under his right wing, and, diving, side slipping, and spinning, crashed into the woods some 12,000 feet below. But the others were keeping things busy and making it very annoying for a lonesome American aviator among nine inhospitable Boches. With their formation split and coming at him from all sides, a real tournament ensued. Very shortly Lieutenant Spencer, the Observer, was hit. Tracer bullets were crossing and recrossing through the wings and fuselage. Then a bullet cut the rudder control, making it impossible to maneuver. This probably saved both their lives. It threw the machine into a tail spin and for probably 1,000 meters Erwin struggled to regain control. The machine fell so apparently out of control that the Boches did not follow them down. When he regained control, seeing that the Huns had so far been eluded, Erwin allowed the plane to continue its fall until only about 1,000 feet up off the ground; then he straightened it up and headed for home. By flying in a "lopsided" position and using the elevator to do the work of both rudder and elevator, he managed to coax the badly crippled old bus back to the airdrome.

His next Boche he got at St. Mihiel. A Hun sneaked over about noon September 15th and burned two of our captive balloons. Lieutenant Erwin and Lieutenant Dahringer, his Observer, were doing a reconnaissance just inside the German lines when he saw the first balloon go up in flames. Taking advantage of his superior altitude, he dived on the Hun and, engaging in a brief but brisk battle, succeeded in downing him within sight of the two balloons he had just burned.

In the Argonne drive, he, Erwin, did his best work, shooting down seven Hun planes between October 6th and October 24th, for which he received official confirmation, and between September 26th, which marked the beginning of the drive, and the signing of the armistice, actually downed three others for which official confirmation was not obtained.

On one trip, made the afternoon of October 8th, Lieutenant

Erwin, with Lieut. A. E. Easterbrook as Observer, had six separate combats, in each case forcing the enemy to retire, and in the course of one of these combats brought down two of the opposing planes. For this feat they were cited in General Orders, which were read to every Air Service organization by order of the commanding general.

October 15th, Erwin started out on a patrol and propaganda-dropping expedition with some other member of the squadron. Having no particular mission except to drop the leaflets, on which was printed the bill of fare of the American prison camps and other inducements for the hungry Huns to surrender, he and his Observer, Lieutenant Baucom, known to his comrades as "Battling Baucom," decided to distribute their "Food Will Win the War" literature among the Huns *toute de suite*, and then look for a little trouble. But not a Hun was to be seen in the vicinity of a German airdrome which Erwin had located on a previous trip. One Boche observation machine had taken the air and, having attained some 1,000 meters of altitude, started for the lines. By careful maneuvering Erwin was on the tail of the Rumpler before he was hardly aware of an enemy's presence. This particular Hun was a very gallant fighter and put up a real scrap. For perhaps three minutes they fought, viraging, diving, and zooming, each striving for the advantage, until with a well-placed burst Erwin killed or severely wounded the Hun Observer, whereupon his gun flew up on its turret and he slumped down into the cockpit, closing in on his tail to almost point-blank range. It was an easy matter to finish the job. The German crashed within a mile and in plain sight of his airdrome.

On his birthday, October 18th, Erwin shot down a Fokker in flames. The Pilot jumped from the burning machine in a parachute and made a safe landing in our lines. Our doughboys made him prisoner. That night at corps headquarters he and his victor had a nice long chat. The prisoner was only twenty-seven years of age, an officer and from the German nobility. Incidentally he established the fact that the Americans were contending, among others, with the old "circus squadron" formerly commanded by the late Baron von Richtofen, the famous German ace of aces.

Some of Erwin's best work was done with Capt. A. J. Coyle, the squadron commander, in strafing the roads and battery positions in the German rear areas. He was three times shot down by ground fire—twice by the Germans and once by the

American infantry (who probably were wondering at the time "where are the American airplanes?").

The last time, just four days before the armistice was signed, he was shot down by the Germans and forced to land in their front-line positions. Lieutenant Baucom was with him. Fighting with their rear machine guns, they got clear of the plane and into a large shell hole. From this point of vantage they held off the enemy advance posts until dark, then crawled back a mile and a half to our lines with much valuable information. In taking his report back to division headquarters that night Lieutenant Erwin and Lieutenant Baucom were recommended by the wing commander of the 1st Army for the Congressional Medal of Honor.—*Air Power*.

There were four other American aces who were observation Pilots pure and simple. All four of these officers belonged to the 91st Squadron—an observation squadron which as a mere incident to its regular duty brought down twenty-one enemy planes. In the armies of our Allies there were more fifty Aces who were observation Pilots.

LIII

From the earliest moment of their training, both the Pilot and the Observer are taught to use their eyes at least 101 per cent of the time. The very third paragraph of the curriculum for flying schools —coming even before the pupil has been told how the controls are worked—is, "Teach the student to be *constantly* on the lookout for other machines." This means to look out for friends and enemies both; for it is a wise flyer who knows his own ally, and any other ship in the sky is presumed hostile until it is proved affectionate. A ship may be two miles away when sighted, and cross your bows thirty seconds later; and it is better to be overcautious than to have a pretty nurse in a base hospital.

Eddie Rickenbacker tells how he and Douglass Campbell, in their first patrol over the German lines with Maj. Raoul Lufbery, saw no airplanes at all. They constantly "raked" the sky, but saw neither friend nor enemy. Both of them were expert Pilots, as far as their ability to handle their ships was concerned, but neither of them had yet learned the shifting focus of the air, so that both of them were shocked when Lufbery told them what they had missed. "One formation of five Spads crossed under us before we passed the lines," he said, "and another flight of five Spads went by about fifteen minutes later, and you didn't see them, although neither one of them was more than 500 yards away. It's just as well they weren't Boches! Then there were four German Albatroses two miles ahead of us when we turned back, and there was another enemy two-seater nearer us than that, at about 5,000 feet. You ought to look about a bit."

Many an old and experienced flyer has been startled by bullets ripping through the fuselage before he knew that an enemy was even in the offing—wherever *that* is.

The rule in the air, during hostilities, is to "rake the sky" at least once every thirty seconds; and this means that when you are over the lines you keep your head and eyes moving pretty nearly all the time. Probably, after you have once got into a fight, you can't rake the sky any more, and this gives rise to a very serious complication. In combat, the danger isn't so much from the enemy who is your actual opponent, as from some other enemy who can sneak up on you while you are too busy to notice him.

The French practice was also for the Observer to keep his eyes out of the boat whenever he was sending radio; he could lean back in his seat, if he had one, and watch the sky as he sent his message. The sun is the dangerous spot, for the enemy always tries to get between you and the sun; and if you see a ship against the glare, you can't tell, on account of sun-blindness, whether it's a Boche or a bunkie. And even when the sun isn't troublesome, you have to keep changing your focus or you wouldn't see one ship in five that you ought to see.

If you have ever watched, from the ground, an airplane going away into the sky, you probably lost it and picked it up again half a dozen times in a few minutes, even although it was flying in a perfectly straight line. This was because you didn't change your eye focus quickly enough. It is the same principle which sometimes makes a man lose a golf ball in the open. If he focused to a distance of ten yards, the ball can lie almost at his feet, and he won't see it—he *can't* see it—until he has changed his focus to the proper length. Suddenly he finds that he has been looking at the ball without seeing it. It is the same thing in the air, except that a golf ball costs only a dollar.

Next in importance to the sun as a danger spot come the edges of clouds. Clouds, as Capt. Alan Bott says, are either useful aids or unstrafable opponents, depending on your own location at the time. You are safer on the silvery side—which is the side above them. Hostile planes are often lurking on the edge of clouds, confident that they are hard to see, and ready to dive on the slower observation machine; and it is partly due to this danger from above that a good Pilot never flies in a straight line for more than a very few seconds at a time, but keeps changing his course so as to change the "dead angle of vision" and get a fresh perspective of the danger spots overhead.

As soon as an enemy is once sighted, it becomes the duty of the Pilot and the Observer to decide, instantly, whether the sensible thing to do is to fight or to play safe. Theoretically, the Observer is in command of the ship, but practically, as in every other situation in life, the man with the stronger personality is in charge of the party. The rule for observation machines is not to fight unless you have to; but if you do have to, go at it hard, and then when the battle is over complete your mission anyway, unless you are disabled.

This doesn't mean that there is any merit in engaging the enemy at long range. On the contrary, it's poor judgment. To be sure, the chief of fire instruction at the Cazaux school, firing 100 rounds at 700 yards against a silhouette airplane, got 38 good hits, of which 12 struck either the gas tank or the Pilot, but 400 yards is about the limit of effective range, and the French experts say that 90 per cent of all hits were made under 100 yards. Long-range combat is usually futile; and when a man began to fire feverishly at long range his opponent put him down for an amateur and gathered confidence. Tracer bullets (these are used in the proportion of from 1 to 2 to 1 to 5) burn out at a little over 300 yards, and would naturally give the Observer the impression that he is shooting *under* his opponent; so that all the value of the tracer bullet is gone unless you hold your fire until you have come to a reasonable range.

From the moment the fight begins, one of the spare-time jobs of the Observer is to note the distinctive markings and color of the enemy ship.

This is really important, because the identification of the ship as one of a particular squadron might very well tell something about a shifting of the enemy's air forces.

Technically speaking, the Observer is in command of the ship. As long as the work is uninterrupted, the Pilot must follow the Observer's orders, so that the Observer can get precisely the information he has been sent for. If a fight starts, the Observer's whole attention is put upon the enemy, and since he has two movable guns, while the Pilot has one fixed gun, he is far more important as a combatant than the Pilot is. Of course, he can hardly give verbal orders to his Pilot, but he can signal to him by any one of several simple codes—by two cords like reins attached to the Pilot's upper arms, or by a mirror placed like the fender mirror on an automobile. Or, to attract the Pilot's attention, the Observer touches his left shoulder, or rattles the stick control—but not sidewise, because he might put the ship into a side slip. To change direction, the Observer gets the Pilot's attention and shows the desired direction by pointing. To command a sharp reverse of direction, he pulls either shoulder of the Pilot. To signal the approach of another airplane, he taps the Pilot's head and makes a circular or cross motion in the air, to identify it as friend or enemy. This circular motion, simulating the cocard which marks Allied ships, brings up an amusing memory. The familiar star insignia carried on all our airplanes in America was never used in the A. E. F. The Allied insignia consisted of concentric circles of red, white, and blue; the British cocard had the red in the center, the French had the blue, and we had the white. Five of our planes, bearing this marking, were shot up one morning by our own troops, which had just come up to the front and still supposed that the star insignia used in America was also used in France. Indeed, Major Haslett reports innumerable conversations with American officers who claimed never to have seen an American plane in flight. They were still looking for the wrong insignia.

As long as the observation mission proceeded smoothly, the Pilot had all the serious responsibility of taking care of two lives. But on the appearance of an enemy the Pilot has to trust the Observer to do most of the shooting. Among other details, he has to trust him not to shoot up a friendly ship and not to let an enemy get too close.

In case of any mechanical disability to the ship, the Pilot is at once promoted to command, and takes no orders.

Now any typical small boy can identify, at sight, dozens of different varieties of automobiles. That's simple. But it would take a genius to tell one car from another if the car were upside down and a few hundred yards away. Yet that task would be simple in comparison with identifying airplanes flying at a distance. There are at least seven different angles, from any one of which a plane won't look as it does from any other of the seven, and no one but a very experienced man can hope to recognize a ship unless he sees it in one of its characteristic silhouettes against the sky.

Experienced aviators, however, will recognize a ship at nearly three miles distance, no matter whether it looks like its formal photographs or not. The wings are the first points of the ship to betray it, for wing construction is very varied. After that, the rudder and the tail give the next best clue. If by this time there is still any strong doubt, the appropriate thing to do is to take no chances. At very close range the Allied cocard and the German iron cross served as a calling card, but oftener the other ship sent over a burst of explosive bullets to save guesswork.

Of the best-known German types, the Albatros scout (or fast reconnaissance plane) was the easiest for an Ally to detect. It had a fish tail, which was one of the great German characteristics, and in the air the tail was pertly cocked up and very noticeable. From underneath, or head-on, the overhanging upper plane was prominent. The Aviatik was very similar to the Albatros, but the tail looked rather like that of the De Havilland; and the overhang would put an Allied Observer on his guard. The huge Gotha had a tail like the blade of a short chisel, and no other aircraft had anything like it. The Rumpler had the typical German overhang and fish tail, with the upper plane cut back and the lower plane nearly square. The Fokker (a broad copy of the French Morane-Saulnier) and the Halberstadt shared another special design of tail, and both had, in addition, a curious style of rudder. They were hard to identify unless you got them sidewise, but if you did they were unmistakable.

So many of these types were modeled after the Allied planes that it was never safe to assume friendship; and a good many amusing stories are told of misunderstandings. Allies have fled desperately from Allies, and Allies have bravely attacked Allies. Twice in a week Rickenbacker stayed his trigger and was glad of it, because at the last fraction of a second he discovered that he had been carefully stalking French planes.

The requirements of practically every sort of observation, except strategic reconnaissance, demand that the ship fly low—lower, that is, than the levels of pursuit planes, and for this reason the Observer and his Pilot could almost invariably figure on being attacked from above. They were always in danger of attack, and almost always at an initial disadvantage, because the enemy would have seen them first and dived on them. This element of surprise is what wins the majority of battles in the air; and since neither the Observer nor his Pilot was often justified in starting any action himself, they had to accustom themselves to so many attacks that surprise became almost a normal state of mind for them.

The enemy, being a combat plane, in the great majority of cases was a monoplace machine, or one-seater, and this meant that the Pilot of it was limited to the use of fixed guns. These guns could fire in only one direction—the direction in which the ship itself was actually traveling. Unless the enemy, during his dive, disabled our ship, or one of its two passengers, he no longer had any advantage, except in the speed and maneuverability of his plane; for in addition to a fixed gun or two of our own, operated by the Pilot under the same limitation of aim that the enemy Pilot always had, there were the Observer's two guns which could be aimed and fired in almost any direction. So that a German *chasse* plane seldom attacked an Allied observation ship without at least two friends to help him. Often they went after a single reconnaissance plane with a whole *Jagstaffel*, or squadron.

The primary tactics of the observation ship thus attacked depend to a great extent upon its mission. A ship on artillery reglage, for instance, is never more than a few miles from its own lines, and rarely more than twenty miles from its own airdrome; it can get home quickly and it can probably get home safely even if it is hit. Allied photo ships were generally slow—very slow—and wide open to attack, if they were flying low enough. The famous Immelmann gained the greater part of his reputation by his quick attack and victory over ships of this class, and not, as many suppose, over Allied *chasse* planes. But Eddie Rickenbacker tells at great length of his own struggles for many successive days to get at a big Rumpler machine which was willing to take its pictures through a telephoto lens at 22,000 feet, rather than risk attack from a Nieuport, whose ceiling was only 19,000. In this case there was really nothing to do. The Rumpler was always far out of effective machine-gun range. We have already pointed out how the Germans played safe in photography.

Reconnaissance ships were often protected by strong detachments of fast *chasse* planes, whose duty it was to see that the reconnaissance was completed. Mark that. They were not to hunt for trouble, but to insure the success of the principal mission.

A slight protection was also afforded by camouflage, and ships were painted so as to render themselves less visible. To be sure, no ship can ever fully disguise itself, but the art of "baffle painting" consists in giving to a ship the impression of a different size from what it actually is, or in giving the impression that it is turning to one side or the other, so that an enemy would wrongly calculate the point at which he should dive. Observation planes were generally painted in values of earth coloration, depending on the season of the year. This was to deceive an enemy flying overhead; for it is almost beyond hope to hide a machine from the ground on account of the silhouette it has to make against the sky. Nevertheless, the lower planes of a ship were often painted with the idea of softening the silhouette as much as possible. At the end of the war, all new French and Italian ships were camouflaged, and Britain had just approved the theory.

LIV

So many different types of airplanes have been mentioned in the press, and their names (but perhaps not their functions) are known to the public, that it may not be out of place to give a list of those ships which were used solely, or primarily, for purposes of observation. All of them were biplanes.

British	*French*	*German*
De Havilland 4	A. R. 1-A2	D. F. W. C-5
De Havilland 9	A. R. 2	Halberstadt C-5
F. E. 2B	Breguet 14-A2	L. V. G. C-5
R. E. 8	Caudron G-4	" C-6
Sopwith 1-A2	" G-6	Roland C
Vickers FB-14	Farman 30-C2	Rumpler C-4
" FB-14D	" 40-A2	" C-5
" 14 F	" 41-A2	" C-6
	" 51-A2	" C-7
	Hanriot-Dupont 9-Ap. 1	Pomilio E
	Lettord 1-A3	S. A. M. L.
	" 2-A3	Savoia-Pomilio SP-3
	" 5-A3	S. I. A. 7B-1
	Salmson Moineau 1-A3	" 7B-2
	Salmson 2-A2	S. V. A. 5
	" 5-A2	" 9
	Paul Schmidt B-10	" 10
	Spad XVI-A2	
	Voisin 8-LBP	
	" 9-A2	

LV

Aviation has literally opened a new world of thought and brought into being a new vocabulary. And one of the lesser novelties concerns a subject which apparently had nothing left to grow on. This was superstition.

Superstition is as old as humanity. The Greek classics are based upon it, and from Homer down to Clifton Johnson's *What They Say in New England*, the literature of all people reeks with it. It is peculiarly interesting to note, throughout the centuries, that the greatest number of superstitions cluster about the most dangerous occupations. The mercenary soldier of Asia Minor, the Crusader, the Royalist alike believed in talismans and in the power of the talisman to ward off danger. And a vast number of matter-of-fact young gentlemen of Anglo-Saxon birth and parentage, who at home had hooted at common superstitions, would never dream of taking off for a flight without some trivial pocket piece for luck. These ranged all the way from an old golf ball to a photograph of Her tacked to the instrument board. Horseshoes were pretty good talismans, and one famous French Pilot who was crashed on innumerable occasions believed that his life was always saved by the queen of spades in his pocket.

There were all sorts of superstitions in the service. One of the commonest was borrowed from the old Texas cattlemen, who decline to allow three cigarettes to be lighted from one match. Hardly an airplane in service was without its distinctive insignia; sometimes the mere initials of an unmentioned personality were painted very small and inconspicuous, to turn aside the bullets of the Hun. Dean Lamb, in the *Air Service Journal*, tells this incident to illustrate the point:

A certain newspaper man who was allowed to visit a squadron of the R. A. F. in France was under the impression that airmen were not superstitious. The Pilot who was showing him over the place made him a small wager that every machine carried a mascot of some sort; the wager was accepted and they started an inspection of the machines. Each machine was found to have some sort of a charm except the last one to be inspected. This machine had just arrived from the aircraft depot to replace a machine that had been crashed; and the Pilot was about to pay his wager when a merry young cutthroat, with eleven enemy machines to his credit, walked into the hangar and proceeded to fasten a powder puff on one of the struts.

