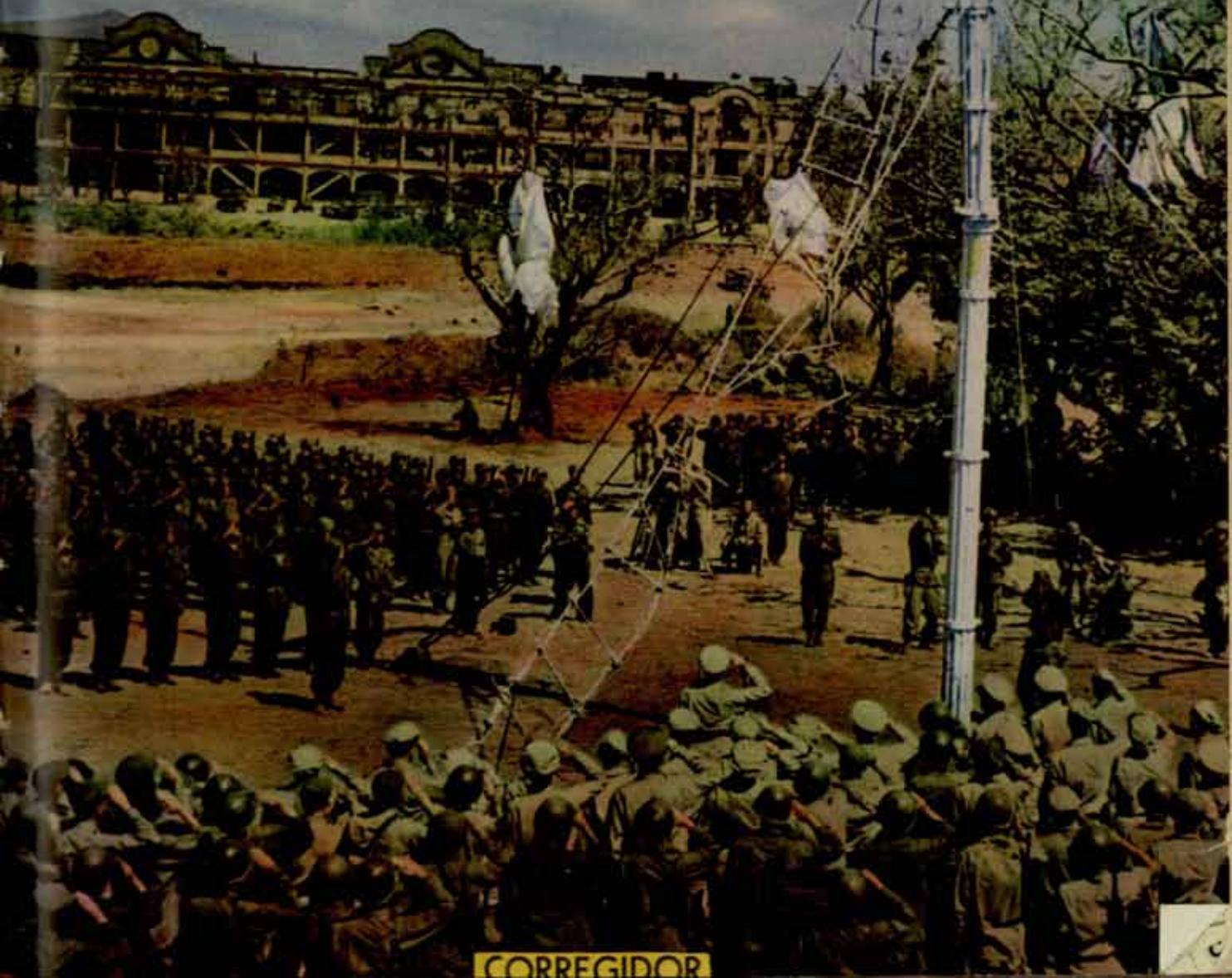


COAST ARTILLERY JOURNAL

JULY-AUGUST, 1947



CORREGIDOR

ASSOCIATION ROTC MEDAL WINNERS

This year the Coast Artillery Association resumed the practice of donating a medal to be awarded to the outstanding advanced student in each of the Coast Artillery Corps Senior ROTC units.

Due to the status of the ROTC during the war, donation of the award was suspended after 1943 but the reception which it received this year highly justifies the decision of the Executive Council to reinstate it.

Although the Association has hitherto prescribed the rules for the selection of the recipient, it was decided to leave the method to the discretion of the President of the University or College during the present period of reorganization.

A short sketch of each of this year's recipients follows:

University of Alabama: Ernest L. Brown from Mobile, Alabama. Cadet Brown is 20 years old and a graduate of the Mobile public schools. During the war he served as a radio operator in the Merchant Marine. He is Executive Officer of the Cadet Battalion and a member of four honor societies.

University of California (Berkeley): Donald F. Whistler of Palo Alto, California. Cadet Whistler is 24 years of age and holds the cadet rank of Major. During the war he served seventeen months overseas with a chemical mortar battalion and was awarded the Bronze Star and the Purple Heart Medals.

University of California at Los Angeles: James V. Traugbber, who holds the cadet rank of Captain. During the war he saw overseas service with the 13th Armored Division and participated in two campaigns. He is a member of four campus societies and has been awarded a varsity letter in track.

University of Cincinnati: (Two awards were made as the previous medal donated had not been presented.) Donald D. Johnston of Wyoming, Ohio. Cadet Johnston is 22 years of age and a cadet First Lieutenant. During the war, he participated in two campaigns and one invasion in the Asiatic theater as an amphibious tractor driver.

Edward J. Farmer of Hamilton, Ohio. Cadet Farmer is 23 years of age and a cadet First Lieutenant. During the war, he saw service in the Navy as an Aviation Radioman 3rd Class.

The Citadel: Marion Pinckney Shuler, Jr., of Orangeburg, South Carolina. Cadet Shuler is 19 years of age and at present is a member of the band. He led the Junior ROTC CAC class with an average of 97%.

University of Delaware: Kurt L. Seligman of Arden, Delaware. Cadet Seligman is 24 years of age and holds the cadet rank of Major as Executive Officer of the ROTC Battalion. He is also a member of the varsity track and soccer teams. During the war, he saw combat service with the 102d Infantry Division and was awarded the Purple Heart with Oak Leaf Cluster.

Fordham University: Henry H. Iles of Clifton, New Jersey. He is 24 years of age and commands the Cadet Battalion with the rank of Lieutenant Colonel. Cadet Iles served with the 97th Infantry Division both in the E.T.O. and the Pacific when it was redeployed. He earned two campaign stars in Europe as a member of a 105mm howitzer battalion.

Georgia School of Technology: Buck Mickel of Elberton, Georgia. Cadet Mickel holds the rank of Captain in the Cadet Corps. During the war, he was a Naval Reserve Cadet Midshipman in the Merchant Marine. He is a member of six campus societies.

Hampton Institute: John C. Littlejohn of New York City, New York. Cadet Littlejohn is 20 years of age and a Cadet Captain. He is a member of five campus societies and captain of both the school track and wrestling teams.

University of Kansas: Robert A. Franklin of Kansas City, Missouri. Cadet Franklin is 19 years old and a Captain in command

of the Cadet Corps. He is a graduate of the Missouri Military Academy where he received the *Chicago Tribune* Medal for general military merit.

Kansas State College: Joe E. Zollinger of Junction City, Kansas. Cadet Zollinger is 24 years of age and a Lieutenant Colonel in the Cadet Corps. He is a member of eight campus societies. He saw service in the E.T.O. from the fall of 1944 till the end of the war as liaison agent for the 94th Cavalry with the 14th Armored Division.

University of Maine: Clayton Edward Johnson of Bangor, Maine. Cadet Johnson is 24 years of age and is a Second Lieutenant in the Cadet Corps. During the war, he saw service in the Navy as a 2nd Class Fire Controlman and is authorized five campaign stars for service in the Pacific.

University of Minnesota: Wilson L. Wells, Jr., of Wahkiakum, Minnesota. Cadet Wells is 22 years of age. During the war, Cadet Wells saw service both in the Army and the Navy with the 14th Armored Division at Camp Campbell, Kentucky, and U.S.N.T.C., Bainbridge, Maryland, respectively.

Mississippi State College: Lawrence E. Baldwin of Crowder, Mississippi. Cadet Baldwin is 24 years of age and a Captain in the Cadet Corps. During the war, he spent five and one-half years in the Army including six months on Okinawa.

University of New Hampshire: James S. Weeks of Keene, New Hampshire. Cadet Weeks is Lieutenant Colonel of the ROTC Battalion. He is a member of four campus societies. He saw three and one-half years overseas service during the war as a 40mm gun commander in the 210th AAA AW Battalion.

University of Pittsburgh: Joseph L. Walker, Jr. Cadet Walker is 25 years of age and is Cadet Battalion Commander with the rank of Captain. He is a member of three campus societies. In the war, he earned three battle stars for campaigns in the Pacific during thirty months overseas.

University of San Francisco: John F. Marias of Piedmont, California. Cadet Marias is 22 years of age and a Cadet Lieutenant Colonel in command of the ROTC Battalion. He is a member of one campus society. While in service in the Pacific, he was awarded the Philippine Military Merit Medal with cluster, three battle stars and one arrowhead for combat service in New Guinea, Leyte, Mindora, and Luzon.

Agricultural and Mechanical College of Texas: Edward D. Bateman of Wills Point, Texas. Cadet Bateman is 19 years of age and a Captain in the Cadet Corps. He is a member of two campus societies.

Utah State Agricultural College: Gordon L. Schvaneveldt who is Cadet Lieutenant Colonel in command of the ROTC AAA Battalion. He is a member of two campus societies and the varsity baseball team. During the war, he served with the 4th Infantry Division in the E.T.O. and is entitled to wear the Bronze Star, Purple Heart and French Croix de Guerre medals, and the assault arrow and five battle stars on his E.T.O. ribbon.

Virginia Polytechnic Institute: Wesley L. Baum who is a First Lieutenant in the Corps of Cadets. He is a member of five campus societies besides being active in intramural athletics.

Washington University: Edward E. Fesler of St. Louis, Missouri. Cadet Fesler is 22 years of age and holds the rank of Cadet Major. He is a member of three campus societies. He served with the 95th Infantry Division in Europe and was awarded the Purple Heart Medal for being wounded in action.

University of Washington: Robert P. Hungate of Kent, Washington. Cadet Hungate is 21 years of age and is a Second Lieutenant in the Cadet Corps. He is a member of one campus society. During the war, he served with the Army Air Forces Communications System.

COAST ARTILLERY JOURNAL

FOUNDED IN 1892 AS THE JOURNAL OF THE UNITED STATES ARTILLERY

VOLUME LXXXX

JULY-AUGUST, 1947

NUMBER 4

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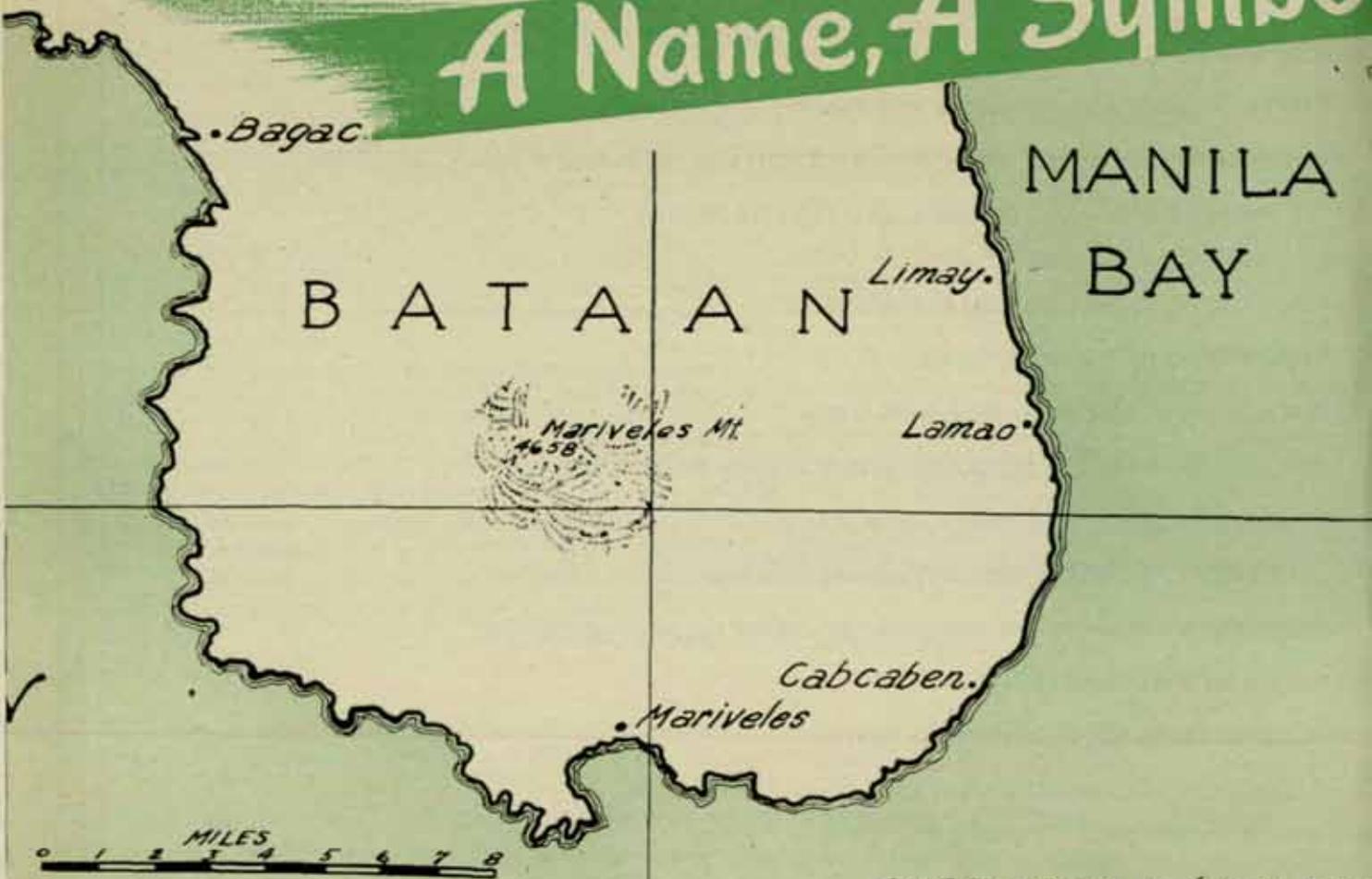
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PUBLICATION DATE: 1 August 1947.



CORRE

A Name, A Symbol



REGIDOR

A Tradition

By Colonel William C. Braly, CAC, Retired

(Editor's Note. The accompanying article is based on records contained in the author's Operations Office Diary which he carried from Corregidor through more than three years in Japanese prison camps, and his personal diary, found when Corregidor was re-taken, and eventually returned to his wife. The play by play account herein is therefore absolutely authentic.)

WAR COMES

A telephone in the Harbor Defense Command Post jangled noisily, jarring the early morning quiet of 8 December, 1941. As I picked up the receiver, the clock indicated 3:40 A.M. The voice I heard was that of Captain Bob Brown, Aide-de-camp to Major General George F. Moore, Commanding General of the Harbor Defenses of Manila and Subic Bays.

"Rudie Fabian¹ just phoned me two messages he picked up a few minutes ago," said Bob.

"Let's have 'em," said I.

"Hostilities commenced with air raids on Pearl," and, "Air raids on Pearl Harbor. THIS IS NOT DRILL!"

Both messages were signed by the Naval Commander-in-Chief, General Moore, who had also gotten the word from Fabian, came at once to the Command Post, accompanied by Colonel Joseph F. Cottrell, the Harbor Defense Executive, and followed shortly by several other staff officers. This was IT. The war we had feared was inevitable had arrived. A few days earlier I had received a letter from my wife written in San Francisco on 18 November, 1941 in which she remarked:

"If war comes, and everyone says it will, I suppose I need

not look for you soon." Little she knew how right she was.

For several months we had been rotating one third of the command in positions of readiness each month, and for the past eight days all units on the fortified islands of Manila and Subic Bays had been at battle stations, under continuous alert. Thus the transition to actual war conditions was slight indeed.

General Moore promptly issued the necessary orders to accomplish this and transmitted the text of the above messages to General MacArthur's Headquarters in Manila, designated USAFFE. Then, at 6:02 A.M. this communication was received from the Manila Headquarters:

"A state of war exists between the United States and Japan. Govern yourself accordingly." That made it official.

Our portion of General MacArthur's U.S. Forces in the Far East consisted then of approximately 275 officers, 2,000 American enlisted men, 1,200 Philippine Scouts and 400 Philippine Army personnel. These troops were distributed among the four fortified islands stretching in an irregular line across the entrance to Manila Bay, except for two batteries of Scouts garrisoning Fort Wint on Grande Island in Subic Bay, some 30 miles up the coast northward. (See map opposite.)

The longest range cannon in the Harbor Defenses were two batteries of 12" guns on Corregidor with all around fire and a horizontal range of about 30,000 yards. There were also other 12" gun batteries, besides mortars for high angle fire, and smaller calibers. At the other three Manila Bay forts, calibers varied from 3" to 14", while at Fort Wint the heaviest guns were 10".

All heavy seacoast armament was of pre-World War I type and had been emplaced prior to the present day concept of air warfare. Thus, while formidably designed to repel any attack from sea, many batteries were wide open to aerial bombing as well as vulnerable to artillery fire from their rear, such as enemy batteries firing from the adjacent shores of Bataan or Cavite Provinces. The protection of

¹Lt. Rudolph J. Fabian, USN, in charge of Navy Radio Intercept Station on Corregidor.

these flanks was not a Harbor Defense function but depended on such mobile forces as were available in the Philippines.

Antiaircraft units were equipped with pre-war 3" AA guns, caliber .50 machine guns and Sperry 60" searchlights. Two radio direction finding sets were received in October 1941.

A brief word on the tactical organization may be worth while. The three major elements of the defense were:

1. The Seaward Defense Command, under Colonel Paul D. Bunker, CAC.

Troops: 59th CA (American) (less Battery I)
 91st CA (Philippine Scouts) (less Batteries C and E)
 92d CA (Philippine Scouts)
 1st CA (Philippine Army)

2. The Antiaircraft Defense Command, under Colonel Theo. M. Chase, CAC.

Troops: 60th CA (American)
 Batteries I-59th, C-91st and E-91st CA.

3. The Beach Defense Command, with Colonel Sam McCullough as Executive for Beach Defense.

Troops: Alternate mission for all troops.

For anyone serving in the Philippines during the years immediately preceding World War II the thought of war with Japan was ever present, including the possibility of a surprise landing attack prior to any formal declaration of war. War plans therefore provided a dual assignment for all Harbor Defense troops:

- 1st: An M-Day assignment to their organic armament.

- 2d: An assignment to emergency beach defense missions in the event of such a surprise landing attack.

These plans, or variations thereof, had been in effect for several years.

As time progressed through 1941 the wisdom of such plans became increasingly evident. Accordingly, with the availability of long delayed appropriations, intensive preparations were instituted for the provision of such means as were possible to increase the effectiveness of the Harbor Defenses. Many of the projects thus initiated contribute to the story that follows.

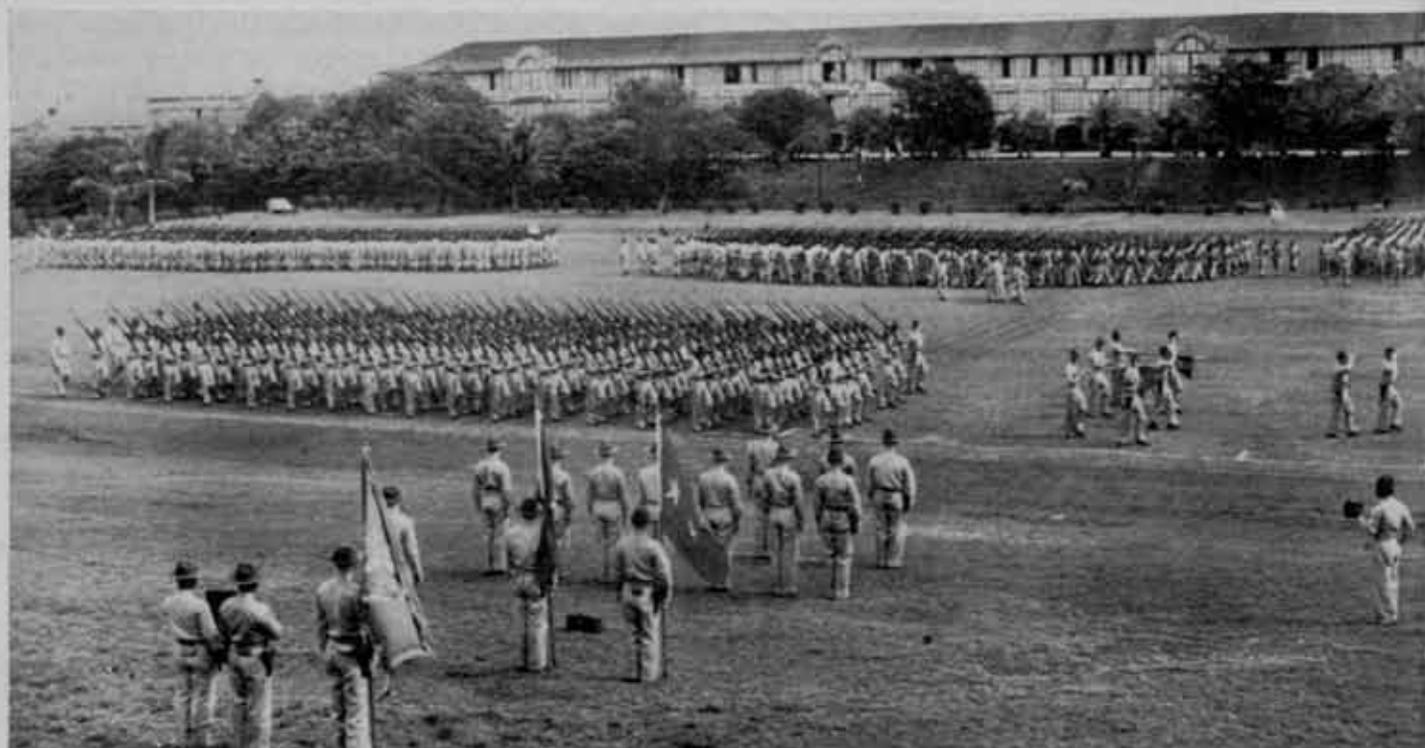
Among the more important of these was the laying of the mine fields across the entrance channels to Manila Bay in the summer of 1941. The Coast Artillery controlled mine field closed the north channel while the Navy contact mine field effectively blocked the south channel.

When news of the Pearl Harbor attack was flashed to shipping in Philippine waters there was a general rush for the safety of Manila Bay. Throughout the day on 8 December, vessels of all types were entering the bay through the controlled mine field, always with coordination between the Navy Inshore Patrol and our Seaward Defense Command.

Our first Air Raid Alarm came at 10:26 A.M. when a flight of 17 enemy medium bombers was reported from the direction of Neilson Airport, near Manila. The flight turned off without coming within range.

At 1:15 P.M. however, three medium bombers passed just east of Corregidor and Fort Hughes. Two antiaircraft batteries, I-59th and D-60th, opened fire, severely damaging one plane. Thus began our "shooting war" in the Harbor Defenses of Manila Bay.

That night we had a report from Major S. A. Mellnik,



Prewar review of the Corregidor garrison by Major General George Grunert following presentation of the Coast Artillery Association Trophy to the 92d CA (PS).



The V for victory chalkmark is clearly visible on the helmets of this 3" antiaircraft gun crew. This picture was taken on 5 January 1942.

CAC, a staff officer at Philippine Coast Artillery Command headquarters in Manila, of enemy air raids that morning on Baguio and at noon on Clark Field near Fort Stotsenburg. In the latter, many B-17s and P-38s had been destroyed on the ground, a loss we could ill afford as of course none of these were replaced.

We did get a momentary thrill from U.S. High Commissioner Francis B. Sayre's broadcast to the States on the morning of 9 December. Said he:

"The message I send to you in America is this: We on the front line are fighting to the death, for we have abiding confidence in our cause and in our leader. We know that you back home will send us help and that you will not permit divided counsels or capital-labor disputes or red tape or anything else to delay your getting effective help to us before it is too late. We are in the fight to stay. War enjoins upon us all action, action, ACTION! Time is of the essence. COME ON AMERICA!"

Many a weary month was to pass ere that longed-for help arrived.

The next few days saw Japanese landings at Aparri and Vigan in northern Luzon while small enemy forces appeared at Legaspi and other southern ports. From bases in Formosa, Japanese air forces were carrying out daily heavy bombings of Cavite Navy Yard, Neilson Airport, Nichols Field and the Manila Port Area. They would arrive about noon, unload their bombs, then swing out past the fortified islands on their return to base, being careful to

keep well out of range of most of our antiaircraft batteries.

At that time B-60th was the only battery equipped with mechanical fuzed ammunition reaching to the normal enemy bombing altitude of around 30,000 feet. Even so a number of medium bombers were shot down during these early raids over Corregidor, southern Bataan and Fort Wint.

Meanwhile, all organizations were busy digging in, camouflaging, and sand-bagging their positions. While a few of the shelters might have been considered bomb-proof most were of splinter-proof type construction. All seacoast batteries with an exposed flank or rear toward Bataan erected protective barricades of timber, rails, oil drums filled with earth or any other materials available.

On 14 December, the Harbor Defense Command Post was moved from Topside, Corregidor, to Lateral No. 2 in Malinta Tunnel where it functioned throughout the campaign. This was one of the numerous smaller tunnels opening off the main passageway under Malinta Hill. The Station Hospital had already occupied its Malinta Tunnel quarters as had the Navy.

By agreement with the Navy, all lighthouses in the vicinity of Manila Bay had been extinguished. General MacArthur however authorized the occasional use of Corregidor Light to facilitate the entrance of submarines. For each entry a secret schedule was agreed upon for the light. The Navy maintained a "control ship" inside the bay near the entrance to the channel through the controlled mine fields. During passage of the submarine, the mines were to be on "safe," with the channel marking buoys illuminated by seacoast searchlights on Corregidor. Action by the Naval In-

shore Patrol and the proper Harbor Defense stations were coordinated for each passage.

For exit or entry of commercial vessels the same procedure was followed. This part of the operation had been routine ever since the mines had been put down, five months earlier. Even so, a most regrettable catastrophe occurred.

A fast inter-island steamer, the SS *Corregidor*, sailed from Manila for points south some time after dark on 16 December. Hundreds of people from the southern islands, caught in Manila when war broke, rushed the gang plank at the last minute in a desperate effort to get home. How many crowded aboard will never be known but I heard estimates of from twelve to fourteen hundred. All cabins and the decks were full.

Concurrently with her arrival outbound at the Control Ship the Navy was bringing in six submarines which delayed the exit of the *Corregidor* several hours. As the last sub turned into Mariveles harbor the Control Ship was about to signal the inter-island steamer to proceed when, BOOM! She hit a mine in the outer field and sank in 3 minutes with heavy loss of life.

Navy small boats from *Corregidor* and Mariveles picked up 280 oil-soaked survivors most of whom were treated at our Malinta Hospital, then transferred to Manila. Naval officers stated they had been informed the previous afternoon that the vessel would be going out but never authorized her to pass the Control Ship. Neither were the Harbor Defenses informed that such an exit was anticipated. The Captain of the ship had traversed the mine fields several times previously; he knew the regulations and was familiar with the channel. It appears he proceeded on his own initiative, without permission from the Inshore Patrol or illumination of channel buoys by our searchlights. Unfortunately his course swerved from the channel just before he cleared the outer mine field with the resultant catastrophe. As he himself was lost all the facts will never be known.

The first Coast Artillery casualties occurred in the bombing of Fort Wint on 21 December when several men were wounded. The next day the Navy ordered the complete mining (Navy contact) of the entrance to Subic Bay, to be completed by dark, 23 December.

By that time the Japanese were advancing rapidly down the Central Plain of Luzon as well as northward from Tayabas Province. When it became evident that Manila must be evacuated all U. S. troops were ordered into Bataan in accordance with earlier war plans while we on *Corregidor* were notified of the early influx of the High Command from Manila.

They arrived on Christmas Eve, after dark, and included General MacArthur and family, with USAFFE Headquarters, U. S. High Commissioner Sayre with his family and staff and President Quezon with family and staff. Before morning other parties arrived, including Admiral Rockwell and Naval District staff, Headquarters Philippine Department, and about 900 officers and men constituting the first contingent of the 4th U. S. Marines. This regiment had recently arrived in the Philippines from duty in Shanghai. After the evacuation of Cavite and Olongapo Navy yards, it was attached to the Army for tactical employment and assigned to the Harbor Defenses.

The remainder of the outfit, under Colonel S. L. Howard, USMC, arrived on the evening of 27 December, making a total of about 125 officers and 1400 men. This regiment, supplemented by Coast Artillery troops manning 75mm and 155mm guns, took over the Beach Defenses of *Corregidor*.

In conformity with the general withdrawal plan, General MacArthur had ordered Fort Wint evacuated on Christmas Day. At 6:15 P.M., Colonel Napoleon Boudreau, the Fort Commander, radioed in code: "All personnel evacuated with matériel as directed." That included 34 officers, 505 enlisted men, 2 ten-ton tractors, 2-155mm guns, 4-3" antiaircraft guns with fire control equipment, ammunition for both calibers, and 1-60" antiaircraft searchlight. The remaining seacoast armament was rendered unserviceable prior to evacuation. All troops from Fort Wint joined the Bataan forces. Colonel Boudreau himself rejoined the Harbor Defenses and was assigned to command Fort Frank, which position he held until surrender.

As December wore on, the Japanese established their own air bases on Luzon and proceeded to bomb their objectives at will. All day long their planes could be seen circling over Manila Bay, Bataan and Cavite. Three weeks of this aerial bombardment made a shambles of the Cavite Navy Yard, wrecked Neilson Airport and Nichols Field, and left the bay dotted with burning or sinking vessels. On 29 December the attack switched to *Corregidor*.

INITIAL AERIAL BOMBARDMENT PERIOD

After a quiet morning with fleeting clouds at about 18,000 feet, the Air Raid Alarm sounded at 11:54 A.M. and the antiaircraft guns opened fire. The attacking force, which consisted of 81 medium bombers and 10 dive bombers, approached in formations of 27, broke into smaller groups of 9 each, and passed over us in waves, raining bombs on our little island. Between runs, the dive bombers were strafing the batteries with machine-gun fire. The attack lasted until 2:15 P.M. by which time all of *Corregidor* had been blasted with 300 lb. bombs.

First to be hit was the Station Hospital, with its huge Red Cross clearly painted on the roof. Soon the Topsis Cine, *Corregidor* Club, and numerous other wooden structures were burning as was the Navy gasoline storage dump at the tail of the island. The antiaircraft gun batteries came in for heavy bombing, especially B-60th. Also hit were the various barracks and quarters, water tanks, 60th CA garage, and shipping in *Corregidor* Bay. Two Philippine Army observation planes at Kindley Field were also destroyed.

Power, water and communication lines generally were disrupted. Casualties were 22 killed and about 80 wounded. In my rounds I discovered that one bomb had hit just outside the quarters which Colonel Louis Bowler and I shared, blowing out all doors and windows in the house and really wrecking the place. Miraculously, Colonel Bowler's two beautiful Persian cats had escaped injury. Our Filipino house boy took to the bushes but showed up later. He wanted a pass to go to Manila "to see about his brother." He got it. I didn't blame him;—I had no "brother in Manila." Everyone realized that this was only the beginning and steeled himself for what lay ahead.

Our antiaircraft meanwhile had exacted a heavy toll

from the enemy by shooting down 9 medium bombers and 4 strafing planes, for which they were officially commended by the Harbor Defense Commander. The Japs had made the mistake of coming in at around 20,000 feet. They immediately raised their bombing altitude to about 30,000. Their propaganda radio in Tokyo then proudly announced that "the raid on Corregidor by Japanese planes was so successful every battery on the island has been silenced, the 'Rock' is in flames, and Corregidor as a fortress is now as good as useless." Time would tell!

In the late afternoon of the next day, outside the east portal of Malinta Tunnel, were held the Inaugural Ceremonies of the President of the Philippine Commonwealth. The oath of office was administered to Mr. Quezon by the Honorable Jose Abad Santos, Chief Justice, Supreme Court of the Philippines, after which the President made a brief inaugural address. He was followed by His Excellency, Francis S. Sayre, U.S. High Commissioner to the Philippines, who spoke well for the United States, then read a message from President Roosevelt. After the oath of office to the Vice-President, Mr. Osmeña, General MacArthur spoke briefly but impressively. It was evident that he was deeply moved. The National Anthems of the Philippines and the United States were to have been played by the 91st Coast Artillery Band, closing the program, but the enemy bombing of the previous day burned their barracks and instruments so a small organ, played by one of the ladies in Mr. Quezon's party, sufficed instead.

