



THE ORDNANCE SERGEANT



VOL. 3

FEBRUARY 1942

NO. 2



Published by the Ordnance School in the interest of Ordnance Sergeants

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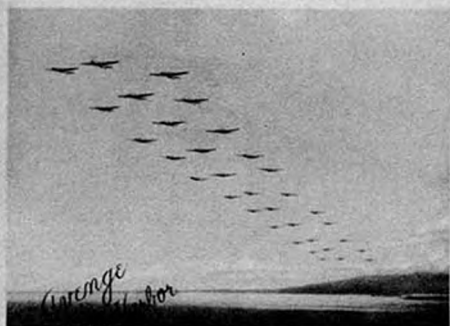
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HIGHLIGHTS

Most of the feature articles in this issue tell of some of the industries developed during times of peace, and now being converted from civilian to military production.

Of special interest are "A Layman Looks at Light" (a simple explanation of the current theories of light) on page 122 and "Eyes of Defense" (a description of the manufacture and inspection of optical lenses) on page 124.

Molybdenum, an important item in the metal industries engaged in defense production and one which should interest many Ordnance men, is the subject of articles on pages 134 and 135.

The cover photo has a pre-war date. It is a formation of Douglas B-18 bombers winging its way over Oahu some time prior to December 7, 1941. "Remember Pearl Harbor!"

The December (1941) issue contained an article pertaining to camouflage in the Ammunition Depot (equally applicable to all installations behind the lines), in which mention was made of the operations of aerial observers and aerial photographers. "Mata Hari with a Glass Eye" on page 132 tells the other side of the story - what results from the activities of aerial observers and photographers. It's well worth keeping in our minds - it may save our lives.

Address all communications to THE ORDNANCE SERGEANT, The Ordnance School, Ordnance Training Center, Aberdeen Proving Ground, Maryland.

REPRODUCTION PLANT
THE ORDNANCE SCHOOL
ABERDEEN PROVING GROUND
MARYLAND

--IN THIS ISSUE

Editorial	115
"Lest We Forget"	116
The Army Moves on Its Tires	117
A Layman Looks at Light	122
Eyes of Defense	124
From Time Candle to Tank Clock	130
Mata Hari with a Glass Eye	132
Molybdenum	134
Molybdenum in Cast Iron	135
The Army Rolls	136
The A-B-C of Stainless Steel	140
Esprit de Corps	141
Orlando Air Base	142
Special Gages	144
Small Arms	148
Artillery	151
Automotive	152
Fire Control	155
Administration	158
Depot and Supply	160
Machine Shop	164
Carpenter Shop	165
Welding Section	166
Ammunition	168
Aviation Ordnance	169
Ordnance Training Activities	170
Aviation Ordnance Training	170
Training Ammunition Supply Replacements	171
Library	173
Letters from the Field	174
Ordnance NewsItems	174
Notes from the Editor's Desk	193



Principles of Success by: Abraham Lincoln

EDITORIAL



The story of Abraham Lincoln's early life is an old one to all Americans. Laborer, rail-splitter, rough and tumble wrestler, small-time politician, he rose from the lowest rank of his profession to the very pinnacle of success. All his life he was opposed, by nature, by man, by fate, but he consistently met opposition in a simple but effective manner.

HONESTY

"Fellow citizens, I presume you all know who I am. I am humble Abraham Lincoln. . . . My politics are short and sweet, like the old woman's dance. These are my sentiments and political principles. If elected I shall be thankful; if not it will be all the same."

His maiden effort as a stump speaker was interrupted by a fist fight and he was compelled to throw a bully "twelve feet away". Then he faced his audience and gave them an honest expression of his feelings. No bragging, no self praise — just simple, honest expression of his thoughts.

In 1847 Lincoln expressed sentiments which all men must acknowledge as a basic principle of success. If this idea was true in Lincoln's time, it is even more true today. Never before in our history has useless labor or idleness been of greater damage to the individual and to the nation. The ability and intelligence of any man can produce profits only if they are exercised; otherwise they wilt and wither.

LABOR

"The habits of our whole species fall into three classes -- useful labor, useless labor, and idleness. Of these the first only is meritorious, and to it all the products of labor rightfully belong; but the two latter while they exist are heavy pensioners upon the first, robbing it of a large portion of its just rights. The only remedy for this is to, so far as possible, drive useless labor and idleness out of existence."

Lincoln's greatest success was not nearly achieved with his election to the Presidency. Not until that time was he able to exercise that element of leadership so essential to real success — the ability to gain the full cooperation of his fellows.

COOPERATION

"My friend, you didn't vote for me but I have been elected. I am your President. I am going down to Washington to tackle a very hard job and I need your help. Will you help me?"

On his way to Washington his train stopped for a short time in Wellsville, Ohio. As he addressed the assembled crowd an inebriate yelled, "I voted for a damn sight better man than you." Lincoln was not offended, but he insisted that he be allowed to meet the man. Before his train left Wellsville he had not only gained the friendship and pledge of a potential enemy, but the respect of many

who witnessed the scene. When the frightened offender stammered, "Sure I will, Mr. Lincoln, sure I will," he spoke the thoughts of many a man who was present. Lincoln was willing to cooperate, and he received cooperation in return.

LOYALTY

Before he reached Washington he spoke to a large crowd in Independence Hall in Philadelphia, the birthplace of American independence. Little did he know that he would die by the hand of an assassin because of his loyalty to the greatest of American principles — freedom. Little did he know that almost a century later America would again be engaged in a fight for freedom — for "four freedoms", in fact. Lincoln lived a life of loyalty to his convictions, and his pattern of success lives many years after he wove it.

"I have often inquired of myself what great principle or idea it was that held this confederation so long together. It was not the mere matter of separation of the colonies from the motherland, but that sentiment in the Declaration of Independence, which gave liberty not alone to the people of this country, but hope to all the world, for all future time. . . . If this country cannot be saved without giving up that principle, I would rather be assassinated on this spot than surrender it."

Honesty, labor, cooperation, and loyalty, and yet the pattern lacks one figure in its design. Lincoln's entire life was one of humbleness, of humility, yet it did not

HUMILITY

"Never mind, I will be willing to hold McClellan's horse, if he will only bring us success."

cheapen him in the eyes of those who knew him best. Sometimes he astounded his closest friends with his simple humility which partook of the divine. One day, calling on General McClellan, during the war, the General, as was his rude habit, kept the President waiting. Someone expressed anger at the indignity, (Continued on page 193)

"LEST WE FORGET"

There comes a time in the life of every nation, sad to say, when the most important part of that nation is its fighting force. But let us remember that this "time" is only a small proportion of the life of the nation. What of the rest of the time?

At the end of all our wars we have plunged into the task of getting back to normal, or giving a maximum of attention to our civilian needs and a minimum to our possible, or positive, future military needs. The army is reduced, as it must be, and the huge bulk of our population gets back into what might be called a rut of normal living. But this rut always leads someplace — to advancement. Industry devotes its energies to the development of new processes, the manufacture of new products, exploitation of new sales fields, all this for the improvement of business. Capital invests huge sums of money in new and additional plants and facilities, unheard of appropriations are made for advertising campaigns, all for the improvement of business. Individuals buy all the new gadgets industry can put on the market, homes are improved, living conditions are bettered, luxuries are indulged in, all for the sake of individual comfort, convenience and enjoyment.

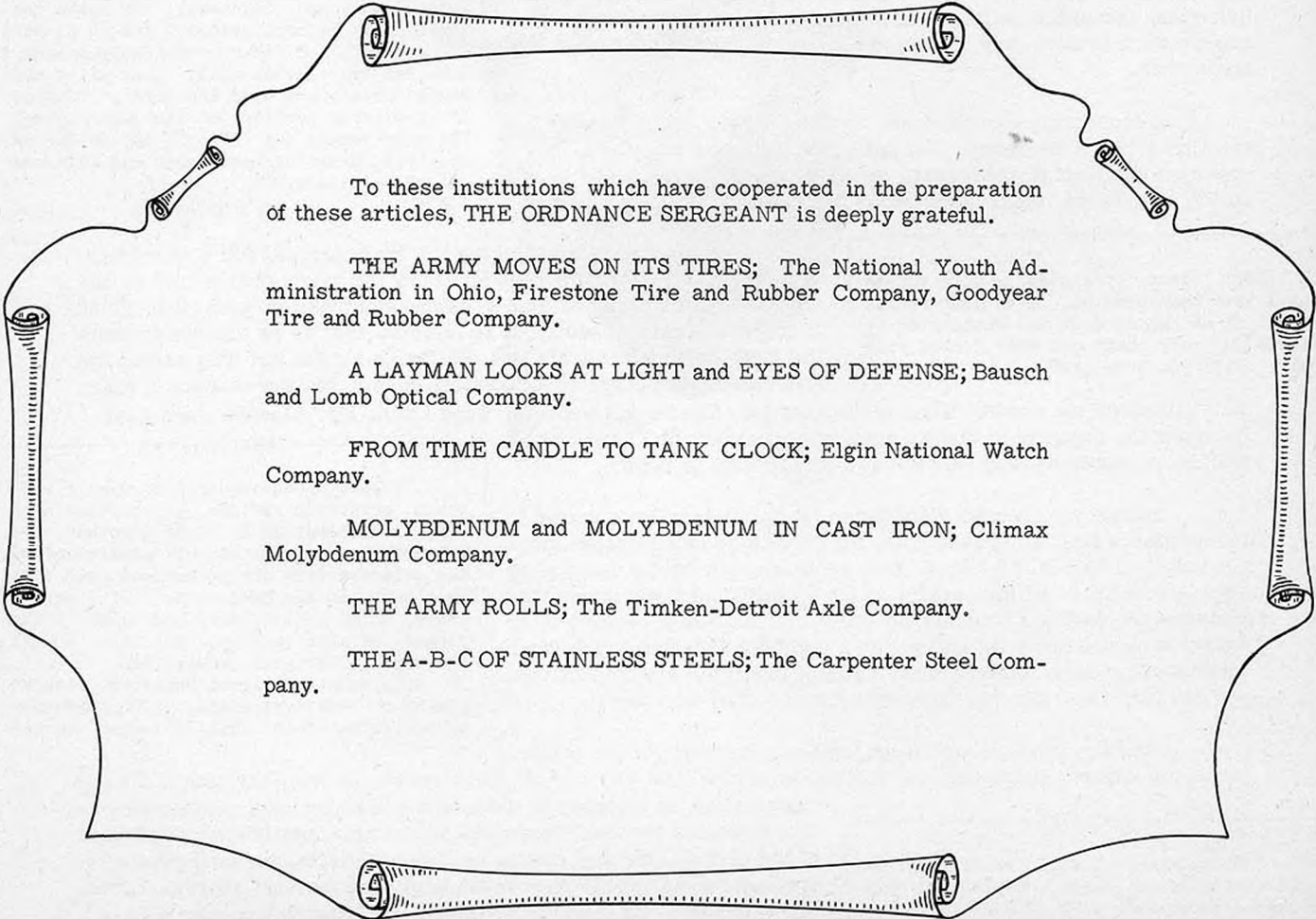
And then a war comes along. The army may have improved some of its equipment since the last war, but not to any great extent. But suddenly all the facilities of the nation are aimed at one target — the assembling,

training and equipping of an adequate defense. The fighting force has become the most important part of the nation.

Luxuries may be replaced by scarcities. Conveniences are forgotten in the mad rush to increase accomplishment. Comforts are forgotten and replaced by military or semi-military duties of various kinds. The aims of individuals and of the nation are changed; all for defense.

During the period between wars improvements have been enjoyed by individuals, by industry, and indirectly by the nation. But now the nation alone reaps the profit — through its fighting force. All the lessons learned during a period of peace are applied to defense needs. Most military men give little thought to this idea. Only a minority of industrialists gear their peacetime development to the defense needs of the future. To those few who in time of peace prepare for war, who study the application of peacetime facilities to wartime requirements, and who are prepared when the time for a sudden change arrives, this issue of THE ORDNANCE SERGEANT is dedicated, though their names be not mentioned.

The articles which follow, we hope, will increase understanding of the above thoughts. To science and industry and business we owe a lot, for their peacetime pursuits give us our wartime tools.



To these institutions which have cooperated in the preparation of these articles, THE ORDNANCE SERGEANT is deeply grateful.

THE ARMY MOVES ON ITS TIRES; The National Youth Administration in Ohio, Firestone Tire and Rubber Company, Goodyear Tire and Rubber Company.

A LAYMAN LOOKS AT LIGHT and EYES OF DEFENSE; Bausch and Lomb Optical Company.

FROM TIME CANDLE TO TANK CLOCK; Elgin National Watch Company.

MOLYBDENUM and MOLYBDENUM IN CAST IRON; Climax Molybdenum Company.

THE ARMY ROLLS; The Timken-Detroit Axle Company.

THE A-B-C OF STAINLESS STEELS; The Carpenter Steel Company.

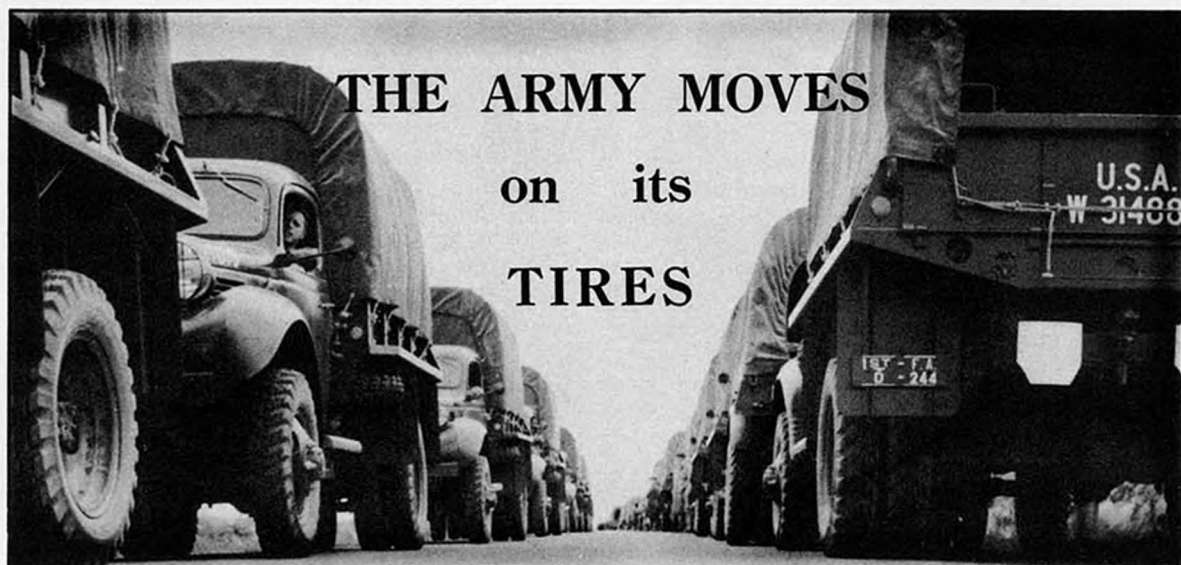


Photo by U. S. Army Signal Corps

If all units of the Ordnance Department (excepting the Proving Ground, Training and Service Companies) simultaneously moved their authorized motor equipment, almost 32,000 rubber tires would be upon the ground (or pavement) at one time. Astounding? Yes; and not so many years ago it would have been utterly unbelievable. But during those years an intriguing story has been enacted. That story itself is based upon another which began many years ago, a story which has changed the histories and destinies of nations, and the lives of many thousands of people in all parts of the world. Yet the current chapter of this story is so commonplace that we give it but little notice.

Rare indeed is the Ordnance Sergeant who does not have under his control one or more motor vehicles which roll upon rubber tires. They vary in size from motorcycles to huge wreckers. They serve many purposes and are of vital importance in the operation of all units. But let us consider the story from other angles first, before we study our own responsibilities in connection with it.

In the little French town of Doullens, not far from the English Channel, stands a tiny schoolhouse around which live hallowed memories of the World War. It is said concerning this quaint building that some of the most important decisions of the war were reached within its weatherbeaten walls. One of these decisions bears a special relation to the story of military use of rubber, because it was in this schoolhouse that a military campaign based on the use of rubber-tired automobiles was planned for the first time.

One day early in October, 1914, soon after the war had begun, General Foch, who was later to become supreme commander of the Allied Forces, went to the Doullens schoolhouse to meet Field Marshal French, who had just arrived from England with 26,000 British troops. The Germans were smashing hard at his lines and Foch was in dire need of the help of these English soldiers to stem the tide.

In the historic little schoolhouse the two distin-

quished warriors greeted each other as old friends. With all the skill of a master diplomat, General Foch made clear the urgent need for immediate reinforcements at the front. Suddenly he jumped to his feet, and seizing his English ally by the arm, escorted him to a large military map hanging on the wall. There he traced the twenty-five miles the British troops would have to travel to reach the place where they were so vitally needed. But Marshal French listened without enthusiasm. Finally he said: "My men are foot-soldiers; they would not be fit for action after marching that distance." After a moment's thought the General's face brightened. "Ah", he exclaimed, "then why not transport them by motor truck?"

This idea which suddenly entered Foch's mind was new and revolutionary, since the motor truck had not at that time won its place as a medium for military transportation. But it must have appealed to Marshal French, for that afternoon he agreed to the plans, and at eight o'clock that night his men were on the move.

However, it was not until the battle of Verdun, eighteen months later, that this new use of motor vehicles served its greatest purpose. In preparation for a smashing blow against the army of the German Crown Prince, the Allied Forces early in the winter had concentrated a large army at Bar-le-Duc, about thirty miles south of Verdun. They had counted heavily on using a narrow-gauge railway running between the two towns for the quick transportation so essential to success. But all their well laid plans were ruined when, without warning, the railway was completely destroyed by German shellfire, and in desperation they turned to rubber-tired motor transport.

When the time came to strike, 8,000 trucks carried the troops to the front over a quickly built road which the soldiers had christened "The Sacred Highway", because it was the key to their dream of victory.

To care for the heavy burden imposed upon it, the highway had been organized with railroad precision. There were time-tables to send a truck on its way every fourteen seconds; there were telegraph operators and dispatchers with their system of signals by night and day; there were repair crews standing tense at their posts

along the way. All had only one thought — that this great stream sweeping on to battle should not cease to flow. During the two weeks of that terrible struggle more than 190,000 men and 22,000 tons of munitions were transported on rubber tires into the inferno of No Man's Land.

These two stories are not presented as a comprehensive history of the use of rubber-tired motor transportation in military operations. We know that the use of this means of transportation has increased both constantly and rapidly. Today our maneuvering army is moving about the country in thousands of rubber-tired trucks, and vehicles ranging from signal corps reel carts to heavy gun mounts are rolling over the highways and cross-country on rubber tires. In the current war motorized columns are being used constantly, for speed, to preserve the strength of fighting troops, to increase the element of surprise, to add to the power of offensives by getting the most men there first. True, the latest innovation is the transport of troops by air, but even the transport planes require rubber tires for successful operation.

Just as rubber tires are becoming more and more important to combat troops, so are they also becoming more useful in their value to the service troops which support those in actual combat. Consider the motor transportation now authorized for the various types of Ordnance companies:

Unit	Total Motor Vehicles all types	Number of tires on road
Medium Maintenance Company	36	171
Heavy Maintenance Company (Field Army)	81	397
Heavy Maintenance Company (Tank)	48	172
Railway Artillery Maintenance Company	10	46
Ammunition Company	9	43
Depot Company	9	43
Aviation Company (Pursuit)	16	62
Aviation Company (Bombardment)	88	349
Aviation Company (Air Base)	29	113
Ordnance Battalion (Armd)	166	756

These totals are impressive, but consider the one you are about to read. It is utterly impossible to furnish an accurate total of the number of vehicles now in use by the Ordnance Department, or the number of tires actually on the road, for these totals change almost daily. But, considering the number of units now in existence, rough figures would be as follows:

Vehicles	7307
Tires	31114

These vehicles constitute, we realize, only a fractional portion of the totals for the entire army.

A letter from a leading manufacturer of tires appeared in the August issue of THE ORDNANCE SERGEANT. A portion of it is worth reprinting here.

"The abuse of pneumatic truck tires and tubes by Army drivers is something that the nation needs to correct

as quickly as possible because crude rubber is one of the most vital raw materials in our Defense Program, and one of the most obvious ways to conserve crude rubber is to see that manufactured products of crude rubber are properly taken care of.

"For example, checks at Army camps made by our Service Department and other Service Departments disclose that practically no attention is being paid to the proper inflation of tires. Adequate air pressure is as important to tires as adequate water is to the radiator of the truck."

If these statements are true, and we may assume that they are, then those individuals in the Army charged with the care of motor vehicles are neglecting their duty in this respect. Possibly Ordnance Sergeants are guilty in some cases. If this article, and those which follow, can help correct this fault within the Ordnance Department alone, its printing and distribution will be justified.

It is obvious that the increased use of rubber tires for military purposes has been accidental. To meet the demands of today the tire industry of twenty years ago has experienced a mushroom growth. All the resourcefulness of business and science has been called into play to bring about an expansion which makes possible the motorized army of today. It is obvious, also, that this expansion has not resulted from military demands. Armies use those modern developments which are made available by industry in sufficient quantity and with sufficient quality to render them of real military value. A constant source of supply must be assured, and sufficient flexibility to produce products suited to meet all new conditions are required of the industry which would produce materials of military importance.

In time of peace the military demand upon industry is slight. Industry, therefore, can improve a product of potential military value only if there is some other incentive to improvement. In the case of the rubber tire there has been provided this incentive. Our civilian population has taken to wheels. Thousands of miles of hard surfaced highways have been built, not for military use, but for the pleasure and convenience of the civil population. Millions of motor vehicles have been manufactured to meet civilian demands. The rapidly growing number of vehicles in operation, together with additional highways, increased speeds, and other factors, have resulted in a constant growth of the tire industry. The civilian needs of the nation have demanded this growth, industry has met the demands, and now in time of emergency the army has a new and improved method of transportation placed in its hands. So, the army takes to wheels, and moves upon its tires.

THE ROMANCE AND DRAMA OF RUBBER

We who enjoy the many benefits of rubber in its many forms so vitally linked with modern life, including its military uses, in which we are now especially interested, seldom give thought to the crude beginning of the rubber industry which makes these benefits possible or to the raw material itself.

It is reported that Columbus found rubber on the island of Haiti on his second voyage to America. It is a known fact that Spanish explorers found it in Mexico about the year 1821. They saw it there as a milky substance



Photo by U. S. Army Signal Corps

which flowed from a cut in the bark of a tree. The natives called this tree "caoutchouc", meaning "weeping tree". But the thing which fascinated the Spaniards most of all was the fact that balls made from this substance would bounce when thrown against a solid material. No one knows how long the natives had been using rubber, but they found numerous uses for it, and in the activities of their crude and primitive life they had found a material which was destined to become a basic necessity in the development of our modern civilization.

For the next two hundred and fifty years rubber was not developed. About 1770 an incident occurred which gave the substance its name. Englishmen had been importing it in gradually increasing quantities, and some of the scientists and alert business men of the time were studying it with reference to its commercial possibilities. Probably the most famous of these was Doctor Joseph Priestly, a famous chemist, teacher and author. It was he who discovered oxygen. In the preface of one of his books, published in 1770, he wrote the following special notice: "Since this work was printed off, I have seen a substance excellently adapted to the purpose of wiping from paper the marks of a black lead pencil. It must, therefore, be of singular use to those who practice drawing. It is sold by Mr. Nairne, Mathematical Instrument Maker, opposite the Royal Exchange. He sells a cubical piece of about half an inch for three shillings; and he says it will last several years." It is especially interesting to notice that at the price mentioned by Doctor Priestly the average set of tires used today would cost about three thousand dollars. Gradually the substance came to be known as "rubber", because of the use an Englishman had found for it.

The development of the modern uses of rubber, and the processes to make it suitable for use, was slow and difficult. In 1823 one Charles Mackintosh, a Scotchman, operated a thriving clothing factory in Manchester, England. While experimenting with rubber he found that it was possible to dissolve it in coal-tar naphtha, so that it might

be applied to cloth for waterproofing purposes. His process consisted of applying a coating of dissolved rubber to two pieces of cloth, and joining them together under pressure. The greatest defect was the tiny holes left by needles used in manufacturing clothing from this cloth. In spite of this defect, however, these early raincoats served a very useful purpose.

During the next few years the struggling young rubber business went through a variable and somewhat precarious existence. It seemed to do better in England, possibly because of the more even climate, or of the greater patience of Englishmen in enduring its defects. Several small factories for making rubber articles were started in America, but most of them disappeared in a few years under the weight of the problems confronting the industry.

Already an attempt had been made to use rubber in the tires of vehicles. In 1855 a Frenchman devised a plan to place a layer of crude rubber between the rim of a wheel and the outer steel band. The idea did not prove to be very practical, and little use was made of it.

The rubber industry in America, in the meantime, had become very weak but had not died, and from its weakest period came one of its greatest developments. In 1834 Charles Goodyear became interested in manufacturing with rubber. Probably the greatest defect in rubber goods was the fact that summer heat caused it to soften or melt while winter cold caused it to stiffen and crack. Goodyear determined to overcome these defects. He worked many tons of "gum elastic", as rubber was called commercially, with his hands, mixing it with various substances to change its texture. He met with slight success, received some honors for his work, and finally was financially ruined by the panic of 1837. He and his family were reduced to poverty.



Artist's conception of Goodyear's discovery of vulcanization

One day early in 1839, while working in the kitchen of his home at Woburn, Mass., Goodyear dropped a piece of rubber mixed with sulphur on the kitchen stove. It charred like leather. The combination of high heat and sulphur changed the character of the rubber and furnished the answer to the problem of making it useful and usable. The process was called "vulcanization", derived from the Roman god of fire, Vulcan.

The scene again shifts to England, and it is known that as early as 1845 Thomas Hancock was producing solid rubber tires for vehicles. He described these tires in a book written ten years later, saying: "These tires are about one and one-half inches wide, and one and one-fourth inches thick. Wheels shod with them make no noise and they greatly relieve concussion of pavements and rough roads; they have lately been patronized by Her Majesty." The use of "Her Majesty" in this case referred to Queen Victoria. These tires were crude, undoubtedly, but we are not surprised that they pleased the Queen.

A pneumatic rubber tire had already been invented, in 1845, but strangely it did not receive recognition for more than forty years. The inventor, Robert William Thompson, also an Englishman, referred to his invention as a "hollow belt" inflated with air, "whereby the wheels are at every part of their revolution, presenting a cushion of air to the ground, or rail, or tract on which they run." The tire was actually made up of several thicknesses of canvas, each saturated with rubber which had been dissolved. The pieces of rubber canvas were then laid one upon the other and cemented together with more of the rubber solution. It is of special interest that Thompson used leather for his outer casing, for man had not yet learned to cure rubber to give it durability. Finally, in 1898, pneumatic tires began to be made for automobiles, and this date marks the beginning of the tire industry.

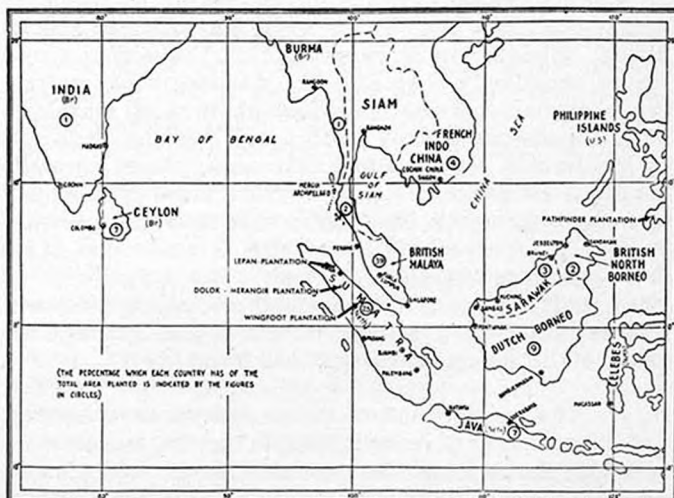
One other phase of the rubber industry should be mentioned in any account of the development of rubber. Although the early Spaniards had found rubber in Mexico, almost all of the world's original supply grew wild in Brazil. It was collected by native labor under enormous difficulties. The supply was limited not only by the conditions under which it grew, but by the obstacles that nature had thrown in the path of those who gathered it. The Brazilian government sought to control for all time the growth of rubber by placing a most rigid embargo on the exportation of either plants or seeds.

Every effort to smuggle out seeds or plants failed until Henry Wickham, a British citizen, was commissioned in 1875 by the Government of India to secure a supply of rubber seeds by any possible means. He had spent a considerable time in Brazil, where he had made a careful study of rubber trees from the viewpoint of botany, and also as to their habits and requirements, and returned to the Brazilian jungles to look for an opportunity to carry out his mission.

Just at the time when the seeds were ripening upon the trees, a British steamer arrived in Brazil, delivered its cargo, and sailed up the Amazon River with the understanding that it was to take on a load of crude rubber. But the men who had chartered the boat had been interested only in the original cargo, and left it stranded on the river bank. Wickham heard about the deserted boat and, offering to charter the vessel in the name of the Government of India, staked his all on the chance of success.

His problem then was to gather the seeds from the dangerous inland country. Selecting a large quantity of seeds from the best type of seventeen rubber trees, he dried them slowly and carefully in the shade, and packed them in layers, with dried wild banana leaves between the layers. He then represented himself through the British Consul at the port as "a British emissary, taking back some rare botanical specimens for the Queen's private gardens. In spite of several narrow escapes from detention he was able to leave Brazil. When the seeds reached England they were planted in the greenhouses at Kew Gardens.

Much of the credit for the expansion of the growth of rubber trees must go to the great Disraeli, Prime Minister during the reign of Queen Victoria. He foresaw



Principal rubber producing region

what others could not — that rubber had many uses not yet known, and he, the master builder of empires, chose it as a means of extending British commercial interests, the goal closest to his heart.

The immediate problem was to choose the place where this new kind of agriculture should first take root under the British flag. Tropical climate was essential. The question virtually answered itself, for off the southern tip of India the little Island of Ceylon was facing ruin through the devastation of its coffee plantations by a leaf disease. While rubber cultivation was utterly new to the natives of Ceylon, and while they understood little of the rewards it might bring, in their desperation they were willing to try anything.

Toward the end of 1876 some of the original plants from the Wickham seeds in Kew Gardens, London, were taken aboard a vessel plying in the East Indian trade and started on the slow voyage to Ceylon. Part of those which survived the sultry heat of the calms and the violent tempests of the monsoons became the First Plantation. There were forty trees in all, planted irregularly and too close together, but this was the beginning of the plantation rubber industry in the Far East. But the enormous output from plantations was not destined to start until some thirty years later, when America began to manufacture automobiles in large quantities, and rubber was needed for tires.

Strange to say, while the rubber industry was thus stolen from Brazil by Britain, the coffee industry, which had met ruin under British control, gained a new foothold in Brazil. In comparatively recent years, too, the cultivation of rubber has been revived in Brazil, although the supply there is somewhat limited.

WHAT HAVE WE DONE ABOUT IT?

In this article two things have been mentioned, which, from our American viewpoint, do not match. 1. The bulk of rubber production, originally centered in the western hemisphere, is in the Far East. 2. Rubber, one of the most important items in our present day economy, both military and civil, is principally used here in the western hemisphere. This mismatching of facts has become increasingly true during the last two decades. And we may well wonder what we have done about it, especially

in these days of rationing of numerous rubber products for civil use.

The following news item, clipped from The Baltimore Evening Sun, answers our question.

FORD GETTING BRAZIL RUBBER

(By Science Service)

Dearborn, Mich., Dec. 31 — Henry Ford's new rubber plantation at Belterra, Brazil, is within a few miles of the spot where in 1876 Henry A. Wickham obtained 70,000 seeds of the Hevea tree and smuggled them out of the country to England. These seeds became the ancestors of nearly all the rubber trees of the East Indies, from which the United States obtains ninety-three per cent of its rubber supplies.

Although the 3,651,500 rubber trees planted at Belterra (the name means beautiful land) are still quite young, they are already in production on a limited scale. About 750 tons of concentrated latex will be shipped to Dearborn in 1942. By 1950 the estimated production is 7,500 tons, and the eventual goal is 38,000 tons annually.

Points Way to Goal

While this is only a fraction of the 600,000 tons this nation normally consumes in a year, Ford and the Department of Agriculture experts believe that in time rubber production in the Western Hemisphere can be brought to the point where we shall never again be faced with the problem of bringing our rubber half way around a hostile world.

There is also the Mexican quagule shrub, which grows well in Southwestern United States and is already under cultivation there.

As a quick source of natural rubber, this plant is unrivaled. Rubber can be obtained after one year's growth, although it is better after four years. Without a de-resinating process, the rubber is not the equal of that from the Hevea trees and is more costly. But as a stopgap until the new Hevea trees get going, it may be a lifesaver.



FOR INVENTORS ONLY!

If you are an inventor; if you have an idea loitering in your mind; if you wonder what to do about it — watch for the March issue of THE ORDNANCE SERGEANT. Any idea which improves anything in any workable manner is now of the utmost importance to your Government. There must be many good ideas in the minds of Ordnance personnel which should be transformed into useful additions to an all out defense. A special article in the March issue will tell you about the National Inventors Council, how it operates, what its purposes are, how your ideas receive a square deal, how your own interests are protected and other information of interest to inventors or potential inventors.

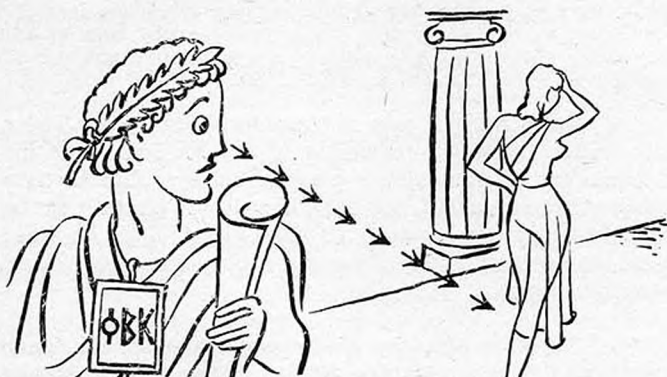
A LAYMAN LOOKS AT LIGHT

By: Rudolph Miller*

"And along came a black bird and pecked off her nose." Substitute "a quantum" for black bird and "electron" for nose and in this paraphrased portion of the old nursery rhyme you have a fairly comprehensive statement of modern theory of vision and a rough approximation of the nature of light.

Some twenty-two hundred years ago, Euclid laid down as his first "supposition" concerning vision the following dictum, "Rays issue from the eye and proceed in straight lines a certain distance apart." Thus vision was supposed to take place by ocular emission — the flashing eye in fact as well as in fancy. Not until Alhazen, the Arab scientist, some 1200 years later, was this idea seriously challenged.

Although optical instruments were in use prior to this time, the foundations of our present knowledge were



Lack of instrumental means for experimental verification did not deter the ancient Greeks from speculation about light and other natural phenomena.

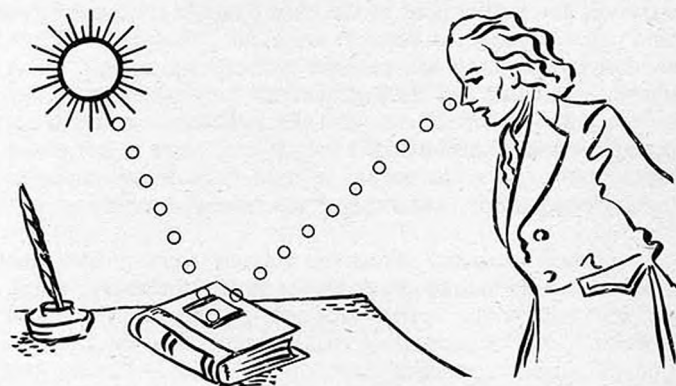
laid down by Sir Isaac Newton in 1666. Passing a beam of sunshine through a prism he broke up white light into its component colors and demonstrated that no consequent prismatic passage resulted in further decomposition. Reversing the process he recombined the spectrum colors and again formed white light. Before Newton it was thought that the prism manufactured the colors, rather than sorted or separated them, an idea not entirely out of line with advanced mathematical consideration of light today.

To Newton, also, along with the theory of gravity we are indebted for the Corpuscular Theory of light. According to this, light was a flight of minute material particles which by mechanical impingement upon the retina resulted in the sensation of sight. To explain reflection on this basis was easy. To explain refraction, or the bending of light by lenses or prisms, it was necessary not only to assume a greater speed in dense media than rare, which we now know is not true, but also different speeds of light depending on nature and distance of source, alternate fits of attraction and repulsion and incompatibilities which required rather devious and naive thinking to accept.

However, the prestige of Newton was such that notwithstanding definite evidence to the contrary, the cor-

puscular theory had adherents long after the wave theory was clearly demonstrated. Thus Huygens, who outlined a wave theory of light in 1678 which dispensed with material particles, and explained reflection and refraction satisfactorily, had a formidable rival in Newton and considerable opposition among contemporary scientific leaders.

Huygens' waves were longitudinal, that is in the direction of travel and not at right angles. This idea of longitudinal waves made it difficult to explain all of the observed optical phenomena of his time, and no satisfactory account could be given for double refraction and



Newton's light corpuscles bounced around like tiny table tennis balls. Modern mathematical physicists do not consider this idea completely untenable.

polarized light, the bending of light around obstacles, or diffraction, and light interference.

About 1814 Fresnel brought some order out of confusion by introducing the idea of transverse waves to explain polarization, diffraction and interference, and with it the necessity of a rather peculiar and unique medium in which such transverse rays could be propagated. "Light on this theory is regarded as a transverse displacement of a medium called ether, having properties similar to those of an elastic solid, the displacement being propagated from point to point according to the well known laws which govern wave motion."

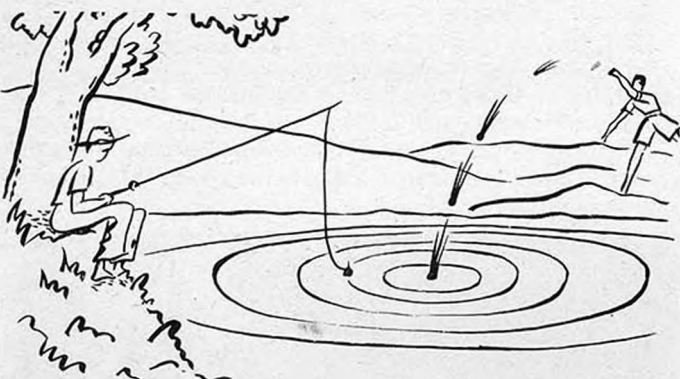
Hence wherever and when such displacement occurs there must be this imponderable and all pervading medium. Completely elastic in one plane it must be completely rigid in another. It leads to the somewhat confusing conclusion that an opaque object moving freely is passing through a substance more inflexible than the most resistant armor plate or conversely exists as a void in space, a hollow shell that in itself can offer no resistance.

Highly fantastic as the Elastic Solid or Ether Theory may be in its implications, like the equally not wholly consistent corpuscular notions of Newton, it is still useful in explaining many optical phenomena and is held to be more easily intelligible than modern Electro-Magnetic Theory, by some authorities.

*Bausch and Lomb Optical Company

At present there seems to be less conflict with higher mathematics and the findings of experiment to assume that light is identical with the electro-magnetic disturbances radiated from bodies in which electrical oscillations are taking place, such as a radio antenna. For the mathematical invention of the Electro-Magnetic Theory we are indebted to Clerk Maxwell and for the experimental substantiation to Heinrich Hertz. Of all the theories of light, this is the most difficult to visualize.

Here we are confronted with "periodic disturbances", in themselves very difficult to define, all travelling at the same speed and at widely different frequencies, in a medium which can be either a conductor of electricity or a non-conductor. A complication added to the Electro-Magnetic



Familiar physical analogies fall short of completely satisfying modern light theory. Our model making for this purpose has many complicating factors.

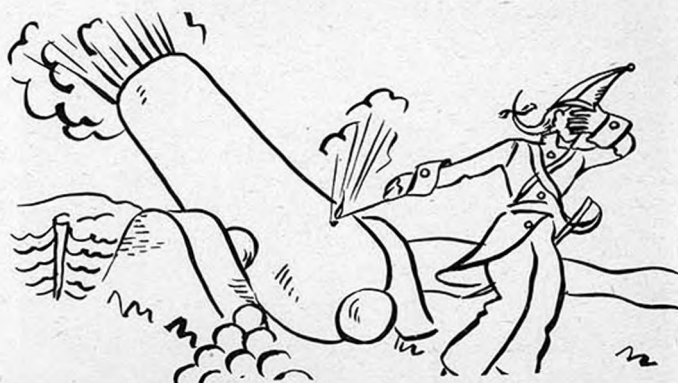
Theory by modern thought is the idea of a transfer of energy in discrete amounts. By substituting one abstract idea for another at least equally abstract it may not even be necessary to complicate our thinking with the assumption of an ether through which this energy is transferred. All we need to do is to be willing to accept the transformation of energy into matter and matter into energy, a conclusion that seems inevitable in the findings of the spectrographer and astrophysicist.

Luckily man can work with forces he does not fully understand and for this reason it is possible to outline a plausible if somewhat polyglot conception of light which, although it does not reach the altitude in abstract thinking of Planck and Einstein, gives the man on the street some satisfaction in the consideration of phenomena which make up everyday life.

Until comparatively few years ago it was customary to consider light solely from the standpoint of its visible manifestations and the science of optics was concerned only with the control of its direction.

With the implications inherent to the Electro-Magnetic Theory and further speculation, calculation and experiment, came the realization that no such hard and fast delimitation could exist. What we have been accustomed to call light is but a very small portion of an unbroken series of electro-magnetic disturbances all obeying the same laws and differing only in wave length and frequency.

Using the dimensions actually involved the range runs from wave lengths of 30,000 meters (18.6 miles) to



Who knows, but soon some cosmic ray may so jolt a gene yet unformed as to result in a future genius who will blow to bits our present most cherished concepts of light and vision.

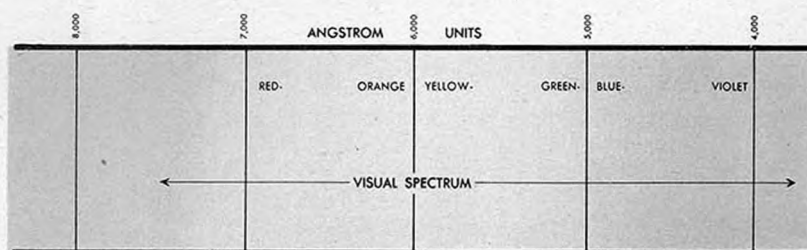
only 0.000 000 000 000 01 meter (0.000 000 000 003 9 inch) long, which is entirely incomprehensible.

Compton says "If we expand the scale until the wave of a cosmic ray is equal to the thickness of a post card, the longest wireless wave would on this scale extend from here to the nearest fixed star."

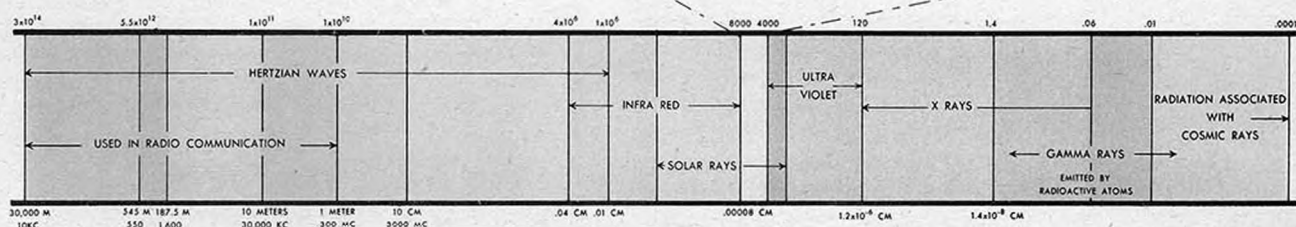
Some further if equally vague idea of the range involved is given by the fact that light from Alpha Centauri, the nearest fixed star, at about 300,000,000 meters or $186,272 \pm 8.7$ miles per second, requires approximately 4.3 years to reach the earth.

Before we get hopelessly bogged down in figures, which are interesting if not definitely informative, let's take time out to consider what these light waves may be like and if possible without too great a departure from our ideas of familiar things.