Is it a ridiculous thing? Consider what a paradox it was, for four long years, that the Pilots and the Observers, young men and strong, should fly to the heavens, nearer to infinity than any men had previously approached, and that in this miraculous occupation they should be too involved in warfare to think of God.

What do you suppose a flyer thought about when his controls were shot away, and in a sudden instant he knew that he was going down in flames—going down a matter of fifteen thousand feet, in a little furnace which would consume itself halfway?

VI

THE BALLOON OBSERVER

A.—*General*

LVI

SO far, we have dealt entirely with the Observer in an airplane. But there is another kind of Observer whose duties are somewhat similar, although he never travels in the air except vertically or when his craft goes adrift. This is the Balloon Observer—a man both unappreciated and misjudged. And, indeed, his work would seem to the public to be the least spectacular of all forms of observation. It seems like a positive sinecure; nothing to do but sit in the basket and observe, and when the balloon is shot down, jump. After that there is no further need of the Observer to use any judgment.

But the Balloon Observer has a serious and a dangerous mission, and although it is certainly less dangerous than that of the Airplane Observer, and certainly not so important in general, it is very important indeed in particular. Lieut. H. K. Black, R. F. C., writing in the *Saturday Evening Post*, says that

> It is largely through the agency of the observation balloon that the Hun batteries are smashed up. . . . It is true that airplanes direct artillery fire also, but not with nearly so much accuracy as the balloon is capable of.

This, as official statistics demonstrate, is not a fact; but when you recall that the airplane is necessarily traveling at high speed over the target, and communicating with the artillery by radio or projector, whereas the balloon is stationary,[1] and is communicating with its battery by telephone (as well as by radio, or projectors, in some cases), it appears that, subject to its natural limitations, the balloon offers a very adequate support to the information people. The Balloon Observer has a telephone receiver and transmitter fastened to his body much more firmly than a blonde central operator does, and he can call up through the balloon's own field exchange his own chart room, his headquarters, any battery in his sector, and any other balloon in his sector. If he is performing badly he can be helped out by advice or reprimanded on the spot;[2] and he can talk to his associates as comfortably and unexcitedly as though he were sitting in his own library, making a date for the theater. The exchange may have anywhere from twenty-five to seventy-five batteries connected with it, to say nothing of the lines to headquarters. On the other hand, the balloon is a considerable distance from the target; its low height is a disadvantage; and in bad weather

[1] Now and then, of course, a captive balloon does free itself, and if the wind is wrong sails pleasantly into the enemy's country; but as the Balloon Observer isn't trained for reconnaissance, he generally gets little information out of the trip.

[2] As in the case of the Observer who had been continuously in the air for fourteen hours and telephoned down, as Major Haslett tells us, "Colonel, it's pitch dark up here, and I can't see a damn thing, and it's raining like hell." To which the Regular Army colonel, who fancied that altitude conquered all elements, simply responded: "Will you shut up and go on and work? It's pitch dark down here, too, and I can't see a damn thing down here, either, and it's raining like hell down here, too."

the Observer can't function at all. But in good weather he has field glasses, and uses them, and sees infinitely more in detail than the Airplane Observer can. So the reader may take his choice.

But it is conceded—and has to be—that the balloon is really good for one thing, and that is for artillery reglage, at close range. That is because of its anchored position. The French *Air Service Manual* for 1917 said, however:

> In general, do not expect too much of balloon observation for artillery. Utilize balloons to commence adjustment which is to be perfected by airplane, or to finish observation in which airplanes have been interrupted.

But Lieutenant Black claims that from 4,000 feet on a clear day he can detect a difference of 15 feet in the fall of a shell. Again, you may take your choice between the *Manual* and the Lieutenant. One exceptionally clever Observer doesn't make an Air Service; and if all Observers were as accurate as Lieutenant Black, the *Manual* might have to be rewritten.

The second most important function of the balloon is supervision—to see what it can see, wherever it can see it; and because it is anchored in one place the Observer forms a very intimate acquaintance with a certain limited area of the front, which he learns to know as well as he knows his own front yard at home, so that he detects a large number of minor activities which an Observer in an airplane, with a far more divided responsibility, could easily overlook. Broadly speaking, every balloon is expected to gather general information, no matter what its specific mission may be, and it is very unusual for any balloon to be sent up for intelligence work alone.

Part of this surveillance duty is to watch the hostile shelling of our own positions; and since the balloon can sometimes spot both the flash of the enemy's gun, and then the bursting of the shell within our lines, this is a very immediate aid to our own artillery. Another part of the duty is to report enemy airplanes and balloons and to check up on the amount of photographing and bombing which the enemy is doing, and to supply information about aërial combats. No victory in the air is ever made official until it has been confirmed by some one who actually saw it, and the greater number of air battles are confirmed by the balloons.[1]

It cannot safely be said that any one of these duties is more *important* than another; the importance is constantly changing as the condition of the front changes or as a battle changes; and the functions themselves vary greatly according to whether they are performed in connection with an offensive or a defensive organization. Balloon work is *chiefly* with artillery—meaning exactly what it says. The Observer is supposed to "speak the language" of every arm of the service, and to make his reports so that they can be quickly understood, without any

[1] It is interesting to quote from the *Air Service Journal* part of the report of the Allied offensive of September 26th–November 11th, in the operation between the Meuse River and the Argonne Forest:

"An unusual service rendered by the Army Balloon Service was the systematic effort to secure confirmations for the aviators of the pursuit groups. The success in this matter may be indicated by the fact that the balloon companies reported enemy planes falling in flames or out of control seventy-five times. This figure, compared with the fact that the First Pursuit Group claimed a total of seventy-two victories and the Third Pursuit Group claimed a total of thirty-five victories, indicates that the balloons kept a reasonably accurate check upon the aviation's exploits. The days of poor visibility rendered the task difficult, but lookouts of each company were constantly stationed on the ground, even when the balloon was not in ascension."

confusion in terminology; he is catholic to the last degree, but artillery is his major obsession.

You may be amused, and enlightened, to know that the records of German aces refer only to the destruction of airplanes, and almost never to balloons. This doesn't mean that they weren't interested in bringing down balloons—quite the contrary; but they had their own special system of keeping score. They gave credit to their Pilots at the rate of three airplanes for each two balloons actually brought down.

Another amusing fact is that French balloons were frequently sent up in ballast, with no Observer aboard. This was partly because the Hun's morale always suffered when a balloon was in sight, and France was willing to let it suffer. The other reason was simply to hold the balloon in readiness for genuine work; it takes much less time to haul it down and send it up again than it does to maneuver it out of bed and send it up originally.

LVII

The old-fashioned balloon, the one which made the country fair romantic and put Major Baldwin at the head of his profession, was spherical; but the modern military Caquot, or kite balloon,[1] was called by the British a "Rupert," for no apparent cause, and by everyone else a "sausage," or a "K. B.," with very good cause, indeed. It was invented by Captain Caquot of the French army, and it looks like a sausage with elephant's ears on one end of it. These ears are the stabilizers and are put there to

[1] At the end of the war, Italy had developed a balloon claimed to be even better than the Caquot. It was smaller, took less gas, was safe in winds up to fifty-five miles per hour, and was easier to transport and house. But like so many other inventions, it was just too late.

keep the head of the balloon (which is, paradoxically, at the other end from its ears) into the wind. The spherical balloon couldn't be controlled in this fashion, and so in a stiff breeze it ducked about with such dizzying rapidity that there was no possible chance for the Observer to do anything but hang on for dear life. Furthermore, the wind would always push a spherical balloon down low to the ground; whereas a wind helps a Caquot to rise. And the wind, which plays no favorites, does the same thing for the German *Drachen*, which was simply a copy of the Caquot. That is why this type is called a "kite" balloon—not because it looks anything like a kite, but because it is pushed up by the wind in the same way that a kite is pushed up.

The kite balloon, which is some 200 feet long and 50 feet in diameter, is made of rubberized silk, or a very high grade of cotton cloth ("no balloon is stronger than its weakest seam") prepared by a most delicate and intricate process. It is anchored, usually to a motor truck, by a very slim steel cable (about as thick as a lead pencil) attached to a winch which is operated by a gasoline engine. By this method the balloon can be quickly raised or lowered at will; it can be hauled down to avoid trouble, and it can shift to a higher or lower level to suit the weather conditions and the eyesight of the Observer. Now and then, either a friendly or a hostile plane will misjudge the position of the cable, which is so small that it is all but invisible, run foul of it, and cut himself neatly in half.

All modern military balloons have motor-truck consorts, on which the winch and the engine are placed; so that it is quite possible to send up the balloon and then run the truck along a road to take it nearer to or farther from the front lines. Often a balloon detachment had to change its position two or three times a day, on account of too accurate shell-fire. A balloon is to an artilleryman as a silk hat is to a small boy with a snowball. It engenders an irresistible impulse to take a shot at it.

The lifting power goes down as the balloon goes up, but a good Caquot will lift about a ton at the start. Later, if the Observer throws out so much as a pair of field glasses, it will rise appreciably. With two Observers in the basket, it won't rise within a couple of thousand feet as high as it will when there is only one Observer aboard—even a fat one. When at rest it sleeps on a bed which may be composed of almost anything from a permanent concrete and sand foundation to one of canvas stretched taut. The balloon is firmly guyed to the bed, and heavily weighted besides, to keep it down. The wind plays such antics with a K. B. that it is always best to have the bed in a forest, where there will be a wind-break of trees in every direction. A "balloon square" if about 900 feet on each side; for it takes a great amount of room to maneuver such an unwieldy object.

The basket is wicker and has a floor area of about twenty square feet. Perhaps this doesn't seem like a very small space, but an average man couldn't take two steps from corner to corner. The Balloon Observer (they generally go up two at a time) has hardly more elbow room than the Airplane Observer, but he really doesn't need it. He has no machine guns to look out for, and comparatively few accessories to watch, chiefly a Venturi-Pitot tube to measure the wind velocity, a barometer, a thermometer, and a compass. The Pitot tube, made of wood and

TYPE "R" BALLOON

rubber, is also used on airplanes, but to indicate the *air speed* of the plane. In the balloon it simply records the velocity of the wind. The aneroid barometer is to tell the Observer the actual height of the balloon, which isn't by any means the same as the length of wire let out, for the wind may have blown the balloon until it is lying at a long angle from the ground.

LVIII

We mustn't make the mistake of assuming that balloons and airplanes operate independently, because they don't. They work in the closest harmony throughout; and many of their functions are really in danger of duplication. Information gained by the one is of the highest value to the other. For example, the balloon which has plenty of time at its disposal can ferret out little defiladed areas which the airplane then proceeds to examine carefully from overhead. Airplane photographs are filed in great numbers in the intelligence section of a balloon outfit, and help the balloon man to spot his objectives more clearly. Balloon reports of targets which the balloon itself has detected, but can't see distinctly, are often responsible for special investigation by airplane. Furthermore, it isn't uncommon for a plane to go out and help a battery to register on an enemy target, and then turn the shoot over to the balloon, which can conduct the rest of it more gracefully and economically.

The question of whether a balloon or an airplane shall be used for any particular duty is something which has to be decided from each set of facts. In our own army, the commander of the Air Service in each army corps distributed the aëro squadrons and the balloon companies according to the missions which had already been outlined by the Chief of Staff, and he naturally distributed them where they would serve to the best advantage, and supplement one another. The General Staff is in constant touch with all the different sources of information, and there are so many conferences between the representatives of these sources themselves, especially between the representatives of the artillery and the Air Service, that it is easy to decide how each job can best be handled so as to get the best results at the lowest cost and at the least risk.

The swift development of airplane observation created an early prejudice, on the Allied side, against captive balloons, and in spite of the early dependence of Germany upon them it wasn't for three years that the Allied artillery put very much faith in them. This faith might never have developed at all unless the old system of "grounding" wires had been eliminated. And this is a bit of a paradox, for the "old" system of wiring, which is to say the one which the balloons used until 1916, was apparently modern; and in order to get full efficiency they found that it was necessary to go back fifty years and adopt an ancient principle of our grandfathers.

Up to 1916 the balloon was wired, on the same principle as the one on which all modern telephone and telegraph lines are based. You use only one wire between stations; you attach the two ends of that wire to a piece of metal in the ground—this is "grounding" the wire—and let Mother Earth, who is a good conductor of electricity, take care of the return current, and complete the loop. She does this neatly and with dispatch, and you save half your wire. The old balloon system was a one-wire system, and anybody could "listen in" on it, because of that grounded wire. You can send radio in code, but it isn't quite so practicable to *talk* in code, and often the Boche got a clear idea of what was going on. The balloon crowd simply went back a generation and made the familiar arrangement of two wires carried completely off the ground and forming an unbroken loop. Nobody could listen in on this, and the resultant privacy and close liaison with the artillery gave results which attracted favorable attention. It is perplexing now to recall that the British expeditionary force took with it no kite balloons at all, in spite of their great success in previous small wars with the spherical balloon.

LIX

Elementary training in balloon observation in America was given to Observers and mechanics at Camp John Wise, San Antonio, Texas; and advanced instruction at Fort Omaha, Nebraska; Fort Sill, Oklahoma (for the observation of light artillery fire); Camp Lee Hall, Virginia (for heavy artillery); and at Arcadia, Florida. Out of 219 candidates for the half wing, 206 got it, which again is an indication that our personnel might conceivably have been improved.

In England, Balloon Observers were given a good deal of training in free balloons, of the archaic spherical kind, to inspire them with confidence and teach them what to do if they ever went adrift in earnest. It so happens that in France, as we have already said, the prevailing winds were toward the enemy lines. When a balloon got loose and started toward Germany the Observer was expected to get out at once and drop in on his friends; but if it drifted the other way, toward his own S. O. S., he was expected to bring it down safely somewhere, for it had cost a lot of money. Occasionally, however, a stubborn Observer refused to descend in spite of an involuntary journey into Hun-land, and insisted, like a sea captain, in sticking to his ship until it sank. In a high wind at St. Mihiel, when a balloon broke loose and an unforeseen accident in the basket left only one undamaged parachute for two Observers, both generously declined to use the chute and be saved; they made a landing over the Boche lines and were both taken prisoner. This was heroic of them, but it was also unpatriotic, for an Observer is a valuable man, and one of them should have saved himself for the good of the Air Service. It was heroism which reacted to the disadvantage of the Service.

Shortly after the war our army ordered a large number of free balloons to be made out of surplus fabric on hand. The previous argument that free ballooning couldn't be very valuable experience, or the French would have made more use of it, became suddenly humorous when you remember about those prevailing winds in France. The mere fact of the argument, nevertheless, is a distinguished compliment to our Gallic friends. As a broad theory, anything which wasn't done by France wasn't worth doing.

The final balloon project of the American Air Service was for 175 balloon companies, each with two balloons—on the principle of the millionaire who bought twice as many automobiles as he needed, so that half of them could always be in process of repair in the garage. One balloon company is attached to each division; one balloon group (5 companies) is attached to each army corps. A balloon wing consists of 3 groups.

The personnel of a balloon company consists of 8 officers and 170 men of widely different experience, from the chief mechanic of the gas plant to a telephone-repair man; from pipe fitters to mechanical draftsmen (to plot mosaics, etc.), from cooks to cordage workers. It takes a large crew to maneuver a balloon on the ground and to inflate it; and in a high wind it takes all the strength of the crew to control the balloon at all. That is why balloons are oftenest domiciled in the protection of trees.

As we shall not again refer to the enlisted personnel of a balloon company, it is pertinent here to quote from an order from the commander of the Balloon Group, Fifth Army Corps, in reference to the tribulations of the ground men:

> 1. The entire Balloon Service honors the maneuvering squad of the Twelfth Balloon Company. The devotion to duty shown by the men who composed this squad on October 1, 1918, was such as to set a glowing example to all other balloon companies in the American Expeditionary Forces.
>
> 2. Despite the fact that shells were falling on all sides of the balloon, two so close as to tear holes in the fabric, no man left the ropes nor faltered, well knowing that death was liable to come to them at any moment. The safety of the balloon was their first thought; their personal safety second. They have shown the spirit and loyalty which is expected of true soldiers.
>
> 3. This order is to be read to all balloon organizations in the Balloon Group, Fifth Army Corps, at the first formation after its receipt.

And to relieve the situation with a bit of humor, we quote from the *Aerial Age Weekly*.

> "My," said a sweet young thing, ambling about the side lines, to a sweaty, tired guard, "does the wind make that balloon sway like that?"
>
> "Naw," replied the guard, in disgust, "they're just feeding it meat."

The statistics branch of the General Staff has published the following:

COMPARISON OF BALLOON STRENGTH OF ALLIED AND ENEMY AIR SERVICES AT DATE OF ARMISTICE

French and Belgian Front	*Number of Balloons*
German	170
French	72
British	43[1]
American	23
Belgian	6
Total Allied	144
Total Enemy	170
Italian Front	
Italian	32
Austrian	26

A good deal of publicity has been given to the statement that we "had" 574 balloons at the end of the war. So we did. We had produced 642, borrowed 20 from France, lost 43, and given 45 to our allies. The arithmetic points to the fact that we "had" 574 left. But the official published statement goes on to say, "these figures mean that at the end of the war we had nearly twice as many observation balloons as the enemy and the Allies combined had at the front." In other words, we compare our total resources with what the other fellow had actually in use. Many people have failed to notice the fallacy and have assumed that in this field we were greater than all other nations combined.

For the 43 balloons we lost, we destroyed 71 of the enemy's, and that was good business.

LX

The Balloon Observer must have a peculiar brand of courage; and he needs to be of the same cold-

[1] Britain actually had 83 kite balloon sections of the R. A. F.

blooded type as the Airplane Observer, and even more so, because he never gets a chance to fight back. He can only go over the side as a last resort; and until that necessity arrives, he must go calmly about his job in spite of the fact that enemy guns are banging away at him, enemy planes are trying to shoot him down, and the wind is always hoping to break the cable.

As to the danger and discomfort of balloon observation, it is acute, but it is very different from the danger and discomfort of airplane observation. For one thing, the stationary post of the balloon means that the fire from Archie is less. It is annoying, but only a few direct hits are made (Lieutenant Black says that no British balloon was ever brought down by enemy gunfire). Nevertheless, the heaving about of the basket by near-by explosions is rather more exciting than anything the flyer gets from the ground; especially since the balloon has to sit still and take its medicine, or quit entirely, and go down to earth. But to offset this, there is the hostile airplane which comes along, preferably early in the morning or late at night, and fires tracer bullets into the balloon, sending it down in flames. (The balloon doesn't explode; it burns.) The Observer has no possible means of defending himself,[1] but on the other hand, he is often warned by telephone of the approach of a plane which he himself hasn't seen. That is why attacks are made at early morn and dewy eve—the attacking plane can't be seen so clearly either by the Observer or by the ground. The Observer can always demand to be hauled down; but in the end,

[1] There are isolated cases of armed balloons, but the practice is attended with tremendous hazard. Usually the Observer hasn't so much as a revolver with him.

if he is shot down, or sees that the destruction of the sausage is inevitable, his one recourse is to go over the side, and even then he has four great dangers. One is that the parachute won't open; one is that bits of the burning balloon fabric (for no method of fire-proofing it has ever proved successful) will graze and ignite the parachute; one is that the enemy airplane will follow him down, firing at him (although in view of the machine guns on the ground, this is dangerous to the enemy); and the last is that he may land in anything from a river to a mass of barbed wire. You would hardly believe that even a German would try to shoot an Observer coming down by parachute, but they did it—and more than one young man knows what it must feel like to be a partridge in the open season.