1 January was a *not* so Happy New Year. The Japs were almost in Manila. The rear echelon of USAFFE pulled out just ahead of them for Corregidor after destroying records, Port Area warehouses, and installations. During the forenoon a Jap fighter plane swooped low over Kindley Field, a

small air strip on the tail of Corregidor. Battery M-60th CA (antiaircraft machine guns) opened fire and after the first bursts, the plane crashed near a Navy small boat in Manila Bay. Many vessels from Manila, including President Quezon's yacht the *Casiana*, had taken refuge under the shelter of our Corregidor batteries. Just before the evening meal, I heard the President phoning to Mr. Jorge Vargas, his former Secretary, whom he had left as his representative in Manila. His order was: "You go to the treasury Jorge, and burn every — thing there, TONIGHT!"

2 January dawned cloudy with a ceiling of about 5,000 feet. We did not like it and sure enough, the Jap bombers took advantage to attack, dropping through the clouds, letting go wherever they happened to be, and disappearing into the clouds again. By 2:30 P.M., 54 enemy planes were operating in the area of the defense. The attack concentrated on Topside, pounding the barracks and quarters again. The car barn, a wooden structure, was hit and burned with several casualties. The Command Post of Battery L-60th, on South Shore Road, received a direct hit, killing the battery commander, Captain Alva L. Hamilton, and three of his men. Total casualties were 13 killed and about 30 wounded.

There ensued several consecutive days of bombing. From fragments assembled it appeared that 1,000 lb. bombs were being used, making craters 40-50 feet across. At Battery Geary (12" mortars) where the assigned personnel (from Battery H-59th) had been constructing a bomb-proof shelter, 34 men took cover in the incompleting structure when the Air Raid Alarm sounded. Unfortunately a large bomb hit adjacent to the shelter, collapsing it on the occupants. Three men were gotten out, injured and shocked,

The gallant defenders of Corregidor surrender after making the capture of the island a most bitter and costly campaign for the Japs.



but the other 31 were completely lost beneath the debris.

The Quezon yacht *Casiana* became a casualty in Corregidor Bay during this period. Only her masts remained above water with the American and Filipino flags flying. The week's bombing disrupted water, power, and telephone lines all over the island but emergency repair details soon restored service at most essential points.

When, on 5 January, our ration allowance was cut in half, most batteries adopted the two meals per day schedule. At Battery C-91st a muzzle burst from a defective antiaircraft round killed 4 and wounded 8, including the battery commander, Captain Jack Gulick, and his executive officer, Lieutenant Morris Shoss. Meanwhile the antiaircraft gun batteries were knocking them down daily in line with their new slogan,—"Keep 'em falling." A recapitulation to date showed a total of 75 enemy planes downed by antiaircraft fire of the harbor defenses and the 200th and 515th AA Regiments in Bataan. At the price they were paying, we felt we could take a lot more of their bombing. The Japs evidently decided it was rather expensive and we were given a week's respite.

On 13 January a small Japanese vessel approached Ternate on the Cavite shore but retreated promptly when Fort Drum opened fire with a 3" gun installed that morning.

The next day two flights of bombers returned to the Corregidor attack, hitting Topside mainly. The lighthouse and surrounding buildings were damaged and there was a huge crater in front of the Post Telephone Switchboard Room but sandbag protection prevented damage to that facility. 4 mules were killed at the picket line in Government Ravine. These were carved up and the mule meat distributed to the various messes. Not bad either. We made it an expensive operation for the enemy by shooting down 4 of the raiding planes.

CAVITE ARTILLERY BOMBARDMENT PERIOD

The middle of January witnessed a change in enemy tactics. He was seen, by our AAAIS detail in Cavite Province, emplacing artillery in defiladed positions between the villages of Sapong and Ternate on the bay shore. His air activity over the harbor defenses was restricted to observation only ("Photo Joe" we called the daily morning observer), while on the west coast of Bataan he landed detachments in rear of our lines. This resulted in a request from our forces in Bataan for artillery fire on an enemy concentration on Longoskawayan Point which was answered at 12:13 A.M. 26 January by Battery Geary (12" mortars).

Sixteen rounds of 700 lb., point detonating, instantaneous fuze, personnel shells were used and proved most effective. According to our observers on Pucot Hill, Bataan, some fragments flew 500 yards and a large fire was started. This firing, under Captain Ben King as battery commander, was the first action by major caliber coast artillery guns against a hostile force since Fort Sumter in 1861. The next morning 24 more rounds were fired, with another 16 on the 29th.

A G-3 Information Bulletin issued by USAFFE on February 2 stated:

A wounded Japanese prisoner captured at Longoskawayan Point, during interrogation by G-2 HPD was asked: "What effect did the large artillery shell fire have on your force?" Answer: "We were terrified. We could not know where the big shells or bombs were coming from; they seemed to be falling from the sky. Before I was wounded my head was going round and round, and I did not know what to do. Some of my companions jumped off the cliff to escape the terrible fire." It would seem that the 12" mortar fire from Corregidor did a bang-up good job.

As enemy activity in Cavite Province increased it was



As can be seen from this picture, troops of the 503d Parachute Regiment used the Corregidor parade ground as a landing field in the recapture of the island.



Paratroopers make the initial landing on the bomb-battered terrain of Corregidor on 16 February 1945 during its recapture.

decided to take their operations under fire from Fort Frank. On 31 January Battery Koehler (eight 12" mortars), which had not been fired in several years and never at an enemy, blasted 30 rounds at a Japanese concentration near Ternate, and Battery Frank North (four 155mm guns), 36 rounds. It was evident by that time that we had a land war on our hands and not an operation against naval vessels. The "forgotten guns" that could fire back inside the bay were coming into their own. Thereafter, for many weeks, some of the seacoast batteries which could fire on the south mainland were in action almost daily, especially those at Forts Frank, Drum, and Hughes.

Observation was very difficult from the fortified islands but Captain Richard G. Ivey, 60th CA, with a small party of enlisted men, all volunteers, using a walkie-talkie radio set at an observation point on the mainland, gave spotting data until his detail was attacked and driven out.

There was considerable undercover excitement the night of 3 February when a fleet submarine came in, direct from Honolulu, bringing 2750 rounds of sorely needed 3" anti-aircraft mechanical fuze ammunition. This enabled the Antiaircraft Defense Commander to equip one more battery (C-60th) with the longer range ammunition. The submarine loaded up with torpedoes and about \$4,000,000 in gold bullion from the Philippine Treasury vault on Corregidor, submerged east of Corregidor until the next night, then was passed through the mine fields safely and eventually reached Australia with her valuable cargo.

With her went my good friend Lieutenant Colonel Warren Clear, a War Department Intelligence Officer who had been roving the Far East before the war. I went down to the south dock to see him off in the darkness, little dreaming that his report of our parting would reach my family

and hundreds of friends through his subsequent story in the *Reader's Digest*.²

Shortly after 8:00 A.M. on 6 February, Forts Drum and Hughes received the first enemy artillery fire against the fortified islands. A few minutes later we on Corregidor were hearing the familiar "whiz-bangs" of 1918,—shrill whistles ending in detonations as the shells landed. The bombardment came from 105mm batteries on the Cavite mainland and lasted until about 11:00 A.M., with Fort Drum receiving the heaviest attack. Although hit by approximately 100 shells, her fighting strength was unimpaired. (We drew little comfort that day from a news report that an American Expeditionary Force had landed in Ireland!)

Meanwhile the various vessels which had taken refuge in San Jose Bay south of Corregidor moved over to the Bataan side of the island to escape the artillery fire from Cavite Province. These included several harbor boats and launches, and three Yangtze River navy gunboats, the *Oahu*, *Luzon*, and *Mindanao*. These were left behind when Admiral Hart and his Asiatic Fleet took off immediately after Pearl Harbor.

I spent the period of February 13 and 14 on a staff visit to our various Coast Artillery organizations in Bataan of which there were quite a few. Batteries B, D, and H, 92d CA, were all manning 155mm guns there; G-60th and C-91st had anti-aircraft guns, while E-60th was an anti-aircraft searchlight battery. A Philippine Army outfit under Lieutenant Al D'Arezzo, 92d CA, was manning an 8" railway gun on concrete emplacement at Sasayin Point, up the

(Continued on page 36)

²The Heroic Defense of the Philippines, by Lieutenant Colonel Warren J. Clear; *Reader's Digest*, July, 1942.

JET PROPULSION—

By Captain C. R. Tosti and Joseph B. Tuzen

THE FUTURE OF JET PROPULSION

At the present time, six basic types of aircraft power plants are under development—the reciprocating engine, the turbo-prop engine, the turbo-jet engine, the pulse jet engine, the ram jet engine, and the rocket engine.

We pointed out in the previous installment of this article that the efficiency of the propeller-reciprocating engine combination drops off at speeds in excess of 450 mph because of the compressibility effects of the air on propeller efficiency.

In order to overcome the size and weight disadvantages of the reciprocating engine, we must look to a new type of power plant—the thermal jet engine. We shall see, in the discussion of thermal jet units, that each type of engine has its particular application and that we cannot designate any one type as the ideal jet engine of the future.

The thermal jet power plant has certain distinct advantages over the reciprocating engine. These may be summarized as follows:

1. The elimination of the propeller results in:
 - a. The removal of speed and altitude limitations as encountered with the reciprocating and turbo-prop engines.
 - b. A considerable weight reduction which allows the utilization of lighter and less complicated landing gear assemblies.
 - c. The design of airplanes closer to the ground, since no propeller clearance is required.
 - d. A reduction in frontal areas, thus affording better streamlining of aircraft designs, since the jet engines can be completely enclosed in the wings or fuselage of the airplane.
2. Jet engines* can, in general, use a wider range of fuels, including lower grade fuels such as kerosene to the high octane fuels. This does not apply to rocket engines, however, in which special types of liquid propellant fuels are utilized.
3. The power produced by jet engines is applied directly to the propulsion of the aircraft, and eliminates the requirement for complicated transmission or power conversion mechanisms.

ERROR'S NOTE: In the first part of this article which appeared in the last issue we erroneously stated that Air Commodore Frank Whittle obtained his first patents on jet propulsion in 1940. This should have been 1930.

*The term "jet engine" is used to denote all jet propulsion devices as outlined in Part One of this article.

4. Thermal jet units can be built with a considerable reduction in weight and size for a given output as compared with a reciprocating engine. Thus, jet engines provide greater specific horsepower, i.e., horsepower output per pound of engine weight.
5. In the case of the gas turbine type of jet engine, dynamically balanced rotary components can be used exclusively, thus enabling higher operating speeds to be obtained as compared with the reciprocating engine. Also, lubrication of this type of engine is comparatively simple since it incorporates only one major

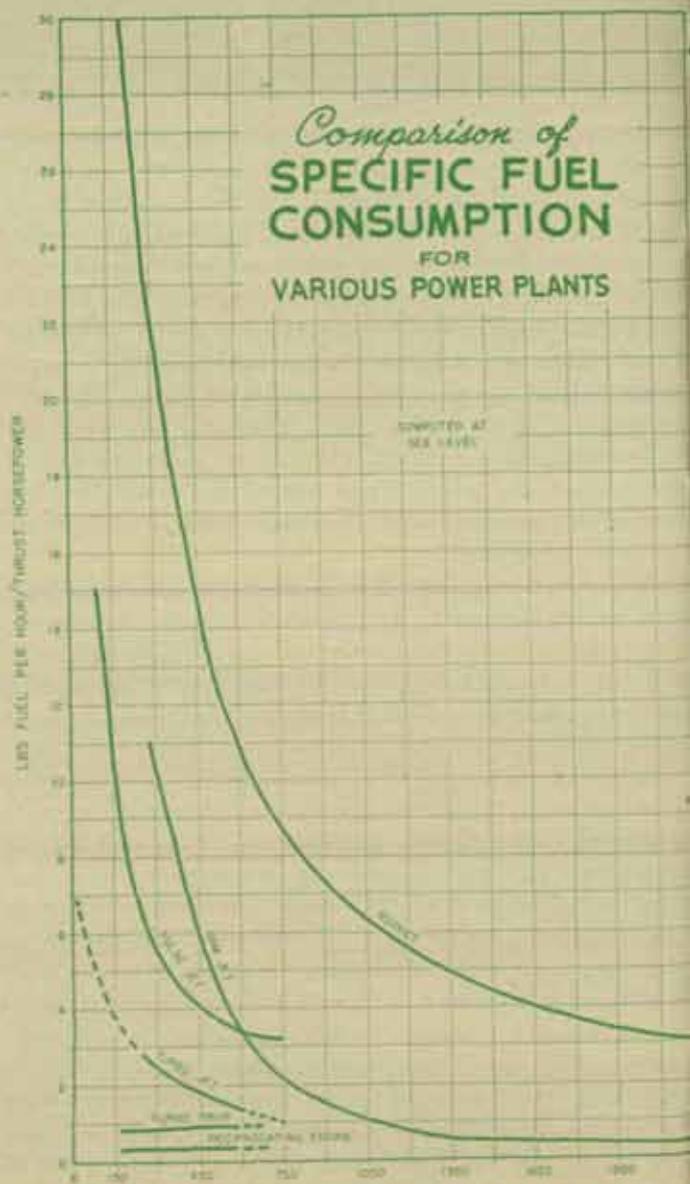


Figure 1

PART TWO

st, Present and Future

rotating part—the main shaft to which are attached the compressor and the turbine.

6. Jet engines require no warm-up as do reciprocating engines.
7. The operation of the jet engine is smooth, with the exception of the pulse jet engine which is not intended for application to passenger carrying aircraft. Thus, jet propelled airplanes will afford more comfortable and smoother air travel than that obtainable with the reciprocating engine.

Having discussed the advantages of jet engines, let us now consider their main disadvantage—high fuel consumption. Figure 1 illustrates the trends in fuel consumption with flight velocity for the various types of engines.

You can see from Figure 1 that the rocket engine has a high specific fuel consumption, regardless of flight velocity. The specific fuel consumption of the ram jet engine is high at low velocities, but improves with an increase in flight velocity until it approaches that of the reciprocating engine at supersonic speeds in the magnitude of 2000 mph. The fuel consumption of a ram jet is high at low velocities because the ram pressure is too low for efficient acceleration of the gases. As the velocity is increased, the pressure rises and the efficiency improves. For very high velocities, the ram jet engine should have a lower specific fuel consumption than any other of the thermal jet engines. The specific fuel consumptions of the pulse jet engine and the turbo jet engine bridge the complete region between the ram jet engine and the reciprocating engine as indicated in Figure 1.

The relationship of thrust horsepower output with speed for the various types of engines is shown in Figure 2.

$$\text{THP} = \text{lbs. thrust} \frac{\text{MPH (engine speed)}}{375}$$
The propeller type engines, such as the reciprocating engine and the turbo-prop engine, have the advantages of providing thrust horsepower output at zero speed; and therefore, have better take-off characteristics. Thus propeller type engines lend themselves to application on heavy payload aircraft, such as cargo aircraft and transports, which require high power outputs for take-off on comparatively short runways. Figure 2 indicates, furthermore, that the rocket and ram jet engines will provide the greatest power outputs at very high speeds and that the ram jet comes into its own at speeds greater than 1500 miles per hour and surpasses the rocket in power output. It is pointed out that the set of curves in Figure 2 is computed at sea level and that at higher altitudes the speeds at which the ram jet surpasses the rocket in power output become higher because of the rarer atmosphere. Of course, since the ram jet is an air breathing engine, it becomes inoperative at altitudes beyond the atmosphere.

In order to synthesize our ideas as to the application of

the various types of engines we have prepared a chart, Figure 3, which summarizes some of the salient performance characteristics of the various types of power plants.

The predictions made in Figure 3 are conditioned by numerous problems which must be solved before development in the field of jet propulsion can reach its ultimate stages.

PROBLEMS TO BE SOLVED

Although the thermal jet engine is striking in its simplicity, as compared with the reciprocating engine, there are several major problems involved with the development of jet propulsion engines. Briefly, these are:

1. *Problems of Combustion.*—These problems are concerned with the maintenance of combustion in a rapidly moving current of air which may be greatly in excess of the amount of air required to furnish the oxygen needed for combustion.
2. *Problems of Metallurgy.*—The major problems under this head relate to a search for high temperature resisting metals with high tensile strength and other properties for the construction of turbine wheels and buckets as required in the case of gas turbine types of engines.
3. *Problems of Structural Design.*—New materials and

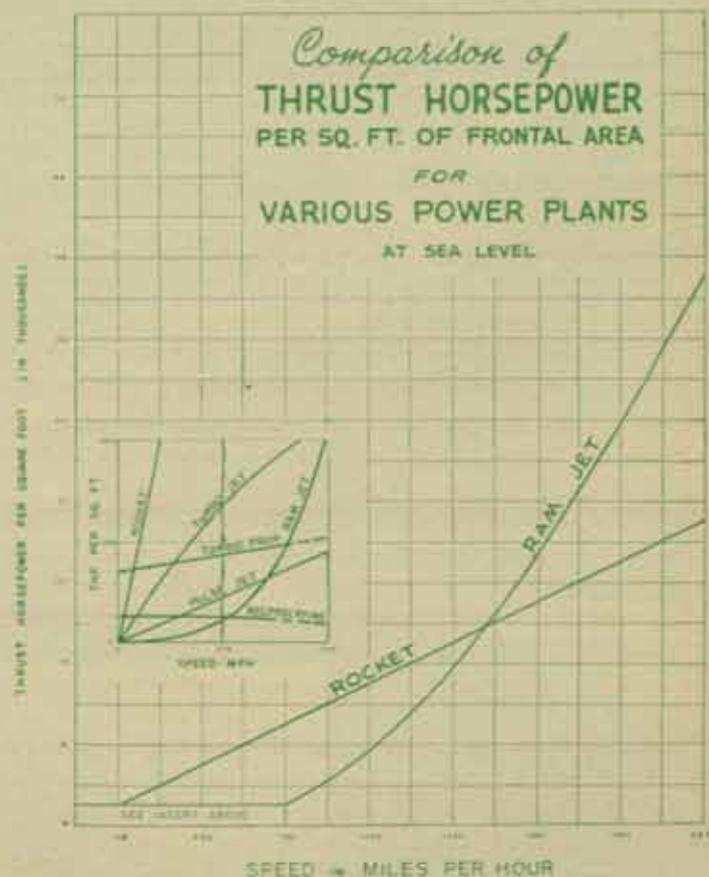


Figure 2

TABLE OF PREDICTED PERFORMANCE OF VARIOUS ENGINES

ENGINE TYPE	ENGINE CLASSIFICATION	RELATIVE THRUST (LBS)	RELATIVE WEIGHT OF WING, FUEL & OIL (LBS)	MAXIMUM SPEED (MPH)	MAX. EFFICIENT ALTITUDE (FEET)	PRINCIPAL APPLICATION
WINDMILL	CONVENTIONAL CYCLICAL COMBUSTION ENGINE (AIR BRAKING, ROTATING ENGINE)			UP TO 450	35,000	LONG RANGE, HEAVY PAYLOAD TRANSPORT AND CARRO AIRCRAFT
RAM JET	HOT TUBE (AIR INTAKING, BUCKING ENGINE)			UP TO 550	45,000	LONG RANGE, HEAVY PAYLOAD TRANSPORT AND CARRO AIRCRAFT
TURBO JET	CAT T-BLOCK (AIR INTAKING, ROTATING ENGINE)			350-1500	60,000	HIGH SPEED FIGHTER, BOMBERS, AND TRANSPORTS
WIND JET	IMPULSIVE PISTON JET (AIR INTAKING, ROTATING ENGINE)			200-750	50,000	WIND MILLERS
RAM JET	CONTINUOUS FLOW JET (AIR INTAKING, NON-ROTATING ENGINE)			600-3000	80,000	WIND MILLERS, HIGH SPEED FIGHTER AIRCRAFT, FOR THE AT MOST ADVANCED CONSTRUCTION WITH THE BEST FUEL PLAN (THIS ENGINE IS A WIND SPEED RANGE)
ROCKET	EXPLODING ENGINE (NON-ROTATING, AIR-INTAKING ENGINE)			? ? ? (APPROX 20,000 MPH MUST BE OBTAINED TO ESCAPE INTO SPACE)	UNLIMITED	WIND MILLERS, HIGH SPEED FIGHTER AIRCRAFT, AND SHORT TAKE-OFF SPEEDS

Figure 3

new methods of installing and arranging parts with respect to each other may result in marked improvements over present-day types of jet propulsion engines.

4. *Problems of Supersonic Speed.*—Whereas jet propulsion power plants come into their own at sonic and supersonic speeds, the same is far from true for the remainder of the airplane. Therefore, fundamental and advanced research on the aerodynamics of sonic and supersonic speeds is of highest importance. At sonic and supersonic speeds, the shock, or compression waves formed, greatly increases the resistance, or drag, of the object, and changes greatly the distribution of pressure over its surface. Thus, control surfaces properly adapted for use at normal speeds may fail utterly to furnish control at sonic and supersonic speeds. A continuing and active research in the field of supersonic aerodynamics must go hand in hand with the study of ways and means for the improvement of jet propulsion power plants.

The great vigor with which the problems of supersonic speeds are being attacked by the Army and Navy gives great promise for the solution of these problems in the future. But, conceding the solution of these problems, what will the supersonic airplane of the future look like and what will it do? Mr. Hall Hibbard of the Lockheed Aircraft Corporation says that in appearance the supersonic airplane will compare with the present design, but that it will be modified for high speed; that its fuselage will have a long pointed nose; that it will have wing and control surfaces with sharp leading edges to provide lift and maneuverability for taking off and climbing through the atmosphere and also for descent and landing of the airplane; that the wings and control surfaces would be useless at high cruising altitudes and that all steering would be done by a directable jet exhaust nozzle; that an airtight cabin will be required to

maintain pressurization at high altitudes and that oxygen will be required for breathing purposes.

This prediction of a future passenger carrying airplane seems to be fairly logical and it seems to agree with the idea of National Advisory Committee for Aeronautics whose conception of a passenger carrying supersonic airliner is shown in Figure 4, which you may remember seeing in the 6 January 1947 edition of *Life Magazine*. This futuristic airliner design would be capable of operating at a speed of 1000 MPH at 35,000 feet. Friction at that speed would heat the plane to 113° F., but the passengers would be comfortable because the cabin would be refrigerated and pressurized to the proper temperature and pressure conditions. The propulsion of the aircraft would be accomplished by seven engines of three different types—the turbo-jet, the ram jet, and the rocket. The turbo-jets would propel the airplane to a speed of approximately 600 MPH; the rockets would then take over and propel the airplane through the sonic barrier; and then the ram jets would take over when the rockets were expended and maintain the airplane's cruising speed at 1000 MPH.

However, as pointed out by the editors of *Life Magazine*, the fuel consumption of this type of aircraft is prohibitive and thus its eventual development may be dependent upon the development of atomic power plants for aircraft propulsion.

Before leaving this discussion of the airliner of tomorrow, let us say a word about the "Buck Rogers" type of rocket plane which we usually visualize as the space ship of the future. Many engineers believe that bullet-shaped rocket planes, without wings, are impractical for carrying humans because of the sudden acceleration required to propel such an airship into space. They point out that a human can comfortably withstand a maximum acceleration force of only 3 G's—three times the pull of gravity—whereas an ac-

celeration of 9 G's is required to escape from the earth's atmosphere. Furthermore, they point out that such a rocket plane could not slow down for a safe and comfortable landing.

THE FUTURE OF GUIDED MISSILES

In general, missiles may be divided into three basic types:

1. *Short Range Missiles.*—The barrage type rockets which are in this class have a range of a few thousand yards and are of relatively low accuracy.

2. *Intermediate Range Missiles.*—This type of rocket is fired as from a gun barrel as a projectile with the rocket engine starting to burn after the velocity of the missile has slowed down. The range of this type of missile is from 40 to 60 miles.

3. *Long Range Missiles.*—The long range missile is used to attack extensive targets at a long range. The V-2 rocket, which was fired against London at a distance of 300 miles, is an example of this type of missile.

The three basic types of missiles may be classified as follows:

1. Air launched to air targets.
2. Air launched to surface targets.
3. Surface launched to air targets.
4. Surface launched to surface targets.

Guided missiles have three major problems; high fuel consumption, heat-resistant alloys for combustion chamber construction, and controls. The fuel consumption problem

may be solved by atomic power. However, the control problem may be a more difficult one.

The remote control of missiles requires the employment of an "electric guiding system," a servo-mechanism, for the purpose of insuring flight stability. This guiding system can be broken down into the following elements:

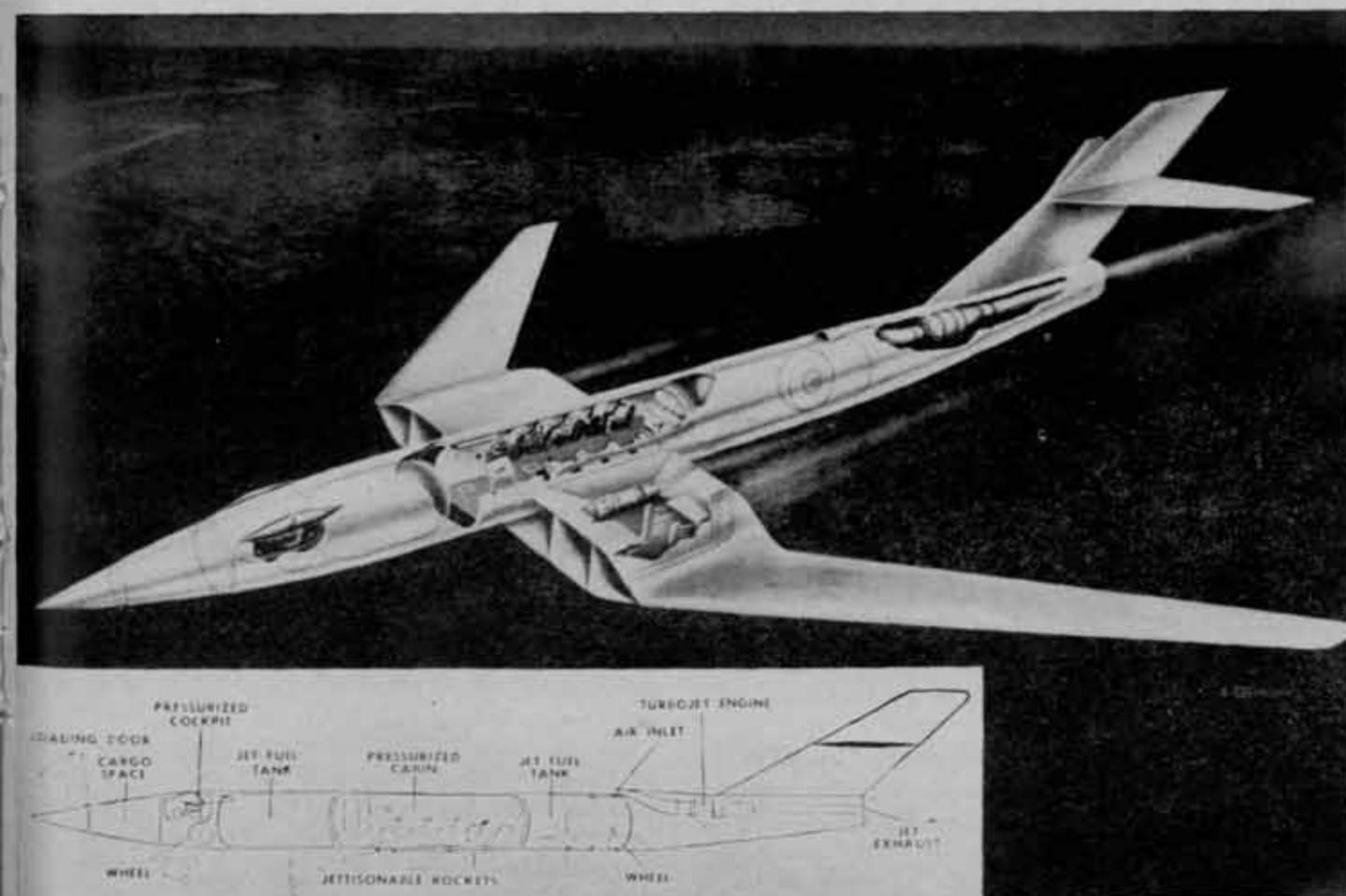
1. *Stabilization Controls.*—Deviations in angle of attack, yaw and pitch, are corrected by the Gyro system. Three different gyros corresponding to these three angular degrees of freedom, act as stabilizers for deviation from the normal values (pre-set values before launching).

2. *Steering Controls.*—Azimuth accuracy of the missile can be maintained by a radio beam system similar to the ordinary commercial aircraft navigation beam system. Another unique method of steering control of subsonic missiles is the wire control system. In this system, a coil of very fine steel wire is mounted on each wing tip of the missile and a mating coil is mounted on the parent airplane. During flight of the missile, the wire is paid out by the missile while moving away from the launching airplane. Steering control of the missile could be maintained up to 15 to 18 miles by sending electrical signals along the wire. This method of steering control was first patented in 1917 by the Germans and was developed during World War II.

3. *Flight Controls.*—These controls consist of aerodynamic control surfaces, rudders, and exhaust jet rudders.

The subject of remote controls is highly technical and, therefore, no attempt is made to fully discuss it. However,

Figure 4—Supersonic airliner of the future as conceived by the National Advisory Committee for Aeronautics.



it will suffice to say that the stabilization steering control system sends out electrical signals which, in turn, activate the flight controls, thereby keeping the missile on the flight path to the target. It is apparent from this discussion that a missile is only as good as its controls, assuming, of course, that the power plant can propel it over the required range.

SUMMARY

It is difficult at this time to state with any degree of certainty that the speeds and configurations of the supersonic airplanes and guided missiles of tomorrow will conform to the predictions which we have made in this article. Many

aerodynamic and mechanical problems remain to be solved before supersonic flight can be achieved—and when supersonic flight is finally achieved, who knows but what our present theories on the subject may be completely revised. Of one thing we can be sure, however, and that is that jet propulsion will play an increasingly important part in the future of air travel and aerial warfare. In this latter respect, the Coast Artillery, in the accomplishment of its mission of National Defense, will probably employ jet propelled missiles of some of the types discussed above. Therefore, jet propulsion is a field of development in which Coast Artillery Officers should have a keen interest.



ORC Guided Missile Battalion at Fort Bliss*

It is quite natural that the first guided missile battalion to be organized among the Civilian Components of the Army should get its start at The Antiaircraft Artillery and Guided Missile Center at Fort Bliss, Texas. And it normally follows that the officers of the new reserve battalion should hail from the Texas border city of El Paso which is adjacent to Fort Bliss and less than fifty miles from the White Sands Ordnance Proving Grounds in New Mexico.

The 400 Army Ground Force Reserve Officers in the El Paso area have their headquarters and hold their regular meetings at Fort Bliss. Officers from the Antiaircraft and Guided Missiles Branch of The Artillery School frequently visit and serve as instructors at the ORC troop schools. The Guided Missile Museum and the specialists of the Army Ground Forces Board No. 4 are also available to add stimulus and increase interest in rockets and rocket development. And at near-by White Sands Proving Ground, experimental German V-2 rockets are being launched to explore the stratosphere and to advance scientific knowledge of rocket behavior.

In this atmosphere, the first ORC guided missile battalion was born and is taking its first steps under the able guidance of the Antiaircraft Artillery and Guided Missile Center. The fact that no such unit as a guided missile battalion exists in the troop basis for ORC units did not long deter Lieutenant Colonel W. L. Sanders, El Paso Area ORC Instructor, and his Reserve Officer rocket enthusiasts. Nor did it keep the Commanding General of the Antiaircraft Artillery and Guided Missile Center from making available to the pioneer battalion all of the facilities and resources of the Center, the Artillery School Branch and AGF Board No. 4 and the valuable experience of the 1st Guided Missile battalion.

Under authority from the Commanding General of the Fourth Army, the new guided missile battalion has been organized within the 482d ORC Composite Group, with the

assistance and addition of officers from the 483d Group.

The organization of the new battalion is based on the proposed T/O&E that has been recommended for the Army Ground Forces 1st Guided Missile Battalion now actively engaged in training and guided missile development at White Sands Proving Ground. Great care is being exercised in the selection of qualified Reserve Officers to fill the variety of highly technical vacancies in the new battalion. As soon as the officers are selected and the necessary specialists are available in the Enlisted Reserve Corps, it is planned to man the battalion with as near a complete component as is possible.

The mission of the new guided missile battalion parallels that of all other reserve units in that it will provide peacetime training for its personnel in their primary arm. This it should accomplish with rapidity and relative ease. The officers of the battalion are enthusiastic for their new work; they have the incentive of being pioneers in a new endeavor with the attention of the army and the entire nation focused on their activities; and there is the physical proximity to the center of the nation's guided missile development to add impetus to their program.

But with all these birthrights, the First ORC guided missile Battalion has a tremendous responsibility. It is not just another reserve unit. It is a pioneer, a new kind of outfit in a new and untried field. If it succeeds, it will form the nucleus and pattern for guided missile units among the Civilian Components just as the Army Ground Forces 1st Guided Missile Battalion is blazing the way for future Regular Army guided missile units. It will prove that even with new and relatively undeveloped weapons, the Reserve and National Guard officer can keep abreast of the latest tactics and techniques in his peacetime training.