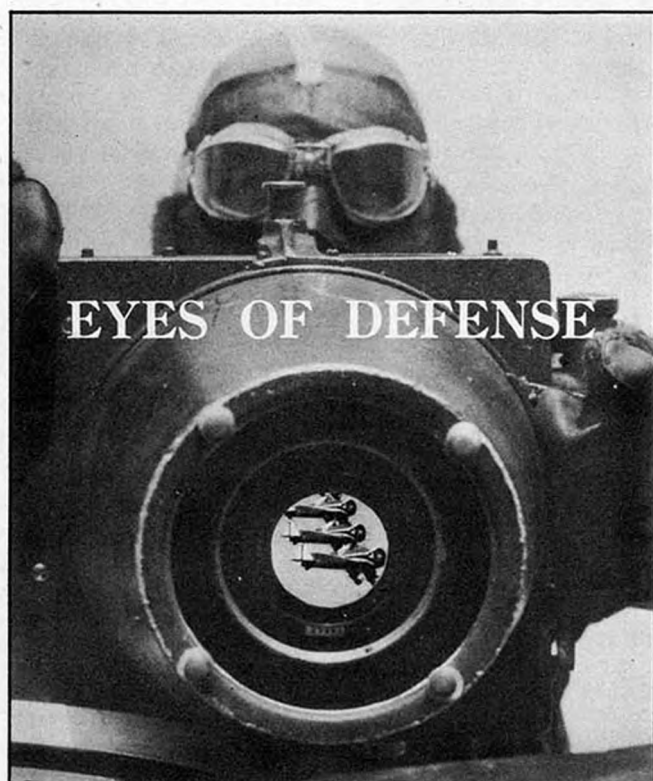
(Continued on page 145)



EXPLORED RADIATION SPECTRUM (ANGSTROM UNITS)



By: Everett White Melson *



There are few problems of optical designing that require more knowledge of the principles underlying lens action than the design of photographic objectives. In the first place, lenses are required for many specific purposes and a lens computed for one purpose rarely suffices for another. In achieving his purpose, the designer has four variables with which he works: The properties of the glass, the curves of the surfaces, the thickness of the lenses, and the spaces between them. He is confronted with a series of conflicting conditions and the final result must necessarily be a compromise since all the aberrations cannot be fully corrected.

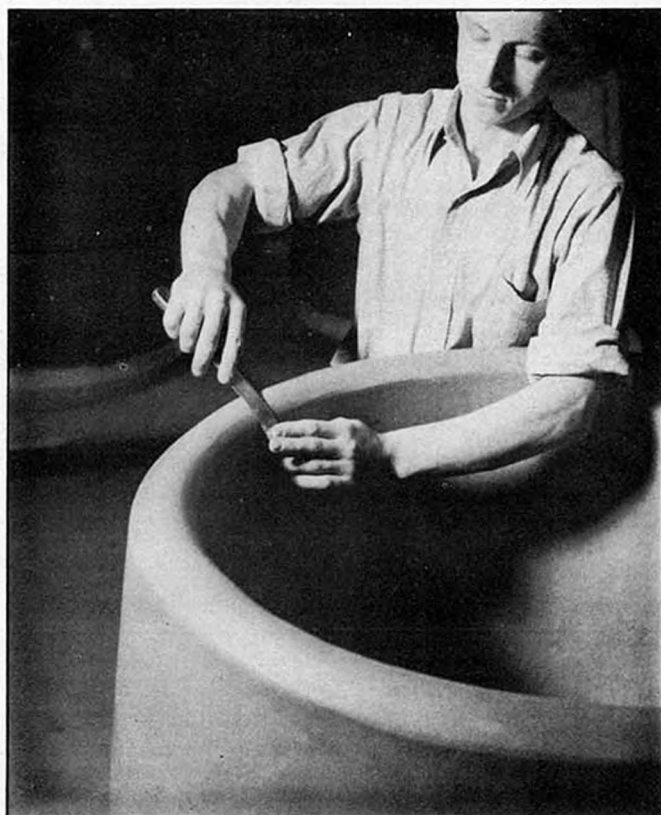
The deficiencies of simple lenses are well known and this type of lens is largely confined to cheap cameras of fixed focus and low speeds. The modern photographic objective is composed of a number of elements, depending upon its type, rarely less than four and frequently eight elements. The design of such types often requires weeks, sometimes months, of trigonometrical computations before a satisfactory result is reached.

Optical glass, the raw material with which the designer works, took its first strides on the road to development in 1789 when Guinand introduced his stirring method to improve homogeneity. This was followed by Fraunhofer's work in attempting the accurate measurement of the refractive index and dispersion of his melts by spectrometric methods. His purpose was to reduce the secondary chromatism in his lenses. It was not, however, until the joint investigation of Abbe and Schott from 1881 to 1886 that glasses were developed which broke down the old linear relationship existing between refractive index and dispersion. In 1912, William Bausch began his intensive efforts to produce these glasses in the United States and succeeded in the development of several necessary types for the U. S. Government during the period from 1916 to 1918. Bausch & Lomb's glass plant today makes

The general principles of lens making are pretty well covered in this article, which the author titled "Making Photographic Objectives." This article is good for all lenses with the exception of spectacle lenses. These are made of rolled glass and annealed in large ovens. They are less exacting because the eye can accommodate for many deficiencies, whereas in lenses for instruments no allowances can be made.

some fifty types of glasses with indices of refraction from 1.500 to 1.720 and "v" values ranging from approximately 64 to 29.

This "v" value represents the reciprocal of the dispersive power for a glass. The solar spectrum contains three special lines whose wavelengths are important in the measurement of refractive index, the sodium D line, located in the central region of the visible portion of the spectrum, the hydrogen C line in the red, and the hydrogen F line in the blue. The sodium D line is usually meant when the mean refractive index D is mentioned. In each

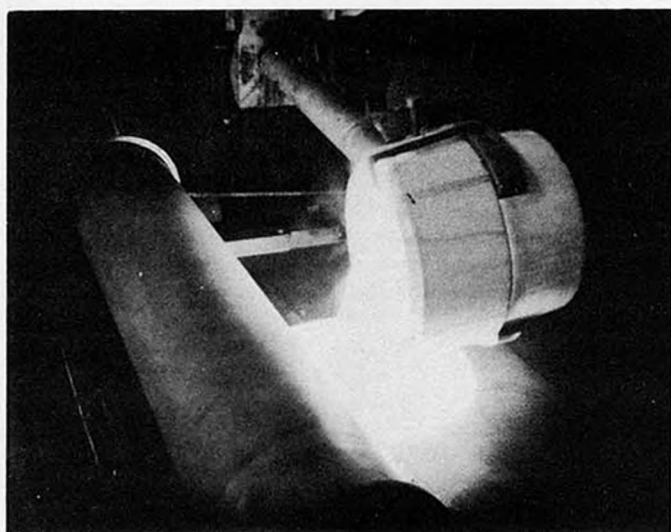


Smoothing the lips of a pot in which optical glass is to be made. The pots are a mixture of kaolin, ball clay, and burned clay or grog.

type of glass there is a relationship between the refractive indices of the three spectral lines mentioned. This relationship is known as the relative dispersion of the glass, a measure of its dispersive power. Because this quantity is always fractional, its reciprocal is invariably employed as the measure of the dispersion of the glass and is referred to as the "v" value. $v = \frac{n_D - 1}{n - n_D}$. A high "v" value

represents a low dispersive power and a low "v" value represents a high dispersive power.

* Bausch and Lomb Optical Co.



Pouring a pot of glass on heated table for rolling. No Bausch & Lomb lenses for photographic use are made with rolled glass.

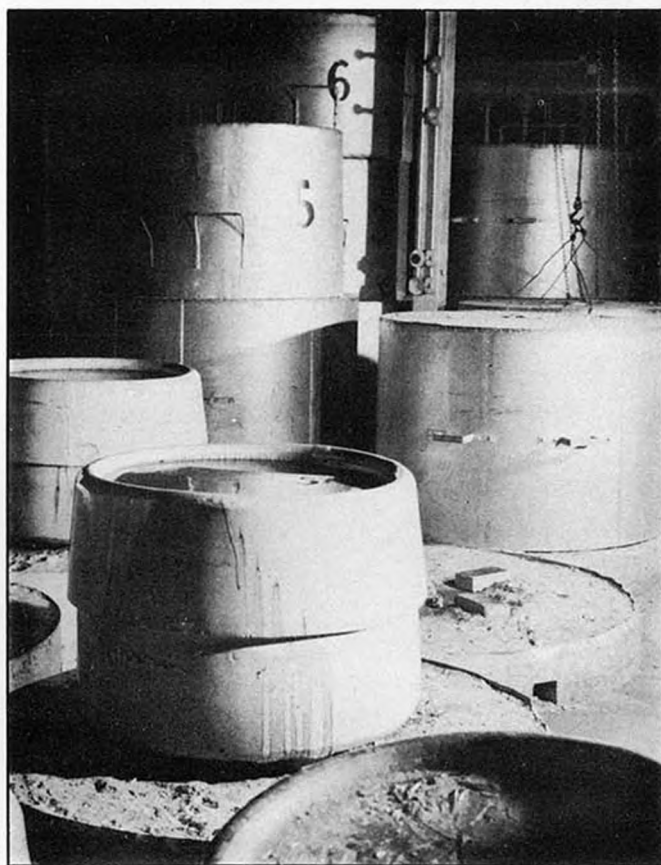
In making these glasses the optical constants vary very little. The lens maker would like to get glass with no variation in refractive index or "v" value but he must be content with ± 0.001 in index and ± 0.3 in "v" value. All pots of glass are carefully measured for refractive index. For routine measurements, the Abbe and Pulfrich refractometers are used, giving the index accurately within .0002. For checking standard samples and other extremely precise work, the spectrometer is necessary since this instrument affords accurate measurements of refractive index within .00002.

To obtain the desired quality in photographic lenses, the glass must be homogeneous since striae produce changes in the refractive index of the glass wherever they occur. In a volatile mixture of this nature in which ingredients of various specific gravities are involved, stirring is an important factor. This is done with a water-cooled stirring rod fitted with a semi-porcelain thimble. This mechanical instrument is carefully adjusted to the desired speed. Since too vigorous stirring would result in excessive evaporation of some ingredients and produce undesired accessions from the pot walls. The glass must be absolutely transparent over the whole visible spectrum and this factor has been greatly improved over the past twenty-five years. Today, the best glass absorbs no more than four to six-tenths of a percent per centimeter, except in the dense barium crowns and the densest flint glasses, whereas one per cent per centimeter was regarded as excellent twenty-five years ago.

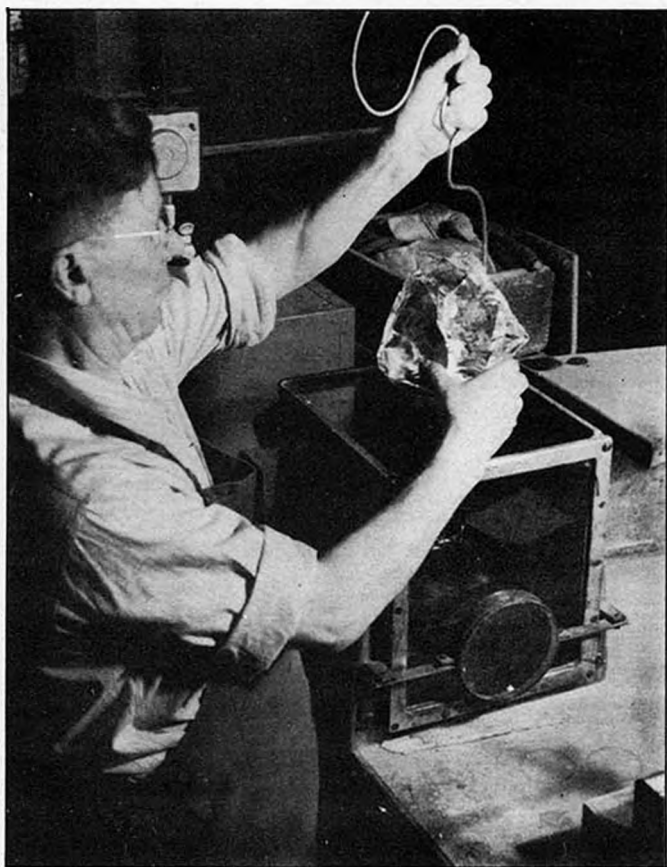
Freedom from bubbles is desirable — but only because the buyers dislike them. Bubbles do not affect the optical quality of the glass. Some of the glasses most important in the improvement of photographic objectives are the most difficult to obtain free from bubbles. It happens that due to the chemical nature of these glasses they cannot be held at the required temperatures long enough to permit all the gases to rise to the surface and escape. The barium glasses, for instance, indispensable in photographic objectives today, are among the most difficult to make. These types, known as anomalous glasses because of their high refractive index and low dispersion, are unlike any other kind. Most glass becomes soft when heated to the proper temperature and can be molded,

drawn or rolled into various forms. Barium, on the other hand, stays just about as hard as when it is cold until just below its melting point, then it becomes very soft and rapidly turns to a thin syrupy liquid. It is only by the most precise proportions of barium, boron, quartz, potash and lime and by the inclusion of zirconium in the melt that Bausch & Lomb makes barium glasses as stable as the flints. Despite the optical properties demanded and the chemical composition necessary to achieve them, these glasses must be resistant to acids, alkalis, and water vapor, and to a large extent they are, although studies on the durability of polished glass surfaces have been continued by Bausch & Lomb at the Mellon Institute and in its own laboratories in the hope of even greater perfection.

The pots in which optical glass is made are no ordinary pots. The first commercial pots tried by Bausch & Lomb many years ago contained about one hundred times as much iron per cubic centimeter as could be permitted in the finished glass. As a consequence, no matter how pure the glassmaking ingredients were, enough of the pot wall would be dissolved to contaminate the glass. The iron would diminish transparency and the sulphur would cause milkiness. During World War I, the Geological Survey canvassed six states for the types of clay in use today and Bausch & Lomb set up its own pot mill to produce these pots. They are a mixture of kaolin, ball clay, and grog, or burned clay. Iron is extracted by running the milled clay over a magnetic separator. The grog and plastic clay are ground and screened to a fine dust and frequently a little fine feldspar rock is added to act as a flux so that when the pot is heated it will have a close texture to prevent the corrosive action of the glass. The



Pots of optical glass placed under insulated drums for annealing.



Inspecting for striae by immersing chunk glass in a liquid of same refractive index and examining by polarized light.

clay must be thoroughly processed for homogeneity before aging. Before the pot is used it is air dried under controlled humidity and then placed in a pot arch where the temperature is gradually raised to 2000° F. This glazing of the pot produces a semi-porcelain finish which greatly reduces the solution of the pot. Optical glass, as opposed to other types, will permit the use of the pot only one time, since the pot is cracked away from the glass when annealing is completed and the good glass retrieved in chunks. In some ways the one-time use is desirable since it limits the solution of the pot in the glass. An absolutely insoluble pot can hardly be attained since all of the oxides which enter into glass composition, as well as the refractory oxides used about the furnace, are mutually soluble at the high temperature involved. These pots are made in various sizes depending on the type of glass. The fact that a melt can be successfully made in a 36-inch pot, holding a half ton of glass, is no indication that the same batch composition will be satisfactory in a 49-inch pot, holding a ton. There are time-temperature limits for all glasses and the annealing rate is affected by the size of the batch.

It would be much quicker if photographic lenses could be produced by rolling the glass into sheets and, no doubt, some simple photographic lenses are still made from such glass. It is made by removing the pot from the furnace, pouring the molten glass on a hot cast iron table and rolling it out to the desired thickness with a heavy roller. This, however, leaves all the striations in the finished product since the glass is poured at a temperature when it is not free of them. An attempt is made to render the striations innocuous by rolling them out in planes parallel

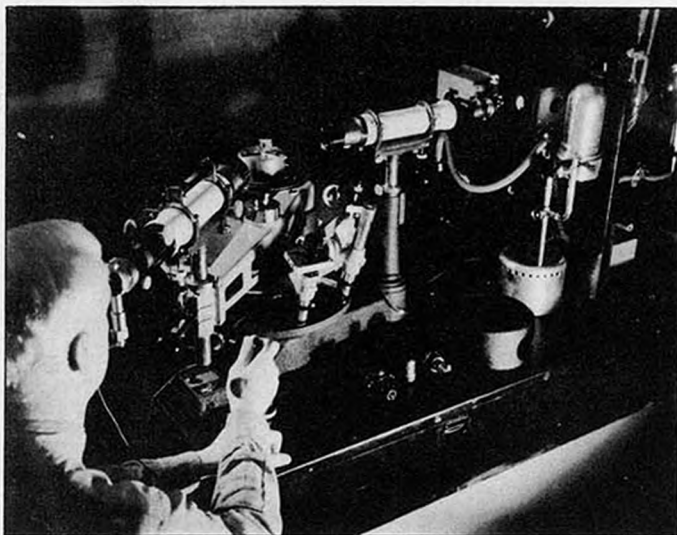
to the surface of the plate, so that it is possible to cut lenses from such a sheet in which the striations are all perpendicular to the line of sight. However, for fine lenses and even more so for prisms, this method is not satisfactory. Slow annealing in the pot, under a cylinder insulated with distomaceous earth, followed by fine annealing of the chunks later, is still the best method to obtain well annealed optical glass for photographic lenses. As the pot cools the glass contracts, breaking up into irregular pieces. These are retrieved and sorted. Each piece is immersed in a liquid of the same refractive index as the glass thus disclosing striations which would render it unusable.

Next these irregular pieces must be given form. They are placed in rectangular fireclay molds and inserted into furnaces until they assume the shape of the mold. Then the fine annealing process begins, a slow cooling which usually runs about thirty days for moderate sized pieces. This process is to relieve the glass of internal strains. The molding process leaves a rough, uneven surface so that the glass is not transparent. In order to examine this glass brick for bubbles and striae, two of its opposite sides must be ground and polished to transmit light.

When the plate is examined through the polished edges, striae will be disclosed if present because of the difference in refractive index. Fine striae mean that the plate must be rejected. Sometime, flaws resembling fine lace appear. These are caused by the re-fusion, during the molding process, of undiscovered cracks. Slabs of this glass are cut and examined under polarized light to disclose strains which create double refraction. If the



Chunk glass in fire-clay containers inside annealing oven.



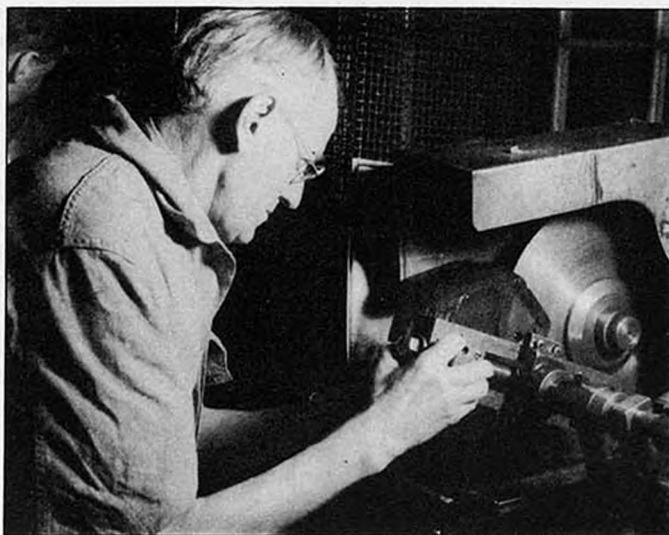
Measuring the refractive index of optical glass with a spectrometer.

glass is free from this defect, no light will reach the eye when the planes of polarization are at right angles to each other. Strains, however, cause a rotation of the planes of polarization, showing irregular colored patches. After all the tests have been made, not much more than 20% of the glass is usable, and sometimes even less. Rejected glass cannot be re-melted since the flaws would merely be accentuated. It will readily be seen that large chunks of perfect glass are difficult to obtain and this is why the price per pound on large perfect slabs is considerable above that of average pieces.

Slabs of selected glass are either cut or sawed into squares of the proper dimensions for the next step. Sometimes these squares are ground down to the shape desired, without recourse to further molding, but the usual process is to place them in a gas furnace where they are heated until soft and then pressed with a hot disc into blanks of the approximate curvatures and diameter that the finished lens is to take. This means that the blanks must be re-annealed again to remove strain and further inspected for fire-cracks, pits, dirt and striae. Blanks that pass all these inspections are then ready for the grinding room.

Here, we find a battery of machines fitted with grinding blocks and shells of cast iron. To make a converging lens with a convex surface a concave tool is required, the opposite type of tool would be used for a concave surface. The lens blank is cemented to a block of the proper curvature with hot pitch and allowed to cool before being attached to the spindle. Between the tools of reversed curvature water and corundum is used while the grinding proceeds. A gradual introduction of finer grades of corundum cuts the surface finer and finer, while the surfaces are constantly examined by expert workmen to detect flaws or any imperfection in the machine process. The thickness of the lens must be held rigorously to the calculated amount and this is achieved within 1/2500th of an inch in extreme cases.

With the lenses smoothly ground, the corundum is washed off and a polishing tool replaces the grinding tool. The polishing tool is a shell into which a hot wax composition is molded. The polishing element is rough, specially refined for this work. All silicia is eradicated as far as possible and the residue rendered harmless by



Sawing a slab of glass with diamond toothed saw.

crushing to a fine powder. The average grain size is 0.85 of a micron in diameter. The lens now receives a very severe test for accuracy of the radius of curvature and sphericity of surfaces. This is done with an optical test glass of opposite curve to the lenses. When placed on the lenses, the reflection of light from their surfaces and from the test glass produces interference colors which measures the difference in the two surfaces to within a few millionths of an inch. With one side of the lens polished, the finished surfaces are sprayed with shellac, the block is then chilled with ice water, the sudden cooling releasing the lens from the pitch. With both sides polished, the lenses are given successive baths in chemical solutions and soap suds to remove all traces of shellac, pitch and rouge, and again inspected for surface defects, thickness and sphericity.

The next operation is to center the lens. Its periphery must be ground so that the optical axis is at the center of the cylindrical boundary. The lens is cemented by one of its surfaces to a hollow horizontal lathe chuck so that a point of light is reflected in the surface of the lens. When the lens is rotated two images of the point of



A battery of automatic polishing tools for finishing optical elements.

light will rotate about each other if the optical and rotational axes do not coincide. If both are coincident the reflected image stands still. When this adjustment is achieved the edge of the lens is given the proper diameter and symmetry by a grinding wheel charged with diamond dust.

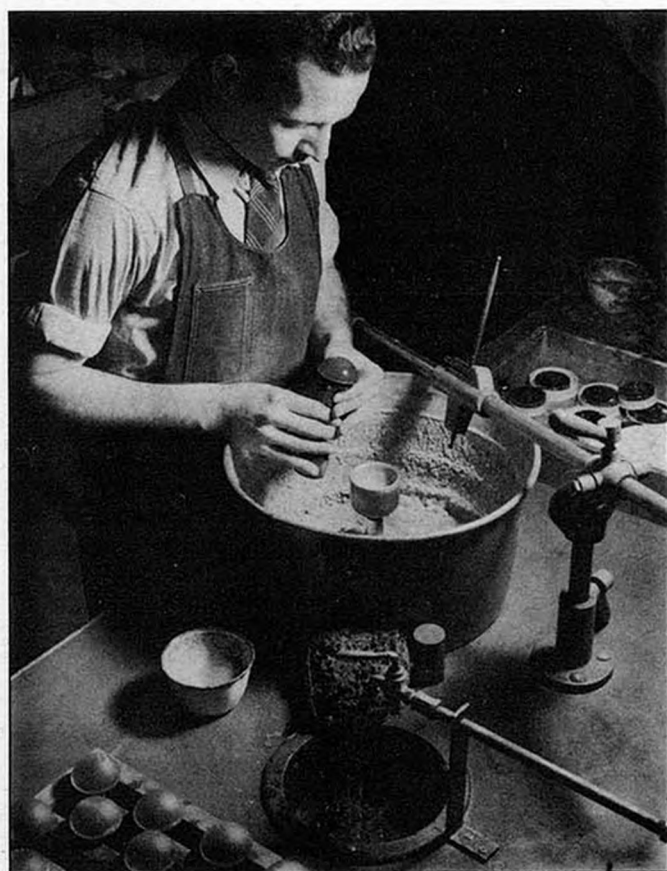
In cementing lens elements, scrupulous care must be taken to keep dust out. This work is done in an air filtered room under controlled humidity. The Canada balsam is filtered through asbestos and glass to remove all impurities and then bleached to a color as near water as possible. A drop of balsam is applied to warmed lenses and a gentle pressure applied to expel the air and excess balsam. When the balsam cools, the lens is once more trued on a lathe to see that the optical axes still coincide. When the bond is permanent the lens is ready for mounting.

The mount for each lens type is as carefully designed as the lens. The mount for one may be brass, whereas another intended, let us say, for aerial purposes, is of a special aluminum alloy. The latter is chosen to reduce weight and withstand the tremendous and sudden changes in temperature to which it is subjected, since sudden contraction or expansion may break or strain the lens. The distances between the component parts of the lens have been calculated so carefully that they must be adhered to within the smallest fraction. Excessive pressure or one-sided pressure must be avoided in mounting and yet the lens must not be loose. The mount must center the lens on the camera axis and keep the principal planes of the lens parallel with the camera front.

The inspection for optical and mechanical defects



Centering cemented lenses on a lathe.



Hand grinding operation on a deep curve lens element.

is made not only during the fabrication of the objective but during the final tests. These tests usually begin with the measurement of focal length. For some lenses of ordinary precision, this measurement is applied to the back focus, or the distance from the vertex of the rear surface of the objective to its focal plane when the objective is focused for infinity. In practice, this consists of focusing a distant object sharply on the ground glass of the test camera and measuring the distance from this position to the vertex of the rear surface of the objective. In cases where more precise measurements are necessary, it is customary to measure the equivalent focus rather than the back focus. This is usually done on an optical bench using the method invented by von Messard. It consists of adjusting the position of the nodal point of the objective until it coincides with the axis of rotation until there is no movement of the image through small angles of rotation. The distance of the nodal point from the focal plane is the equivalent focus.

Another method of measuring equivalent focus makes use of the unit magnification principle. At the focal point of a collimator objective is an illuminated scale so that parallel rays proceed from the collimator objective and enter the photographic objective being measured. Outside the collimator objective in parallel light is an engraved plate with two vertical lines. The test objective is adjusted so that the image of these lines on the ground glass of the test camera coincides exactly with a duplicate of these lines on the ground glass. From this position the photographic objective being tested is moved until it produces a sharp image of the collimator scale on the ground glass, which is an infinity adjustment. The move-



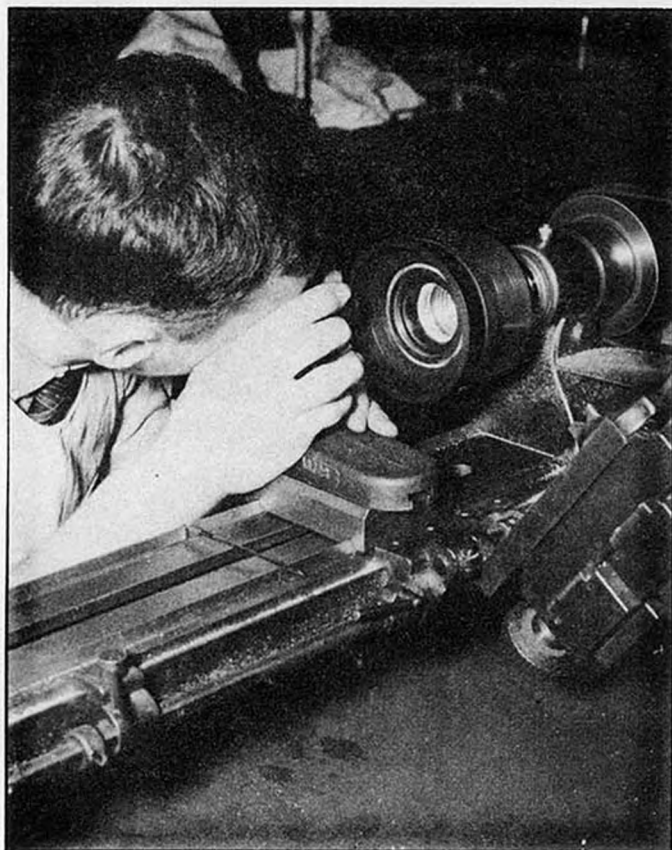
Cementing warmed lenses with Canada balsam.

ment of the objective between these two positions is equal to its equivalent focal length.

For definition, there are two methods which are used independently or jointly, one visual, the other instrumental. For photographic lenses of ordinary precision the visual method usually suffices. This consists of examining both center and marginal definition of a test target imaged through the objective on a ground glass. Center definition should be sharp and critical, except in the case of soft focus lenses, and marginal definition should depart very little since sharpness denotes eccentricity, zonal aberration, or astigmatism, which must be corrected and the test repeated.

In the case of such ultra-precise objectives as the Baltar, Altimar, Aero and Enlarging Tessars, the Metrogon, and other lenses of similar precision, the instrumental method of testing is applied. Optical bench measurements of equivalent focus are made and the character of a pin-hole image is simultaneously examined at the focal point of the objective. The definition of the pin-hole image is an indication of the general characteristics of the objective. Focal flares are produced by the influence of eccentricity or poor surface quality.

The optical bench is also used to measure dis-



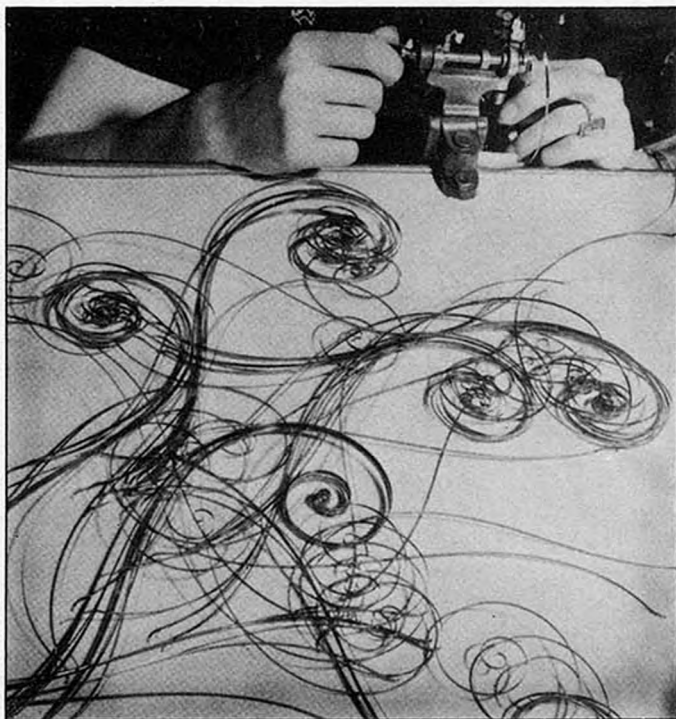
Mounting an aerial lens in a barrel.

tortion at various angles through the field which the objective is computed to cover. For ultra-precise objectives, the customer frequently specifies Bureau of Standard tests. In addition to distortion, such tests apply to resolution, curvature of field, spherical and chromatic aberration, and so on. All of these aberrations are carefully measured in experimental and sample objectives and the measurements are repeated frequently on manufactured objectives of the same type. Particular attention is paid to resolution which is photographically determined by means of a special collimator camera at various angles throughout the field to be covered. The actual performance in lines per millimeter resolved at each field angle is carefully measured on the photograph with a binocular microscope and compared with the required specifications.



NEWS FOR WELDERS AND CARPENTERS!

In this issue you will find new departments intended especially for you. Lt. Kuehne has promised a series of articles dealing with carpentry and woodworking. If you have carpentry problems, tell THE ORDNANCE SERGEANT about them. And Lt. Sylvester gives you in this issue a dictionary of welding terms which should be worth noticing. His articles on welding will continue in future issues.



A study in mainsprings

FROM "TIME CANDLE" TO "TANK CLOCK"

Fascinating is the study of Time, its history, its recorders, and its keepers. Through the centuries, the finger of Time had written legibly that all may read. Here we attempt to roll back the centuries and take a view of the fascinating developments in measuring time.

Even before man knew the world, there were time-recording devices. Before man came to the earth, the world recorded events of the years between stratas of rocks, forming the pages of history before mankind. Tiny streams produced deep canyons, while the great, cooling earth wrinkled up its skin into mountain ranges and ever-changing oceans.

With the coming of the dawn of man, there was only night and day to mark the never ending strife for survival of the fittest. Here, all that man could conceive of time was the uncertain length of his life span. Then



Earliest concept of time, when the antediluvians measured time in terms of life and death and the survival of the fittest.

the cave man ingeniously made a rope of grass, tied knots in it at equal distances, and when he wanted to measure time, he set fire to one end of the rope. By the length of time it took to burn from one knot to another, he knew when it was time for him to keep a date with a neighbor girl or to meet some of the boys for a game of leapfrog.

Candles used for timing

Centuries later, time was measured by burning "time candles", with notches at regular intervals, or with alternate black and white stripes to mark roughly the passage of the hours.

About eight thousand years ago the Chaldeans were determining the time of day by the length of the shadow of an obelisk. Five hundred years later we see man measuring time by the drip of water from one vessel to another. Marks on the inside of the vessel showed the height of the water, which agreed with the hour of the day or night. Crude as this may seem to us today, it was an improvement since it showed the passage of time in the dark as well as in the sunshine.

In the year 340 B. C., an astronomer by the name of Berosus made what was called a "sun dial" which showed the time of day by the angular position of the shadow. Meanwhile, sand had replaced water in a glass vessel. Called an hour glass or sand glass, this vessel could be inverted at the end of an hour and the sand could then flow back into the first chamber again. The mythical character of "Father Time", well-known to historians, carried an hour glass.

First Clock made in 1370

During the centuries following up to the thirteenth century, there were slight developments but many variations. In 1370 A.D., the first clock with wheels and pinions



A concept of the era of the water clock when time was recorded by the dripping of fluid through an aperture of control.

was made by a Hollander, Henry de Vick, to present to Charles V. King of France. The clock was a rough and heavy machine, driven by a weight of more than five hundred pounds, and regulated by a bar which vibrated back and forth in a horizontal plane. It had but one hand pointing to the hours. The name "clock" was taken from the bells, "glocken" or "clotches", which were used to strike the hours.

Watches or "pocket clocks" were not made until the sixteenth century when, although they varied more than an hour a day, they sold for the equivalent of fifteen hundred dollars. They were made of iron, were six inches in diameter and weighed about ten pounds. The motive

power was a coiled spring. Night watchmen carried these timepieces — when the price came within their reach — and so they came to be known as "watches".

Slow progress was made in improving the watch during the next three hundred years. By 1687 it had grown smaller and had acquired a minute hand. Watches had no balance spring or hair-spring until 1661 when a crude hair-spring was made of pig's bristle. This was done by Dr. Robert Hooke of England as a means of applying the pendulum principle to watches. The pig's bristle which he used for this purpose, he described as "a tender, straight spring, so affixed that one end thereof plays backward and forward with the balance."

Jewel bearings introduced

After the art of piercing rubies and other precious stones was discovered by Nicholas Facio of Switzerland in 1700, these stones were used as bearings for pivots in watches, as they are still used.



Depicted in mural paintings are stages of time keeping progress. At first, necromancy or magic utilized time theory.

Whether it helped or hindered watch development, at least it was a step in the right direction when, in 1752, a keyless watch was made in France by a Monsieur Caron for Madame Pompadour who immediately began winding it by drawing a tiny, projecting hook half way around the dial. One winding would do for 30 hours, which seemed quite a marvelous matter to everyone of that day.

It wasn't but 28 years more when another Frenchman, Abraham Brequet, secured a patent on what was called a self-winding watch. It was a pedometer watch kept wound by the motion of the wearer's body. This man Brequet also gave the world the overcoil hair-spring, a notable step toward perfect isochronism, and which still bears the name of its inventor.

Key bows to stemwinder

The matter of winding a watch took another big step in 1838 when the first "stem winder" made its debut, and Queen Victoria of England paid more than 4,000 francs for a very small, thin watch made by Brequet. This tiny wonder required no key for it was wound direct by the stem or pendant.

Previous to this a regulator and a lever escapement had been invented. The form of regulator now generally used on watches was patented in 1755 in England by Joseph Bosley who made the balance move faster or slower



The day came when the church institution adopted time as a standard and devised chimes and bells to proclaim periods.

by shifting the curb-pins of the hair-spring. Shortly thereafter, came the lever escapement whose action was similar to the modern doubleroller escapement. Invented by Thomas Mudge, it was in effect an adaption of the dead beat escapement invented in 1730 by Graham. As was the custom of the day with the cleverest of inventions, this masterpiece was presented by Mudge to Queen Charlotte of England.

Significant in watch production of the world was establishment of an American watch factory in 1838 by James and Henry Pitkin. The brothers, however, were unable to compete with cheap foreign watches. Two years later the watchmaking industry in Switzerland began to assume factory proportions, but was still greatly hampered by lack of standardizing and interchangeability of parts. It was not until many years later that actual factory production of watches began in America.

The year 1873 marked the first stem-winding watch made by an American factory. This was a watch made over from the B. W. Raymond movement which was a key-winding model. In June, 1878, one of America's leading manufacturers put on the market a series of several stem-winders. Still another step in the making of American watches was in 1914 when the first strap watch went on the market.



Orderly time as applied to the labor of slaves in early Egyptian days. The gongs signaled the periods of effort.

Changes made in design

One of the most important improvements ever made in American watches was achieved in the early seventies when the train was changed from what was known as "slow train" to a "quick train." This improvement caused the balance wheel to change from 14,400 to 18,000 vibrations an hour, and from 240 to 300 a minute. This change per-

(Continued on page 146)

camouflage precaution. Even color photography has been enlisted to bring before his careful scrutiny, for instance, the slight difference in color between living foliage and wilted branches cut for camouflage.

The natural protection of darkness and blackout strategy has made it almost axiomatic for military leaders to make their important secret moves at night. Thanks to the experiments of the materiel division, great strides have been made in the field of night photography. It is now possible to penetrate the darkness with specially controlled flash bombs and cameras, thus surprising the enemy red-handed in his most secret activities.

The army's first course in photo interpretation in recent years was concluded last July. Seventy-five officers, including two from the Marine Corps, successfully completed it, and other classes have followed. Plans are also being formulated for an Air Force Intelligence School, where the interpreters of aerial photographs will form a major part of the training. This school, if plans go through, will undertake to supply the army air forces with trained personnel — which will be much needed. Air force officials confidently speak of a battery of 30,000 cameras especially designed for aerial intelligence duty.

Briefly, the functions of men of photo interpretation units are to receive, record and collate all aerial photographs from all sources; then develop from the photographs the maximum accurate intelligence in the minimum time; to arrange this information in the most usable form; to maintain a complete photo-library and filing system; to train others in all phases of photo interpretation and to conduct research to test and improve methods of interpretation.

The operation of a photo interpretation unit is shown on the accompanying chart. Pictures of tactical or strategic

activity as taken at Point A are transmitted to a developing laboratory, which may be either stationary or mobile. The interpretation officer C, who has been studying all previous photos, is prepared to analyze the new photos and report any activity which may affect the day-by-day conduct of the war. His first, "quick" interpretation is transmitted to all tactical units affected.

The films, prints and copies of the first-phase report are quickly forwarded to the photo interpretation unit, D, while other copies go to E and F for simultaneous processings. The "second-phase" interpretation at E involves the plotting of the photos on large index or situation maps. The "first-phase" report is here verified and greatly amplified, after which it is forwarded to the headquarters of tactical units at G.

The final "third-phase" interpretation is a specialized strategic analysis. Officers and civilian specialists in various spheres go over each photo minutely to extract every grain of intelligence affecting their respective fields. Army specialists would offer their interpretation in the light of their knowledge of ground-force tactics, army installations, equipment, ammunition dumps and barracks. Industrial specialists would be well versed in the appearance and importance of oil refineries, power stations, munitions industries, railroad centers and all types of manufacturing docks and shipping.

The results of these expert interpretations are graphically illustrated and arranged in a final interpretation report by a staff of expert draftsmen and clerical assistances, including officers, enlisted men and civilians. The interpretations in their final form provide valuable source material in the preparation of air estimate, objective and target folders — point H — and also play an essential function in the functions of the war room and high command.



LOYALTY

If — You work for a man, in heaven's name work for him; speak well of him and stand by the institution he represents.

Remember — An ounce of loyalty is worth a pound of cleverness.

If — You must growl, condemn, and eternally find fault, why — resign your position and when you are on the outside, damn to your heart's content — but as long as you are a part of the institution do not condemn it, if you do, the first high wind that comes along will blow you away, and probably you will never know why.

ELBERT HUBBARD

MOLYBDENUM

The Office of Production Management announces that considerable demand has arisen for literature instructing metallurgists, heat-treaters and users as to a method for treating molybdenum high speed steel to bring forth its greatest efficiency.

Many statements are made that molybdenum high speed steel is as efficient as tungsten high-speed steel, provided the former is properly treated to avoid decarburization and to bring out its best qualities. Because of the shortage of tungsten and instructions prohibiting the use of high speed tungsten steel, when avoidable, it seems desirable to circulate the pertinent information. Committees of experts on the various phases of this important matter have been appointed, and when their final reports and recommendations have been passed upon, they will be printed and circulated among those interested.

"BULLETIN", Cincinnati
Ordnance District

NOTE: The following article is not an attempt to supply the deficiency of information mentioned above. It is, rather, merely an introduction to the characteristics of Molybdenum as presented by the producers of this product.

MOLYBDENUM

The use of Molybdenum in steel dates back into the early eighties, but its commercial application in any quantity was limited by the fact that no assured supply was available. The logical result was that very little research or development work was done at that time. The first assurance of a regular supply was obtained when the Climax Molybdenum Company began operating its mine at Climax, Colorado, in 1918. From then on a continual increase in interest resulted in growing consumption.

The progress which the application of Molybdenum has made in the past decade is shown by the consumption figures. In 1929, by which time Molybdenum steels had obtained a substantial field of usefulness, the world consumption of Molybdenum was about 3,000,000 pounds. In 1938 it was about 28,000,000 pounds. The figures are particularly interesting when they are compared with a world steel consumption of 118,300,000 gross tons in 1929, and only 105,850,000 gross tons in 1938.

The effect of Molybdenum on the physical properties and fabricating qualities of steel has a decided influence on its performance, from the standpoint of both service in the field and economy in production. As a result the effect as regards both physical properties and fabricating qualities merits detailed consideration.

Effect on Physical Properties

The effects of Molybdenum on the physical properties of steel may be summarized as follows:

Heat Treatment: The more important effects of Molybdenum on heat treatment are outlined below.

1. The upper critical (A_{c2}) point is slightly raised on heating and lowered on cooling.
2. The commercial safe quenching and normalizing temperature limits are widened.

3. All transformation changes are retarded.

4. Higher drawing temperatures are required to produce similar hardness.

5. Temper brittleness is practically eliminated.

Tensile Strength: The presence of Molybdenum in steel increases the useful range of tensile strength of the steel by improving its toughness. This is a fundamental effect of all alloying elements. Molybdenum improves other properties that are closely related to tensile strength. Fatigue strength is raised, and the susceptibility to "notch effect" is reduced. By "notch effect" is meant the lowering of fatigue strength by grooves, sharp fillets, machine tool marks, or other surface defects. In some combinations Molybdenum also increases the resistance of steel to corrosion fatigue.

Tensile-Yield ratios of from 80% to 90% are characteristic of most heat treated Molybdenum steels. Practically, this means a high factor of safety for the steels.

Hardness: Molybdenum with the exception of Carbon, is the most effective hardening element that can be added to steel. By slowing down the transformation rate Molybdenum promotes the uniformity and depth of hardening. This property is particularly advantageous in parts having sections.

Impact Strength: Molybdenum improves impact strength in steel in two ways. In the first place, higher drawing temperatures are required to produce similar hardnesses. Higher drawing temperatures will result in a more complete relief from internal strains caused by the quenching operation. Naturally, the more complete the strain relief, the greater the impact strength. In the second place, Molybdenum eliminates temper brittleness in steel. Temper brittleness is the phenomenon of a loss of room temperature impact strength that occurs in many steels if they are slow cooled from operating or draw temperatures in the range of about 850° to 1100° F. This loss of impact strength is so great in some cases that a part may fail suddenly under a relatively low impact load.

Molybdenum steels, as a class, are practically free from temper brittleness. It is also possible to eliminate the brittleness in steels that are ordinarily susceptible by adding calculated amounts of Molybdenum.

Elevated Temperature Properties: The effect of Molybdenum on the properties of steel which are of interest in elevated temperature applications is one of its most interesting and unique features. Molybdenum greatly improves the ability of steel to retain its strength, as measured in an ordinary tensile test, when heated to elevated temperatures.

The remarkably high creep strength of many Molybdenum steels is so generally known that it does not need discussion. These steels have made possible a good many developments in oil refinery and steam generating processes which would otherwise have been impractical.

Corrosion Resistance: When Molybdenum is added to plain Carbon steel it substantially improves its corrosion resistance, but not to an economically practical extent. In the case of the authentic stainless steels, the combined effect of Molybdenum as both an alloying agent, and as a stabilizer of carbides, results in remarkable improvements in resistance to many corrosion media. The pearlitic Nickel-Molybdenum steels are known for their resistance to corrosion fatigue.

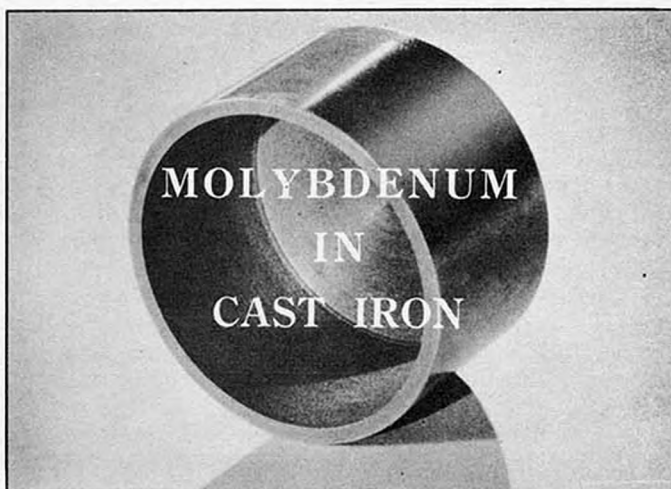
Effect on Fabrication

The effect of Molybdenum on the fabricating qualities of steel is briefly discussed below.