The modern British—as well as the American—parachute has been aptly described as resembling a breeches buoy. It is a sort of silk folding umbrella attached to a harness of web belting, and the harness is attached to the Observer before he goes up. The parachute itself, packed tightly in a case, hangs on the outside of the basket; when the Observer jumps off it is automatically detached by his weight, and opens after a fall of perhaps two or three hundred feet. This intermediate period, before the parachute has opened, is a great experience for any man who tends to be introspective. The German parachute was sometimes carried, case and all, on the Observer's back; and one German inventor, who had probably been brought up in a boarding house, patented a sort of box-couch arrangement by which the Observer could sit down on the case and be comfortable. This idea has also been elaborated in America, where there are more boarding houses than there are in Germany.

The Observer, then, is always working in harness and cursing it, and claiming that it is too tight or too heavy or something. And there is always the chance of an accident similar to that which befell an Observer at Verdun. The parachute got tangled and the balloon was on fire before the parachute could be disengaged.

Once over the side, the Observer has no more control over his movements than a piece of thistle-down. He may drift into Germany as well as not. He may come down in a high wind in a wire entanglement. This is not pleasant. To be sure, he has a knife with which he is supposed to cut the parachute ropes just before he lands, to prevent being blown against anything uncomfortable before he can get his feet, but this doesn't always help.

And there is no limit to the necessity of jumping off, either. In the Meuse–Argonne offensive, one student Observer made three jumps in four hours, two balloons burning over his head. Another jumped three times within twenty-four hours; and during this offensive, between September 26 and October 11, 1918, a total of 30 parachute jumps were made and 21 of our balloons destroyed, 15 by enemy airplanes and 6 by shells. Two or three forced jumps will shake the nerve of a very courageous man. All the warring nations discovered that when an Observer had made a very limited number of hops his usefulness in the air was gone forever. At first, to be sure, the Anglo-Saxons thought that a man was a coward for losing his nerve, but when France demonstrated that a balloon-shy Observer was merely a psychological and not a court-martial case, the higher authorities—few of whom would care to step in the basket—of the Anglo-Saxons finally concurred.

AËRIAL OBSERVATION

A Balloon Observer is on a longer tour of duty than an Airplane Observer, and there are countless men who have served for as much as twelve hours at a stretch. For such a duty there are one prime advantage and one prime disadvantage. The balloonist has a tendency to suffer more from cold, because he is exposed to it for a longer time, but since no muscular activity is expected of him he can wear heavier and warmer clothes. This helps out his endurance; in the Meuse–Argonne show, the balloons were on watch by day and on the road at night. The infantry was going forward, traveling fast, but the big gas bags were bouncing along behind, over torn roads, through barbed wire, and through forests, and the Observers slept in the open during that cold and rainy weather, and then got up for an early start the next morning. And many of the companies had already served, without rest or leave of absence, through Château Thierry and St. Mihiel and Verdun.

The Observer is subject to airsickness and not very much ashamed of it, for the basket is small and light and has a pet aversion to standing still. There is nothing to do about this, except what urges. A forty-mile wind will often save the Observer from thinking what to do next, for the basket is as skittish as a fragile skiff would be in a heavy sea. And as at sea, the passenger may be affected during or afterward. Airsickness, however, is infinitely more trying than the aquatic variety. It is superconcentrated Hades, and when it takes hold of a man, he doesn't care whether anybody loves him or not. The worst of it is that you never know when you are safe; an expert is as liable to succumb, on the spur of the moment, as a novice.

In a high wind there is an additional peril, in that the balloon may break away entirely. The winch is powerful, but when it is fighting against the wind pressure on a big Caquot the strain on the thin cable is something terrific. If the cable parts and the wind is blowing toward Germany, the Observer throws all his maps, photographs, and instruments overboard, to prevent the Boche from getting them, and then takes what care of himself he sees fit.

Thunderstorms are not nice in a balloon, but they are uncomfortable rather than physically dangerous.

Even the matter of landing, in a high wind, is awkward, because when the balloon, in coming down, strikes an air pocket which would simply "bump" an airplane, the balloon dives headlong, completely out of control. In this performance it is as helpless and clumsy and crazy as a frightened and pneumatic elephant. Sometimes it crashes, and in this event there is practically no chance at all for the Observer.

The danger from enemy planes is pretty constant, despite the antiaircraft protection which is supposed to guard each balloon. Sometimes, in addition, a small amount of airplane protection is attached to each balloon company.

On July 31st, near Pont-à-Mousson, Lieutenant Higgs was carrying on a general surveillance of his sector from his balloon with a French soldier, when an enemy plane dived from a cloud and opened fire on the balloon. In imminent danger, he remained in the basket until he had helped his French comrade, after whom he himself jumped. On August 21st, in the same sector, Lieutenant Higgs was performing an important mission regulating artillery fire. Enemy planes attacked, and with great gallantry Lieutenant Higgs remained in the basket until his assistant had jumped. On October 29th, near Gesnes, Lieutenant Higgs was conducting a reglage from the basket with a student Observer. Attacked by enemy planes, after his balloon was burning, Lieutenant Higgs would not quit his post until he had assisted his

companion to escape. In each of the foregoing instances, Lieutenant Higgs at once reascended in a new balloon.

Two balloons per day is a fair loss in an active sector.

Machine guns *have* been mounted in the basket, but the idea isn't universally approved. Hydrogen is too inflammable. The use of helium gas instead of hydrogen would insure the Observer against fire, and it would also let him arm himself with weapons for defense; but in practice the Balloon Observer was literally defenseless. Helium was used in a few navy dirigibles, but practically not at all in the army. It is absolutely noninflammable, but hard to prepare, and there is a tremendous waste of it in filling a balloon. Then the item of cost helped to keep it out of war. Helium comes from radium and its associates, and also from certain natural gases. A good supply of this gas will be of vital importance in any future warfare, and there is fair reason to hope that America will have some.

The danger from enemy aircraft is slightly lessened by the fact that the ground can call the Observer, and say, cheerfully, "Four Fokkers coming from the northwest," and that the Observer has a slight margin of time in which to use judgment. He can be hauled down without jumping, he can be hauled down halfway and then jump, or he can jump without being hauled down at all. Singularly enough, this freedom of choice is little appreciated.

There is a slight but piquant danger from collisions of either friendly or enemy planes.

We have already pointed out that our own Air Service suffered comparatively few casualties. We lost only one Balloon Observer in combat, and he wasn't killed by the direct act of the enemy. He died an altruist. But the story of three American Observers ought to be set down here, because they give such a clear picture of what the Observer sometimes goes through, whether he is on our side or the other.

The first quotation is from the *Aerial Age Weekly* of January 20, 1919:

First Lieut. W. J. B. Taylor, Observer, Balloon Corps, First Army, residence Rochester, N. Y., has reported to the Division of Military Aeronautics Headquarters overseas for discharge. Taylor wears the Distinguished Service Cross awarded him in action on September 26th and October 10th, for declining to discontinue making observations for the Division Commander when his balloon was attacked by enemy airplanes and refusing to abandon his records, although he could have safely jumped in his parachute.

From the records it appears Taylor had several unusual experiences in parachute jumping under fire. One time he landed in a tree; another time on an army mule. This last adventure took place about the 1st of October near Montfaucon, when the infantry were assaulting Romagne. Taylor had been up about two hours, watching the Boche infantry digging in and fortifying machine-gun nests in front of the U. S. infantry attack. Suddenly in the midst of this observation his balloon was attacked by a single-seater combat plane. The Hun Pilot was so near him that he could easily distinguish the man's features. But on account of the close range and the very hot fire Taylor did not hesitate to jump immediately. The German Pilot missed the balloon in his first onslaught and turned to follow it down, as the crew below hauled it to earth. Despite the machine-gun fire of the balloon company against him the Hun came as low as two hundred feet. His engine was finally so badly hit that he lost control and fell. The motor was cracked up, but the plane was undamaged, and as the Hun landed he vigorously cursed the Americans, one and all, whereupon a buck private punched him in the face. In the meantime Taylor's parachute had carried him well beyond this exciting scene into a peaceful pasture and a herd of army mules, on one of which he landed, and was rescued from the bucking, kicking animal by some artillerymen who came by just in time. Taylor said he was more concerned over his seat on the army mule than he was about his safety in making the parachute jump.

AËRIAL OBSERVATION

Although this is a book specifically to the exclusion of the pursuit Pilot, the next two incidents concern them and illustrate, by example, how vital it is to destroy the enemy sausages. An enemy airplane would use exactly the same procedure in trying to destroy one of ours. The first is merely a citation for the Distinguished Service Cross:

First Lieut. Lansing C. Holden, Air Service, First Pursuit Group. For extraordinary heroism in action near Montigny, France, October 23, 1918. Lieutenant Holden was ordered to attack several German balloons, reported to be regulating effective artillery fire on our troops. After driving off an enemy plane, encountered before reaching the balloons, he soon came upon five balloons in ascension one kilometer apart. In attacking the first, which proved to be a decoy with a basket, his guns jammed; after clearing them he attacked the second balloon, forcing the Observer to jump. His guns again jammed before he could set fire to this balloon. Moving on the third balloon at a height of only fifty meters, he set fire to it and compelled the observer to jump. He was prevented from attacking the two remaining balloons by the further jamming of his machine guns.

The record of the other man, Lieut. Frank Luke, who ranked second among the American aces, explains some of the reasons for balloon observation, and many more reasons why the other side wants to prevent it, and what risks it will run to prevent it, if humanly possible.

. . . .

Regardless of weather conditions, Luke went into the air at dawn and crossed the enemy lines before daylight had been able to conceal the flashes of terrific gunfire that raged that morning on the field. He scoured the whole front in search of enemy balloons, but without success. Far to the south and east, however, he observed one German balloon operating on the extreme right of the American sector and on a portion of the line allotted to other aviation units. Luke determined the exact position of this and, returning to his airdrome, learned that this balloon had already that day been attacked repeatedly by other American and French pilots without success and was causing great damage by directing enfilading fire on our advancing troops. Luke volunteered to destroy the balloon and disappeared in a very few minutes with his side partner, Lieutenant Wehrner, in quest of the balloon. Ground observers state that at 8.19 A.M. Luke dropped out of the clouds, surprised the balloon, and on his second dive shot it down in flames, thereby removing this menace which had so successfully hampered the advancement of our troops. As a matter of fact, it was Luke's first experience with a balloon gun. This was a machine gun designed to fire a heavy incendiary bullet. Heretofore Pilots had never been very successful with it, but Luke felt that when properly handled it would ignite balloons when all others failed. On his first dive the gun jammed and his other machine gun stirred the whole antiaircraft system into double activity, challenging the efficacy of their lead and phosphorus. Luke repeated his maneuver, and in the very face of escorting enemy machines succeeded in igniting the huge clumsy gas bag. . . .

. . . The enemy could only keep three balloons in the air, and these were in the neighborhood of Boinville. The erratic movement of those balloons as they ascended and descended at the least provocation indicated clearly not only the nervousness of the personnel operating them, but also the value in the minds of the German General Staff of the work demanded of them. They appeared to be frantic in their attempts to send and give information, and at the same time were terribly fearful lest they should share the fate of so many comrades and be shot down in flames. They attempted, therefore, to operate from very low altitude; so low, in fact, that it would be impossible for the Observers to jump out in their parachutes, as the drop would not have been sufficient to enable the parachutes to open and land the Observers safely. . . . At a few moments before Luke was supposed to shoot the balloon down his escort became engaged in a fearful fight against odds, and it seemed hopeless under the circumstances to make the attempt. Undaunted, Luke darted in beneath the "dog fight" which was raging above, and dived on a balloon again and again, succeeding in shooting the balloon down in flames, despite the showers of machine-gun bullets, antiaircraft shells, and flaming onions. . . .

. . . In reading the history of Luke's balloon career and observing how he seemed to delight in the venture, one is inclined to gain the impression that balloon strafing is an easy venture. Any experienced Pilot, however, will soon dispel from the mind of the reader this impression. In reality it is one of the most dangerous exploits any man in any branch of the service can undertake. It is the antiaircraft fire from the ground which makes it so much more hazardous than other fight.[1] Up to date, on every occasion Luke's machine was literally riddled with bullets, and twice he had been compelled to abandon his airplane entirely and break in a new one. . . . It is hard for the layman to appreciate the many risks and dangers to which this officer was subjected that afternoon. It meant that he had to fly in the face of almost certain death over units of enemy troops, all of whom were firing at him from extremely low altitude and short range.

LXI

The French authorities hold that when a balloon is within four miles of the front lines it is in a remarkably advanced position, and that three miles is so dangerous as to be almost out of the question. This, of course, really depends on what the enemy's artillery is doing. As a general proposition, the defect of the balloon is the beauty of the airplane, and vice versa. The airplane can't stay in one place, and the balloon has to; and there are moments when an Observer in either style of craft would give a million dollars cash to be in the other. These moments are brief; ordinarily, each type of Observer regards the other as an unfortunate and pitiable person.

To be sure, the balloon can be moved from time to time, but the times are pretty far apart.

The ideal situation of the sausage was about a mile up in the air and about five miles behind the

[1] Please note this phrase. The Pilot concerned was one of the best in the world, and one of the bravest, but he was performing low-altitude work which many Airplane Observers perform as a routine business.

lines. From this point, the Observer was supposed to be able to note every slightest sign of enemy activity in his own area, from movements on roads and railroads to suspicious clouds of dust. His stationary post gave him the best possible opportunity to learn what the enemy did by schedule—how the trains ran and how supplies were brought up, and so on. In this respect he had a pronounced advantage over his cousin in the airplane.

In addition to the question of movability, the balloon has another defect—its comparatively low height. In bad weather, when visibility is low, the balloon is out of a job—the airplane can hunt for rifts in the clouds, and sometimes even find them, but the balloon is quite useless.

Before the Observer could reasonably be expected to make intelligent comments on what was going on in his sector, he naturally had to understand what he was seeing from the basket. Before he ever left the ground, therefore, in a region which was unfamiliar to him, he was supposed to have studied all the available maps and photographs and to have taken advice wherever he found it, so that when he first went up alone he would know the strength of the enemy, and his positions; he would know the lay of the land, the enemy's roads, railroads, depots, and ammunition dumps, and particularly the enemy's routine, the enemy batteries and their bad habits. In the French army the Observer, unless he had been originally an artillery officer, was actually attached to a battery for a while, so that he could learn at first hand some of the problems of the gunners. Just as the best Airplane Observer is an artilleryman, so is the best Balloon Observer an artilleryman.

The surveillance balloon, being a divisional institution, supposedly covers a *sector* of the front. If it covered only the operations of a brigade, or a regiment, the frontal ground would be called a *sub-sector;* or, in the case of a battalion movement only, a *quarter.*

At the end of each day, no matter what his specific mission may have been, the Observer made a general report to Air Service Information, covering his entire tour of observation. This report was in the most minute detail, and included everything seen, suspected, and deduced. The surveillance, or intelligence balloon, which has nothing to do except to watch for anything and everything, naturally furnishes a good deal more information than the infantry or artillery balloon, which is up on a definite assignment.

B.—*In the Basket*

LXII

The French belief is that the Observer should always be sitting down (except on absolutely calm days), in order that he can have a secure rest for his map and that he won't have to be constantly stooping to pick up his paraphernalia; and also that by the slightest change of his position he can meet and offset the movements of the basket, which is so sensitive that it reacts to a gentle cough. Riding a balloon isn't unlike riding a horse for the first time, with the difference that you can't balance the horse.

In spite of the small space in which he has to work, the Balloon Observer carries up with him a kit of tools which staggers the imagination. But there's a reason. Since he can't fly about at will, he has to work out his map problems by instruments.

Now, regardless of whether the Observer is looking at a spot on the map and trying to find it on the ground, or looking at a spot on the ground and trying to find it on a map, he is working with two separate factors—"alignment and range," which is to say, direction and distance. And the first thing is the easiest—to get the direction accurately.

This, of course, isn't easy at all unless the Observer has already made himself pretty familiar with the country. But he is supposed to have done this anyway, and to have fixed solidly in his mind, without the aid of a correspondence course in memory training, such vital features of the sector as trenches, roads, villages, forests, and streams. He has done this by "orienting" a map of the sector; that is, by placing the map before him in such a way that each item of it corresponds in position to the actual points as he sees them on the ground, and by learning this map by heart, or rather, by eye. He ought to be able to shut his eyes at any instant and see his sector as clearly as though he were staring at it through his field glasses.

There is one curious point to repeat here, and that is that the position of a balloon isn't always what it seems. In fact, it is almost never there. The Observer may have oriented his map all right enough, but until he has worked out the actual position of his own balloon he couldn't report accurately on questions of direction and range, because the balloon, instead of being directly over the winch (by which it is raised and lowered), might have been—and almost invariably is—blown by the wind until the wire makes an angle with the ground. The actual position of the balloon may be a quarter of a mile from the winch. The Observer must locate himself, not only for personal reasons, but also for the information of his section on the ground. The ground needs to know his exact position as much as he does, so that it will understand the basis of his calculations. Then again, there are days when the balloon keeps turning around and around, like a balky but consistent mule, and orientation is a continuous performance.

But after the Observer has found himself, both in the air and on the map, he has gone ahead to study the terrain by one or both of two methods: "cheminement," which consists of tracing landmarks as they appear on the ground, and "alignment," which is tracing a line on the map, and then checking up the course of that line slowly and carefully on the face of nature.

Now one of the persistent troubles of the Balloon Observer is with "dead spaces." Remember, he can't fly around as an Observer can in a plane. He is anchored. He is working under the same handicap as though he were standing on a high hill. He sees everything in perspective; if there is a forest with a valley in it, he can see the forest, and he may know roughly where the valley is, but he can't see *into* the valley at all, and he can't see how wide or how deep it is, or what's in it. And one of the factors which decide whether a balloon or an airplane shall conduct any particular shoot is the ability or inability of the Balloon Observer to avoid a dead space. The target may be only a few miles distant from him, and yet quite invisible. (There is kept up-to-date an exhaustive map of the "dead ground" from various altitudes, in order to check reports in which this factor enters; France had all the dead areas worked out for three different heights.) So that the process of "cheminement" is full of mistakes, because there is always a certain amount of low ground which is utterly invisible to the Observer.