Any other units or groups of individuals interested in the organization of similar type units will receive the full cooperation of the Antiaircraft and Guided Missile Branch of the Artillery School at Fort Bliss by addressing communications to that installation.

*Released through P.R.O. Fort Bliss, Texas.

"THE TURBO-JET"

By E. S. Thompson

The constant urge of airmen to fly faster and faster has received a tremendous impetus in the past few years because of the creation of new modes of aircraft propulsion. Spurred on by the war, the development of the prop-jet, the turbo-jet, the pulse-jet and the rocket has now reached a stage which prompts many to believe that the present forms of aircraft propulsion are outmoded. Careful analysis will show that this is by no means the case.

One of these new engines, the turbo-jet, is making a bid for a large portion of future aircraft installations. It has now established itself as a fairly dependable aircraft powerplant and its characteristics appear ideal for many applications.

It is the purpose of this article to evaluate the turbo-jet with respect to other types of aircraft powerplants. Many features of the turbo-jet will require modification and further development and perhaps a somewhat new concept of design will be necessary before the turbo-jets can claim their rightful place in the aircraft field.

In order to establish the position of the turbo-jet with respect to aircraft speed and range, it will be desirable to review briefly each type of powerplant suitable for aircraft propulsion. An estimate of the maximum effective speed attainable by aircraft equipped with various types of powerplants is shown in Figure 1. Generally, the speed of an airplane increases with increase in altitude as long as the engine power can be maintained at its maximum value by supplying excess air or supercharging in the case of the reciprocating engine, or by maintaining the highest design compressor pressure ratio in the case of the gas turbine. The power of rockets, which do not depend upon atmospheric air, is not affected by change in altitude.

The reciprocating engine which must get along on the air it can suck in, can be brought up somewhat below its cellar position on the speed scale by the addition of an air pump driven from the engine crankshaft. Addition of a supercharger driven by a gas turbine to this type of engine allows full power operation at even higher altitudes resulting in a gain in maximum speed. A further increase in speed may be obtained in the reciprocating engine and propeller-driven aircraft by directing the exhaust pipes rearward so as to utilize the thrust from the exhaust gases. The maximum effect from the exhaust gas is obtained by using separate jets for each cylinder, or at the most by combining the exhaust gas from two cylinders.

Installation of an exhaust-gas-driven-turbosupercharger within the nacelle or fuselage in such a position that the exhaust from the turbosupercharger is in a horizontal direction opposite to the line of flight allows very effective use of the residual velocity of the exhaust gas in increasing the combined thrust of the powerplant. As altitude is increased

the ratio of the thrust available from the turbosupercharger exhaust becomes a larger percentage of the total engine power. Airplanes equipped with this type of powerplant are capable of speeds of approximately 500 miles per hour. This speed limitation will be increased somewhat when new developments now underway result in acceptable propeller efficiencies at speeds above 500 miles per hour.

The turbosupercharged powerplant does not utilize the entire flow of exhaust gas from the reciprocating engine in the turbosupercharger but wastes a considerable portion of the gas through a valve or wastegate. Consideration is now being given to utilization of all the exhaust gas in the turbosupercharger and this will probably make it possible to eliminate the geared-driven supercharger within the engine and possibly result in reducing the specific fuel consumption, at least at the higher engine speeds. All the designs for increasing the relative amount of work done by the turbosupercharger, whether by directly gearing it to the reciprocating engine or not, are called "compound engines."

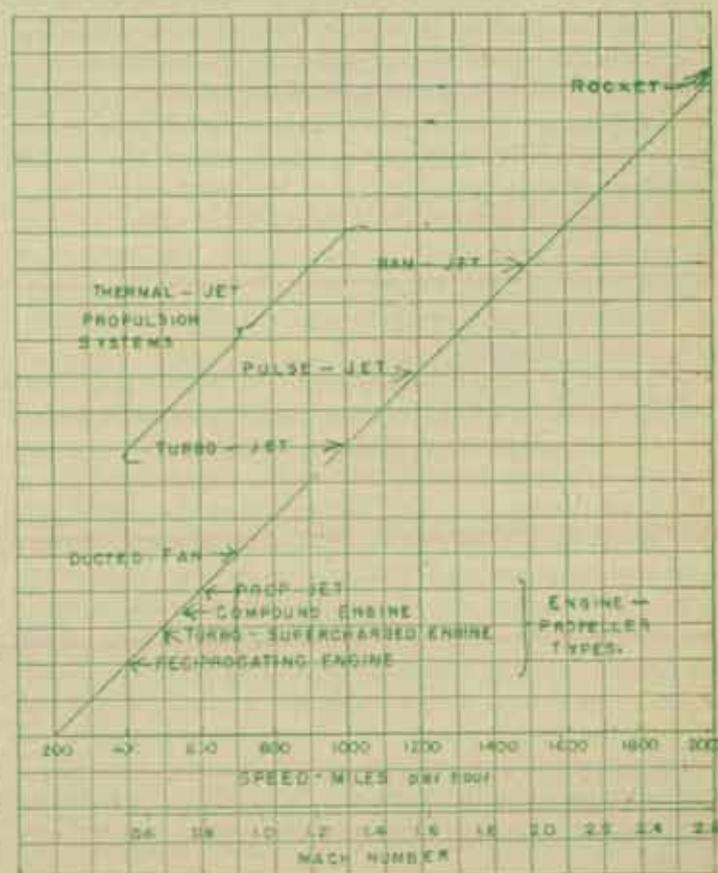


Figure 1—Maximum effective speed of aircraft powerplants.

The powerplant for aircraft of the next higher maximum speed is the *aircraft gas turbine for propeller drive*, or more popularly known as the *prop-jet engine*. This engine is a high-speed, turbine type, powerplant driving a propeller through a reduction gear. Air is the working fluid and either kerosene or gasoline of any octane rating is the fuel. Combustion is a continuous flow process and is self-sustained after the powerplant has been started. Ram air enters the compressor, is compressed, and passes into the combustion chambers where the gas temperature is increased by combustion of fuel. The hot gases from the combustion chambers expand through the turbine where power is developed to drive the compressor, the accessories and the propeller shaft. The energy remaining in the exhaust gases is utilized in a high velocity jet to produce additional propulsive thrust. The compressor for this engine can be of either the axial or radial flow type. Approximately 80% of the propulsive thrust is obtained from the propeller and the remainder from the jet exhaust. An airplane utilizing prop-jet engines can obtain speeds approaching 600 miles per hour and again this may be increased when higher efficiency propellers at increased speeds are available.

To advance in speed beyond 600 miles per hour, aircraft must be powered by using some form of jet propulsion system. Jet propulsion systems embrace two main types, i.e., those using atmospheric air, called jets and those not depending upon atmospheric air for combustion, called rockets. There are three main types of jets: *mechanical*, *auxiliary* and *thermal*.

A *mechanical jet propulsion system* may employ a reciprocating engine or a gas turbine for the prime mover. Forward thrust is obtained by means of an enclosed or *ducted fan* driven by the engine. A mechanical jet propulsion system may be designed to combine the air from the ducted fan with the higher velocity gas from the engine so as to augment or increase the velocity of the mixture.

Auxiliary jet propulsion has been referred to above in those powerplant combinations which utilize the exhaust from a reciprocating engine or a turbosupercharger. Utilization of a greater percentage of the available energy in these auxiliary jet propulsion devices reduces the amount of power required from the propeller driven by the engine, particularly at higher altitudes, and will, therefore, result in an increase in speed.

Thermal jet propulsion includes four main types. These are the *Campini system*, *turbo-jet*, *aero pulse* and *athodyd*.

The first thermal jet powered aircraft to fly was the Campini-Caproni. It made a successful ten-minute flight in Milan on August 27, 1940. The design of this engine was laid down by S. Campini in 1932. This engine utilized a standard reciprocating aircraft engine driving a compressor, whose air was then mixed with the exhaust from the reciprocating engine and fed to combustion chambers, where additional fuel was added. The resulting products of combustion were then directed through a nozzle which furnished the high velocity jet. The Campini system was quite complicated in comparison with the turbo-jet, which was developed shortly thereafter. As no relative advantages over the turbo-jet were apparent, *the project was not continued*.

The *turbo-jet* is an aircraft engine which makes use of



Figure 2—Turbo-Jet.

the thrust provided by a high velocity jet of gas from a suitably shaped jet nozzle. (See Figure 2.) As in the prop-jet, air is the working fluid and either kerosene or gasoline is the fuel. Combustion is a continuous flow process and is self-sustained after the powerplant has been brought up to starting speed and the fuel ignited by a spark plug, which is used in the starting cycle only. Ram air enters the compressor, is compressed, and passes into the combustion chambers, where its temperature is increased by the combustion of fuel. On expansion of the gas through the turbine, sufficient energy is extracted to drive the compressor. The energy remaining in the gas produces a high velocity jet. Thrust is the reaction to this high velocity discharge. The compressor can be of the radial type, or of the axial flow type.

The *aero pulse*, or *pulse jet*, which does not employ a mechanically driven compressor but depends upon its forward flight for compression, is best exemplified by the German V-1 "Buzz Bomb." This system employs a properly shaped cylinder with the diffusing air inlet periodically interrupted by shutters or valves, a fuel nozzle, a spark plug and a jet nozzle for discharging the high velocity exhaust. Since air is forced into the combustion space as a result of the forward motion of the aero pulse, it is necessary to launch this device before it will operate under its own power. Ignition is intermittent. The spark discharge explodes the fuel-air mixture, increasing the pressure in the combustion space, causing the inlet shutters to close and forcing the gas rearward through the jet nozzle. Release of the gas through the nozzle lowers the combustion space pressure below that on the forward side of the shutters, so that they open and admit air for the next cycle. Frequency of the explosions, which has a direct effect on speed, can be varied by spark discharge timing. The pulsating cycle is relatively inefficient, but the device is quite simple and inexpensive.

The *athodyd*, or *aerothermodynamic duct*, popularly known as the *ramjet*, is a cylinder with a diffusing air inlet and jet nozzle discharge. Fuel is supplied to the combustion space in the cylinder. After ignition, combustion is continuous. Compression of the air depends entirely upon forward motion of the athodyd through the air. The athodyd can not be started from a static condition, but must have an initial velocity of approximately 350 miles per hour before sufficient net thrust is obtained for forward motion. The efficiency of the athodyd is very low until speeds of 800 miles per hour and above are reached. It is even simpler than the aero pulse, as there are no moving parts. An excellent description of the ram jet appeared in the January-February 1947 issue of THE COAST ARTILLERY JOURNAL.

Rockets which do not use air for combustion may be divided into four classes, depending on the type of fuel used. These are—*solid propellant*, *liquid propellant*, *gas propellant* and *mixed or combination* types.

The *solid propellant* rocket can be exemplified in its simplest form by the Fourth of July skyrocket in which gunpowder is the fuel. When ignited, the gunpowder burns and the resulting gas exhausts through a jet nozzle, thus developing the thrust.

Liquid propellant rockets employ various combinations, such as alcohol and oxygen, which are fed to the combustion chamber at high pressure, ignited and burned continuously. The products of combustion are directed through a jet nozzle.

Gas propellant rockets have not received much attention because of the difficulty in storing the gas. Operation of this type of rocket is similar to the liquid propellant type in that the gas is injected into the combustion chamber where it is ignited. Combustion is a continuous process, with the products of combustion being ejected through a jet nozzle.

The *mixed* type of rocket, as its name implies, may combine any combination of solid, liquid or gas for the propellant. The means of mixing and causing combustion varies with the combination of propellants used, but, as in other cases, the device consists of a fuel injector, a combustion chamber and a jet nozzle.

Now which types of aircraft should employ each of these kinds of engines? Obviously, there must be considerable overlapping. Speed, which is the main variable being considered here, is not the only criterion for selection of a powerplant. In borderline cases, the choice will be influenced by many other factors. Operational economy has been considered in the choices listed.

PERSONAL AIRCRAFT

The *simple reciprocating engine with, or without, a geared-driven supercharger* is universally used at the present time on all personal aircraft. The privately owned airplane will undoubtedly for many years to come, use this type of engine. The increased cost of the turbosupercharged or compound engine can not be justified for the low use factor prevalent in this class of airplanes. The fuel economy of the large prop-jet is poorer than that of comparable size reciprocating engines hence it is obvious that the small prop-jet will be unable to compete with the commendable performance of existing piston engines in the personal plane size. Whether their lower specific weight, relative simplicity and eventual attainment of longer life will offset the disadvantage of high fuel consumption remains to be seen. At any rate, there will be no major invasion of the prop-jet in the low powered field for at least ten years.

The *turbo-jet* will not find ready application to the personal plane because its efficiency below 400 miles per hour is so poor as to make it uneconomical for this purpose. Speeds of 400 miles per hour and above will not be attractive to the great majority of private flyers.

Rockets, except for assist at take-off, are out of the question because of the high speeds involved in rocket powered aircraft and because of the extremely high fuel consumption.

TRANSPORTS

Transport airplanes in use on all commercial air lines are powered by the reciprocating engine with a geared supercharger. Without pressurized cabins, there was no need to take advantage of the higher speeds offered at the higher altitudes. With the advent of the pressurized cabin, it will soon be possible to fly at 30,000 ft and more with complete comfort and safety for the passengers. Here the turbosupercharger plays a triple role, for, in addition to supercharging the engine to maintain sea level power at high altitude and assisting in power production by making use of the thrust from the turbo exhaust, it also furnishes air for pressurizing the cabin.

Certain advantages of the prop-jet over the reciprocating engine will offset any disadvantage in fuel consumption, and ultimately will insure their use in certain applications, especially for engines of 1000 hp and above. The characteristics of the prop-jet are such that it may be operated at very close to maximum power for its best specific fuel consumption. This, of course, allows continuous operation of the aircraft at the so-called cruising power at speeds approximately 100 miles per hour faster than is possible with reciprocating engines. The capacity of reciprocating engines has certain definite limitations, because of the difficulty of increasing the combustion volume beyond about 5,000 cubic inches without resorting to extreme complication in cylinder arrangement. Output per cubic inch can be increased by increasing engine back pressure and utilizing the exhaust gas in a turbosupercharger. Ultimate limitations to this scheme will also be found. On the other hand, the prop-jet engine has no reasonable size limitation. The number of turbine and compressor stages and the diameter thereof can be increased well beyond any number and size now in existence. If required, a single prop-jet powerplant of 50,000 hp would not be an impossibility. It therefore appears that the most suitable field for exploitation of the prop-jet is in sizes beyond that obtainable by a reciprocating engine. The lower limit in size should then be about 6,000 hp with the most attractive size for the next few years being about 10,000 hp.

Reciprocating engines, when used in combination with the turbosupercharger, offer performance economy up to at least 450 miles per hour, which can not be matched by the prop-jet. Problems of commercial flight at speeds higher than 450 miles per hour, not the least of which is discomfort upon encountering turbulent air at such speed, are being analyzed most carefully by airline operators before deciding upon the use of higher speed transports.

If the desire is for increased speed, then why not take a real step? The prop-jet makes possible "cruising" speeds equal to the maximum reciprocating-propeller engine speed of 450 miles per hour, but the turbo-jet allows operation in the 600 miles per hour class. For even reasonable comfort, the flights must be at 35,000 ft or more; but here again the turbo-jet is at its best at high speeds and high altitudes.

If the trend is toward super transports of 500,000 pounds gross weight or better, at speeds in the 500-mile class, and the desirable four engine configuration is to be maintained, then prop-jets of about 25,000 hp would be in a class by themselves.

Rockets have been used for assisted take-off of transport planes of both land based and seaplane types. Increased use of this device is expected. Use of the rocket as the main power source for commercial airplanes will inevitably follow successful military exploitation but until the attainment of supersonic speeds with safety is assured, the commercial airlines will not be interested.

MILITARY AIRCRAFT

Now let us consider the military services who have supported the development of all these new types of aircraft powerplants. At the end of World War II, production of aircraft was greatly reduced, but certain long-range bomber and pursuit projects using the dependable *reciprocating engine and propeller* were continued. Notable in the bomber class are the six-engine Consolidated B-36 and the four-engine Northrop B-35 and Boeing B-50. The North American P-82 pursuit is outstanding because of its long range.

But for the air force of the future, the Army and the Navy are interested in the highest speeds possible, with reasonable consideration of range and maneuverability requirements. The turbo-jet is a powerplant for high speed aircraft which has made possible the design of pursuit and bomber types of aircraft which admirably fill the requirements of the Services.

How well the *turbo-jet* has been accepted can best be exemplified by a look at the newest Air Forces planes now on procurement. In the pursuit class there is only one airplane in the 80 to 90 series which uses the reciprocating engine propeller combination.

The two 80 series pursuits, for which there are sizable production orders, and which have received the most attention in the past year, are the Lockheed P-80 "Shooting Star" and the Republic P-84 "Thunderjet." The flight by Colonel Council from Burbank, California to LaGuardia Field, New York on January 26, 1946 in 4 hours, 13 min-

utes, 26 seconds at an average speed of 586 miles per hour and recent overwater flights of more than 700 miles by several P-80 airplanes in the Pacific area indicate both the speed and reliability of this plane. The Republic P-84 "Thunderjet" now holds the official American speed record of 611 miles per hour.

The North American XFJ-1, which is flying, and the Douglas D558, soon to fly, are the latest high-speed additions to the Navy's jet powered planes. The McDonnell XFD-1 "Phantom" was the first pure jet plane to take off and land on a United States carrier. This event, which took place on July 21, 1946, proved that take-off and acceleration characteristics required for a wave-off were at least acceptable.

Combination of propeller drive and turbo-jet in one airplane offers certain characteristics of special appeal to the Navy. The first such plane was the Ryan FR-1 "Fireball" with a reciprocating-propeller engine in the forward end and a turbo-jet in the aft end of the fuselage. The latest version is the XF2R-1, with a prop-jet forward and a turbo-jet aft. The Glenn L. Martin XP4M-1 has two nacelles, each equipped with a reciprocating-propeller engine forward and a turbo-jet aft. Major claims for the combined powerplant type are superior take-off and longer range, as compared with the all jet type. Long range cruising is accomplished at most economical propeller engine speed with the turbo-jet inoperative.

The turbo-jet has invaded the bomber field and although flight test results are not available, performance predictions indicate that their use for this application will be highly acceptable. The Douglas XB-43, North American XB-45, Consolidated-Vultee XB-46, Boeing XB-47, Martin XB-48 and Northrop YB-49 will all be in the air this year, establishing an entirely new conception of bomber operation. (See Figure 3.) These planes range in size from the medium to the heavy bomber class and the number of turbo-jets installed varies from two to eight.

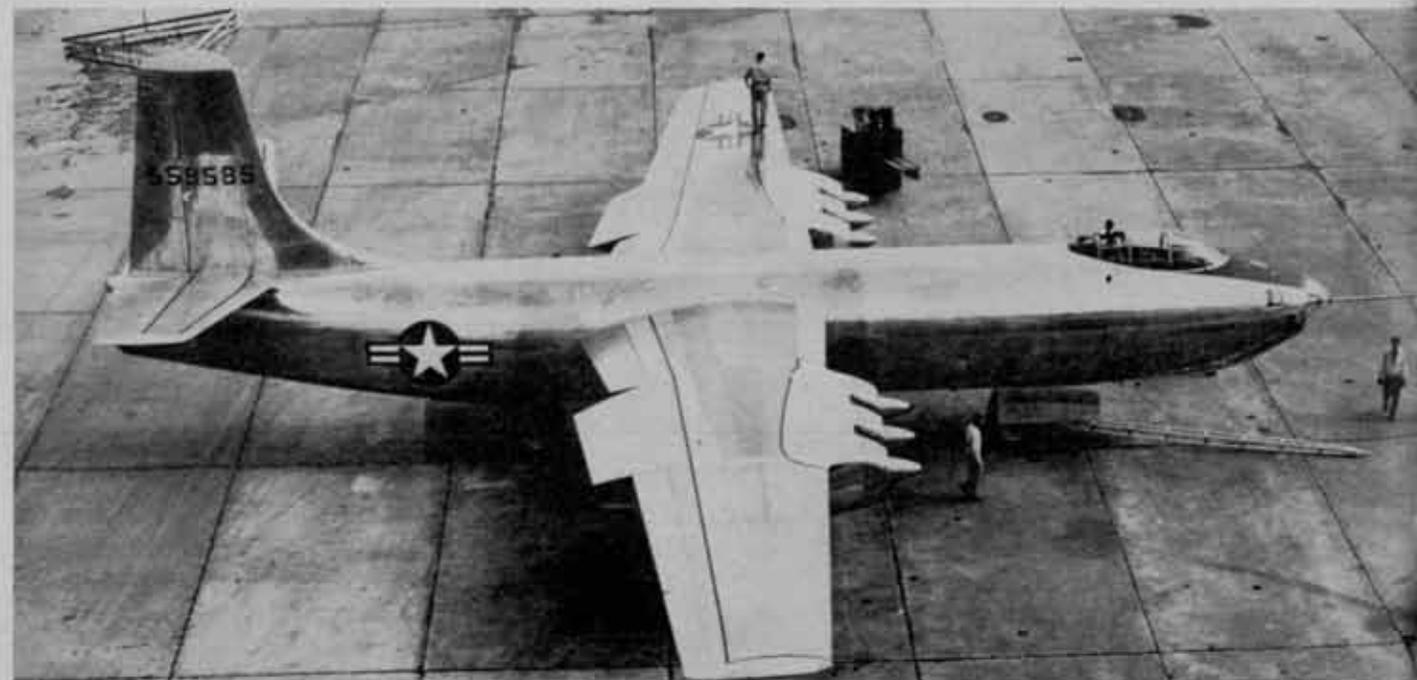


Figure 3—The Army Air Forces' latest jet bomber, the Martin XB-48.

An excellent opportunity to make a comparative evaluation of jet and reciprocating engines will occur when the first YB-49 takes to the air this summer. The Northrop XB-35 "Flying Wing," powered by four Pratt & Whitney R4360 engines and eight General Electric BH-1 turbosuperchargers is now undergoing shakedown flights at Muroc Army Air Base. The YB-49, is the same airplane but equipped with eight TG-180 or J-35 turbo-jets. For operation at 375 miles per hour, which is the speed at which one pound of thrust is equivalent to one horsepower, the YB-49 will have nearly three times the power available from its 8 turbo-jets as will the XB-35 from its 4 turbosupercharged-propeller engines.

The *ram-jet* is suitable for the main powerplant for ultra-high-speed pursuits, but such a ship would have to be launched from a catapult or a mother plane. Ram jets for extra bursts of speed in combat would be feasible.

Rockets are the obvious answer for the highest speeds, so the development of rocket powered planes for military use is underway. The first of these, the Bell XS-1, is now flying and others are on the way. Rockets have the advantage over the ram jet of being able to take off under their own power.

The *helicopter* is a slow-speed aircraft, but the blade tips move at speeds which make the use of turbo-jets or ram jets at their tips an attractive possibility. Dismemberment of the turbo-jet so that the main engine feeds compressed air to tip combustion chambers and jet nozzles at the tips of the wings making huge pin wheels would remove the complication of driving the rotor by means of a reciprocating engine or gas turbine. With an auxiliary starting means provided, ram jets at the wing tips offer another possibility of simplifying helicopter powerplant installations.

As so much of the military air program and some of the future commercial air plans are dependent upon the aircraft *gas turbine*, it will be well to take a brief look at the short history of its development. In comparison with the time and the amount of work expended in developing and perfecting the reciprocating engine, the prop-jet and the turbo-jet have had a relatively short existence.

Except for the pioneering work done by Group Captain Frank Whittle, there was no real concentration of effort on this program until 1940. Even spurred on because of the War, it would not have been possible to bring the various types of engines to their present state if it had not been for the work done in previous years on the various components of jet engines and on gas turbines for other than aircraft use.

Many of those in this country who were actively engaged in gas turbine work feel somewhat chagrined, for having all the components of a turbo-jet in their grasp, they did not assemble them into a jet engine at least as soon as the British and Germans did. However, with the background of experience in working with similar kinds of equipment, workers in this country were able to make rapid progress when the basic idea of jet propulsion was handed to them in the tangible form of the Whittle W1X engine. Independent development along this line was being pursued by several companies prior to receiving the Whittle engine, but the fact remains that those ideas had not progressed to the point where an engine was actually operating

before the time the British engine was sent to this country.

The General Electric Company was assigned the task by the Army Air Forces in September 1941 of improving and placing into quantity production the Whittle W1X engine. Although the basic design of the Whittle engine was not altered, it was necessary to adapt it to American requirements and the resulting engine was known as the I-16 which powered the Bell P-59. This airplane, which first flew on October 2, 1942, has the distinction of being the pioneer in jet powered flight in this country. Even during attempts to get the I-16 into mass production while it was still in the development stage, it became evident that an engine of larger output would be required for a single engine pursuit airplane offering superior tactical characteristics. The General Electric I-40, or J-35, was next developed and is now being produced in considerable quantity by the Allison Division of General Motors Corporation for the Lockheed P-80 "Shooting Star."

Paralleling the above programs, General Electric also was developing the TG-180, or J-35, turbo-jet engine and the TG-100, or T-31, prop-jet engine. These two engines differed from the "I" types in that the compressor was of the axial flow rather than the radial or centrifugal variety. Much of the fundamental data upon which designs of the axial flow compressor were based were obtained from the original research conducted by the National Advisory Committee for Aeronautics at its Langley Field Laboratories in Virginia. Work on the axial flow type gas turbine was begun prior to receiving the Whittle engine, but its use was not specifically pointed towards aircraft propulsion at that time.

Entirely independent of any work being done by General Electric, the Westinghouse Electric & Manufacturing Company, under the sponsorship of the Navy Bureau of Aeronautics, developed and now has in production the W-19B, or J-30 and the W-24C, or J-34. These turbo-jet engines are both of the axial flow type.

During the war period, the other of the three largest American electrical manufacturers in this country, Allis-Chalmers, undertook the manufacture of the British De-Havilland H-1 engine.

At the present time there are a dozen or more concerns engaged in the development of turbo-jet or prop-jet engines. These companies, of course, include the three large reciprocating aircraft engine manufacturers, Allison Division of the General Motors Corporation, Pratt & Whitney Aircraft Company and Wright Aeronautical Corporation. The only one of these three companies now actively in production of jet engines is Allison, manufacturing the General Electric I-40 and TG-180.

Questions have recently been raised as to why the large electrical manufacturers rather than the large aircraft engine manufacturers were called upon by the Army and Navy to develop the aircraft gas turbine. Briefly the problems of the aircraft gas turbine are far more closely associated with those encountered in the steam turbine than with those encountered in the reciprocating engine. Actually, the only point of similarity between the gas turbine and the reciprocating engine is that they are both installed in airplanes. The background of experience which the electrical manufacturers could draw upon as a result of many

years of manufacture of the steam turbine has certainly been an important factor in bringing this program to its present state.

On top of these considerations of experience, it must be remembered that we were just entering a war, the duration and magnitude of which no one could predict. It was evident from the outset that it would be fought in or from the air. At that time all of this country's existing aircraft designs used the reciprocating engine, and it was imperative that Allison, Pratt & Whitney and Wright exert heroic efforts to meet our demands for production, as well as the demands which were placed on them by France and England. It was impossible at the time the decision had to be made for any one to determine the usefulness of the jet or prop-jet engine. It was a gamble which should be taken but which should not in anyway interfere with the important work of improving and producing the reciprocating type engines.

The decision to place the responsibility for the development of turbo-jet engines with the electrical manufacturing companies rather than with the aircraft engine companies was made and no one can deny, in the light of what has transpired, that it was a wise move for which the Services should be congratulated.

Progress which has been made to date in the development of turbo-jet engines should not obscure the fact that there are a great number of detailed design problems still to be solved. Further improvement of the turbo-jet depends upon development of new, or better ways of manufacturing the various components. Any major improvement to the turbo-jet will depend upon a new conception of design of one or more of the major components.

Turbo-jet designers have been continually treading on the heels of metallurgists in attempting to obtain alloys for turbine buckets, turbine nozzles, jet nozzles and combustion chambers which would withstand temperatures higher than those to which the engines are now limited.

In addition to being subjected to elevated temperatures, the aircraft gas turbine buckets must also withstand high centrifugal stresses. A considerable amount of information has been accumulated on the relation of stress, temperature and life of many existing alloys which were developed for this use. Information regarding resistance to fatigue, caused by bending due to gas impingement and also due to nodal vibration, is not complete but is being accumulated as rapidly as possible. Extensive tests on many high temperature alloys to determine the effect of grain size and means of preventing cracks due to thermal stresses are now underway.

Many of the difficulties now being experienced with turbo-jet engines can be traced to the problem of burning large amounts of fuel in a confined space. Heat release rates in the order of ten million b.t.u.'s per cubic foot per hour are not uncommon. Temperatures as high as 4000°F are encountered in certain areas in the combustion space. For best efficiency, the combustion must be uniform and steady as any pulsation may induce vibration of nozzle blades or turbine buckets which will result in ultimate failure due to fatigue. The pressure drop of air and the resulting products of combustion into, through and out of the combustion chamber must be kept to a minimum. Combustion must be maintained over an exceedingly wide range of power from

sea level to altitudes extending up to 50,000 feet or higher.

The use of multiple combustion chambers, resorted to in many designs, has certain advantages but it is important that the combustion in all chambers be equalized, so that there will be no variation in gas flow over the entire turbine nozzle ring. It is also essential that the gas leaving each combustion chamber should have a fairly uniform temperature over its entire cross-section.

Complete combustion of the fuel is essential in order to prevent smoking, which in itself is not detrimental but is an indication of a reduction in combustion efficiency over that theoretically possible. The problem of completely mixing the fuel and air in a very small combustion space has been met by various means of whirling the air as it enters the combustion chambers, and also by introducing the air in proper portions throughout the length of the combustion chamber. Solving the smoking problem when using kerosene for fuel has presented far more difficulties than when using gasoline.

In attempting to mix the fuel and air completely, care must be exercised to prevent any local reduced pressure areas which will result in excessive carbon formation. Proper placement of the spark plug for initial ignition has also been the subject of considerable research. Although the ignition is on only during the starting period, it is important that the spark plug itself be in a location where electrodes will not be subject to carbon formation or excessive temperatures. Relighting of the fuel following engine shut-down at altitude is more difficult than at sea level and for this reason it is highly important that the spark plug be in perfect condition.

The turbo-jet engine revolves at speeds in the order of 7500 to 20,000 rpm, depending upon the size and type of design. Selection of bearings suitable for the compressor end, which is subjected to inlet temperatures of as low as minus 70°F, and the exhaust end as well as the mid-bearings which are surrounded by or close to combustion chambers or turbine nozzle boxes at temperatures of 1800°F and higher, becomes a major design problem. Sleeve type bearings have not been satisfactory for this service so anti-friction bearings of both the ball and roller type have been used.

The anti-friction bearing offers the advantage of lower starting power, which is a most important item during cold weather operation, and also the power loss at high speeds is relatively low. In addition, the lubricating oil requirement is only a small fraction of that for sleeve bearings. In fact, many turbo-jet engines have a self-contained oil system with no external storage tank, with no need for an oil cooler. As turbo-jet engines are installed in high speed airplanes, which in the case of pursuit ships are expected to engage in violent maneuvers, the bearings must withstand heavy precession loads.

The accessories for turbo-jet engines are entirely different from those used on reciprocating engines, and therefore the entire line has been subject to an intensive development program since the project was initiated.

The attention of all those engaged in the development of turbo-jet and prop-jet engines is being focused on design problems. With their solution, will be born an aircraft engine embodying the characteristics of dependability and

long life which have become the accepted standard of the reliable reciprocating engine.

And what about engines that will provide aircraft with speeds higher than those attainable by the turbo-jet? These are the pulse jet, the ram jet and the rocket. The turbo-jet has been successfully used for aircraft up to a Mach number of about .82. At sea level this corresponds to a speed of $.82 \times 763$, or 625 miles per hour. The speed of sound at sea level is 763 miles per hour and reduces for increase in altitudes to about 660 miles per hour at 50,000 ft. Mach number is merely a convenient ratio of actual speed divided by the speed of sound at the particular condition being considered. The present world speed record of 616 miles per hour is not an indication of the highest speed a turbo-jet powered airplane can attain in level flight. Upon reaching the velocity of sound, air flow conditions over aerodynamic surfaces undergo a violent change in characteristics. Some portions of the aircraft are locally subject to the velocity of sound prior to the entire aircraft reaching that point. Increases in aircraft speed at the present time are not mainly dependent upon obtaining more power from the turbo-jet but, are rather upon designing an airframe structure suitable for higher Mach numbers. The problem of control and stability when approaching and passing through the transonic range is now one of the major projects in the Army Air Forces, Navy Bureau of Aeronautics and the research laboratories of airframe manufacturers.

Figure 4 is an indication of the thrust required for a pursuit airplane at various altitudes up to a Mach number of 2.4. In addition to showing the tremendous increase in thrust required at Mach numbers above 1.3, it is interesting to note that information on thrust required in the transonic range (Mach number range of 0.9 to 1.3) is non-existent. Extensive wind tunnel testing programs have provided data for speeds in the supersonic range so that the power requirements in this range are quite well known. The extreme difficulty in making wind tunnel measurements in the region where the air velocity approaches, reaches and goes above the speed of sound, has so far prevented the accumulation of accurate data in this region. Until such data is obtained, designing aircraft to enter or cross the transonic region becomes pioneering in the true sense of the word.