Forging: Molybdenum tends to inhibit undesirable grain growth of steel during the soaking operation before forging. In addition to this, as a rule, Molybdenum steels are free scaling, resulting in better surfaces on forged parts, increased die and tool life and decreased pickling costs.

Case Hardening: Molybdenum improves the properties of the case of steel whether the process be carburizing or nitriding. In both cases the penetration of the hardening medium is accelerated. The distortion of Molybdenum-containing case hardening steels is minimized, and often predictable.

Molybdenum carburizing steels are characterized



The practical and economic improvements brought about by the addition of Molybdenum to cast iron are based primarily on its effect on the structure and physical properties of the metal. It is definitely known that Molybdenum has a decided influence on the nature of the decomposition products of austenitic which are formed as the iron cools in the mold. The net result of this control of austenite decomposition is a strong refining action on the structure of the matrix.

Small and uniformly distributed graphite particles are characteristic of iron properly alloyed with Molybdenum. This effect on the graphite is accomplished by the formation of a homogeneous structure in the matrix. Such a structure is better from the standpoint of both strength

by tough strong cores and hard cases well bonded to the core. Because the case retains its hardness at relatively high operating temperatures, these steels are very valuable for gears. The addition of Molybdenum to nitriding steels improves depth hardening. It also eliminates temper brittleness usually found in high Aluminum steels, thus permitting nitriding at the most effective temperature.

Molybdenum steels in the higher Carbon range (0.35 to 0.50%) make excellent flame hardening steels. Their hardenability is increased and, since Molybdenum inhibits grain growth over the transformation point, the steels react better to this treatment. Consequently, a loss of control of hardening temperatures does not necessarily result in spoilage.

Machining: Molybdenum steels often machine more easily in the fully heated condition than similar alloy steels not containing Molybdenum, when heat treated to the same hardness. In the softened condition, if properly heat treated, Molybdenum steels do not offer any difficulty in machining under ordinary shop conditions.

Welding: Many Molybdenum steels are readily welded by any of the well known processes. This property has resulted in the wide use of both Carbon-Molybdenum and Chromium-Molybdenum steels for certain types of welded construction.

and machinability than the lamellar pearlite that is usually found in irons that do not contain Molybdenum.

The metallurgical effects of Molybdenum on cast iron can be summarized as follows:

1. Marked improvement in tensile and transverse strength, combined with higher deflection. (This holds particularly for castings of large section.)
2. Higher impact strength.
3. Greater fatigue strength.
4. Improved wear resistance.
5. Better toughness and strength at elevated temperatures.
6. Intensification of the effects of other alloying elements.

The effects of any alloying element on the properties of cast iron are naturally dependent in a large measure on the quality of the base metal. Molybdenum is not recommended as a remedy for improper foundry practice, either in melting or casting. Given a good base iron and proper casting practice, full advantage can be taken of its effect on both the physical properties of iron and the economy of its production.

The toughness of Molybdenum irons, together with their superior strength at elevated temperatures, reduces their susceptibility to cracking when they are subjected to sudden changes in temperature. Since Molybdenum slows

(Continued on page 147)



The United States Army has learned about motor vehicles the hard way, by actual experience under all sorts of circumstances — mostly unfavorable. To begin with, it was in 1916 that the U. S. Army, although poorly equipped with motor vehicles and without trained men for their operation and maintenance, found that motor transport of men and supplies had great possibilities. There was every indication that armies were to undergo sweeping changes with respect to mobility.

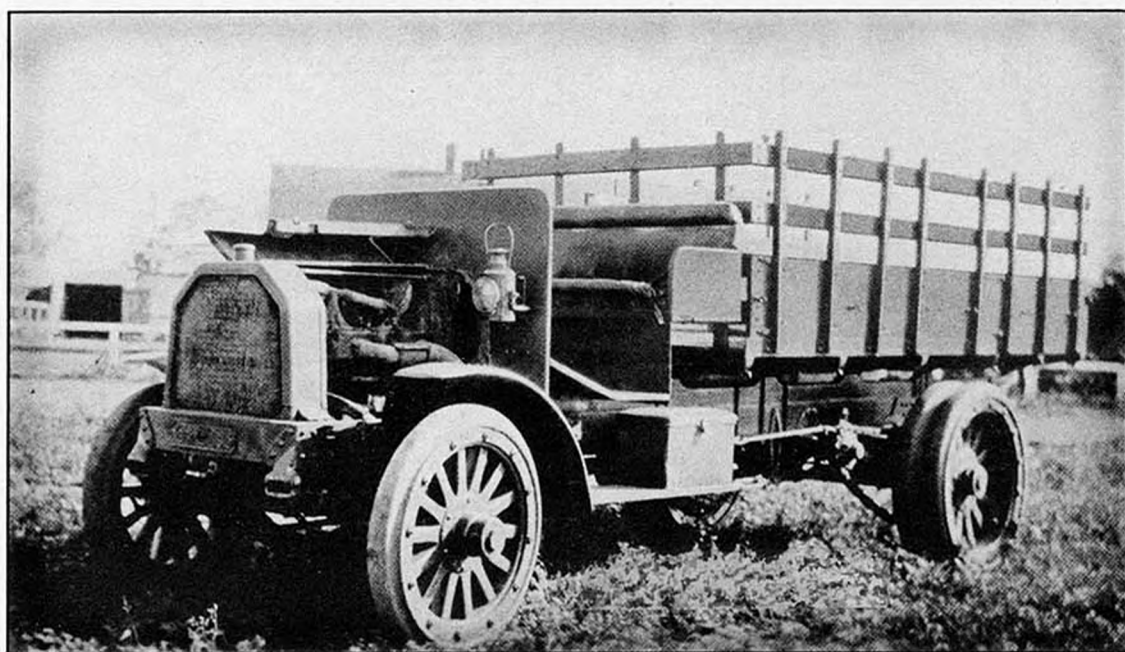
Our army did not have much opportunity to profit from the lessons learned in Mexico, because it was only two years later that the army found itself in France. Our army demonstrated that motor transport was the best means

of moving men and supplies directly to the reserve lines and operations that had never been considered practical in the combat zone by any of the European armies up to that time. Based on the early experience with the operations and maintenance of motor vehicles, the production of some standardization of motor trucks was imperative. The Motor Transport Corps, with the assistance of the Society of Automotive Engineers, designed a standardized motor truck known as Class B and this truck was built in large quantities for the service of supply in France.

At the same time the Ordnance Department was developing designs of motor vehicles known as Artillery Wheeled Tractors for towing guns into position. Ex-



World War I found us unprepared



1916 Army truck -- notice only 2 driving wheels and solid tires.

perience in France indicated that two-wheel-drive motor trucks were next to useless when used off-the-road.

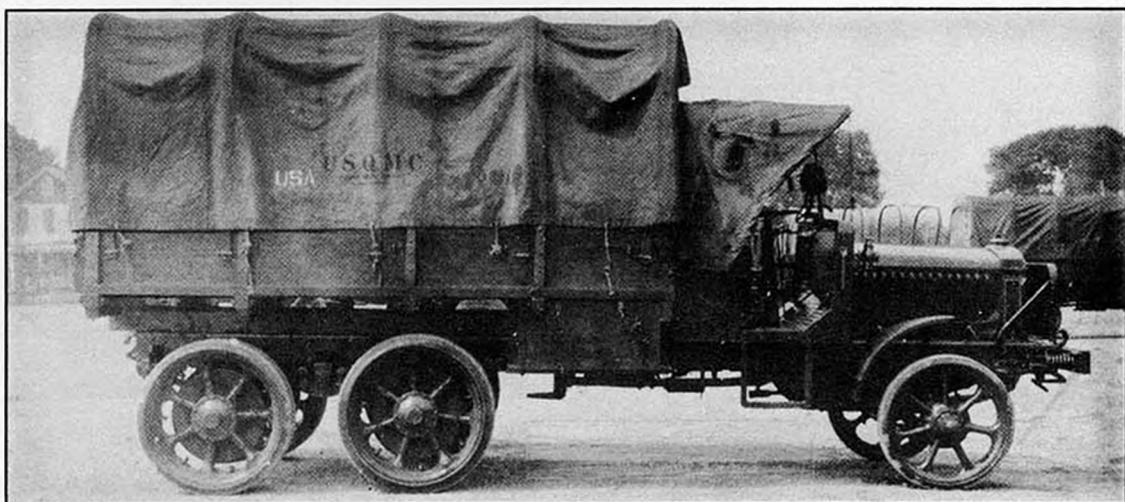
A year or so after World War I, the Motor Transport Corps was consolidated with the Quartermaster Corps which was then charged with the responsibility of developing motor transport for the U. S. Army. This did not of course include combat vehicles which remained the responsibility of the Ordnance Department. The first and foremost thought in connection with motor transport was the chaotic nightmare of trying to maintain a replacement parts supply for over 200 different types of motor vehicles used in France and widely separated from the source of supply. The project of designing and developing a series of motor trucks with maximum interchangeability of parts was not an easy one. Wide difference of military opinion and of automotive opinion led to long-drawn-out controversies

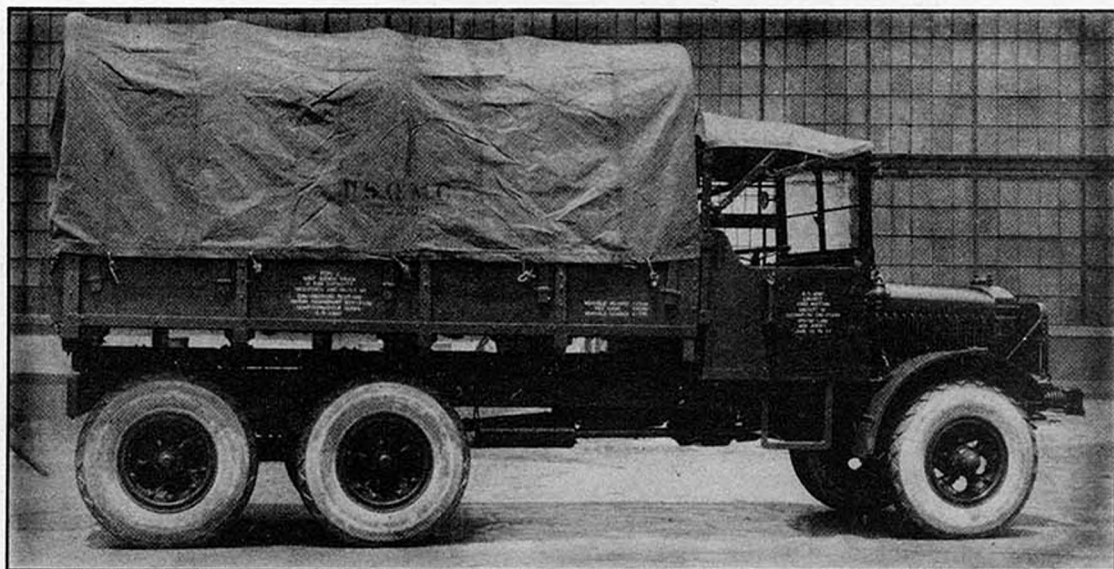
as to what characteristics were essential to the various types of motor vehicles required for military transport.

Four-wheel trucks with two rear-wheel drives only were at that time considered suitable for road transport only. Four-wheel-drive four-wheel trucks were demanded for off-the-road service. Four-wheel steer on these trucks was considered indispensable for maneuverability in off-road operations, but it was admittedly impossible to run on roads at speeds of over 15 miles per hour with four-wheel steer. Two-wheel steer on four-wheel-drive trucks was reported as being too difficult for one man to handle. The limited turning ability had to be improved and easier steering was absolutely essential.

The transfer case -- the gear box which divides the drive line between the front and rear driving axles -- was

Early type 6-wheel Army truck, driving on rear wheels only





1923 modernization of World War I type truck by Holabird QM Depot

another problem. It was found that gear drive did not give sufficient life and chain drive transfer cases were developed as the final answer at that time.

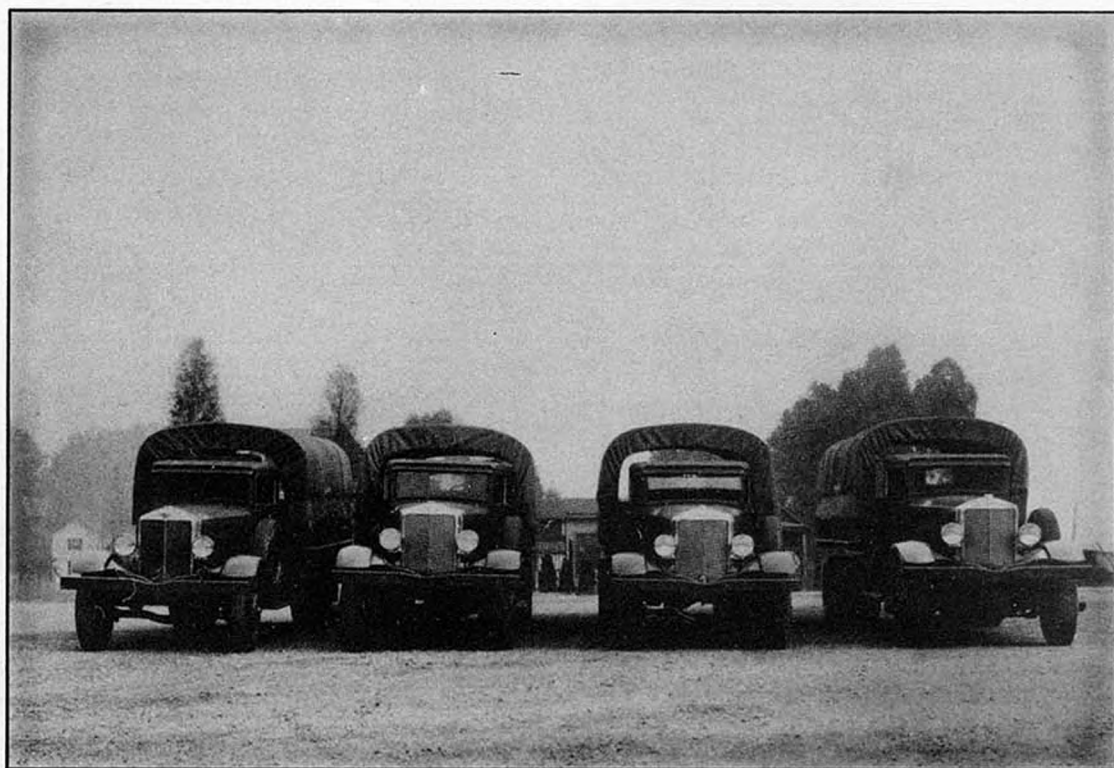
One type of front driving axle was of the internal gear type and was found to have too many shortcomings, and the enclosed universal joint drive was being developed.

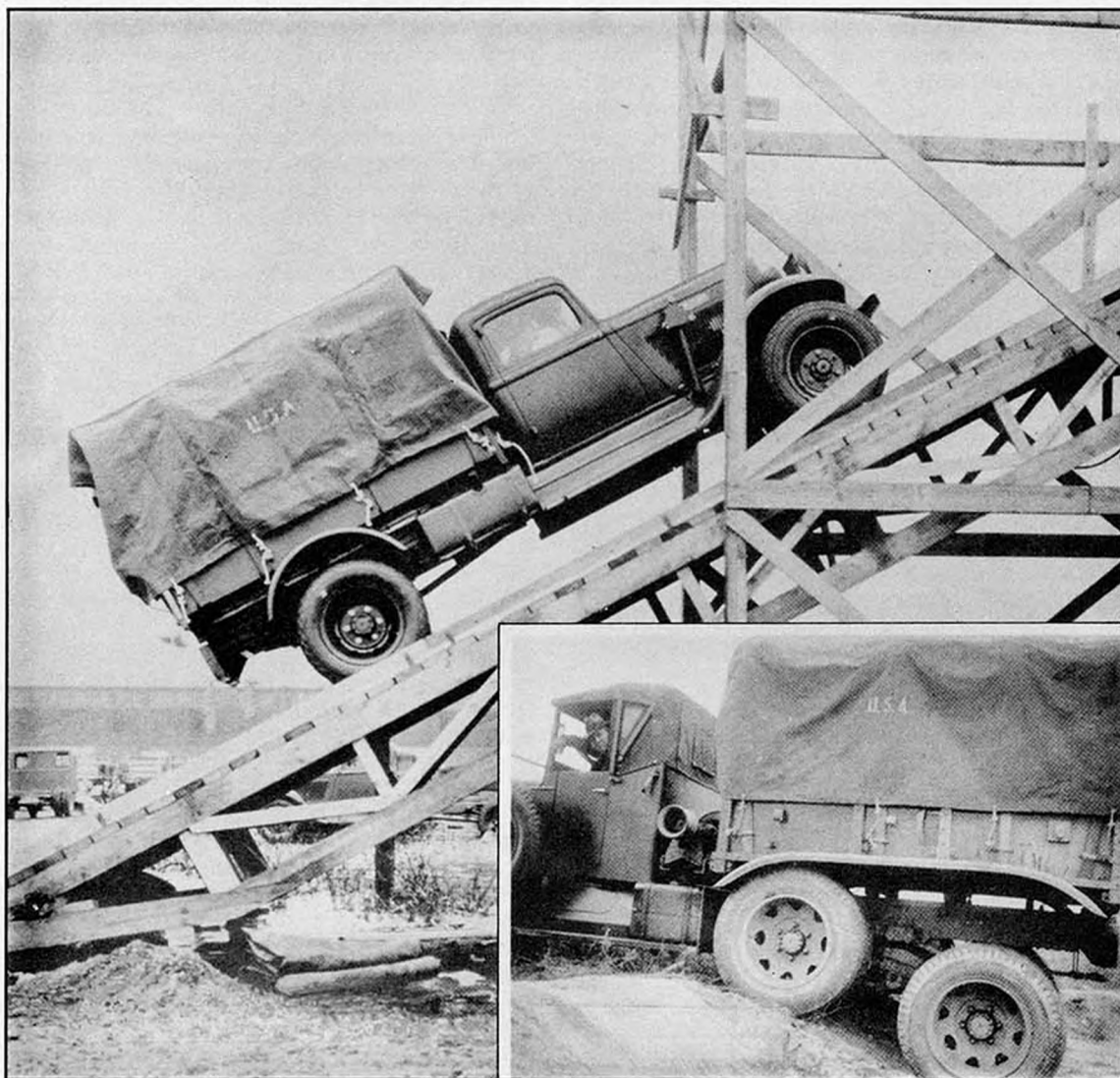
The inter-locking type differentials in the front and rear axles were reported to wear out much too fast and some other equivalent was under consideration.

In view of today's motor trucks, the foregoing problems seem a bit ridiculous, but one has only to look at photographs of those early motor trucks to realize how inadequate they were.

For artillery operations where the service is entirely off-the-road under all conditions of terrain, the two-wheel-drive four-wheel truck was impractical. The maximum ability for artillery use was claimed for track laying vehicles and many officers favored this type. The four-wheel truck was considered to have very limited ability, lying

1929 group of standardized Army trucks, designed and built at Holabird Quartermaster Depot to demonstrate advantages of maximum unit interchangeability.





Factory testing of 1934 Model, 1½-ton 4-wheel-drive Army truck on 55% grade.

Showing flexibility required by Army motor vehicles.

somewhere between the two-wheel-drive four-wheeler and the track laying vehicle.

Many will recall that various types of motor vehicles were brought from France, including several types of German vehicles. There can be no question that the Quartermaster Corps certainly inherited a hot potato, when handed this stupendous task of developing a line of motor vehicles to cover motor transport and artillery requirements.

To cut short a long and fascinating story, the Quartermaster Corps completed in 1929 the building of a group of 18 different types and sizes of chassis. This standardized list was based on five sizes of chassis, ranging from 1-1/4 to 7-1/2-ton payload capacity, with four different types of driving combinations in each of the four larger sizes. These designs provided a maximum

degree of interchangeability to the point where it was considered that 10% of the vehicle investment expended in spare units and parts would be sufficient. This compared with the condition in World War I where 150 million dollars or 25% of the vehicle investment failed utterly to maintain 275,000 vehicles of 200 different makes.

The modern part of the story of motorization of the United States Army started at this point in 1929. Need we remind you that 1929 was also just about the starting point of the volume production of the 1-1/2 ton truck, back when it was used to carry 1-1/2-ton payload?

At about this same time, the Comptroller General of the United States ruled "The procurement of motor vehicles to be limited to models in commercial production

(Continued on page 146)

THE A-B-C OF STAINLESS STEELS

Everyone knows what chromium plate looks like. It is pure metallic chromium which has been electroplated on the surface of some other metal. We know that chromium is a bluish white metal capable of taking a brilliant finish; we know it is hard and resists scratching or abrasion; we also know it is highly resistant to rust and corrosion. When a chromium-plated article rusts, it is not due to any attack on the chromium itself — that would be impossible. It is caused by a break in the plate which permits the metal underneath to rust, and this in turn serves to peel off more of the plating.

This same uncorrodible metal, chromium, is the basis for all Stainless Steels. Instead of plating it on the surface, we alloy large percentages of chromium into the steel while it is being melted in order to communicate to the alloy the desirable properties of chromium. The steel becomes harder, more wear resistant and less subject to corrosion. It even borrows somewhat the color of chromium. The more chromium we add — the more corrosion resistant the product becomes until, with about 12% chromium, we have an alloy that will not rust when exposed to the weather. To get greater corrosion resistance, more chromium is added, and so we find Stainless Steels with chromium content of 12% — 17% — 20% — and even 30%.

It is therefore quite accurate to think of Stainless steel as "solid chromium plate." The relation is not unlike that between "sterling silver" and "silver plate." Both sterling silver and Stainless Steel are "that way" clear through.

Along with iron and chromium, all Stainless Steels contain some carbon. It is hard to get less than about .05% and sometimes carbon is deliberately added up to 1.00% or more. The more carbon there is, the more chromium must be used, because carbon steals from the alloy about seventeen times its own weight of chromium to

form carbides, and this stolen chromium is of little use in resisting corrosion. The carbon is added for the same purpose as in ordinary steels — to make the alloy harder better.

Other elements are sometimes added to give the Stainless Steel special properties. The most important of these is nickel. If enough nickel is added, the entire nature of the alloy changes — and it really begins to behave more like nickel than like steel. Even the color acquires a yellowish nickel tinge, and the corrosion resistance is considerably increased. A variety of other elements such as copper, molybdenum, silicon, aluminum, sulphur, selenium, titanium, etc., are sometimes added to further modify the properties of Stainless Steel and so fit it more accurately to special jobs that it must do.

All of this need confuse no one. Regardless of how complicated the analysis of a Stainless Steel may be, it is quite sure to fall into one of three well-defined groups — and one who is familiar with these simple groups can prophesy many of the properties of practically any Stainless Steel. Minor details of each steel will vary depending upon its exact analysis, but it simplifies the whole thing tremendously to become familiar with the group characteristics. These groups have been named Group A, Group B and Group C, and because this division is so fundamental, it may justly be called "the A-B-C of Stainless Steels."

Below will be found a tabulation of these A, B and C groups. Certain properties are listed which are characteristic of the various groups — and hence of all the steels that fall into those groups. He who acquires the information contained in this table will have a sound working knowledge of Stainless Steel. He who does not, may easily become confused by the vast number of trade names, special analyses, and catalog data that he encounters.

GROUP A	GROUP B	GROUP C
Analysis: Groups A and B are primarily straight chromium steels. Multiply the percent of carbon in the steel by 17. Subtract this from the percent of chromium in the steel. If the result is less than 12.5%, it is Group A; if greater than 12.5%, it is Group B. Either group may contain small percentages of copper, nickel, silicon, molybdenum, sulphur, etc., for special purposes.		Contains at least 24% of chromium and nickel combined. Neither chromium nor nickel should be less than 8%. May contain small percentages of other elements for special purposes.
Magnetic Properties: Steels of this group are magnetic.		Steels of this group are non-magnetic
Heat Treatment: Respond to hardening and tempering like ordinary steels. Resulting physical properties depend largely on carbon content.	Do not respond to hardening by heat treatment.	
Toughness: Are structurally dependable. Are not brittle in sharp-notched sections or under impact.	Have low impact resistance in notched sections.	Extremely tough at all times. Thoroughly dependable for any type of shock service within the capacity of their strength.
Grain Growth at High Temperatures: Not subject to excessive grain growth at elevated temperatures. Remain tough when cooled from all temperatures up to 1400° F.	Prolonged exposure to elevated temperatures usually causes excessive grain growth and brittleness.	Grain growth is rapid above 1800° F. Caution must be used for operating temperatures between 800° and 1500° F. See "intergranular corrosion."

GROUP A	GROUP B	GROUP C
<u>Hot Working Properties:</u> Readily forged, pierced or rolled.		
<u>Air-Hardening:</u> Steels of this group air-harden from above 1500° F.	Do not appreciably air-harden.	Do not air-harden at all.
<u>Cold Working Qualities:</u> Can be cold drawn into wire, cold rolled, bent, formed upset, coined and deep drawn.		Can be cold drawn into wire, cold rolled, bent, formed, upset, coined and deep drawn. Work-harden more rapidly than Groups A and B.
<u>Machinability:</u> Machine satisfactorily with properly designed tools. Become very free-machining upon addition of sulphur or selenium.		Difficult to machine. Become free-machining when sulphur or selenium are added to the analysis.
<u>Riveting:</u> Make excellent cold rivets. Not recommended for hot rivets driven above 1500° F., on account of air-hardening.	Make excellent cold rivets. Due to low impact values, special precautions are necessary when used for hot rivets.	Excellent for either hot or cold rivets. Hot rivets should be heated all over to at least 1800° F.
<u>Welding:</u> Can be welded with gas, electric arc or resistance. Weld air-hardens. No grain growth. Free-machining types are not recommended for welding.	Can be welded with gas, electric arc or resistance. Grain growth and brittleness may result. Free-machining types are not recommended for welding.	Easiest group to weld. Welds are tough. Corrosion resistance may be badly damaged by welding. See "intergranular corrosion." Free-machining types are not recommended for welding.
<u>Corrosion Resistance:</u> Very satisfactory for resisting weather, water and some chemicals.	Better than Group A.	Better than Group B having equal chromium content.
<u>Intergranular Corrosion:</u> No.		Yes.
<u>Scale Resistance:</u> Recommended for continuous service up to 1200° F.	Better than Group A. Useful temperature increases with the percentage of chromium.	Better than steels of equal chromium in Group B.
<u>Strength at High Temperatures:</u> Has better strength than carbon steel up to 1200° F.	Stronger than carbon steel, but inferior to Group A steels -- especially in "creep" values.	Strongest steels available are of this Group.



ESPRIT DE CORPS

Listen to two or more World War (I) veterans talking.

The Rainbow Division man will swear by all that's good and holy that the 42nd Division won the war.

The Yankee Division man will dispute this, and advance reasons why the 26th Division deserves all the credit, and so on, ad infinitum.

Each and every man who fought overseas knows without a question that his division and his division alone made the armistice possible.

It's this wonderful spirit of loyalty that permeated the entire A. E. F. — that made a victory for the Allies quick and certain.

All veterans, however, are agreed upon one point, and they are absolutely right. The American soldier, properly disciplined, trained and equipped, can lick his weight in wildcats anywhere, anytime, and do a thorough job of it.

We are the only nation upon the entire earth which has never lost a war, and has never sued for peace.

If you doubt this, delve back into history as far as you want to go. The farther back you go the more you will be convinced; the more you are convinced the prouder you will be that you enjoy the distinct honor of being selected to wear Uncle Sam's uniform and the privilege of serving this wonderful nation of ours. Only real men are selected for this job, no weaklings are considered — none need apply.

(Continued on page 193)

ORLANDO AIR BASE

By: J. F. Schneider, 2nd Lt., Ord. Dept.

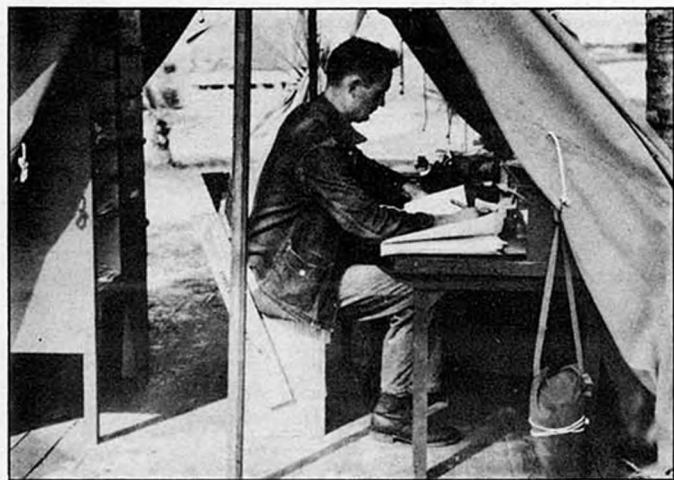
At Orlando Air Base, we read in THE ORDNANCE SERGEANT of the accomplishments and activities of the other air bases with much interest. We believe others are finding the same interest, and with this in mind, we wish to submit our history to help complete the picture of Ordnance work at the air bases throughout the country.

On February 20, 1941, the 336th Ordnance Company of MacDill Field, Tampa, Florida was broken up into cadres to form the 452nd (B), 722nd (AB), 715th (AB), 447th (B), 463rd (B), 729th (AB), and 686th (P). Captain Richard E. Sims, who at the time was a 1st Lieutenant, was given command of the 452nd and the 722nd, and on April 14, 1941, he was ordered to Orlando Air Base. At that time, the Air Corps was doing their own ordnance service. To aid Captain Sims until more ordnance officers could be sent to

Ordnance and it is hard to find the questions he cannot answer.

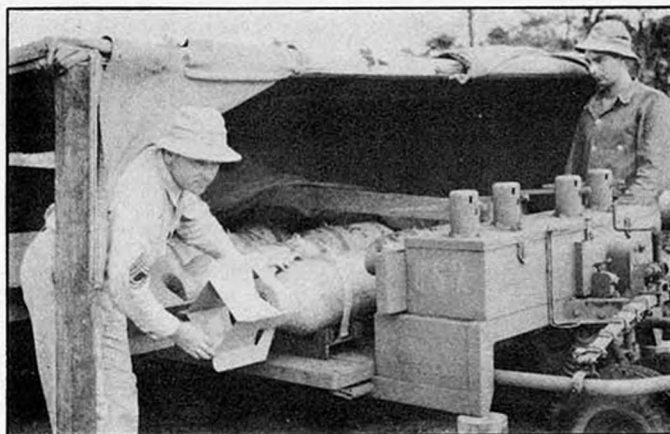
While the officers are here, they are assigned to be in charge of a section and are responsible for the functions and training within the section. Section training takes place in the afternoon; during the mornings, instruction is given to all men except the ones to form skeleton crews to carry on the work. All officers attend these instruction periods to keep themselves refreshed. After being in charge of a section for a certain period, the officers are rotated and put in charge of another section. We have an officer for each of these sections: ammunition area, motor pool, warehouse, and armament section. Officers are also assigned as gas instructor, A. & R. Officers, publicity officer, etc.

Upon arriving at Orlando, Capt. Sims acquired the southeast corner of the landing field, where he established the bomb storage area (practice bombs), and near the edge of the southeast corner, he located the motor pool. (At a later time, it was discovered that this location was identical to the one used by the 10th Ordnance Service Company in maneuvers in 1937.) At that time our motor equipment consisted of: 5 bomb service trucks, 12 bomb service trailers, and several 1-1/2 ton cargo trucks. At this time we have: 46 bomb service trailers, 5 bomb service trucks, 2 bomb service tractors, 3 special Ordnance trucks, and 24 other vehicles, so our motor pool is somewhat of a problem.



Dispatcher at motor pool!

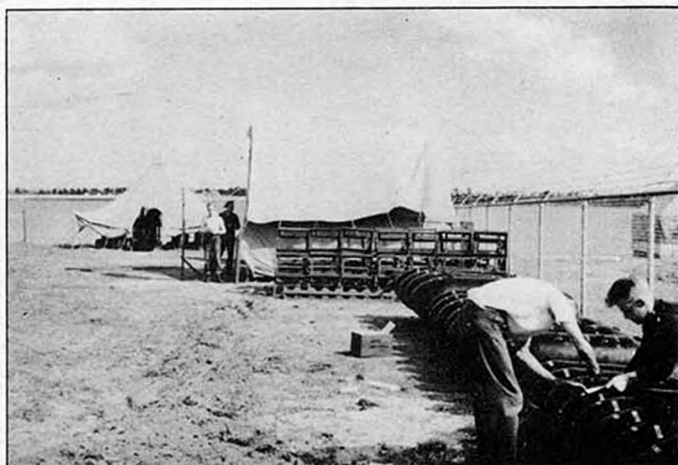
Orlando, an Air Corps officer, Lt. Skipper was assigned to duty with the Ordnance and was given command of the 452nd Company. The latter part of May brought the arrival of Lt. Schnieder and Lt. Munford, fresh from the officers troop school at MacDill. In June, Lt. Hemmerich arrived from a one month course at Aberdeen, Maryland. Two more officers were assigned to us in July, Lt. Nolan, and Lt. Smith who had just completed a two months course at Aberdeen. While these six officers are assigned to Orlando, there has been one, two, and sometimes three away on other duty most of the time. Captain Sims was confined to the hospital for three weeks after the arrival of Lt. Schneider and Lt. Munford. In September, Lt. Schneider was ordered to Aberdeen to receive more schooling, and the latter part of September and all of October, Lt. Munford was on duty in the 3rd Air Force Office in Tampa, Florida. Then on the first of November, Lt. Hemmerich went back to Aberdeen for a course in ammunition. Due to these absences, we have but few times operated under our full quota of officers. We are fortunate in having an "old timer" to handle our chief clerk's job in base ordnance. Master Sergeant Maze has 19 years and 5 months service in the Army of which 18 years and 3 months has been in



Sergeant Didjulis inspecting the 300# M31 bombs stored on trailers during the alert; recently they have been placed back on the ground on dunnage.

Four well constructed magazines about 12 feet by 12 feet are located on the base, but as they are located on an extreme corner of the base it is necessary to maintain a 24 hour guard to insure safety from civilian workers and night prowlers. At first, Ordnance personnel was small and it would have been a detriment to keep a 24 hour guard, so until our guard could be worked without personnel shortage, we used some bomb sight vaults, which were well guarded.

We were given a bachelor Officers' barracks for our warehouse, and it has proven difficult to keep it as well arranged as warehouses should be. Shelves were built in



Lettering our new supply of drill bombs.

the rooms and we have our stock arranged as orderly as space permits, but daily we are becoming more crowded and are looking forward to our long anticipated warehouse.

Our enlisted and selective service personnel increased rapidly in the following months. By the end of May we had a strength in the base company of 24, and 84 in the bomb company. By October 1st, our companies had increased to 46 and 129, respectively. For two months after arrival at the Orlando Air Base, the men lived in tents, but by constant begging, we acquired barracks until we had first one, later two, and now three. As yet it has not been possible to supply us with day rooms and company supply rooms, so consequently, N. C. O. rooms in the barracks have been sufficing in an inadequate way. The ord-



Guard and guard house at entrance to demolition bomb storage area. (A pet goat was given to the men by a neighboring farmer and now roams the area and does a lot of grass mowing for us. The name, "Amotol".)

nance men show a lot of spirit in extra activity. We have no trouble winning the honors in boxing, field meets, church attendance, and any cooperative contests. In this extra activity our men show that they are "all for one and one for all".

A weekly training program has been religiously followed for the men since the arrival of the companies. At first, the program was carried by Capt. Sims, Master Sergeant Maze, Technical Sergeant McSween, and the few older soldiers of the companies. The arrival of the new

officers reduced the load per instructor, and specialized functions could be stressed.

Every day we feel ourselves better able to handle the job. Our men are over in hours of training in all the scheduled technical work listed in the training program. They are gradually acquiring the needed experience that turns the raw recruit into a seasoned soldier. As has been pointed out, we shall never be able to experience real duty unless we are actually under war conditions, but we are



Ammunition Section minus men on K.P., or on afternoon off for athletics.

striving to foresee as many of these conditions as possible and find a solution for the problems, now, while there is time to think them out.

In the latter part of August, we were notified that a shipment of 60 - 100 pound MK 1 MIV Demolition bombs, and 24 M31, 300 pound Demolition bombs were coming, so our ammunitions section pitched in with all the enthusiasm which comes with a new job, and had proper facilities ready upon their arrival. Much credit for this job goes to Technical Sergeant Didjulis and the men in his section. Closely following the arrival of the bombs we were ordered to be on a 24 hour alert. During the alert, we were called on for deliveries, which we made in 25 minutes to the planes. Our bomb service trucks are unable to pull trailers loaded

(Continued on page 193)



Making a clay road into our SANDY motor pool. It helps.

SPECIAL GAGES

By: A. C. Fabrize, S. Sgt., Ord. Dept.,
Small Arms Section

This article covers special gages used in the inspection of the following Small Arms weapons: Machine Guns, Cal. .50; Revolvers, Cal. .45; U. S. Rifles, Cal. .22. It also includes trigger weights required for Small Arms weapons, combination head space and timing gages for Cal. .30 and .50 Machine Guns (aircraft), gages, gas cylinder and gas piston for the Browning Automatic Rifles and the Reflector, barrel, for the Cal. .50 Machine Guns.

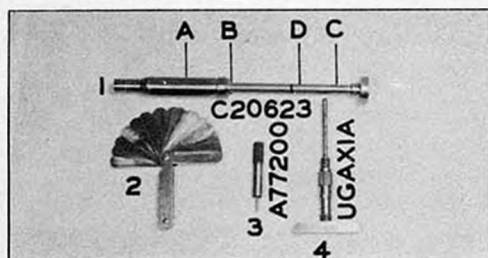


Fig. 1.

1. Gage, combination, headspace and breech bore, C20623, Cal. .50; (a) Gage, headspace; (b) Gage, headspace rear shoulder; (c) Gage, breech bore; (d) 2.0 inch index line.
2. Gages, thickness.
3. Gage, firing pin hole, A77200, .083 inch.
4. Gage, depth, micrometer, 0 to 3 inch, UGAXIA.

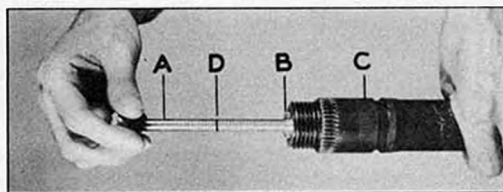


Fig. 2

- a. Gage, breech bore; b, Gage, headspace, rear shoulder; c, Barrel, Cal. .50 machine gun; d, Red index line, 2.0 inch.

The Gage, breech bore (a) and Gage, head space (b) shown in Figure 2 are inserted in the chamber of the barrel. When the erosion of the barrel results in the breech bore gage (a) entering the barrel to or past the red index line (d) the resulting initial velocity has dropped approximately 200 foot-seconds. The barrel may still be fired several thousand rounds, but evaluating the additional firing of the barrel against accuracy, cost of ammunition, etc., indicates that the barrel had best be replaced.

The 2.0 inch red index line (d) on the breech bore gage indicates that the barrel has been fired approximately 3000 to 5000 rounds and that the practical life of the barrel has ended. (The average barrel should be scrapped at this point.) If the rear shoulder of the head space gage (b) comes flush or enters past the rear of the barrel, the barrel is declared unserviceable and scrapped due to excessive head space.

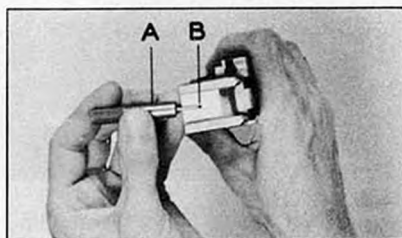


Fig. 3

- a, Gage, firing pin hole, A77200, .083 inch; b, Firing pin hole, Cal. .50 machine gun bolt.

If the firing pin hole gage (a) A77200, shown in Figure 3, enters the firing pin hole (b) the bolt is declared unserviceable.

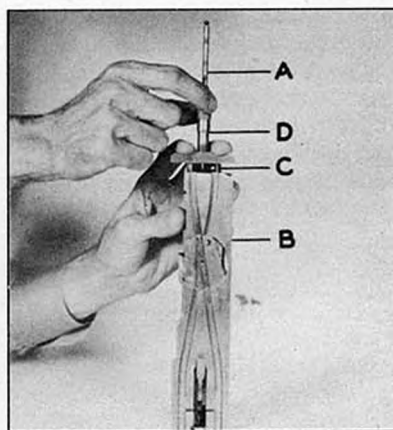


Fig. 4

- a, Gage, depth, micrometer, UGAXIA; b, Bolt, machine gun, Cal. .50; c, Dimension; c, Reading.

To determine if the face of the bolt is set back, place the depth gage (a) UGAXIA, shown in Figure 4, across the top of the lips on the bolt and screw down the gage until it just comes in contact with the cartridge seat. The dimension (c) from the top of the lips to the face of the bolt should not have a reading (d) to exceed .199 inch.

The gages (b) and (c), shown in Figure 5, are used in the inspection of Revolvers, Smith and Wesson, and Colt, Cal. .45, M1917. The Gages, thickness (b) are inserted between the rear of the barrel and the cylinder (arrow). There should be enough clearance for the proper rotation of the cylinder but not enough clearance to allow excessive gas to escape. A clearance of not less than .002 inch or more than .006 is the advisable space allowed.

The Gage, alignment (c), is used to check the alignment of the chambers in the cylinder with the barrel. The gage can be made either of brass or steel and the diameter should be such that it can be inserted smoothly into the barrel. To be in proper alignment the gage should continue

(Continued on page 177)

A LAYMAN LOOKS AT LIGHT

(Continued from page 123)

Imagine the still surface of a pond unruffled by the wind. You throw a pebble in the center. Spreading from that point a wave will extend in all directions. A cork in the path of this wave will bob up and down, but will not move forward. There is no longitudinal translation of the water. At exactly timed intervals, say a half second apart, you toss pebble after pebble in the same spot. Each impact will result in the generation of a new wave, which in the half second ensuing its generation will travel the same distance from the center as the previous wave. The distance from crest to crest will be the wave length. The total distance travelled by the foremost wave in a second, divided by the wave length, gives the frequency.

Crude as this example is it provides a rough visualization of something that occurs in a much more intangible way in the actual generation and propagation of light. In the act of throwing, you correspond to an apparatus in which electrical oscillations are taking place. The moving pebble represents a definite amount of energy. This energy is converted into wave form on impact with the water surface. The more pebbles you throw per second the shorter the wave length. The heavier the pebbles or the greater force employed the higher the waves will rise. But within certain limits speed of wave propagation remains the same. With actual electro-magnetic disturbances the speed of travel remains constant regardless of frequency and intensity.

If we choose one uniform weight for the pebbles, and the same identical swing for each throw, only one variable, that of periodic frequency, remains. Naturally the more throws, the more energy is required and the greater the release the resultant transfer of energy from yourself to the water. When electro-magnetic disturbances are considered, this analogy holds approximately. A higher energy level is required to release or radiate disturbances of short wave length and high frequency, and these radiations in turn are more active.

Cosmic rays are active through several feet of lead, X-rays which have lower frequency will penetrate a fraction of an inch, and visual light with wave lengths many thousands times longer are completely stopped by a thickness of a few molecules.

Fortunately for us, without instrumental aids we are largely unaware of the vast realm of radiations in which we live or may in fact be but temporary assemblages. The life of a goldfish would be as secret by comparison as "the goings on" in the most remote lamasery in Tibet if we had direct sensory perception of the entire range.

Human eyes take cognizance of but a very narrow portion, those frequencies resulting from wave lengths of approximately 0.0004 to 0.0008-mm. Within this limited range we find all of our rich enjoyment of light and color. To the physicist and chemist, the optical scientist and electrical engineer, we must look for the detection and utilization of the rest.

Prior to the comparatively recent electron theory

of matter there was no plausible basis for explaining how light behaved or became manifest.

Briefed into narrow compass the electron theory states that the indivisible, unchanging and eternal atom upon which the chemistry and physics of fifty years ago was founded in fact does not exist. It holds that the atom is itself divisible, a sort of minute solar system in its own right, in which a dense nucleus, the proton, carrying a positive electrical charge, corresponds to our Sun. About it in planetary orbits revolve electrons which are but negative charges of electricity.

Here again the magnitudes involved are entirely without the realm of ordinary experience. The mass of an electron is calculated as 0.00055 part of the mass of a hydrogen atom. The radius of an electron is of the order of 0.000 000 000 000 1 millimeter. In size a hydrogen atom is to a constituent electron as the earth is to the dome of a Cathedral. The electrical charge on the electron in electro-magnetic units is 1.56 preceded by 19 zeros.

When considered in connection with the atomic weights of all elements which can be arranged in a series from low to high it seems that each separate element is but a rearrangement of one primal combination. Hydrogen (atomic weight 1) seems best to fill the specifications.

The interesting feature of the electron theory is its concordance with calculations concerned with the high frequencies of light and heat. Displacement of an electron from its orbit requires the application of force and results in the release of radiant energy, which may take the form of radio waves, heat, infrared, visual, ultraviolet and so on up the scale.

Energy is not released in unspecified amounts but in packages of definite amounts or "quanta", depending upon the frequency of the radiation.