But if the Observer starts to follow on the map a line in any direction from his own position, and traces the ground exactly according to that line on the map, as far as he can see, he discovers where these dead spaces are, and he also straightens himself out on any tricks of perspective. And if he goes on to draw on his map a whole series of rays from the balloon to a lot of different points and to follow them carefully, step by step, on the ground, he knows something. This latter method is alignment.

The use of both methods together gives him all the information that he can get by his own individual effort. Airplane information has to furnish him with all the rest.

Because of the need of working always from the map, and figuring by it, and sketching from it, the Observer carries with him an outfit which would do very well as a set of samples for a drummer traveling for an art stationery house.

At a lecture at the Army Balloon School, A. E. F., Commandant (Major) Maudin of the French army offered the following list of implements to be taken up:

1/20000 map (about three inches to the mile) on a roller board. (The map must rest on a hard surface when the Observer is drawing on it.)

1/10000 map on a roller board. (This size of map is used on the offensive to show the disposition of all troops.)

Carrier for the documents in the basket.

Three pairs of field glasses, of different power (one with the artillery mil scale).

Chamois for cleaning the glasses.

Duodecimeter rule. (To measure distances on the map.)

Two hard pencils with protected points. (Soft pencils are not as neat or precise.)

Eraser.

Pad of paper.

Celluloid scale for 1/20000 map and one for 1/10000 map.

Hand anemometer.

Altimeter (have it set).

Compass.

Thermometer.

Table of signals, in case the telephone gets out of order.

Knife.

Change of microphone capsule for the telephone.

Straightedge (for ruling lines).

Weighted envelopes (for dropping messages or maps overboard).

"It is also a good thing to take up a reel of wire four or five hundred meters long. If the telephone wire in the cable should be short-circuited, this wire would alleviate the necessity of returning to the balloon bed and hauling the balloon down, which would result in a big loss of valuable time."

Now, a few words about the documents in the basket.

I have mentioned the two maps at the scale of 1 20000 and 1/10000. On these should be marked the most important alignments running from the balloon position. The woods and hedges should be colored green so that they can easily be picked out. These maps should be corrected and added to as new information comes in. As soon as the bulletins and photographs arrive the corrections should be made. In the document carrier the following documents are placed:

THE BASKET OF A CAQUOT APPEARS COMMODIOUS ONLY TO THOSE WHO HAVE BEEN BROUGHT UP IN NEW YORK APARTMENTS

The photographic reduction to 1/50000 of the sector and the two neighboring sectors.

Map of 1/5000. This map is usually cut into kilometer squares and mounted in a book or on cards.

Map of 1/50000 mounted on cloth, with a front of about 25 kilometers. On this map the important railroads, roads, enemy balloon emplacements, camps, supply parks, ammunition dumps, etc., should be marked and colored.

Artillery map of enemy batteries and their usual zones of action.

Photographs in a pocket or file.

Map of 1/20000 on cloth, with the territory covered by each photograph carefully marked and numbered according to the photograph.

Program of the day's work in a small notebook.

Map of 1/200000, which would be useful if the balloon should break away.

LXIII

If the Observer is trying to find on the ground some point which he has first picked out on the map, and it doesn't happen to be such a large or such a distinctive landmark that he can put his eye right on it after a moment's actual search, he sighs wearily, and then draws on the map a ruled line from the balloon position (*not* from the winch position) to the point in question, and a little beyond it. Then he picks out, on that ruled line on the map, some very prominent landmark *beyond* the point he is trying to locate, and another prominent item *short* of it, and these two points, taken together, make a "bracket." A landmark for this purpose might be anything from an isolated tree to the bend of a stream—anything at all which will stick in the Observer's eye as a guide to the line. Now he takes his field glasses, and locates on the ground the two items which make up the bracket, and of course he knows that his objective lies somewhere in between them. The rest of the problem consists of narrowing down the bracket, which is to say, crawling up, step by step, upon the objective from both front and rear. He uses his glasses and his map alternately, and, staying always on that ruled line, checks off all the little intermediate points as he proceeds mentally along it, until suddenly, when he has narrowed the bracket down to a few yards, he catches sight of what he is looking for, or "gets the range."

Now, although a Balloon Observer uses co-ordinates in exactly the same way that the Airplane Observer does, to describe locations, he can't make the same rapid use of them. He is always hampered and delayed by his angle of vision, because he always sees the world at a long slant. Nevertheless, he has a tremendous advantage in measuring with instruments of precision on a map, instead of having to make more or less hasty estimates; and when his calculations are once worked out and verified, they can't be improved. There are, practically speaking, only two ways for him to go wrong, and he ought to have sense enough not to fall into either mistake. He mustn't attempt to judge the range of any one point by its apparent nearness *on the ground* to any other point which isn't on exactly the same ruled line from the balloon. You may have to read that sentence twice. The size of the two objects may be very different, and so the perspective may even deceive him as to which is the nearer. Sometime when you are standing on a hill, pick out two trees, standing reasonably close to each other a mile away, but not in the same straight line from you, and try to decide which is the nearer to you. Invariably the tree which is actually *larger* will look actually *nearer;* so that even if you know the distance from yourself to one of the two trees, and try to judge from this fact the distance to the other tree, you'll be wrong in any event. And if the two objects aren't of the same kind, like two trees, but one of them is a building and the other is a quarry, and they are both about eleven miles away, your judgment—or the Observer's—will be very, very far from accurate. The Observer mustn't let himself in for optical illusions.

The other mistake occurs if the Observer yields to the temptation of saving time by working out alignments and getting the range of an object when the line doesn't pass through the "horizontal projection of the balloon." That is, suppose the position of the balloon yesterday had been a quarter of a mile from where it is to-day, and yesterday the Observer had ruled a map with a line from his own position to a certain interesting point. To-day he wants to locate a different point, which happens to be in the same line as that one of yesterday. He mustn't use that old line at all; he mustn't try to figure sidewise. This oblique sort of alignment was spoiled by Columbus, for no part of the world is really flat; and even if you have the proper direction you won't get very far with this apparently simple method of range-finding. "It would seem plausible to hunt out on the map two points through which a straight line would pass, and also pass through the objective; prolong this line until it cut the line of absolute direction, and spot your target with absolute accuracy."

But to do this you would have to *imagine* the oblique line drawn on the ground between the two chosen points and the objective. You could draw it on your map easily enough, and have it as straight as a die, but when you came to visualize it on the ground you couldn't visualize it straight to save your life; so that this method is as full of flaws as it would be for a billiard player to hold his cue sidewise, at arm's length, and try to make the cue ball travel a given distance on a given line. He couldn't possibly get a clear aim, or a clear judgment of the distance. Depending upon his skill and experience, he might come close to it; and a good player would always come closer to it than a bad player would; but even so, it isn't the way to tackle the proposition.

The accuracy of an alignment comes from the fact that the Observer rules a map from his own position, and by holding the map in front of him can visualize the ruled line on the ground. As soon as he throws away this power of perfect visualization he has thrown away a large part of his value.

LXIV

When the Observer wants to find on the *map* something which he has already seen on the *ground*, he simply reverses the procedure. The first thing for him to do, then, is to visualize the alignment on the ground—to imagine a straight line between the object and the balloon—and this test is genuinely difficult, and takes more concentration than you would think, unless the line happens to pass through at least one very distinctive landmark on the way. Oftentimes, in flat or monotonous country, the line simply has to be approximated, and worked out second hand by means of other lines which *do* pass through distinctive landmarks near by. Then the range is obtained by bracketing, as already described. But since any mistake in direction brings about quite as serious a waste of ammunition as any mistake in range, it goes without saying that the Observer is supposed to use all the mathematics he knows in order to get the direction perfectly.

LXV

Artillery observation from a balloon follows the broad principles of reglage from a plane, with the invariable handicap—or advantage—of a fixed position, and the slight advantage—or handicap—of keeping a fixed relation toward the target, instead of cruising all around it, and having to lose sight of it for a large part of the flying period. No one has ever yet decided, once and for all, whether the advantage is greater than the handicap, or vice versa. There is some merit in Josh Billings's advice to hunters: "In shooting at a deer that looks like a cow, or a cow that looks like a deer, always aim so as to hit it if it is a deer, and miss it if it is a cow." In other words, it makes all the difference in the world whether you are talking to an Airplane Observer or a Balloon Observer. In the field, you couldn't very well get along without either, but to hear them talk about each other's importance, you would imagine that neither of them could get along with anybody. Curiously, however, each thinks that the other's work is less valuable, but more nerve-racking and dangerous.

The Balloon Observer is not only dealing always with two very different alignments which he must try to reconcile—the alignment of himself with the target, and the alignment of the *battery* and the target—but he is also bothered, especially when he is working against the wind, by the fact that smoke from one shell-burst cuts off his vision of where the next shell bursts, unless there is a good interval between the shots—much more of an interval than the Airplane Observer would ever ask for. And the Balloon Observer is absolutely dependent upon his map, because without it he can't even judge the range of a shot fired from any place except in exactly the same line with himself and the objective; and naturally enough, the battery is very seldom in that same line. It wouldn't be very healthy for the Observer if it were; the enemy could shell two birds with one Jack Johnson. For this reason, in spotting the fire of big guns, France customarily had two balloons, about five miles apart, working on the same job. One was placed on each side of the battery; both reported at once, and the reports, taken together and averaged, were very satisfactory.

When the balloon and the battery aren't in the same line the Observer has to do a little extra figuring because obviously the battery wants to be corrected on the basis of its own location and not on the basis of the balloon position. A burst which would look like "right and over" on the balloon-target line might really, if the balloon were placed to the right of the battery, be a correct alignment and an almost perfect range on the battery-target line. The Observer has to do his figuring so that when he says "short" or "left" the battery will have no figuring to do, except with relation to the guns themselves.

First, he draws the balloon-target line on his map, and at the point of the target he draws a short perpendicular line. Then he draws the battery-target line, and its perpendicular, also. The ends of these two perpendiculars are brackets; and on the perpendiculars, both of which run through the target, he takes, as reference points, any landmarks which will help him to narrow down both brackets either before or after the battery opens fire. Of course the Observer may have doctored his map while he was still on the ground; and he certainly has made a very careful study of all the pertinent maps and photographs, so that when he is once in the air he won't have to take up a lot of time in locating the target. And as he knows the number and type of the guns which are to shoot, and their time of flight, he has a fair chance of spotting the bursts without much trouble and giving back some helpful news from the front.

As soon as the shell bursts the Observer has got to try to put out of his mind all regard for the *smoke*, which is deceptive and meaningless, and to see nothing but the inverted cone of the burst itself. He must keep his eyes on the exact spot where that shell burst until he has frozen the picture solidly into his brain. Then and only then may he turn to his map, mark it, and begin to think about his bracket.

The French were the first to point out that since artillery reglage by airplane is more dangerous, as well as more expensive, than by balloon, the airplane should never be used to spot any fire which could be spotted just as well, or nearly as well, by balloon. The Balloon Observer uses mil-scale glasses, the same as the artillery uses, and if he can see the objective at all he can adjust fire with uncanny precision, using the same terms as the artillery commander himself would use in ordering alteration of range, or deflection. Instead of sending home slow radio messages in code, he suavely telephones: "Ten mils more left; drop fifty," and the battery is just as pleased.

In American schools it was laid down as a principle that one Observer, on a good day, can take on several shoots at the same time, just as an Airplane Observer can. The French manuals are more conservative. "Ordinarily, an Observer can observe the fire of two batteries. The fire of three can be observed only when one is of large caliber and slow fire."

On the German side, balloon observation was more practicable in the morning than in the afternoon, because the Boche Observers had the morning sun at their backs. By the same token, the Allied Observers worked better in the afternoon. Lieutenant Black says that on account of the glare of the sun his section rarely had decent visibility until after 2 P.M.

We have already discussed what is meant by artillery registration; and it is obvious that the balloons can help a battery to register with great accuracy. This was a daily occurrence in the war.

On the German side, it was customary to group three or four batteries of 10-cm. and 15-cm. guns, and howitzers, under the command of one balloon, for fugitive targets only.

Reglage by balloon is very simple in comparison with reglage by plane. The Observer, once in the air, telephones down his position and height, the direction and velocity of the wind, and tells when he is ready to begin. The battery telephones back what sort of shell it intends to use, the kind of fuse it will have, and the time of flight. In the British service the chartroom officer then notified the

Observer, "gun fired," "ten seconds to burst," "five seconds to burst," and then counted the last five seconds, so that the Observer didn't have to pick up his glasses and focus on the target until the shot was practically due.

LXVI

Spotting the *enemy's* artillery fire is a routine balloon function, and it's considerably different from spotting one's own. In the one case the Observer knows everything about the guns and the objective; in the other, he has everything to learn. The chief purpose of the Observer, of course, is to furnish an exact report of every enemy battery, including the co-ordinates and locality, the number of guns firing, and their caliber, their objective, and any counter-battery against them. It is his duty, in case he can't see the enemy battery itself, but only the smoke or flash of its guns, to locate it as nearly as possible. If he also sees the bursting of the shells within his own lines, and measures the time of their flight by a stop watch, he can tell something about the number of guns firing, the kind of guns they are, and what their range is. His information may not be very exhaustive, but, no matter how meager it is, it will have a lot of value when it's added to the ground and airplane information. The ground and airplane information, as we have already learned, is daily added to the balloon reports, and a careful objective card, with maps, photos, and data of all kinds, is kept of every hostile battery and of the limit of range of both our own and the enemy's guns. To-morrow, the Boche battery is liable to find itself more fired upon than firing.

Actual records of any one locality or organization are valueless except as a basis of comparison, and we have no comparisons to make. But to give a faint idea of what Balloon Observers do, incidentally, we might say that American balloons in the Verdun sector, in the week of October 28 to November 3, 1918, accurately reported the fall within our lines of 1,152 enemy shells.

LXVII

The surveillance, or intelligence balloon, like the old lady who sits by the window to "watch the pass," has the function of observing everything that happens, whether it happens or not; and on account of its fixed position it can be rather leisurely, and form very accurate opinions about what is going on in the enemy lines.

For instance, if the Observer sees infantry on the march he can make a very close guess about the number of men in the party. Suppose the organization is in column of fours; the Observer knows from the balloon bible that a company will spread over about 100 meters of road, measuring from front to rear; and even if the irregularity of the ground prevents him from approximating this distance, he still has another chance, for he knows that a company of infantry in column of fours takes about a minute to pass a given point. This is figured on the speed of troops on a serious march and not as though it were a Fifth Avenue parade. The Observer can simply focus his glasses at one spot on the road and let his watch take care of the arithmetic. Similarly, if an organization in column, including a lot of wagons, takes about an hour to pass the given point, the Observer knows that he has probably seen a brigade. A battalion takes about six or seven minutes to pass, and a regiment takes from twenty to twenty-five, depending upon the number of wagons. Obviously, if the command is marching by twos instead of by fours, the time will be doubled.

But estimates are undeniably estimates, so that the Observer doesn't usually claim to have seen so many regiments or companies; instead, he passes the statistics back to Information, and merely gives the time that the troops passed, the size of the column, the particular road where they were observed, the direction of march, and the exact hour. One of the important little tricks of this business is to make sure that a column is all that it seems to be. Sometimes artillery marches between battalions of infantry, and from a great distance might appear like ordinary wagons. An Observer who went to sleep at this time could easily miss the guns entirely and make a report of an infantry column only.

The mere fact that troops are marching in column is considered good evidence to show that they are not going into battle. They are simply being herded from one place to another, either for exercise, or to take up their permanent residence elsewhere, or to be rested, or bathed or something. If troops are seen deployed, however, that's a different story, and in this case the Observer doesn't lose any time in marking the direction of the movement and the number and extent of the successive lines of men; and he doesn't lose any time in getting this news over the wire as soon as he can, because the deployed troops are certainly not on the way to Tipperary.

Just as he can guess at the size of an infantry unit by timing it on the march, so can the Observer also guess at the size of an artillery organization. Overseas, the Observer knew that the battery of 4 guns carried perhaps 25 wagons and 175 men with it, and that normally it would take seven or eight minutes to pass a given point. Three batteries constituted a battalion, and two battalions a regiment; the multiplication is simple.

In surveillance work in France, the Observer, mindful that the enemy couldn't possibly forage on the country, because the country couldn't begin to support 1 per cent of the invaders, knew that supplies must be brought up regularly, first by rail to some convenient base for distribution, and then by motor truck to the neighborhood of the front. In peace time, the normal army corps supply train had about 30 five-ton trucks; but it would be quite impossible for any modern army corps to be supplied by such a low tonnage. Trucks are used to convey the supplies from the railway station to the points where they are needed, but trucks never make long hauls, and they generally move by night. The French experts told us that when all supplies, including clothing and subsistence, must be sent up from the rear, an army corps will demand at least 300 tons a day of necessaries. This doesn't take into account the artillery and engineering material, which is quite likely to run up as high as 1,000 tons a day, or even higher when the action is brisk. In a major offensive there is almost no limit.

Now since all these supplies, both for the men themselves and for army operations, are carried up toward the front on railways, an army corps will have to be supplied from some near-by base which will receive perhaps three or four trains a day, each train having from fifteen to twenty cars. These trains don't return empty; they carry back men and material, both damaged. The routine traffic, then, is the same number of trains each way, each day. The Observer who sees that this traffic keeps down to ordinary routine and doesn't vary more than a few cars, or one train a day, has nothing to worry about. But if, on the front which an army corps occupies, he sees all at once that ten trains instead of four have arrived, he knows that something is in the wind. Large supplies of material or a lot of fresh troops are being brought up for practical use.

The Observer is able to put a rather close construction on any unusual activities like this. "Unusual" activity is anything beyond the customary routine. An excess of trains, then, if they can be identified as troop trains, gives him precious information, because it is a fair enough generality that a train carries one unit—a battalion, a squadron, or a battery. A division requires about 40 trains, and an army corps about 120.

Our own arrangements of troops and support, and our requisitions for material, depend largely upon what the other fellow is doing; so that if the Observers see signs of another enemy corps coming in we beckon for one of our own.

Can you imagine us, in another great war, without trained Balloon Observers?

LXVIII

The balloon of liaison, or command, is attached direct to an infantry division, and, as Commandant Maudin says, acts as the general's field glasses during an attack, reporting direct to Headquarters by telephone everything that happens in connection with the action. It plays about the same part as that of the airplane of command, helping to keep up communication between Headquarters and the new front lines. There are countless instances of balloons staying up after dark, when the ground-telephone system hadn't yet been installed, to keep up this communication; and there is one record of the official commendation of a British balloon which at Neuve Chapelle, when all ground communication had been broken, stayed in the air for twenty-nine solid hours, and kept Headquarters constantly informed of the progress of the battle. A performance like this can't be appreciated too highly. It is almost beyond the limit of physical and mental endurance.