Turbo-jet engines for powers required in the supersonic range can be built. As it is not definitely known what power will be required to drive the airplane through the transonic region, it can not be definitely stated that the turbo jet will be able to accomplish this. For operation at a Mach number of about 1.5, the rise in temperature of the inlet air to the turbo-jet compressor will have reached a value of about 200°F . This introduces an extra design complication, and it is doubtful whether the use of turbo-jets much above such speeds is feasible. The use of exhaust reheat will raise the maximum speed at which turbo-jet units are useful. With this improvement it is doubtful whether the turbo-jet gas turbine will be competitive at Mach numbers above about 2. The rise in temperature presents no difficulty in the operation of the ram jet and, of course, has no effect on rockets which do not use atmospheric air so it would appear logical to consider either of these types for speeds above 1,000 miles per hour.

In addition to requiring more thrust for take-off because of its low speed thrust characteristic, it is obvious that extra bursts of power from the turbo-jet engine may be useful in entering and crossing the transonic range. This can be accomplished by injecting water and alcohol mixtures into the engine. Introducing this mixture into the compressor inlet provides a greater power increase than if it is injected into the combustion chambers but has the disadvantage of precluding the use of the air from the compressor for cabin supercharging.

Another method of obtaining short time but large power increases is to burn additional fuel in the tailpipe just ahead of the jet nozzle. As the fuel air ratio of a turbo jet is quite high, there is sufficient air remaining in the turbine exhaust to support combustion if fuel is added in the tailpipe. The resulting thrust from the burning of fuel in the tailpipe is only about one half that obtainable from the fuel burned in the engine. It is possible to obtain thrust increases up to fifty per cent by this method.

A third means of increasing thrust for short periods of time, again at the expense of over-all fuel consumption, is to bleed some of the excess air from the compressor for use in an auxiliary combustion chamber which discharges its gas into the main tailpipe. As the same kind of fuel is used in this and also in the tailpipe burning system as is used in the main portion of the engine, it is not necessary to predetermine the length of time available for booster operation for each flight. In the case of water alcohol injection, the augmentation is limited by stored liquid capacity.

With the requirement of extra take-off power met by one of the augmentation methods, there remains only the problem of economical operation at low speed and low altitude

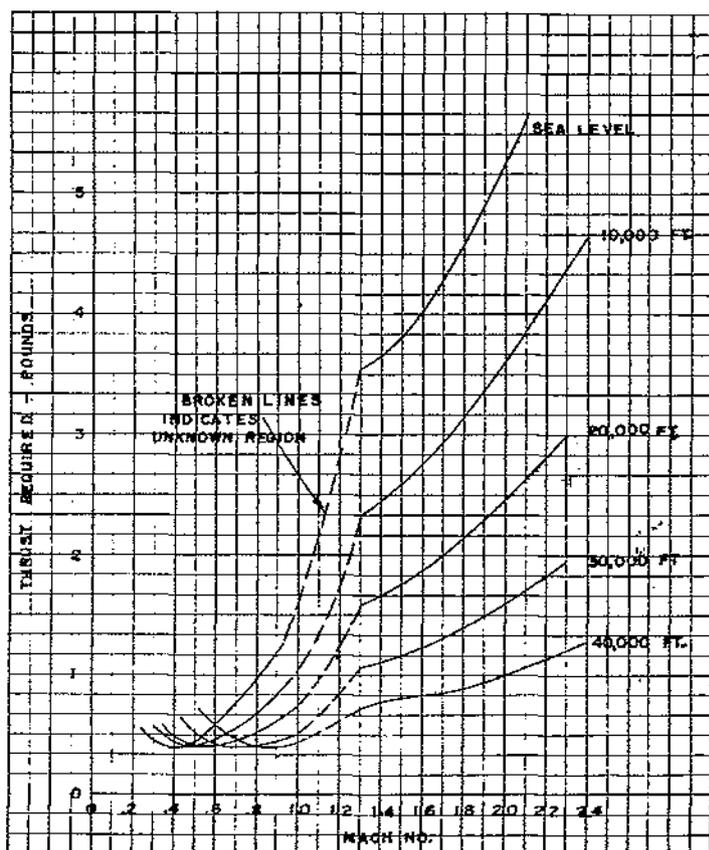


Figure 4—Thrust Required vs Mach Number.

and the improvement of accelerating characteristics in the event of wave-off or overshoot of the landing field. The latter is partially met by thrust augmentation if control devices can be devised to make the added thrust available instantaneously. Use of a variable area jet nozzle appears to offer the best solution to the acceleration problem, for it allows the engine to be operated at nearly full speed at reduced thrust. Opening of the variable jet nozzle from a partial area position will provide rapid increases in thrust. The variable jet nozzle, perhaps in combination with one of the thrust augmentation methods, should give satisfactory acceleration characteristics.

The poor economy of the turbo jet at low speed and low altitude still is to be solved. The variable area jet nozzle is of some help, but leaves much to be desired. Awaiting the signal to land at a low visibility airport or circling for a landing on a carrier deck becomes a risky business with a thirsty turbo-jet gulping the last few gallons from the tanks. And what is the use of flying from Los Angeles to New York in four hours if an hour or more is wasted because of poor weather at destination?

The turbo-jet powered plane must land when it arrives and, until this can be assured, its usefulness for commercial operation is seriously handicapped. Installation of some or all of the many available all weather landing aids will remove this final obstacle from general acceptance of the turbo-jet for high speed commercial airline service.

When the Instrument Landing System, the Ground Control Approach, the fog dispersal system, the high intensity runway and approach lighting, and the control tower surveillance radar are in operation, safety of airline operation will be tremendously improved. They *must* be in operation

before widespread use of turbo-jet planes becomes a reality.

Predictions should be avoided in a fast moving business like air transportation, but as it is a most intriguing sport, the author will also indulge.

To look ahead ten years may seem like a very long-range prediction, particularly when there is likelihood of a method of using nuclear energy for propulsion of aircraft being perfected within that period. Disregarding that possibility, here are the powerplants for the 1957 model airplanes.

Small personal plane	Reciprocating engine
Executive type or business plane	Reciprocating engine Small number with Prop-jet
Feeder line commercial	Reciprocating engine
Medium range commercial	Turbosupercharged engine Few with Prop-jet
Long-range commercial (medium size)	Compound engine Some with Turbo-jet
Long-range commercial (large size)	Prop-jet Some with Turbo-jet
Pursuit	Turbo-jet Some with Rocket
Medium-range bomber	Turbo-jet
Long-range bomber	Compound engine Larger sizes with Prop-jet Few with Turbo-jet
Missile or uninhabited aircraft	Rocket or Ram jet



As a professional soldier you do not inherit a greater share than your citizen brothers of the courage, endurance and fortitude that millions of Americans have so generously displayed on many stricken fields. Neither does your commission confer upon you distinctive right or privilege. But you are set apart professionally that you may better fit yourself for a particular and exacting role in preserving our American heritage of human dignity and justice for all. To measure up to that responsibility, no field of knowledge nor enterprise within our economy is alien to your interest. The arts and sciences, as well as the profession of arms, are bulwarks of security. And greatest of all is the spirit—the will for freedom and justice—that binds together Americans of every age and provides the mainspring for your own life work.—Extract from 1947 graduation address at U.S.M.A. by GENERAL OF THE ARMY DWIGHT D. EISENHOWER.

ROCKET PROPULSION

By Dr. Louis G. Dunn

PRINCIPLES OF ROCKET PROPULSION

The terms jet propulsion and rocket propulsion have become familiar to the average citizen in recent years. It is customary to consider a jet propulsion system as one in which matter is ejected from the propelled body to create momentum. This matter may either be carried in the body or taken in from the surrounding medium in which the propelled body moves. A jet propulsion device of the first kind is called a rocket, whereas one of the second kind is classified as a thermal jet (ram jet, pulse jet, turbo jet). It is evident that mixed cases are possible; i.e., a system may be a combination of rocket and thermal jet, or thermal jet plus a mechanical system. The above definition of jet propulsion is, however, sufficient for the present discussion which will be limited to rocket propulsion.

The fundamental process in all jet propulsion is the conversion of heat energy into kinetic energy by an adiabatic expansion, i.e., one not accompanied by gain or loss of heat. Heat energy is obtained by burning a propellant (fuel and oxidizer). The propellant may be in either solid or liquid form. To illustrate this process, consider the liquid propellant rocket motor shown in Figure 1. The liquid propellant which consists, in this case, of a fuel and oxidizer is continuously injected through suitable orifices and allowed to mix in the combustion chamber. If the propellant is not of the spontaneously ignited type, a combustion initiator, such as a spark plug, is required. The combustion process gives rise to conditions of heat, pressure, and velocity in the following manner. Throughout the cylindrical portion of the combustion chamber, the pressure and mass velocity

of the combustion gases are essentially constant. As the combustion process proceeds, however, the temperature rises and reaches a maximum near the end of the cylindrical section. In the distance from the cylindrical portion to the throat of the motor the molecules begin their motion toward the exit; that is, their random velocity begins to change to mass velocity with accompanying reductions in temperature and pressure. The gas, being a compressible medium, will, upon expansion in the expanding portion of the nozzle, undergo a further decrease in pressure and temperature and a rapid increase in velocity. For a properly designed nozzle, the exit pressure should be equal to the pressure of the surrounding medium. This design, however, is not always possible since the rocket has to operate under conditions of varying external pressure.

The basic problems of design are: (a) to generate a gas under high pressure at a constant rate and (b) to convert the high-pressure gas into a jet of high velocity.

The problem of generating high-pressure gases at a constant rate is primarily concerned with chemical reactions. The components entering into the chemical reactions may be in either the gaseous, solid, or liquid state; and, depending upon the initial state of the components, rocket motors may be classified as either gaseous, solid, or liquid types.

The problem of converting the high-pressure gases into a high-velocity jet is primarily one of nozzle design. The shape of the nozzle through which the compressible gases exhaust is important in determining both the mass flow and the exhaust velocity. The required shape for a supersonic nozzle is as shown in the rocket motor seen in Figure 1 and is known as a de Laval nozzle.

Rockets possess two characteristics unique in the field of propulsion. First, the propulsive force delivered by a rocket is independent of atmospheric air, and thus it is possible to propel a body through empty space. Second, the propulsive force of a rocket is unaffected by the velocity of the body being propelled.

The propellant consumption of a rocket is the highest of all jet propulsion devices. In the best present designs, the propellant consumption of rockets is of the order of 5 to 15 times that of the thermal jet propulsion systems. In spite of its high fuel consumption, however, the rocket competes favorably with other power plants in a number of applications, either because of its greater mechanical simplicity or because of its superior impulse-weight ratio. (Impulse equals thrust times its duration.) The latter advantage is especially significant in applications requiring very high thrust for a short period of time. An interesting demonstration of the high propulsive power developed by a rocket

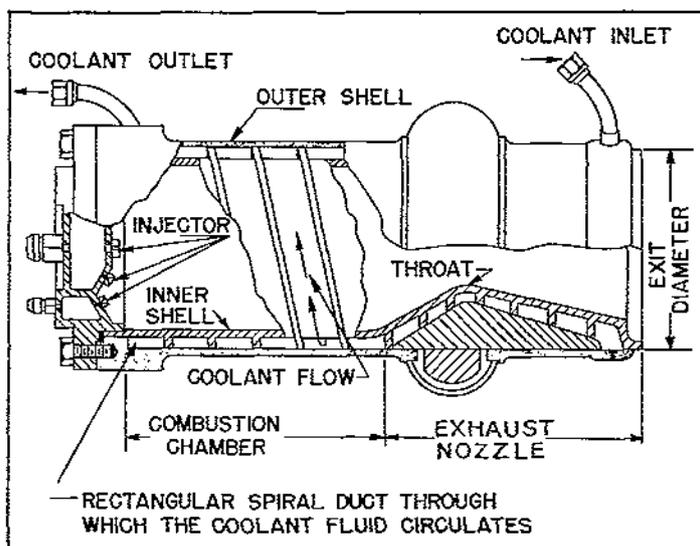


Figure 1: Schematic illustration of a typical liquid propellant rocket motor.

is furnished by the German V-2. This rocket motor develops 55,000-pound thrust and reaches a maximum speed of about 5000 feet per second. The propulsive power at this speed is equivalent to 500,000 horsepower. The large propulsive power of rockets can be advantageously applied in three main fields of application:

- a. Propulsion of missiles.
- b. Propulsion of high-speed interceptor aircraft.
- c. Auxiliary propulsion for aircraft propelled by other types of power plants to improve takeoff characteristics or to furnish superperformance for short periods of time in either level or climbing flight.

As previously indicated, the thrust of a rocket motor is independent of the velocity of the body being propelled and is affected only to a minor degree by atmospheric pressure. Hence, to rate the propulsive power of a rocket, thrust is a more logical measure to use than is the more conventional horsepower rating.

In general, the impulse-weight ratio of liquid rockets is higher than that of solid propellant rockets. For short durations of thrust, up to 40 seconds, the solid propellant type competes favorably with the liquid propellant rocket because of greater mechanical simplicity.

As already discussed, the rocket is extremely simple in conception. This fact has led to the belief that the design of a rocket motor should be extremely simple. Such a conclusion, however, is without foundation. It should be realized that the combustion of a propellant occurs within a very small chamber at temperatures very much higher than those occurring in any other type of heat engine, and that the generated high-temperature gases in parts of the motor reach supersonic velocities. In addition, the unusual chemical and physical properties of most liquid propellants introduce the designers to little-explored fields of chemistry and physics.

SOLID PROPELLANT ROCKETS

The term solid propellant rocket arises from the fact that, prior to combustion, the propellant charge (fuel and oxidizer) has the normal mechanical properties of a solid body. Inasmuch as the solid propellant rocket consists essentially of only a combustion chamber and nozzle, it is basically a simple design. The entire solid propellant charge is carried within the combustion chamber. Because the size of this chamber is limited, the solid propellant motor operates for a very short period of time, usually lasting from a fraction of a second to a maximum of about 30 to 40 seconds. Because of its simplicity, the solid propellant type of rocket motor is readily adaptable to applications such as assisted takeoff of aircraft and as the propelling device for short-range missiles.

Since all of the propellant is carried in the combustion chamber, it is necessary that the propellant burn smoothly, at a uniform rate, from the ignited surface. Solid propellant charges are usually designated as restricted-burning or unrestricted-burning types. They are illustrated in Figure 2.

In the restricted-burning type, the charge consists of a circular cylinder in which the cylindrical surface and the forward end face are prevented from burning by a suitable chemical coating. Burning is allowed to proceed from the

rear face only. This type of charge is commonly referred to as an end-burning or cigarette-burning charge. For a given charge length, the duration of burning is a function of the rate of burning, which depends primarily on the propellant composition and chamber pressure. The fundamental process of converting heat energy into kinetic energy is the same for both liquid and solid propellant rockets; in both cases, the thrust is equal to the mass flow times the exhaust velocity. It is easy to see that the mass flow of the exhaust gases is proportional to the burning area and the rate of burning. In the solid propellant motor, the rate of burning, expressed in inches per second, is defined as the rate at which the burning surface recedes in a direction normal to itself.

The unrestricted-burning charge is often in the form of a hollow cylinder and is held in place in the combustion chamber by a suitable grid or ring support. The propellant as shown in Figure 2 is ignited and allowed to burn on all surfaces. As noted above, the end-burning charge has a duration of burning that is proportional to the charge length. On the other hand, since the unrestricted charge burns on all surfaces, its duration of burning is proportional to the web (wall) thickness. The thrust is proportional to the total burning area and to the rate of burning which is a function of chamber pressure.

Although the simplicity of the solid propellant rocket makes it attractive for applications in which short-duration thrust is required, it has a number of characteristics which impose serious limitations on its operation. In considering a given application, it is well to understand these limiting characteristics which are enumerated below:

- a. Temperature sensitivity
- b. Temperature limits
- c. Combustion limit
- d. Pressure limit
- e. Decomposition on storage.

If two rockets are considered which have identical solid propellant charges but which are fired under such conditions that the two charges are at widely different temperatures, then the charge at the higher temperature will operate at a higher chamber pressure, higher thrust, and shorter duration than the one at the lower temperature. The total impulse of the two charges, however, will be very nearly the same. It may be seen, therefore, that temperature has an important effect on the rate process of burning but not on the total energy resulting from the total burning. This phenomenon is called temperature sensitivity.

The temperature limit is concerned primarily with the mechanical properties of the propellant. At low temperatures, the charge may become embrittled and shatter upon ignition, thus causing a very large burning surface and possibly a violent explosion. At high temperatures, the charge may soften so that it deforms upon storage, thus causing an abnormally large burning surface and resulting in a sufficiently high chamber pressure upon ignition to cause failure of the casing.

Solid propellants for rockets can be roughly classified as homogeneous and composite. The most important homogeneous propellants developed to date are the ballistites which consist of about equal parts of nitroglycerin and nitrocellu-

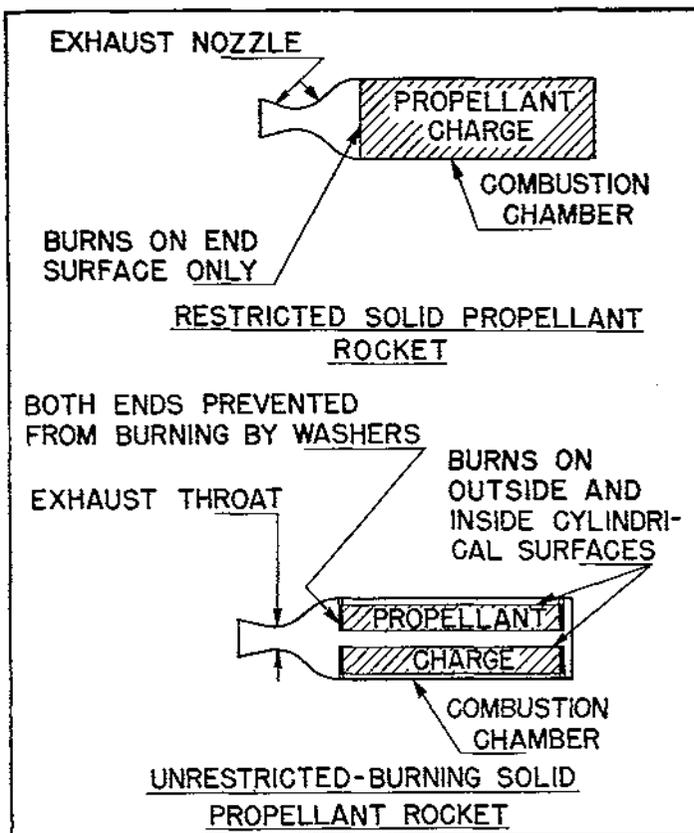


Figure 2: Solid propellant charges, restricted-burning and unrestricted-burning types.

lose. The composite propellants include two types developed by the National Defense Research Committee (NDRC). One consists of ballistite modified by the addition of large amounts of inorganic salts to reduce the temperature sensitivity of the propellant; the other consists of various modifications of a mixture of equal parts of pulverulent ammonium picrate and sodium nitrate molded together with about 10 per cent of an artificial resin binder.

THE LIQUID PROPELLANT ROCKET

The liquid propellant rocket unit consists essentially of a rocket motor, a propellant feed system and feed system controls, and the liquid propellant which is used in the particular rocket.

A. The Rocket Motor

The rocket motor consists of three major parts: (1) an injector which introduces the propellant into the combustion chamber, (2) a combustion chamber in which the transition from the liquid phase to a gaseous phase occurs, and (3) an exhaust nozzle which converts heat energy of the gases into kinetic energy by an adiabatic expansion process. A typical rocket motor showing these major parts may be seen in Figure 1.

The particular design of a rocket is largely determined by the nature of the propellant and the type of operation for which the motor is intended. For example, since liquid propellant rockets operate at very high combustion temperatures, certain designs must necessarily have a cooling system. Hence, liquid rocket motors may be broadly classified as uncooled or cooled. As will be seen in this section, problems connected with cooling a motor are considerable.

At the present time the greater part of development research is directed toward lightweight, cooled motors and improved cooling techniques. The lightest type of motor actually used in service is the German V-2 motor.

1. Injectors

The function of the injector is to introduce the propellant in such a manner that the reaction will proceed to a maximum degree of completeness in a minimum of time and at the same time with a minimum transfer of heat to the chamber and nozzle mass. It is particularly important to avoid local concentrations of heat. Since practically every propellant poses a different injection problem, many designs have been studied. The factors which influence the injector design include:

- Nature of the chemical reaction of the propellant
- Degree of atomization of fluid streams
- Orientation of resultant fluid streams
- Spatial distribution of injected fluids
- Available propellant feed pressure
- Density and viscosity of injected fluids

Injectors range in complexity from a single pair of circular orifices to elaborate multiple units involving hundreds of orifices such as are used in the German V-2 motor.

2. Combustion chambers

The majority of rocket motor combustion chambers are cylindrical in shape, with the injector and nozzle attached at opposite ends as is seen in Figure 1. Several factors are known to influence chamber design:

- Adequate strength of materials is needed to withstand the necessary pressures at the operating temperatures. The temperature of the combustion gases is of the order of 5000° F and the chamber pressures range from 300 to 400 pounds per square inch.
- Minimum surface area in contact with the hot gases is desirable to reduce heat-transfer problems.
- Adequate combustion volume to insure completion of the chemical reaction is necessary.
- Lightweight motors are desirable for efficient rocket performance.
- Ease of fabrication is important in rocket design.
- Control of the internal flow pattern to eliminate "hot spots" must be accomplished in the design.

3. Exhaust nozzles

In the past, exhaust nozzles have generally been of the de Laval type, consisting of a section converging from the combustion chamber, a throat, and finally a diverging section. The contours of these sections may be varied within fairly wide limits without appreciable effect on performance. The nozzle design is influenced by considerations of heat transfer, weight, and the necessary expansion ratio, i.e., the ratio of the exit area of the nozzle to the throat area, necessary to expand the gases from the pressure at the throat to the surrounding pressure at the exit. It cannot be concluded that the de Laval type nozzle is necessary in order to obtain supersonic flow. Other types of nozzles are being developed.

4. Methods of cooling

In high-performance rocket motors, the combustion chamber temperature will reach values in excess of 5000° F. The heat liberated at 5000° F is approximately 520,000,000 British Thermal Units per cubic foot of combustion volume per hour. In an automobile engine the average value is approximately 7,000,000 and in an airplane engine 12,000,000 BTU per cubic foot per hour.

A rocket motor, therefore, operates under more severe conditions of high temperature and of continuous rate of heat release than most other engines. For these reasons, problems of heat transfer are among the most acute and important in rocket motor design. The following are some of the techniques employed in the cooling of rocket motors:

- a. Heat-capacity cooling
- b. Radiation cooling
- c. Convective cooling.

If the heat transferred from the high-velocity hot gases in the combustion chamber is absorbed by the heat capacity of the motor materials, the motor is understood to be uncooled. This type of motor is usually made of metal with a sufficient mass to absorb the transmitted heat for a limited time interval, which is generally less than 20 seconds.

The liquid-cooled motor generally uses part or all of the propellant liquid as a coolant to absorb the heat. Cooled motors can be further subdivided into (a) the kind in which the coolant liquid absorbs heat as it circulates in ducts around the motor, after which the coolant is injected into the combustion chamber (regeneratively cooled type); and (b) the kind in which part of the coolant liquid is injected directly into the motor in such a way as to provide a coolant film on the inner wall surface (film-cooled type). The regeneratively cooled type is illustrated in Figure 1. The coolant fluid is introduced at the nozzle-end of the motor and circulates around the motor, through the spiral ducts. After cooling the motor, the coolant is injected into the combustion chamber and burned.

It is interesting to note that the Germans employed a combination of regenerative cooling and film cooling in their V-2 motor. The bulk of the coolant fluid (alcohol) was injected at the nozzle end of the motor and forced to flow in an axial direction, between the inner and outer walls, toward the injector. A small portion of the alcohol, separately manifolded, was injected directly into the combustion chamber by means of small holes drilled through the inner wall. This coolant fluid provided a "cool" film adjacent to the inner surface. The areas which were film-cooled were rather small in comparison with the over-all surface of the combustion chamber. According to the Germans, regenerative cooling was inadequate when "hot spots" occurred in the motor; hence, the addition of film cooling became necessary.

This type of cooling is about the same as that employed in the cooling of an automobile engine and a liquid-cooled airplane engine, except that in a rocket motor, it is necessary to use one of the propellant components, either the fuel or oxidizer, depending upon which one is the more suitable, for the coolant fluid. Because of the large amounts of coolant fluid necessary and because of the necessity of keeping weight to an irreducible minimum, in most applications it

is not feasible to use an auxiliary fluid as a cooling agent.

Radiation and convective cooling are methods in which equilibrium conditions are reached under which motors employing them are basically capable of continuous operation. In radiation cooling, the inner motor wall surface receives heat by both convection and radiation; the heat is transmitted through the wall by conduction to the outer wall surface, from which it is radiated to the surrounding medium.

The heat transmitted to the motor wall can be reduced by a factor of 2 to 5 by inserting a refractory liner between the hot gases and the motor wall. Commercially available refractory materials, however, have a very limited lifetime in rocket motors. Considerable research and development work is accordingly being undertaken to develop suitable refractory liners. Other methods of cooling are currently being developed, but details of these methods cannot be discussed here.

B. Propellant Feed Systems

The propellant feed system must supply propellant at a rate and pressure required by the rocket motor to produce a specified thrust. The gas-pressure and pump-feed systems are the two main types of feed systems in use at the present time.

In the gas-pressure system commonly used at present, air or nitrogen is stored in a tank at pressures around 2500 pounds per square inch. The gas is then supplied to the propellant tanks through a regulator at a pressure and rate required to feed the propellant to the rocket motor. This gas-pressure system is shown in Figure 3. Gas-pressure systems which utilize solid or liquid propellants are currently being developed. These systems offer a considerable saving in weight and will undoubtedly replace the gas-storage type. In the pump system the propellant is fed from unpressurized tanks to the rocket motor by means of high-pressure pumps. The size of the pump system employed in the German V-2 is shown in Figure 4. The pumps are located immediately forward of the motor.

The type of feed system to be used in any particular application is generally determined by the duration of operation. For relatively short durations, such as 30 to 40 seconds, it is more economical, from a weight standpoint, to use a gas-pressure feed system.

If a pump-feed system is used, the tanks for storing the

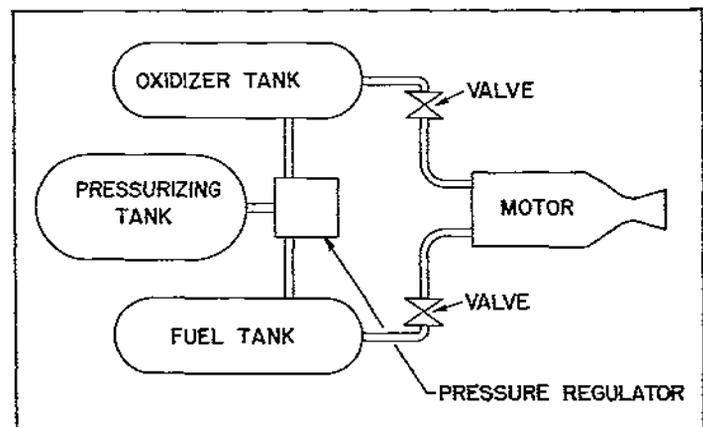


Figure 3: Gas pressure propellant feed system.

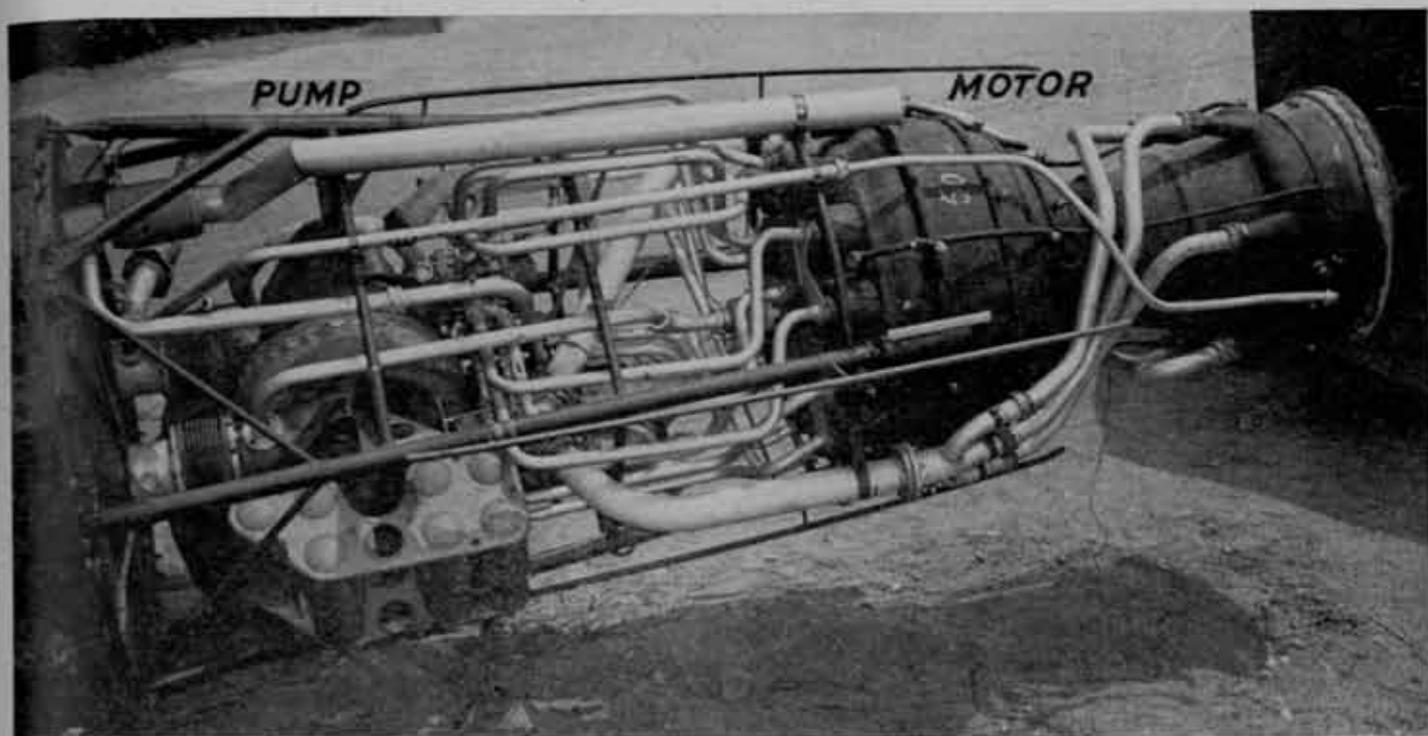


Figure 4: Pumping system of the German V-2.

propellants can be of lightweight construction, with only sufficient strength to carry the propellant weight under conditions of acceleration or deceleration. A gas-pressure system requires that the tanks be constructed to withstand the above-mentioned loads and, in addition, the pressure required to feed the propellant to the rocket motor.

Special materials for the construction of tanks may be required in certain cases, since some propellants have a corrosive effect on certain metals. For example, the nitric acid-aniline propellant requires stainless steel tanks for the nitric acid component.

C. Liquid Propellants

Liquid propellants fall into two general classifications, bicomponent propellants and monopropellants. Bicomponent propellants consist of two components, one of which is the oxidizer and the other the fuel. In the use of the word bicomponent, it is understood that the fuel or oxidizer may include more than one chemical compound. The oxidizer is a substance in which the available oxygen represents a large fraction of the total weight. The fuel is a compound containing essentially carbon and hydrogen, whose combustion products are carbon dioxide, carbon monoxide, and water. It is from the heats of combustion of these products that useful work is obtained. The relative quantities of oxidizer and fuel used in propellant combinations are indicated by the mixture ratio, which is the weight of oxidizer divided by the weight of the fuel.

A monopropellant is a single compound containing all of the elements needed for combustion. It offers a number of advantages over the bicomponent propellant in that a much simpler installation is possible. A disadvantage is a possible sacrifice in stability. Since a monopropellant is able, by itself, to undergo rapid decomposition yielding high-temperature gases, it is more sensitive to temperature and shock than are the separate members of bicomponent propellant.

For best motor performance, the propellant should release a maximum of energy into products of combustion having minimum average molecular weight and ratio of specific heats. In addition to these basic requirements, an acceptable propellant has to meet many requirements determined by practical considerations such as handling, storage, availability, etc. A list is given below of the significant properties of liquid propellants. The properties are divided into two groups, those which are of engineering importance and those which are of utilization importance. Some of the properties are important in both categories.