In the process of electron displacement and rearrangement an interesting phenomenon seems at times to occur, a sort of trigger action that results in the release of locally generated or possible latent electro-magnetic disturbances. An impulse so slight as to be practically inconceivable acts as a petcock to turn on and off the locally generated power that operates your radio loud speaker. The light from a star so distant that it had to start before this earth was born reaches our eyes and causes sufficient chemical change to result in energizing those nerve centers upon which visual perception depends. Small as this may be, it must be many times greater than the energy received.

The implications of the electron theory are as intriguing as the philosopher's stone. The transmutation of elements has been observed, the transformation of radium to helium and lead is a case in point. Life itself becomes a matter of electron excitation and vital processes a series of electron displacements and rearrangements.

Maybe some metaphysical speculation is not out of order. Viewed in a broad sense, possibly creation had both its beginning and its end with "Let there be light."

FROM "TIME CANDLE" TO "TANK CLOCK"

(Continued from page 131)

mitted the use of a balance wheel both smaller in diameter and lighter in weight. Also, it allowed the use of a weaker and longer main spring, which in turn reduced the friction. Result of these improvements was a far better timepiece than ever before produced in the world.

Probably the greatest developments in all history of watchmaking were those made between 1850 and 1910, and now used by watch manufacturers in other countries. Among these are the reversible center pinion invented by Fogg, and micrometer regulator invented by Reid. What is of greatest importance to the industry is the system of standards established and gauges perfected, which system was capable of accurately measuring dimensions in units of one ten-thousandths of an inch. These and the mechanical tools already mentioned are miracles of mechanism, many of which have been in use for several years.

Looking back over watchmaking, it is realized that fashions in watches have several times changed radically. In 1871 watches were large in diameter, thick and clumsy, well meriting the term of "turnip". They had closed or hunting cases, and were as heavy as the buyer could afford. Pacific Coast dealers, especially, wanted very heavy gold cases. Many shipments contained 18K cases weighing six ounces or more. Men who had made large fortunes in silver or gold mining then were as fond of displaying these big gold watches as they are today of their over-sized hats. Oftentimes, with such a watch, a heavy, gold chain was worn around the neck, and as one authority who twenty-five years later traveled to San Francisco, said, "Now I know why one sees so many round-shouldered men on the street".

Open-face watches revived

In the eighties, the fashion of forty years returned, and everyone wanted an open-face watch. By 1900 fashion demanded that watches be much thinner, also smaller in diameter.

A watch mechanic of unusual skill was Herman Eisen who was employed from 1882 to the early nineties in a New England jewelry shop. During his spare time he made for himself a complete watch movement. It was only five-eighths of an inch in diameter, or a little more than a silver dime. Herman mounted the watch in place of the stone in his seal ring and wore it on the third finger of his left hand. Doubtless this watch was the great grandfather of all very tiny watches, though he was still thirty years ahead of the fashion which still prevails in wrist watches for women.

How many readers have already thought of the application of this developing industry to military needs? The watchmaking industry, just as many others, grew and developed to meet civilian needs and demands and fancies. But at the same time it grew to meet that time of emergency when its abilities and resources might be of extreme value to the Nation.

Consider for a moment the mechanization of our

expanding Army. Think of the combat vehicles moving into conflict. Individuals under normal fighting conditions can carry on their persons watches useful for the coordination of the efforts of all units. But in a mechanized army there arise conditions which we cannot consider as normal fighting conditions.

In code, messages flash back from advancing tank units to field headquarters. This tank unit has reached its objective at 10:46 — that one has met unexpected resistance at a specified point at a certain time — another, at 10:59, is in danger of a flanking attack from a given direction. As reports come in from all the units, giving situations, and times, the commanding officer has a clear picture of the front. He can coordinate operations. He knows where and when all his forces can be maneuvered to the best advantage.

Time control in U. S. Tanks is maintained by special tank clocks. Increasing quantities of these jeweled, carefully adjusted timepieces are not being produced on government order. They are something more than simple timepieces. They are special vibration-proof, sweep-second instruments, forced to undergo the most rigid tests, for they must perform reliably under conditions of severe shock, sudden changes in position, and wide ranges of temperature.

Thus another industry comes to the aid of a Nation composed of those individuals who made its development and advancement possible.



THE ARMY ROLLS

(Continued from page 139)

by two or more competing companies and available at reasonable prices. To require the minimum deviation from standard commercial models as may be necessary to conform to the military characteristics set up by the using arm or service to which the vehicle is allocated. The parts or unit assemblies so used to be standard in the automotive industry.

This ruling prohibited the purchase of motor vehicles of strictly military design. This, together with limited annual appropriations forced the Quartermaster Corps to modify their designs and enlist the cooperation of the automotive industry.

This is where the parts makers proved of value because modifications of more or less standard chassis could not be made to make use of major units more suited to military specifications.

Perhaps the greatest advance in military motor transport was the introduction of a front driving axle, which utilized most of the parts of a high production rear axle for 1-1/2-ton trucks. A transfer case of the all-gear drive type was produced for use in connection with these front and rear driving axles. For the first time anywhere, it was now possible to modify the conventional 1-1/2-ton chassis by the use of the front driving axle, transfer case and rear driving axle. The height of the truck was increased only 4" and the performance ability was considered remarkable. Here, then, was a low cost, light weight, 4 x 4, 1-1/2-ton truck

which would meet the military specifications. The 1-1/2-ton, 4 x 4 vehicles have been purchased in increasing quantities since 1934.

Simultaneously, another rear driving axle and suitable spring suspension were also provided to produce what is known as the 2-1/2-ton, 6 x 6, six-wheel-drive six-wheel truck using the same axles and basic transfer case as the 1-1/2-ton 4 x 4. This certainly provided the maximum interchangeability of driving mechanism parts that the army demanded.

The 1-1/2-ton 4 x 4 and the 2-1/2-ton 6 x 6 com-

prised by far the biggest portion of United States Army trucks. Requirements for both motor transport and artillery have been met largely with the same vehicle. The four-wheel-drive four-wheel (4 x 4) truck now employs a front axle declutching device, whereby the truck may operate as a conventional two-wheel-drive on the highways and a four-wheel-drive in off-the-road work. The use of dual tires on the rear axle and introduction of traction devices give the 4 x 4 and also the 6 x 6 trucks the ability to travel almost everywhere. These trucks now traverse, without any hesitancy, types of terrain where heretofore it was thought only the track laying or caterpillar type of vehicle could travel.



MOLYBDENUM IN CAST IRON

(Continued from page 135)

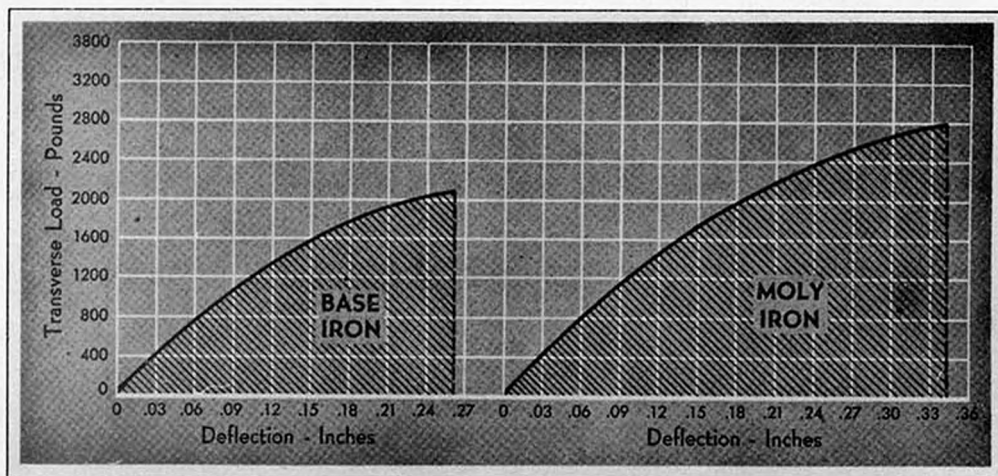
down phase changes at elevated temperatures, the irons have excellent resistance to growth. The superior toughness, fatigue strength and wear resistance that characterize Molybdenum irons are largely due to their greater homogeneity of structure.

As a matter of fact the tensile strength of a good base iron can be raised as much as 50% by adding Molybdenum. The proof rests in the experience of a growing number of American foundries that are producing 50,000 pound iron and better, consistently and economically.

The addition of Molybdenum raises hardness less per unit of improved tensile strength than does the addition of any other alloying element. Resilience, which is a function of the work required to break an iron bar of given section, has been accepted as a measure of toughness, or impact strength by the A-3 Committee of the American

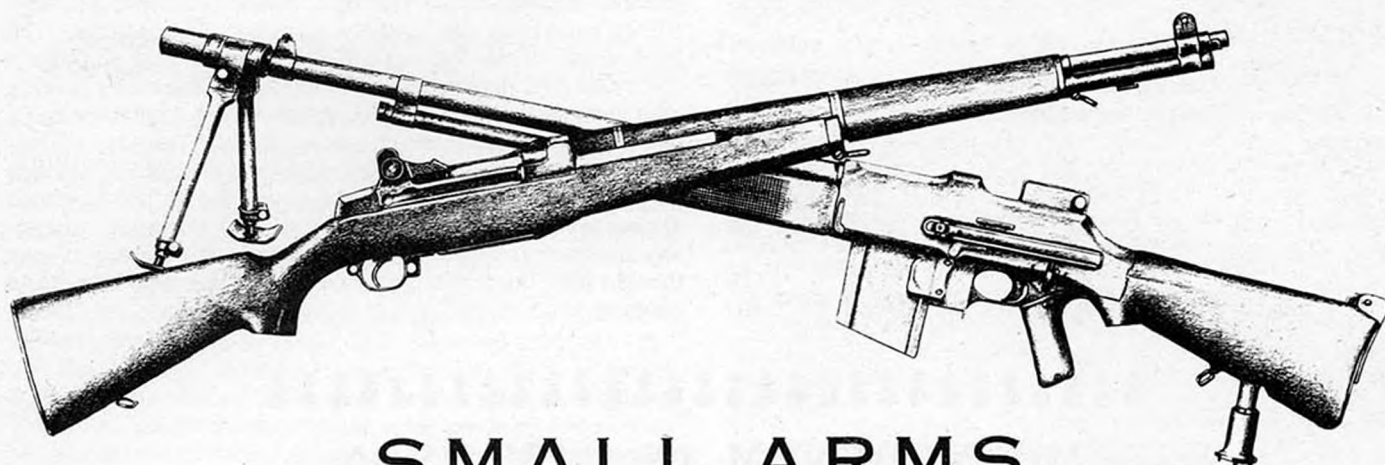
Society for Testing Materials. The chart below shows the effect of Molybdenum on the resilience of cast iron. The comparative resilience can be determined by comparing the areas under the two curves. The analyses of the two irons are:

Total Carbon.....	3.30%	3.30%
Combined Carbon ..	0.57%	0.57%
Silicon	2.25%	2.25%
Manganese	0.70%	0.70%
Molybdenum	-----	0.35%
Resilience in./lb. ..	340	575



The March issue of THE ORDNANCE SERGEANT will contain a price list of publications of Ordnance interest which are now available from the Government Printing Office, Washington, D. C., together with instructions for ordering them. Beginning with the April issue

THE ORDNANCE SERGEANT will try to keep its readers posted on new publications as they become available from this source. An effort will also be made to publish price lists of publications available from other sources.



SMALL ARMS

Conducted by: C. B. Goodman, 1st Lt., Ord. Dept.

WINCHESTER SHOTGUN, 12-GAUGE, M1897, RIOT TYPE

By: Edward Dyer,
Tech. Sgt., Ord. Dept.

DESCRIPTION OF PARTS

BOW GUARD: The upper sides of the bow guard, Figure 1, are ribbed *a*, to permit assembly of the piece in its grooves in the receiver. A recess *b*, is cut in the vertical plane into which the trigger is inserted at assembly. A blind hole in the forward part of the recess forms a seat for a small helical spring (about 9 coils) which supplies spring energy to the trigger. A stop screw *c* is assembled near the rear of the recess and protrudes into the bow of the guard. The protruding part of the stop screw restricts rotation of the trigger beyond limits. A hole *d* is drilled laterally through the bow guard for the trigger pin.

TRIGGER. - The trigger is an irregularly contoured piece with the trigger pin hole drilled through the front end. The rear end terminates in the trigger bow.

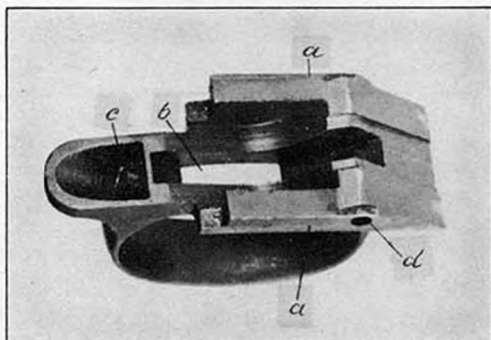


Figure 1
Bow guard.

CARTRIDGE STOPS. - Two of these, Figure 2, are needed per weapon, one right hand and one left hand. The stops are marked with the legend 12L or 12R indicating on which side of the receiver they belong. There is very little difference between the two, since they are the same length, have the same general outline, etc. However, the forward part of the inside surface of the right hand stop is cut slightly different than the left hand stop; the right hand cartridge stop is also thinner overall than the left hand stop.

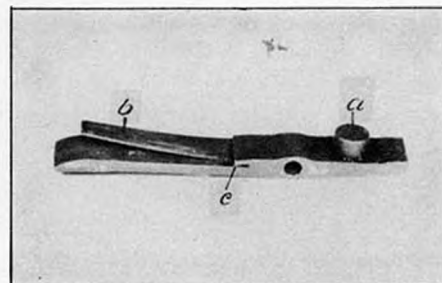


Figure 2
Cartridge stops.

The right hand cartridge stop screw hole is smaller in diameter than that on the left hand stop. Each cartridge stop has a small cylindrical stud or button *a*, that protrudes through the right or left receiver wall as the case may be.

CARTRIDGE STOP SPRING. - The cartridge stop spring *b*, Figure 2, is a leaf type spring, the widest end *c*, of which is inserted into a small slot just in front of the cartridge stop button. The other end bears against the receiver walls. The springs are interchangeable for right and left hand cartridge stops.

ACTION SLIDE HOOK. - The action slide hook, Figure 3, is the connection between the action slide and the bolt.

The hole *a*, is drilled through the small end to accommodate the pin end of the action slide hook screw.

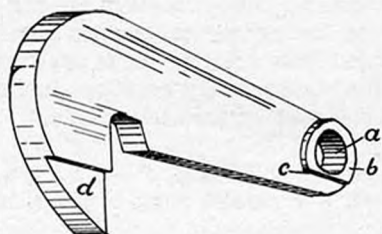


Figure 3
Action slide hook

The hole has a small boss *b*, on the bolt side of the hook, that mates with a counterbore in the left side of the locking lug on the bolt. This boss has a part of its circumference cut away *c*, to provide clearance when the hook is in the horizontal position. The other end of the hook is rounded and has a claw-like projection suitably cut away at *d*, to provide for engagement with the action slide.

FIRING PIN LOCK. - The firing pin lock, Figure 4, is a flat piece about 2-1/2" long and 1/16" thick.

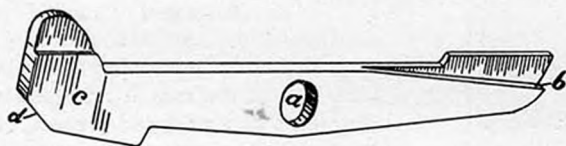


Figure 4
Firing pin lock.

It has a hole *a*, drilled through the center, into which fits the pin end of the firing pin lock screw, about which it is free to pivot. Its front end is slightly wider and has a step *b*, on which the left ear of the carrier acts to pivot the lock upward in functioning. The rear end of the lock is also widened at *c*, and the end surfaces are cut to act as camming surfaces *d* to retract the firing pin from the face of the bolt.

FIRING PIN. - The firing pin, Figure 5, is about 3-3/4" long and has a body diameter of approximately 3/16".

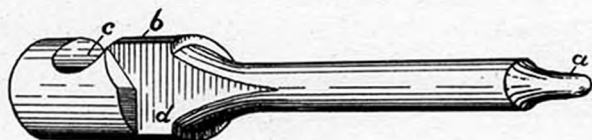


Figure 5
Firing pin.

The point *a*, is smaller and is rounded to form the striker. For about 13/16" from the rear end, the diameter of the pin is 3/8". What is normally the bottom side *b*, of the firing pin on the enlarged diameter bears a relieved portion *c*, cut wide enough to permit the necessary forward and rearward travel of the firing pin, and through this relieved section is assembled the firing pin stop pin. The left side of the enlarged circumference is cut away at *d*, as a camming surface which is acted on by the camming surface of the firing pin lock.

MAGAZINE TUBE. - The magazine tube, Figure 6, is roughly 15-3/4" long and 1" in diameter.

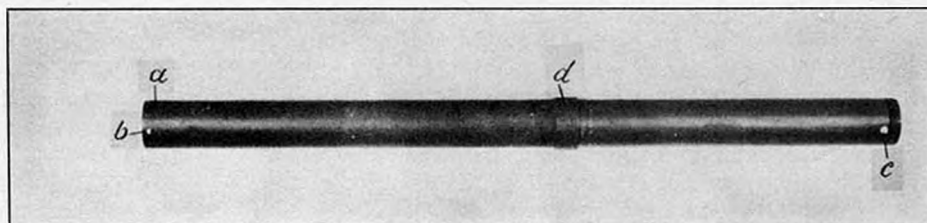


Figure 6
Magazine tube

The front end is plain and has holes *b*, drilled through it diametrically opposite. The holes are of different diameters and accommodate the head and the pin end of the magazine plug screw. The other end of the tube is threaded and the hole *c*, is drilled on one side to accommodate the magazine stop screw. On the circumference, opposite the magazine stop hole is the alignment mark for assembling the tube to the receiver. The action slide spring stop *d*, is a raised piece on the tube about 1/2" wide and 1/16" thick. This piece is manufactured integrally with the tube and is not to be removed. The interior of the tube is a straight cylindrical bore except for a small shoulder on the threaded end. This shoulder acts as a stop for the follower.

MAGAZINE PLUG. - The magazine plug, Figure 7, is cylindrical and turned to fit the front of the magazine tube.

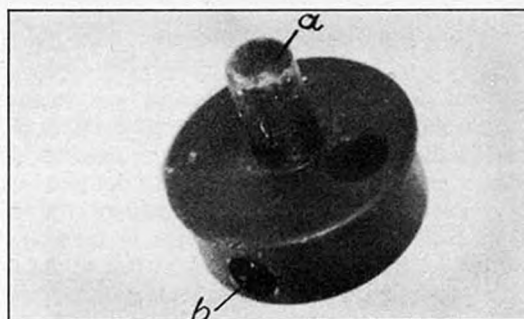


Figure 7
Magazine plug.

It is about 3/8" wide and is rimmed to prevent assembling it too far into the tube. The front face has a stud *a*, about 1/2" long and 1/4" in diameter that enters the rear end of the bayonet attachment and thus supports the front end of the magazine group. The plug screw hole *b*, is visible on the circumference of the plug. One end of the screw hole is larger and is tapped and counterbored while the other end is plain. The 1/2" hole in the face of the plug, permits the escape of the air from the magazine tube during loading.

MAGAZINE FOLLOWER. - The magazine follower, Figure 8, is a hollow cylindrical sheet steel stamping closed at one end.

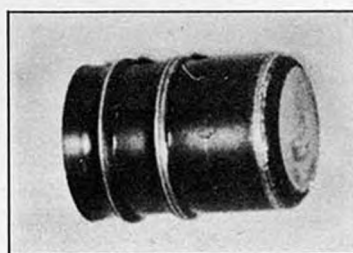


Figure 8
Magazine Follower

The outer circumference has two ribs that act as bearing surfaces and the mouth is belled to facilitate entrance of the magazine spring at assembly. The closed end bears against the first cartridge loaded into the magazine. When the magazine is empty the follower protrudes from the tube, being prevented from complete emergence by the front rib striking a shoulder on the interior of the tube. For this reason, the follower can only be assembled, closed end first, through the unthreaded end of the magazine tube.

MAGAZINE SPRING. - The magazine spring has an expanded or free length of approximately 28-1/2". It is a helical spring made of No. 26 gauge wire.

ACTION SLIDE. - The action slide, Figure 9, consists of light sheet steel rolled into a cylinder *a*, to one end of which is brazed an internally threaded ring *b*. The other end has riveted to it another wide ring *c*, from the face of which extends an arm *d* for a distance of about 5-1/2", the arm being 7/16" wide.

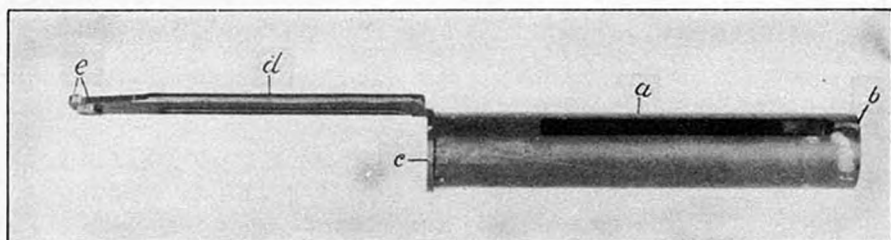


Figure 9
Action Slide

On the extreme end of the arm are formed two cams *e*. The one on the extreme end of the arm or slide engages with the cam surface on the action slide hook, and the other cam on the inner surface of the arm engages in the cam groove to function the carrier. Two buttons protrude from the outer circumference of the cylindrical portion of the slide, which engage in the end of the wooden handle to prevent the rotation of the latter.

ACTION SLIDE SPRING. - The spring, Figure 10, is a single coil made of 3/64" x 5/16" flat spring stock.



Figure 10
Action slide spring.

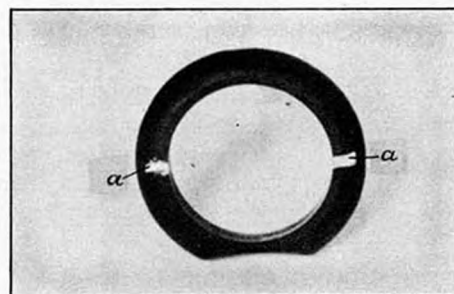
It assembles over the magazine tube and its purpose is to take up shock caused when manipulating the action slide.

ACTION SLIDE HANDLE. - The action slide handle is wooden and formed cylindrically. The upper part of its circumference is cut away as clearance between the barrel and the action slide group. A series of grooves are

provided on the circumference the entire length of the handle. The handle slides over the cylindrical portion of the action slide and is prevented from rotating out of position by two buttons on the action slide entering recesses in the mortice provided for the shoulder on the action slide.

ACTION SLIDE SLEEVE SCREW CAP. - This cap, Figure 11, has an externally threaded portion which is screwed into the internally threaded end of the action slide.

Figure 11
Action slide
sleeve screw cap



An enlarged rounded over section of the cap fits over the action slide handle to keep it in place. The face of the cap is provided with diametrically opposed slots *a*, for a face spanner wrench to facilitate assembly and disassembly.

BAYONET ATTACHMENT GROUP. - The bayonet attachment, Figure 12, is formed and then slit along the right side. The slit side of the attachment has three counterbored holes to accommodate the heads of the attachment screws. These holes continue laterally through the attachment and are tapped. When the attachment is fitted over the barrel, the screws advancing in the threaded portion of the holes cause the screwheads to draw up the slit side of the attachment and thus tighten it around the barrel.

At the front end of the attachment is a heavy lug *b*, over which passes the barrel hole of the bayonet guard.

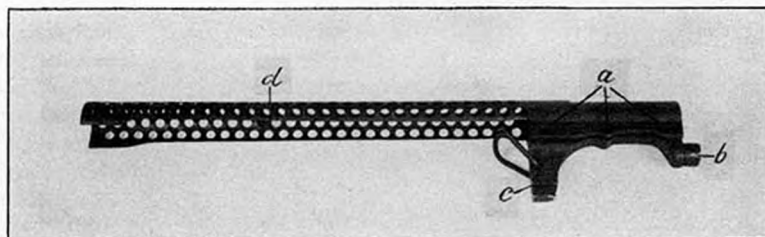
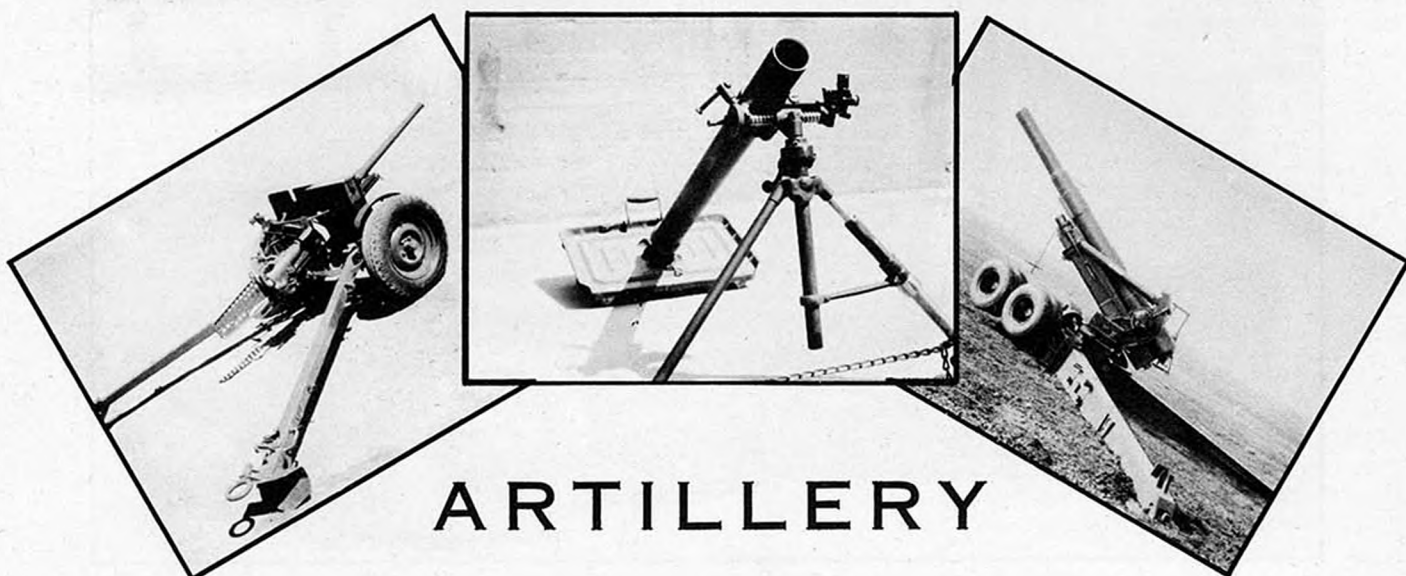


Figure 12
Bayonet attachment group.

At the rear of the attachment is a long projection extending in a vertical plane, which ends in a stud *c*, on which the bayonet catch engages.

About midway on this projection is assembled the upper sling swivel. In the rear face of the bayonet stud projection is drilled a blind hole into which assembles the stud on the magazine plug to support the front end of the magazine.

HAND GUARD. - The perforated metal hand guard
(Continued on page 178)



ARTILLERY

Conducted by: W. C. Minshaw, 1st Lt., Ord. Dept.

NITROGEN PRESSURE TEST OF THE 75mm RECOIL MECHANISM, M1897

1. MANOMETER TEST. - In order that an intelligent and consistent inspection may be made of the recoil mechanism, it is essential that the inspector be informed not only as to its action but also with regard to certain of its technical peculiarities with which he will come in contact. Therefore, examination for excessive oil leakage past the packing of the recoil piston, recoil piston rod stuffing box, oil index, and filling and drain valve should be made. Normally a slight leakage of discolored oil past the packing of the recoil piston and the recoil piston rod stuffing box is in evidence. The slight leakage past these two packings insures lubrication.

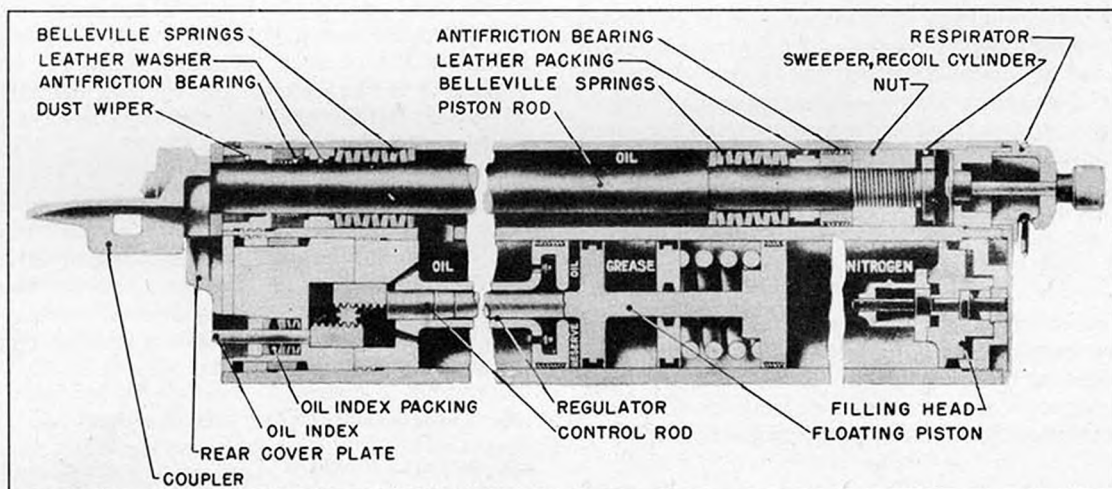
a. General tests. - (1). The oil reserve or reserve oil are terms applied to that portion of the oil which normally separates the floating piston from the regulator. Referring to sectioned view it will be apparent that the compressed nitrogen acts to put pressure on the oil only so long as there is oil between the regulator and the

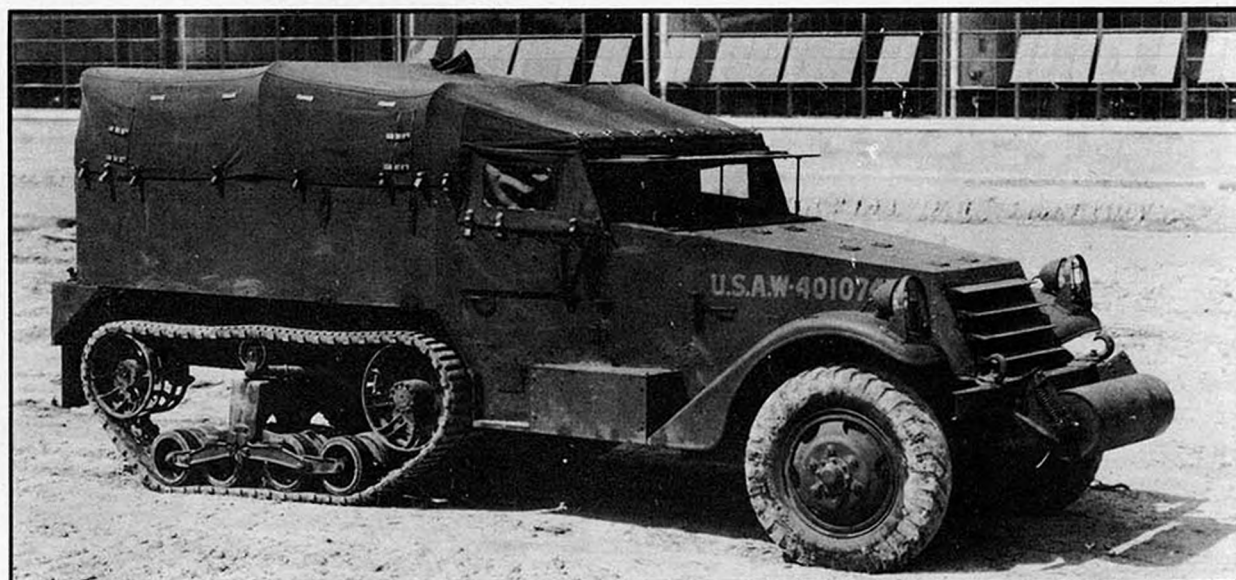
floating piston. After these components come in contact, further movement of the floating piston is prevented and consequently the pressure of the oil will drop to zero. In amount, the reserve oil represents a volume corresponding to a movement of the floating piston of about $\frac{3}{8}$ inch or exactly the same as the travel of the oil index between its extremes of movement.

(2) In determining the nitrogen pressure, the inspector is actually measuring the pressure on the oil transmitted to it by the compressed gas through the medium of the floating piston.

(3) The oil, in passing from the vicinity of the pressure gage to the vicinity of the floating piston, or vice versa, must pass through very small orifices. Because of the resistance offered in these orifices, if the recoil piston jack is operated rapidly in either direction, a mislead-

(Continued on page 193)





AUTOMOTIVE

Conducted by: J. W. Winslow, Master Sergeant, Ord. Dept.

VALVE HOLDERS

By: A. L. Hettrich, 1st Lt., Ord. Dept.

It is the intent of this article to briefly describe the purpose and use of valve holders in the removal of the hydraulic valve lifters, valves and valve springs on the White 160 AX engine used on the Car, Half Track, M2.

Just why it should be difficult to remove these units without damage will probably be more easily understood if the purpose and operation of the hydraulic or 'Zero-Lash' valve lifter is very briefly described.

They are known as zero lash valve lifters because when functioning properly there is no 'lash' or clearance between the end of the valve stem and the face of the plunger (c). (See Figure 1.)

Many divergent factors of engine design and operation such as wear, engine operating temperatures, load, etc., affect what is commonly known as "Valve clearances". To set valve clearances for one engine operating condition, of course, necessarily penalizes the engine for other operating conditions. The purpose of the zero-lash lifter is to eliminate the manual setting of a definite clearance that would only be absolutely correct for one engine condition by taking up the clearance under every condition of engine speed, load, temperature, wear, etc.

The zero-lash valve lifter automatically takes up the clearance between the lifter and the end of the valve stem by introducing between the cam on the cam-shaft and the end of a valve stem a confined column of oil whose length is automatically adjusted every cam-shaft revolution.

The zero-lash lifter consists of:

1. The outer portion or body (A), which is similar to the manually adjusted type of lifter except for having a straight, machined hole to receive the hydraulic unit instead of a threaded hole for an adjusting screw.
2. The hydraulic unit itself, consisting of a cylinder (B), plunger (C), ball check valve (D), and a plunger spring (K). (See Figure 1.)

The following information on the operation is quoted from the manufacturer's manual: *

"Oil under pressure from the lubricating system of the engine is supplied to the reservoir back of the lifter bracket (E). The entrained air escapes through the hole (G) into the upper crankcase of the engine, while the oil itself flows under pressure through hole (H) into the supply chamber (J).

With the face of the lifter on the base circle of the cam, and the engine valve seated as shown in Figure 1, the light spring (K) lifts the hydraulic plunger (C) so that its outer end contacts the valve stem, giving zero-lash. As the plunger (C) moves outward, increasing the volume of the pressure chamber (L), the ball check valve (D) moves off its seat and the chamber (L) is filled with oil from the supply chamber (J).

As the camshaft rotates, the cam pushes the lifter body (A) upward, tending to decrease the volume of chamber (L) and forcing the ball check valve (D) onto its seat. Further rotation of the camshaft moves the tappet body (A) upward and the confined body of oil in chamber (L) acts as a member in the valve operating mechanism, the engine valve being lifted on a column of oil.

* "Zero-Lash Hydraulic Valve Lifters"
Wilcox-Rich
Detroit, Michigan

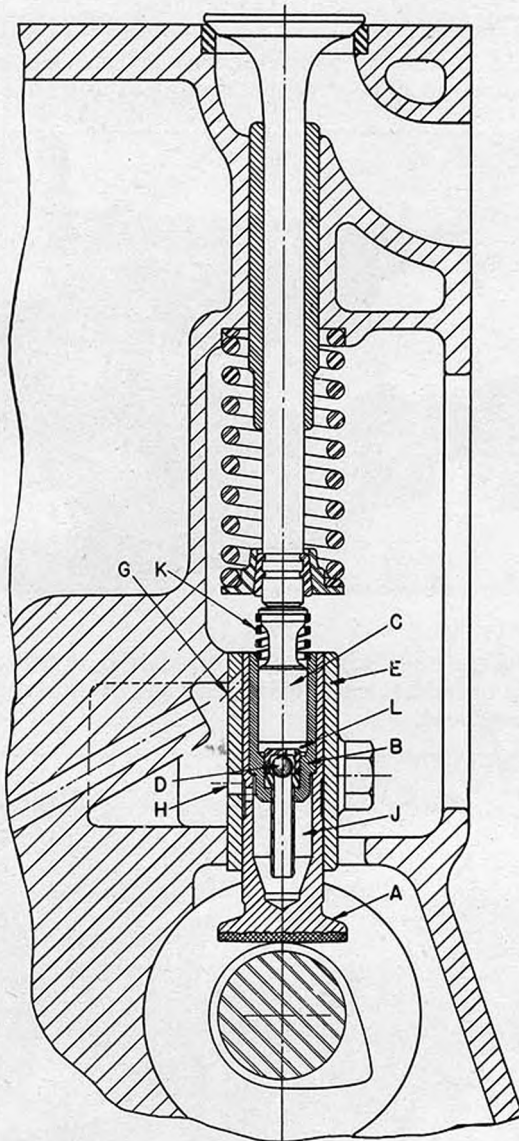
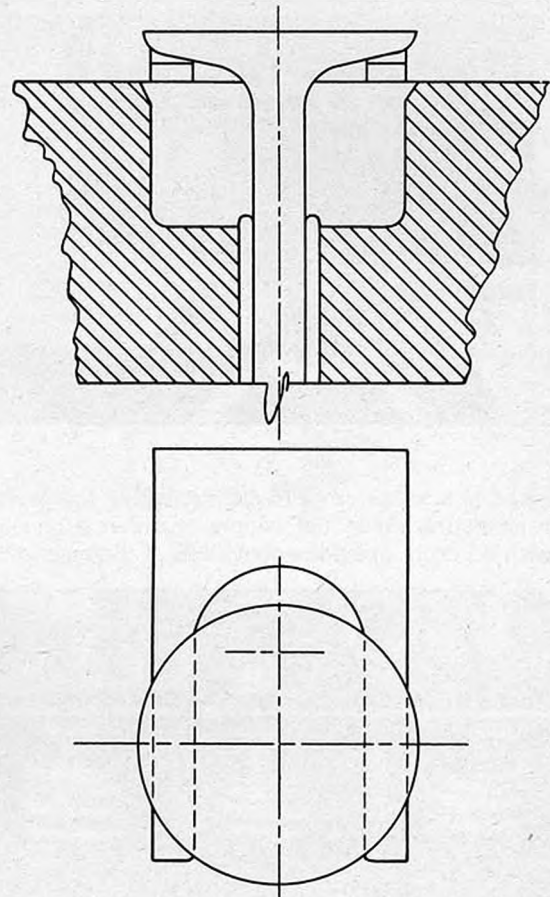


Fig. 1

So long as the engine valve is off its seat, the load is carried by this column of oil. During this period a predetermined slight leakage of oil from chamber (L) occurs between the plunger and the cylinder bore. This is necessary in order to provide space so that the amount of oil required to fill the chamber, and thus maintain the adjustment at zero-lash during the next cycle, be permitted to enter the chamber (L) as soon as the tappet body leaves the receding flank of the cam and contacts the base circle".

To summarize: The Zero-Lash Hydraulic Lifter provides, between the cam and valve stem, a column of oil which carries the load while the engine valve is off its seat and the length of which is automatically adjusted each cam-shaft cycle to give Zero-Lash.

It is impossible for the zero-lash hydraulic lifter to hold the engine valve open when it should be closed, during normal engine operation. When the lifter body is on the base circle and the valve is closed, the principle force tending to hold the valve open is due to the spring (K) which obviously is much lighter than the valve spring holding the valve closed. An additional force tending to push the plunger upward results from pressure of lubricating oil in supply chamber (J), but its effect is minor since an oil

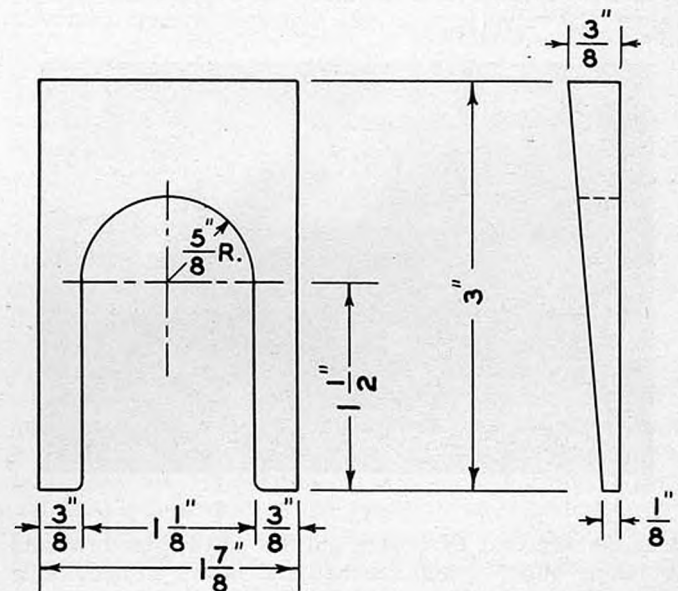


HOW TO PLACE VALVE HOLDER UNDER THE VALVE FACE SO AS TO HOLD IT OFF THE VALVE SEAT.

Fig. 2

pressure of 500 pounds per square inch is required to overcome 100 pounds spring pressure. This relationship exists because of the small area of the plunger.

The self adjustment of the zero-lash lifter is ac-



MATERIAL-ANNEALED COPPER

Fig. 3

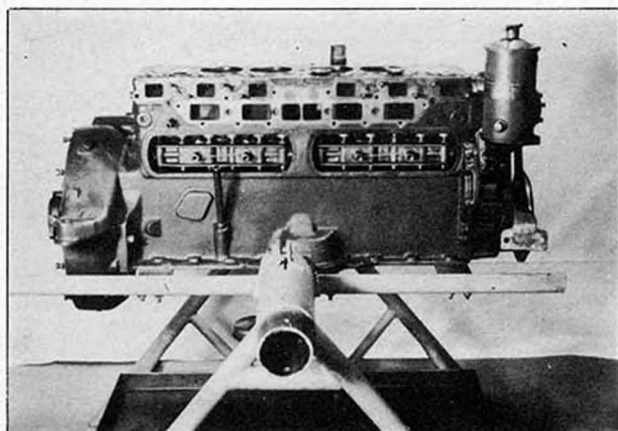


Fig. 4

complished in a warm or cold engine during the period of starter operation since the supply chamber (J) remains filled with oil from previous operation of the engine."

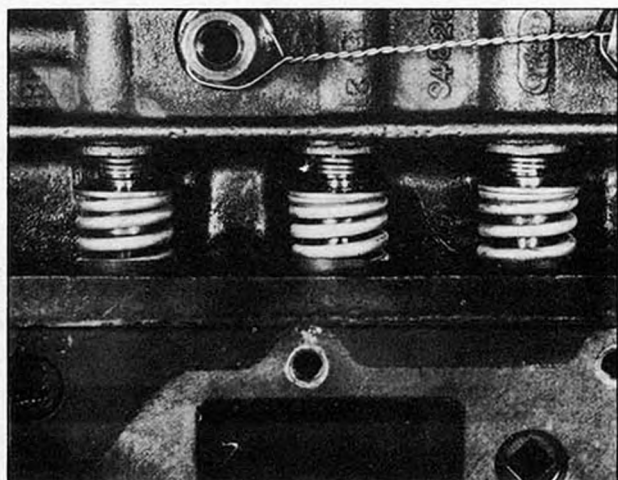


Fig. 5

The maintenance of the above mentioned zero-lash (Figures 2 and 3) even when the engine is not in operation presents difficulties in that very often hydraulic lifters, valves and valve springs are damaged in their removal.



Fig. 6

Also the removal by prying out the valve lifter brackets or taking out the valve springs and valves without using valve holders is a slow and inefficient method of removal.

The construction of the holder is shown in Figures 4 and 5.

The holders are used as follows:

1. The engine is turned over by hand and as each valve comes up a valve holder is slipped under the valve

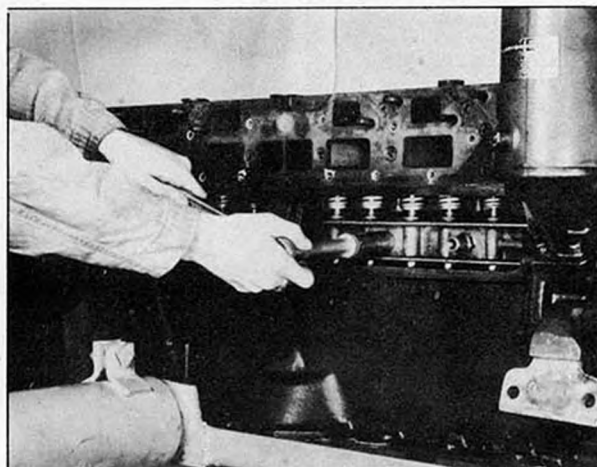


Fig. 7

face (Figure 6). Six holders are required to hold up the valves in order that one lifter bracket and lifter assemblies can be removed.