LXIX

We have now, after a good many vicissitudes, arrived at a situation where we can assume that the Observer has picked up some information and is ready to telephone it down to the ground. There is no need to go into the set rules for transmission, because they are merely common-sense rules which any intelligent man would supposedly adopt over the telephone, and very few of them actually do; but one of the Observer's axioms is worth mentioning, as a sort of platitude for Observers, and novelists, and speakers at banquets, and the like. His messages are required to be "simple, neutral, clear, precise, and complete." He is not supposed to say that a battery is "strong," or that a convoy is "large"; but to give some sort of arithmetical summary. If he can't estimate the caliber of the hostile guns he can at least count the number of shots they fire per minute; if he can't judge the strength of a convoy, he can at least say something definite about its length. He has got to talk in figures, although the figures can refer to time, or space, or quantity, or personnel.

Balloon information is parceled out to different places in accordance with the momentary conditions. The people who need it most get it earliest. The priority always goes, as you would naturally assume, to troops in action or troops liable to be called into action in a little while; second, to commanding officers; last, to Air Service Information, which is going to take more time over it and make it a matter of record. Enemy guns in action, for instance, are first reported to whatever counterbattery organization can put up the best and quickest answer, and the report goes afterward to the artillery commander. When the action is really lively it would take far too much time to clear all this information through the General Staff, so that the rule is to give it at once to the people who need it.

Air Service Information keeps on hand a tremendous mass of highly detailed and classified information, always up to the minute. When any datum is wanted, it is almost invariably wanted in a hurry. The energy and health of enemy batteries is, of course, about the most urgent of all this datum, and it is the balloon reports which tell quickest, and most convincingly, whether any particular battery is active, inactive, or completely out of business.

LXX

Any reader who has got this far, and remembers what was said about reconnaissance, or is willing to look back there, may conceivably be patient enough to go on a little farther. We went rather deeply into the subject of reconnaissance by airplane, and showed what a difference there was between offe and defensive work. There is also a difference between the offensive and defensive work of the Balloon Observer before a big fight. The whole problem, from the standpoint of observation, is one of planning, and probability; and the Observer's duty is to get into his head as much information as he can possibly cram there before the battle begins. He takes some, but not all, of the pertinent documents into the air with him; for the most part, he has to succeed with what lies under his overseas cap.

A tabular view, lifted bodily from French authorities, may help to render the pill more palatable.

	Offensive	Defensive
Order of Battle *Infantry*	Observer has copy of the plan showing the general purpose of all large units, the position of divisions, regiments, and battalions; their first posts of command,[1] and the successive positions of these; the location of reserves.	Observer has copy of the general plan of defense and reinforcements, covering all contingencies which can be foreseen. Naturally, the most interesting of the contingencies don't appear on this schedule. This plan also gives the position of all posts of command, which probably will not be changed during the battle. At least, we hope not. If they go anywhere, it will be backward.
Artillery Organization	Observer has a general plan to show the present and also the potential later range, after the advance, of all artillery in the sector, wheth-	Observer knows the ranges already, so that he is concerned only with any fresh batteries which may have to be brought in for reinforcement.

[1] A post of command is the field headquarters of the commander of a unit not smaller than a battalion or battery.

	Offensive	Defensive
Order of Battle	er regularly attached to the present units or not; and he has this plan for the two neighboring sectors as well.	
Air Service		Observer has plan to show how the Air Service is to be utilized especially.
Artillery Action	Observer is provided with scheme of battering down the enemy defenses; barrage fire; artillery advance (if any) in the order in which the units will move, and the locations to which they will go, and any scheme for cutting off the enemy's supplies.	Observer has plan of barrage fire, demolition fire, defense against tanks—practically the same as on the offensive, except that the artillery won't advance, nor will it feint at attacking, or accompany any infantry advance.
Liaison	Observer is furnished with plan to be followed, including any new codes or signals; the scheme of telephone communication, the use of panels, rockets, wireless, etc.; and he also has the radio call for every post of command in the sector.	Identical

	Offensive	Defensive
Order of Battle *Expediting*	Observer has a general plan to show how all information is to be passed on to the people who most need it, so as to combine the greatest accuracy and the greatest speed.	Identical

Terrain Finally, the Observer has, in addition to all his regular maps, charts, *Plans Directeur*, and large-scale objective maps, special topographical maps to show all the new enemy trenches, batteries, and emplacements. He has a map showing all the enemy balloons, and another showing all the enemy railroads. (Incidentally, balloons are always identified by the name of the nearest town.) He has a map of vulnerable points, and an "octopus" map with all the roads and paths in relief, to show where our own troops must occasionally come out into the open. These are all the same maps by which the whole plan of attack was itself worked out, so that there won't be any mistakes in co-operation.

As we have already seen, the disposition of troops and the artillery work are the result of airplane photographs and visual reconnaissance; and after the attack has begun the airplane photographers are doubly busy, getting pictures to show the actual amount of destruction. Every day a new map of destruction is made, and printed directly over an old map of the same scale, to show exactly how the demolition is getting along. The Balloon Observer is deeply interested in demolition, but he can't take pictures of it. He can, however, occupy himself by patiently regulating fire on any defenses which the enemy patiently starts to build up again. We have previously shown how the Airplane Observer detects this work. Here is another instance of a duty which the Airplane Observer originates and then passes on to the balloons.

LXXI

There is one tremendously interesting phase of balloon work which comes as close to chicane as anything you can imagine. This is panoramic drawing. A panoramic drawing shows the ground as it would appear from a balloon, but instead of making if from the balloon you make it on the ground, from an ordinary flat map, or a vertical photograph. The purpose of it is to serve, later, as a guide to the Observer.

When the battle of the Aisne was planned the French authorities had panoramic drawings made, not of the ground which they hoped or expected to capture, but of the region beyond *that*—the region which their balloons would then overlook in case they did take it. That territory, being held by the Germans, couldn't very well be made the subject of low oblique photographs without excessive danger. So that panoramics were made from maps, of the farther ground, and after the French advance, when the balloons went up in their new positions, the Observers who had studied these panoramics were already fairly well acquainted with the outlook. And since the artillery got the drawings, too, and could also see just how that ground was going to appear to the Observer, a good deal of time was saved all around.

The problem is simply one of plane geometry. You recreate, i ramic drawing, everything which shows on the map, by translating into perspective the objects and distances already known. Say the map is divided into 1,000-meter squares; you draw a 1,000-meter square, like the frame of a picture, to start with, and find the "main line of vision"—the line which would represent, for example, the direct aim of a camera over the country which is being viewed. Now all lines which are really parallel to this main line of vision on the map will *not* be parallel to it in the picture—they will start from the same base, but they will incline in toward that main line of vision and make right triangles with it. This is ordinary perspective, and you can prove it, if you need to, for your own satisfaction, in ten seconds. If the main line of vision is the center of the frame, then you draw the next 1,000-meter lines on each side so that they meet the main line of vision at a common point, as far above the base line proportionately as the balloon's altitude is to 1,000 meters. That is, assuming that the balloon is to fly at 1,000 meters, these two lines will meet the main line of vision at the point where the main line of vision reaches the top of the frame. After that, you project the 1,000-meter lines which are at *right angles* to the main line of vision, and run east and west on the map—this process is a bit rocky to grasp unless you have kept up your mathematics—but, anyway, you do it, and you now have your 1,000-meter square in perfect perspective. All that remains is to fill it in with little designs of villages, rivers, forests, trenches, and so on, from the map, making sure to have everything in its proper relation to the perspective.

You do this for two or three different balloon altitudes, and the job is over.

We were speaking, a short time ago, of "dead spaces." Panoramic drawings can show all the dead spaces for several different altitudes, by the use of colored pencils; and this is one of the best ways of charting them.

You can see for yourself what a wonderful thing it is for the Observer to be able to study, beforehand, a panoramic which will show him just what an unfamiliar area is going to look like to him.

VII

THE UNITED STATES AIR SERVICE BEFORE, DURING, AND AFTER THE WAR

LXXII

IT would never do to imply that aërial observation, either as an art or as a science, owes very much to America.

The net result of the World War, as far as the United States is concerned, appears to be a spirit of complacency which is as quietly dangerous as a trainload of TNT. Modesty in military affairs has never been one of our national characteristics, and in a hundred years we have never done anything to be modest about. More than once we have asked a large number of men to spring to arms overnight, and then to wait six months for the arms. Because Germany was defeated, and was not defeated until after our own entrance into the war, we are praising ourselves for a feat which we never accomplished. We began to praise ourselves before we had done anything but make our plans; and while the Liberty engines were still cracking as fast as they could be set up on the block, we were telling one another that the Liberty was infinitely better than the Rolls-Royce and was the "greatest single achievement of the war." That is, almost all of us but Col. George Harvey and Theodore Roosevelt were saying so. We supplied morale and money to our allies, and on the day of the armistice we had a million and a quarter men on the firing line, but we supplied few troops which actually participated in more than a few days' fighting. This doesn't prove anything; it is merely a fact. We supplied no guns,[1] no ammunition,[2] no airplanes, and we spent a million dollars an hour while we were at war. Our dollar brought us about as much as thirty cents brought to the other important nations concerned. The few pitiable exceptions only prove the truth of this generality. We spent prodigious sums, and we were voluntary combatants for no ulterior purpose of gain, and we mobilized and transported men overseas at high speed (on transports of which about 45 per cent of the tonnage was our own, 50 per cent was British, 3 per cent Italian, and 2 per cent French), and there our praise of ourselves should cease. If the war had gone on for another twelve months we should have been a decisive military factor; but on the record, we were a moral factor and a financial factor, and not much else. There were fourteen nations which actually fought battles in the war; in point of combat losses we stood twelfth, topping only Greece and Portugal. The eleventh nation, Bulgaria, lost twice as many men as we did. The greatest noise we made was about the Liberty engine, and it was indeed a very good engine in its place—but its place was back in the

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[1] We spent over three billion dollars for artillery and ammunition, and only seventy-two pieces of artillery, exclusive of naval guns, ever reached the front.

[2] To quote merely an incidental item, we spent a hundred and sixteen million dollars for gas shells, of which not one got overseas.

On November 9, 1918, the Ordnance Department issued orders closing down two government arsenals for lack of raw materials, and had in its possession a cablegram from General Pershing, stating that he didn't have sufficient ammunition on hand to support a two-day offensive or defensive action [illegible] American front. Fortunately, the Germans [illegible] nterattack.

workshop and the laboratory and the testing field. Never until the war was safely over did it justify the mildest of the claims made for its actual service in wartime, and even yet it has defects which render it unsuitable for the purposes for which it was designed.

As to our own Air Service, it had begun to spark regularly, but not very powerfully, when the war ended. The fault was not overseas, but at home. We had spent eight hundred and fifty-nine million dollars in getting ready to begin. We had accomplished nothing to deserve the immense flattery which we have gratefully received. We were tardy when the bell rang, and we had hardly begun to concentrate upon our lesson when the class was dismissed. Our pursuit squadrons were middling to good, our bombing squadrons were fair to middling, and our observation squadrons were sometimes pretty fair. It could not have been otherwise; our personnel was excellent, but it lacked training, it lacked equipment, it lacked experience. And a beautiful, a piercing commentary upon our wastage, our folly, and our stupidity is that after all our efforts to produce one single type of airplane which would fly, and after all our vainglory concerning the De Havilland 4, the most unsatisfactory ship ever built since 1914 [1]—after all this backing and filling and failure and vanity, the pursuit squadron sent to the Mexican border in the autumn of 1919 was outfitted entirely with a British type of plane, the S. E. 5. We had plenty of D. H.'s on hand, but in the words of Eddie Rickenbacker, they were too crude for service. It was for this reason that we scrapped over 1,000 of

[1] Except the Bristol Fighter, designed in England and manhandled in America.

them in France, in 1919, and brought home second-hand French and British ships by preference.

> The young aviator was dying,
> And as 'neath the wreckage he lay—he lay—
> To the A. P. reporters around him
> These last parting words he did say:
> "Take the cylinders out of my kidneys,
> The connecting rod out of my brain—my brain—
> From the small of my back take the crank-shaft,
> And assemble the D. H. again."

It is really an amazing thing that this Air Service of ours drew to itself so much inclusive repute. Glance at the figures—all of them official. In the second most perilous of all military employments (for infantry is far and away the most perilous) we lost in combat at the front only 205 of the entire Air Service personnel in the A. E. F.;[1] 145 were taken by the enemy, 132 wounded, 29 reported missing in action, 41 killed in accidents, and 3 reported casualties from "other causes." By months, beginning with March, 1918, and ending on November 11, the total casualties of all kinds were 2, 0, 27, 29, 65, 82, 181, 125, and 43.[2] Our losses at the front are highly significant, however, when they are classified; there were 184 pursuit Pilots who became casualties, as against 150 Observers and 105 observation Pilots. That is to say, we were in the war for 10 months, so that our Air Service averaged 30 casualties per month for the actual period of warfare. France was

[1] We lost 89 additional officers and men who were attached to the British, French, and Italian forces.

[2] The total of these figures disagrees slightly with that in the previous sentence, but this is only natural, for the two sets of figures are taken from two different official reports. A still later report brings the deaths up to 236, and the accidents to 296.

in the war for 51 months and lost an average of 151 flyers per month, with a total of 3,872 Pilots and Observers killed, 2,922 wounded, and 1,461 missing. Germany lost in battle 5,904 flyers, and lost 1,962 in training. Britain, France, and Germany averaged apiece about 4,500 flying officers killed in action. We had 205.

Take another set of figures, and wonder at them. For each 1,000 American officers overseas, the following ratio of officers of the different arms were killed or wounded: infantry 330, tank corps 82, Air Service 57, engineers 52, artillery 47, signal corps 25. (The figures for enlisted men are immaterial and amount only to one man per thousand, for all of our actual flyers were officers.)

There are plenty of statistics which on their face will show a very different condition of affairs. Even as late as January, 1921, there have been published some sets of figures which would indicate that in percentages our Air Service losses ranked high in comparison with those of our friends and of our enemies. These lists are as well ventilated as a Swiss cheese. For instance, the loss in German *officers* is compared with ours—and more than half of the German flyers were not officers at all, and none of our flyers were enlisted men. Similarly, many French flyers were non-coms. The German official figures, published in 1920, show that 4,878 German officers and men were killed, and 5,123 wounded, at the front.

The meaning of the actual figures is unescapable. Individually, the American flyer was always brave, and often efficient, in comparison with other Allied flyers. If he had not been brave he would never have discounted, for example, the inefficiency of his betters, who let him go out for two weeks on patrol duty over the lines without a machine gun on his plane. This was what the 94th Squadron did. The guns were late in arriving, and the squadron had to patrol without them and take a chance on being attacked and found defenseless. Luck was with them; in a solid fortnight not one member of the squadron met a Hun. But if the American flyer's duty was so hazardous, why should his total number of casualties be vastly less than that of the engineers, who are not in the war to fight at all, and considerably higher than that of the artillery, who seldom sleep? The answer is not that our Air Service was any less hazardous than we admit it to be; nor that its skill was so superhuman that it won easy victories; but that it performed, comparatively, so little work that the total casualties were few; and that our flyers were so inadequately prepared that the *percentage* of casualties was pretty high.

Glance at the mathematics. Reconnaissance Squadron 680 alone, of the R. A. F., lost in action in 6 weeks 19 Pilots and Observers. *One* squadron lost 19 flying officers in 6 weeks. Was it an inefficient squadron? It crashed 37 enemy planes during the same 6 weeks, in addition to performing its observation duties. Mind you, fighting was purely incidental with it. And there could be adduced the records of dozens and dozens of British and French units of similar achievement, and similar tragedy. You could also count on the fingers of your hands all American squadrons who in four times the length of service either lost as many men or brought down as many of the enemy.

We had less than 600 casualties, all told, and we had only 205 flyers killed in action, because we had barely begun to participate in

We lost these men, however, three or four times as fast as any other nation lost them at the front. That is all the figures can say. We were not too proud to fight; we were simply too late. Speak of actual achievements of America in the air, and you are compelled to fall back upon sweeping generalities, upon the work of half a dozen squadrons, upon the accomplishments of a scattering of individuals, and upon the St. Mihiel and Meuse–Argonne offensives. There is nothing else to talk about. Speak of observation, and you must generalize, you must study the calendar, or you must draw your material from France, or Britain, or Germany.

French ingenuity, French initiative, French practice, is the foundation of aërial observation. America, with its Wright brothers, its Maxim, its Lewis, its Eastman, its superb collection of scientists and engineers and executives, discounted its national genius when it came to the 11th of November, 1918, with an Air Service so belated that a mere handful of flying officers had been given the opportunity to sacrifice their lives, and in borrowed airplanes at that.

That is a terrible way to look at it, but it is just. We were nationally in the position of Rip Van Winkle, and we are turning over, to-day, for another nap. The Air Service was not created in order to provide a casualty list, but the list is in a large degree a measure of the work performed.

To write of the American Air Service is to write of a vision unfulfilled. To write of observation and of the glory of France is to create a new vision of the future, a vision in which there is room for America—plenty of room for America—if the smirk of complacency is wiped away forever, if the saccharine self-praise of ourselves is renounced, if it be realized that we are the luckiest nation God ever made, and if we confess, without further adulation of a failure, that to profit by a failure is the surest way to success.

LXXIII

Let us glance, for a moment, at the progress of military aviation in America and elsewhere. In 1910, at the French army maneuvers, a flying officer spotted an "enemy" counterattack in preparation, flew to brigade headquarters, and turned in a report which led to the crushing of the movement. This was perhaps the first instance in which the airplane, in the field, demonstrated what it could do; but four different nations were experimenting vigorously, and the other three were only one step behind France. Germany, from the date of those French maneuvers, bent every effort to catching up with the French program and going ahead of it. It took nothing more convincing than that one incident of a war game to teach the Continent the serious value of the plane. Britain, however, continued to regard aviation largely as a sport, and America continued to regard it as an activity designed for professional acrobats and ex-automobile racers.

In 1910 the United States, which, of course, has never bothered with army maneuvers, had a grand total—a baby-grand total—of one officer and nine enlisted men on aviation duty. And in that very same year Congress refused to make any appropriation at all for aviation. In 1911 there was a gigantic appropriation of $125,000. Few of us would grant that a person could learn to play the piano b··
one lesson a month and never practici
but we are perfectly willing to believe

in taking one lesson in war every twenty or forty years, and then failing to rehearse the lesson, in private, so as to fix it in our minds. We won't even rent the piano, to say nothing of buying it.

In 1912, Capt. Paul W. Beck, U.S.A., the first American army officer to receive the rating of military Aviator, wrote a monograph, "The Aeroplane as Applied to the Army," in which he considered the airplane according to the two invariable military tests: 1. Can it be used to kill the other fellow, and 2. Can it be used to prevent the other fellow from killing us? He said: "Can a man act as aviator and at the same time . . . kill the other fellow? If not, an aeroplane can be built to carry two men, one as manipulator of the death-dealing apparatus. . . . The most effective way to keep the other fellow from killing us is to find out where he is, what he is doing, and how he proposes to accomplish his object. . . . We can use it to gather information about the enemy, his lines of communication, his defenses, his probable lines of advance or retreat, his rail and water communications, his artillery positions, a host of things. He will be aided by a camera . . . and a wireless outfit."