1. Properties of engineering importance
 - a. Heat of combustion
 - b. Average molecular weight of combustion product
 - c. Stability
 - d. Rate and ease of reaction
 - e. Ignition lag
 - f. Density
 - g. Vapor pressure
 - h. Specific heat of the liquid phase
 - i. corrosivity
2. Properties of utilization importance
 - a. Availability
 - b. Corrosivity
 - c. Stability
 - d. Toxicity
 - e. Inflammability
 - f. Vapor pressure
 - g. Freezing point
 - h. Cost

A rather limited number of liquids or combinations of liquids have been found which satisfy the necessary requirements for many of the above properties. These propellants, however, generally result in poor motor performance, and

practically all of the high-performance propellants offer numerous difficulties from an engineering as well as utilization standpoint.

There are numerous problems connected with the combustion of the propellants. The propellant, for example, must be ignited in some way to start combustion. Certain propellants ignite spontaneously when the fuel and oxidizer are mixed, whereas others need a combustion initiator, such as a spark plug.

The designer of a rocket motor must understand the details of the chemical reactions which take place in the combustion chamber. For such understanding it is necessary to study the manner and speed by which the different steps in a reaction proceed. When it is realized that the total time a particle of fluid remains in the combustion chamber is of the order of 1/100 second, it is obvious that the rate of reaction becomes of major importance. At the present time the information of combustion kinetics is very meager and the whole problem is not too well understood. For a number of compounds, combustion kinetic equations are available. The constants appearing in these equations, however, have been determined under experimental conditions, which differ widely from conditions found in a combustion chamber of a rocket motor.

In the past, the design of combustion chambers has been based on empirical laws obtained by measuring the effects of the ratios of volume to throat area and of length to diameter of cylindrical motors on over-all performance. It can be shown, for instance, that the ratio of chamber volume to throat area is a measure of the time the propellant spends in the motor during combustion. In general, these laws are limited in their applicability to combustion chambers of "similar" design and to a given propellant. Also, these empirical laws make scaling from motors of small thrust to those of large thrust somewhat doubtful.

SOME APPLICATIONS OF ROCKETS

A. Solid Propellant Rockets

The unrestricted type of solid propellant charge was used extensively in short-range (artillery) rockets during the last war. Ballistite was primarily used as the propellant in this type of rocket. Typical examples are the spin-stabilized and fin-stabilized rockets used by the Navy as ground-to-ground, air-to-ground, and air-to-air missiles, and also the "bazooka" which is used by the Army. This latter weapon was very effective, particularly when used against tanks at short range.

Rockets using the JPL type of solid propellant have been developed for assisted takeoff of aircraft and have been used by the Navy to a considerable extent. A serious limitation in the use of the propellant is the large amount of smoke in the exhaust, which makes it difficult to operate from a carrier deck.

Since the end of the war, solid propellant rockets have been developed as boosters in connection with the firing of liquid propellant rockets and ram jets. As high-altitude missiles are more extensively developed, the need for efficient boosters will become increasingly greater.

Although the application of solid propellant rockets is much more limited than that of the liquid type, they are

generally superior from a standpoint of weight and economy for durations of less than 20 seconds; and there are many uses, primarily in applications requiring a short duration of thrust, in which they are superior.

B. Liquid Propellant Rockets

Liquid rockets have found limited application as assisted-takeoff devices because of the relatively short duration required, usually less than 30 seconds.

During the latter part of World War II the Germans had a number of high-speed, rocket-propelled aircraft in service. Considering the relatively short time in which the propulsion system and airframe were developed, it can be said that they performed rather well. Extensive development of supersonic piloted aircraft is currently being carried out in this country. One such project is the development of the Bell XS-1, a rocket aircraft designed to fly 1700 miles per hour at an altitude of 80,000 feet.

The term long-range missile is used to denote a vehicle whose range is of the order of 100 miles and which is propelled by a rocket having a burning time of 30 seconds or more. These characteristics serve to distinguish it from the short-range artillery rocket whose burning time is generally less than 2 seconds.

The earliest attempts in this country to develop a long-range or high-altitude vehicle were made by R. H. Goddard, starting about 1912 and continuing until 1941. In 1935 he launched a 14-foot rocket to an altitude of 7500 feet. This rocket used oxygen-gasoline as a propellant.

Although the Germans started their liquid propellant research in 1923 under the auspices of the Verein für Raumschiffahrt (Society for Space Travel), it was not until 1932 that serious work began on the development of rocket propelled missiles. At this time the society was disbanded and the program taken over by the German Ordnance Department. By 1942 the Germans tested prototype models of the V-2 and shortly afterward went into production on the V-2 missiles.

In 1936 rocket research on a very modest scale was started at the California Institute of Technology. At that time interest centered primarily around a high-altitude sounding rocket to be used for meteorological observations. This program was stimulated by F. J. Malina, who with his associates carried out theoretical calculations on the flight performance of a sounding rocket and also studied the thermodynamics of rocket motors. In 1940 the program was expanded and directed toward rockets for war purposes. From 1940 to 1944 the program was primarily concerned with the development of assisted-takeoff rockets. In 1944 the Ordnance Department requested that the Institute undertake the development of a series of long-range missiles. One phase of this over-all program resulted in the development of a high-altitude sounding rocket. This vehicle, known as the Wac Corporal, was designed specifically to carry 25 pounds of instruments to high altitudes. An additional requirement was that the vehicle be lowered by parachute or some other device.

Preliminary tests of the Wac Corporal were started in 1945 and since then have been completed. Altitudes in excess of 250,000 feet have been attained and vehicles have been lowered by parachute from these altitudes.

In addition to the sounding rocket and the long-range missile whose function is to carry an explosive charge to a given target, the possibility of space flight has been given serious consideration during the last few years. Many difficult and diverse problems, such as method of trajectory control, navigation, communication, takeoff and landing techniques, etc., are involved in space travel. The basic problem, however, concerns the means of imparting sufficient thrust to the vehicle so that it may escape the Earth's gravitational field. The following cases which are of general interest have been studied:

1. The Earth-satellite, a vehicle permanently revolving in a closed elliptic or circular orbit around the Earth, at a distance from the Earth that is small compared to the radius of the Earth.
2. The "stationary" Earth-satellite, a body revolving in a circular orbit with the same angular velocity as the Earth so that it always appears overhead to an observer on the Earth.
3. Complete escape from the Earth, but with insufficient energy to depart from the solar system.

An Earth-satellite, revolving in a circular orbit, can remain in such an orbit indefinitely without requiring the expenditure of additional energy, provided it is not struck by meteoroids and the orbit is sufficiently far from the Earth so that the atmospheric drag on the vehicle is zero. Its velocity must be such that the centrifugal force on the vehicle balances the gravitational attraction of the Earth.

In the "stationary" satellite the angular velocity must be identical with the spin velocity of the Earth. Calculations show that it would be located at a distance 22,900 miles from the Earth's surface and have an orbital velocity of 10,200 feet per second, or about 7000 miles per hour.

Calculations on the escape vehicle indicate that escaping completely from the Earth's gravitational field would require an amount of energy which is capable of imparting an initial velocity to the space vehicle of about 37,000 miles per hour.

Preliminary studies have been carried out to determine whether rocket propulsion using the chemicals now avail-

able can meet the requirements indicated above. These studies show that with a single-step rocket, using liquid oxygen-liquid hydrogen propellant, it might be possible to design an orbital vehicle. The requirement for the other two cases, however, can be met only by a multiple-step rocket.

A multiple-step rocket consists essentially of a series of rocket units; the number of steps used being two or more, depending on the performance requirements, the type of propellant used, the payload to be carried, etc. A step rocket operates approximately as follows: First, step 1 of the rocket is fired. It carries, as its payload, the other separate steps which make up the rocket unit. Second, at the very instant step 1 stops burning, step 2 is ignited. At this point, step 1 detaches itself and falls back to Earth. Again, step 3 takes over when step 2 is exhausted. This process is continued until the last step, which carries the payload, is ignited and burned. After this, the last step coasts out of the Earth's gravitational field or until its velocity becomes zero.

To obtain a required performance with a given propellant, the multiple-step rocket is more efficient than the single-step rocket. The basic reason for its efficiency is that in a single-step rocket the entire mass, except the propellant which has been consumed, is accelerated; whereas, in a multiple-step rocket, the structural weight, such as tanks, motors, pumps, etc., is continuously decreased as the number of steps is separated from the missile. Hence, the energy required to accelerate the rocket to a given velocity is less for the multiple-step rocket than for the single-step rocket.

Studies of the three types (an Earth-satellite, a "stationary" Earth-satellite, and an escape vehicle) have led to the conclusion that such rockets are possible with the engineering knowledge now available. It is true that these rockets would be bulky and inefficient from a weight standpoint and that they would not necessarily carry human beings.

It should also be realized, however, that the development of rocket propulsion systems is relatively new as compared with some of the more conventional types of propulsion systems.



It is obvious that we would not be attacked, this time, on the high seas alone, or only at some far-flung outpost like Hawaii or the Philippines. We would be attacked everywhere, simultaneously, at our outposts and right here at home. Under such circumstances, without universal military training, without full-strength National Guard units, fully trained, ready to take the field, defeat for the United States, and the world, at the hands of a conquering foe, is not inconceivable.

—GENERAL JACOB L. DEVERS.

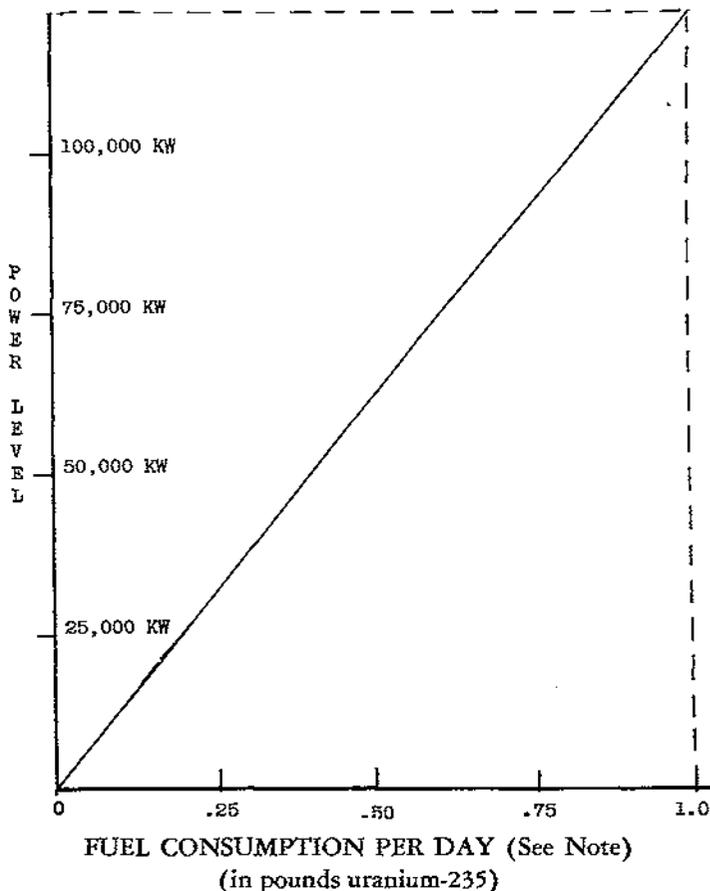
NUCLEAR POWER — Its Military Application

By Dr. R. E. Lapp

NUCLEAR POWER—WHEN?

To date no nuclear machines have been constructed which generate useful power that can be applied in industry. Therefore, the question as to when we will have practical nuclear power plants must of necessity be only answered with rough estimates or good guesses. There are already in existence seven nuclear reactors (chain reacting controlled systems) but only a few of these run at a high power level and none of them are adaptable for the commercial production of power.

Obviously, any estimate as to when we will have nuclear



NOTE: Fuel consumption is based upon a 25% efficiency and refers to the total amount of U-235 which is burned (fissioned) in a nuclear reactor. See Section, Fuel Consumption in a Nuclear Machine.

EXAMPLE: A nuclear machine which burns 1 pound of U-235 with a 25% efficiency will produce 120,000 kilowatt days of power. This equals 3 million kilowatt hours of power.

The same machine would run for 1 day at a power output level of 135,000 horsepower.

power plants in operation will depend on many factors. The first power piles (plants) will undoubtedly be land installations of experimental type which will be used for test purposes rather than for supplying power as such. It cannot be overemphasized that the outlook for atomic power is not bright. The piles which are being designed are experimental units which will serve as prototypes of prototypes. We are a long way from being able to fix upon a reactor design which can be considered as suitable for the efficient generation of atomic power.

Few scientists believe that the widespread use of nuclear power will come within the next two decades. It is probably true, however, that if there were urgency for a reactor for military application, as for example, for ship propulsion, such a unit might well be designed and constructed in less than this time. In the following sections many of the difficulties in the design and operation of nuclear piles will be explained.

Both the Army Air Forces and the Navy have announced that they are interested in a design of nuclear power plants for the propulsion of aircraft and naval vessels, respectively. The latter application is one which, should it be of sufficient strategic importance to warrant diversion of scarce fissionable material, might be realized on a test basis long before nuclear power plants could be developed for the Air Forces. It is still too soon to even predict when aircraft may be powered by nuclear energy. In the long run it may be a question as to whether we can afford to expend fissionable material unrecoverably for anything except atomic bombs.

NUCLEAR POWER—WHERE?

For military purposes, where the high cost of power is no a deterrent, nuclear power plants may well be used as stationary units to supply power at:

- A—Remote air bases
- B—Secret research laboratories
- C—Arctic proving grounds
- D—Isolated island posts of strategic importance.

Such power units would be semi-permanent installations.

Nuclear power is potentially an excellent means of driving naval vessels either of the fast surface type or of the submarine class. Here the excessive weight required to shield against radioactivity from the reactor is not prohibitive and substantial progress in nuclear-powered ships may be expected.

Relatively recently, a large group of scientists advising

the Secretary of War's Interim Committee on Atomic Energy reported ". . . we see no foundation in current science for the hope that atomic power can be effectively used for light, small portable units such as are required for aircraft and automotive transportation. . ." This should dispel any hope of the layman who looks forward to automobiles powered by nuclear engines.

However, we should not strike out the possibility that nuclear power may be adapted to aircraft use. It is true that there are many difficulties in designing a reactor for an airplane. But if we consider a guided missile where no shielding would be necessary, perhaps the goal can be realized. We should at least investigate every possibility in this field, and it is encouraging that the Air Corps is taking such a farsighted and optimistic view of this possible application of nuclear power.

NUCLEAR POWER—WHY?

This is not an altogether naive question. To answer it we must assess the relative merits of ordinary power sources against the nuclear power possibilities. It requires that we look closely at our coal, oil, and gas reserves and their geographic distribution.

One of the prime reasons for seeking nuclear power for military purposes is to obtain a more efficient fuel. While we have not as yet exhausted the means by which we can improve engines for driving naval vessels or propelling rockets with conventional fuels, it is fair to say that we are approaching saturation in this respect. The military man who has had to deal with logistics especially at a remote island air base can appreciate that any fuel which furnishes more power per unit weight is a thing to be cherished. A compact power source using small quantities of fuel has so many military applications that the list of these would be very long. This list is shortened, however, by the fact that most nuclear power plants will only be used to generate large quantities of power. Probably no military application involving less than 10,000 kilowatts of power would ever be given a priority for a nuclear power plant.

For submarine power, the Navy is interested in nuclear power because the fuel involved does not burn up valuable oxygen and may allow extended sub-surface operations at relatively high speeds.

NUCLEAR POWER—HOW?

To many the mere mention of the word "nuclear" implies that this is something which is very mysterious and only understood by the elite of the scientific world. There is really nothing mysterious about nuclear power. However, the layman who has been misled by overly optimistic predictions about nuclear power may come to regard it as a major mystery when he fails to see practical nuclear power plants within a few years.

By the process of fission, the nucleus of certain special materials, such as uranium-235 and plutonium-239, splits up into two fission products which serve to generate heat energy in the uranium or plutonium metal. Because small quantities of fissionable material can be used to sustain a chain reaction of fission processes, an extremely compact source of heat energy is made possible at a temperature which is limited only by the rate at which the generated

heat is removed. The fact that when the source is small it will be at a very high temperature creates many difficulties which will be discussed later.

Now every engineer knows that if he is given a good source of heat he can devise a power plant which runs from this source. So the process of using nuclear power then becomes a technical or engineering task to extract the heat from the small source and to use this heat in a conventional power plant. For this reason, nuclear power plants will be *conventional* plants except for the fact that a small nuclear reactor will take the place of the conventional heat source (coal or gasoline). Should nuclear reactors be designed for aircraft, there would be an exception to this statement which might lead to a radically different design.

It is not unreasonable to expect that nuclear reactors will be designed to furnish power in amounts sufficient to supply all the needs of a large city. However, no one would advocate the installation of a 500,000 kilowatt power plant in Washington, D. C., unless it were cheaper to run than the present plant. It will be a long time before this condition will obtain. Therefore, nuclear power piles will be placed only at installations where other power sources are not available.

BUDGETING FISSIONABLE MATERIAL

The basis of our source of all fissionable material is uranium-235 which is present to the extent of only one part in one hundred and forty parts of natural uranium. Using U-235, we can manufacture two other fissionable isotopes—uranium-233 and plutonium-239. All of these materials are fissionable and may be used in an atomic bomb just as well as for nuclear power.

In any preparedness plan for national security, our goal would be the production and stock-piling of the greatest possible number of atomic bombs.

NUCLEAR POWER PILE BY-PRODUCTS

As a necessary consequence of fission, there will be produced a pound of fission products for every pound of U-235 which is fissioned. These highly radioactive materials constitute a radiation hazard, and must be carefully shielded to protect plant personnel. They furthermore tend to contaminate the pile (analogous to clinkers in the ashes of a fire) and must be periodically removed from the pile. This is a troublesome procedure since the fission products are intimately mixed with the fuel material and have to be chemically separated by a costly remote control process.

In order to keep as many neutrons as possible inside the pile, every pile will probably be surrounded by a "reflector" which serves to reflect back escaping neutrons into the active part of the pile.

From the standpoint of offensive warfare, it might be decided to store up long-lived radioisotopes and fission products for radioactive warfare.

CRITICAL SIZE OF A NUCLEAR PILE

The concept of critical size has been introduced in the popular press in connection with the mass of fissionable material required to make an atomic bomb. The same concept holds for nuclear reactors. In this case, the amount of fissionable material required for a "critical" pile is usually

much greater than that for an atomic bomb. The reason for this is that most piles will be of a type that utilizes a thermal or slow fission process [i.e., fission due to the absorption of thermal or slow neutrons by the fissionable material] rather than fast fission which is used in the bomb. To slow down the neutrons from the high speed which they have as a result of their fission origin, one uses a light element or moderator. The moderator has to be placed close to the fissionable material in a lattice (heterogeneous) or in a homogeneous arrangement. This interposition of the moderator between lumps or rods of the uranium increases the critical size of the pile so neutrons can more easily escape through the lattice of moderator plus uranium. This is an important factor to consider when planning for a nuclear-powered guided missile.

FUEL CONSUMPTION IN A NUCLEAR MACHINE

While it is quite true that a single pound of pure uranium-235 contains energy equivalent to the heat energy in 1500 tons of coal, it is a very misleading statement when applied to nuclear power application. Partly due to design considerations, partly to structural strength of the fuel rods and also to the accumulation of fission products, it is not possible to completely convert a single pound of U-235 in a pile into fission energy. You can easily see that if we made fuel rods out of pure U-235 and then were able to fission fifty percent of all this uranium, the rod itself would be a spongy mass containing fifty percent unfissioned uranium and the rest would be split-atoms. Such a conglomerate would obviously be structurally unsound and the fuel rods would be useless. What would probably happen would be a crumbling of the rod and a consequent blocking of the channel in which it was centered. Immediate local overheating of that part of the pile in the vicinity of the blocked channel would occur.

Figure 1 shows a graphical plot of the power output level of a nuclear reactor as a function of the uranium-235 used per day. An over-all efficiency of twenty-five percent is assumed for the nuclear power plant in this particular instance. From the foregoing paragraph, it should be clear that the fuel consumption refers to the total amount of U-235 which is fissioned in the entire nuclear reactor.

SOME PILE PROBLEMS

Just what are some of the problems with which we are faced in designing nuclear power piles? Before discussing some of the physical problems, let us point out that the rapidity with which the problems will be solved will be a function of the intelligence we apply to the task, the energy we expend in trying out new ideas, and the fearlessness with which we tackle difficult assignments. In this new field one brilliant idea may be worth a hundred days in progress! Today, almost two years after the end of World War II, we do not have that array of scientific might which tackled and licked the atomic bomb problem. Many of the top scientists and more of the younger researchers have returned to peacetime jobs in universities and in industry. Some, dismayed at the terrible destruction wrought by the use of a weapon which they helped to develop, shun employment in the government atomic laboratories. Gone is the wartime stimulus that spurred scientists to work day and night on

atomic research. Will the leaders of our present government research laboratories take the chances that they did during the war or will they feel the deadening and stultifying need to refer to higher authority all their decisions? Secrecy is still with us and will probably remain for some time. No one can estimate how much secrecy cost us during the war for secrecy is a two-edged sword that may do great harm to progress. So our progress in solving problems in nuclear energy application will depend not only on the physical problems but upon the human factors and the political situation. Since the latter are difficult to evaluate, let us turn to a brief discussion of some of the more important physical problems.

PILE CONTROLS

While the pile itself has no moving parts which are fundamental in its design, it does contain the control mechanism. This, in general, will consist in a neutron absorbing rod which can be moved in and out of the pile or it may consist in relative motion of a part of the pile. In any event, there is a basic requirement that the control mechanism must be able to respond to neutron fluctuations in the pile. Should the mechanism be too slow then the neutrons would flare up and the pile would go out of control. While this would not result in an atomic explosion, it would undoubtedly ruin the pile and might constitute a serious health hazard due to the release of radioactive fission products from the reactor. This means that the controls must be foolproof. There should also be emergency controls to stop the pile should the ordinary controls fail to operate.

The necessity of carrying out all operations remotely makes the control problem somewhat more complicated but is not a serious difficulty. However, the necessity for keeping all pile products sealed within the pile, means that all controls must move in perfectly sealed channels.

PILE MATERIALS

Perhaps one of the most crucial points in the evolution of power piles will be the development of material that will be resistant to high temperature, and will have good neutron properties. In addition, these materials must be unaffected by nuclear radiation or by corrosion; still they must have good mechanical strength and be easily fabricated. It is quite difficult to find materials that will satisfy all of these requirements and it is very clear that much depends on what metallurgical progress can be made in the near future. These materials must be used for fabricated fuel rods (or containers), moderators, liners, structural supports, outer container and sealing devices.

One difficulty which is very evident is the manufacture of fuel rods that can withstand extreme conditions in the interior of the pile and yet be removed easily and replaced with fresh fuel rods when they have been depleted in fissionable material.

This means a periodic "shut down" for the plant while rods are discharged and new ones put into the pile. These discharged rods must then be chemically processed to remove the unwanted fission products and recover the fissionable material. This must then be reprocessed and fabricated into new fuel rods.

HEAT TRANSFER

In the piles which have been built to date, it is necessary to remove heat from them to prevent excessive temperatures from being reached. To accomplish this, cooling air or water is forced through channels in the piles. It is a fundamental law in physics that if one wishes to generate power most efficiently, one uses as high a temperature heat source as can be obtained. Just as a high waterfall is more effective in producing large amounts of water power so is a pile more efficient in generating power if it operates at high temperature. Our present day materials, however, cannot stand up at temperatures greater than 1500°F, so that until new materials are developed, piles must be operated below this temperature. Where the power pile is a stationary plant and size is no object, there is no great advantage to operating the reactor at temperatures greater than 1500°F for at this temperature the theoretical thermodynamic efficiency is already high.

If a relatively compact pile is to yield 10,000 kilowatts of power and not exceed a temperature of 1500°F, it is obvious that heat must be removed from it very rapidly and efficiently. There are again restrictions on the materials which one can tolerate inside a pile and any coolant (heat transfer medium) must satisfy stringent tests. Liquid metals have been suggested to overcome some heat transfer difficulties and it may be possible to use such a scheme. Gas is not very efficient as a coolant but it might be used to run a closed cycle gas turbine.

SHIELDING

Even a small pile running at low power generates enormous quantities of radioactivity and requires thick shields to protect personnel in the vicinity. A power pile supplying two thousand kilowatts of power would generate radiation equipment to many tons of radium! When one considers that a gram ($\frac{1}{450}$ of a pound) of radium must be treated with great care, this huge quantity of radiation is almost fantastic! It has been estimated that at least fifty tons of shielding material would be required around a low-power pile to protect against the radiation.

All the piles which have been build up to now have been located far from the near-by cities. It is problematic as to what rules will be drawn up in the future should power piles be designed to supply an isolated city with power.

Because the fission products formed inside a pile cannot be discharged into the air or water, the reactor must be a sealed system. All openings into the reactor must be sealed and protected with ingenious closures. Furthermore, any coolant which flows through the pile will itself become radioactive and thus certain parts of the conventional power unit must be shielded. All equipment (pumps, motors, and controls) within the shield must be capable of indefinite operation or must be replaced by remote handling.

There is very little hope that any substantial progress will be made in developing a new type of shield which will be much better than those which have been developed to date.

OTHER PROBLEMS

There are still other problems to be solved in the develop-

ment of nuclear power. What makes the situation less optimistic is the fact that some of the solutions require time for the proper answers. Yet, we must wait for these and sometimes the whole feasibility of a pile design may depend on a single property of a pile material. If one element in the situation is unfavorable our design is washed up and must be started anew. Nuclear science and engineering will contain many discouraging results and for every possibility that opens up only one in ten will prove worth while. However, we have worked with worse odds than these before and must have faith in the ingenuity and resourcefulness of the American scientist and engineer.

We should not be misled by those who naively point out that a single pound of U-235 will give off as much heat as 1500 tons of coal. Before we jump to the conclusion that uranium will provide cheap and abundant power we have to consider more than energy-equivalence figures.

WILL URANIUM REPLACE COAL?

In order for uranium to supplant coal as a power source, it would have to be available at less than \$15,000 per pound. This assumes pure U-235 which is completely fissioned! We shall not even go any farther into the economics of the situation for until we have actually built nuclear power plants which operate continuously we really have little basis for calculation. For example, it is very clear that chemical processing of partially fissioned fuel rods will be quite costly but we are not sure how often this will have to be done or how it will be done.

On the gloomy side of the picture is the possibility that the international situation will require the limitation of power piles because of the fact that every nuclear reactor is a potential bomb factory. Even now scientists have advocated that we should be willing to give up atomic power for world peace. No one will deny that were we to follow this recommendation our economic system would remain unaffected and international inspection of illicit atomic bomb manufacture would be greatly simplified. On the other hand, we would be asking time to stand still in this new field which, while difficult in the extreme, holds promise of fruition. We have no precedent that such scientific retrogression can be accomplished. How ironic that man should consider depriving himself of the peaceful use of atomic energy simply because he cannot control its wartime application?

RECOMMENDED READING

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6. "Nuclear Power" Vol. IV of Scientific Information Transmitted to U.N. A.E.C. by Bernard M. Baruch
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OPERATION "BEEF"

By Captain Vance H. Taylor

For three days now Company "G," Combat Infantry, had been out of the war. Nobody wanted them to move. No brass hat, in newspaper terms, wanted them to "slash" through the enemy lines. Apparently they were forgotten. It was pleasant to loll here in an orchard and contemplate the war—somebody else fighting it. Except for keeping an eye on a Kraut outfit, a little less than a mile away across the field, it was luxurious indeed.

Shad pushed his helmet up and scratched the top of his head. He spoke to another soldier in an adjoining foxhole.

"Flip me a box of them horror-derves, will you Slim?"

Slim slowly dug a ration out of his hole and tossed it over.

"That's the second 'K' you've had today and it's only eleven o'clock. You got stock in the Chico Company?"

Shad expertly opened the ration with the end of his trench knife. "This is a breakfast which I et an hour ago."

"Well, you can take it or leave it—breakfast is all I've got. You're sure getting to be a gormit—next thing you'll want 'em hot."

"Just gimme the ration and don't give me no trouble."

The two men were in foxholes about ten feet apart dug at the edge of a hedgerow. They were on the lookout for any activity taking place in the German positions on the other side of the field.

Shad looked back and spied a figure crawling toward them up the hedgerow. "You'd better police up your area, Slim, here comes the Lieutenant. It's a good thing they got officers in this army, you'd live in any old hole. Just like that night in Piccadilly, you wanted to take the first girl that spoke to you. I'm afraid this war is submerging your finer instincts."

A scornful snort issued from Slim's hole. "So you admit I did have finer instincts."

"Seen anything?" Said the Lieutenant who was crouching in the hedgerow behind them. His face wore the weary look of combat.

"Ain't seen a thing, Lieutenant, except that cow out there." Shad peered at it hungrily.

All three regarded the cow silently. It was about five hundred yards away grazing peacefully around a clump of five trees.

"How long has it been there?" The Lieutenant asked.

"Bout all morning. I ain't seen it leave them trees," Shad answered. "You ain't thinking the frogs would like to contribute that there animal to this campaign?"

The Lieutenant stared at the cow thoughtfully. He spoke without expression.

"For the safety of our position we'd better send out a patrol tonight, and don't forget to bring a rope."

"See what did I tell you," Slim observed after the Lieutenant had gone, "He's a guy, even if they did make him a

officer. And what's more I'll betcha he leads the patrol himself."

"Yeah, he'll lead the patrol and he'll get the first filet mignon off'n that critter too."

"He's got responsibilities and it makes him hungrier than you and me."

"Brains don't need no food. If they did we'd all be imbeciles eatin' all these 'K' rations."

About three hours later Shad became rigidly attentive in his hole. He spoke without turning. "Slim, do you see something movin' down there in them trees? Looks like it's right in that third tree from the right, and a few hundred yards beyond."

"Gimme the glasses. You're right it's a coupla Krauts crawling along on their stomachs. They're after our beef, damn 'em."

"The sneaking slinkin' crawlin' B—," Shad swore, "Right on their bellies like a coupla hungry jackals. This is gonna be a long shot," he added raising his rifle and settling himself.

Dust spurted about ten feet from the Germans. They rose with enthusiasm and sprinted for a hedgerow. Shad got in two more quick shots before they disappeared but it only affected a noticeable increase in the runners' velocity.

"They won't get no purple hearts outta' your shootin'," Slim observed drily.

"What's going on?" The Lieutenant had come scrambling up the hedgerow.

"They tried to steal our steaks," Shad complained bitterly, "A couple of 'em practically had their hungry paws on that cow. I gave 'em a good dustin'."

"By Cripes! That's going too far." The Lieutenant roared, "Keep an eye on them, I'm going to get some mortars ready. Keep shooting if they show up again. You'd better move to new holes." He moved down the hedgerow in a crouching run.

A few minutes later a German mortar shell landed about fifty yards from their foxholes throwing up dirt.

"See what you did," Slim criticized with melancholy, "Yuh made 'em mad with that wild shootin'."

"Don't know how I missed 'em. Especially that one with the big butt, it was sticking up like a knoll. I'll bet they're just as hungry as we are for that critter. Do you suppose they're eatin' something like our 'K' rations?"

"Yeah, I guess they do," Slim answered, "Probably dehydrated sauerkraut and wieners with powdered beer."

At eleven o'clock that night Shad, Slim and the Lieutenant started crawling across the field toward the trees. The whole company was alerted to cover them if anything happened. Shad was dragging a length of rope. It seemed to him they had crawled clear into Russia when Slim whis-

pered, "We're about there."

"How can you tell?" Shad grumbled.

"I've got clinging odorous proof there's a cow around here some place," Slim whispered angrily.

A flare went up and they froze, it outlined the cow standing at the edge of the trees about fifty feet away.

"There she is," The Lieutenant whispered, "Get that rope ready."

Shad straightened out the loop and they crawled forward.

"What's that?" The Lieutenant whispered and they stopped, listening.

"Sounds like voices."

"The bastards, they're after her too. Here Slim, put this end around her neck," Shad whispered desperately. Slim took the end and crawled toward the cow which was about twenty feet away. A mortar shell exploded too close for comfort. Shad jerked the rope feeling a pull. "We got her, Lieutenant." They started crawling off with the rope over their shoulders.

"Com'on Slim," Shad whispered back.

"I'm coming, dammit."

They stopped and Slim crawled up. The rope was fastened securely around his arm. Another mortar shell exploded and a flare lit up the whole area, they hugged the ground.

"What the hell were you doing back there?" Shad whispered.

"What the hell was I doing, what the hell were you doing? Jerking that rope just as I was putting it around the cow's neck and draggin' me all over this damn pasture."

Another flare went up making them feel naked.

Mortar shells began exploding in the German positions.

"We'd better go back," The Lieutenant whispered, "They're onto us now and our mortars have opened up on 'em."

They crawled between flares.

"You and your damned rope tricks," Slim whispered bitterly.

"Yeah?" Shad puffed, "If I'd been as close to that critter as you were I'd be eatin' a piece of her right now."

The rest of the night flares were fired alternately from both sides till a rabbit could not have crossed the field without drawing fire. Shad complained they were making his steak tough by keeping it awake.

The next morning, from their respective foxholes, Shad and Slim observed the appearance of some object near the Germans' hedgerow.