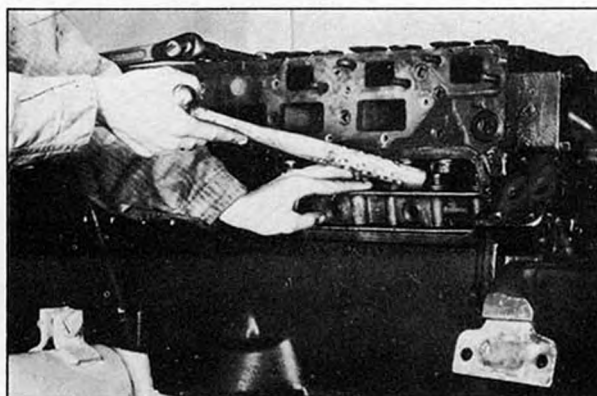


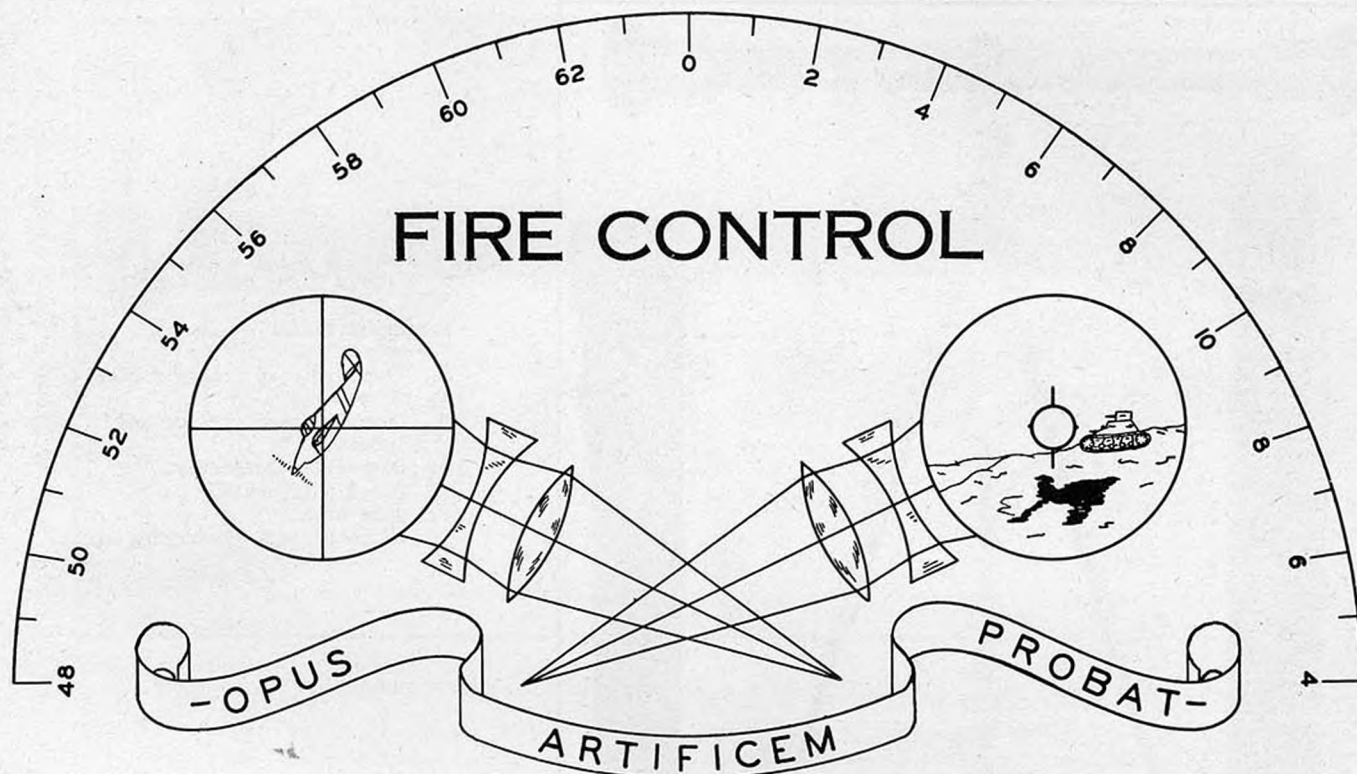
Fig. 8

2. Remove the locking wire and take off the two 7/8" holding nuts (Figure 7) that hold the bracket to the block.

(Continued on page 179)



Fig. 9



Conducted by: R. L. Johnson, 1st Lt., Ord. Dept.

FINDER, RANGE, 1 METER BASE, M1916

Part I

1. The following article is the first of a series covering the description, care, inspection and adjustment of the Finder, Range, 1 meter base, M1916.

2. Save each copy of THE ORDNANCE SERGEANT as the following parts of this article will make reference to this and succeeding articles by paragraph numbers.

3. To understand the inspection, adjustment and repair of this instrument it is necessary that a thorough knowledge of its use and operation be clearly understood. Therefore, the following article, Part I, will be devoted to description and operation of the Finder, Range, 1 meter base, M1916.

4. COMPONENTS. - The instrument complete consists of:

- (1) The range finder proper.
- (2) The mount
- (3) The tripod, Type U.
- (4) The adjusting lath with carrying strap.
- (5) The tube sight.
- (6) The carrying case for the instrument.
- (7) The carrying case for tripod and mount.
- (8) The camel hair brush.
- (9) The correction wedge key.

These nine items are illustrated and identified in Figure 1.

5. USE. - This range finder is an instrument used for measuring distances from 400 yards to 20,000 yards. It may be used to measure horizontal and vertical angles, but it is not convenient for this purpose.

6. SALIENT CHARACTERISTICS. -

Magnification.	15 power
Field of view.	3°10'
Diameter of exit pupil.	0.1"
Aperture of objective	1.5"
Effective focal length	8.66"

7. RANGE FINDER. - a. This instrument is primarily two periscopes laid horizontally to each other, so that their objective windows are spaced exactly 1 meter apart, but having one common eyepiece giving a split field of view.

b. The range finder is of the horizontal base, inverted field, coincidence type. It calculates ranges for distances ranging from four hundred to twenty thousand yards, by means of triangulation, using a one-meter base line for the triangle.

c. The instrument has a focusing eyepiece with an allowable movement of plus or minus four diopters. This movement is used for the rapid setting, or focusing, of the eyepiece after the individual observer has learned his particular diopter setting. The diopter movement permits the adjustment of the eyepiece to compensate for variations in the eyes of different observers. The zero setting indicates the normal eye reading.

d. The ray filter, located near the eyepiece, contains one smoked and one amber glass filter. These are provided for use when it becomes necessary to look into

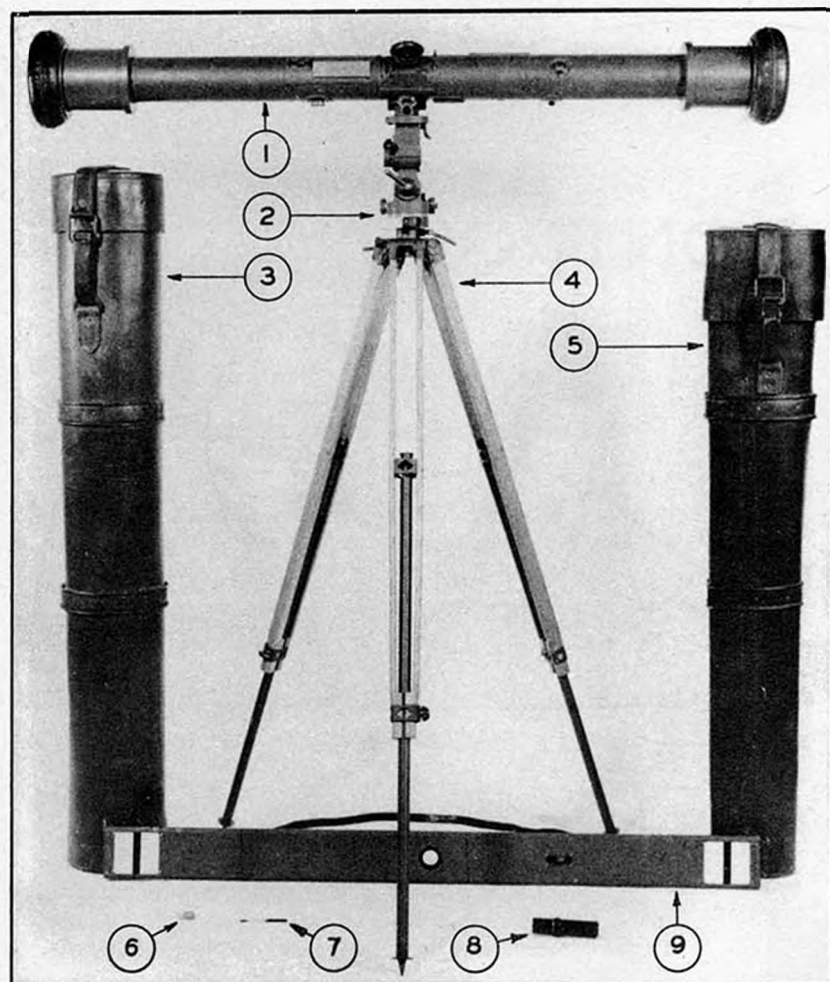


FIGURE NO. 1 . - FINDER, RANGE,
1 METER BASE, M1916 (COMPLETE)

1. Range finder.
2. Mount.
3. Carrying case (range finder).
4. Tripod.
5. Carrying case (tripod and mount.)
6. Correction wedge key.
7. Camel hair brush.
8. Tube sight.
9. Adjuster lath w/carrying strap.

the direct glare of the sun or a powerful searchlight. The interjection of such a filter neutralizes the glare and allows normal functioning of the instrument in every other sense without in any way affecting the optical characteristics or accuracy of the instrument.

e. The open sight on the top of the tube is provided for the quick sighting of the instrument on an object. The adapter is provided for attaching the instrument to the mount.

8. MOUNT. - a. The mount contains an azimuth mechanism above which the elevating mechanism is hinged, allowing an elevation and depression of eighteen degrees. The angle of site mechanism is attached to the side of the elevating mechanism.

b. When the support lever is released, the instrument can be rotated about ten degrees in azimuth and this movement is used to orient the instrument.

c. The azimuth scale is graduated from one to sixty-four in one-hundred-mil graduations.

d. The azimuth micrometer is graduated in one hundred graduations, each graduation being equivalent to one mil. It can thus be seen that one complete turn of the azimuth micrometer will only move the azimuth scale one complete graduation or $1/64$ of the total circumference of the scale.

e. The throw-out lever, when rotated and held, dis-

engages the worm from the worm wheel and is used for large and rapid changes of azimuth.

f. The angle of site scale is graduated from zero to six, each of the six graduations being equivalent to one hundred mils. The three (or three hundred graduation) is the normal or zero setting, indicating if in correct adjustment, parallelism with the horizontal, insofar as the instrument is concerned.

g. Rotating the hinge clamp screw lever permits lateral motion of the upper part of the mount, allowing a means whereby the range finder may be leveled.

h. The mount is kept attached to the tripod at all times but can easily be removed by loosening the vertical spindle locking screw. The mount and the tripod, with the salient components of the assembly identified are illustrated in Figure 4.

9. TRIPOD. - a. The tripod type U, is used with the range finder, 1 meter base, M1916. The tripod, type U, is illustrated in Figure 5.

b. The tripod consists of:

- (1) Tripod legs, upper section.
- (2) Tripod legs, lower section.
- (3) Tripod head.
- (4) Tripod head bushing.
- (5) Vertical spindle clamping screw.
- (6) Vertical spindle clamping lever.
- (7) Leg clamping parts.

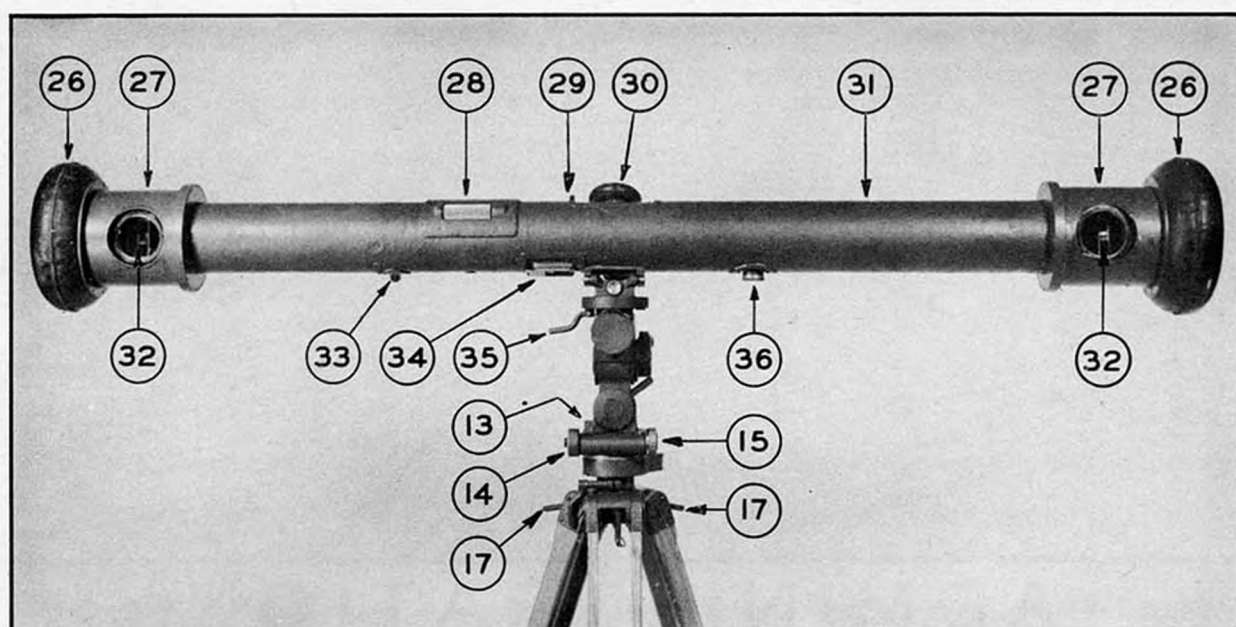


FIGURE NUMBER 2. - RANGE FINDER, 1 METER BASE, M1916 (FRONT VIEW)

- | | | |
|--------------------------------|-------------------|-------------------------------|
| 13. Throw-out lever. | 27. End box. | 32. Objective window. |
| 14. Azimuth knob. | 28. Range roller. | 33. Correction wedge control. |
| 15. Azimuth micrometer. | 29. Open sight. | 34. Halving adjusting roller. |
| 17. Tripod leg clamping lever. | 30. Eye shield. | 35. Support clamp lever. |
| 26. Buffer. | 31. Outer tube. | 36. Gimbal joint cover. |

c. The tripod head bushing is held in place in the tripod head by the vertical spindle bushing locking screw. The tripod legs (upper section) are attached to the tripod head and are braced by the leg separators. The lower sections are of tubing and slide freely through the base of the upper sections; by means of the clamping wing nuts they can be locked in any position to suit the observer.

d. The tripod may be used by the observer in a standing or kneeling position. It can also be used in the prone position by supporting it with the hands.

e. For use in the standing position the tripod is taken from the carrying case and the legs extended by loosening the leg clamping nuts, allowing the extensions to drop out, after which the clamps are tightened. With one leg pointing away from the observer the legs are spread out to form an equilateral triangle. When the legs have been spread enough to insure a rigid support, they are clamped in that position by the locking clamp arm.

10. ADJUSTING LATH. - The adjusting lath consists of a metal strip upon which two vertical lines are placed, the distance between these two lines being the exact optical length of the instrument. This makes each adjusting lath applicable only to the instrument for which it is adjusted. This is because there may be a minute difference in the optical lengths of instruments due to manufacture. The adjusting lath has a serial number and this lath must be the same serial number as the instrument that it accompanies. The tube sight in the center of the lath is used to set up the lath parallel to the instrument, as this is essential to accurate adjustment. The adjusting lath is illustrated in Figure 1.

11. ACCESSORIES. - a. Tube sight is used with the adjusting lath to secure parallelism of the adjusting

lath with the range finder when adjustment is performed by the infinity method. The tube sight is carried in the lid of the carrying case for the tripod and mount.

b. Correction wedge key is used to rotate the correction wedge when it is necessary to adjust the range finder. It is carried in the lid of the carrying case for the tripod and mount.

c. Camel hair brush is used to remove dust from the exposed lens surfaces on the range finder. It is carried in the lid of the carrying case for the tripod and mount.

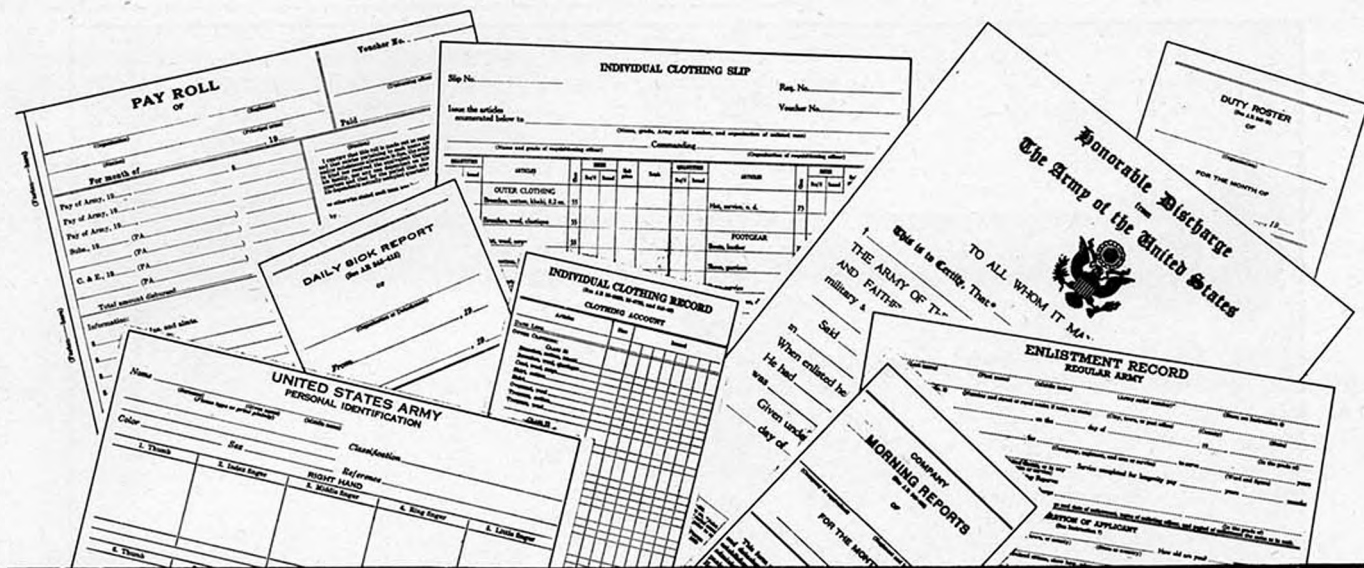
d. Two leather carrying cases, one for the range finder, and one for the tripod and mount are well constructed to provide a suitable container for the instrument and accessories. The instrument and accessories should be placed in the carrying case when not in use.

12. OPTICAL SYSTEM. - The optical system of the range finder, M1916, 1 meter base, is illustrated diagrammatically in Figure 7. Figure 6 shows a complete view of the ocular prism of the range finder, and another view showing the path of a ray of light entering from either side passing through the various component parts of the ocular prism.

13. CARE AND HANDLING. - a. The gimbal joint cover to the left of the eyepiece on the upper side of the tube is not removed in the field as the slightest disturbance of the parts enclosed therein renders the instrument inaccurate.

b. Before mounting the instrument on the tripod, the covers on the ends are rotated to expose the windows.

(Continued on page 180)



ADMINISTRATION

Conducted by: J. E. Dempsey, 2nd Lt., Ord. Dept.

MILITARY CORRESPONDENCE

By: C. B. Hudson, S. Sgt., Ord. Dept.

You will, at some time or the other, regardless of the nature of your duties, have occasion to use some form of military correspondence. All written communications between offices and individuals in or under the War Department, and with offices and individuals in or under the Navy Department will be considered as military correspondence. Communications to other than the above mentioned offices and individuals will be in the forms used in the best civilian practice. A practical knowledge of the subject will be of value to you from the purely personal standpoint; as well as meeting the requirements of your work.

Before going into the various forms of military correspondence let us consider certain basic fundamentals. Your character is directly reflected in the manner in which you express yourself when writing. Strive to make yourself clear, without sacrificing that certain personal touch which is oftentimes lacking where extreme brevity is sought. Regardless of your feelings, never indulge in personalities. The Service may suffer as a result of your indiscretion, as well as yourself.

You can improve your style by using short, "meaty" sentences rather than long involved, "wordy" ones. The excessive use of superlatives and flowery language in general, creates a false and often mistaken impression of yourself in the mind of the reader of your letter, besides being unmilitary. Likewise, repetition of the same words or phrases detracts from the smoothness of the composition. Last but not least, correct spelling is an absolute essential.

FORM. - We will now consider the composition of the military letter. All letters should be written on one side only of letter-size paper (8 x 10-1/2 inches). The following margins will be used:

Top margin, first page	1 inch
Top margin, second and succeeding pages	1-1/4 inches
Left margin	1 inch
Right margin	3/4 inch
Bottom margin	1 inch

The first and succeeding pages will be numbered consecutively, in Arabic numerals, midway in the lower margin and one-half inch from the bottom of the sheet.

HEADING. - The heading of the letter is all that will be written in the upper third of the first sheet. It will consist of the following:

- The name of the headquarters
- The name of the office
- The initials of the dictator and transcriber
- The reference file number, if used
- The post office address
- The date
- The subject
- To whom the letter is sent

Example No. 1

HEADQUARTERS FORT RODMAN, SG-jt
Office of the Ordnance Officer

In reply refer to: Fort Rodman, Maryland,
126 December 29, 1941.

SUBJECT: Allocation of Ordnance Personnel.

TO : Commanding General, Third Corps Area,
Baltimore, Maryland.

The general rule of limiting the statement of the "Subject" to ten words or less should be observed. Also, only one subject will be referred to in a single letter.

Following the word "To" will appear the official designation or grade, name, organization, or branch of the person addressed; when necessary the post office address will be written underneath. Abbreviations will not be used except for states and similar geographic divisions. The writer should bear in mind the requirements set forth in Army Regulations as to whom communications should be addressed: "Official communications will be addressed to the commanding officer concerned and not to his adjutant general or other officer occupying a corresponding position." "When the command is normally that of a general officer, the expression "Commanding General," or its abbreviation, will be used in addressing the commander thereof even though an officer of lower grade be temporarily exercising command, e.g., Commanding General, Second Corps Area. When the command is normally that of an officer below the grade of brigadier general, the expression "Commanding Officer", or its abbreviation, will be used, e.g., "Commanding Officer, 17th Infantry."

BODY. - The body of the letter begins in the lower two-thirds of the first page. You do not use the form of salutation common in civilian correspondence, such as: "Dear Sir," "Yours truly," or other similar expressions. In the first paragraph, which is numbered "1" and single spaced, you state what you want and quote the Army Regulation or other authority authorizing your action. Double spacing between paragraphs you begin the second paragraph which is, in turn, indicated by the number "2" giving the reason for your request. In the third paragraph, designated by the number "3" you will give any additional information required or which will serve to further justify your action. There is no limitation on the number of paragraphs that may be used.

SIGNATURE. - The signature is approximately four single spaces below the last paragraph in the right hand portion of the page. Sufficient space should be allowed for the writer to sign his name. The signature will consist of the first name, middle initial, and last name of the writer. In the case of an enlisted man, his Army serial number must follow his last name. Immediately below the signature will appear the typed name identical with the signature, followed by the grade and organization. If it is that of an officer signing in his official capacity rather than as an individual, an indication of the special capacity will be indicated, e.g., "Captain, Ordnance Dept., Ordnance Officer."

ENCLOSURES. - Enclosures are noted opposite the signature on the left hand side of the page at least two single spaces below the last paragraph of the letter. If space permits, it makes for better appearance to balance them with the typed signature on the right side of the page. The total number of enclosures will be noted together with a list showing the subject of each, example:

3 Encls -

- Encl 1 - W. D., A. G. O. Form No. 44, w/2 Encls.
- Encl 2 - W. D., A. G. O. Form No. 32, in duplicate.
- Encl 3 - Report of Clothing Abandoned by Deserter.

If any of these enclosures are in duplicate, triplicate, etc., that fact should be indicated as in above example. An enclosure having in turn, enclosures of its own, will be indicated as in above example. All enclosures to a communication will be arranged in their proper sequence and numbered consecutively. The fact that a paper is an enclosure, will be so noted in pencil, usually in the lower left hand corner of the sheet.

The letter shown in the following example embodies the various forms and rules we have discussed. To be correct, military letters do not have to necessarily follow any one set form. This divergence of form is particularly noticeable upon comparison of correspondence emanating from the various departments. Nevertheless, certain basic rules must be followed and it is with these rules that the person unfamiliar with military correspondence should become familiar.

Example No. 2

OFFICE OF THE ORDNANCE OFFICER SG-jt

In reply refer to: Fort Rodman, Maryland,
128 December 29, 1941.

SUBJECT: Disposition Excess Ordnance Equipment.

TO : Ordnance Officer, Third Corps Area,
Baltimore, Maryland.

1. Pursuant to authority contained in Paragraph 2e, AR 45-30, January 16, 1934; disposition is requested for the following excess serviceable ordnance stores now in storage at this post:

SNL C-4

PARTS, spare, 75 mm gun, M1897, set 12 sets
PARTS, spare, 75mm gun carriage, M1897M1, set 12 sets
PARTS, spare, 37mm gun, M1916, set. 27 sets

2. The above listed stores are in excess of reserve requirements. It is desired that movement of this equipment be expedited in order that storage space may be available for materiel now in transit.

3. Complete itemized lists of the respective sets are enclosed. All of the equipment is in original packages.

3 Encls -

- Encl 1 - Set List, 75mm gun.
- Encl 2 - Set List, 75mm gun carriage. Ordnance Officer.
- Encl 3 - Set List, 37mm gun.

Samuel Gunner
SAMUEL GUNNER

Captain, Ord. Dept.

You may have occasion to write military letters in connection with your personal affairs. The same general form is followed with the exception that the heading and signature is modified accordingly.

Example No. 3

Mitchell Field, L. I., N. Y.,
December 29, 1941.

SUBJECT: Transfer of Enlisted Man.

TO : Commanding General, Third Corps Area,
Baltimore, Maryland.

1. Under authority contained in AR 615-200, November 24, 1939, application is made for transfer in grade of Corporal to the 40th Ordnance Company (Tng.), Aberdeen Proving Ground, Maryland.

2. This transfer is desired by reason of my having been graduated from the Ordnance School, Depot and Supply Specialists' Course, November 5, 1941. It is my belief that

(Continued on page 185)



Conducted by: J. E. Dempsey, 2nd Lt., Ord. Dept.

THE RECEIPT AND ISSUE OF ORDNANCE GENERAL SUPPLIES AT AN AIR BASE COMMAND

By: Walter S. Howard, S. Sgt., Ord. Dept.

Army Regulations 35-6520, Paragraph 3a, states in part: "All public property, whether acquired by the War Department or the Army at large, by purchase, or by transfer from other agencies of the Government, and whether paid for or not, must be accounted for on an appropriate property account." From this statement we can see that no matter what system is employed to handle property accounts, it must conform to general Government and War Department accounting principles.

In this discussion we will endeavor to picture the manner in which Ordnance General Supplies are handled by the Base Ordnance Office at an Air Base of an Air Force.

When present expansion plans are completed we will find that there is an Air Base for each Group of an Air Force. This may be a Bombardment Group or a Pursuit Group, but regardless of which type is stationed at an Air Base we will always have an Aviation Ordnance Company (Air Base), and to its personnel falls the task of the receipt and issue of General Supplies to all the Squadrons that compose the Group and to all other Arms and Services of the Army that are stationed at that Air Base.

The principal difference between the issuing of General Supplies to Air Force organizations and the issue of similar property to other branches of the Army is the method of handling "Tables of Basic Allowance Property". To the Air Force units we issue all non-expendable property on Memorandum Receipt, regardless of whether it is organizational equipment (T B/A) or Post, Camp and Station equipment (T/A). All items classed as expendable are issued to the Air Force units on approved requisitions which are used as vouchers to drop the items from the Stock Record Account of the Air Base Ordnance Property Officer.

However, it should be borne in mind that GENERAL SUPPLIES ISSUED TO BRANCHES OF THE SERVICE OTHER THAN THE AIR FORCE WILL BE HANDLED IN THE REGULAR MANNER: i.e., organizational equipment

will be shipped on Shipping Ticket to the appropriate organization supply officer, and Post, Camp and Station equipment will be issued on memorandum receipt by the Base Ordnance Officer to the individual organizations. Therefore, our main difference is in the fact that accountability for all non-expendable Ordnance Property that is issued to Air Force units at any given Air Base is retained at all times by the Ordnance Property Officer at the Air Base from the time of its receipt until it is transferred away from the Air Base.

In order to provide for the vast number of transactions resulting from the use of Memorandum Receipts for the issue of property to Air Force units, a form for the receipt and issue of all supplies has been devised and is used with minor local changes in all Aviation Ordnance activities. At an Air Base it supplants WD, QM C Forms No. 489 and 490 (Tally-In and Tally-Out Sheets). A study of this form (see Figure 1) shows that it is readily adapted to all phases of the issue of Ordnance General Supplies. This form is known as a "Stores Slip, OFM 311".

We will now trace the accountability and the administrative transactions from the time we receive a shipment of Ordnance General Supplies until it is in the hands of an Air Force Squadron at our Air Base. We will assume that we have requisitioned 10 each GUN, machine, caliber .50, Browning, M2, aircraft, flexible. These weapons have arrived and are now in our Warehouse. The Storekeeper is checking them. Since these are serial-numbered items, he must carefully check the numbers on the guns to see if they correspond correctly with the numbers as listed on the Shipping Ticket. After ascertaining the correctness of these numbers, the Storekeeper will accomplish a Stores Slip as shown in Figure 1. This Stores Slip is accomplished in duplicate, the original of which is routed to the General Supply Section of the Ordnance Property Office, and will have attached to it a copy of the Shipping Ticket on which the property was received, and the duplicate retained in the Warehouse office.

OFM 311		STORES SLIP	
		Unit	Location
		Air Base:	<u>Fort Blank, Md.</u>
		Date:	<u>Jan. 4, 1941</u>
RECEIVED FROM:			
Issued to: <u>ABERDEEN ORDNANCE DEPOT, Aberdeen Proving Ground, Md.</u>			
Transmitted to:			
S.N.L.	Quantity	Item	
A-1	10 each	GUN, machine, cal..50, Browning, M2, aircraft, flexible.	
		Serial Nos. -13456-13457-13458-13459-13460-13461-	
		-13462-13463-13464-13465-	
		AS PER ATTACHED SHIPPING TICKET	
Authority: <u>App Req: 00638-34-42</u>			
To be delivered at: <u>xxxxxx</u>		xxxx	xxxx
(Place)		(Date)	(Time)
Purpose: *Organizational Equipment: Voucher No. <u>APG 345-42</u>			
*Immediate Expenditure: Reg. of Training Org. or Ind. SPECIAL PURPOSE AMMUNITION			
Received by: <u>Sgt. Joe Smith,</u>		Posted by: <u>Pvt. Frank Jones</u>	
Storekeeper		Warehouse Clerk	
		Slip No. XXXX	<u>11</u>
		*G.S.	
*—Cross out words not applicable.			
OFM 311			

Fig. 1

When the General Supply Section in the Ordnance Office receives the copy of the Shipping Ticket and the Stores Slip indicating the receipt of the property, the amount of property received on the Shipping Ticket is posted to the Stock Record Account (See Figure 2), the original copy of the Shipping Ticket is signed by the Air Base Ordnance Property Officer and returned to the Shipping Officer, and the duplicate copy is filed with the vouchers to the Stock Record Account. After the "posting" is accomplished to the Stock Record Account, "Serial Number Record Cards" are prepared for each serial-numbered weapon received as a result of this shipment. (See Figure 3.) As an indication that these two actions have been taken, it should be required that the clerks who perform these duties enter their initials on the Shipping Ticket opposite the word "POSTED" and "DATE", which should be stamped on the Shipping Ticket with a rubber stamp. (See Figure 4.)

We now have these items on our Stock Record Account and on our Serial Number Record Cards. Let us now assume that we have an approved requisition from the 22nd Bombardment Squadron of the 25th Bombardment Group, which is the Group that we are servicing from our Air Base. This requisition calls for the issue of 10 each GUN, machine, caliber .50, Browning, M2, aircraft, flexible. The Armament Sergeant of the 22nd Bombardment Squadron, who is authorized to draw supplies by his Squadron Commander, comes to our warehouse to obtain the 10 guns from our Storekeeper. Our storekeeper accomplishes three copies of the Stores Slip, issues the guns to the Armament Sergeant and obtains his receipt on the Stores Slip. (See Figure 5.) The original copy of the Stores Slip is then sent

to the Ordnance Property Office, the triplicate copy is retained in the Warehouse office, and the duplicate copy is given to the Armament Sergeant for his records.

As has already been noted, all non-expendable property issued to Air Force units, regardless of whether such property is listed as Table of Basic Allowance Property or Table of Allowance equipment, is issued to such units on Memorandum Receipt, and accountability for the property is retained by the Ordnance Property Officer at the Air Base.

Because of the great number of issues and receipts made to Air Force units by the Ordnance Property Officer at an Air Base by means of Memorandum Receipts, it is necessary that there be in operation a property record system that will permit an accurate check on any and all such transactions, both as to the amount of any issue or receipt, who made the issue and who receipted for the property. For this purpose a system of account numbers is set up in the Ordnance Office for all Memorandum Receipt Records. Each organization at the Air Base is assigned a basic number for their Memorandum Receipt transactions. We will assign Number "4" as the basic number for all transactions involving the issue or receipt of property to the 22d Bombardment Squadron. This means that any Memorandum Receipt concerning any Ordnance property to be issued or received from the 22d Bombardment Squadron will have this basic number "4" as a part of its account number. These "basic" numbers and "transaction" numbers are recorded in ordinary ledgers, using two sheets, opposite each other, for each Air Force unit stationed at the Air Base, one sheet to record the

OFM 311		STORES SLIP	
		Unit	Location
		Air Base:	Fort. Blank, Md.
		Date:	January 6, 1942
*Issued to: <u>22nd Bombardment Squadron, 25th Bombardment Group</u> *Returned to:			
S.N.L.	Quantity	Item	
A-1	10 each	GUN, machine, cal..50, Browning, M2, aircraft, flexible. Serial Nos:-13456-13457-13458-13459-13460-13461- -13462-13463-13464-13465-	
Authority: <u>App Req: 25BG-14-42</u>			
To be delivered at:		xxxx	xxxx
(Place)		(Date)	(Time)
Purpose: *Organizational Equipment: Voucher <u>xxxx</u> *Immediate Expense <u>xxxx</u> Reg. of <u>xxxx</u> Org. of <u>xxxx</u> Special Purpose <u>xxxx</u>			
Received by: <u>T/Sgt James Fry,</u>		Posted by: <u>Pvt Frank Jones</u>	
Arm/Sgt, 22nd Bomb Sqd		Warehouse Clerk	
*—Cross out words not applicable.		Slip No.	<u>14</u>
		*G.S.	
OFM 311			

Fig. 5

Bombardment Squadron, is entered on the Memorandum Receipt that the Armament Officer signed indicating that he had received these weapons. All the "Credit" Stores Slips and all the "Debit" Stores Slips prepared in one given month are filed in the Ordnance Property office in numerical sequence for that month.

Prior to filing the Memorandum Receipt in the Memorandum Receipt file, entries are made thereon indicating that the issues or receipts are posted to the "Account of Property on Memorandum Receipt" and, in the case of serial-numbered items, that the proper entries are entered on the serial-numbered record cards. These entries are initialed by the clerk who made the "postings" to these two files.

We now have a complete record of this transaction at all times from the time of issue to the Armament Sergeant to the time we receive the original copy of the Memorandum Receipt signed by the Armament Officer. In addition, we have the necessary data posted to the "Account of Property on Memorandum Receipt" and the "Serial-Numbered Record Cards", and by reason of the requirement that clerks initial items entered on the various records by them, we know who made any one particular entry, and we can call on that particular person for additional information if any discrepancies or misunderstandings arise in the future.

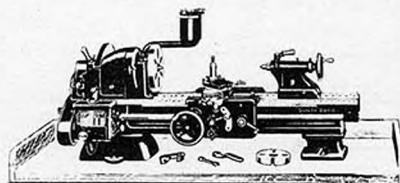
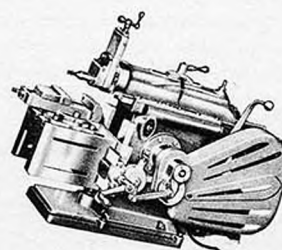
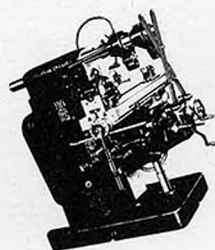
In general, the same procedure is followed when an organization returns any article, but of course it is a credit to the organization, and we send a "Credit" Memorandum Receipt signed by the Ordnance Property Officer to the Armament Officer concerned.

(Continued on page 186)

MEMORANDUM RECEIPT		
*CREDIT DEBIT SLIP		
*Issued to: <u>22nd Bombardment Sqd., 25th</u> *Returned to: <u>Bombardment Group</u> Place <u>Ft. Blank, Md.</u> Date <u>Jan. 6</u> , 1942.		
ORDNANCE Property (Name of supply branch)		
NO.	STOCK NO.	ARTICLES
		GROUP A-1
10	each	GUN, machine, cal..50, Browning, M2, aircraft, flexible, Serial Nos. -13456-13457-13458- -13459-13460-13461- -13462-13463-13464- -13465- //////////////////////////////////////
PLEASE SIGN AND RETURN TO THE BASE ORDNANCE OFFICE.		
ABSTRACT M/R ACCT POSTED <u>W.S.N.</u> SERIAL NO. CARDS POSTED <u>W.S.N.</u>		
S/S No. <u>14</u>		
Received the above-named articles. <u>Bert Jacobony</u> BERT JACOBONY (Signature with rank and organization) 1st Lt, Air Corps Armament Officer, 22nd Bomb. (Official designation)		
No. <u>D 1-4</u> Q. M. C. Form 487 Revised May 14, 1931 * Strike out words not applicable. 16-21003 GPO		

Fig. 6

THE MACHINE SHOP



Conducted by: L. Kaldizar, Master Sergeant, Ord. Dept.

TRAINING THE ORDNANCE MACHINIST

In a series of articles in THE ORDNANCE SERGEANT, we are going to enter, instruct and graduate Pvt. G. M. Root from the Specialist Machinist Course at the Ordnance School. This series of articles will clearly outline to you the scope of teaching, and learning, that the instructors and students undergo during the course of instruction for Machinists' at the Ordnance School.

If our methods of instructing are not the exact duplicate of your methods of producing work, as a machinist, remember they constitute one of the many accepted standard methods used in the machinist trade. Though we will have many methods with which you may disagree, we find it necessary to present our course in this manner, as many of our students probably have never seen the inside of a Machine Shop. So, therefore, we must simplify complicated and elaborate operations in order for our students to thoroughly understand them in such a short time.

This course is a condensed version of the old nine-month course previously given by the Ordnance Field Service School at Raritan Arsenal. Instruction involving machinery other than that normally used by the Ordnance Machinist, together with the arithmetic and drawing course, has been eliminated. This permits essentially the same number of hours of practical instruction and work as in the old course.

Instruction in each subject is given first as a lecture demonstration, and then as supervised application by the students. Problems of a practical nature are used.

Each subject is divided into appropriate units. The available time is divided into periods of an hour and forty minutes each. Although a definite number of periods is allotted each unit, this is to be considered a normal rather than a prescribed allotment. The class progresses from one unit to another, whenever qualified, and in those subjects where such action is possible each student progresses independently from one unit to the next. Advanced work is

By:
F. P. Bingert and G. E. Tibbetts,
Staff Sergeants, Ord. Dept.

given to those students who are qualified therefor.

At any time throughout these articles, any suggestions, hints, and constructive criticism will be taken as a stepping stone toward increasing our efficiency as instructors, and will be accepted as friendly cooperation.

In this "Blitzkrieg" course, we realize that we cannot produce a highly polished machinist, or mechanic, but we do know that we can produce a machinist with the knowledge and facts that are most needed in the field for efficient results, and also to equip him with a base from which he can develop rapidly.

We cannot begin to express in writing the facts and knowledge that a student must absorb in such a short time that is allotted to him to become a graduate from our course. Therefore we will roughly outline our course, and then proceed to explain in detail, each and every phase that we consider necessary for our students.

SUBJECT

FLOOR AND BENCH

- a. Ferrous and non-ferrous metals
- b. Nomenclature, use and maintenance of hand tools
- c. Simple layout and free hand sketching
- d. Drills, offhand grinding
- e. Grinding necessary hand tools
- f. Shop safety precautions

PROBLEMS

- a. Cast iron block
- b. Collar and shaft
- c. Tool angle gauge

DRILL PRESS

- a. Nomenclature, care and maintenance
- b. Speeds and feeds
- c. Selection and mounting of drills
- d. Safety precautions

OPERATIONS

1. Drilling
2. Countersinking
3. Counterboring

PROBLEMS

1. Cast iron block
2. Collar and shaft
3. Miscellaneous

BENCH GRINDER

- a. Care and maintenance
- b. Off-hand grinding
- c. Safety precautions

THE ENGINE LATHE

- a. Nomenclature, capacity, function of various groups, care and maintenance
- b. Safety precautions
- c. Speeds and feeds
- d. Cutting tools, mounting and grinding.
- e. Mounting of work

OPERATIONS

1. Turning, straight and taper
2. Facing
3. Drilling, reaming and tapping
4. Boring, straight and taper
5. Threading, internal and external, right and left hand
6. Use of tool post grinder

PROBLEMS

- a. Steel shaft
- b. Cast iron collar
- c. "T" Bolts
- d. Pin punches
- e. Stud with nuts
- f. Lathe mandrel
- g. Tap blank
- h. Beam trammels
- i. Lathe centers
- j. Maintenance work

SHAPER

- a. Nomenclature, capacity, function of various groups, care and maintenance
- b. Safety precautions
- c. Operation of controls and set-up
- d. Tools, grinding and dressing
- e. Mounting of work

(Continued on page 187)

TRAINING THE ORDNANCE CARPENTER

By: W. Kuehne, 2nd Lt., Ord. Dept.

Students specializing in carpentry are required to understand the grading of lumber. They must not only understand the reasons for grading, but they must also know the rules for grading both hardwood and softwood.

Some method of grading must be used in order that the consumer of lumber may specify the quality which he may use to advantage for his particular purpose. Since high quality lumber which is free from natural and manufacturing defects is more valuable than lumber of a lower grade, it would be wasteful to use a quality which is better than is required by a given job. The use to which lumber will be put is certainly an important factor in its grading. Appearance and strength are other factors in grading.

Rules for the grading of practically all kinds of hardwood lumber have been fixed by the National Hardwood Lumber Association. The grade classification is based upon the amount of clear, usable lumber in a piece. Ordinarily, one side must be clear (free from all defects). The other side must be sound (free from rot, heart center, shake, and other defects which might effect the strength of the board.)

When speaking of hardwood lumber, "Firsts" is the highest grade and "Seconds" is next. In practically all cases these two grades are combined and the lumber is then classified as "F A S" (firsts and seconds). It must be possible to cut ninety one and two-thirds percent of the surface measure into clear face material if the lumber is "Firsts", and eighty-three and one-third percent of the surface if the lumber is "Seconds". It must be remembered that in both cases the lumber must not be less than six inches wide and eight feet long. There is also a third

grade termed "Selects" which calls for ninety one and two-thirds percent clear face in pieces with two and three surface feet, with the reverse side sound. No. 1 Common, No. 2 Common, and No. 3B Common are lower grades having increasingly large amounts of defects. No requirement of strength is made for the hardwood lumber, however, each different kind of lumber is classified as to its use — flooring, doors, sash, interior trim, etc.

In the grading of softwood lumber there are entirely different sets of rules. It would require many pages to give all the rules for the grading of one kind of softwood lumber since many different rules are made by different manufacturers. There is a tendency to standardize all grading methods, however.

In the grading of softwood lumber, the basis is not the percentage of clear-face material but the number and kinds of defects which may be present. Knots, stain, shake, wave, rot, pitch, splits and seasoning checks are the most common of these. The grade is determined on the better side of the piece unless the lumber is to be used for work on both sides. In the latter case, the poor side is used for grading.

Softwood lumber is divided into three main classes, namely, yard lumber, structural material, and factory and shop lumber. Yard lumber is, of course, the one in which most people are interested. Structural material and shop lumber are used mainly only by those people who are thoroughly familiar with their uses and requirements. At the Ordnance School, however, students are taught to understand all grades of both hardwood and softwood lumber in a surprisingly short time.

WELDING SECTION

Conducted by: W. G. Sylvester, 1st Lt., Ord. Dept.