Did the Government listen? Did the recent Administration ever listen to *anything?*

Then, in 1913, when Lieutenant Milling broke both the army distance and endurance records in a flight between Texas City and San Antonio, he made, "over wholly unfamiliar country . . . a remarkable military sketch map . . . showing railroads, wagon roads, streams, woods, and so on." This was reconnaissance with a vengeance, but not much attention was paid to it, even in army circles, and no effort was made to capitalize it. We were not in the habit, then, of capitalizing any of our military genius, or any of the other fellow's. Milling had done a clever thing and we let it go at that. Britain had 300 officers and 2,000 enlisted men on aviation duty at this very minute; Germany had over 600 military and civilian Pilots. On a percentage basis, we could truthfully say that our flying personnel was being increased at the rate of 25 per cent a year, but there is here a reminiscence of the old story told to illustrate the value of percentage estimation. A police inquiry, in Turkey, brought out the alarming statement that the Armenian population of one Turkish town was 300 per cent criminal. But the recount showed that only one Armenian lived in the town. The answer was that he had been sentenced to jail three times.

It is true that our flying personnel was increasing at the rate of 25 per cent a year. We had 16 flying officers, and 4 more were being taught.

The splendid preparedness of France became suddenly evident during the time of the Moroccan crisis and Germany had taken the hint. From this time forward the United States was virtually the only one of the great Powers which shut its eyes to the truth—the truth which Americans had first demonstrated—the truth about aviation. In 1914 Germany stood first in general efficiency as to aëronautics, France stood second, Britain stood third, and the United States stood nowhere. Britain, which had considered aviation as a form of sport rather than as an aid to warfare, Britain which was utterly dependent upon France for engines and Germany for magnetos, even Britain could send overseas fifty serviceable ships to accompany the first hundred thousand.

On December 8, 1914, General Scrive
House Committee on Military Aff

"are the most tremendous implement for reconnaissance and for the gathering of information that modern war has ever seen." They could adjust artillery fire, he said, by smoke bombs, or by dropping fragments of tinsel paper, which would refract light and glitter in the air. On this occasion, the committee inquired if the army were in touch with foreign developments, and Colonel Reber, to whom that particular question was addressed, responded frankly that the army could hardly be expected to keep in touch with conditions it knew nothing about!

In March, 1915, the United States owned twelve airplanes in fair condition, it hadn't the trained personnel to form one complete squadron—and the army appropriation for the year was $300,000. Commander T. D. Parker, in the *Proceedings of the Naval Institute*, pointed out in May, 1915, that we were already outnumbered a hundred to one by France, Germany, and Britain, and that unless immediate steps were taken to make us an air power we should find ourselves permanently at the tail end of the procession. At this time, with the war nearly a year old, not a gun had been fired in America under the supervision of an Airplane Observer, nor was one fired for nearly another year.

In March, 1916, General Pershing's punitive expedition entered Mexico, and, as Captain Sweetser points out, "afforded the first practical demonstration"—to ourselves, of course, for everybody else in the world had been convinced two years sooner—"of the value of aircraft for reconnaissance." The first—and only—aëro squadron, commanded by Capt. B. D. Foulois, and consisting of eight decrepit ships of the Noah-Cæsar types (three different types and three different styles of control), established itself at Columbus, New Mexico, where the ships went out of commission, one after the other, as fast as they conveniently could. On March 11th there were eight ships in commission, and on March 27th there were two; and during that period there had been virtually no flying, either. Twelve new Curtiss ships were bought, fitted with Lewis machine guns, automatic cameras, and radio sets, and since we were engaged against a child's-size enemy which had practically no armed troops, to say nothing of an Air Service, the squadron then accomplished, in these new ships—the best we had ever owned, but very far from the sort of ships to operate against a real enemy—a large number of triumphant flights over the desert. A flight was considered successful if the ship got home safely; it was triumphant if it brought any information home with it. And the results were all that could have been expected. The Air Service had finally proved itself, in America, incalculably superior to cavalry for purposes of reconnaissance; just as it had previously made this same proof to every other civilized nation on the face of the globe. Then, for the first time, the Government put its ear to the ground, and heard that there was something in this newfangled idea, after all. It heard, among other whispers from the little birds, the rather ludicrous fact that in airplanes and aviation personnel we were about a quarter as well off as Montenegro. But instead of setting out to catch up with the world, we were still satisfied to catch up with the Montenegrins.

In another hearing before the House committee, early in 1917, Colonel Squier, who in many respects was the Cassandra of the Air Service, said: " this war, the armies in general will disban' but the Air Service is going to stay w go on. It is an asset that is going to remain. All we learn in this war about aërial navigation will be applied to the uses of civilization in the peace which follows." He had observation in mind. No one else did. And he also realized that since 1914 we had actually been in the war, whether we knew it or not; and that we were bound to go in deeper, no matter who wanted to keep us out of it.

Just as we entered the war, José Caruo, a neutral and unprejudiced Spanish military expert, ranked the nations of the world, in regard to their aviation progress (not simply their military strength): France, Germany, Italy, Russia, Britain, Belgium, Sweden, Roumania, Greece, Spain, Argentina, Bulgaria, China, Mexico, Turkey—and added, "the United States does not seem to possess the fifth arm."

LXXIV

Under the administration of Colonel Squier, who, as Chief Signal Officer, was then in charge of army aviation, an Observers' school was opened at Post Field, Fort Sill, Oklahoma, early in 1917. This school had a maximum capacity of 315 individuals, but the capacity was never strained, because, as Captain Sweetser points out in *The American Air Service*, the sole method of obtaining candidates at that time was by proselyting among the ground schools, which were filled with students who had gone there because they specifically wanted to be Pilots. But if the Observers' school had been filled, or even half filled, there wouldn't have been nearly enough planes for instruction purposes, anyway. On the date of American entrance into the war we had exactly fifty-five planes,[1] not

[1] The navy had also a "pitiably inadequate service" and 45 flyers, although Admiral Fiske had begged for an aviation bureau ever since 1912.

one of them worth very much more than the cost of its fuel, and fifty-one of them were of types actually obsolete. They looked all right, and they photographed beautifully, and they could do almost anything but fly.

In October an abrupt effort was made to inveigle National Guardsmen into applying for observation training, but the National Guard wasn't enthusiastic. "This failure of interest may very well have been due to the very high requirements, and to the low grades of commissions offered." The requirements read as though we wanted a whole flock of embryo Napoleons, with a few Alexanders for variety, and all of them could spend a few months in a desolate camp, study and drill for eighteen hours a day, pass long and arduous examinations, and then go and be second lieutenants. Naturally, the guardsmen preferred to get into more immediate action with their own regiments. They were never told, convincingly, what an Observer's life is like; they still shared the public impression that an Observer ranked, in the tables of organization, just below a German prisoner.

In the end, when we had got ourselves into the war for keeps, "the neglect of the War Department to popularize the Observers' course led to the acquisition of personnel by strong-arm methods." From among the officers detailed as Observers to the artillery (you must bear in mind that even now the artillery has on the ground some one to help spot the fall of shells, as best he can) in the various divisional camps, and from other defenseless sources, twenty-five officers a week were ordered to Fort Sill and definitely attached to the Signal Corps. There were also sent to the Observers' schools young men who had failed to make good Pilots. This was absolutely contrary is the spirit of military aviation. You never get a good flyer by impressing a man and telling him that he has got to fly whether he wants to or not. You get him by telling him that if he is lucky, he has one chance in ten of being permitted to fly—provided that he is physically perfect.

"At this time, an Observer was required merely to be able to send and receive eight words per minute by radio, make twelve good aërial photographs on eighteen assigned locations, locate and direct artillery fire against enemy batteries, and conduct a prearranged shoot without error." By May, 1918, the school at Langley Field, Virginia, was in operation; over 10,000 hours had been flown, and 355 Observers graduated. Captain Sweetser says that "of the Observers, one had been discharged for every three graduated, which well illustrates the early inferiority of personnel." Strictly speaking, it doesn't necessarily illustrate anything of the sort; it illustrates, instead, the inferiority of the curriculum. Some one has pointed out that at the time of the Spanish-American War the average young man knew something about a horse, whereas to-day all he knows is something about a Ford car. Average young men make worse than average Observers. To expect that 75 per cent of the students, chosen more or less at random, should in a few short months, and with so very little time in the air, become experts in a highly specialized technical field, is to discount the importance of the duties to be performed. There will always be plenty of Pollyanna critics to chirp happily that we did the best we could and that the pressing need for Observers was an excuse for rushing the candidates through the schools, just as the pressing need for airplanes was an excuse for manufacturing bad ones. But it so happens that a mediocre Observer is almost worse than none at all. More than that, it is pretty nearly a crime to force an Observer to learn his job in actual combat. As a matter of fact, the personnel *was* inferior, too, but the courses could be passed by anyone who had brains enough to pass a college entrance examination—and by a good many who didn't have them.

It is not intended to imply that the schools were poorly managed or that the instructors were incompetent. Quite the contrary. The courses were simply too short, the flying periods were too short,[1] and it was a serious mistake to graduate any student before he had been trained in conjunction with infantry and artillery. Some one may protest, here, that we *did* so train our Observers, and that at the various schools of fire they worked directly with the artillery. Yes, but the school artillery was composed partly of permanent organizations and partly of student officers. Artillery reglage should have been studied at camps, in contact with overseas divisions; and infantry liaison should have been studied in concert with overseas detachments. Observation is like the ministry—in order to understand the masses, you have to associate with them.

The French and the British military missions came to us in April, 1917, and reported the complete German mastery of the air. This, of course, didn't mean that the air forces of the Allies had been annihilated, but that German observation couldn't be prevented, and that Allied observation was under the thumb of the enemy. As regards aviation, we were

[1] From January to November, 1918, 486,988 hours were flown at our training schools. During the same peri[illegible] was flown at British schools.

admittedly the white hope. France and Britain were down to the king row of their man-power, but they both had splendidly efficient systems of training. America had a bulk of man-power which was practically inexhaustible, but it had no experience. At the first blush, it didn't seem as though the combination could have been better—but he who blushes last blushes for good reason. And it is now time for us to be embarrassed.

They begged us to send over officers who would learn something about aviation at close range, and for many months we sent practically no one. We thought we could learn aviation by correspondence. They told us how to train Observers, and after a series of conferences we worked out a sort of compromise of both systems, so that when our Observers arrived overseas they were quite ready to be trained some more. Indeed, a large part of their instruction had been out of date when they received it; and furthermore they had been trained far from actual troops, so that in action, neither our troops nor our aviators knew what to do next. It is an actual fact that an American artillery Observer once dropped to an inexperienced battery a message tin which, on landing, put up a phosphorescent flare. This was a common type of container; the flare was to call attention to it. And the battery personnel ran to cover, and sent to the Observer's own squadron a loud howl for help, saying that an enemy bomber was taking point-blank aim at them. The artillery couldn't even recognize an Allied plane; and it had never heard of a message tin. This is the kind of war that is really hell.

To be sure, conditions at the front were changing so rapidly that it was almost impossible to keep any system of training up to date, but at least there could have been some sort of coeducation with troops. France was the pioneer in aërial observation, and France had attained the highest efficiency; France should have been our guiding star, particularly because the war, staged chiefly on French soil, was fought in accordance with French topography and under French artillery practices. Perhaps we compromised because we could understand the British officers without borrowing an interpreter.

At any rate, we opened schools in America and, at the very cogent suggestion of Major Tulasne of the French mission, a huge school at Issoudun, in France, with the object of training a few flyers over there. The school at Issoudun gave us, eventually, some first-rate men. But flying conditions in France were so bad that many of the students who were sent over for instruction were prevented, by evil weather, from qualifying as flyers until long after the arrival in France, and then the departure for the front, of Pilots and Observers who had begun their training in America on practically the same day that the first-mentioned group sailed from Hoboken.

One of the very best things that can ever be said by the politicians about the instruction of American students, here and abroad, and one of the worst things that can be said by a practical flyer, is that for every training fatality a distance equal to seven times the earth's circumference was traveled. We at least made our schools as safe as any in the world. Both France and Britain thought that we made them too safe for the proper development of the pupils. Britain lost one man to every 573 training hours; we lost one to every 2,802 training hour[illegible]
the men got to the front we lo[illegible]
men while Britain and Fran[illegible]

one. The reader is at perfect liberty to draw his own conclusions.

It was in August, 1917, that observation got practically its first respectable recognition in the summary of overseas requirements of any kind, the schedule of aircraft production calling for 6,667 combat planes and 4,000 observation machines, with 1,333 bombers. (Many were called, but few were delivered.) But Captain Sweetser says that at this time "aviation, naturally, could be considered only as an incident." Inexperienced officers were still being placed in charge of important projects; the ignorance of some of them is proverbial. One illustration is enough; it is presumably not true, but it is not in the least improbable.

"A cavalry colonel, assigned to take charge of an aviation field, spent the first day looking through the various departments of his new post. Astonished at finding so many broken landing gears in the repair rooms, he inquired the reason and was informed that the cause was bad landings on the part of student aviators. Forcibly impressed by this apparent waste and determined to eliminate it, he immediately went to headquarters and issued an order that no more bad landings would be tolerated at that field." As a matter of fact, this is no more of a burlesque than thousands of well-authenticated stories. The Air Service included experts in virtually every field of human endeavor except that of aviation.

Much, much later, after the war was over, the Chief of Air Service, A. E. F., testified that France, with 1,500,000 men actually on the front, had 3,321 planes of all descriptions in operation; that England, with 900,000 men at the front, had 1,758 planes; and that the United States, with 1,250,000 men at the front, had just 740 planes in operation, and that just

57 of them were borrowed planes at that. To have been adequately protected, Colonel Patrick testified, the American forces should have had 3,400 serviceable planes.

These figures must not be confused with the various statements of *production*. Recent official figures claim that we had produced over 11,000 planes by November, 1918. But we couldn't fight or observe or bomb with any but the 740 at the front; the others are of use to us only in the tables of statistics, and, to be strictly truthful, the Assistant Secretary of War, who signed the report, should have pointed out that this table included over 3,000 condemned Bristols, Standard J-1 training planes, and Penguin "wooden grasshoppers." As a matter of fact, France actually had a fleet of over 30,000 airplanes; many of them in reserve, many of them undergoing repairs, many of them still at the factories, but the total French production during the war was 56,000 army planes and they were in *France*.

Of course, if you want any more official figures there are several sets of them; the third to be published gives us credit for 3,227 D. H.'s overseas and, later, this figure was raised—still officially—to 4,942.

But they didn't get there until after the war.

Altogether we procured from France a total of over 2,500 service planes, and from the British 189 service planes, and of these, 527 were still serviceable on the 11th of November.

Colonel Patrick further testified that when the armistice was signed he had 744 Pilots, 457 Observers (France had 1,682 Observers on January 1, *1916*) and 23 aërial gunners, all completely traine[illegible] 1,234 flyers; that the total number o[illegible] Air Service was 7,726, with 70,7[illegible] whom about 20,000 were being trained in England. That is, in spite of all our pioneering in aviation, all our experience in Mexico, all our knowledge of the value of observation, all the appeals made to us by our allies, we had trained and sent to the front only 457 Observers up to the last minute. And even if we had had ten times the number, they would have had to stay on the ground, for the obvious reason that there were no ships for them to fly in.

The collapse of our program of aircraft production is too well known to need an elaborate exposition here. The only reason for mentioning it is to show that even if we had produced the ships on time we wouldn't have the personnel to operate them. To be sure, the public was told that over 5,000 Pilots and Observers had been sent to join the A. E. F.; but the public didn't realize that the A. E. F. included schools, and that hardly a quarter of these 5,000 men were actually flying. We were like a very fat woman running for a very fast trolley car; the car was slowing down, and presently we should have caught it. We should perhaps have caught it in another six months. As it is, we contributed almost as many alibis to the cause as we contributed dollars.

"Look, General!" cried an excited staff officer. "That's an American airplane!"

"Well," said the general, according to the *American Legion Weekly*, "you may be right. I understand we have one over here."

Guynemer had died; the original Escadrille Lafayette was reduced to two members; the French *Plan Directeurs* showed, in an air map, almost every square inch of the front; aërial photographs had rendered ground camouflage almost useless; no attack was ever made until the Allied air forces had reported on the terrain and upon the disposition of the opposing troops and batteries—and it was never made without Air Service co-operation; artillery fire was regulated almost entirely by airplane; all scouting was done in the air, and thousands of miles a day were being flown; but aviation in America, as Captain Sweetser points out, was "only an incident"; and observation was only one phase of aviation.

On June 4, 1918, the A. E. F., in setting forth the total strength of the Air Service required overseas within the year, called for 13,314 Observers. It was a large order, and America was out of stock. An observation candidate was almost as rare as a glass of water in a German restaurant. We had, in May, 1918, exactly 266 students of observation actually under instruction in America. We had sent a few hundred men over to be trained on French soil, and, according to General Pershing's testimony, a few of them waited a year, many of them waited six months, and practically all of them waited at least three months before they could even begin their training. There weren't any ships. And on November 11th, when the last chance of going overseas was snatched away, we had graduated in this country only 907 Observers, and sent only 509 of them to France.

Let us attempt to reconcile the official statistics. It is a hard problem, because you seldom get any two sets which check up even in totals, but take them as they are, and suffer with them. The A. E. F. wanted 13,314 Observers by June, 1919. It certainly needed them, and the question of ships was beside the issue. And we had graduated 907 here, sent 509 across, and had a handful in school in America. Overseas, the Chief of Air Service had 457 at his disposal on armistice day. Then along comes Captain

Sweetser, who also had official figures, with his statement that on armistice day we had graduated from the French schools 88 pursuit Observers (properly called aërial gunners) and 1,425 artillery Observers. Then we have a further report from General Harbord, in a cable made public by the War Department on December 22, 1918, that 2,045 observation Pilots and Observers had graduated from the French schools, and that 2,012 were under instruction. It is fair to assume that half of these 4,057 flyers mentioned by General Harbord were to be Observers. That gives us approximately 400 graduates languishing somewhere in America, 1,000 in France, 457 overseas and ready for service, and say 2,000 in school, in France and America, on November 11th. This was five months after General Pershing had stated his needs, and more than eighteen months after we entered the war.

France, starting from scratch, trained 1,682 Observers in sixteen months. At the outbreak of the war their facilities for training were no better than ours, and no worse. We had 457 half-wings ready to fly in France, and perhaps 3,500 others soon to be available.

If the war had lasted until June, 1919, General Pershing would still have lacked more than two thirds of the Observers he had asked for. That is exactly the reason why the domestic authorities, in the autumn of 1918, were so seriously concerned over the failure of the public to appreciate observation, and over the failure of candidates to appear for examination. We were lucky.