"What do you make of that?" Slim asked Shad who had the glasses. "I don't know, it looks like a cow, or maybe a cow hide. By Cripes! that's what it is. Them Krauts has fixed up a hide to look like a bull to attract that she of ours. She notices it too. Look at her. Of all the low-down tricks, playing on a female's weakness. Go get the Lieutenant, Slim, this calls for some generalship."

He glared into the glasses rigidly pointed toward the Germans' hedgerow.

Slim came back in about five minutes, alone.

"What's he gonna do?" Shad asked.

"I don't know," Slim answered, "But when I left I heard him talking to headquarters about artillery, give a position,

and say something about five tiger tanks."

"Was he mad?"

"Yeah, I guess you'd say he was."

"Mighty unsporting of them Germans if you ask me."

"Listen! Look!"

Overhead there was a fluttering sound like sand being whisked out of a tin pail and the area in the vicinity of the hide erupted in explosions.

"There goes the sex appeal," Shad exclaimed joyfully.

The Lieutenant had crawled up, "Does that fix it?"

"It sure does, Lieutenant, t'ain't ary a piece of that hide left to attract the most 'loose' cow."

"Sure would look like hell in a official report." The Lieutenant spoke half to himself. He watched the cow with a new gleam in his eye. "Shad," The gleam included the soldier, "Are you a farmer?"

Shad looked startled, "No sir, Lieutenant, I ain't never been on a farm in my life."

"Do we have anyone who was a farmer?"

"Well, there's Elwood. He was a farmer, from Missouri, I think."

"Good." The Lieutenant crawled off.

"What do you suppose he's up to now?" Shad asked.

"I don't know but that's a cow and farmers know how to handle cows."

About half an hour later the Lieutenant came back with Elwood, the farmer. They had a large megaphone fashioned from cardboard. "All right," The lieutenant spoke to Elwood, "Now call that cow." Elwood put the megaphone to his mouth. "Suc-boss, Suc-boss, Suc-boss." His words carried across the field. The cow didn't move. Under the silent critical scrutiny of six eyes Elwood tried again putting real feeling into the words. The cow didn't even raise her head.

"It'll never work." Shad spoke suddenly.

"Why not?" Slim asked with argument in his voice.

"Well, that there's a French animal and he's hollering in English."

"I don't suppose you know French, Elwood?" The Lieutenant ventured.

"Nary a word, Lieutenant," Elwood answered.

"Well, I guess that's that, we'll have to try something else." The Lieutenant and Elwood crawled off.

"Why didn't you call her, Slim, you know some French?"

"I don't know as much as you do. It's a good thing you didn't try it, what you know in French isn't fit for even that cow to hear."

They watched a plane drone overhead.

"That's what we need. A plane, we could dive right down and scare that critter over here." Shad mentioned speculatively. Something detached itself from the plane and set up an eerie whistle followed by a terrific explosion.

"Where'd it hit?" Shad exclaimed after they had emerged from the very bottom of their holes.

"Right where that cow so lately was." Slim spoke mournfully and reverently.

"Why those dogs! Those haphazard crows of satan, flying around up there bombin' a top sirloin right outta' our mouths."

Slim was looking at something in his hand, "Here's your lunch, soldier." He tossed a familiar box in the general direction of Shad.

Corregidor

(Continued from page 9)

west coast of Bataan, within 2000 yards of the enemy lines and well in front of most of the 75s. Then there were the two New Mexico National Guard antiaircraft regiments, the 200th and the 515th CA. Brigadier General William F. Marquat, operating from the Advanced Command Post of USAFFE in Bataan, was the chief coordinator for this group. I managed to see most of the officers and positions besides a short call at General Wainwright's Corps Headquarters.

It was very dusty in Bataan, with heavy traffic and much engineer road work in progress. All headquarters were well off roads; gun positions even more so. All our batteries were well dug in and camouflaged; morale was excellent. Their only gripe was wanting "more targets." The Japs supplied that briefly on the afternoon of the 13th with a bombing raid on Cabcaben while we were at Colonel Charles G. Sage's nearby 200th CA. They used white phosphorus incendiaries, burning the town as the Filipino nipa shacks went up like tinder. It was pitiful to see the natives carrying their few little belongings up the road, looking for another place to live.

When I returned to Corregidor I found that Forts Drum and Frank had been under desultory fire from Cavite since morning. Based on the best information available the enemy fire had been returned by Battery Roberts (6") at Fort Drum, and Batteries Koehler and Frank North at Fort Frank. A muzzle burst at Battery Koehler killed one Philippine Scout soldier and wounded 7 others besides the battery commander, Captain Robert J. White. The latter died in Bilibid Prison Camp a few months later as a result of this wound.

The next day Fort Frank was included in the enemy artillery bombardment. In fact, from that time onward there was the constant threat of enemy fire from the Cavite shore as the Japs unlimbered additional batteries including 150mm and 240mm howitzers. Daily counter-battery action from the fortified islands, especially from Fort Frank, answered the enemy fire. The following quotations from my diary notes of February 15 are typical:

- 3:40 P.M.—Enemy opened fire on Corregidor from Cavite. Shells falling in vicinity of south dock.
- 3:52 P.M.—Batteries Hearn (12" gun) and Hamilton (155mm guns) on Corregidor and Frank North opened counter-battery.
- 4:10 P.M.—Enemy firing ceased.
- 4:23 P.M.—Capt. Ivey (observer on Cavite mainland) reports salvos hitting right in area of enemy gun flashes. He recommends 155s sweep the area. Battery Frank North starting to "sweep."
- 4:28 P.M.—Fort Frank under enemy fire.
- 4:35 P.M.—Corregidor under fire.
- 4:55 P.M.—Enemy ceased firing.
- 5:15 P.M.—Enemy firing on Fort Hughes: broke water pipe at Battery Leach (6").



Fort Drum was recaptured by pumping 3200 gallons of a gas and oil mixture into the fort and igniting it with the explosion of a 600-lb. charge of TNT.

- 7:00 P.M.—Battery Frank North completed 139 rounds.
- 7:11 P.M.—Fort Hughes again under harassing fire.
- 9:08 P.M.—Corregidor under harassing fire.
- 9:15 P.M.—Firing ceased.

Late that afternoon Captain Ivey and his observing detail were attacked by a Jap patrol and forced to withdraw. An American corporal was killed and Sergeant Boyd of the 60th captured but Captain Ivey and two Philippine Scouts eventually returned to Fort Frank safely.

Although sporadic, this harassing fire was none the less annoying. You never knew when or where an enemy shell might land. For instance, at 9:30 P.M. on 18 February, just after Battery Frank North ceased counter-battery fire, an enemy shell hit in the powder pit of No. 4 gun wounding 7 members of the crew who were cleaning the gun.

Another lucky shot for the enemy happened the next night. Sometime after midnight the harbor boat *Neptune*, completely blacked out of course, approached the Fort Frank dock to deliver supplies but withdrew when a shell landed nearby. Later, at about 3:35 A.M. she again came in to dock. At that instant an enemy shell hit her forward deck. Fifteen drums of gasoline went up in a flash as did 500 powder charges for 155mm guns intended for Fort Frank. The fireworks turned the ship into a blazing furnace and threw burning powder all over the post, starting numerous brush fires. Miraculously there were no casualties as the crew jumped overboard and swam ashore but the ship and all supplies aboard were a total loss.

After daylight the next morning Colonel Napoleon Boudreau, the Fort Commander at Fort Frank, sent a volunteer working party of 15 men to Calumpan barrio* on the Cavite mainland to repair the fresh water pipe line which had been blown up two days previously by the Japanese. (Both Forts Frank and Drum had salt water distillation plants for emergency use.) While the men were working, they were attacked but succeeded in killing 25-30 Japs and got back to Fort Frank safely. One Philippine Scout was wounded in the arm. Colonel Boudreau covered their withdrawal with 75mm fire from Fort Frank. The working detail credited Private James L. Elkins, 60th CA, with most of the Jap casualties. He was armed with a Browning automatic rifle. His only comment was: "I got all I saw." The enemy retaliated by burning Calumpan and Patungan barrios that night.

*Barrio—Filipino native village.



The author inspecting Topside officers' quarters on Corregidor after liberation from Japanese prison camp.

On 20 February Battery Woodruff (14" gun) at Fort Hughes joined in the counter-battery action for the first time. That night a friendly submarine exited carrying President Quezon and Vice-President Osmeña of the Philippine Commonwealth, together with the private and official family of the President. The party was landed safely in the Visayan Islands, from which point some weeks later they proceeded by patrol-torpedo boat to Mindanao and thence by air to Australia.

Some time previously General Moore had ordered the emplacing of two 155mm guns in a new battery position at Fort Hughes, sited to fire back inside the bay. On 22 February Lieutenant Colonel Armand Hopkins, in command at Fort Hughes, reported the construction completed and the battery ready for action. This was named Battery Williams, in honor of First Lieutenant George L. Williams, CAC, killed in action at Abucay, Bataan, early in January.

For the next few days there was a period of Japanese inactivity during which all batteries took advantage of the opportunity to dig in deeper and several fired calibration problems. Meanwhile Batteries Woodruff, Koehler, and Frank North fired daily interdictions at Japanese activities in Ternate and Maragondon on the Cavite mainland. Native informers reported the enemy improving trails, using forced Filipino labor, to new gun positions high in the Pico del Oro hills overlooking Fort Frank.

In 1921 a tunnel for the Seaward Defense Command Post on Corregidor had been started but work was discontinued the next year on account of treaty agreements. After

Pearl Harbor the Engineers began again and by the end of February had it about completed.

At 2:00 P.M. February 26 Colonel Boudreau at Fort Frank scattered a Jap looting party in Calumpan barrio with 75mm shrapnel. He also transmitted to Harbor Defense Headquarters a propaganda message he had received from the Japanese through a Filipino civilian. It read:

Surrender Carabao (Fort Frank) and save lives; the whole area along the coast line of Cavite Province is now a Japanese Military Reservation; large guns in large numbers are being massed there; Carabao will be reduced by our mighty artillery fire, likewise Drum; after reduction of Carabao and Drum our invincible artillery will pound Corregidor into submission, batter it, weaken it, preparatory to a final assault by crack Japanese troops. Be wise; surrender now and receive preferential Japanese treatment.

Other similar messages were dropped in leaflet form from time to time.

Early in March an 8" railway gun, which had been brought over from Bataan, was mounted on a prepared concrete base near Road Junction 43, east of Malinta Hill on Corregidor. It had a range of 24,000 yards and all-around fire except to the west which was screened by Malinta Hill. After proof firing by the Ordnance Department it was ready for service but as no troops were available for assignment to it the gun was never in action against the enemy. It had been anticipated that troops would be available from Bataan to man this battery.

Frequently, in early March, we were receiving word of some Philippine vessel trying to reach us with supplies from the southern islands. Among the casualties were the inter-island steamers *Princessa*, *Don Esteban*, *Legaspi*, and *Florence D.*, while the *Don Isidro* had been bombed and sunk in Port Darwin harbor, Australia. This prompted some one to suggest that the theme song for "MacArthur's Magnificents" should be, "I'm Waiting for Ships that Never Come In." Others were wondering whether the chalk "V" on some of the soldiers helmets stood for "Victory" or "Victim." All of us were strong for Walter Winchell however when he remarked in a States broadcast we picked up: "To hell with this hero stuff; let's send them some HELP!"

By that time the Engineers on Corregidor had completed the construction of reinforced concrete shelters over several 75mm beach defense guns for protection from dive bombing attacks. They had also many other projects under way such as drilling of additional wells, bomb-proofing the Morrison Hill gasoline storage tanks, construction of personnel bomb-proofs at various batteries, erection of Malinta water tanks, Panama Munts (circular rails) for 155s, etc. Many tunnels were started by troops, with the Engineers supplying technical advice and supervision. Innumerable splinter-proofs were built by Beach Defense troops using such scrap or salvage materials as could be spared from the main projects. In fact, all concerned worked unceasingly to better their positions.

In the meantime we had had our 75th air raid of the war while our antiaircraft batteries competed for top honors in

enemy planes shot down. Seacoast batteries in action most frequently against Jap activities in Cavite during this period were Hearn and Hamilton on Corregidor, Woodruff and Leach on Hughes, Roberts and Hoyle on Drum, and Koehler and Frank North on Frank. Our main difficulty was lack of observation. Also, it was almost impossible to spot the enemy artillery flashes as usually he held his firing to the morning hours when we were looking directly into the sun.

About 4 March General MacArthur called the Harbor Defense Commander, General Moore, into conference and told him that he had received orders from President Roosevelt "to proceed to Australia." He had protested to the President but had nevertheless been ordered to leave. By that time the enemy had established his blockade of the entire Philippines; he had complete air supremacy, and his navy "Wild Eagles" were roaming the Philippine skies daily in search of prey. However, on the night of 11 March, General MacArthur, with his family and staff and Admiral Rockwell with his 16th Naval District staff started on the now famous "dash through the lines." Four fast navy patrol-torpedo boats were assigned the task of transporting the official party to Mindanao, from which point all flew to Australia four days later.

USAFFE was succeeded by the United States Forces in the Philippines or USFIP, with Lieutenant General Wainwright in command. He immediately moved to Corregidor from Bataan but made no change in the existent Harbor Defense Command and no change in the conduct of the defense by General Moore. The morning after he arrived General Moore was showing him around and they had just reached Battery Monja, on the South Shore Road, when an air raid came over. General Wainwright rather protested having to step into the sidehill shelter available but a moment later bombs were bursting outside, causing a big landslide and wrecking the battery kitchen. It had been a narrow escape. When they returned from the inspection tour they had just left their car to enter Headquarters when another load of bombs came down, one of which demolished the car they had vacated.

"My Gosh!" exclaimed General Wainwright. "On Bataan you can move around a little, but here on Corregidor you're right on the bull's-eye."

Before breakfast on March 15 Jap artillery shells began falling on Fort Frank. At 8:00 A.M. General Moore and I went to a station atop Malinta Hill to observe the action. By that time Forts Drum and Hughes were also under fire. Our batteries Hearn and Hamilton opened counter-battery but sun and haze combined to make observation very difficult. Soon shells were landing on Corregidor at Middleside, South Shore Road, and the south dock. During the day however Drum and Frank received the brunt of the bombardment which was from 240mm howitzers. It was certainly painful to see those heavy shells socking the little islands and to know what must be happening.

At Battery Frank North, 2 of the 4-155mm guns were destroyed and the other 2 damaged but reparable. The same was true at the 3" antiaircraft battery manned by E-91st. 7 out of 8 mortars at Battery Koehler were out of action temporarily. Other batteries at Fort Frank received less

punishment. Thanks to splinter-proof tunnels, casualties were comparatively few although approximately 500 shells hit the tiny island.

At Fort Drum, one 240mm shell penetrated the casemate shield at Battery Roberts (6") disabling one gun temporarily. A fire was started but was extinguished before it reached the powder. Lieutenant Sam Madison and several gunners were burned and gassed by the fumes in the casemate. There were about 100 hits on Fort Drum (the concrete battleship). At 5:00 P.M., when I phoned to the fort commander, Lieutenant Colonel L. S. Kirkpatrick, Jap shells were still falling. There was a break in our conversation, then:

"Pardon the interruption, Colonel," said Kirk, "that last one bounced the phone right off the desk."

A week later Forts Hughes, Drum, and Frank were again targets for terrific artillery bombardments with the latter receiving the heaviest concentration. Again several hundred 240mm and 105mm shells hit the island.

Intelligence sources indicated considerable enemy activity in coves on the outside coast, south of Manila Bay. As a result additional batteries, which could fire in that direction, got into action. Among these were Craighill (12" mortars) on Fort Hughes, and Wilson and Marshall, the two 14" turret batteries on Fort Drum. During all of this period nightly details of 3 officers and 150 men on Corregidor were loading out barges of supplies to Bataan.

SECOND AERIAL BOMBARDMENT PERIOD AND BATAAN REDUCTION

24 March witnessed what the Japanese press called "the largest air raid carried on so far in the Philippines." The objective was Corregidor. A Tokyo news release the night before had attributed continued resistance in the Philippines to several reasons all of which revolved around "the powerful fortress of Corregidor." It was soon evident that the enemy air forces had received replacements for earlier losses and had been reinforced by additional bomber units. This attack coincided with the general resumption of the offensive in Luzon by the Japanese in their final operations against Bataan and Corregidor.

In the next ten days we had 34 air raid alarms during daylight and 30 at night. One alarm sometimes lasted for two hours and included several actual raids by bombing planes. Frequently enemy aerial bombardment was accompanied by artillery fire from Cavite. The operations of March 24 were typical of what followed. Here is a summary:

7:07 A.M.—Batteries Woodruff, Marshall and Koehler opened fire on Cavite targets.

9:24 A.M.—Air Raid Alarm No. 77 sounded.

9:25 A.M.—9 heavy bombers, a new type in this area, bombed Middleside and Morrison Hill.

9:45 A.M.—27 heavy bombers came in over tail of Corregidor and bombed Middleside, closely followed by 17 heavies bombing Topside.

9:50 A.M.—25 planes followed by 9 more made another attack. Meanwhile, artillery shells from

enemy batteries in Cavite were bursting on Corregidor. Several fires were started, communication cables and water mains cut, and an ammunition dump of 75mm shells on Morrison Hill was set off. These shells were exploding for hours. Battery Wheeler (12" guns) had a direct bomb hit on the racer of No. 1, putting it out of action temporarily.

11:00 A.M.—All Clear sounded.

2:35 P.M.—Air Raid Alarm No. 78. 9 heavy bombers approached Corregidor from SE. Bombs dropped on Kindley Field.

2:38 P.M.—7 more planes from SE with more bombs. Shelling from mainland also.

3:29 P.M.—All Clear.

3:52 P.M.—Air Raid Alarm No. 79. 9 heavy bombers hit Kindley Field again.

4:20 P.M.—All Clear.

4:40 P.M.—Air Raid Alarm No. 80. Mariveles and Cabcaban areas hit by 9 heavies.

5:03 P.M.—All Clear.

9:15 P.M.—Air Raid Alarm No. 81. 3 medium bombers dropped incendiary bombs in Cheney Ravine, Corregidor; returned later and bombed Bottomside.

10:34 P.M.—All Clear.

Bombs dropped during the day's raids were of heavier type than formerly, estimated as some 1100 lbs., 500 lbs., and none (except incendiary) less than 200 lbs. 6 enemy planes were shot down and others, severely damaged, were probably lost to the enemy. Altitudes for the heavy bombers varied from 21,000 to 30,000 feet. That day, for the second time, a car I had been driving was demolished by bombs only seconds after I had left it to enter an observing station.

The next day's seven bombings seemed to concentrate on the Bottomside area, Malinta Hill, and the tail of the island. Numerous wooden buildings were burned including the Post Bakery thus depriving us thereafter of the bread component of our rations. At the cold storage plant, the bombing burst the ammonia pipes thus putting the finale to use of that facility and necessitating the immediate issue of the remaining small stock of frozen beef for Bataan and ourselves. Always, between raids, communication details were at work repairing lines.

On the morning of 26 March I was making my daily Operations Officer rounds of the batteries when the air raid alarm sounded. I stopped at B-60th, an antiaircraft gun battery at Topside. Flash messages were coming in continually on the AAIS phone and ran something like this:

"Six enemy dive bombers over Ternate, flying west."

"Motors heard in the south."

"Nine Jap Zero fighters over Mariveles, high, flying southeast."

"Seven heavy bombers, high, over Monja Island, coming toward Corregidor."

A Texas antiaircraftman on the height finder drawled:

"Somethin' tells me the Japs have air superiority."

The bombers continued to approach. The sergeant in charge of the director to lateral observer:

"Get on that leading plane and keep tracking."

Reply: "I will if they'll keep the bombs out of the way so I can see it." He wasn't crazy either. The bomb bays opened and down they came, from 27,000 feet. That was more than 5 miles up and they would take over 40 seconds coming down. With the bombs halfway down the planes came within range and the battery commander, Captain Arthur Huff, gave the order:

"COMMENCE FIRING!"

Battery B fired 18 rounds, all being in the air before the first one burst. One bomber started smoking badly, dropped out of the formation, and lost altitude until she crashed in Manila Bay. One less to worry about. Most of the bombs hit on Morrison Hill that time, two straddling the height finder at C-60th. The detail ducked but the instrument was knocked out of adjustment.

It took plenty of iron nerve to stand there turning a hand-wheel or wait, projectile in hand, for the order to load, with the bombs falling faster every second. My hat is still off to those antiaircraft batteries.

Inasmuch as the enemy heavy bomber operations were then based on Clark Field his attacks extended over a longer period of daylight hours than in December and January. There were many landslides blocking roads, besides impassable bomb craters, so that Engineer road crews were kept busy continually on repair work. On March 24 a considerable quantity of TNT stored in the north end of Topside barracks received a direct hit and blew up, demolishing that end of the barracks. No personnel had been quartered there since Pearl Harbor.

Early on the morning of 27 March it was noticed that 45 bancas⁴ had been assembled on the beach of the Cavite mainland, south of Fort Frank. The Fort Commander, Colonel Boudreau, interpreted this as a preparation to send a landing party to test his defenses. He opened fire with 75mm guns and destroyed all bancas. Every day various seacoast batteries engaged every reasonable target on the Cavite mainland with artillery fire.

At 5:00 p.m. on 30 March 2 bi-motored bombers approached Corregidor at just above 20,000 feet. Both were shot down in a brief fire action which caused much concern to the Japanese. Their excitement, evidenced in intercepted radio messages, suggested that persons of importance may have been aboard. Later, in prison camp, we read in the Japanese press, under the caption *A Year Ago Today*, this quote:

"A group of Axis officials including military attaches are now on an air tour of the southern areas."

We wondered. Anyway, the Japs kept their bombers up to 30,000 feet thereafter.

The first few days in April developed relatively less enemy activity against the fortified islands as the Japanese

⁴Bancas—native small boats.

were concentrating their efforts against the Bataan peninsula in accordance with their radio announcement of April 2 that, "we are starting an all-out offensive in Bataan." This culminated in the capitulation of the Luzon Force on 9 April.

The enemy contented himself during this period with occasional attacks on the island forts by small formations of bombers and daily shelling from Cavite which was answered by our counter-battery.

The early fall of Bataan appearing unavoidable, orders were issued on 8 April for the withdrawal of the two 3" gun batteries that were extending our antiaircraft defense into Bataan. These were G-60th and C-91st. The movement was accomplished during the night of 8-9 April amid vast congestion and confusion along all roads in the Mariveles area caused mainly by the masses of civilian refugees retreating before the Japanese. Due to forcible intervention by the Military Police, the troops were permitted to withdraw only two 3" antiaircraft guns and about 650 rounds of ammunition. All equipment left behind such as anti-aircraft guns, searchlights, radio direction finder, fire control instruments and ammunition was destroyed or damaged beyond repair. This had been the battalion commanded by Lieutenant Colonel Howard Breitung, 60th CA.

From 6:10 p.m. 8 April till 5:00 a.m. 9 April upon call from the Luzon Force Commander, Battery Hearn on Corregidor put down interdiction fires on Bataan roads to delay the southward advance of the enemy.

When Bataan fell, General Wainwright directed that no troops would be brought to Corregidor except the 45th Inf. (PS), our antiaircraft gun batteries mentioned above, and the nurses; also, that no civilians would be evacuated to Corregidor. The 45th was actually assembled but never reached Mariveles for embarkation. The nurses did get over safely.

However, in spite of the General's prohibition, about 1600 miscellaneous Army, Navy, and Philippine Constabulary, plus 800 civilians rushed into Corregidor. All night 8-9 April and all the next day refugees from Bataan poured across the narrow channel to "The Rock" by boats, rafts, bancas, or any floating means. Leaflets dropped in Bataan that day stated:

"Your convoy is due in the Philippines on 15 April but you won't be alive to see it. Ha! Ha!"

At 1:10 P.M. on 9 April we could see troops in fatigue clothing marching northeast on the Cabcaben road. Thus the beginning of the infamous "Death March" out of Bataan. Meanwhile, Corregidor had been subjected to 4 bombing attacks during the morning and Topside was under artillery fire from Cavite. At 3:40 P.M. 9 planes, in waves of 3, bombed Batteries Wheeler and Geary and the Ordnance Instrument Shop. Returning at 3:49 P.M. they proceeded to bomb Malinta Hill and Kindley Field.

All vessels were moved back to the south harbor for better protection from Bataan. The Cavite shore being considerably farther away, that seemed the lesser of two evils.

The artillery personnel from Bataan was assigned to various artillery missions while all others were turned over to Colonel S. L. Howard, USMC, the Beach Defense Commander, to augment his force. Such civilians as were

physically able were drafted as laborers for the Quartermaster, the Army Transport Service, or the Engineers. Others parked themselves in Malinta Tunnel day and night.

At 4:00 P.M. 9 April, a Jap 75mm battery which had been rushed forward opened fire on Corregidor from the beach near Cabcaben. Bataan, as a foretaste of what we were to expect. As this battery was in plain sight it was quickly destroyed by 155mm fire from Battery Kysor. However, when our forces in Bataan were out of the way, the enemy lost no time in moving his artillery mass forward and into defiladed positions from which to pound Corregidor and Fort Hughes.

FINAL BOMBARDMENT AND ASSAULT PERIOD

The next morning (10 April) an enemy observation balloon was seen, for the first time, rising from the vicinity of Lamao, Bataan, concurrently with a bombing attack on Topside. A few minutes later a Japanese plane was seen landing on Cabcaben air strip just behind our own captive troops on the road. The day continued:

- 8:35 A.M.—2d string of bombs—landed at Middleside.
- 8:50 A.M.—Artillery shells from Cavite shore falling near Ordnance Point (Corregidor).
- 9:50 A.M.—Fort Frank under fire.
- 9:52 A.M.—4 flights of 3 each bombed Topside and Morrison Hill.
- 9:58 A.M.—2 bombers hit Topside.
- 10:43 A.M.—2 bombers again hit Topside.
- 10:56 A.M.—Enemy shelling Corregidor from south mainland.
- 11:15 A.M.—Bombs dropped at Bottomside and Morrison Hill.
- 11:21 A.M.—Jap plane landed at Cabcaben airfield, Bataan.
- 11:27 A.M.—2 heavy bombers hit Morrison Hill.
- 11:44 A.M.—4 heavies hit between Morrison Hill and Middleside.
- 11:47 A.M.—3 planes bombed Morrison Hill.
- 12:20 P.M.—Jap plane took off from Cabcaben.
- 12:22 P.M.—Long column of our troops seen marching north on Cabcaben road.
- 1:13 P.M.—9 heavy bombers, in flights of 3, dropped bombs along South Shore Road.

And so on, hour after hour. Perhaps it should be mentioned that Morrison Hill was an exposed elevation on Corregidor, facing Bataan, where were located two seacoast batteries, Grubbs and Morrison, and an antiaircraft gun battery (C-60th). All of these took terrific punishment.

All our antiaircraft batteries were the particular objectives of enemy bombers that day but shortly thereafter anything visible from Bataan was subjected to gruelling artillery fire at comparatively short ranges. With the great eleva-

tions available in Bataan for observation points, plus captive balloons and their own airplanes to spot artillery fire for them, the Japanese were able to adjust quickly and accurately on any point desired. This factor contributed more than any other to the ultimate wearing down of the defenses, this, and the realization that no help was coming.

In the late afternoon of 11 April, five landing barges appeared from around Hornos Point, the southwestern tip of Bataan, hugging the shore as they headed for the inner bay. When Batteries Rock Point (155mm), Sunset (155mm) and Hanna (3") opened fire the boats promptly retreated outside and around the Point.

On April 12 Battery Kysor destroyed a Japanese harbor vessel off the coast of Bataan but was immediately subjected to counter-battery. Geary's mortars then opened fire on the enemy but were in turn shelled and bombed. There were 9 separate bombings of Corregidor that day while artillery fire was almost continuous. Battery Craighill (12" mortars) on Fort Hughes also participated in the counter-battery action and was shelled from Bataan.

By that time all seacoast batteries and searchlights facing Bataan were under daily accurate artillery bombardment and it was with the greatest difficulty that Ordnance personnel were able to keep some batteries repaired. As time progressed some guns were put out of action permanently.

In contrast with the Cavite shelling where a warning whistle permitted you to hit the dirt if you were on your feet, we found that shells from Bataan, due to its closer proximity, arrived simultaneously with the boom of the cannon. If one caught you it was just too bad. One such shell landed in one of the gun pits of C-60th on Morrison Hill, instantly killing Lieutenant Pace.

During a heavy bombardment on the morning of 15 April part of the Philippine Army personnel manning Battery James (4-3" guns) took shelter in excavations into Morrison Hill behind the battery. The intensity of the enemy artillery fire collapsed the hillside above the entrances, suffocating the 40 Philippine Army occupants.

The Seaward Defense Command, some time previously, had organized a special spotting section with officers detailed as observers in OP's at Topside, Morrison Hill, the Mine Command OP, Malinta Hill, and on the *Don Jose*, a commercial vessel burned and beached off Hooker Point (tail of Corregidor). From 12 April on this group concentrated on locating enemy batteries in Bataan for our counter-battery action.

On 17 April three B-17's from Australia via Mindanao completely surprised the Japanese (and us) with bombing raids on the Jap occupied Clark and Nichols Fields. Our pleasure was short-lived however as we learned the next day that the raiding planes had used the small remaining stock of aviation gas on Mindanao for their return hop to Australia.* Nevertheless this demonstration encouraged us to hope that more American planes might be sent our way rather than across the Atlantic.

For several days no 240mm howitzer fire had come out of Cavite and on 18 April the reason became apparent. These heavy batteries had been moved around through Manila and emplaced in southern Bataan for bombardment of Corregidor. Thereafter they were a constant threat and with their high angle fire were able to blast out 12" mortar

pits which flat trajectory weapons had been unable to reach. By that time a number of our seacoast and antiaircraft guns had been disabled. Battery Morrison (6" guns) was out completely and the personnel manning it (C-91st from Bataan) had been transferred to Battery Grubbs, 2-10" guns facing Bataan.

At Topside all height finders were out but one. A telephone circuit from that one provided altitudes for the other batteries pending repair of their own instruments. It was apparent that everything visible from Bataan was fast being put out of action thus crippling our counter-battery work. To remedy this I suggested, and General Moore approved, the selection of a number of 155mm positions defiladed from Bataan. Ten were chosen. Guns would be emplaced in some of these to fire counter-battery. That night they would be moved to other positions and the scheme repeated. The plan worked splendidly. These were called "roving guns" and were designated by the name of the officer commanding the battery. Enemy fire inflicted minor damage on the matériel each day but frequent inspections and efficient ordnance repairs kept these roving guns ready for action most of the time.

On 24 April, starting at 3:00 P.M. an exceptionally heavy concentration of 240mm fire was put down on Battery Crockett (2-12" guns), punishing the battery severely. No. 1 gun was put out of action and there were several casualties. The rear of the battery emplacement was a mass of debris. Shot hoists were ruined and a fire was started in the power passages of the emplacement but fortunately it did not reach the powder rooms.

The controlled mine channel on the north side of Corregidor being then subject to artillery fire from Bataan, two navy small boats started sweeping a channel through the contact mine field south of Corregidor in order to permit passage of our own vessels, if any.

Reports which had been received indicated that the enemy might be assembling a landing force up the east coast of Bataan, inside Manila Bay. After dark on 24 April the U.S. Engineer launch *Night Hawk*, First Lieutenant James Scater, C.E., in command, with a volunteer crew of six enlisted men from the 59th and 60th Coast Artillery regiments, made a reconnaissance up the east coast of Bataan looking for any concentration of troops or landing craft. Off Lamao they contacted a small Japanese boat with two men whom they took prisoner. Continuing, off Limay, they were hailed by a larger launch (about 120'). The *Night Hawk* opened machine-gun fire killing most of the Jap crew and setting fire to the boat.

Meanwhile the two prisoners jumped overboard and were shot. Lieutenant Scater was attaching a line to the enemy launch to tow her in when other enemy boats came rushing out from shore. As it was too dark to see anything worth while on shore anyway, he cut loose and ran for it, reaching Corregidor safely at about 5:00 A.M. of the next day.

On that day we had four separate bombing attacks with enemy dive bombers concentrating on shipping in the south harbor. The harbor boat *Miley* was burned, and sank. Craighill, Geary and two roving batteries fired counter-battery. Standing orders to the contrary, a large crowd had congregated outside the west portal of Malinta Tunnel

that night for a last smoke before going to bed. At 9:58 P.M. a heavy shell exploded in their midst, causing about 50 casualties. Several were killed instantly.

Beginning on the night of 26 April the Navy Inshore Patrol, at General Moore's direction, stationed two small vessels east of Corregidor to patrol about 600 yards offshore during hours of darkness and to give warning of the approach of any enemy by a vertical sweep of their searchlights.

The next two days were a prelude to a tremendous offensive effort by the enemy on 29 April in honor of Emperor Hirohito's birthday. We had several bombing raids each day while Kindley Field and the north dock area received the heaviest shelling. Battery Monja and roving batteries Farris, Byrne, and Rose were especially active against enemy targets, the latter setting fire to a Japanese harbor boat, the *Apo*, with four direct hits.