CLASSIFICATION OF WELDING AND CUTTING PROCESSES

The development and growth in the fields of application of welding and cutting as formative processes for the fabrication of metals has been enormous. Their use in the design of industrial equipment has been reflected in greater production, lighter and more efficient structures, and in general, quicker, quieter and more economical fabrication methods. The successful use of welding for these purposes has of necessity been contingent upon its efficient coordination with oxyacetylene cutting processes. In order to establish a clearer conception of the size of each of these fields, the charts for both welding and cutting processes as shown have been prepared.

The chart of welding processes has been developed to classify all welding into three main groups, namely, pressure, non-pressure, and brazing processes. These main groups have been further subdivided so as to comprehend the principal methods used to develop the heat energy required for welding.

The chart of oxyacetylene cutting processes classifies all cutting operations into two main groups, namely, flame cutting, and flame machining. These are further subdivided in accordance with both the relative motion between the torch tip and the work piece and the methods used for guiding the torch. The principal applications for flame cutting and flame machining are indicated for each of the major subdivisions noted. To facilitate in the classification of flame machining operations, the terminology used in machine tool practice has been adopted where the particular flame machining operation simulates work normally performed with machine tools.

Although separately classified, there are certain oxyacetylene cutting processes which successfully combine flame cutting with flame machining to develop a desired surface shape or contour. Specific examples of this are evidenced in the methods used for preparing "U" or "J" shaped joints on plate edges for subsequent welding. These operations are performed by first flame grooving and then machine flame cutting to the groove. These and similar applications enable the controlled removal of a large quan-

tity of metal with a minimum of oxygen consumption. The further breakdown for each of the welding and cutting processes, the necessary equipment and procedures used, and their specific application to particular metals or operations is subject matter beyond the scope of this article.

To obviate any misunderstanding as to their exact meaning, a list of definitions has been prepared in brief for each of the welding and cutting processes and their applications. These definitions also include additional terms commonly used in technical literature on welding and are intended to clarify any misconceptions that may arise as to their proper interpretation.

DEFINITIONS OF WELDING TERMS & PROCESSES

Some of the more common welding terms and processes used in the description of the various welding operations may be defined as follows:

ACETONE: An inflammable and very volatile liquid used as a solvent in acetylene cylinders to dissolve and stabilize acetylene under high pressure.

ACETYLENE: A highly combustible gas composed of carbon and hydrogen (C_2H_2) and used as a fuel gas in oxyacetylene welding.

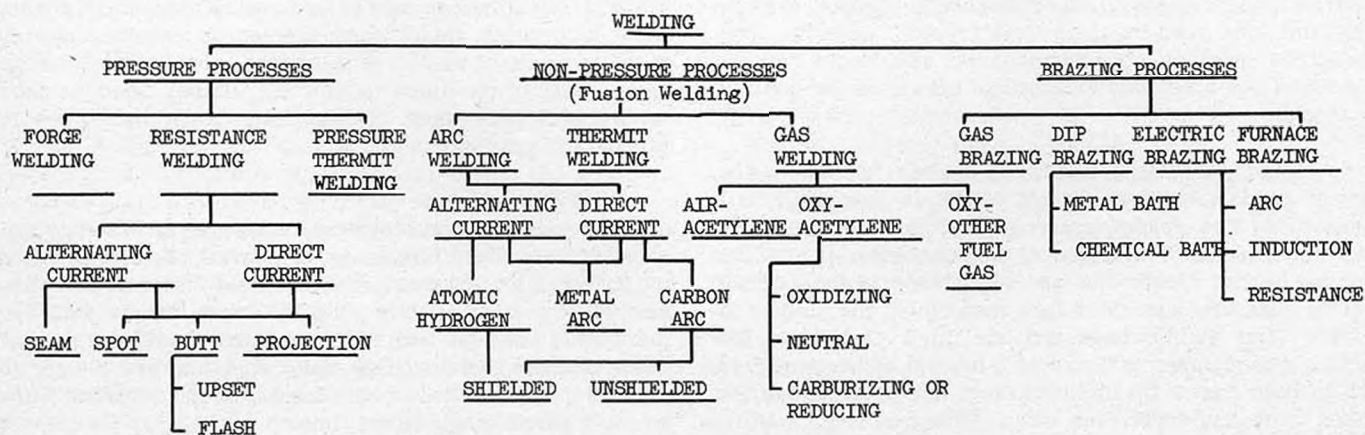
ADHESION: A condition existing in a welded joint where the molten metal merely sticks to the adjacent metal without actually being fused with it.

AIR-ACETYLENE WELDING: A gas welding process in which the welding heat is obtained from the combustion or burning of acetylene and air.

ALIGNMENT: The arrangement of parts in a straight line or proper position in relation to each other to restore the original shape as near as possible.

ALLOY: A mixture of two or more entirely different metals intimately united by melting them together.

CHART OF WELDING PROCESSES



ALTERNATING CURRENT ARC WELDING: An arc welding process in which the power supply at the arc is alternating current.

ARC BRAZING: An electric brazing process in which the heat is obtained from an electric arc, formed between the base metal and an electrode or between two electrodes.

ARC VOLTAGE: The voltage across the arc.

ARC WELDING: A non-pressure (fusion) welding process in which the welding heat is obtained from an arc either between the base metal and an electrode or between two electrodes.

ADBESTOS: A fibrous material refractory to heat, used in welding as insulation against transmission of heat from one body of metal to another.

ATOMIC HYDROGEN WELDING: An alternating current arc welding process in which the welding heat is obtained from an arc between two tungsten electrodes in an atmosphere of hydrogen.

BACK FIRE: The popping out of the torch flame or momentary burning of the gases within the torch tip.

BACKHAND WELDING: A method of gas welding in which the flame is directed toward the finished weld.

BACK-STEP WELDING: A welding technique in which the beads of weld metal are deposited opposite to the direction of progress of the weld along the joint.

BACKING STRIP: Material (metal, asbestos, carbon, etc.,) used to back up the root of the weld and retain the molten metal. Used in some arc welding and hard-facing operations.

BARE (lightly coated) ELECTRODE: A solid metal electrode with no coating other than that necessary to manufacture the electrode or with a light coating.

BASE METAL (parent metal): The metal to be welded or cut.

BEAD WELD: A type of weld made by one passage of the electrode or rod.

BEVELING: The cutting or forming of angles on the edges or ends of metal plates, shapes, or sections.

BLOW HOLE: A hole or cavity formed in the weld by entrapped gases, dirt, grease, or other foreign matter. Usually caused by welding too fast.

BOND: The junction of the weld metal and the base metal.

BOURBON TUBE: A curved metal elastic tube, oval in cross section, open at one end to gas, steam, or other fluid pressure and closed at the other. Changes in pressure cause it to move and this movement is used to indicate the pressure.

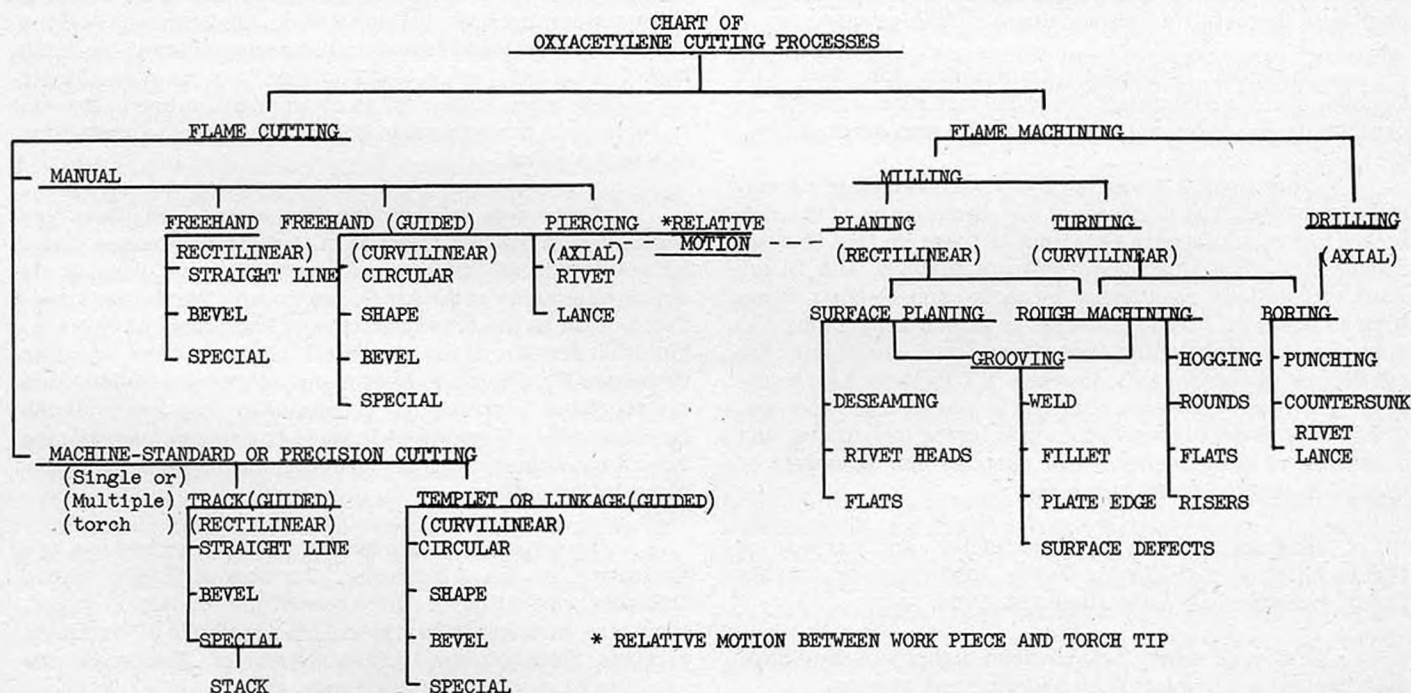
BRAZING: A group of joining processes in which the filler metal is a non-ferrous metal or alloy whose melting point is higher than 1000°F., but is lower than that of the metals or alloys to be joined. The application of brasses or bronzes on steel, cast iron, or malleable iron are examples of brazing processes.

BUCKLING: Distortion of sheet or plate, due to the forces of expansion and contraction as caused by the application of heat or excessive loading.

BUTT WELD: A weld made between the ends or edges of two plates or surfaces approximately in the same plane with each other.

CARBON ARC CUTTING: The process of cutting or severing metals by melting with the heat of the carbon arc.

CARBON ARC WELDING: An arc welding process
(Continued on page 188)





Conducted by: L. I. Dance, Master Sergeant, Ord Dept.

ENLISTED AVIATION ORDNANCE INSTRUCTION IN THE AMMUNITION SECTION

By: R. Fitzwater, 2nd Lt., Ord. Dept.

The Aviation Ordnance Munitions Workers Course in the Ammunition Section is designed to train selected enlisted students in the Basic elements and components of ammunition pyrotechnics, and explosives, used by all types of military aviation and anti-aircraft artillery; the handling incident to receipt, storage, shipment, and issue of such material; and Ordnance Service to the Air Force for both concentrated and dispersed operations.

This course consists of two phases. The first phase is devoted to instruction in technical ammunition subjects, while the second phase deals with the particular requirements and operations in fulfilling the Ordnance Ammunition Supply Mission to the Air Force.

During the first phase the students are instructed in explosives, general; military high and low explosives; principal explosives of each class, their uses and characteristics; the elements of the explosive train and its functioning; and essential requirements of military explosives. Small Arms Ammunition is taken up in considerable detail which includes types, packing, marking, identification, grades, components, complete rounds, etc., with emphasis on metallic link packing and A.C. grades.

Chemical Grenades, ammunition for Air-craft Cannon, and Anti-Aircraft Weapons are also covered in practically the same manner as Small Arms ammunition.

Since bombs comprise the greatest bulk of ammunition handled, and because of the complexity of the different types, a proportionate time is spent on this subject. Bombs are classified according to purpose and filler. Each type is then considered by model and weight. Some time is spent on characteristics of incendiary bombs and methods of extinguishing incendiary fires. Necessity for knowledge of components to make a complete round assembly of each separate bomb is stressed and repeated. Considerable time is spent in actual fuzing and finning and assembly of components. The purpose and principle of operation of each fuze is covered.

Instruction in types, functioning, and purpose of pyrotechnics used by the Air Force, to include serviceable life of emergency landing flares is given.

Anti-tank mines are covered both from the actual employment angle as well as handling and storing.

Considerable time is spent on Regulations covering shipments of explosives, by land and water, with accent on packing and staying methods and materials used. Quantity distance tables and Storage Groups are thoroughly discussed, as well as types of magazines and open storage with practical class room problems employed to acquaint the student with the importance of these subjects.

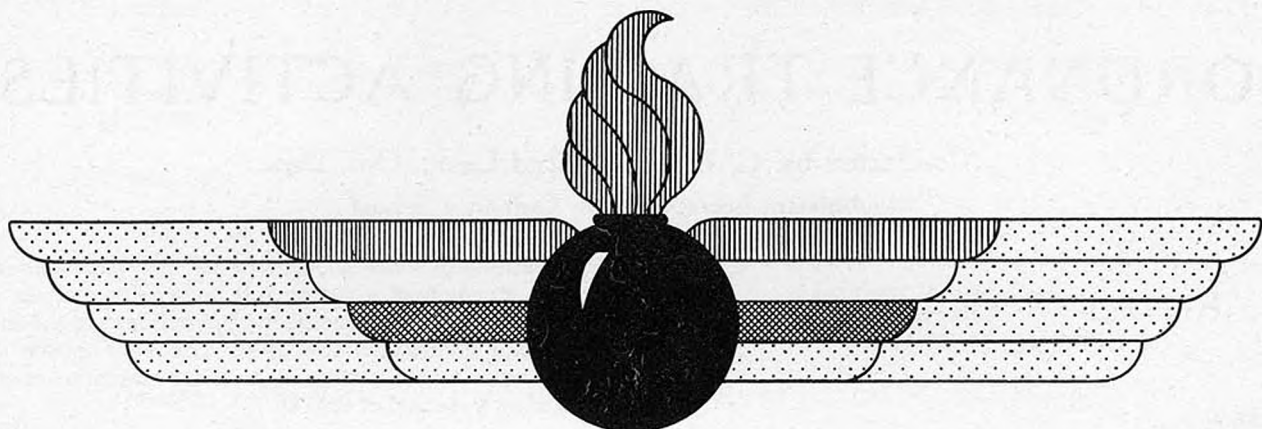
Instruction is given in methods of destroying un-serviceable and unexploded bombs, projectiles, and explosives of all types. A demolition area has been set aside so that burning pits and ovens can be constructed and actual demolition work performed by the students. They are instructed in proper methods of completing the electrical circuit with the blasting machine, use of the demolition chest and use of safety fuze by means of inert triton blocks and blasting caps, one to each student, before the actual destruction is begun.

The Mission of Ordnance Service in the Supply of Ammunition to the Air Force is the delivery to the individual planes of ammunition ready to fire or drop, in the kinds and quantities required by the Air Force Commands. In the accomplishment of this mission, the Ordnance Service delivers bombs fuzed and completely assembled at the bomb bay of the plane, ready to be hoisted into the plane by air corps personnel. Other types of ammunition are delivered in belts or in magazines, in suitable packing for immediate use in the plane.

To be able to perform this service, students are instructed in the organization of Aviation Ordnance Companies and their division into sections and platoons to service elements of the Air Corps group. Particular attention is paid to the organization and equipment of the Ammunition Section of the Airdrome platoon of the Aviation Ordnance Co. (Bomb.) Here the students are divided into crews, have instruction, and actually engage in bomb handling drill. No attempt is made to produce coordinated crews, but rather, to point out common mistakes and omissions in the drill.

To acquaint the student with supply procedure, organization of the Air Force, the command and supply channels, operation of the ammunition Supply and Expenditure Authorization system, the methods of obtaining original stockage, and replenishment of Stocks and the

(Continued on page 188)



AVIATION ORDNANCE

Conducted by: Glenn H. Staley, 2nd Lieut., Ord. Dept.

THE CHALLENGE!

That lusty youngster, Aviation Ordnance, is due for his baptism of fire! The first rude bomb dropping from the Japanese war-planes on peaceful Pearl Harbor below, did more than reverberate around the world with an angry roar. It did more than awaken a sleeping giant from a state of semi-lethargy into which he had been lulled by false emissaries of a pretended peace. It marked the day and hour when the American Air Force was called upon to demonstrate to the despots of the world that courage and grim singleness of purpose in its leaders which will carry it and this nation to ultimate victory. It marked the beginning of a ceaseless job for Aviation Ordnance.

Little did the Continental Congress realize the complete significance of its move in 1775 when it established the forerunner of the Ordnance Department in the person of the "Commissary of Artillery Stores." Still less, perhaps, did the 13 officers and 250 enlisted men representing the Ordnance Department in its infancy in 1823, visualize the deserved prominence to be fully attained by their branch of the service after long and tedious years of development and expansion. It may be that General Maxwell, who, as a Lt. Colonel in 1935 so ably filled the position of GHQ Air Force Ordnance Officer, could have predicted the enormous strides Aviation Ordnance has been called upon to take in the past year in order to keep pace with the Air Force. Certain it is that he guided the footsteps of Aviation Ordnance as such in its inception, and stood always ready to give impetus to any worthwhile program contemplated for this highly specialized division of Ordnance service.

Blinded to the truth is he who fails to agree that the swiftly moving events of war, as we have watched them unfold on the battlefields of Europe and Asia in the past two years, are convincingly assertive of the role of increasing importance which combat aviation is playing. It would be a sad commentary upon the alertness of any country to relate that it is not cognizant of the fact that he who rules the air is most likely to be sovereign over the land and sea beneath.

However, air power is not measured in number of planes and pilots alone. Each new trim pursuit ship, each

rumbling flying fortress is not sufficient within itself to assure mastery of the air. There must be guns and cannon; bullets and shells; bombs and pyrotechnics; each adding its potent complement to the plane to produce a formidable combat unit. The angry scream of the dive bomber is drowned in the ponderous roar of its released bomb. The whine of the speedy pursuit plane merges with and becomes a part of the staccato chattering of its machine guns. The majestic rumble of the heavy bomber pales into insignificance above the unleashed fury of a 2000-pound bomb's sudden detonation.

There must be a source of supply for these guns, bombs, and flares, and Aviation Ordnance units establish that source. Required to perform more detailed service than the ordinary Ammunition Supply Point, Aviation Ordnance personnel must deliver the ammunition to the plane itself. Hands which have become skilled through technical training and exacting practice must take care that the bombs are fuzed and finned and the ammunition properly belted before being turned over to the using squadron. Upon the degree of care and proficiency with which these men handle their work depend the very lives of the combat crew.

In addition to supply, one of the major problems confronting any tactical organization since the days of the old muzzle loader, has been that of maintenance of its weapons. Care and preservation by the using arm is not enough to win a battle. The demands made upon any weapon by the rigors of war far exceed the limited capabilities of the using troops to repair. The highly complex and delicate mechanisms of modern war machines require technical knowledge and skill in maintaining them which can be developed in only a select few.

Thus far, modern wars seem to have been fought with too little regard for the importance of continuous maintenance. Armies locked themselves in mortal combat for long and exhaustive periods of time and then each withdrew to lick its wounds, repair its battered materiel and resume the conflict. Obviously, the army with the speedier and more efficient maintenance organizations were enabled to

(Continued on page 188)

ORDNANCE TRAINING ACTIVITIES

Conducted by: G. D. Meixel, 2nd Lieut., Ord. Dept.

Assistant Secretary, The Ordnance School

REPORT OF GRADUATES DECEMBER, 1941

Officers —

Ammunition -----	10
Artillery -----	9
Automotive -----	11
Depot & Supply -----	8
Small Arms -----	9
AA Fire Control -----	4
Regular Army Officers -----	1
Total Officers Grad. -----	52

Enlisted Men —

AA Fire Control -----	14
Artillery -----	29
Automotive -----	47
Carpenters -----	10
Depot & Supply -----	58
Electricians -----	23
Instrument Repair -----	20
Machinists -----	32
Machinists, Adv. -----	17
Munition Workers -----	91
Small Arms -----	34
Welders -----	17
Cooks -----	28
Total Enlisted Men Grad. -----	420
Grand Total -----	472

AVIATION ORDNANCE TRAINING

By: H. M. Randel, 2nd Lt., Ord. Dept.

The Aviation Ordnance Section of The Ordnance School has as its primary mission the introduction and education of officers and enlisted men in the field of Aviation Ordnance. At first thought this may seem quite simple and concise but, unfortunately, it is not that easy.

For many years prior to the present war, aviation was considered an auxiliary force; one to be used for scouting, observation, and possibly an occasional minor bombing mission. Therefore the Ordnance Department trained only limited personnel for aviation activities; only a sufficient number of men to maintain the one or two guns found on the early type of reconnaissance plane, or bomber, and too few men to service and maintain the bombs for the bombers.

As World War II spread throughout Europe, every passing day proved to the world the total misconception of modern warfare. The bomber of this war is not the auxiliary type of weapon it was once suspected of being.

The battleship, once thought of as the backbone of the armed strength of a nation fell before the assault of the modern bomber. The designers and builders of the modern battleship maintained that it could not be broken as the backbone of armed strength — modern warfare has proven this to be a matter of doubt.

With this turn of events, the same cry went forth from all nations. "Give us more, and more, and still more planes." Industry, geared up to the speed of modern production methods, is answering that cry. Production schedules soar upward, planes flow off the assembly lines, and the army has found it necessary to buckle down to meet the demand for trained men. These planes which are the product of modern industry need more than just ordinary men to service them; their caretakers must be above the average, highly skilled men. Newspaper headlines scream of airdromes blasted from the face of the earth, while lesser lines of type tell of the days and weeks of hard fighting by a handful of men to keep one or two small but strategically important airdromes from falling into enemy hands, and to keep them operating twenty-four hours each day.

In the early summer of 1941, the Aviation Ordnance Section was reactivated at The Ordnance School. Men who came to the School without ever having heard of Aviation Ordnance, graduated with a knowledge of both the practical and the theoretical aspects of the subject. As the months passed, we began receiving men from the field who already possessed a working knowledge of Aviation Ordnance. It then became necessary to modify our course of instruction, and to give these men a more comprehensive course in the details of Aviation Ordnance rather than the fundamentals. Thus, in the training outline which follows, it must be remembered that it is tempered to meet the demands of the type of students being trained during a particular month. Although the course during one month may differ from that given earlier or later, the broad fundamentals of the subject are taught to each class.

The general plan of study and training in the Aviation Ordnance Section is as follows:

A. Theoretical

1. Making an Ordnance officer or enlisted man.
2. Acquiring a working knowledge of Ordnance procedure and Ordnance Department setup.
3. Requiring a working knowledge of Aviation Ordnance procedure.

B. Practical

1. Bombs

- a. Construction, components, fillers
- b. Field Maintenance
- c. Servicing and bomb handling

2. Bomb fuzes
 - a. Construction
 - b. Operation
 - c. Purpose
 3. Pyrotechnics
 - a. Composition
 - b. Construction
 - c. Purpose
 4. Storage
 - a. Magazine storage
 - b. Field storage
 5. Small Arms weapons
 - a. Pistols and revolvers
 - b. Rifle, M1
 - c. Sub-machine guns
 - d. Shotguns
 - e. .30 cal. aircraft machine guns
 - f. .50 cal. aircraft machine guns
 6. Aircraft cannon
 - a. 20mm automatic cannon
 - b. 37mm automatic cannon
 7. Aircraft installations of all types of guns
- C. Field Exercises
1. Camouflage
 2. Demolition

3. Distributing Point Procedure
 4. Bomb Servicing
 5. Observation of Proof Tests
 6. Inspection Trips
- D. Classroom Work
1. Conference
 2. Lecture
 3. Movies
 4. Writs and Examinations
 5. Problems
- E. Homework
1. Problems
 2. Text Problems
 3. Write-ups on actual observations

An interesting feature of this course, which is an indication of the importance being attached to it, is the scheduling of homework. This is designed to keep abreast of current classroom work. Some of this work requires the development of the student's research ability; some requires him to familiarize himself with texts, by requiring him to state the sources of certain information.

Thus, it is seen that the objective of the Aviation Ordnance course is not only to instruct the student during all hours of the school day, but in the hours which follow the day as well. The course is concentrated, but not to the disadvantage of the student. He is guided carefully in his classes, then released to pursue his studies further while he exercises his initiative and ingenuity, returning again the next day to the guidance of his instructors. Thus, he is kept continually in line with his classmates and with the normal exploitation of his schedule of study.

TRAINING OF AMMUNITION SUPPLY REPLACEMENTS

By: R. E. Hurley, 1st Lt., Ord. Dept.

An indication of the efforts being made at the Ordnance Replacement Training Center to meet every Ordnance need of the armed forces, may be seen in the program arranged for the training of personnel intended as replacements for units engaged in the supply of ammunition. Two of the factors which have necessitated this phase of training are mobility and fire-power, both of which have become of increasingly greater importance in the modern version of our armed forces. These two factors are at the same time the means of fierce attack or certain defense; they are the ingredients of sure and swift victory.

Mobility of fighting troops is of no advantage if it is not coordinated with a flexible system of supply capable of furnishing the required materials at the place of their use at the required time. Fire power is maintained not by the number of men and guns alone; it is equally dependent upon sufficient quantities of usable ammunition delivered to the fighting units.

A reliable system of supply is truly a "secret weapon" of modern warfare. This is true of all supplies, but especially so of ammunition. Whereas the consumption and distribution of other supplies remain about the same, or even decrease, during the heat of battle, it is at this particular time that the supply of ammunition becomes a

gigantic problem. This we call the "battle importance" of ammunition supply.

During the crucial period of a decisive engagement the average soldier may actually require his own weight in ammunition almost daily. Our troops may march to battle under their own power, but their replenishments of ammunition, which amount to staggering totals, must be brought to them over strafed and battlescarred country. These many tons of ammunition must be moved as nearly unobserved as possible over the best routes available, be they roads, improvised roads, or cross-country. Reserves of ammunition must be stored where there is the least likelihood of them being discovered and destroyed by enemy aircraft. And in spite of all these difficulties and hazards, the supply must be sure.

To this there is added still another problem, a result of the modernization of fighting forces. The variety of modern ammunition is a far cry from the powder and shot of colonial days. Modern artillery requires the correct complete rounds or components; ammunition which does not fit the weapon is useless.

Of equal importance with guns, tanks or planes, ammunition supply, this vital link in our defenses, is being studied today at the Ordnance Replacement Training Cen-

ter. This is in coordination with the general policy of deriving the maximum benefit from research, of testing every logical idea and theory, of adopting the best and discarding others. Thus our methods of ammunition supply are being kept in tune with the requirements of our modern army.

A complete realization of our plan of ammunition supply requires intelligent and thoroughly trained Ordnance personnel. A large proportion of trainees passing through the Ordnance Replacement Training Center find themselves in Munitions Workers Classes. These men are a part of the unprecedented program of Ordnance training which is now under way here. These men will be sent out to Ammunition Companies and Aviation Ordnance Companies, in the field, where they will become an integral part of the entire plan of Ordnance Service, which of course includes ammunition supply.

While at the Ordnance Replacement Training Center the prospective munitions worker is first of all given instruction in all types of powder and ammunition. He is shown the safe methods of handling, storage, inspection, and demolition of ammunition.

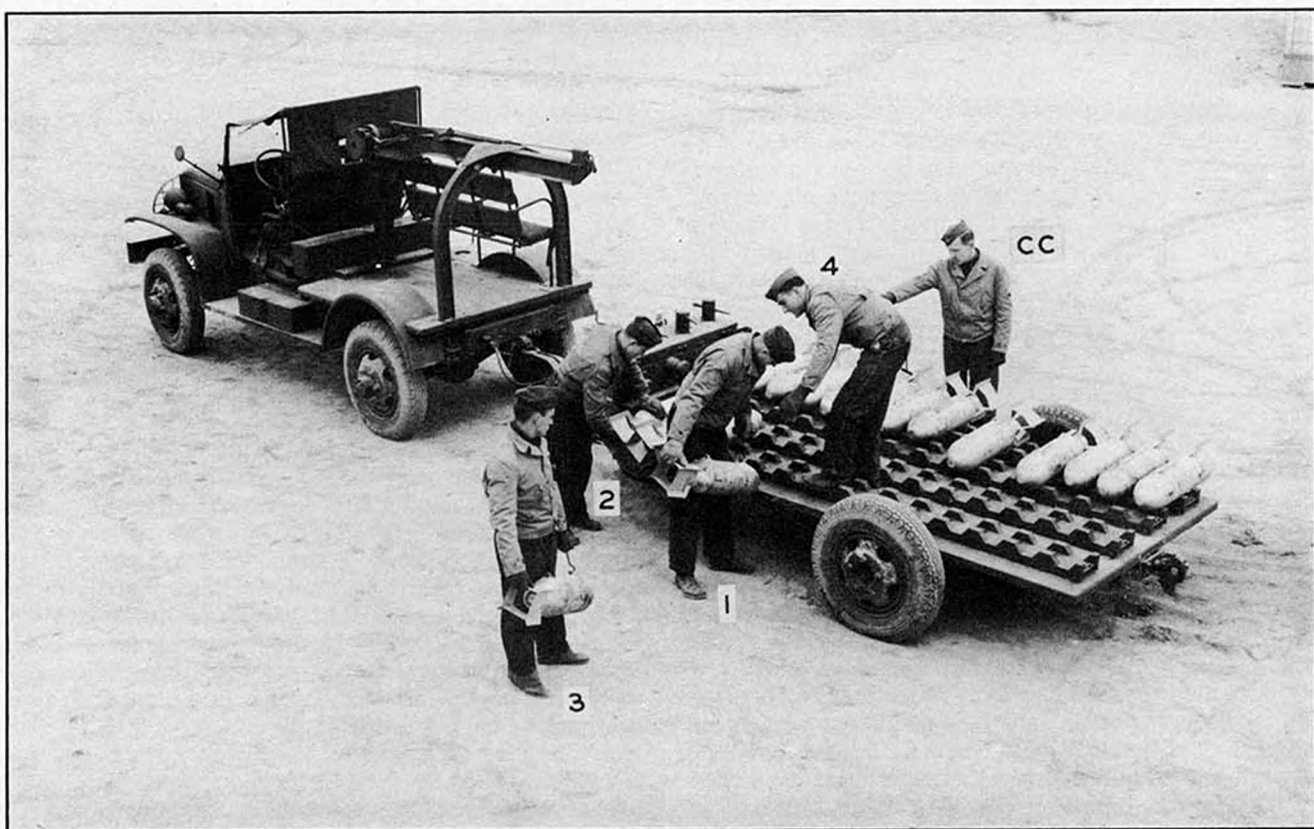
This generalization is desirable so that each man may have a knowledge of all types of ammunition before going into the field, even though he may be called upon to work with only a few types and calibers.

Next, he is shown the standard methods of packing and marking ammunition, and the various identifying devices in current use. This knowledge is most essential to the soldier who will be engaged in supply activities. A quick recognition of the various classes, types and calibers will prove to be the best insurance against costly errors in the field.

Until this stage of his training the student has become acquainted with what we may consider the peace-time duties of the munitions worker. These duties, however, are secondary to prompt, continuous and efficient supply activities in time of war. This later consideration must therefore be stressed in training. The student is shown the organization of the troops he will serve, so that he may see the broad field of his activities, and understand to a considerable extent the reasons behind the duties he will be expected to accomplish. Theory and practice of supply are also covered, in order to develop self reliance and confidence, in order to enable him to function as an individual if need be, as well as a member of an organized force.

The next phase of training consists of a CPX, or Command Post Exercise. This is an actual problem in ammunition supply, making use of the prescribed supply forms, even though the exercise is conducted in the classroom with no actual movement of ammunition. This CPX is more or less preliminary to the blackout exercise, wherein several classes are combined and put into operation some of the supply establishments which would exist behind the lines in actual warfare. Sand-loaded ammunition containers are used to stock "army ammunition depots" from which ammunition is taken "forward" to distributing points where it would normally be issued to the troops engaged in combat. Students work in small groups under the control of acting noncommissioned officers who are their own classmates. They use 2-1/2-ton trucks and observe blackout and camouflage discipline.

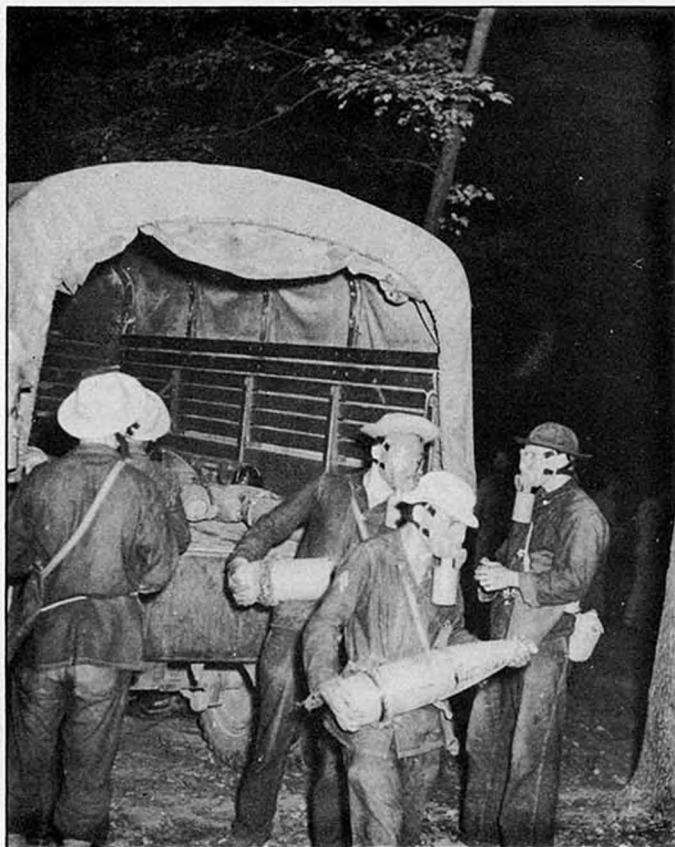
A young but rapidly expanding branch of ammunition supply is that pertaining to Aviation Ordnance. The student receives a background of the organization of the Air Force Combat Command, and of the various types of



Aviation Ordnance Companies. He receives a short but intensive review of bombs and pyrotechnics and then studies the problem of Aviation Ammunition Supply. This branch of the subject differs in several ways from normal ammunition supply, and may be said to be more specialized in that additional duties, not required of other ammunition units, are regularly performed by the personnel of Aviation Ordnance Companies. The basic technique is different in that air bases, unlike armies, do not move back and forth across the country. Special training and skill is required in order for personnel to be capable of properly finning and fuzing the many types of bombs now in use. A thorough knowledge of aircraft small arms and artillery ammunition is most essential.

A large part of the course in Aviation Ammunition Supply is conducted in the open, using the bomb service trucks and trailers assigned to the Ammunition Section of the Aviation Ordnance Company. A part of the outdoor exercise consists of an actual problem, during which bombs are withdrawn from storage and delivered (fuzed and finned) to an assumed squadron airdrome.

Throughout the training of the munitions worker, two thoughts are kept in mind. First: that America is at war, and all training should be considered from the viewpoint of its "battle importance". Second: that the individual should be instructed in the reasons behind his job, so that he will be able to function intelligently and logically, rather than blindly or automatically regardless of circumstances or conditions.



LIBRARY

Conducted by: J. M. Kelleher, Staff Sergeant, Ord. Dept.

One of the most informative Ordnance Field Service Bulletins that has been published recently at Raritan Arsenal, is that titled "Ordnance Field Service Publications — OFSB 1-8".

This pamphlet should be read and thoroughly understood for it is of inestimable value.

Reading it one can visualize what a tremendous task the Publications Department at Raritan has set out to accomplish and why it is essential that those whom it serves should acquaint themselves with the methods used in keeping the Ordnance Department and other components of the armed services, posted and up-to-date.

Some of Raritan's recent publications which are of

primary importance are as follows: OFSB 1-2 (List of Current Pamphlets and changes), dated November 15, 1941; OPSI (Ordnance Publication for Supply Index), dated December 18, 1941; and FSMWO — Subject Index (Ordnance Field Service Modifications Work Orders), dated November 15, 1941.

Checking over the November issue of THE ORDNANCE SERGEANT one may delete the notes "Not yet released for publication" following field manuals 23-36 and 23-80. An important change to FM 23-70 may be found in OFSC 247. The following technical manuals have been published recently and should be underscored in your copy; Group A, TM's 9-225 and 9-227. Group B — add: 9-292 Projector, Ground, Signal, M4, Group C, TM's 9-315 and 9-320. Group D, TM 9-350, Groups K, L, M, N, TM 9-850

(Tables for Allowances cleaning, Preserving and Lubricating Material, Recoil Fluids, Special Oils and Similar Items of Issue, replaces the data formerly found in TR 1395-A) Group A, TM 9-1205.

In the December issue the following may be underlined; Group C, TM 9-1305; Group F, TM's 9-1548,

9-1578, 9-1581, 9-1611, 9-1655, 9-1680, 9-1685, and 9-1695; Group P, TM's 9-1900, 9-2682 (See OFSC 246), 9-2683 and 9-2684.

Training Circulars numbers 65 and 69 contain changes to FM 21-6 (List of publications for training), many of which may be of more than passing interest.

"LETTERS FROM THE FIELD"

P. O. Box 269,
Arlington, Virginia,
December 15, 1941.

The Editor,
THE ORDNANCE SERGEANT,
The Ordnance School,
Aberdeen Proving Ground, Md.

Dear Sir:

May I make a few observations in regard to the problems of ammunition supply, as referred to in the articles of Brigadier General Hatcher and Major Billingsley on the IV Army Maneuvers?

What a blessing it is that those in the drivers' seats have come around to the idea of using ammunition boxes sandloaded to weight and/or wooden blocks cut to size, properly stenciled, etc. In no better way can the "using troops", personnel that man ammunition depots, dumps, and ammunition trains, etc., be made to appreciate the magnitude of their tasks.

I have been involved in two large CPX's in the northeastern part of the United States, and was in the Army Ordnance Office both times.

In the first CPX, the umpires turned in the combat troops ammunition expenditure reports. These reports were, in effect, requisitions, and were used as a basis for replenishing troop requirements. As these reports appeared to be excessive, I did some computing such as converting the number of rounds into boxes, and boxes into carloads, then into trainloads for some types of ammunition. I could hardly believe my figures, so after checking and double checking, I showed the results to the Army Ord-

nance Officer — now one of our brilliant Major Generals. We then made similar computations for each type of ammunition and pyrotechnics we had. The result was that it would have been difficult to muster sufficient cars for the daily trains.

The Army Ordnance Officer had a real talking point at the critique that evening and some eyes were opened, with the proper results.

The second CPX was similar but with a different Army Ordnance Officer. However, with the experiences of the previous CPX of record in the Corps Area Ordnance Office, the same errors were not repeated to such an extent.

In 1935, the First Army held maneuvers in the Pine Camp, New York, area. This time there were troops to be moved from here to there with nothing assumed. We had Ordnance Service, including Army and ammunition depots, and the 40th Ordnance Company (TNG) with a lot of experimental equipment, both machine and rolling. The ammunition depots were stocked with blank ammunition and pyrotechnics.

Now it takes time to move troops across country, or to draw ammunition. So compared to the two CPX's, we had but little to do and a lot of time to do it in.

These observations are not made to substantiate the remarks of General Hatcher and Major Billingsley, for they are so well founded that they will stand alone. I just present them for what they are worth.

Very truly yours,

Clyde Whitlatch,
M/Sgt. (Ord. Dept.) U. S. Army, Ret'd.

ORDNANCE NEWS ITEMS

Prepared by: W. L. Boland, 1st Lt., Ord. Dept.
Record Secretary, The Ordnance School

SERVICE SPORTS

Ordnance soldiers often come in for their share of razzing from Air Corps men when they are stationed at large Air Corps Training Fields, according to an item sent in by an anonymous member of the 461st Ordnance Company.

"The 461st Ordnance Company, Aviation (Bombard-

ment), together with the 689th Ordnance Company, Aviation (Pursuit), is approaching its full strength due to rapid receipt of men from the Ordnance Training Center at Aberdeen, Maryland. At present the boys are being instructed in Infantry drill, the rifle, and firing of the pistol.

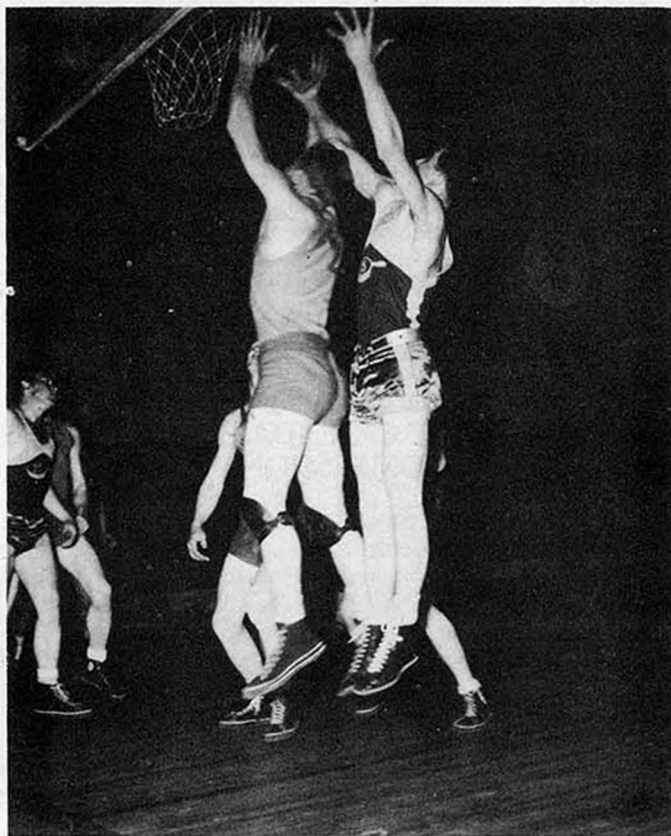
"The training in bomb handling by the N.C.O.'s of the 461st is moving along with clock-like precision, and the teamwork of the crews shows that they are a select group of men.



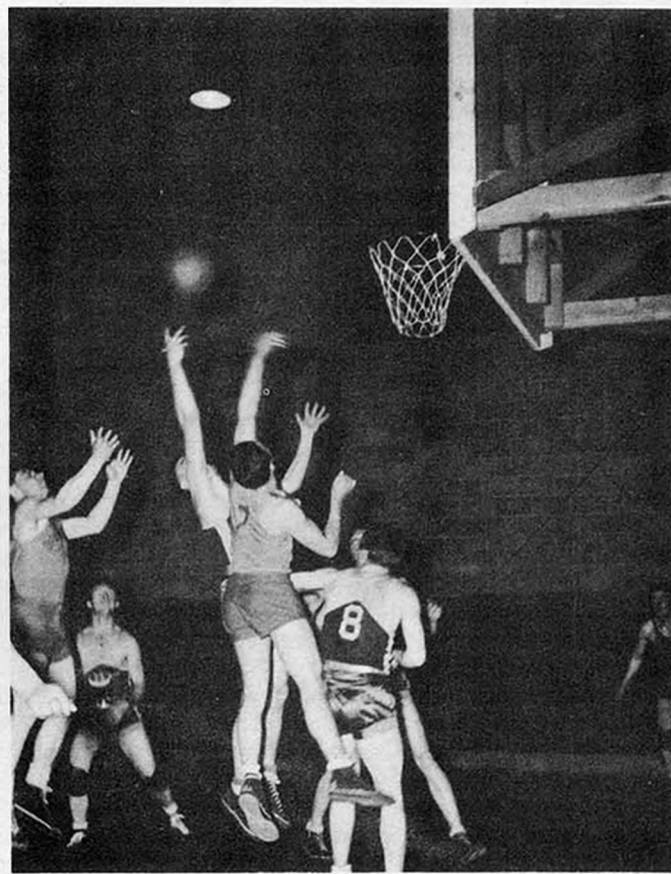
Standing, left to right: S. Sgt. R. R. Whiteside, Coach; Pvt. Muhvic, Pvt. Rossi, Pvt. Schultz, Pfc. Thomas E. Griffin, Pfc. Newhard, Pfc. Winter, Pvt. Brandt and Sgt. Morgan, Asst. Coach. Kneeling, left to right, Pfc. Mohn, Pfc. Vasquez, Sgt. Oravetz, Sgt. Armstrong, Corp. Haney, and Pfc. Bennett.

"The 461st-689th basketball team on the Post Gym floor, even though they are greatly outnumbered by the vast selections from Air Corps Squadrons. To date (December 5th) these basketballers have only lost the first game and won the next six games by walk-aways. However, the toughest games of the season are about to begin, and we wish them all the luck possible in winning the Post Championship Trophy."

War has begun since this item was written, but



war or no war athletics are still recognized as good conditioning for fighting men. All success to the Basketballers of the 461st-689th team.



ORDNANCE SCHOOL SECTIONS MERGE

Due to the stress being placed on Aircraft Armament in the Aviation Ordnance Courses, the Aviation Ordnance Section has been combined with the Small Arms Section, as of January 1, 1942. This permits the maximum utilization of instructional personnel and equipment available for these courses. This new section has become the Aviation Ordnance and Armament Section, with Captain John F. Foy as Senior Instructor.

This merger of Sections will have no effect upon the Small Arms and Aviation Ordnance pages of THE ORDNANCE SERGEANT.