And in juggling statistics, we always have to remember that some of the graduates and students in the French schools had already graduated from

American schools, so that there isn't very much white meat for us in this compilation, anyway. Whatever the figures seem to say, the fact is that we were in a ghastly predicament, and that we had more luck than brains.

Consider, finally, the relationship, in the forces of our allies, between the number of *non*pursuit planes and pursuit planes. The Belgian proportion was 3½ to 1 (and we salute the Belgians for it), the French proportion was exactly 2 to 1, the British 1.7 to 1, the Italian 8 to 7.

The German proportion was 7 to 5, and the Austrian 1½ to 1.

Of the planes in the American service (not American *planes*, but in our service) the proportion was 1 to 1.

Therefore, if you ask any American artillery officer, or any American infantry officer, how much help he got from American Observers, the answer is almost certain to be that he never had any help at all. The A. E. F. had four successive heads of aviation in about a year; each new broom swept clean. The experts disagreed about everything but their own expertness; and General Pershing says that he was actually embarrassed by controversy.

A book about *American* observation would be a sort of blank book. This is not in any sense the fault of the men who flew, or of the best of the administrative officers overseas. Indeed, our final arrangements were hugely promising; flying officers were in command of the situation, and, given time, they would inevitably have accomplished magnificent results. The fault is the fault of civilians and of civilian officers, who in America were squabbling over details and keeping their minds clean by changing them every day. This is one of the strongest arguments for a unified and independent air force in America. With it, we shall progress; without it, we shall sink back into aërial obscurity.

It is the achievement of our allies, and not our own trolley-track minds, which makes possible the subject of this volume.

LXXV

On October 31, 1918, there were 17 American observation squadrons at the front; 11 of them equipped with Salmson airplanes acquired from France, 5 with De Havilland 4s[1]—the "flaming coffins," so nicknamed because of their exposed gasoline tank with no protection from bullets; although this defect, says the *Army and Navy Register* for December 27, 1918, is now being removed, and the D. H. 4 remodeled so that "the greatest source of danger in the present model will be eliminated"[2]—and 1 with the Breguet A2, another French model. That is, twelve of these squadrons, even at this date, were equipped with French ships. The De Havillands, even at this date, weren't properly fitted for the cameras we used at the front. Some one had forgotten to change the order for camera mounts at the

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[1] General Mitchell told Congress on October 16, 1919, that on armistice day exactly 196 American ships were on duty; all the rest of the ships used by Americans were French, and there were only 540 of them. The D. H. 4 was said to be the fastest high-altitude ship at the front, but was very unreliable and not very maneuverable. It is really a compromise between a pursuit and an observation plane. The Pilot and Observer were too far apart for effective work, and the Pilot sat between the gas tank and the engine, so that in case of a crash he was sure to have one or the other on his spine.

[2] In the transcontinental race in October, 1919, 73 planes competed. Of this number, 39 were unconverted D. H. 4s—and in less than 60 hours' flying they killed 9 expert flyers. Out of the other 34 ships *one* man was killed.

HOW A FLYING FIELD LOOKS FROM THE AIR

same time that somebody else ordered one of the 3,600 changes which were made in the design of the plane. (Report 67, House of Representatives, 66th Congress, 2d Session.)

In addition to the vast field at Issoudun, covering 36 square miles, and accommodating 2,175 officers and 6,100 enlisted men, there were Observers' schools at Tours and Châtillon-sur-Seine, schools for spotting artillery fire at Meucon and Coetquidan and Souge, and an aërial gunnery school at St.-Jean-de-Monte. Colombey les Belles was the actual base of operations of all American service squadrons at the front. The complete list of overseas establishments, in case anybody wants to know it, was: *Concentration Camp:* St. Maixant. *Acceptance Park:* Orly. *Fabricating Plant:* Romarantin. *Depots and Warehouses:* Orly, Clichy, Paris, Villeneuve, Le Roi, Châtenay, Vinets, Colombey les Belles, Latrecey, Ravenne-Fontaines, Is-sur-Tille, Dijon, Romarantin. *Airdromes:* Romarantin, Artenay, La Chapelle, Bonny-sur-Loire, Vaucouleurs, Amanty, Chaumont, Autreville, Gondrecourt, Colombey les Belles. *Schools:* Coetquidan, Meucon, St.-Jean-du-Monts, Saumur, Tours, Issoudun, Mailly, Châtillon-sur-Seine, Le Valdahon, Souges, Cazaux, Clermont-Ferrand. The total capacity of these schools was 3,800 officers and 11,700 enlisted men.

The first American observation squadron to be ready for duty was also the first American squadron of any kind to be completed—it was the Twelfth, the squadron to which the best of all American Observers, Major Elmer Haslett, was assigned, and it was ready and waiting to do business on March 6, 1918. It was another case of being all dressed up, with no place to go. It was assigned to the First Corps on April

30th, and on May 3d it reached the front at Ourches. We had been in the war for just about one calendar year, and this was our first appearance in our own colors, with our own organization, under our own command.

But in a month or two our little handful of Observers had reached such individual efficiency that on July 14th, at the battle of Champagne, they succeeded in locating twenty-five enemy batteries "most of which were neutralized by our artillery before they were fairly in action." It was smart work, and especially creditable in view of all the circumstances.

The personnel of an American observation squadron at this time consisted of 43 officers (5 ground officers and 38 flyers, or 19 teams), and 178 enlisted men; with an authorized replacement of 16 machines per month for a day squadron, and 5 machines and 7 engines for a night squadron. This gives a good idea of how much damage was expected to be done to the ships. The French figures allowed for exactly three times as many ships as they expected to have in commission at any given moment. Of the Observers, 12 were for artillery work, 4 for infantry, 2 for the Staff, and 1 to command the squadron. This commander was supposed to be a captain. The squadron was divided into 3 flights of 6 ships each; three squadrons comprised a wing, which was commanded by a major. Later on, the size of a squadron was increased to 24 ships.

The enlisted men of a squadron theoretically comprised 1 airplane mechanic, engine expert; 1 airplane mechanic, general; 17 airplane riggers; 1 auto mechanic, magneto; 18 repair men, general; 15 repair men, engine assemblers; 2 blacksmiths, general; 2 buglers; 2 canvas workers; 9 carpenters; 1 caterer; 5 chauffeurs;

19 motorcycle chauffeurs; 5 chauffeur truckmasters; 4 clerks; 6 cooks; 4 coppersmiths; 1 mechanical draftsman; 3 general electricians; 3 storage-battery experts; 15 gunsmiths (these are the armorers); 6 instrument repairers; 3 lathe operators; 11 general mechanics; 1 painter; 3 stock keepers; 1 tire repairer; 1 typist; 1 welder; 4 radio constructors, and 1 radio operator. This list, added to the lists of other men who are working on behalf of aviation, although not always attached to the Air Service, gives us the startling fact that for every man in the air, 46 men are required on the ground.

LXXVI

One of the most unkind, as well as one of the most unreasonable, criticisms recently directed against France is that when France, pending the production of our own equipment, loaned us certain airplanes and sold us others, she gave us only obsolete or obsolescent ships, inferior to the poorest of the German craft, and hardly safe to fly at all. This story has had a wide circulation, and wherever it has been told it has usually been believed. Naturally, it would be. It sounds like an alibi, and if it were, it would be very useful to us.

The fact of this matter is that France saved us from public international ridicule. Perhaps it was to her advantage to do it; perhaps it wasn't; at any rate, she did it. Our own airplane program, ridiculously advertised, amounted in the end to little but the advance advertisement. Every warring nation knew that our anticipations were ridiculous; Germany came closer than we did to an exact estimate of what we could actually turn out. General Pershing, in his final official report to the Secretary of War, said that we were "entirely dependent upon our allies. From time to time we obtained from the French flying corps such planes as they could provide. Without going into a complete discussion of aviation material, it will be sufficient to state that it was with great difficulty that we obtained equipment even for training. As for up-to-date combat planes, the development at home was slow (!), and we had to rely on the French, who provided us with a total of 2,676 pursuit, observation, and bombing machines. . . . The first American squadron, completely equipped by American production, including airplanes, crossed the German lines on August 7, 1918." And these American airplanes were De Havilland 4s,[1] half-breeds, obsolete in England, their native land, even while they were being brought into production in America. That is, they were glaringly unfitted for use as combat planes, and only fair for observation purposes.

A large part of the public still insists that, all things considered, we did as well as we could in aviation and in the entire conduct of the war. It is safe to say, however, that few of these optimists-after-the-fact saw anything of the war from the inside. With our methods and our temperament, we qualify in the same class as Dr. Sam Johnson's woman preacher and the dog who walked on his hind legs. The wonder wasn't that we accomplished the task so badly, but that we accomplished anything at all. When we started we had all the advice that our allies could

[1] The chief reason for our failure of production was that we tried to improve everything. We wouldn't build on what we had; or what anyone else had; we got the idea that we could make a lot of improvements on everything from the plans of Geoffrey de Havilland to the plans of the Almighty. And so, in America, we even improved on the spelling of Mr. de Havilland's name. We officially eliminated one of the 'l's. It saved ink.

give us, we had both precept and example to follow, we had limitless possibilities for the production of our equipment. In twenty months or so we produced and sent overseas a few hundred De Havillands, and that's all. Britain, which was quite as unprepared for an aërial program as we were, developed with infinitely greater rapidity. France, originally in the worst position of all of us, because of her geographic position, was actually able to furnish equipment, and *had* to furnish equipment to the nation which had the most money, the most factories, and the most superb confidence in its own ability.

It is perfectly true that France loaned and sold us "*coucous*" which were not of the best. For pursuit planes, for example, they provided us with Nieuports, while their own best Pilots were flying Spads, and for observation they delivered us A. R.'s (Avion Renaults, or Antique Rattletraps), which were in reality their old training planes. But why in Heaven's name should they have given up Spads? There was no reason under the sun for France to cripple her own efficiency in order to heighten ours. Nothing could conceivably have been gained by this exchange of merchandise between Peter and Paul. They gave us the best they could spare, and we were lucky to be associated with a nation whose second-best ships were half as good as Nieuports. To be sure, the Nieuports "had a droll little habit of shedding their fabric" on a long fast dive, and their "ceiling"—the limit of altitude which they could reach—was comparatively low, but even so, they were as maneuverable as any ship made; and they served so infinitely much better than anything America ever put into production that criticism is rather out of place.

France did for us the best she could. The Salmsons and Breguets we got for observation purposes were first-rate ships. Any Observer would rather have either one of them than a top-heavy and probably wing-heavy De Havilland with a Liberty engine. French flyers gave voluntary instruction to our own graduated but inexperienced personnel. In the meantime, we were doing such extraordinary things as to send the Ninety-fifth Squadron up to Villeneuve, at the front, when it hadn't a single plane or a bit of equipment, and when the Pilots hadn't even been instructed in aërial gunnery. The Ninety-fifth was kept at the front in utter impotence for six or eight weeks, and then sent back to Cazaux, to learn how to shoot. It came back to the front in a month and made a splendid record. This whole transaction was a colossal waste of energy and personnel; it took place in the war zone, where things are turbulent, and for one such piece of administrative inefficiency at the front there were ten thousand at home.

VIII

CONCLUSION

LXXVII

THERE is probably no one in the civilized world so silly as to doubt that in all future wars, fought by so-called "civilized" countries, aviation will be of the very first importance. And if aviation is to progress, it must be nursed by nations, not simply as a phase of military prepardness, but also as a phase of national commercial enterprise. Indeed, General Duval of the French army goes so far as to say that unless commercial aviation is encouraged, military aviation will die. This brings up, naturally, the question of America's future in the air.

It is a prime rule of warfare that a good attack is the best defense, and so it is in air as on land. America, to-day, is utterly helpless to defend herself against aërial operations, or to put a competent air force in the field. We can hardly engage Mexico, aërially, on equal terms. We have no Department of Air, no program sponsored by the Administration, no apparent concern over our safety. And it is no less true, because it is a truism, that any nation, like any individual, tends to get what it most deserves.

Three recognized authorities—so recognized for different reasons—agree that before the mobilization of armies can be effected in the next war, tremendous activity will take place in the air; and these three strategists are Foch, Haig, and Ludendorff. And many nations, now that transoceanic flights have proved successful, are practically sitting on our front doorstep. These same nations have not only encouraged, but also subsidized, commercial aëronautics.

The value of this encouragement and subsidization is cumulative. Improvements in aircraft will be made chiefly through the genius of civilian engineers. Progress will be led by those whose livelihood depends upon their inventive ability; and this eliminates, at the start, the professional soldier. Furthermore, the presence within any nation of many thousands of commercial planes, built more or less along accepted lines, means that in case of need, it will be the work of only a few days to transform these planes into ships of great military value. The experience of our own navy in securing privately owned craft should point an unescapable moral.

To summarize the commercial uses of aircraft would require too much space and too much imagination. The possibilities are unlimited. Passenger, mail, and freight service stand out as obvious uses, but 99 per cent of the potentialities will have to come out of the calendar—they will be discovered as soon as the necessity arises, but not until then. The striking feature of peace-time flying, however, is that so large a part of it concerns, in one aspect or another, observation. Peace-time observation is naturally as far removed from war-time observation as pursuit piloting is different from driving a mail plane, but the uses of aircraft, as already developed in a few months, show very conclusively what the amateur Observer can do for his country, and what the country can do with a few Observers.

In Texas, the Department of Agriculture has mapped and photographed very large areas of pink bollworm territory, and has been able to set up very stringent and necessary quarantines, to prevent this pest from spreading. Scouts have discovered, in wooded country, a good many "outlaw" cotton fields (*i.e.*, fields planted in areas ordered to have no cotton in them, so as to offer resistance to the spread of the bollworm) which had previously escaped detection.

The Navy Department has already helped, especially in Virginia and North Carolina, in visual reconnaissance to locate swamps and marshes which are breeding places for pestilential mosquitoes.

Real-estate operators have made countless surveys of property, and taken thousands of photographs either for advertising purposes or for their own information.

The preliminary survey for a new railroad has been made in the Philippines by the 3d Aëro Squadron, and many months of time and thousands of dollars saved.

Owners of ranch property in the West are using airplanes for the rapid inspection of their property, especially if their holdings are at all scattered.

Forest patrols are already on routine duty, and many large fires have been detected and controlled by airplane. Observation from the air is obviously far superior to observation from the ground. On June 6, 1918, a post adjutant at Ross Field, Arcadia, California, discovered, at about two o'clock in the afternoon, a fire at a near-by ranch. At the time of discovery the adjutant was in an observation balloon at an altitude of 1,500 feet. Within seven minutes after the fire was located a fire truck, ordered by telephone from the balloon, had arrived at the ranch, and what might otherwise have been a heavy loss was almost entirely averted. Fire-insurance companies in cities are also seeing the value of aërial photography to identify buildings; and fire departments are taking pictures to show the dangerous areas in congested districts.

The following information was sent out from the War Department in the summer of 1918:

Army airplanes and captive balloons will cover portions of the national forests of California, Arizona, New Mexico, and other states this summer to aid in detecting and suppressing forest fires.[1] In compliance with an order from Secretary Baker directing the Air Service to co-operate with the Forest Service of the United States Department of Agriculture in this work, conferences are under way to determine where and to what extent the air scouts will supplement the forest rangers.

That there is a distinct and important place for aircraft in fire protection of timberlands is regarded by the forestry officials as beyond doubt, but experimental trial of methods and possibilities will have to be the first step. This is now being planned for the coming fire season. Army airdromes and bases will be utilized for the experiments. Some of the bases near enough to national forests to be used advantageously are the flying fields at San Diego, Riverside, and Arcadia in southern California. Other points in the west and in the east are under consideration, including one near the White Mountains in New Hampshire.

One of the interesting possibilities to be tested is bombing fires to put them out. It is believed that bombs charged with suitable chemicals can be used with good results. Another plan to be tested is transporting fire fighters by dirigibles from which ladders can be lowered to the ground.

The chief use of the aircraft this summer, however, will be for fire detection. At present the Forest Service relies for this partly on patrol, usually by men on horses, motorcycles, or railroad speeders, and partly on watchers stationed at lookout points.

[1] During the calendar year 1919 army airplanes flew 2,872 hours (235,724 miles) on forest patrol operations in the West, and actually discovered and reported 570 different fires.

Lookouts in a very broken country, cut up by deep cañons or where mountain ridges obstruct the view, or in a flat country that affords no good points of vantage, are often unable to pick up all fires quickly by the rising smoke, or to locate them accurately.[1] For precise location the system in use depends on triangulation through reports telephoned from separate observation points. Airplanes will use wireless in recording fires, as they have done in communicating with the artillery, and would locate fires by co-ordinates in the same way that gunfire in war is directed to a particular spot or object.

The United States Weather Bureau is using airplanes for meteorological observations. These observations, taken at short intervals over widely distributed areas, are of great help in determining the depth and intensity of storms and, therefore, in increasing accuracy in forecasting storms.

The Geological Survey is employing airplane photographs for mapping purposes, and saving 95 per cent of the time previously spent on this work. These maps are to show coast lines accurately, or to show the horizontal position of features *other* than elevations and contours, or to show all features valuable in an engineering sense. It is said that less than two fifths of the area of the United States has been carefully mapped. And coast lines change rapidly—sometimes as much as a mile in fifteen years. Finally, the aërial camera can work just as easily over marshy or heavy country as it can anywhere else. One of the main objects of the magnificent New York-to-Nome flight in 1920 was to furnish the Geological Survey with a photographic map of 5,500 miles of unexplored territory north of the 66th parallel.

Airplanes have been used successfully in India for reconnaissance in case of riots.

[1] Compare this statement with what has been said about "dead spaces" in balloon observation.

Especially in Canada, airplane observation has proved very useful in forestry work, and photographs have been taken to show not only the different species of trees in various tracts, but also the underbrush, the soil, and other details of interest to lumbermen. Aërial maps of forests have been made, and the old-fashioned type of survey has definitely been declared inferior. Timber-cruising by airplane is quite as accurate, and infinitely quicker, than the rough estimates made by cruisers on foot or horseback.

Part of the Sahara desert has actually been surveyed from airplane.

Chambers of Commerce are having aërial photographs taken to show city outlines, trackage, bridges, and building sites, for the use of prospective manufacturers, and saving 95 per cent of the time previously needed to make surveys.

Maps for any purpose can be made on military principles, by taking the pictures from a fixed altitude, by pasting them to form a mosaic, and then by drawing off a map, showing whatever natural features are wanted—and these may be as detailed as those on any military map.

The Treasury Department, which has supervision over the Coast Guard, is in process of arranging to use seaplanes for locating derelicts and other impediments to navigation. Furthermore, an aërial photograph shows up shallows and channels so beautifully that the Department of Commerce is using, through the Bureau of Fisheries, a patrol for spotting seals and schools of fish.