Battery Way (4-12" mortars) on Corregidor, which had been out of service for several years, had been taken over by Battery E-60th under Major William Massello, when they returned from Bataan. Having completed reconditioning the battery, it was proof fired shortly after noon on the 28th and reported ready for action.

As anticipated the enemy "celebration" began early on the 29th. As our Air Raid Alarm No. 260 sounded, two flights of bombers hit Fort Hughes, 3 dive bombers strafed Malinta Hill and south dock areas, enemy shells from Bataan hit Bottomside, and his observation balloon rose above Cabcabén. The record continues:

- 7:55 A.M.—6 dive bombers hit Malinta Hill and 92d CA garage.
- 8:00 A.M.—Extremely heavy shelling at both portals Malinta Tunnel and north dock.
- 8:21 A.M.—Enemy shelling Topside while observation plane overhead adjusts fire. Stockade level and old Spanish Fort receiving some shells.
- 8:40 A.M.—Counter-battery fired from Batteries Marshall, Crofton, Way, Cheney, Craighill, Geary, Byrne, Rose and Farris.
- 10:00 A.M.
- 9:23 A.M.—Bombs dropped on west end of Corregidor.
- 9:35 A.M.—Battery Ramsay and H-60th bombed. Fire started below Middleside incinerator.
- 9:57 A.M.—Middleside barracks bombed; several casualties.
- 9:58 A.M.—Enemy shelling North Point.
- 10:02 A.M.—Two ammunition dumps at Topside on fire. Shells exploding continually.

Thus it continued until dark. As a result of the enemy action, a number of our observing stations on Malinta Hill were destroyed. The power plant for No. 8 seacoast searchlight was hit and burned. The three 75mm beach defense guns atop Malinta Hill were wrecked as was a 1.1 quadruple mount, automatic weapon installed there. Several officers and enlisted men were killed and more wounded. Numerous wooden buildings that had escaped thus far

were burned. All in all it was an extremely busy day for us.

That night two naval seaplanes from Australia, via Mindanao, landed in the bay south of Corregidor at about 11:00 P.M. They brought some much needed hospital supplies and 740 mechanical fuzes for 3" antiaircraft ammunition. As soon as these were unloaded, fifty selected passengers (including about 38 American nurses) were taken aboard and the planes took off for Lake Lanao, Mindanao, without having been detected by the Japanese.

With the enemy's final preparations for assault on Corregidor, the action progressed with ever increasing tempo. Day and night we were under fire from some of the more than 400 pieces of artillery which the Japanese had emplaced in Bataan and Cavite. This was interspersed with several bombings daily of Corregidor and Fort Hughes while our antiaircraft and seacoast batteries engaged all reasonable enemy targets.

On May 2 the Coast Artillery Mine Planter *Harrison* in the south harbor was hit and burned, and the Master, Chief Warrant Officer James Murray killed. In fact, the vessels remaining were such frequent objectives for bombing and strafing that the crews came ashore. Colonel Val Foster, then Fort Commander at Fort Hughes, found useful assignment for most of the navy personnel from the three gunboats.

That was the day the Crockett-Geary area at Topside underwent a 5-hour plastering from 240mm howitzers while other calibers were sweeping the rest of the island. At 4:27 P.M., a big shell penetrated the magazines of Battery Geary, which blew up, taking out the whole center traverse and reducing the battery to rubble. The heavy mortars were scattered over the landscape while huge blocks of concrete were thrown more than half a mile. Fortunately, most of the personnel had taken shelter in a store room at the south end of the emplacement and were unharmed. Four men who were trapped in a rear passage at the north end of the battery were liberated next morning when the engineers drilled through a concrete wall. As I saw them driven away in an ambulance I had little hope for any of them but three of the four did recover.

No. 1 Harbor Defense searchlight, near Battery Point, also received a terrific concentration of 240mm fire which buried the light. Over 300 shells exploded there before Battery Marshall, firing from Fort Drum, silenced these enemy guns.

The next day was more of the same, with no respite from the incessant shelling and bombing. At about 8:00 P.M., a U.S. submarine stopped outside the south channel mine field for an hour. Navy small boats were sent out to her via the recently swept channel through the mine field, taking about a dozen army and navy officers, 13 or 14 American nurses, and many USAFFE and USFIP official records.

I think we all realized that there would be no more outgoing groups and I'll never forget that little procession of official cars leaving Malinta Tunnel for the south dock. Each fortunate passenger was happy to be escaping from that hell on earth, but sick with pity for the rest of us. Among the nurses was Lieutenant Mary Lohr who took a hurriedly scribbled note from my hand as she waved "Good-bye" and, upon her arrival in San Francisco, kindly delivered it to my wife.

On 4 May there was again the continuous drum-drum of detonations, separated by seconds only. After having pounded our batteries and observation points for weeks the enemy attack switched that day to the Corregidor beaches facing Bataan, such as James Ravine, Power Plant Ravine, and the beach between North and Cavalry Points. Beach Defense communications on that side of the island were disrupted and some machine guns and 75s were damaged. General Moore alerted our beach defenses for possible landing attack before the moon rose at 11:00 P.M. No Japs showed up however.

5 May saw all four of the fortified islands under heavy enemy fire. It seemed that as soon as one of our batteries opened up, several Jap batteries cracked down on it. When we were fortunate enough to silence one, another opened up in its stead. During the morning we had four bombing raids on Corregidor. At 12:30 P.M., under an order from General Wainwright, heavy counter-battery fire was opened *simultaneously* by Batteries Crofton, Marshall, Way, Cheney, Wheeler, Monja, and roving batteries Wright, Rose and Gulick. Three enemy ammunition dumps were set on fire and several of his batteries silenced, at least temporarily.

Air Raid Alarm No. 300 was sounded at 2:47 P.M. with Fort Hughes on the receiving end. Both mortar pits at Battery Craighill were filled with debris and there were several casualties.

By 6:30 P.M. all the fortified islands were being pounded terrifically. On Corregidor, it was especially the north shore and tail of the island. Communication lines were shot out in many places, numerous beach defense guns and searchlights were out of action, and many beach defense land mines had been blown up by enemy artillery fire.

At 9:00 P.M., Colonel Howard, the Beach Defense Commander, reported all of his stations manned. At 10:30 P.M., General Moore again alerted all control points for possible landing attack. The two small naval vessels were stationed as usual east and northeast of Corregidor, to warn of the approach of enemy landing boats by a vertical sweep of their searchlights.

At that time, the Japanese cannonading of the tail of the island was very heavy and many telephone lines were still out. Most of the beach defense installations on the north side of the island were practically non-existent, with barbed wire entanglements, machine-gun emplacements, personnel shelters, and most of the 75mm guns destroyed. The terrain was bare of trees and vegetation and the ground was powdered dust. Malinta Hospital was full and overflowing with sick and wounded.

I was on duty at the Operations Desk in Harbor Defense Headquarters until midnight when I turned over to my assistant Lieutenant Colonel Clair Conzelman. Several of us were still there, talking with General Moore when a Marine Corps runner arrived breathless from North Point and reported a landing there "of probably 600 men."⁵

Messages were immediately sent to all control stations by every means available. The Seaward Defense Commander, Colonel Bunker, was ordered to send the 59th CA personnel manning Batteries Cheney, Wheeler, Crockett, and Geary

to positions in Beach Defense Reserve. These included Batteries B, C, D, and H. Later, other Coast Artillery troops manning seacoast and antiaircraft armament were released to the Beach Defense Commander in accordance with a prearranged plan of priorities.

An enemy barrage caught C-59th (Captain Harry Schenk) while passing through Bottomside and killed several, including the battery executive, Captain Arthur D. Thompson. This battery and B-59th (Captain Herman Hauck), moved to positions in readiness for counter-attack in the East Sector, under the Beach Defense Commander.

A Scout messenger from Lieutenant Colonel Lloyd Biggs, 92d CA, brought word he had formed a line across Kindley Field Water Tank Hill with Batteries E and F, 92d, and was cooperating with the Marines in the East Sector Defense.

Out beyond the Jap landing point was one 2-gun 75mm beach defense battery, commanded by First Lieutenant Ray G. Lawrence, 92d CA, which had never disclosed its position. Its fire apparently came as a complete surprise to the Japanese. These two guns fired a total of 193 rounds at close range, sinking many landing barges, and accounting for hundreds of casualties. Lieutenant Lawrence stated later that the continuous stream of defending tracer bullets from the shoreline gave enough illumination to permit firing at enemy barges. By 1:50 A.M. the full moon was lighting up the situation.

Information obtained subsequently from Japanese officers indicated that the first wave consisted of 2,000 of whom only 800 got ashore. Their second wave totalled 10,000; losses, over 4,000. All batteries that could bear on the landing party opened fire, including those at Fort Hughes. Meanwhile our beach defense forces engaged in hand to hand fighting with the enemy on shore.

At 4:00 A.M., Fort Drum opened fire on the Cabcaban dock. As dawn broke about 20 minutes later, a wave of landing boats was seen approaching our north dock area. Drum changed target to the boats which were also taken under fire by roving batteries Wright and Gulick with damaging effect. A-91st with Battery Stockade (1-155mm) also got into the action. This artillery fire broke up what appeared to be another landing attack destined for Bottomside and Power Plant Ravine.

The East Sector Commander, Lieutenant Colonel Curtis L. Beecher, USMC, had reported "situation well in hand," but new enemy landings behind our line near Infantry Point necessitated withdrawal toward Malinta Hill.

The Beach Defense Reserve Battalion and Batteries B and C, 59th CA, counterattacked in the East Sector soon after daylight and drove the enemy back some distance but with the sunrise, effective artillery fire from Bataan was brought to bear on our troops while dive bombers in large numbers strafed them mercilessly. Some of our men were driven back into Malinta Tunnel while all others were pinned to the ground.

At 10:20 A.M. it was learned that enemy tanks had landed on the island and were assembling in the vicinity of Kindley Field. General Wainwright sent for General Moore and informed him that, in view of the present situation and what might be expected to occur during the ensuing night,

⁵As nearly as can be determined the 1st wave of the Japanese landing attack hit the beach at 11:30 P.M., 5 May, 1942.

and in order to prevent the further useless sacrifice of lives, he had decided to surrender the fortified islands to the Japanese at noon. He was going to have a message to that effect broadcast at once. He further directed that the armament be destroyed in accordance with secret instructions already issued to regimental and fort commanders, this to be accomplished by noon; also, that the command would lay down arms at noon at which time the Corregidor flag would be lowered and burned and a white flag displayed. These instructions were relayed to all concerned as fast and insofar as disrupted communications permitted. All units received the orders in time to comply with instructions except Fort Hughes.

At noon (this was 6 May 1942) our firing ceased and the post flag, which had been shot down and replaced twice under fire during the siege, was lowered and burned by Colonel Paul D. Bunker, the Seaward Defense Commander, whose Command Post was at Topside not very far from the flagpole. He was accompanied on this sad duty by Lieutenant Colonel Dwight Edison, 59th CA.

A flag of truce was carried out by Captain Golland H. Clark, USMC, accompanied by First Lieutenant Allan S. Manning, USMC. They proceeded eastward from Malinta Hill until they contacted the enemy and were taken to the senior Japanese officer on the spot. Neither nationality could speak the other's language but the difficulty was overcome when it was found that Lieutenant Manning and a Jap officer could manage a few words of French to each other. About an hour later the Marine officers returned with the word that General Wainwright should come out to the Japanese commander if he desired to discuss terms.

Accordingly General Wainwright, accompanied by General Moore and their respective aides, Lieutenant Colonel Johnnie Pugh and Major Tom Dooley, and Major Bob Brown, proceeded by car, under a white flag, to the foot of Kindley Field Water Tank Hill where they got out and walked up the hill to meet the Jap commander. Dead and dying were on every hand, the proportion being about three Japs to one American.

At the conference with the Japanese officials arrangements were made for General Wainwright to be taken to Bataan to meet General Homma, their supreme commander in the Philippines. After some delay this was accomplished by means of a Jap boat from North Point to Cabcaben, Major Dooley accompanying the General. Meanwhile General Moore and the others returned to our headquarters, traversing en route an area being swept by artillery fire from Bataan and strafing planes. The white flag flying meant nothing to our antagonists.

Around 4:00 P.M. the Japanese moved in and took charge and we were no longer free agents. That night they landed, unopposed of course, at Fort Hughes and took over, followed by similar operations the next afternoon at Forts Drum and Frank.

The final gallant defense of the Philippines had ended.

IN RETROSPECT

In retrospect, many ideas suggest themselves as to what might have been. One wonders if a closer knit defense might not have resulted had we had a real unification of the services in 1942. How much damage could the B-17s, lost at Clark Field on the opening day of the war, have done to the invading Japanese convoy? Had hostilities been deferred until the American convoys then en route reached the Philippines how much stronger would have been our defensive effort? Idle thoughts now.

The fact remains that the fortified islands of Manila Bay, and especially the island fortress of Corregidor, with an area of less than two square miles, withstood a siege by vastly superior forces on land, sea, and air, for five months. It is doubtful if any similar area had ever before been subjected to such heavy concentrations of artillery fire and aerial bombardment.

During these operations our antiaircraft had established new records in enemy planes shot down; our beach defense forces had inflicted unprecedented losses on the enemy before yielding; and our seacoast artillery had actually accomplished its assigned mission of denying Manila Bay to the enemy navy. In that connection it should be remembered that those few outmoded seacoast batteries which remained intact after the terrific bombardment and shelling to which they were subjected, actually forced the Japanese to defeat our field army and to stage a costly landing on Corregidor in order to capture these batteries and secure Manila Bay.

When informed of the surrender General MacArthur stated:

"Corregidor needs no comment from me. It has sounded its own story at the mouth of its guns. It has scrolled its own epitaph on enemy tablets. But through the bloody haze of its last reverberating shot, I shall always seem to see a vision of grim, gaunt, ghastly men, still unafraid."

Later, in a Japanese prison camp in Manchuria, a group of Dutch officers asked me to review the Corregidor campaign for them which I did on two successive evenings. At the conclusion the senior Dutch officer, Captain G. G. Bozuwa, Royal Netherlands Navy, thanked me kindly and closed with these words:

"Before the war, Corregidor was to us just a name on the map; during the war, it became to us a symbol of the matchless courage and fortitude of the American fighting forces; now, Corregidor has become for us a TRADITION!"

May the tradition of Corregidor live on in the hearts and minds of Americans everywhere!



Industry Underground?*

By Leonard J. Grassman

In considering going underground, it is easily recognizable that such a move is highly practicable in enhancing our national security in view of the modern type and future potential type of warfare. The underground evolution can and should be achieved gradually, and in its achievement might give the rest of the world evidence of our caution and potential strength.

Will international distrust—the nonacceptance of U.S. good intention and the threat to peace—force the United States to undertake a policy of perpetual preparedness necessitating costly protective measures for our industrial facilities? And, will war potential and war protection play an equal role with commercial practicality in industrial planning in the future?

These questions, stimulated by the slow progress at the peace tables of the world, have caused speculation on the utilization of underground sites in the United States for storage and factory facilities to reach a high point among people interested in the future invulnerability of our nation in the event of another war. This speculation, of course, is natural. Both the novelty and practicability of protected subterranean facilities grasp the attention of the curious and concerned.

The science of warfare has altered so rapidly in recent years, the military feasibility of underground utilization is still in the research stage. True, such utilization was proven practicable during the past war, but those instances were the result of emergency action rather than of long-range planned defense. Consequently, widespread utilization in the future must come as the result of careful study and planning and extensive preparation, which, naturally, takes time, and which, of course, makes the present too early to anticipate any lengthy official information on the subject.

The idea of subsurface facilities is not new. It was put into practice by many nations prior to and during the war, and proved practical to varying degrees, and, in some instances, highly impracticable. At the end of the war, the knowledge of these experiences was part of the vast knowledge gained by U.S. Armed Forces, and with the advent of peace, this data was being weighed and evaluated by those charged with the security of our nation.

Many months ago, the Corps of Engineers, in behalf of the Army-Navy Munitions Board, which is charged with planning U.S. Industrial Mobilization against any future emergency, undertook a preliminary survey on caves, mines, and quarries as underground sites. This survey, as indicated, was preliminary in nature—the type of survey usually indicative of nothing more than to show whether or not an extensive survey is justified.

The purpose of the survey was to determine the availability of underground sites for industrial facilities, if needed, and all possible relative data concerned in the great problem of subsurface utilization—structure, strength, accessibility, humidity, etc. All such information is essential before any planned pattern for underground utilization can even be considered.

Although the report of the survey is classified and has not been made public, it is understood that the survey covered some 1,000 representative types of underground sites, determining their possible utilization value for storage and other industrial facilities.

Research has made it evident that, contrary to popular misconception, natural caves do not make the best underground sites for these purposes. Natural twists and variations in levels make a great amount of reconstruction requisite. Another detrimental factor existent in caves is high humidity, which is harmful to stored materials and costly to control. And since many of the cave hollows have been cut by underground streams, or water seepage, conditions of high humidity usually exist and make the site unsuitable for further use.

The preliminary survey report provides a wealth of data, and a concrete picture of the value, locations, and accessibility of underground sites for potential utilization. It also furnishes data on the apparent and possible weaknesses of

*Reprinted courtesy of the *Armored Cavalry Journal*.

these sites. Other studies will be required to determine whether or not constructed subsurface facilities will provide better service and protection and prove less costly.

Quite apparent are some of the advantages manufactured sites have over natural sites. Mechanically constructed subsurface facilities can be built per specifications based on need in accordance with the latest military knowledge of the subject, where needed and with ideally chosen accessibility, and to the size desired, whereas natural sites would be limiting in most cases in each of these features except in highly coincidental cases. Constructed facilities may also prove to be less expensive than reconstructed natural facilities.

In considering *going underground*, it is easily recognizable that such a move is highly practicable in enhancing our national security in view of the modern type and future potential type of warfare. Now, more than ever before, and even more so in the future, as the Atomic Bomb and similarly devastating weapons indicate themselves as standard weapons in future warfare, utilization of below-surface protection is essential to the unhampered productivity of our industry, our populace, and material resources during any future hostilities. Effects of the strategic bombing in Europe and Japan during the past debacle proved that even in the use of the lesser weapons of the recent era, underground factories and facilities are an absolute necessity. The good condition of such facilities in Germany after bombing which obliterated whole cities indicates the greater impregnability of "down under. . ."

However, "going down" for the human race is much more problematical than for the Gopher. There are many difficulties involved, requiring a special research and development program. So different is such a project from anything we have had to date, a vast study, in addition to all which has been achieved heretofore, is requisite before a workable plan for underground protection can be perfected.

EVALUATING UNDERGROUND UTILIZATION

In an attempt to evaluate the necessity and value of underground utilization it is essential to start at the point whereupon this element of warfare first assumed an importance in the modern age. Militarily, the underground has been used for centuries and was proven practicable. Many of our modern fortresses and installations, primarily those of stable defense artillery, have subterranean spaces for storage, magazine, and shelter purposes, all of which are of proven value. Corregidor's great stand is a monument to the value in the era just past as were the Catacombs a monument to that value in Antiquity. Now, it becomes the task of the Army-Navy Munitions Board to acquire the knowledge to recommend the action which will achieve more than a monument of defense, but a monument of invulnerability.

In the Pacific phase of World War II, the Japs utilized the underground wherever possible, and, in those territories and islands long in their possession, went to great pains to provide such facilities. The accumulative defense tenacity of these measures added to the time extent of that phase of the war. Each cave so utilized by the Nips proved a veritable fortress and took all the power our forces could muster to obliterate it.

In Germany, underground sites were utilized extensively,

and there, too, proved valuable. At Neuhof, Germany, the salt mine was used by the German Army for their medical and chemical warfare supplies and quartermaster materials as long ago as 1936. The mine, 1,800 feet below the surface of the ground, had 64 miles of storage space. Hundreds of tons of supplies were stored there. Small trains with battery motor power were used with a great deal of efficiency for transportation through the tunnels, while two speedy elevators were used for communication with the surface.

Along with using these spaces for storage, the Nazis used some of the huge compartments to fill hand grenades and explosives.

At Geislingden, Germany, the enemy had achieved a huge factory cut into a hill which provided both natural camouflage and natural protection. Although it took only two tons of dynamite, carefully distributed throughout the entire plant by our victorious forces to destroy this factory, flotillas of B-29's could have unloaded carloads of blockbusters on top of it with little more effect than the concussion experienced by a battleship from its own guns.

With the termination of hostilities many of our officers returned to the United States highly impressed with the value of the underground for industrial facilities. However, until all possible information on the subject has been examined thoroughly, it is impracticable to determine what influence the experiences in Europe will have on our activities. After an extensive study and a careful evaluation of all possibilities, with complete data, and the proven military feasibility of subsurface utilization, it is presumed that plans will be developed further. At the moment underground investigations are confined to research projects and little more.

As earlier stated, the value of underground utilization was proven to some extent during the late war, and, rumor and fact indicate that other nations are a little faster and less cautious in seizing upon the idea as a defense measure. Great Britain, which had underground factories which withstood the pounding during the Battle of Britain, is said to be enlarging upon what it had previously. Another country, it is persistently rumored, has pressed prisoner-of-war labor into the construction of the largest underground airfield in the world—located in a highly dominating and commanding area, which has been semiglobal air-striking potential. Sweden, also, has many such facilities, some of which have been constructed since the war.

With such a background, subterranean facilities cease to be a matter of conjecture, but a concrete element in the science of modern warfare—an element worthy of careful study and evaluation. This evaluation will require, among many other things, an extensive study into the geophysical aspects, morale and psychological effects, effectivity of the below-surface sites against specific weapons, the efficient interweaving of sites into the national industrial pattern, costs, and the extent to which American industry might or should go underground.

Earlier information eliminates the utilization of natural caves for this purpose, outside of, perhaps, as storage facilities for rugged materials. Abandoned mines might prove to be of some value for storage only, because of structure and limited accessibility.

In order for an underground site to be efficient as well as protective as a factory facility, it must have normal and

expeditive accessibility for both personnel and materials. One of the great errors committed by the Germans was in commandeering underground mines with limited means of physical communication with the surface for below-surface factories. It has been reported that as much as half a shift was absorbed in some instances in the transportation of workers to and from the surface. With portal-to-portal pay a labor factor in the modern world, such a situation would mean: "Go down; go up; go bust!"

Similar and many other problems rule out the extensive use of abandoned coal mines as practical underground facilities, aside from limited storage and shelter purpose. Upon abandonment, most of the physical communication systems are removed along with much of the protective construction such as shoring and other similar construction. Subsequent deterioration and collapse offer extensive costly construction to achieve rather limited space, and a good argument for man-made below-surface areas.

ABANDONED QUARRIES LIMITED

It has been suggested abandoned quarries are highly adaptable for the purpose, but these, too, are limited because of their nature and relation to national economy. Quarries invariably never "run out," and are almost limitless in their productivity. The causes of their abandonment have generally been production costs because of having been cut to a depth that equipment to bring the product to the surface is more costly than profitable, depressions, which curtail building activity and consequently the demand for quarry material, and the war, which had a similar effect. Building booms and normal national material expansion would complicate underground planning to an embarrassing extent, and in the case of the former limitation—depth—it might prove equally limiting because of costly accessibility.

Relatively, there is little left for our industrial and defense planners to do but figure on constructed subterranean facilities.

For such construction, it becomes immediately apparent that softstone areas, primarily limestone, are most adequate and widespread in our country for the purpose of underground building. Limestone, according to the Department of Interior's Minerals Yearbook, "in the form of dimension stone, is used almost exclusively for building purposes. Under normal conditions limestone is the most widely used building stone. . . ."

Areas of this and similar stone are located in almost every part of the United States, offering part of the solution to the general problem—location. Materials on (or in) site are a valuable asset in such a selection.

In construction of a below-surface facility, it can be recognized that if such a facility must be constructed for protective reasons the problem of depth is of major importance. How deep must one go to be immune from modern or possible and probable future weapons? Apparently, from the type of weapons now used, the depth need not be great. Bombs do not have a great penetrating effect, and all known explosives have a tendency to blow up or about rather than down, and, it is doubtful, if a propelled missile, such as a rocket, could add much to the normal weight velocity of a standard artillery missile or bomb to achieve greater ground surface penetration.

In any event, available statistics on the earth surface penetration of existing weapons will provide the key to both the depth needed and an estimate of the penetrability of possible future weapons. However, ventilation systems now used could be vulnerable points in the impregnability of Mother Earth. Radioactivity might be able to transverse this system as could chemical weapons. However, proper plating could protect such a facility from radioactivity and sealing up ventilation systems and using emergency oxygen during attack periods, with the aid of proper decontamination systems could negate the effects of such attacks upon underground facilities. Better still would be a ventilation system, composite within the facility with a completely artificial air source and with a standby oxygen supply for emergencies caused by breakdown or power failure.

In the realm of morale, underground facilities offer a complex problem, not new, but a new version on an old mental quirk relative to the underground. Maintaining good morale among workers in underground developments should not be too difficult. There is little difference in working in a below-surface factory than in many of our modern plants which are completely sealed from natural atmosphere, depending completely upon artificial light, and mechanical ventilation. The problem, however, will be primarily in "conditioning" workers to overcome the "trapped" complex which invariably smites one in working in such a plant. Normally, the worker in such a plant becomes accustomed to the odd surroundings the underground facility offers, but "warmth" in the interior design of such a facility would aid the underground worker immeasurably in overcoming whatever qualms he might have upon entering such

A salt mine in Neuhof, Germany, was used as a storage bin by the German Army for their medical and chemical warfare supplies and quartermaster material, as long as 10 years ago, a further indication of the long-term planning of the Nazis for World War II.

Signal Corps Photo



an activity or which he might acquire after working here.

Psychologically, an underground worker will have to be made to feel the "strength" of his surroundings and all its accompanying assurances, and extensive health measures, similar to those used by the Navy for its submarine personnel, will have to be assumed to assure the worker that his health is not being impaired by his "gopher" activity.

Generally, during war, underground morale will be dependent upon the same assurances it took for workers under normal conditions during the past conflict.

Perhaps the biggest psychological threat in the idea of underground protection is not the fearful effect of such a situation on people but the overconfidence such protection might instil in our people. The Maginot Line, and its effect on the French populace is highly indicative of what extreme faith in a defense measure can accomplish. In a similar but smaller fashion, our nation suffered because of our confidence in the protection of a few thousand miles of ocean. Initially, with the inception of below-surface protection for our industry and people, should come an emphasis that such a measure, great as it might be, is but a small part of national defense. Our nation, like the ostrich, might well stick its head into a hole only to have its tail feathers—or something less superficial—shot off.

Interweaving underground facilities into the national industrial network could be more of an asset than a problem for it would be part of a planned industrial layout. Existing industrial facilities, for the most part, are ill-planned because of the nature of their inception into the national economy. Heretofore, an industry, at birth, depended on its accessibility to the raw material source, to markets, and, in some cases, on accessibility to labor sources and on economical locale. The type of product, the period, available transportation facilities, and many other factors determined the location of a factory, usually bunching them into compact zones, which now provide excellent target areas for potential enemies attacking.

UNDERGROUND SITES LOCATION

Location of underground sites should go hand-in-glove with decentralization of U.S. Industry, which must also be considered in defense planning. In planning a new facility, a corporation now might well consider the value of strategically locating such a facility away from a "vital" area and, while doing this, consider the feasibility of going underground.

It is doubtful that with modern mechanical methods the cost of constructing an underground plant would much exceed that of a surface plant. It may prove to be less costly, and certainly maintenance of such a facility would minimize some expenses.

Immediate apparent benefits of underground and/or decentralized industries and a classic and tragic example of the danger of a surface and centralized industry were illustrated in the recent Texas City, Texas, devastation. There one nitrate-laden vessel, a rough equivalent to a few blockbusters, started a rush of destruction which demolished a city and destroyed hundreds of millions of dollars of industry which would have been vital in a war emergency. Aside from the material destruction, there were many by-effects, terrifically costly in a war effort. The tie-up of emergency

apparatus and personnel, the necessity of the services of medical personnel, and the use of hospital space and housing for such victims would add greatly to the war burden. The whole tragedy caused by an explosive mild in contrast with what the future might offer, gives a vivid illustration of the drastic necessity of remodeling our industrial organization in conformity with the dangers offered in future emergency.

Like decentralization of industry, the suggestion that industry go underground is a vast assumption. Because of the magnitude of such a move, it cannot be suggested that American industry do either as an outright move; it must be an evolutionary program consisting of dispersed construction of new facilities, and later, as existing facilities deteriorate to a renewal point, replacement with a dispersed facility. More evolutionary will be dispersal of the human element in industry. As industry disperses, labor will follow it, when and if living facilities are provided, and decentralization of industry will become gradually achieved. Such a gradual development of a decentralized and protected industry would nullify the economical effects of such planning and construction. A deliberate move would bring hardship on people and havoc on national economy. Consequently, the over-all planning and construction would necessitate subtle reconstruction to eliminate the hardship quick and deliberate action would create. However, a dispersed and protected national industrial might be essential to our national security in the event universal peace is not achieved, and the problems involved should *now* be studied, and sensible planning underwritten by our people, industry and government.

"STRATEGICAL INDUSTRIAL SURVEY"

In such planning, it might be suggested that a *Strategical Industrial Survey*, similar to the strategic bombing surveys of the war, encompassing all the problems and threats, be started. Of course, such a survey would require a great length of time, but its value to our nation would be proven if ever we are engaged in a war in the future. It should be started soon, too, because a nation cannot go underground rapidly, even in time of emergency, and, if it is not underground at the outset of a future war, a wartime exodus into the bowels of the earth would have similar effect as the proverbial lock on the barn door—too late.

Such a survey would necessitate consideration of the most important element of industry—its personnel. Along with housing and community facilities, stores, *et al*, protection similar to the industrial plant would have to be provided underground. Shelter and hospital facilities would be top priority items, the latter being of extreme value in any event. One of the great problems for hospitals faced with air raids was the evacuation of patients. Underground hospitals would have no such problem with which to contend.

At this point, it might be well to recognize the fact that all industries will not lend themselves to underground placement. Shipyards, certain types of mills, and many other industries cannot be drastically converted from their present situations without curtailment of productivity. However, the mere fact that the greater proportion of our industrial strength would be protected by natural fortification, would permit a maximum of surface protection for

those facilities which would have to remain on top of the ground. Protection of similar nature to that provided by the underground, like that used in the German Sub Pens, could be constructed for partial protection. Addition of a thorough antiair or antimissile system about such facilities could provide an almost equivalent to underground protection.

Considering the idea of below-surface protection objectively, it might easily be assumed that the concept is strong only in the minds of those who were frightened too much in the recent war, and that the whole nonsensical business is much too vast and too costly even to be considered. Accumulative indifference to national welfare can well sustain such an assumption and the idea will remain just what it is—an idea. However, a casual scrutiny of the success of the lasting peace efforts and the question: "What are other nations doing along these lines?" along with evidences of what they are achieving will indicate that the matter cannot be dismissed that lightly.

History indicates that a strong, peaceable nation, secure in its defense, is one of the best safeguards of its own peace, and, possibly of the peace of the world. Relatively, if the United States is to be a strong, peaceable nation, it must remain ever strong; ever well defended.

This fact, in conjunction with the type of warfare which may be experienced in the future should peace efforts prove fruitless, plainly indicates it will be a happy day when the vitals of the United States can be shielded within the strong

protective armor of mountains, hills and rock formations.

Dropping U.S. industry into a protective hole in the ground and the accompanying moves will prove terrifically costly and inconvenient. There is no doubt about this, but, as proven by our past wars, precautions of this nature ignored in the past because of cost, have the remarkable faculty of proving themselves absolutely necessary in times of emergency, costing many times the peacetime estimates in money, and much more in blood.

The underground evolution can and should be achieved gradually and in its achievement might give the rest of the world evidence of our caution and potential strength. It need not disrupt our way of life drastically, and may eventually, save that very way of life.

Should that horrific day come as some of our advanced *push-button* theorists predict, an underground industry would transform our country into a huge weapon—THE U.S.A. SUBTERRAIN—not dissimilar to the standard American Sub. Like the submarine, America would lie beneath not a blanket of water but of rock and soil, permitting the enemy to expend its power on U.S. topography, and then torpedo our might against an aggressor.

However, no matter what anyone says, if those men at the peace conference and the peoples backing them fail to create a lasting peace, and nations persist in warfare, the elevator boys of Fate and Intelligence, will open their doors to our nation, cryptically muttering: "GOING DOWN?"



Corps of Engineers Expands Plans for "Protective Construction"

The Corps of Engineers, U. S. Army, has contracted with Guy B. Panero, internationally known engineering firm of New York, "to investigate the feasibility and cost of constructing and operating underground plants and storage sites."

Mr. Panero and his staff have had previous experience with the subject, having prepared a complete report for the Government on underground construction for German industry. The report was based on an on-site investigation made for the Army immediately after the cessation of hostilities.

According to Lieutenant General R. A. Wheeler, Chief of Engineers, these are two additional steps in the "protective construction" program being conducted by the Corps of Engineers to develop information for potential protection of essential war plants against aerial raids such as wrecked enemy industry in the last war. The over-all program will entail investigations in both this country and Europe, and will include cost, as well as technical data on existing foreign underground installations, insofar as is practicable.