SECOND OFFICER CANDIDATE CLASS COMMISSIONED

The second Officer Candidate Class was graduated and commissioned second lieutenants in the Ordnance Department on Tuesday morning, January 13th. Seventy-six young officers heard Lt. Col. Geo. W. Outland deliver a stirring address in which he stressed the responsibilities the new officers were assuming. Captain Edgar H. Kibler, Jr., Director of the Officer Candidate Course and Summary Court, administered the oath of office.

It is expected that the address by Lt. Col. Outland will be printed in a subsequent issue of THE ORDNANCE SERGEANT.

Who Reads THE ORDNANCE SERGEANT? When and How?

Each organization in the Ordnance Department receives a certain number of copies of THE ORDNANCE SERGEANT each month. Admittedly, the number of copies distributed does not meet with the complete approval of anyone. But — other things besides desires and wishes must be considered. As an example, reproduction facilities are jammed with work at present because of the large amount of training literature being reproduced. And, although it may seem strange, machines don't give a hang what anybody wants or demands. They run just so fast and turn out just so much work.

It has been necessary to limit distribution of THE ORDNANCE SERGEANT to an average of one (1) copy per each twenty (20) officers or enlisted men. We often wonder how the organizations make this limited number of copies give maximum benefit to ALL personnel. Letters are often received asking for a copy for each officer and first three grade man (sometimes only the officers are thought of). How about the men of the fourth, fifth and sixth grades? Don't we expect them to be interested, or to learn, or to provide a reservoir of potential first three graders and officers? There can be only one answer.

One particularly interesting plan has been sent in telling us how one organization solves this problem. We hope that all units have or will adopt the same or a similar plan.

This company in question is one of the numerous Medium Maintenance companies. It has an authorized

strength of 6 officers and 140 enlisted men, 8 of the latter being first three grade men. It receives seven (7) copies of THE ORDNANCE SERGEANT.

Immediately upon receipt the following disposition is made of these seven copies:

(a) One copy to a permanent file in the Orderly Room, where it is always available to company officers, and enlisted personnel of the Headquarters and Supply Section.

(b) One copy to a permanent file in the Day Room, where it is always available to all personnel of the company.

(c) Two copies are circulated among the officers, to be used by each officer for a period not to exceed three days. Thus these two copies are returned to the company office at the end of nine days.

(d) Two copies are circulated among the first three grade men, to be used by each man for a period not to exceed three days. Thus these two copies are returned to the company office at the end of twelve days.

(e) One copy circulated among a group of key men below the first three grades (five men), to be used by each man for a period not to exceed two days. Thus this copy is returned to the company office at the end of ten days.

(f) The five copies under c, d, and e, above, upon their return to the company office, are distributed for permanent files in each of the following sections of the company: Service, Artillery, Automotive, Armory, and Instrument.

In this manner each officer, each first three grade man, and each of the group of keymen has had an opportunity to give the issue a fairly good reading. At the same time all personnel has had access to a copy in the day room. And twelve days after the copies are received permanent files have been set up in seven different locations. No one has a personal file, true, but it seems that the most needs of the most people have been served in the best manner. We appreciate the desire for personal files, but after all this is not a personal war. We fight it as a unit, not as individuals.

NEW ARMY ORDNANCE DEPOTS

The new Ordnance Department storage depots are being erected to receive the flow of munitions coming from the new plants as well as from private industry and from the Army's manufacturing arsenals.

Ammunition is now being stored at the following new facilities: Wingate Ordnance Depot, Fort Wingate, New Mexico; Anniston Ordnance Depot, Anniston, Alabama; Umatilla Ordnance Depot, Hermiston, Oregon; and Ravenna Ordnance Depot, Ravenna, Ohio. In addition to these depots, the following new Ordnance Department storage facilities are under construction: Seneca Ordnance Depot, near Kandaia, New York; Red River Ordnance Depot, New Boston, Texas; Milan Ordnance Depot, Milan, Tennessee; and San Jacinto Ordnance Depot, Houston, Texas. Two additional depots will be constructed in the vicinities of Richmond, Kentucky, and Charles Town, West Virginia.

The structures built on the new depot reservations include above-ground storage magazines, some of them made of steel, wood and tile; others of these structures include concrete "igloos" covered with earth. The new depots are located at a distance from large centers of population. In addition to storing ammunition some of the depots will serve as transshipping points for munitions.

ARMY ORDNANCE

ORDNANCE FIELD SERVICE POLICY

The recent completion of the meetings of the committee of officers appointed by the Chief of Ordnance and chairmanned by General Hatcher for the purpose of reviewing several proposed Field Manuals, gives promise that there may soon be published Field Manuals 9-5, (the basic ordnance field manual); 9-6 'Ammunition Supply', and 9-10 'Ordnance Field Maintenance'. The publication of these manuals will be a material step forward in the matter of crystallizing policies and uniform procedures governing ordnance field service.

57-TON TANK

On the very day of the declaration of a state of war, the Ordnance Department unveiled its latest development — the 57-ton tank known as the T1E1. Designed by the Ordnance Department in conjunction with the best automotive engineering skill of private industry, the new tank is the first of a fleet of fifty such vehicles to be built by the Baldwin Locomotive Company for the Army. Requiring a crew of six or seven men, depending upon its mission, the new weapon has the greatest concentration of fire power of any tank yet produced in this country.

Brig. Gen. G. M. Barnes, in charge of engineering in the Ordnance Department, accepted the vehicle from the Baldwin Company on behalf of the Chief of Ordnance. "Today's occasion," General Barnes said, "takes on added importance and significance in view of the declaration of war by Japan against the United States. This great fighting vehicle exceeds all others in its military characteristics. It represents but one of the many new and previously unheard of weapons of modern warfare which are being added day by day to the military equipment of our Army."

ARMY ORDNANCE



SPECIAL GAGES

(Continued from page 144)

smoothly through the chamber in the cylinder. (The gage should be used after the cylinder is rotated by normal operation of the weapon, i.e., the hammer cocked and left in the cocked position.)

The gages shown in Figure 6 are known as "Not go" gages, and should enter the parts referred to herein.

a. Gage, gas piston, A77201, .494 inch, is used for the B.A.R., Cal. .30, M1918, M1918A1 and M1918A2.

b. Gage, gas cylinder, A77204, .503 inch, is used for the M1918A2.

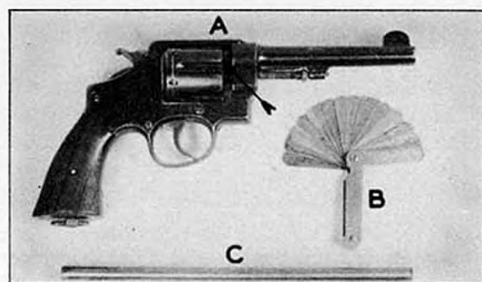


Fig. 5

a, Revolver, Cal. .45, Smith & Wesson, M1917; b, Gages, thickness; c, Gage, alignment (improvised locally).

c. Gage, gas cylinder, A77202, .501 inch, is used for the M1918 and M1918A1.

To Check Headspace

1. Headspace the gun in the manner prescribed for the weapon.
2. Cock the firing pin.
3. Retract the bolt slightly in order to relieve the pressure between the bolt and the rear end of the barrel which is caused by the driving spring.

Then insert the proper headspace gage in the T-slot between the face of the bolt and the end of the barrel. If the gun is headspaced too tightly, it will not be possible to enter the gage between the face of the bolt and the rear end of the barrel. If such is the case, the barrel should be unscrewed one notch at a time until the gage will enter. If the gun has been headspaced in the manner prescribed for the particular weapon, and if the headspace gage will enter between the face of the bolt and the rear end of the barrel, the headspace is correct.

It must be clearly understood that the gage is a "Go" gage which is designed particularly for the purpose of checking guns in installations where tight headspace adjustment would cause serious trouble. However, the gage may be used to determine whether headspace is unnecessarily loose by screwing the barrel into the barrel extension one notch at a time until the gage will not enter and then unscrewing the barrel one notch so that the gage will enter.

To Check Timing

The purpose of this check is to insure that the aircraft machine gun is not fired too early by the trigger motor or solenoid. In extreme cases of early timing, the gun will fire two shots and then stop because recoil from the second shot started before the extractor could engage another cartridge in the belt. It has been demonstrated that even when the time of firing is not so extremely early that the gun stops after firing two shots, firing may be early enough to cause inferior performance of the gun in lifting long ammunition belts.

1. Adjust the headspace of the gun if it is not known definitely that the gun has been headspaced properly, and cock the firing pin.
2. Raise the cover and retract the bolt slightly.

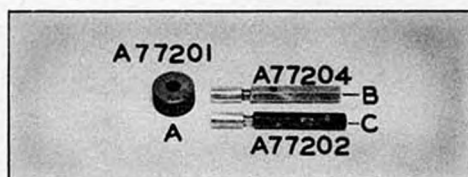


Fig. 6

Since a previous article on Special Gages was published the following gages have been issued: a, Gage, gas piston, A77201; b, Gage, gas cylinder, A77204; c, Gage, gas cylinder, A77202.

3. Insert the proper timing gage between the front of the barrel extension and the trunnion block; the curved portion of the gage is designed to permit this operation, as it conforms to the contour of the barrel.

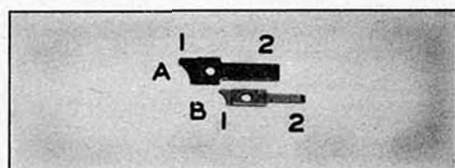


Fig. 7

a, Gage, head space and timing, A.C. Gun, Cal. .50, 1. Timing, .116 inch, 2. Headspace, .200 inch; b, Gage, head space and timing, A.C. Gun, Cal. .30, 1. Timing, .071 inch, 2. Headspace .130 inch.

4. Release the bolt so that the timing gage is pressed against the trunnion block by the barrel extension.

5. With the gage in place between the barrel extension and the trunnion block, an attempt should be made to release the firing pin by means of the trigger motor or the solenoid. If the firing pin is released, the solenoid or motor must be adjusted so that it will fail to release the firing pin when the gage is in place.

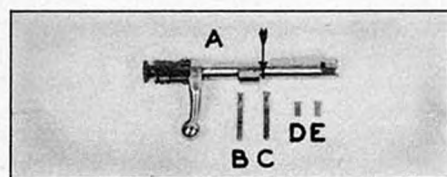


Fig. 8

a, Bolt with headspace adjusting feature, U.S. Rifle, Cal. .22; b, Gage, headspace, .043 inch; c, Gage, headspace, .046 inch; d, Gage, headspace, .043 inch; e, Gage, headspace, .048 inch.

The gages, headspace, .043 and .046 inch, are used with the rifle that has a bolt with the adjustable headspace feature.

The gages, headspace, .043 and .048 inch, are used with the rifle that does not have an adjustable headspace feature.

The correct gage is selected and is put in the chamber of the barrel; then the bolt is closed. (In closing the bolt on a headspace gage, light pressure should be used to avoid crushing the gage.) The headspace is adjusted by means of the headspace adjusting screw (arrow).

Reference: O.F.S.B. 4-6, Par. 10.

The use of trigger weights is one method of checking the trigger pull required in Small Arms weapons. Weights and rods may be made of any type of metal (preferably steel or brass.) The rods may be made of different lengths, so that the desired rod can be screwed into the weight. (A long rod is desirable for a rifle, and a short rod for a pistol, to conform to contour of the stocks.)

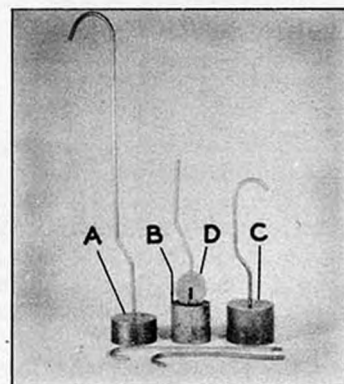


Fig. 9

Trigger weights. a, 3-pound weight; b, 5-pound weight; c, 7-pound weight; d, 1-pound weight.

Additional 1/2, 1, 2, 3 and 4-pound weights may be made to add to the basic weight for the required weight needed, i.e., if a 3-1/2-pound weight is desired, use the 3-pound weight (a) with an additional 1/2-pound weight; if a 10-pound weight is desired, use the 7-pound weight (c) with an additional 3-pound weight.

Checking for spread side plates in the Cal. .50 aircraft machine guns was discussed in the previous article on Special Gages for the Cal. .30 air craft machine guns. The method of using the thickness gages and the dimensions are identical.

The Reflector, barrel, B147001, is used to inspect the bore and chamber in the Cal. .50 machine guns.



WINCHESTER SHOTGUNS

(Continued from page 150)

d, Figure 12, is firmly riveted to the rear end of the bayonet attachment.

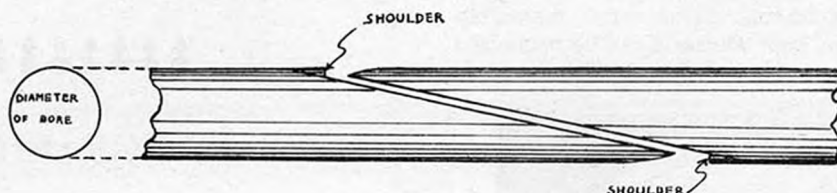
FRONT SIGHT. - The bead type front sight is riveted on top and about one-half inch from the front face of the bayonet attachment.

This completes the detailed description of parts.

INSPECTION AND REPAIRS. - After disassembly, clean and inspect the bore, noting carefully its straightness and any presence of dents, paying particular attention to the front end where the three threaded cuts for the bayonet attachment screws are located. The metal remaining on the barrel, after the cuts are machined, is very thin (approximately .025") and unless the bayonet attachment is lined up properly in assembly, forcing the screws will raise dents on the inside of the bore.

These or any other dents on the inside of the barrel

can be removed by using a round hard brass rod of the same diameter as the bore and cut, as shown in Figure 13.



By driving the two halves together, the dented planes are forced outward and can be smoothed out by peening carefully. When cutting the bar it is necessary to braze a shoulder on one end of the cut to prevent over-travel when forcing the two halves together, with consequent forcing of the barrel out of round. The other end of the cut should be slanted slightly, to allow the bar to slide under the dent.

The bayonet attachment assembly is inspected for dents and burrs.

The action slide must be examined for straightness and if found to be bent can be straightened by hand. The end of the action slide where it engages the action slide lock should be checked for burrs and if found removed, being careful not to change the angle on this surface.

The action slide handle will sometimes be found cracked, in which case it should be replaced.

Inspect the magazine tube for dents and carefully pound these out on a mandrel. Dents in the magazine tube will cause failure to feed by interfering with the free movement of the follower.

Examine the stock for nicks and dents.

Inspect for broken ejector spring and for missing ejector pin. The absence of the later will not stop the gun from functioning, as its purpose is to prevent the breaking of the ejector spring when the fired cartridge is being extracted. After its insertion, the ejector pin must be prick-punched to keep it in place.

The action slide lock release plunger pin should be carefully examined for the burrs. This trouble is one of the main causes of stiff extraction and reloading.

Examine the left extractor pin to see that it is dressed down flush with the walls of the groove below the extractor.

Inspect for a broken or bent firing pin, and for worn or damaged cam surfaces on the firing pin lock. Examine the firing pin stop pin for damage due to tampering.

In very rare instances, a mainspring will be found broken, in which case it should be removed and replaced.

If it is found necessary to remove the cartridge stops, care must be exercised in replacing them to see that their beveled edges are flush with the side walls of the receiver. After the assembly is completed, their functioning must be tested. They should be so adjusted, that the cartridges are held in place in the magazine during the firing but can be released without binding during the

reloading operation. Should it be found that the cartridges in the magazine fall out when the gun is fired, this condi-

tion can be corrected by a slight tap on each of the protruding lugs on the cartridge stops.

As each part of the carrier, the bolt, and the trigger assembly is removed, it should be thoroughly cleaned and examined, and if it is found defective it should be repaired or replaced, depending on the nature and extent of the defect.

REASSEMBLY AND FINAL INSPECTION. - Having inspected and repaired all the individual parts, the shotgun is reassembled. The action slide handle should then be operated several times to check ease of functioning during loading and unloading. With a special weight or spring scale, measure the trigger pull, which should be at least 6 pounds. The gun is then fired at least four shots, using magazine feed, to ascertain whether the cartridge stops are functioning properly. Should they fail to hold the cartridges in the magazine while firing, an additional slight tap on each of the protruding lugs of the cartridge stops will correct this condition. Occasionally after the shotgun has been issued to the service, complaints will be received that the cartridges fall out of the magazine when firing. This may happen in case certain types of ammunition is used in which the rim of the cartridge is slightly smaller than that used in the repair shop.

This completes the article on the Winchester shotgun, riot type. Next month's article will deal with the Remington Shotgun.



VALVE HOLDERS

(Continued from page 154)

3. The bracket may then be pryed loose (Figure 8) from the block by using a hammer handle.



Fig. 10

4. The bracket can then be lifted out of the compartment (Figure 9). Care must be taken to hold all the lifters up to prevent the tappet bodies from catching or dropping into the compartment. (The entire assembly should be cleaned and then kept where it can be protected from dust and moisture.)



Fig. 11

5. Remove the holders with a large "C" shaped valve compressor. Note that the top of the compressor is not placed on the valves (Figure 10).

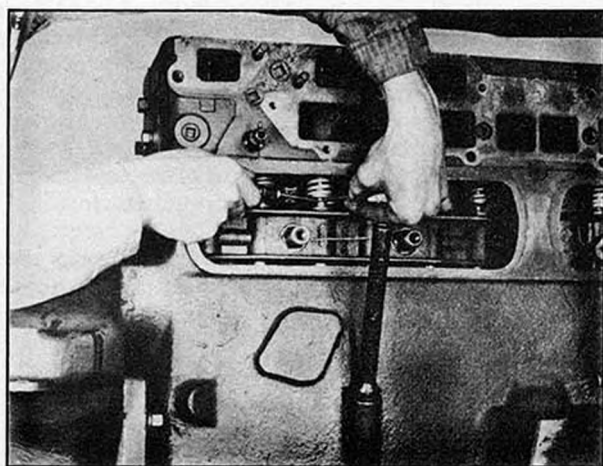


Fig. 12

6. The valves and valve springs may then be removed in the usual manner. (See Figure 11.)

7. Before replacing the units on the engine again the working parts of the lifters should be covered with a light film of oil and all chambers (L) should be bled (oil removed) by tripping the ball check valve (D) (a wire may be used).

In replacing the units the procedure from 1 to 6 is reversed.

Clearances to insure initial operation of the plunger spring (K) and hydraulic plunger (C) should then be taken with a feeler gauge. The clearance tolerance is from .045" to .080" with the operating parts cold. The spring (K) may be compressed with a screwdriver and the clearance may then be measured with a feeler gauge. (See Figure 12.)

In conclusion of this article the writer wishes to

give full credit for the design and development of the use of the valve holders to M. Sgt. Winslow and S. Sgt. Grimme of the Automotive Section of the Ordnance School.



RANGE FINDER

(Continued from page 157)

c. When the instrument is mounted its ends must not be touched or bumped as the parts in the center will be subjected to undue strain, thus tending to shear off the small screws securing the adapter to the tube.

d. The interior of the range finder is sealed against the entrance of dust and moisture and any unnecessary disassembly will unseal the internal parts and may cause serious damage to the instrument.

e. Although the range finder is so constructed as to withstand the maximum amount of hard usage and strains of field conditions it should nevertheless always be considered as being a delicate optical instrument, which it actually is. It should be treated and handled with the care any delicate optical instrument requires.

f. Every precaution should be taken to protect the instrument from shocks, strains, jars, neglect, moisture, etc. To properly care for the instrument, personnel responsible should familiarize themselves with the functioning of the various parts, adjustments, etc., so as to be able to determine steps to be taken for care and preservation.

g. The instrument should be stored in a dry place, with constant temperature, and adequate air circulation.

h. The instrument should be protected as much as possible during wet weather. When the rain is over, or operations cease, the instrument should be carefully wiped and dried. In particular the wedge and scale windows should be wiped perfectly dry. Dry dust must be removed from optical elements with a camel hair brush. Be sure that it is clean. Metal parts should be wiped with a dry cloth. No cleaning paste, or abrasive should ever be used on any part of the instrument.

i. The greatest care should be taken to keep grease or oil off the wedge windows, wedges, lenses, prisms and other optical elements and none of these should ever be touched with the bare fingers.

j. If, in any case, the accumulation of moisture is detected in the inner tube of the range finder, the end boxes may be removed to allow a stream of air to pass through the instrument, dissipate and dry the moisture. This should be done only in dry weather, and then only when no fog, smoke or dust is about the range finder. Experienced personnel should be available to do this. UNDER NO CONDITIONS WILL THE RANGE FINDER BE DISASSEMBLED BY OTHER THAN A COMPETENT, ORDNANCE INSTRUMENT REPAIRMAN.

k. The using service is not permitted any painting operations. Any necessary painting of the instrument must be accomplished by the instrument section or higher echelons of maintenance.

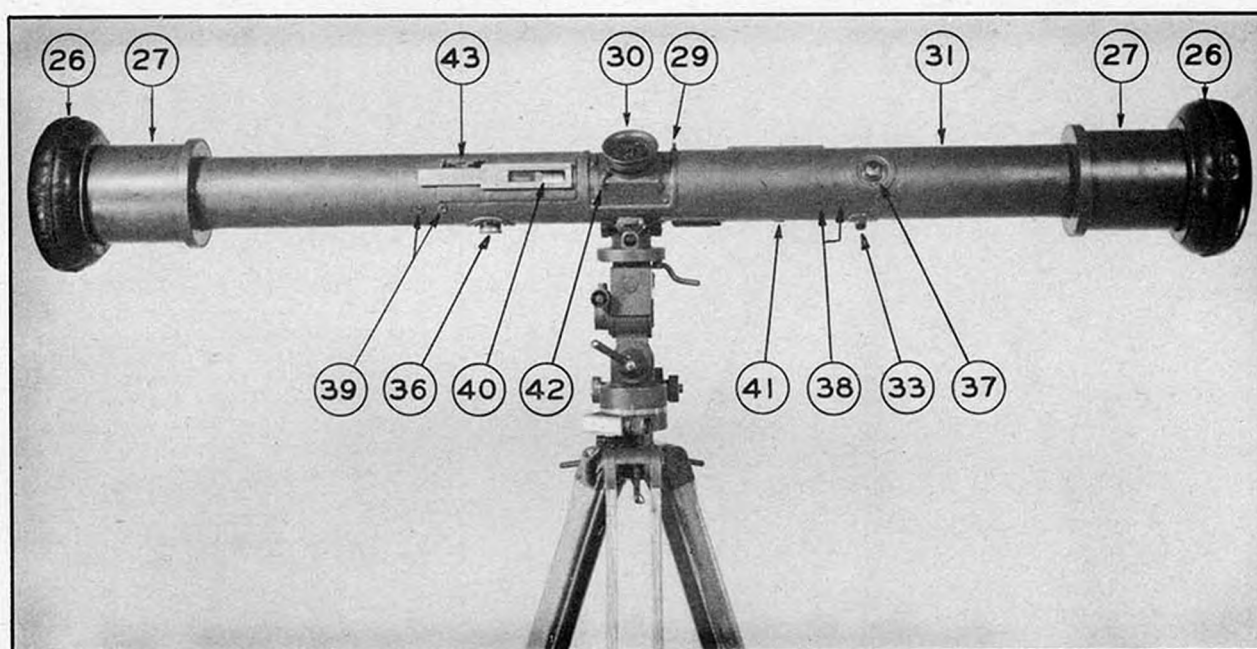


FIGURE NO. 3. - RANGE FINDER, 1 METER BASE, M1916 (REAR VIEW)

- | | | |
|------------------------------------|---------------------------------|--------------------------------|
| 26. Buffer. | 31. Outer tube. | 39. Plugs over left objective. |
| 27. End box. | 36. Gimbal joint cover. | 40. Range drum. |
| 29. Open sight. | 37. Correction wedge window. | 41. Plug over correction lens. |
| 30. Eye shield. | 38. Plugs over right objective. | 42. Ray filter lever. |
| 43. Name plate with serial number. | | |

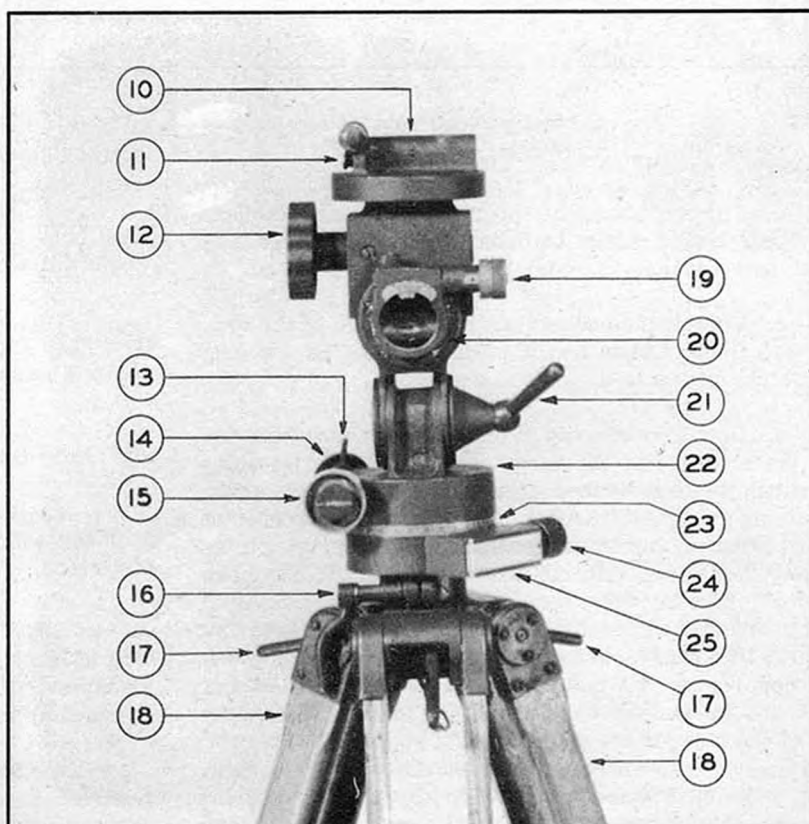
1. ALL WORK ON THE RANGE FINDER EN-TAILING UNNECESSARY TURNING OF SCREWS, ETC., NOT DIRECTLY INCIDENT TO IMMEDIATE CLEANING

OR ADJUSTING IS STRICTLY FORBIDDEN.

14. GENERAL INSTRUCTIONS FOR RANGE

FIGURE NO. 4.-TRIPOD AND MOUNT, RANGE FINDER, 1 METER BASE, M1916

10. Range finder support.
11. Plug for support catch.
12. Elevating knob.
13. Throw-out lever.
14. Azimuth knob.
15. Azimuth micrometer.
16. Tripod head bushing clamping lever.
17. Tripod leg clamping lever.
18. Tripod leg assembly.
19. Angle of site micrometer.
20. Angle of site lever.
21. Clamping screw handle.
22. Upper azimuth worm housing.
23. Azimuth scale.
24. Azimuth adjusting worm knob.
25. Notation strip.



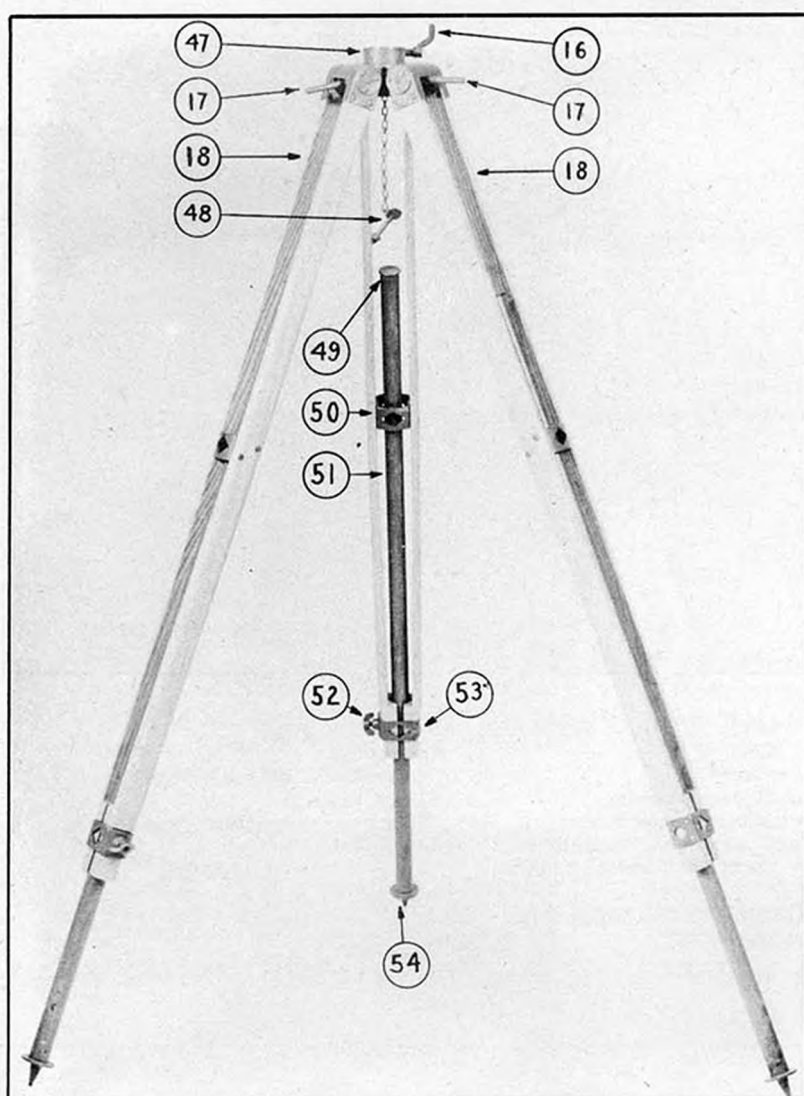


FIGURE NO. 5. - TRIPOD TYPE U

- 16. Clamping lever.
- 17. Tripod leg clamping lever.
- 18. Upper leg assembly.
- 47. Tripod head bushing
- 48. Locking screw with chain.
- 49. Lower leg cap.
- 50. Leg separator.
- 51. Lower leg assembly.
- 52. Clamp nut.
- 53. Lower leg clamp.
- 54. Lower leg shoe.

FINDER. - a. The best defined portion of any object should be selected to range on.

b. The tripod and the mount should always be used if possible. If this cannot be done it must be supported in as practical a manner as conditions will permit.

c. Coincidence should always be made in the center of the field of view and if possible with the dividing line at right angles to the object observed.

d. Upon the accuracy of the coincidence setting depends the accuracy of the range determination. No difficulty should be experienced upon the part of the observer in obtaining good results after a little practice or even at the first attempt, but in range finding as in anything else accuracy increases with constant practice. It has been found that different observers have what might be called personal errors which diminish as their experience increases. The range observer should therefore be given every opportunity for practice in measuring angles and ranges and in making halving adjustments. When both edges of the objects are equally well defined the observer should always make his coincidence on the same edge, right or left. Individual observers have obtained better results by so doing than if they used the right edge sometimes and the left edge other times. It is advisable when time per-

mits to obtain the range by taking the mean of several consecutive readings.

e. With targets moving laterally across the field, it is best to adjust and to make the measurements for range while the target runs across the field.

15. TO SET UP THE INSTRUMENT. - a. Remove the tripod from the case and adjust the lower legs to the desired height.

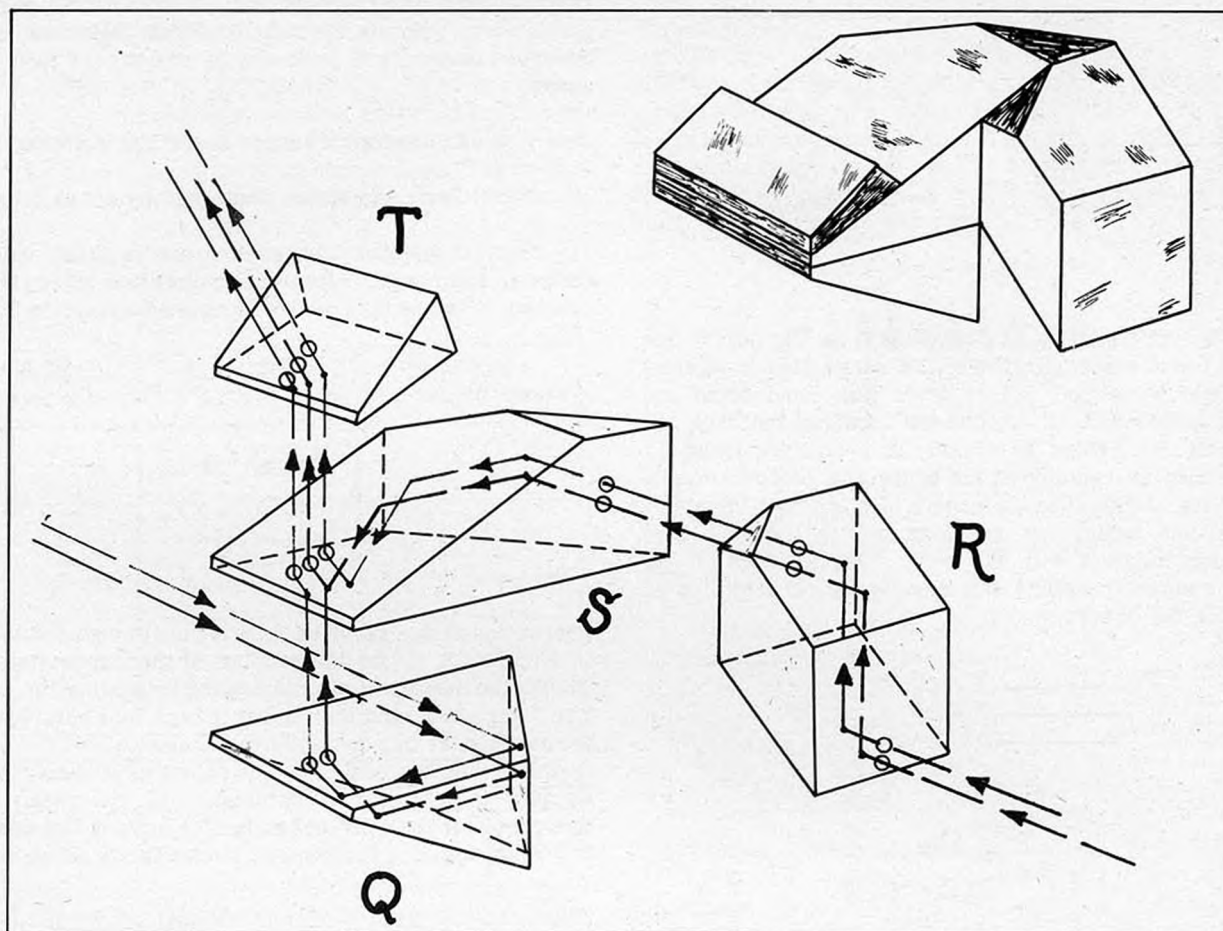
b. Spread the legs to approximately thirty degrees and clamp them securely in place.

c. Remove the range finder from the carrying case, open the windows and mount the instrument securely on the tripod.

16. TO ORIENT THE INSTRUMENT. - After setting up the instrument, and prior to actual use, the range finder must first be oriented. To orient the instrument, proceed as follows.

a. Set the azimuth scale and micrometer to the desired azimuth.

b. Loosen the vertical clamping lever and rotate



the range finder until the vertical line in the field of view is approximately on the target. Then clamp in place with the vertical spindle clamp.

c. Rotate the orienting knob while observing the image, until the instrument is in fine adjustment, or until the vertical reference line rests upon the image. The best and most clearly defined portion of the image should be used as the target and all range readings must be taken from the center of the field of view, since there will be too many aberrations present near the edges of the field of view which will interfere seriously with the accuracy of readings that may be taken in that vicinity.

17. TO OBSERVE AN OBJECT AND TO READ THE RANGE TO THE OBJECT. - a. Rotate the throw-out lever and hold in place.

b. Rotate the range finder until the reference line in the lower field of view is approximately on the target. Release the throw-out lever.

c. The image will now probably appear as in the sketch shown in Figure 8.

d. Then by rotating the halving adjustment roller and the elevating knob the images can be brought into "halving" and should appear as in Figure 9.

e. Rotate the range knob and observe the target. When the image in the upper half of the field of view exactly coincides with the lower image they should appear as shown in Figure 10.

f. The range can then be read from the scale on the range drum.

18. TO MEASURE AN ANGLE OF SITE. - a. Rotate the elevating knob until the horizontal line in the field of view is upon the base of the target.

b. Level the angle of site level by rotating the angle of site micrometer and note the reading of the micrometer. The reading obtained is the angle of site as measured in mils.

19. INDISTINCT TARGETS. - To observe an object that has no distinctive features, such as flat terrain or trenches, the range finder may be used in the vertical position by clamping the instrument in this position by means of the vertical hinge screw clamp. The method of obtaining coincidence is the same as in Paragraph 14, as supplemented by the appearance of the field of view as shown in Figure 11.

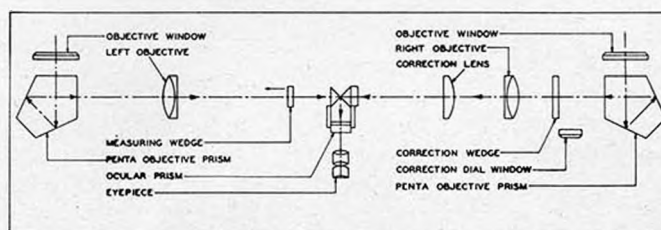
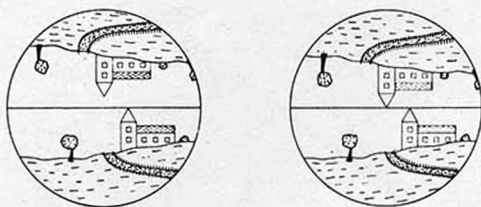
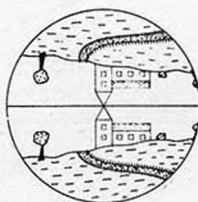


FIGURE NO. 7. - OPTICAL SYSTEM OF THE RANGE FINDER, 1 METER BASE, M1916.



20. EYEPIECE ADJUSTMENT. - To adjust for correct diopter setting direct the range finder against some clearly defined object from five hundred to one thousand yards distant. Rotate the focusing nut back and forth until the target is clearly and sharply defined. Note the diopter reading on the scale and record as indicated below. Make at least three trials and take the average. Do not reject any readings merely because they appear inconsistent with the rest. The average of the three (or more) readings will then be the correct diopter setting for the observer.

1st trial _____
 2nd trial _____
 3rd trial _____

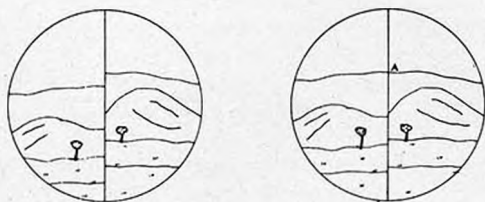


21. HALVING ADJUSTMENT. - Adjust the halving line by rotating the halving adjusting roller and elevating knob until the images appear as shown in Figure 9.

22. RANGE ADJUSTMENT. - If the range finder consistently reads ranges incorrectly there are two methods by which the instrument may be adjusted. Both of the adjustments outlined below may be performed by either the using service or by Ordnance personnel. The two methods are:

- a. The infinity method of adjustment.
- b. The known range method of adjustment.

23. INFINITY METHOD OF ADJUSTMENT. - a. Set the adjusting lath in a horizontal position at least two hundred yards to the front of the range finder. Use the

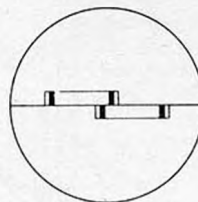


sighting tube to bring the lath to within one degree of parallelism with the instrument. This tolerance must be observed carefully if accuracy of adjustment is to be secured.

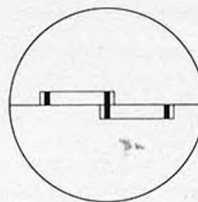
b. Adjust for halving as described in Paragraph 21.

c. The range drum must then be set at infinity.

d. If the two images are not in coincidence, as shown in Figure 12, rotate the correction wedge with the



correction wedge key until coincidence is secured as shown in Figure 13. Note the reading of the correction scale. Throw the image out of coincidence by moving the correction wedge key, and then bring it back into coincidence as above. Repeat this operation ten times and set the average on the correction scale. Do not reject any readings merely because they appear inconsistent with the rest. During this operation the eyepiece should be adjusted as described in Paragraph 20. A chart, as shown below, may be used.



The average of the ten readings should be set on the correction scale. This completes the field adjustment by the infinity method.

1st trial _____	6th trial _____
2nd trial _____	7th trial _____
3rd trial _____	8th trial _____
4th trial _____	9th trial _____
5th trial _____	10th trial _____

AVERAGE OF THE 10 READINGS _____

24. KNOWN RANGE METHOD OF ADJUSTMENT. -

a. The known range method of adjustment is the same as the one given except that a target at a known range is used instead of the adjusting lath and this known range is set on the range drum.

b. Ten readings are taken on the known range by adjusting the correction wedge with the correction wedge key.

c. The same precautions are observed as described in Paragraphs 20 and 21 above.

d. Set the correction scale at the average of the

ten readings obtained. This completes the field adjustment by the known range method.

25. CHECK FOR ACCURACY. - a. To further check accuracy by the known range method select three known ranges and read the range to each target. Record the readings on a table similar to the one below. The known ranges selected should fall between the following distances:

- (1) The first range between 400 and 800 yards.
- (2) The second range between 1000 and 2000 yards.
- (3) The third range between 3000 and 5000 yards.

FIRST RANGE 400 to 800 yards	SECOND RANGE 1000 to 2000 yards	THIRD RANGE 3000 to 5000 yards
1st		
2nd		
3rd		
4th		
5th		
6th		
7th		
8th		
9th		
10th		
Average	Average	Average

b. If the instrument does not read ranges within the tolerances listed in Paragraph c, below, repeat the procedure outlined in Paragraphs 23 or 24.

c. The error that a practiced observer may make in reading ranges is proportional to the square of the distance to the object and also proportionate to the accuracy with which the observer is able to obtain and maintain coincidence. It is additionally proportionate to the base of the instrument, i.e., the longer the base of the range finder the more accurate will be the readings that are obtained. Providing that an observer can reach coincidence within twelve inches, the error which a practiced observer may make under favorable conditions is shown in the following table.

DISTANCE	Probable ERROR
400 yards	2 yards
800 yards	4.5 yards
1000 yards	5 yards
2000 yards	25 yards
3000 yards	45 yards
4000 yards	60 yards
5000 yards	100 yards
6000 yards	140 yards
7000 yards	200 yards
8000 yards	250 yards
9000 yards	325 yards
10000 yards	400 yards

d. Note. - If the range finder is used for a period of several hours it should be readjusted at frequent intervals. The change in the angle of the sun's rays affects vision to such an extent that readings obtained with the instrument will vary appreciably from hour to hour. If the using service cannot adjust the range finder by either the known range or the infinity method of adjustment, as described in this article, qualified Ordnance personnel must then adjust the instrument.

(Continued in the March issue)



MILITARY CORRESPONDENCE

(Continued from page 159)

this transfer will enable me to more fully utilize my training and gain promotion to the mutual benefit of the government and myself.

3. I have sufficient funds to defray cost of transfer and am willing to use them therefor.

Thomas J. Collins
THOMAS J. COLLINS, 6455200,
Corp., 719th Ord. Co. Avn. (AB).

Example No. 4

201-Collins, Thomas J. (Enl) 1st Ind. HBT-ark
Hq. 719th Ord. Co. Avn. (AB), Mitchell Field, L. I., N. Y.,
December 31, 1941. To: Commanding General, Third
Corps Area, Baltimore, Maryland.

1. Approved.

2. Information furnished as follows:

a. Accepted for enlistment: Troy, N. Y.
Nov. 1, 1939.

b. Age at enlistment: 21 years 2 months.

c. Conjugal status: Single, no dependents.

d. Physical condition: Good.

e. Statement of service: Prior service;
none. Current enlistment: Accepted for enlistment at Troy,
N. Y., Nov. 1, 1939, for three (3) years.

f. Soldier is not under charges, in confinement, or under-going company punishment.

g. Statement of accounts: Due U. S. Nothing.
Due soldier current pay.

h. Character: *Excellent HBT*

i. Authorized strength of company: 297.

Actual strength of company: 300.

H. B. Thomas
H. B. THOMAS.
Capt. Ord. Dept.,
Commanding.

INDORSEMENTS. - In civilian practice a letter is customarily answered by the writing of a letter in reply. In the military service, however, this method is not followed. In order to save time, labor, and avoid unnecessary delay the "indorsement" is used in replying to a commu-

nication. An indorsement is a form prescribed for replying to or forwarding of military correspondence which requires further action. In addition to providing sequence or continuity, an indorsement obviates the necessity of repetition of details. It may consist of information, remarks, recommendations, notation of concurrence, approval, or disapproval, etc.

The form of an indorsement will be as follows:

1. Margins and spacing will be the same as for military letters.
2. The first written indorsement will begin approximately one-half inch below the last written matter on the page.
3. The second and succeeding indorsements will follow one another serially with a space of about one-half inch between indorsements on the same page.
4. The heading will include: File number, Number of indorsements, initials of person dictating and the typist, Official designation of headquarters, office, and place from which indorsement is being sent, Date, the word "TO" followed by the official designation of the person to whom the indorsement is being sent, and if to an individual, his grade, name, organization or branch, with post office address if necessary.
5. The body of the indorsement will begin two spaces below the heading, with the paragraphs numbered and spaced as in the regular type of military letter.
6. See Example No. 4 for illustration of an indorsement.