It is worth noting that every one of these activities is a phase of observation. We are attempting to draw no parallels, to make no analogies, but merely to point out that only as the nation familiarizes itself with the tremendous scope of peace-time flying, can it ever get the slightest clear impression of what can be done in war. An enemy air force could photograph and map America from New York to Chicago and New Orleans, raid it and bomb it, as easily as our civilian flyers can make real-estate mosaics and take timid ladies up to see the world at a dollar a minute. With the longest coast line of any nation in the universe, we could not even irritate any hostile observation, or any of its results—not if the enemy were up-to-date. And we are doing nothing to encourage the civilian flying which should be one of the soundest foundations of an air policy.

The Allied armies which won the war were composed, for the vast majority, of non-professional soldiers. A standing army is merely a nucleus, merely a starting point. An Air Service, maintained as a regular, professional service, will be only a starting point. In time of national distress, the amateur soldier comes forward to complete the roster; he makes up in numbers what the nation needs. We must arrange for a generous supply of volunteer trained personnel, or our next incursion into aërial warfare will not be laughable.

Civilian flying is a national safeguard. Every airplane which is used in time of peace, every man who learns to be a Pilot, every passenger who learns even the sensation of being in the air, is to a greater or less degree a national asset.

LXXVIII

The plans of the reorganization committee of the Air Service, as first published, were full of promise and full of promises.

The government practically controls the manufacture of planes, the training of pilots, and the building and equipping of flying fields and airdromes. . . . The credit for what progress has been made in aviation in the United States rests with the air forces as now constituted. . . . It would be doubtful economy to endanger progress by demobilizing the force and scrapping the equipment. . . . European Powers intend to maintain their air forces; army and navy officers are confident that the United States will not want to be found lagging.

To the last statement it seems necessary to hide a polite smile. The United States *is* lagging, and lagging abominably. It is not the fault of the present administration of the Air Service itself; it is the fault of Congress, which presumably represents the people. It remains to be seen what the next Congress, which will come into existence some three months after this writing, will do about it.

On May 22, 1917, long before the end of the war was in sight, Britain had appointed a committee whose duty it was to consider how to develop and regulate aviation after the war "from a domestic, an imperial, and an international standpoint." Nor was it a committee of political favorites or amateur theorists; it was composed in small part of statesmen, in larger part of high-ranking aviators; in still greater part of technical men and actual manufacturers; and in the most part of representatives of each pertinent department of the administration. From the report of that committee, made after a solid year of study, a few sentences stand out like fortresses of conviction.

Civil aërial transport cannot be discussed apart altogether from military aëronautics.

State ownership of airdromes and landing grounds should be extended beyond mere warlike or strategic requirements.

Every effort should be made by state aid to widen the basis of fuel production as much as possible.

Aërial power will be as necessary for the protection of Great Britain and the existence of the empire in the future, as naval power has been in the past.

Without continuity, it will be impossible to have the organization available when required.

It is essential that the services of the aircraft-manufacturing industry continue to be employed for the design and development of naval and military aircraft, and for the carrying out of the national constructional requirements of the future.

The state must have a reservoir of aërial power capable of meeting a sudden demand for expansion of the air forces.

That is the case for Britain, and for practically every other civilized nation except ourselves. And if we look with respect toward British energy, what must we think of ourselves when we know that Germany, even to-day, is making such headway in aviation construction that Lord Fisher says she is ahead of England. Belgium has an Air Ministry, and appropriates money with both hands; Italy and France are far ahead of us—and France has appropriated over 300,000,000 francs for research and development.

At the present date of writing (January 1, 1921) the United States has practically completed its preliminary investigation of facts which were perfectly obvious three years ago. If the ancient official procedure is adopted, the United States will unescapably be beaten in its next war. The official procedure is simple. After investigation, file the report. It shows, among other details, the fact that we own about 4,500 airplanes, which we may divide, roughly, into three classes—obsolete, obsolescent, and certain to obsolesce. For many of them there isn't even the possibility of getting spare parts. The balance are, at best, third-rate ships; and not one of them is of a type which any other first-class Power would consider for an instant as a military possibility. Indeed, in its issue of December 4, 1920, the *Army and Navy Register* stated:

> The close of the next fiscal year will disclose the deterioration, from either use or storage, of practically all the airplanes which were purchased during the war for the army, to the point where they will be unsafe for flying.

On October 31, 1919, Congress rejected an appropriation of only $15,000,000 for army aircraft industry and construction. The plea of one man—Senator Chamberlain—had no avail. "Otherwise (than by insuring control of the air) America cannot hope to attain that position of supremacy which she should have sustained during the war, had our exexcutive efforts been properly co-ordinated." Since then, Congress has refused an appropriation for the continuation of the aërial mail service. And immediately the press of the nation—that press so often innocently in the wrong as to aviation matters, and in this case as righteously correct, broke forth.

"This country must wake up!" cried the San Francisco *Bulletin*. "If our lawmakers refuse to lead, they must be led!" The Richmond *Journal* echoes, sadly, "The war has taught us nothing." The Washington *Star*, on the same subject, says pathetically, "The United States is to be a little child among the nations." The New York *World* calls that refusal of appropriation "a deliberate wrecking of the aircraft service." Major (former Brigadier-General) B. D. Foulois, who was one of the first army officers to learn to fly, and has been flying ever since 1908, hits the nail on the head when he says: "The war history of the United States since the Revolutionary War is a continuous story of war-time extravagance[1] and extreme peace-time economy." Finally, Glenn H. Curtiss says: "We are much in the same position as the railroad that has a lot of locomotives and cars, but no track to run on, no dispatching force, no terminals, no official schedules, no roundhouses, no signals, no regular time-tables, and no general management or supervision."

Now let us agree or disagree on these main principles:

1. Aircraft, whether in the form of airplanes, seaplanes, kite balloons, or rigid dirigibles, constitute the most important auxiliary offensive and defensive agency in modern warfare. Of themselves, they cannot win a war; but no war can be won without them. It is impossible, however, for America to maintain in time of peace an air force as great as that which will be required in time of war—just as it is impossible to maintain a standing army large enough to satisfy the demands of another war.

2. Aviation, in its entirety, must, therefore, be so fostered by the government, both in its military or naval and in its commercial aspects, that in case of need the desired material and personnel will be forthcoming with the utmost possible speed. In another war this country will again depend largely upon the commercial aëronautical industry, and without government encouragement and support it would be ridiculous to expect us to have ships, factories, supplies, and trained personnel ready and waiting to "spring to arms overnight."

3. Unless government supervision of commercial

[1] The facts are now so well known that there is hardly a laugh left in one of the most joyous incidents of the whole war. We owned 483,182 horses for which we bought 945,000 saddles, 195,000 branding irons, 2,374,195 halters, 523,553 saddle bags, 2,161,871 horse bags, 1,771,098 horse covers, and 1,771,098 horse brushes!

development, and government control of military and naval development, are centered in one department, there will always be the same ruthless waste of time, energy, material, and personnel as in the recent war; there will be duplication of endeavor in research, experiment, and practice, and there will be failure of co-operation in active service. This cannot be otherwise, for the peace policies of the army and navy can never be remotely alike. Even now, the two most important military air stations are near Hampton, Virginia, and San Diego, California. So are the most important naval air stations. The duplication at these two points alone is the apotheosis of extravagance and wastage.

4. Under centralized control, there will for the first time be feasible an economy of production and an economy of operation, and a further economy in time of war, when, in any given contingency, the least expensive form of work can always be prescribed by the central authority.

5. In time of war, air service units, whether of the land or water type, should be assigned as needed, retaining always their entity, but being under the immediate jurisdiction of the commander of the organization to which they are attached.

6. Train Observers. Train Pilots. Train them together, soundly, sensibly, and unceasingly, train them to be equally at home in airplanes, seaplanes, or balloons; in order that we may never fight, on our own soil, a war in which the invading enemy will know more about our country than we ourselves do.

LXXIX

It has already been pointed out that when our aviators arrived overseas they had received practically no training whatsoever in conjunction with troops. And if, overseas, they went to school again, they were still, with few exceptions, separated from troops; it was only when they went up to the front with their squadrons that they had their first experience with troops, so that they had to learn, in actual army operations, what should, in common decency to their own self-respect, have been taught them as an A-B-C lesson. Our system was as ridiculous, as fatuous, as though we taught an infantryman how to drill, and then, sending him up to the fire trenches, gave for the first time a rifle into his hands and told him to shoot with it as best he could, because the enemy was just coming over to attack. That is the very principle upon which America undertook the responsibility of war in the air.

Now you cannot teach by theory anything whatsoever which has to do with liaison between the airplane and the ground, and you cannot teach artillery reglage by theory. You have got to get the fundamentals from actual contact. By the same token, troops cannot learn, theoretically, how to get the most help from the Air Service. The two must study the problem together; they have got to study it sometime, and the time to study it is not when the enemy on the ground, and the enemy in the air, are doing their best to break up the lesson by killing off the students.

One of the arguments against unified control of the air forces is that teamwork depends upon centralized control of all units which constitute the team. That is to say, the training must be carried on side by side—airplanes and army, seaplanes and navy, so that there will be no conflict of purpose. It is feared that a separate air force would not co-operate either with the army or with the navy.

If this theory were correct, then it would indeed be useless to divorce from the army and navy their present air forces and to marry the divorcées. But has it proved impossible for the army and the navy themselves to co-operate? Distinctly not. They have always bickered like two Polack women over the back fence, but when the need was pressing enough they have helped each other—as in Cuba and the Philippines, as in the Civil War and in the World War. Why, then, should the navy fear to approve a separate Air Service, except out of sheer selfishness of possession? The army—not the recent administration, but the army—is ready and willing to turn over the whole subject of aviation to an independent organization.

Britain has in the R. A. F. a unified air service. Concerning the result of unification, Air Commodore L. E. O. Charlton, British air attaché to the United States, holds that "the supreme use of the aërial arm of the future is a strategic one," and that he doubts that the strategic use of this arm can be developed supremely unless it has an independent existence, and can't be hindered. And he goes on to say that aircraft used civilly and commercially are the lifeblood of aërial supremacy, because in time of need they will all be pressed into national service, just as the navy commandeered all naval craft which could be utilized. Unified control is necessary to encourage commercial progress along lines of national benefit.

In war time, the military or naval authorities will simply state their requirements to the Air Service, which will fill them.

CONCLUSION

To quote from questions asked by Senator New, and answers made by Commodore Charlton:

4. Was not the independent nature of the air force on the western front a constant source of friction as between the air-force commander and the army commander?

No; there was never to my knowledge a single occasion of friction. The staff of the air force and the General Staff of General Headquarters had drawn up, in conjunction, a working method which answered perfectly. Briefly, it was for the military commander to demand his requirements from the air-force commander, and it was the responsibility of the air-force commander that he should comply fully with these demands. Let me take two instances, explaining this situation by simile:

(1) An attack is planned in which a certain number of divisions are due to go over the top at dawn toward limited objectives. At the conference beforehand, the air-force commander is present and takes part in the discussions; as a result, the requirements of the military commander are made known to him, and they discuss in unison the possibility or feasibility of carrying them out. Any objections which exist are stated then and there and disposed of one way or the other. On the day of attack, the co-operation of the air force is assured to the full extent expected, and neither less nor more.

(2) During a quiet phase the enemy on a special sector of the front suddenly developed air tactics, including the bombing of the army headquarters. The military commander, of a somewhat excitable disposition, rings up the air-force commander, asks him what he is doing to permit such a state of affairs, and orders every machine into the air at once. The air-force commander, realizing the ruination which would immediately follow such a plan of action, and that on the chance of doing a very little good he would place his whole force out of action for a considerable period, in his discretion respectfully points out to the military commander the drawbacks of carrying out his direction. Discussion ensues, the military commander is impressed, agrees, and is further educated in the use of the aërial arm, and so on.

5. How do you answer the objection that Pilots of army machines and navy machines must be fully trained in the methods of the army and the navy and must accordingly, for the efficiency of that training, belong part and parcel to those services?

My answer is that the whole question is one of training only, and that the methods of co-operation between the airplane and army and navy units are largely of a similar description and differ not in principle, but in practice. The method of fighting in the air is the same in principle, the method of artillery observation is the same in principle, the method of reconnaissance is the same in principle, and I do not think there is a wider difference between an Air Service Pilot operating with the army and an Air Service Pilot operating with the navy, than there is between a pursuit Pilot and an artillery observation Pilot or between a night-bombing Pilot and a day-bombing Pilot, or between a Pilot trained to take oblique photographs and a Pilot trained to burn enemy balloons. In other words, it is my opinion that divergencies in training exist between the two natures of Pilot operating with the army greater than exist between an Air Service Pilot operating with the army and an Air Service Pilot operating with the navy on similar work, either of fighting, bombing, photographing, or observing for artillery. If one training system can produce efficiently pursuit Pilots and artillery observation Pilots, then one training can equally well or better produce Pilots to observe artillery for the army or for the navy, Pilots to bomb enemy ships or enemy dumps, Pilots to fight over land or over sea, Pilots to reconnoiter fleet formations or land formations, and, incidentally, the expense of dualism and duplication in training and experimental establishments will be halved.

General Pershing, however, like the naval authorities, rests his case upon the theory (a) that an Air Service by itself cannot win a war and (b) that it must therefore be an integral part of the higher command with which it is most directly concerned.

LXXX

Observation, as practiced in the navy, has not concerned the present volume; but when a unified Air Service is under discussion a brief account of naval achievement is hardly out of place. The navy had seaplanes,[1] small kite balloons, balloons which

[1] It is interesting to note that during the last ten months of the war pigeons delivered 219 messages from seaplanes which were forced to alight

rose from battleships, and a few small rigid dirigibles. All of these were valuable for reconnaissance and spotting submarines, and they might have regulated fire if necessary. There was no such thing as a qualified Observer in the navy; any Pilot was also able to act as Observer to another Pilot, and this is as it should be.

Seaplanes, in practice, have regulated fire with extraordinary accuracy; they have adjusted 12-inch, 40-caliber coast-artillery guns, for example, upon a target 28,000 yards out to sea—a target 10 feet wide, 30 feet high, and 150 feet long, a good battleship silhouette—and after three trial shots, landed five out of the next six shots on the target.

There is absolutely nothing in the manufacture of seaplanes, or in the training of personnel, or in the functions of the naval service in war or peace, which is incapable of amalgamation with the corresponding present functions of military aëronautics. The chief barrier to this amalgamation is a bureaucratic jealousy—as though the prestige of the navy would receive an unforgetable blow if any of its units were detached, in order to join them to other units, and make an efficient Air Service.

LXXXI

The ideal Air Service (and the ideal is what we need) should be under one head, and it should be administered by men who have had actual experience in flying, and not by inexperienced civilians. No man who is without experience in the air should be allowed for an instant to command or to direct

at sea. These planes had no other means of communication, so that each pigeon is morally entitled to a decoration for saving the flyers and the ships. Naval seaplanes are always required to carry pigeons aboard.

the activities of flyers,[1] or to regulate the most trivial phase of their training. To arrange otherwise is a crime against humanity, and a misdemeanor committed against the dignity of a progressive nation.

Production of airplanes both for military and commercial uses should be under government supervision and regulation, with subsidies where necessary; inventive genius should be rewarded; progress in all lines should be substantially encouraged.

Now as to training—especially of Observers. Flying is said to be a young man's job, but there is some doubt as to the age limit of a "young man." Thirty was supposed, in 1917, to be about the dividing line between ability and senility, but on October 7, 1917, when General Mitchell was testifying to the House Committee on Military Affairs, he said that thirty was perhaps the best age for a flyer.

Thirty is a very good age for an Observer, but only if he has already had several years of sturdy training.

No one would be foolish enough to claim that a Pilot can be made in an hour, and yet within that time a man can be shown all that he needs to know about controlling an airplane. Then add ten months of intensive training. Similarly, a student Observer can be given, in two weeks, a faint outline of what to do and how to do it. But you cannot make an Observer in six months; and without actual combat to inspire him you could hardly do it in less than ten or twelve months.[2] The best Pilots should be

[1] The Act of June 4, 1920, provides that not to exceed 10 per cent of the officers in each grade below that of brigadier general shall be non-flyers.

[2] The latest War Department regulations, accepted long after the above paragraph was written, prescribe 4 months' Pilot training, 3 months' artillery training, 3 months at the Air Service School of Aërial Observation, and 2 to 3 months with a squadron.

taught to be Observers, and they should be educated as carefully and thoroughly as men are now educated at West Point and Annapolis.

This training is something which cannot be judged by any other sort of training on earth—or over it. There is no other province of the soldier which requires him to risk his life, whether there is a war or not. Instruction must, therefore, be given by the best men obtainable, and received by the best men obtainable, and training operations must be directed by men who know the game from the flyer's viewpoint.

The student must learn to be a Pilot before he can be an Observer; and he may be an Observer only if he has brains. For if ever a war should come to the shores of America, or if ever America goes overseas again to fight, the chances are that there may not be, the next time, any friendly bulwarks to protect us for a year and a half of preparation. The world may not all be on our side, imploring us to come and help. There will be no cablegram from our commanding general overseas, asking for upward of thirteen thousand *more* Observers, within the year. The demand will be for suitable ships, competent Pilots, and trained Observers—instanter. The demand will be for trained, competent, aggressive men who will not need to learn, in the presence of the enemy, how to justify their Air Service ratings.

Others have spoken, and spoken well, for the fighting Pilot. We must have Pilots, too—thousands of them—the best and the bravest men that we can get. We must encourage peace-time flying to the utmost; we must guarantee to ourselves a ready personnel. But of this personnel, the Observer shall be—and must be—the choicest spirit. Otherwise, there is strong reason to listen to the mutterings abroad, where there sit aloof a few polished gentlemen with high ambitions and gilded visionings; and their words, unintelligible to American ears, are an echo of that portentous ceaseless, irresistible insistence of Cato the Elder in the Roman Senate.

Our little fraction of a war cost us more, in eighteen months, than it had cost us to administer the nation for the entire previous hundred and fifty years. Shall we not, for once, look forward for a decade or two? Or shall the fruit of American genius, and American suffering, and American generosity, for the past four years, rot on the ground while half a dozen nations no larger than the state of Maryland overhaul and pass us—and win again their superiority of 1916?

As this volume goes to press, the Zeppelin Company is negotiating for air bases in Spain and South America. The United States has dropped back to ninth place. British statesmen have said in public that Germany will have aërial supremacy in the next war. France—even France, most injured of all the nations—appropriates enough money to hold its place in aëronautics; we, having awarded ourselves the laurels of the victor, haven't sense enough to take out a small amount of burglary insurance on them.

Our national luck has nearly run out. In another war, it would be most desirable to test the effect of national preparedness. There is no security in conceit. Admiral of the Fleet Lord Fisher remarks, succinctly, "Every fool knows that every war begins where the last war left off," and he adds that the last war *was a near thing.*

THE END