IMMEDIATE ACTION LETTERS. - Up to this point we have discussed the standard type of military letter. Occasion may make it necessary for you to take quick action on a matter. You would naturally think of the telegram as being the accepted medium of communication. However, excepting only the most urgent communications, the "IMMEDIATE ACTION" letter is used. The primary reason for this is to reduce the necessarily considerable expense involved in the use of telegrams; also, to reduce the load on the telegraph system.

Immediate action paper carries a one-quarter inch RED border with the words, IMMEDIATE ACTION, in capital letters, at the top and bottom, spaces being left in the border for these words. Appropriate immediate action envelopes are provided with a three-sixteenth inch border along the left edge, and along the top and bottom edges extending from the left corners to points three and one-half inches from the right corners.

All communications which you receive or send requiring immediate attention and prompt action rather than routine handling will be sent in this manner. Upon receipt of an immediate action letter it will be given prompt attention without delay. In no case will this type of communication be used for routine matters. To do so would soon destroy its value as such and defeat the purpose for which it was designed.

MAIL. - A necessary part of this discussion is the mention of the use of the mails in the conduct of official business. We quote directly, in part, Paragraph 4, AR 340-10, November 17, 1939, on the subject: "Official communications and other mailable matter relating exclusively to the business of the Government of the United States, mailed by an officer, will be transmitted free of postage in the domestic mails of the United States and

certain foreign countries when enclosed in a "penalty" envelope or wrapper." Postage stamps required for official mail are furnished by the Quartermaster Corps. Further study of this regulation is necessary if one is to gain a complete understanding of pertinent postal regulations.

No attempt has been made to cover the subject of military correspondence in its entirety. Its wide application makes it naturally a very detailed study. It will be necessary for the student to familiarize himself with the preferred usages relative to the conduct of military correspondence in force at his particular station.

Everyone dealing with this subject should have the following sources of information at hand:

1. AR 340-10 and 340-15.
2. TM 12-250.
3. Abridged U. S. Government Printing Office Style Manual.
4. Admin. Regs. of the Ord. Dept., Correspondence No. 1469.
5. A good dictionary.



ORDNANCE GENERAL SUPPLIES

(Continued from page 163)

As in all Ordnance activities, we have many issues of expendable property for the use of our Ordnance Shop for the maintenance and repair of Ordnance equipment, and we also use the Stores Slip to record these issues. The Storekeeper accomplishes this form in triplicate and has the person drawing the material sign for it on the form. The Storekeeper then routes the original copy of the Stores Slip to the Ordnance Property office, keeps the duplicate copy in his office, and delivers the triplicate copy to the Shop Office. The entry "FOR MONTHLY EXPENDITURE" is entered on all Stores Slips on which expendable property is issued to the Ordnance Shop for use therein. The entries on these Stores Slips showing the property issued to the Ordnance Shop for any given calendar month is consolidated in the Ordnance Property office on a "Monthly Certificate of Expenditure", which, after approval by the Commanding Officer of the Air Base, is used as a "Credit" voucher to drop the property from the Stock Record Account.

There is one other phase of property accountability for Ordnance General Supplies at an Air Base that is of interest to Ordnance personnel, and that is the transfer of Ordnance property from our Air Base to another Air Base when it is taken as a part of the plane load on the transfer of the plane. Since the Ordnance Property office has all Air Force unit organization equipment charged to the unit on Memorandum Receipt, there must be in operation a system that will expedite the transfer of Ordnance equipment transferred with any plane if that plane should leave the Air Base on a permanent change of station, and in addition to expediting the transfer, the system must be such as to admit of ready and accurate check, and show an accurate picture of all phases of such a transaction.

On receipt of notification by the Ordnance Property Office that a certain plane is going to be transferred from the Air Base station to another Air Base, an Ordnance

Inspector is detailed to check the equipment on the plane and have the Pilot of the plane sign a personal Memorandum Receipt for all Ordnance items on the plane. He also gives the pilot an unsigned Credit Memorandum Receipt. After the Pilot has assumed responsibility for the Ordnance equipment on the plane, the Ordnance Property office issues a Credit Memorandum Receipt to the organization that had been debited with these items. The Ordnance Property Office then prepares a Shipping Ticket listing the Ordnance equipment on the plane and sends it to the Ordnance Property Officer at the Air Base to which the plane is being transferred. When the plane arrives at the new Air Base, an Ordnance Inspector will inspect the Ordnance equipment on the plane, verify the serial-numbered items with the Pilot's unsigned copy of the Memorandum Receipt, and if found correct, will sign the pilot's Credit Memorandum Receipt, thus relieving him from further responsibility. The Ordnance Property Officer at the new Air Base will then sign and return to the old Air Base Ordnance Property Officer the original copy of the Shipping Ticket on which was listed the Ordnance equipment transferred with the plane. The Ordnance Property Officer at the new Air Base will then make out a Debit Memorandum Receipt listing the Ordnance equipment transferred with the plane and obtain the signature of the Armament Officer for such equipment.

All other provisions of Army Regulations concerning property accounts apply equally as well to Air Base Ordnance Officers as they do to any other Ordnance Property Officers. Receiving Reports, Inventory and Inspection Reports, Statement of Charges, etc., are handled in the usual manner.



TRAINING THE ORDNANCE MACHINIST

(Continued from page 165)

OPERATIONS

1. Plain shaping
2. Vertical shaping
3. Angular shaping
4. Grooving
5. Shaping to a layout
6. Shaping on centers

PROBLEMS

1. Cast iron block
2. "V" Block
3. Maintenance

MILLING MACHINE

- a. Nomenclature, capacity, function of various groups, care and maintenance
- b. Safety precautions
- c. Speeds and feeds
- d. Attachments and their uses
- e. Care, selection and mounting of cutters
- f. Mounting of work

OPERATIONS

1. Face milling
2. End milling
3. Form milling
4. Slotting
5. Grooves, and keyways
6. Use of index head
7. Use of Vertical attachment

A SUGGESTED GRADING SCALE

ELEMENT	95-100	85-94	75-84	71-74	below 70%
1. Quantity of work required	Always does more than required	Sometimes more than required	Just meets requirements	Sometimes less than required	Always below requirements
2. Quality of work required	Always better than requirements	Sometimes better than requirement	Just meets requirements	Sometimes less than required	Always less than required
3. Tools and Equipment	Repairs, replaces tools and cleans equipment	Always careful, sometimes repairs replaces tools	Generally careful with tools	Occasionally misuses a tool	Continually misplaces, breaks, or dulls tools
4. Materials	Conserves material and gets others to do so	Always careful with materials	Generally careful with materials	Occasionally wasteful with materials	Wasteful of material
5. Problem solving	Solves all problems	Solves nearly all problems	Solves only those problems in which he is interested	Solves only an occasional and easy problem	Solves no problems
6. Class discussion (TP etc.)	Always alert during discussion periods	Generally alert	Alert when interested	Occasionally alert, generally dull.	Always dull during discussion periods
7. Promptness	Always prompt in assignments	Generally prompt occasional lapses	Just meets requirements	Occasionally fails to meet requirements	Seldom meets requirements
8. Effort	Always to limit of ability	Generally good effort. Occasional lapses	Just enough to meet requirements	Sporadic in effort	Seldom exerts real effort

Above to be used as a guide in determining grades in performance or shop work of a student.

The theory grades will come from written or oral examinations.

PROBLEMS

1. "V" Blocks
2. Cast iron block
3. Step blocks
4. Lathe mandrels
5. Fluting a tap

THE SURFACE AND UNIVERSAL GRINDERS

- a. Nomenclature, capacity, function of various groups, care and maintenance
- b. Safety precautions
- c. Selection of grinding wheels
- d. Attachments and their uses

OPERATIONS

1. Flat surfaces
2. Angular surfaces
3. Cylindrical surfaces
4. Tool and cutter grinding

PROBLEMS

1. "V" Blocks
2. Lathe mandrels
3. Cutter grinding

Our method of grading students does not entirely depend upon the work which is actually produced; attitude is considered in addition to aptitude, as well as willingness to cooperate with the rules and regulations prescribed by the Ordnance School. The chart on the preceding page will enlighten you on our method of grading students.

With this outline as our basis, in the following issues we will present to you in detail the complete course, which the students are now receiving.



AMMUNITION INSTRUCTION

(Continued from page 168)

records necessary for this purpose, are covered, differentiation being made between concentrated and dispersed operations.

Emphasis is placed on storage in the field and the purpose, design, materials, and methods used in the construction of revetted bomb storage units are studied in detail. At this point the importance of, and methods and materials used in camouflage are stressed. Class room problems and actual demonstrations are part of this instruction.



THE CHALLENGE

(Continued from page 169)

hurl the greater strength back into the fray and swing the tide of battle, temporarily at least, to its side. Visualize, then, the tremendous advantage to be gained by the army which can carry on a continuous program of adequate maintenance so that the period of retiring from the field or calling a halt to make necessary repairs may be reduced to an absolute minimum if not eliminated altogether.

Aviation Ordnance men, the greatest challenge ever hurled into the face of an Ordnance man was yours when the first bomb struck Pearl Harbor early December 7, 1941. Let those scoff who may, but this war for days to come will be a war of flashing wings and thundering bombs. Upon the manner in which you tackle the gigantic responsibility which is yours may depend the future course this world is to take. In your lexicon of service let there be no such word as "defeat". Let others "keep 'em flying" ----- you just "KEEP 'EM FIRING!"



WELDING DEFINITIONS

(Continued from page 167)

in which a carbon or graphite electrode or electrodes are used, with or without the use of filler metal.

CARBON DIOXIDE: A heavy, colorless gas (CO_2) composed of carbon and oxygen and which has the property of extinguishing flame. It is more properly called carbonic acid gas. Water will absorb more than its own volume of carbon dioxide under pressure, in which state it becomes soda, or carbonated water. Compressed to a liquid it is used in some fire extinguishers and when frozen it becomes dry ice. It is present in the gases given off by an oxyacetylene welding flame.

CARBON MONOXIDE: A colorless, odorless gas (CO) composed of carbon and oxygen. It burns with a pale blue flame to form carbon dioxide. It is very poisonous when inhaled because it drives oxygen from the blood. It is present in the exhaust gases of internal combustion engines.

CARBURIZING (carbonating) FLAME: A gas flame having the property of introducing carbon into the metal heated.

CAST IRON THERMIT: A thermit mixture containing additions of ferro-silicon and mild steel.

COLD SHUT: Poor fusion between the layers of weld metal or between the weld metal and the base metal.

COMBUSTION: The process of rapid oxidation or burning.

CONCURRENT HEATING: Supplementary heating applied to a structure during the course of welding.

CONDUCTIVITY: The rate at which a metal body will transmit electrical current or heat through its mass.

CONTRACTION: The shrinkage of metal due to cooling from an elevated temperature.

CONE: The part of the welding flame that is conical in shape and located at the end of the welding tip.

COVERED (shielded arc) ELECTRODE: A metal electrode which has a relatively thick covering material serving the dual purpose of stabilizing the arc and improving the properties of the weld metal.

COVER GLASS: A clear glass used to protect the lens in goggles, face shields, and helmets from spattering

material.

CRATER: A depression in the deposited weld metal at the end of an arc weld.

CUTTING PROCESS: The process of severing or cutting metals by means of oxidation or melting. Oxygen cutting is an oxidation process of cutting. Metal arc and carbon arc cutting are melting processes.

CUTTING TIP: A gas torch tip especially designed for oxygen cutting.

CUTTING TORCH OR BLOWPIPE: An apparatus used in oxygen cutting. It is designed to control the gases used for preheating as well as the oxygen used for cutting.

CYLINDER (bottle): A portable container used for storage of a compressed gas.

DEPOSITED METAL: Metal that has been added to a weld, from an electrode or welding rod by a welding process.

DIP BRAZING: A group of brazing processes in which the heat is obtained from a bath of molten metal or chemical. The filler metal may or may not be obtained from the bath.

DIRECT CURRENT ARC WELDING: An arc welding process in which the power supply at the arc is direct current.

DUCTILITY: The property which permits a metal to be drawn, formed or shaped.

EDGE WELD: The joining of two or more parallel pieces of metal by welding their edges together.

ELASTIC LIMIT: The maximum load that a metal will sustain before it takes a permanent set.

ELECTRIC BRAZING: A group of brazing processes in which the heat is obtained from electric current.

ELECTRODE:

A - METAL ARC WELDING: Filler metal in the form of a wire or rod either bare or covered, through which current is conducted between the electrode holder and the arc.

B - CARBON ARC: A carbon or graphite rod through which current is conducted between the electrode holder and the arc.

C - ATOMIC HYDROGEN: One of two tungsten rods through which current is conducted between the electrode holder and the arc.

D - RESISTANCE WELDING: A bar, wheel or die through which the current is conducted and the pressure applied to the work.

ELONGATION: The amount that a metal will stretch before it is pulled apart.

ELECTRODE HOLDER: A device used for mechanically holding the electrode.

FILLER ROD: A rod or wire used to supply additional metal to a weld.

FILLET WELD: A weld made in a corner such as required in a lap or tee joint.

FILTER LENS: A colored glass used in goggles, helmets and shields to exclude harmful light rays.

FLASHBACK: The disappearance of the flame from the end of the welding tip into or back of the mixing chamber of the torch. This differs from a backfire in that the flame continues to burn inside the torch without popping back out to the end of the tip and is generally accompanied by a squealing noise.

FLAME BORING: A flame machining process which combines flame drilling with flame turning to produce a round hole in the surface of a piece. This process is used to remove metal from the ends of steel billets in preparation for centering or piercing operations.

FLAME CUTTING PROCESS: See Cutting Process.

FLAME DRILLING: A flame machining process used to drill or punch holes in metal by moving a flame machining tip or oxygen lance axially (in the same direction as that of the stream of oxygen from the tip). This process is also used to remove countersunk rivets or long bolts frozen in place without scoring the sidewalls of the hole.

FLAME GROOVING: A flame machining process in which a hand or machine guided torch is used to produce "U" shaped grooves in steel surfaces. This process is used to remove rivet heads, defective welds, surface defects, and to cut fillets and to prepare plate edges for welding. The deep narrow grooves produced by this process can be easily welded where this is required.

FLAME MACHINING PROCESS: The process of controlled removal of metal by surface oxidation to develop a desired surface contour. It differs from oxygen cutting in that it is not used to cut or sever pieces of metal but is used to process or shape metal surfaces. In some cases flame machining is combined with flame cutting operations to develop a desired surface contour or shape.

FLAME MACHINING TIP: A gas torch tip especially designed for flame machining.

FLAME PLANING: A flame machining process used to remove surface defects from steel plates, billets, and other steel sections by means of wide and relatively shallow surface cuts. The flame planed surface is either machined further or hot rolled to the desired finished dimensions.

FLAME TURNING: A flame machining process in which a flame machining tip is used to remove metal in shallow layers from a rotating piece. By also feeding the torch along the rotating surface at various speeds a single deep groove, a thread-like spiral, or the entire surface can be removed satisfactorily.

FLASH BUTT WELDING: A resistance butt welding process in which the potential (voltage) and current are applied before the parts to be welded are brought in contact. The heat for welding is obtained mainly from a

series of arcs between the parts to be welded. The parts are pushed or drawn together when the welding temperature is reached.

FLAT POSITION WELDING; (downhand): A welding position in which the plates to be welded are in the horizontal plane and the weld is made on the tip side of plates.

FLUX: A chemical powder or paste used to dissolve oxides, clean the metal of undesirable inclusions and prevent oxidation of the molten metal during welding or brazing operations.

FOREHAND WELDING: A method of gas welding in which the flame is directed toward the base metal ahead of the finished weld.

FORGE WELDING (Blacksmith, Roll, Hammer); A group of pressure welding processes in which the parts to be welded are brought to a suitable temperature by means of external heating and the weld is made by pressure or blows.

FREE-HAND FLAME CUTTING: A cutting process in which the operator both holds and guides the hand cutting torch.

FREE-HAND "GUIDED" FLAME CUTTING: A cutting process in which the operator holds the torch while guiding it along the line of cut by some mechanical means. These guides may be a straight edge or bar for cutting straight lines, a radius rod with pivot for cutting circles, or roller attachments for cutting plate with irregular surfaces. Bevel cuts can be made with any of the above attachments or guides.

FURNACE BRAZING: A brazing process which obtains its heat from a suitable furnace. The parts to be joined are assembled with filler metal and flux in place and require only the furnace heat at brazing temperature to complete the joint.

FUSION WELDING: A group of processes in which the metals are welded together by bringing them to the molten state at the surfaces to be joined without the application of mechanical pressure or blows. Filler rod may or may not be used depending upon the joint design and the thickness of the parts to be welded.

GAS BRAZING: A brazing process in which the heat is obtained from a gas flame.

GAS CUTTING (Oxygen cutting): The process of severing or cutting ferrous metals by means of the chemical action on elements in the base metal.

GAS WELDING: A non-pressure (fusion) welding process in which the welding heat is obtained from a gas flame.

GUIDED BEND TEST: A bending test in which the test piece is bent to a definite shape by means of a jig.

HAND (Face) SHIELD: A protective device used in arc welding for shielding the face and neck, equipped with suitable filter glass lens and designed to be held by hand.

HARD SURFACING (hard facing): The process of applying extremely hard alloys to the surface of a softer metal in order to increase its resistance to wear, abrasion, corrosion or impact.

HARDENING: The process of increasing the hardness of metals by heat treatment, cold working, or by the addition of alloying elements.

HEAT AFFECTED ZONE: The portion of the base metal whose structure or properties have been changed by the heat of welding or cutting.

HELMET SHIELD: A protective device used in arc welding for shielding the face and neck, equipped with suitable filter glass lens and designed to be worn on the head.

HORIZONTAL POSITION OF WELDING: A welding position in which the plates to be welded are in the vertical plane and the welded joint is in the horizontal plane.

HYDROGEN: An inflammable, colorless, tasteless, and odorless gas, which burns with an almost invisible flame to form water. It is the lightest known substance.

INCLUDED ANGLE: The total angle formed between the beveled edges of two plates butted together in position for the welded joint.

INDUCTION BRAZING: An electric brazing process in which the heat is obtained from the resistance to the flow of an electric current.

INFRA-RED: Light rays that are outside of the red end of the visible spectrum. These rays are given up by the arc of an electric arc welding process and by the oxyacetylene flame.

INTERMITTENT WELD: A weld which is not continuous but is broken by unwelded spaces in the joint.

KERF: The space from which the metal has been removed by a cutting process.

LANCE: A long steel pipe, usually 1/4" or 3/8" normal pipe size, used to direct a stream of oxygen against a heated surface to cut or pierce heavy steel sections.

LAP JOINT: A type of joint formed by two overlapping plates with the edge of each plate welded to the face of the other.

LAYER: A quantity of filler metal deposited in a joint to completely cover the filler metal previously deposited. A welded joint on heavier plate may require several layers of weld metal to completely weld the plate.

MACHINE FLAME CUTTING: A flame cutting process in which the speed, angle, and direction of the cutting torch is controlled by a motor driven variable speed machine to produce the desired cut. One or more cutting torches, mounted on adjustable arms or brackets of the machine, can be used to duplicate accurately any shape, contour, or bevel desired.

MALLEABLE: Capable of being drawn out into sheets by hammering or by pressure of rollers.

MANIFOLD: A header with outlets or branches to which several cylinders of gas may be connected to supply gas to a number of outlets or stations.

MANUAL WELD: A weld in which the arc or the torch motion is controlled by hand.

MELTING POINT: The temperature at which a metal changes from the solid to the liquid form.

METAL ARC BRAZING: An electric arc brazing process in which bronze or brass or other copper alloy electrodes supply the filler metal.

METAL ARC CUTTING: The process of severing or cutting metals by melting with the heat of the metal arc. Non-ferrous metals can be cut by this process.

METAL ARC WELDING: An arc welding process in which the electrode supplies the filler metal in the weld.

MIXING CHAMBER: That part of a gas welding or cutting torch in which the gases are mixed for combustion.

NEUTRAL FLAME: A gas welding flame whose inner cone or that portion of the flame used is neither oxidizing or carburizing.

NON-FERROUS: Metals containing no ferrite or iron. Copper, brass, bronze, aluminum, and lead are examples of non-ferrous metals.

OVERHEAD POSITION OF WELDING: A welding position in which the plates to be welded are in a horizontal plane and the weld is made on the bottom side of the plates.

OVERLAP: A defect in the welded joint in which an excess of weld metal extends beyond the zone of fusion.

OXIDE: A compound of oxygen with another element or substance. Rust and mill scale are examples of oxides.

OXIDIZING FLAME: A gas welding flame whose inner cone or that portion of the flame used has an oxidizing effect or has an excess of oxygen for balanced combustion.

OXYACETYLENE WELDING: A gas welding process which depends upon the combustion of oxygen and acetylene for the welding heat.

OXY-OTHER FUEL GAS WELDING: A gas welding process in which the welding heat is obtained from the combustion of oxygen and any fuel gas other than acetylene. Some of these fuel gases are hydrogen, propane, city gas, and natural gas.

OXYGEN: A tasteless, colorless, and odorless gas which supports combustion. It forms about 23 percent by weight and 21 percent by volume of the atmosphere and is the most abundant of all the elements in the earth's surface.

PASS: The weld metal deposited by one general welding progression along the joint to be welded. Several passes may be necessary to complete a layer of weld metal as in arc welding.

PEENING: Mechanical working or stretching of a cold metal surface by means of hammer blows.

PENETRATION: The depth of fusion obtained in a welded joint. It is the distance from the original surface of the base metal to that point at which fusion ceases.

PLAIN THERMIT: A mixture of iron oxide and finely divided aluminum.

PLUG WELD: A type of weld used to join two overlapping plates. The upper plate is welded through a hole in its surface to the lower plate.

POROSITY: The presence of gas pockets or inclusions in weld metal.

POSTHEATING: Heat applied after welding or cutting operations are completed.

PREHEATING: Heat applied before welding or cutting operations are started.

PRESSURE THERMIT WELDING: A pressure welding process in which the heat for welding is obtained from the liquid products (molten metal and slag) of a thermit reaction and the weld is made by pressure.

PRESSURE WELDING PROCESS: A group of welding processes which require pressure to complete the weld.

PROJECTION WELDING: A resistance welding process in which the heat for welding is localized between two surfaces or between the end of one part and the surface of another by means of projections.

PLASTIC: Capable of being molded or shaped in a solid form by outside force.

REDUCING FLAME: A gas welding flame whose inner cone or that portion of the flame used has a reducing or deoxidizing effect, namely, capable of removing oxygen.

REINFORCEMENT OF WELD: Excess weld metal added to strengthen a welded joint.

RESISTANCE BRAZING: An electric brazing process in which the heat is obtained from the resistance to the flow of an electric current.

RESISTANCE WELDING: A pressure welding process in which the heat for welding is obtained from the resistance to the flow of an electric current.

REVERSED POLARITY (Electrode Positive): The arrangement of direct current arc welding leads so that the work is the negative pole and the electrode is the positive pole in the arc circuit.

ROOT OF WELD: That portion of the weld metal deposited at the bottom of the welded joint.

ROUGH FLAME MACHINING: A flame machining process in which a hand or machine guided torch is used to remove large quantities of excess metal in preparation for finish machining with machine tools.

SHAPE CUTTING: A flame cutting process in

which the cutting torch is guided by hand, or machine, to cut irregular shapes from steel plates.

STACK CUTTING: A flame cutting process in which several thin steel sheets or plates are clamped together and cut in one operation.

SEAM WELDING: A resistance welding process in which a row of spot welds is made progressively along the seam of two overlapping sheets. These spot welds may either be adjacent to each other or overlap to make a continuous weld.

SHIELDED METAL ARC WELDING: A metal arc welding process in which the arc and weld metal are protected from the atmosphere by a shielding gas given up by an electrode coating or flux, during welding.

SILVER ALLOY BRAZING (Silver Soldering): A brazing process in which a silver alloy is used as a filler metal.

SLAG: Excess foreign matter which floats on molten metal and acts to protect as well as clean the weld metal of impurities.

SLAG INCLUSION: Non-metallic material entrapped in a weld.

SLOT WELD: A type of weld used to join two overlapping plates. The upper plate is welded through a slot in its surface to the lower plate.

SPOT WELDING: A pressure welding process in which the fusion is confined to a relatively small portion of the area of the lapped parts to be joined. The heat for this process is obtained from the resistance to the flow of electric current in the parts being welded. Pressure is applied by copper electrodes to complete the weld.

STRAIGHT POLARITY: The arrangement of direct current arc welding leads so that the work is the positive pole and the electrode is the negative pole of the arc current.

STRESS: The intensity of forces acting on or within a body to produce tension, compression or shear. When present in welded joints they are known as residual stresses due to welding.

STRESS RELIEF HEAT TREATMENT: Uniform heating of a structure to a sufficient temperature below the critical range followed by a uniform cooling to relieve or remove a major portion of the residual stresses.

TACK WELD: A short weld used to hold assembled pieces in place for welding. By this method of preparation for welding a desired shape in the welded piece can be maintained.

TEE JOINT: A weld made at the joint of two plates located at approximately 90 degrees to each other.

THERMIT WELDING: A non-pressure (fusion) welding process for which the heat is obtained from highly superheated liquid steel produced by chemical reaction between iron oxide and aluminum. This steel acts as a filler metal and the aluminum oxide formed is removed as slag.

TOE OF WELD: That portion of the weld located at the intersection of the filler metal and base metal on the surface of the weld.

UNAFFECTED ZONE: That portion of the base metal which is outside of the heat affected zone and in which no change in physical properties such as strength, hardness, or ductility has taken place as a result of welding.

UNDERCUT: A defect produced in welding in which a portion of the base metal is melted away without filler metal being added. This causes a decrease in the thickness of the base metal at this point and therefore weakens the structure.

ULTRA-VIOLET: Light rays outside the visible spectrum at its violet end. These rays are given off by the arc of an electric arc welding process and by the oxy-acetylene flame.

UNSHIELDED CARBON ARC WELDING: A carbon arc welding process in which no gas or other shielding medium is present.

UNSHIELDED METAL ARC WELDING: A metal arc welding process in which no gas or other shielding medium is present, or in arc welding with bare electrodes.

UPSET BUTT WELDING: A resistance butt welding process in which the potential (voltage) and current are applied after the parts to be welded are brought in contact. The heat for welding is obtained mainly from the resistance offered to the flow of current by the metal parts at the joint.

VERTICAL POSITION OF WELDING: A welding position in which the plates to be welded as well as the joint are in the vertical plane.

VOLATILE: Readily changed to a vapor.

WEAVING: A method of depositing metal in which the electrode is oscillated, that is, moved from side to side.

WELD: A joint made by a welding process in which two or more metal parts are heated to melting and form one solid piece when they solidify.

WELDING GROUP: The side of the circuit opposite the welding electrode in electric arc welding.

WELDING LEADS: Electrical conductors usually insulated cables used to furnish an electrical path between the generator or other source of electrical power and the electrodes.

WELDING ROD: Filler metal in wire or rod form, used in the gas welding process and in those arc welding processes in which the electrode does not furnish the filler metal.

WELDING TIP: A gas torch tip especially designed for welding.

WELDING TORCH OR BLOW PIPE: An apparatus used in gas welding for mixing and controlling the gases.

Principles of Success

(Continued from page 115)

but Lincoln was not disturbed. Each small part in his drama of life needed an actor, and Lincoln was willing to play that small part if need be.

"Lives of great men oft' remind us" if we will but heed. Greatness is something sought by many men, yet he who seeks it least gains it most lastingly.

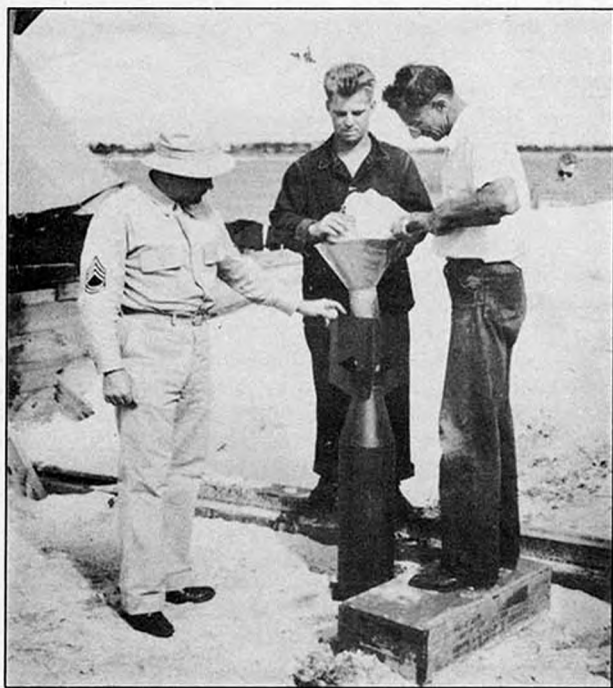


ORLANDO AIR BASE

(Continued from page 143)

with bombs over sand roads. It takes the old four wheel drive to do the job.

Friday morning November the 14th we received a radiogram from the 3rd Air Force stating we would send



Mr. Smith (right) is a retired Sergeant, and handles our bomb loading.

a platoon to Spartanburg, S. C. and a detachment of 10 men and 2 non-commissioned officers to Raleigh, N. C. for the duration of the maneuvers. Captain Sims received permission to be relieved as Base Ordnance Officer and take the platoon. Sgt. Clarke, first Sergeant of the 722nd Ordnance Company, was put in charge of the detachment to Raleigh. The trucks were loaded Friday and Saturday at 6:00 AM the convoy of 12 trucks, 10 trailers, 53 enlisted men and Captain Sims, moved out. Complete T/BA equipment was carried. Meal tickets were used en route but a field range with all necessary cooking utensils were on hand for messing upon arrival. Technical Sergeant McSween, an old hand with property, will be on hand with Captain Sims.

In the future we hope to have an SH9 warehouse, which has been approved, an ammunition area, that is promised, and a better motor pool. If the base is expanded sometime, we hope to have more suitable conditions for these areas, but for the present, the phrase, "necessity is the mother of invention", is the pass word at the Orlando Air Base.



ESPRIT DE CORPS

(Continued from page 141)

I spent many months with the late Floyd Gibbons, world famous war correspondent, covering the various fronts out of G.H.Q. Floyd was all man, and delighted to relate anecdotes about our soldiers. Here is his favorite one and, although it may be pure myth, it illustrates the spirit of the A. E. F. better than anything I have ever seen or heard.

It seems that an American regiment was going into the line one night to relieve another one coming out. The night was pitch dark; no moon, no stars, no nothing, and visibility was about zero.

They moved cautiously and everything was extremely tense because at any moment the Germans might send up star shells, discover the troop movement, and start shelling.

All at once a private dropped out of line and slid up beside his sergeant, a Regular Army four-striper, and under his breath said: "Sarge, there are over fifty Germans marching parallel to us about one hundred yards to the left."

The sergeant did not even turn his head, but out of the corner of his mouth, in a wet, throaty, hoarse whisper, replied: "All right. Two of youse guys fall out and chase them Germans away."

This was typical of the A. E. F., and of Americans in every war — confidence in their men, in themselves, and utter contempt for the enemy. In other words, the modern version of "I came, I saw, I conquered."

Destiny may reach out her hand toward you and, with beckoning hand, lead you across the sea to the field of battle.

If she does, I am sure each and every one of you will do as the sergeant ordered — "Chase them Germans away."

Good luck, soldier.

Sincerely your friend,

"Old A.E.F. Vet"



NITROGEN PRESSURE TEST

(Continued from page 151)

ing pressure will be generated in the vicinity of the gage and registered thereon. For this reason the recoil piston

jack screw must be operated at not over four turns per minute.

(4) The oil within the mechanism becomes sluggish at a low temperature. Its action through the small orifices is therefore erratic and the reliability of the gas pressure measurements under such conditions is always doubtful. Therefore, if pressures must be taken in cold weather, it is necessary that the recoil mechanism and the extra oil be in a room warmed to at least 50°F. for 24 hours preceding the test.

(5) Since the amount of gas originally placed in the mechanism cannot increase, the pressure at any given temperature cannot become higher except by moving the floating piston forward so as to reduce the volume of the gas chamber. This can be accomplished if an excess of oil is introduced, as may be the case if the oil index is stuck and the sticking is not noticed. Make sure the oil index is registering properly by draining off some of the reserve oil and then restoring it. The oil index will move in when the oil is drained and should move out as the reserve is reestablished. Failure of the oil index is almost invariably on the outward movement.

(6) If the gas leaks past the floating piston, it may be detected by the foamy appearance and the sputtering of the oil when draining off the reserve oil.

With the gun disconnected from the recoil mechanism and moved to the rear until the muzzle is even with the front of the recoil mechanism, remove the filling and drain plug, located near the rear end on the right side of the recoil mechanism. Screw the filling and drain valve release into the filling and drain valve plug housing, and release the reserve oil, assemble the gauge and the connection to the filling and drain valve release, making all joints tight.

Remove the respirator from the front end of the recoil cylinder and attach the recoil piston rod jack.

TO MEASURE THE NITROGEN PRESSURE

Move the recoil piston and rod to the rear by turning the recoil piston rod jack until a gauge pressure of 100 kg. per sq. cm. has been established on the gauge. Continue turning the jack ten additional revolutions and moving it slowly (4 turns per minute), read the pressure gauge, tapping the gauge lightly. This gauge reading represents the nitrogen pressure plus the friction of the floating piston. Continue turning the jack five more turns, then reverse the direction, unscrewing five turns. While unscrewing the jack at this point read the gauge a second time. (This reading represents the nitrogen pressure minus the friction of the floating piston.)

$$\frac{(AP + F = 2000 + (AP - F = 1600))}{2} = AP \ 1800$$

TO CORRECT THE PRESSURE FOR TEMPERATURE VARIATIONS

Volume of air chamber remaining constant, gun in battery, the pressure varies directly as the "Absolute" temperature. These recoil mechanisms are charged with nitrogen at a pressure of 120 kg. per sq. cm. at 20° centigrade, which corresponds to 1,707 pounds per square inch at 68° Fahrenheit. To make a correction in the pres-

sure, due to change in temperature, the following formula based on "Absolute" temperature applies:

$$Pt = \frac{(273 + t) \times P \&o}{273}$$

TO DETERMINE THE FRICTION OF THE FLOATING PISTON

The difference between the first reading (AP + F) and the second reading (AP - F) represents twice the friction of the floating piston.

$$\frac{(AP + F = 2000 - (AP - F \ 1600))}{2} = F200$$

Normal value of F is 13 kg. per sq. cm. It may vary between the limits of 10 to 30 kg. per sq. cm. If not within the limits, the recoil mechanism must go to a base shop for repairs.

TO DETERMINE THE FRICTION OF THE RECOIL PISTON AND RECOIL ROD STUFFING BOX

1. Connect the filling and drain valve release and force the recoil piston to the rear (about 2 inches) by means of the recoil piston jack, permitting the oil to escape through the filling and drain valve release. Do not remove jack.

2. Attach the pressure gauge to the filling and drain valve release by means of the pressure-gauge connection.

3. Force the recoil piston to the rear by means of the jack until the gage shows 1,200 to 1,500 pounds pressure per square inch.

4. Reverse motion of the jack until the jack head leaves the piston. The piston follows the jack until the friction of the cylinder and the rod equals the pressure in the cylinder. Since the oil pressure in the cylinder is greater than the friction, until equalized, the gauge hand drops without fluctuating and remains stationary when the piston rod stops moving.

5. Read the gauge. The gauge reading at this point represents the sum of the friction of the recoil piston and the friction in the recoil rod stuffing box.

6. Obtain three uniform gauge readings.

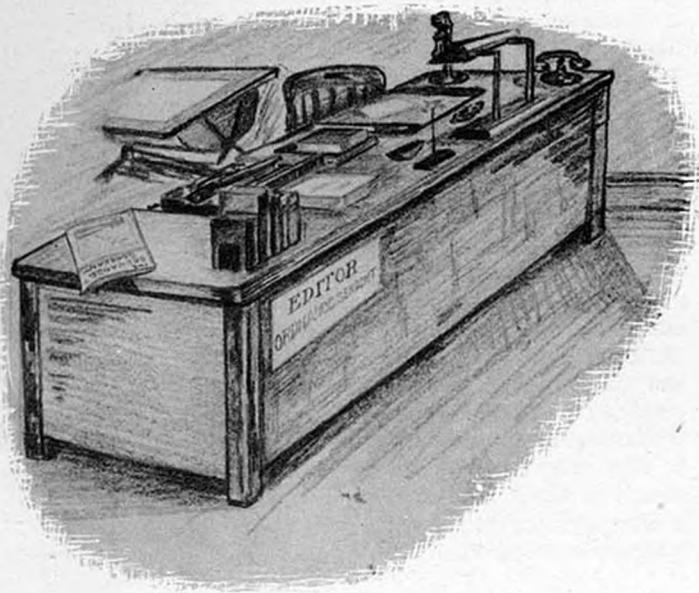
NOTE: Exercise the piston by repeating operations (1), (3), (4), and (5) a sufficient number of times until the last three gauge readings are practically uniform. This is important since true friction readings are practically uniform. This is important since true friction readings cannot be obtained until the packings are well lubricated.

TEST OF PRESSURE GAUGES

Pressure gauges are delicate instruments, and even the most rugged are apt to give incorrect readings after being dropped or carelessly handled. Sudden increments or releases of pressure may cause the hand to strike the stop pin with sufficient force to move it on the spindle. (A small check valve is now inserted in the stem of the pressure gauge to reduce the speed with which the hand travels back to zero when released.)

To use the tester, the best method is to clamp it in a vice. The tester arms should be level, the screw withdrawn, and the tester filled with recoil oil before screwing in the gauges, to eliminate possible air bubbles in the connection. The oil reservoir has a valve controlled by the ring nut which is exposed when the cap of the reservoir is removed. If the gauge being tested does not agree with the master gauge, the probability is that the hand

has been moved. Remove the hand with the jack and reset it to agree with the master gauge. The readings which will be involved in the usual test of recoil mechanism will be between 30 to 70 kg. per sq. cm. and 90 to 160 kgs. per sq. cm. The allowable limits of inaccuracy are plus or minus 2 kgs. per sq. cm. The master gauge should be returned to an arsenal periodically for the verification of its accuracy.



GUNPOWDER

"Who invented gunpowder?"

You have heard that question asked before, and you have heard it answered, probably in several different ways. The correct answer is, "Nobody!"

The truth of the matter is that gunpowder was simply developed, or discovered, or noticed, after it was already in existence. Its first "manufacture" almost certainly was not premeditated, and whoever the first man to realize its existence might have been, he cannot be given credit for its "invention" any more than he can be blamed for all the slaughter which has resulted from it (and we are not thinking about rabbit hunting.)

This is a time when rumors are supposed to be smothered rather than circulated, but the passing of centuries tends to alter the military importance of rumors, and we may safely give thought to a couple of them. Rumors from the far distant past tell us that some Chinaman first used gunpowder, or at least something very much like gunpowder. A companion rumor, however, tells us that its use was principally confined to something similar to our modern firecrackers. As has been noted, this may be only rumor; it is not officially confirmed. There are other stories, however, which seem to fix the scene of use of such explosives rather conclusively, even though in a rather broad manner, geographically speaking.

One story tells us that Alexander the Great, the Macedonian conqueror (356-323 B.C.), who staged one of earliest blitzkriegs of history, refused to attack the Oxydracae, a race which occupied the country between



the Hyphasis and the Ganges, because they "lived under the protection of the gods, and overthrew their enemies with thunder and lightning which they shot forth from their walls." This truly sounds like gunpowder, or something very much like it.

And there are numerous reports of the use of fire and explosives throughout the centuries by magicians and persons of related talents, for purposes of psychological effect or intimidation, etc.

Leaving these early rumors behind us, we know that by the time of the battle of Crecy (1346) cannons in which gunpowder was used as the propellant were well known, and from that time, as firearms were developed, the amount of gunpowder increased.

Credit for the introduction of gunpowder in modern times is given to different individuals by different authorities (?). Most prominent of these discoverers are Berthold Schwartz, a German monk, and Roger Bacon, an English friar. Supporters of the Schwartz theory assume that inasmuch as he was reported to have first invented firearms, and that nothing certain was known of the inventor of gunpowder, the credit for both probably belong rightfully to Schwartz.

Many of the English authorities, although not all of them, claim the credit for Roger Bacon, although they generally give him but little credit for his achievement. As an example, one writer stated that Bacon "chanced upon it" as the result of obtaining nearly pure nitre.

What is gunpowder?

Two definitions may be quoted from among many which are possible.

"A mixture of saltpetre, sulphur and charcoal in such proportions that when a part is heated to a certain temperature, combustion takes place with great rapidity through the bulk in contact and an explosive effect is produced."

"An explosive mixture, consisting of potassium nitrate, sulphur and charcoal, used for military purposes, in firearms, and for blasting."

Notice that these definitions have many loopholes. To avoid any misunderstanding, first of all, let it be noted that saltpetre is potassium nitrate, or nitre, the ingredient with which Bacon was experimenting at the time of his reported discovery. Actually, no true definition of gunpowder can be stated because of the many factors which enter into its composition. Some of these factors are: The chemical content of the various ingredients, the different proportions of these ingredients used for different purposes, the different proportions used because of the varying characteristics of the ingredients, differences resulting from processes of manufacture, differences resulting from raw products used in the preparation of ingredients (for instance, charcoal), and differences resulting from personal, professional or national preferences. More will be said about the various compositions of gunpowder in a later issue.

MODERN SHOT TOWER

At a few places in this country old shot towers still stand. They are tall, chimney-like structures, and in the old days molten lead was dropped from the top of them into water at the bottom. Surface tension formed the metal into round drops which cooled before they sunk to the bottom, and they were then ready for use as bird or buck shot. Of course, they required sifting for proper size.

A modern adaption of this method has been perfected by John L. Gallup, of Newark, N. J. He drops his metal through a long pipe. The metal itself is kept at a constant temperature and rate of flow by feeding a strip or wire of metal into a blowpipe flame at the top. At the bottom, the pellets strike against an elastic plate held at an angle, which bounces them into a vessel of water.

The primary purpose of the shot thus formed is non-military, but it is an interesting adaption of time-worn methods which might conceivably be useful to military men under certain circumstances.

DYNAMITE IN ARTILLERY SHELLS

Loading artillery shells with dynamite has been a dream of inventors ever since Alfred Nobel first produced that high but somewhat touchy explosive. The trouble always has been that dynamite was considered too sensitive to withstand the jar of its abrupt discharge from a cannon.

Now an Australian inventor, John Pomeroy, of Melbourne, comes forward with a type of shell in which he claims dynamite can be used successfully.

The shell is really a double shell, with the dynamite

in the inner container, and the base securely sealed against its possible escapes. When the shell is fired from a rifle gun or howitzer, the spin around its longitudinal axis forces some of the nitroglycerine in the dynamite to the surface of the inert absorbent of the dynamite, where the jar of impact, however slight, will set it off. No other fuse is required.

This projectile is reminiscent of uses made of dynamite in earlier wars. The idea of imbedding a pinch of dynamite in noses of machine gun bullets, invention of a London post office employee, is credited with having stopped Zeppelin raids on London during the First World War. Compression of the absorbent by inertia during the bullet's flight brought a film of nitroglycerine to the surface, ready to explode on contact with the airship's envelope, igniting the inflammable gas within.

Even earlier, during the Spanish-American War of 1898, attempts were made to use nitroglycerine-loaded projectiles. To eliminate the jar of a powder-loaded gun, compressed air was used. Small-caliber pieces known as Zalinsky guns were tried out at the battle of San Juan Hill, and much larger pieces of the same general type were installed on a converted yacht, the *Vesuvius*. However, these airguns of short range were not particularly accurate, so that when more stable types of high explosives came along, at about the turn of the century, Ordnance men gladly gave up their efforts to find safe and satisfactory military uses for dynamite.

"OCTANE"

Fifteen years ago "100-octane" was a supposedly impossible ideal.

Today "125-octane" has become almost commonplace.

Today's engines produce 100 percent more power per pound than could those of 1918, and nearly 50 percent more than the best engines of 1930.

"High octane number" is commonly advertised at filling stations, and every motorist knows that the higher the figure the less his motor will knock — yet the meaning of "octane" is in most instances unknown.

Crude gasoline may be a mixture of fifty different chemical substances. One is "normal heptane" — a combination of seven carbon and sixteen hydrogen atoms. No automobile could be run with it, although it is one of the most powerfully explosive of all the hydro-carbons. Another is iso-octane — technically 2, 3, 4 trimethyloctane, a mixture of eight carbon and eighteen hydrogen atoms. There are seventeen other kinds of octanes, which have no significance. This one produces practically no knock at all — at least it didn't in the automobile engines of the middle twenties.

This was agreed upon by oil companies as the ideal.

The motor fuel was evaluated by the amount of iso-octane necessary to cause the mixture to knock in the same way. Thus a fuel which knocked like a half-and-half mixture of heptane and iso-octane was "50-octane". A fuel which compared with a mixture of 10 percent heptane and 90 percent octane was "90-octane".