Two types of underground plant sites will be considered in this country during the investigation. The first are the existing mines, such as gypsum, copper, lead, zinc, limestone, marble, salt, sandstone and, to a lesser degree, other type mines scattered over half the 48 states.

Available mine sites are already known, having been the subject of a previous survey made by the Corps of Engineers from data compiled to a considerable extent from available records. (See preceding article.)

The current investigation will determine the feasibility and cost of constructing and operating plants and storage depots in this type of underground site. To be considered, a mine has to have in excess of 30,000 square feet of usable floor space, a roof height of not less than eight feet, and a reasonably level floor.

Natural caves are not being considered at this time as they are, in general, relatively small, irregular in character, and at a considerable distance from suitable transportation. Because a majority were formed through erosion by water and have high humidity, they are difficult to modify for plant use.

The second type of site to be considered under the current investigation is the underground chamber purposely excavated to suit the requirements of the plant or storage facilities involved. This type of site calls for an investigation of geological formations best adapted to this purpose.

The current over-all program entails the potential future use of any new construction and construction methods that may be developed by the Corps of Engineers. It also entails an above-ground and underground comparison of the cost, construction and operation of a chemical processing plant, involving large tanks and appurtenances, the generation of large amounts of heat and noxious gases.

The same line of investigation will be followed in regard to precision manufacturing plants.

The studies are part of a long-range program and are being developed under the policy direction of the *Army-Navy Munitions Board*.

BUZZ-BOMB ASSAULTS ON LONDON*

By Colonel Joseph Rogers Darnall, M.C.

For more than a year before the pilotless flying bombs attacked London, I had the experience of witnessing many piloted air raids on southern England. And for several months after bloody dawn of the flying bomb era, it was a dubious privilege to share occupancy of the target—London—which newspapers and radio referred to so evasively as “Southern England.”

Heavy censorship was clamped on stories of what transpired in London from June 15, 1944 to September 1, 1944. Only those who were there can have any true concept of the situation in London at that time. Now that censorship is lifted, a brief account of those days may be of interest.

The flying bombs, dubbed buzz-bombs, doodle-bugs, or V-1, killed and injured thousands of people and caused tremendous destruction of property. Millions of occupants of this sprawling target city were under almost continuous bombardment for more than two months. They were subjected to a prolonged, cumulative nervous strain quite different from the concentrated excitement and acute apprehension induced by the furious but short-lived piloted bomber raids.

Typical of the “old-fashioned” fire raids by piloted aircraft was one which occurred on the night of March 14, 1944. It was reported that 175 planes participated and dropped 200 tons of incendiary bombs. The raid began at 10:30 P.M. and continued for more than an hour. Many conflagrations were kindled throughout London and kept the firefighters busy all night. A number of incendiary bombs fell in the vicinity of my hotel and some landed on the roof but were extinguished by fire watchers before serious damage was done.

Air raids featuring incendiaries, high explosive demolition bombs, or both were almost nightly occurrences, but seldom was there a *daylight* raid. Thus, one could work in London during the day without interruption, and generally look forward to a stimulating air battle over the sombre blacked-out city during the night. The flaming bursts of antiaircraft shells, tracer-like flight of rocket shells, and red parachute flares enlivened a sky already streaked with searchlight beams. It was a far more exciting show than could be seen at any cinema and cheaper, too, for most spectators.

I remember, because of the suspense, a raid which ushered in the 22nd of March, 1944. The sirens wailed an undulating warning soon after midnight, and almost immediately, gunfire from the batteries across the street in Hyde Park rattled my window in the Cumberland Hotel. The first wave of German planes dropped several huge clusters of target-marking parachute red flares. One of these clusters, in which I counted twenty red light flares, hovered in the sky directly over the Cumberland.

A wave of bombers was expected at any moment to drop their deadly freight on the red flares. Therein lay the suspense. The street beneath my window and the Mount Royal Hotel across the street had assumed a reddish hue, while the clouded sky above was bathed in a deep red glow. The bombers were unusually slow in arriving over the targets that night and the Cumberland was spared as the flares drifted over Hyde Park. The Knightsbridge section, across the park, received the impact of bombs from that first wave.

Searchlights, meanwhile, poked around at the cloud ceiling but found few holes. In a few minutes, tons of high explosive and incendiary bombs rained on London so that the sky soon was alight with the fires of burning buildings.

Two of the bombs, that night, dropped on the Paddington Railway Station in London. One was a 2400-pounder which fortunately was a dud. The other, a 500-pounder, exploded between Tracks 2 and 5, while the Cheltenham Sleeper on Track 2 was waiting to depart. The blast knocked two cars off the track and jarred the equanimity of at least two medical consultants who were aboard,—Colonels Rex Dively and Lloyd Thompson. Eight of the German planes were shot down.

Two nights later, I expected to take the midnight (12:55 A.M.) sleeper for Cheltenham, but again the Luftwaffe interfered with my plans. Beginning at 11:15 P.M., more than a hundred bombers came over, in numerous waves, and dropped many tons of high explosives and incendiaries which started multiple fires throughout the city.

At the beginning of the raid, I met Colonel Jim Mason, of General Hawley's staff, in the crowded lobby of the Cumberland Hotel. He had just returned from a flying trip to the States and was accompanied by another officer who had never witnessed an air raid. The three of us watched the show from the Oxford Street and Cumberland Street corner of the hotel, standing on the sidewalk, close to the building for the protection it afforded. There we had an unobstructed view of the very lively show.

The rocket guns in Hyde Park were truly spectacular as they belched forth red-flaming projectiles, at terrific velocity, over the Cumberland Hotel, while antiaircraft batteries pounded away and flak rained down on the street. The low trajectory of the rockets carried them very close to the roof of the hotel. Searchlights roved the sky while flak burst pink and red in the fiery heavens, where target-marking flares hovered over danger points.

We could hear bombs exploding and see some of the fires started by incendiaries, but no high explosive missiles fell near us. The fire bombs that dropped on the Cumberland roof were extinguished promptly.

Most of the hotel residents had come down to the lobby or to the lounge below street level, others jammed the deep shelters. It was 1:00 A.M. before the “all clear” sounded

*Reprinted, courtesy of “The Military Surgeon.”

When daylight came, London was covered by a pall of smoke from the many fires kindled by the bombs. As the sun rose above the roof tops, it resembled a large, lusterless, burnt orange through the smoke haze. Before noon, all fires were under control, most of the smoke had cleared, and the general atmosphere was "business as usual."

Patients and duty personnel at the 121st Station Hospital near Braintree, England, were spared, miraculously, in April 1944, when a 2400-pound demolition bomb and several phosphorus bombs were dropped on the hospital during a night raid.

The 121st was occupying an 834-bed Nissen hutted type of hospital plant, but many of the wards were empty. Two hundred eighty-two beds were put out of commission by the blast. The large bomb struck the soft earth near a concrete walk. Big chunks of concrete were lobbed more than a hundred yards to crash through the roof of the surgical operating theater and the boiler house.

Nine Nissen hut ward buildings, each accommodating thirty beds, were destroyed completely and six others were damaged. The entire roof was ripped off the completely enclosed corridor that connected a block of six surgical wards. The blast shattered windows in the Manor House a half mile away. Only twenty-five of the patients and staff were injured. The most serious was one who, in the excitement, jumped out of bed so fast that he fell and broke a leg. The curved Nissen hut type of construction cushioned the destructive effect of the blast and prevented serious injury to patients.

During my visit to investigate the damage, we stood on the rim of the bomb crater, which was 35 feet in diameter and ten feet deep, and pondered on the trick of fate which had resulted in so much property destruction without loss of a single life!

It was not until after the invasion of Normandy in June 1944, that the Luftwaffe became practically extinct in the English sky—superseded by the V-1 flying bomb. Late in the night of June 15th, and until the small hours of the 16th, there was unusual activity over London. I had worked until 11 P.M., and was in bed, asleep, when the wailing sirens aroused me at 11:40 P.M. It appeared as though the Luftwaffe was sending over raiders in successive waves. Antiaircraft and rocket guns kept pounding at them incessantly. Some of the raiders seemed to fly very low, barely skimming rooftops.

I pulled back the heavy blackout curtains and watched the show from the open window of my darkened room. The cloud ceiling was high but there was a drizzly rain. Several objects, which appeared to be small planes with tails afire, flew at low altitude and were picked up by converging searchlight beams below the clouds. There was intense anti-aircraft fire. Flaming bursts of flak punctured the sky but the guns were unable to get the range although the "planes" flew straight with no attempt at dodging. Perhaps the range was bad because they flew so low. One of them, flying at terrific speed, roared over the roof of the Mount Royal Hotel across the street.

As I watched, the rocket guns, nearby in Hyde Park, went off in salvos with their terrifying noise, and rockets streaked the sky like red comets. A few seconds later, the raiding "plane" exploded in a great glow of pink light, a

half mile or more away. The flak batteries and rocket guns kept up their firing, at intervals, all night. The "raiders" kept coming, even after dawn and they were met by incessant gunfire until about noon. The sky overhead was filled with black puffs from ack-ack bursts most of the morning.

At our London Headquarters, we received word from G-2 that the "raiders" were rocket-propelled, pilotless robot planes or "flying bombs," each carrying an explosive charge equal to a four thousand-pound bomb. This was the new, long-awaited German secret weapon!

Knowledge that we were at the receiving end of "flying bomb" attacks was, of course, electrifying. But there was no panic or confusion. Business went on as usual and life seemed less dull to the sturdy Londoners who had adjusted themselves so well to ordinary night bombing raids. This diabolical new weapon was something extraordinary. It furnished material for speculation; and fired the imagination so that wild rumors of impending doom were commonplace. Early rumors that the flying bombs were radio-controlled proved false when remnants of the exploded self-propelled missiles were gathered together and studied. Complete knowledge of their mechanical structure was made available later when one of them landed in a park without exploding.

It was reported that at least seven flying bombs were shot down that first night over London. When hit, they exploded in midair with great bursts of pinkish flame. Those that landed, however, packed a terrific punch because of their tremendous blast effect. If a building was struck it was demolished, and glass from other buildings within a two block radius would be blown into the streets. These window glass fragments were hurled at high velocity by the blast, like fragments from an exploding shell. This blast effect was a most serious menace to all who were within several blocks of explosions.

Information spread at once that the flying bombs were launched from gigantic ramps, several hundred yards long, located in hidden sites far back from the coasts of France and Holland. Military Intelligence had known of the existence of those ramps for many months, and our Air Forces had been giving them repeated poundings for six months. The nature of the missiles to be launched from those mysterious ramps, however, was not known until June 15, 1944, when the first ones landed in London. It had been suspected that the ramps were designed for the launching of rocket bombs rather than jet-propelled flying bombs.

Sirens wailed again the following night while searchlights combed the sky. Ack-ack batteries barked throughout the city, and rocket projectors hurled their missiles like red comets over the chimney pots of London in a noisy, spectacular attempt to blast the flying bombs in midair. Our fighter planes were up, also, to get a closer view of the new weapons and to shoot down enemy observers and bombers which participated in the mixed raids. That night, I saw two of the flying bombs burst in the air, presumably struck by flak. The windows of the Cumberland rattled with the blast and the flak fell like metallic hail in the street under my window.

The firing kept up all night and it was impossible to sleep except in "cat naps." The hotel lobby was filled with people all night and on each floor residents gathered in the corri-

dors to escape flying glass in case a bomb struck near the Cumberland. Those people had good sense but they missed a wonderful display of pyrotechnics.

My room, overlooking Quebec Street, faced east, so I could look up and down Quebec Street, which ran north and south. Oxford Street ran east and west along the southern front of the hotel. The pilotless flying bombs all came from the southeast, while the piloted enemy planes usually came from the south or east.

Saturday morning, June 17th, my English secretary reported that an eight-inch jagged chunk of flak fell on her windowsill and bounced into her bedroom during the night battle over London. She lived about a quarter of a mile from the Cumberland with another girl employee who brought the exhibit to the office. It was identified as a flying bomb fragment and, since none had landed nearby, it must have been from one of the buzz bombs that exploded in flight, as result of anti-aircraft fire.

All was quiet that morning but shortly after noon, the sirens sounded again, followed by gunfire. From our office windows, we could see a great column of smoke mushroom into the sky, and hear the heavy detonation as a flying bomb completed its dive into a congested section of the city.

From 4 P.M. until 10 P.M., there were six alerts, each followed by gunfire, as flying bombs came over at intervals and dropped on London. People carried on as usual and many were amused at the exaggerated reports, broadcast over the German radio, announcing that the utter destruction of London was in progress. They broadcast that the city was in flames, all stores and restaurants were closed, business was at a standstill and the inhabitants all were cowering in air raid shelters and the Underground. This, of course, was a grossly exaggerated report.

That night, I went across the street to the Regal Cinema to relax. They were showing the first pictures of the Normandy invasion and a Donald Duck cartoon. Two alerts followed by heavy gunfire sounded while I was in the cinema, but the show went on and no one left the theater. The nearby guns in Hyde Park shook the building and made it difficult to hear what the characters were saying, especially Donald Duck.

The flying bombs kept coming over, intermittently, and it seemed as though the air raid sirens must soon wear out. The weird, undulating wail of an alert would be followed soon by the prolonged wail of an all-clear. The cycle repeated itself, endlessly, all day and night, so that people lost track of whether the current status was one of alert or all-clear. It became so confusing that we were obliged to assume a condition of perpetual alert. Meanwhile the city's defense was expending a tremendous amount of ack-ack and rocket gun ammunition. Also, at night, it got to be a real nuisance which interfered with restful slumber.

At 5:30 A.M., Sunday, June 18th, I lay awake listening to the racket. Between bursts of gunfire, I could hear the buzz of a flying bomb—louder and louder! A few moments later, the buzz developed into a crescendo roar like that made by a fast express train when it rushes by, as you stand close on the vibrating station platform. Automatically, I rolled out of bed, expecting a direct hit, as the iron monster

Tyburn Convent, less than two blocks away on Bayswater Road. The explosion burst the building asunder and blew out windows for blocks around. The Tyburn Convent was situated between rows of apartment houses, facing Hyde Park.

My window was not broken when I pulled the blackout curtain aside and looked out. Quebec Street, however, was covered with glass and broken windows could be seen in the Mount Royal Hotel across the street. Jumping into my uniform in record time, I raced out of the Cumberland and hurried to the scene of the tragedy. Glass littered the street and sparkled like diamonds in the early morning light. For more than a block, I had to wade through broken glass which in places had drifted to a depth of nearly a foot.

All windows and doors were gone from the Regal Cinema Building where I had enjoyed the antics of Donald Duck the previous evening. In fact, all buildings between my hotel and the convent were devoid of glass. The sturdy Cumberland, protected from direct effect of blast by a large office building across the street, on Cumberland Place, had few windows broken, while the Mount Royal Hotel, a block farther away suffered more glass breakage. The damage to both was trivial as compared with other equidistant buildings on Oxford Street and Park Lane.

It was not yet six o'clock, Sunday morning, so only a small crowd of scantily clad neighborhood people had gathered to view the "incident." Fire fighters and rescue squads were already on the job. Injured victims were being hauled away in ambulances. Several dead had been removed from the debris. The convent had been used as a day school and only a few Nuns resided there. Blast and glass victims were removed from the badly damaged adjacent apartment buildings. I examined and helped carry out a blinded young mother, cut by flying glass, who kept crying for her baby. A rescue squad nurse hovered close by with the tiny infant which a fireguard had found safe in its crib. Both mother and child were taken to a hospital in one of our Army ambulances.

Fragments of the flying bomb were recovered and thrown on a pile to be carted away for study. There was one large piece of jagged, twisted metal four or five feet long and dozens of smaller pieces. The thickness of the salvaged metal varied from about one eighth to one quarter of an inch.

The explosive charge in these new one-ton flying bombs was said to be about fifty per cent more powerful than T.N.T. Certainly the blast effect was terrific. In Hyde Park, across the street from the demolished convent, the blast had torn all leaves off trees within a radius of a hundred yards and many large branches of nearby trees had been ripped off.

After breakfast at the Grosvenor Mess, I walked back for a more leisurely survey of the damage on Bayswater Road. A large crowd had gathered by that time. While standing across the street near a brick bomb shelter in Hyde Park we heard the ominous buzz of an approaching flying bomb.

The buzz grew louder and louder and seemed to be coming directly toward us from the south, although we could see nothing because of the intervening trees. Suddenly the buzzing stopped. This indicated that it was beginning to dive. We knew that only five or ten seconds would

elapse before it would strike and explode, perhaps very close to where we stood.

Spectators began to "hit the dirt," to escape the blast effect of the expected explosion. I dived for a spot close to the wall of the brick shelter. An R.A.F. Squadron Leader, standing nearby, had the same idea. Our heads collided as we hit the topsoil and we nearly knocked each other out. We held our breath, waiting for the explosion. It came in a few seconds but the impact was nearly a mile away.

The Squadron Leader and I jumped to our feet, apologized sheepishly, and shook hands. By the time we had brushed the dust off our uniforms, a great column of smoke had formed in the sky to mark the spot where the flying bomb had exploded. These things had been coming over, now, for three days and nights, and had been called various names. German broadcasts referred to them as "Hellhounds" but American G.I.'s were beginning to call them "buzz bombs." The Air Force dubbed them "doodle-bugs," an appellation which ridiculously disparaged their fearful, death-dealing destructive power.

Work in the office that Sunday morning was interrupted briefly from time to time by buzz bombs which passed over us. The office windows were vantage points from which we could observe their approach and progress. Two of them passed so close that we could distinguish clearly their structural contours as they roared by, while ack-ack batteries tried unsuccessfully to explode them in the air before they dived earthward.

A British anti-aircraft gunner inadvertently shelled the Cumberland Hotel that Sunday morning. A shell supposedly fused to explode near its target in the air failed to do so. It continued through the air until velocity was expended and, in its downward flight, struck against the wall of one of the inner court light wells, close to the roof. The impact exploded the shell and fragments splattered into windows of the 7th and 8th floor rooms.

An officer of the Adjutant General's Department had just arrived from the States and was in his room on the eighth floor of the Cumberland when the shell exploded. One of the fragments tore into his belly, inflicting a wound that would have proved fatal had he not been rushed to the 16th Station Hospital near Vincent's Square for prompt and skillful surgery.

Reports of considerable buzz bomb damage came in during the day. One exploded not far away in St. James Street. Another crashed near Waterloo Station and not far from the 16th Station Hospital. Still another was reported to have demolished the middle span of one of the bridges across the Thames. Altogether more than sixty of the one ton flying bombs had exploded in London within the past twenty-four hours. The greatest loss of life occurred when one of them struck the Grenadier Guards Chapel at Wellington Barracks in the heart of London. The bomb demolished the building during the Sunday morning services and killed more than two hundred worshippers.

That evening the crowds were out in Hyde Park as usual, and the throngs clustered around the Sunday evening soap box orators were as large as ever, regardless of a constant "alert." But everyone kept an anxious eye on the southeastern sky, on the lookout for more of Hitler's new robot weap-

At about 9 P.M., I had an excellent close view of one of the bombs in horizontal flight. From my window in the Cumberland, I watched one fly directly overhead, only a few hundred feet above the roofs. Flames from its jet-propulsion mechanism, at the rear end, streaked behind and it made a noise like a fast moving motorcycle, only louder. The bomb passed well beyond the Cumberland before its buzzing ceased and the robot monster tilted into a dive. About eight seconds later, the explosion was heard as it ripped into some buildings a mile or so away. Curiously enough, the detonation of the flying bombs was not nearly as loud as ordinary demolition bombs of similar weight, but the blast effect was very much greater.

These vicious attempts to destroy London were the enemy's desperate counterattacks to neutralize our invasion of the Continent. If they proved sufficiently damaging to morale, or annihilated strategic military nerve centers, our success in Normandy would be jeopardized. It was no wonder, then, that those of us who served in London during those days took pride in our jobs, even though we did not share the perils and glory of the initial assaults on the Normandy beachheads. Many an officer from Normandy, on temporary duty in London, voiced the desire to get back to the beachhead, where there were no buzz bombs.

During the first week of the flying bomb attacks, more than eight hundred were launched across the Channel, but many were shot down by daring fighter pilots, before reaching their destination. Only three hundred exploded in London, an average of forty-three a day.

So many people were being injured by flak, or their normal activities halted by taking shelter from flak, that the defense tactics were altered about June 20th. The new policy was to "let the bombs fall where they may, or fly over if they will" without trying to explode them in the air above the city. Meanwhile, efforts were intensified to shoot down the bombs before they reached London.

With the flying bomb assaults against London, there came a cessation of Luftwaffe activity. It was evident that the enemy considered the buzz bomb more effective than his piloted bomber raids. The Luftwaffe, despite its initial head start and early numerical superiority, had become a defeated air force, lacking the necessary offensive punch. Germany was conserving her pilots and bombers while building up a force of defensive fighter planes. Considering her predicament, and faced with overwhelming Allied air power, Germany's ruthless decision to rely on robot bombs was understandable, even though inhuman. Hitler's disregard for civilian lives was revealed clearly by his large scale utilization of a weapon that could not differentiate military objectives and obviously was indiscriminate in its slaughter.

After a lull of more than six hours, the buzz bombs began dropping on London again at 12:20 A.M., June 21st. They came over, one or two at a time, at intervals calculated to establish a continuous alert and create exhaustion from loss of sleep, apprehension, and interruption of necessary activities. In the dark hours before dawn, I watched a number of the bombs explode in various parts of the city. Each explosion was accompanied by a great burst of red flame which lit up the sky with a transient rosy glow. One landed in Green Park on Piccadilly Street and knocked all

windows out of the Park Lane Hotel, Buckingham Palace, also, was shaken by a near miss.

It was the same story next night. Between "cat naps," I heard more than forty explosions, but I was too tired to get up and watch. When morning came, I drove to Langdon, near Tunbridge Wells in Kent, to inspect the 6th Field Hospital, about forty miles southeast of London. The road followed "buzz bomb alley," the skyway through which the "doodle-bugs" roared on their way from across the English Channel to London.

About eighteen miles from London, we passed under a sky barrier composed of hundreds of captive balloons recently raised to obstruct the passage of flying bombs. The balloons and their cables formed a great network designed to entangle and explode the flying missiles en route to London. As we drove down the road, bombs sailed over our heads without striking any of the balloons or cables.

June 23rd was my birthday and I awakened at 2 A.M. to the tune of wailing alert sirens. During the next four hours, fiery-tailed buzz bombs streaked through the dark sky over London and I counted twenty-three explosions, some of them pretty close. Two of the infernal machines roared over the hotel at low altitude, sounding like a fast freight on a trestle.

Before dawn, I visited two of the bombed areas and helped a little with the rescue work. It was a gruesome sight and depressing to see the numbers of dead and maimed that were dug from under the rubble of wrecked buildings.

Russell Square was especially hard hit. Windows were blasted to bits within a radius of several blocks. Captain Ryan, one of my assistants, had just moved out of a billet on Russell Square the previous afternoon. If he had been there that night, his next of kin would have received a posthumous Purple Heart.

About 9:30 A.M., a flying bomb landed on a crowded double-deck bus near Waterloo Station. The bus and passengers were blown to bits.

It was amazing to see how many people flocked to the rooftops instead of the underground shelters during the buzz-bomb era, after ack-ack defense was no longer employed. When the antiaircraft batteries in London gave "silent treatment" to bombs flying above the city, there was no longer danger of watchers being injured by falling flak. One had to fear only a direct hit, or an explosion near enough to produce blast effect. So one was reasonably safe unless the bombs fell closer than several blocks away. The blast effect alone might kill anyone within a hundred yards and flying glass might injure individuals a quarter of a mile away. Within a hundred yards radius fragments of glass were hurled with bullet-like velocity and freakish perforations of heavy timbers and trees by pieces of glass were reported.

I tried to get some sleep in my comfortable Cumberland Hotel "foxhole," while flying bombs exploded throughout the night. One struck a few blocks away in Regent's Park. Another blasted Victoria Station. They stopped coming over at dawn, June 24th, and strangely enough, none came over during daylight hours that day. Perhaps the Germans were replenishing depleted stocks at the launching sites in the Pas-de-Calais.

When activity was renewed, about 11:40 P.M., I heard

one of the bombs buzzing, louder and louder, so I pulled back the blackout curtains and looked out.

The big bomb, with wings spread like an airplane, sailed over the London chimney pots in an eerie pink halo while red flames spouted from its jet propulsion cylinder. Belching fire, it cleared the rooftops of Park Lane just as the jet propulsion stopped and the buzzing ceased. Immediately the flying bomb dipped downward at an angle of forty-five degrees and headed earthward in a falling arc. A few seconds later it landed in Hyde Park and exploded.

During most of those exciting nights, I remained in my room and tried to sleep, but the temptation to get up and watch the show from my window often was overpowering. Whenever I left my room and peeped into the corridor, I found the hallway occupied by chattering residents who were spending the night there to escape the danger of blast and glass.

One officer told me he always dressed and went downstairs when the raids became intensified at night. The ground floor and basement lounges were always full of guests who sought safety there. Many went down right after supper, to find a comfortable chair or sofa. Those who came later slept on the floor.

The Underground (Subway) was packed with people those nights. Families slept there in the dust, drafts, and under the glare of electric lights. Time and again, when I traveled at night on the Underground, I saw children sleeping on the platform only a few feet from the tracks. Many of those families had been bombed out and had no other place to sleep.

By June 28th, the flying bombs had been raining on London for two weeks. Most of them came over during the night or in cloudy weather. They showed preference for weather which would have balked piloted planes. In a drizzly rain, half a dozen inebriated soldiers stood at the entrance to a bar on Quebec Street beneath my window that night and watched the flying "balls of fire" come over. They sang, boisterously, "She'll be coming round the mountain, when she comes!"

On June 30, accompanied by Lt. Col. I. A. Marshall and Lt. Bob Stuart, I drove to the 15th Hospital Center, Cirencester. We passed Coburg Court Hotel on Bayswater Road, where I had once been billeted. My old room overlooking Hyde Park had been blown to bits by a flying bomb, and the entire front of the hotel was a mass of rubble.

Our staff car dropped me off at the Cumberland, hot and tired, after a heavy day, and then took Colonel Marshall to his billet at the Regent Palace Hotel. When he arrived, he found that only a few hours before a flying bomb had blasted this hotel and his billet had become uninhabitable. Six of my officer assistants were billeted there but, fortunately, they were all at work at Medical Headquarters so none was hurt.

The two top floors of this modern nine-story hotel were partially demolished and some of the employees were killed. Most of the rooms were vacant during the daytime, so there was not heavy loss of life. The blast swept through the corridors and rooms of the undestroyed portion of the building, smashing windows and doors. In Marshall's room, the door was blown off its hinges, while windows and mirrors were smashed to bits. Many glass splinters were driven deep

into, or through, woodwork such as dressers and bed-ends.

While Major Dear was busy with rescue work at his hotel, another buzz bomb struck in Aldwich, near the Strand, a half mile away. So he hurried over there, where more than a hundred and twenty-five corpses were found. Some had arms and legs torn off and were otherwise mutilated by the blast hurling them against solid structures. Major Dear described it as a rather gory mess. A building had collapsed on some of the victims and had broken water, gas, and sewer lines. He had to crawl in under debris and help get people out before they drowned.

The bombs kept coming over that night and one fell in the Serpentine Lake in Hyde Park, but failed to explode. It was rumored that this "dud" furnished valuable information concerning the structure and mechanism of the flying bomb.

It was reported that more than five hundred flying bombs had been shot down by fighter planes or by antiaircraft batteries during the first two weeks. Bold and skillful pilots in fast pursuit ships had learned to lie in wait along the Channel and overtake the bombs, which flew at a speed of about 350 miles an hour. Some pilots dared to nudge the bombs with their wing tips and divert them to fall in areas where no serious damage was likely to occur. Others became expert in exploding the bombs with machine-gun fire in midair over the Channel, or in rural areas.

Sometimes a large number of flying bombs would be launched almost simultaneously and arrive over London in rapid succession. On the night of July 1, I counted ten explosions in less than 10 minutes. Colonel Marshall was walking down Piccadilly that evening when one flew parallel above the crowded street and caused great excitement when it dived. Nearly everyone on that street took shelter in buildings or lay flat on the pavement. The bomb barely missed the tall Nelson Monument at Trafalgar Square, and burst against some buildings beyond.

On a flying trip to Scotland, July 2, I talked with a number of pilots and passengers at Prestwick, who had just arrived from the States. They reported that the buzz bomb was a tabu subject in America. Press and radio censorship was so tight that people in the United States knew nothing of the continuous bombardment which London had been subjected to during the past eighteen days.

Upon our return to London, July 3, we learned that about fifty American Military Police had been killed that morning when a buzz bomb dropped in their midst while they were in formation and getting into trucks for distribution to their various posts of duty.

An incident is mentioned to illustrate the importance of lying flat when a bomb explodes. Three soldiers, walking along a street in London, saw a buzz bomb descending upon them. They seemed to be directly in its path and feared a direct hit. Two of the men fell flat on the street while the third tried to run out of its path. The bomb exploded fifty yards away from the two men who lay flat and they were unhurt. The third soldier, seventy yards away from the explosion, and running when the bomb struck, was decapitated by the blast and flying glass.

The Fourth of July was just another busy day at General Hawley's headquarters. Flying bombs continued to drop on London and one of them demolished the Cumber-

land Hotel laundry, located at some distance from the hotel. I was lucky enough to receive clean laundry (a two weeks accumulation) just before the building was "blitzed." Many of my fellow officers, however, lost their shirts and drawers in that catastrophe.

The myth that lightning never strikes twice in the same place does not apply to flying bombs. A major who worked in Headquarters felt badly after eating lunch on July 5, so he went to his billet on Cromwell Road, to lie down and rest. He was on his bed when a buzz bomb struck the adjacent building and also wrecked his billet. Later in the afternoon, while he was gathering up his scattered belongings, another flying bomb struck at approximately the same spot. The major was buried beneath the debris, with lacerations of his head and hand. After his injuries were treated he moved into the Cumberland that night. Soon after his arrival, several bombs came over the Cumberland, very close. We hoped he would not prove to be a jinx.

On July 6, Churchill announced that at least 2,754 flying bombs had been launched against London in less than three weeks. Many were shot down before reaching their destination. He revealed that the buzz bombs had killed 2,752 persons and seriously injured more than 8,000, while many thousands had been slightly injured. What the future held, he would not predict. Meanwhile, London must take it on the chin, and many more would die before the invaders of Normandy could capture the launching ramps in the Pas-de-Calais.

Two street musicians put on a serenade under my window on Quebec Street that evening. One was an old man with a violin. The other was a younger man with a guitar and a good voice. They played and sang opera music and popular airs. A flying bomb came over while they were playing, but they paid no attention to it, even when it exploded near enough to shake the buildings. People leaned curiously out of windows and watched the course of the flying bomb, while the unperturbed musicians played and sang *Red Sails in the Sunset*.

On July 7, another 15,000 children were evacuated out of London. It was expected that departures from the city would continue at that rate for many days. This was in accordance with a program, sponsored by the Government, to send children to rural areas remote from the flying bomb menace. Churchill's speech, the day before, held ominous implications that the perilous situation in London would doubtless become much worse before it became better.

The Prime Minister's pessimism was vindicated by the noisy night that followed. I did not sleep much, but watched a number of the buzz bombs come over and explode. The vibrations of nearby explosions again set off the burglar alarm system in the stores on Oxford Street, opposite the Cumberland. There was a giant alarm bell concealed on the outside wall of one of those large buildings. It was intended to attract police when windows were tampered with. The designers of this alarm system had not anticipated the vibratory effect of nearby bomb explosions on its delicate mechanism.

The huge bell clanged all night and drowned out the buzz of approaching bombs until they were very close. This unpleasant bell ringing had occurred on half a dozen previous nights when bombs had struck near enough to vibrate

the buildings. Sleep was out of the question during this protracted racket. Despite the annoyance, it was nevertheless interesting to watch the flaming buzz bombs rush through the sky, often caught in a cone of searchlight beams that kept pace with their 350-mile-an-hour speed.

The Germans had contrived devices to deflect the altitude or direction of the bombs when the jet propulsion stopped or shortly before the buzzing ceased. Therefore, it became impossible to predict what course a bomb would take when the buzz stopped, or even before it stopped. This first became evident to me on July 7, when one came buzzing in from the southeast and made a wide arc around the Cumberland. It was heading south when it fell and exploded.

Reciting of incidents occurring during the buzz bomb assaults could go on indefinitely and become very monotonous, so I'll skip a lot and bring this narrative to a close.

On July 1, I flew to the Normandy beachhead for a week of temporary duty with ADSEC, primarily to expedite the establishment of hospitals and select hospital sites. It was a strenuous week but a pleasant rest from the buzz bombs. Upon my return to London, I paid less attention to them as preparations for moving to the Continent were uppermost in my mind. The bombs kept coming, nevertheless, and it was estimated that they had caused about 30,000 casualties in London between June 15 and July 15.

August 4, 1944, Prime Minister Churchill announced that 5,300 buzz bombs had been launched against "southern England" in the past seven weeks. They had killed

4,737 people and seriously wounded more than 14,000. Many more thousands had been slightly wounded, 17,000 houses totally destroyed and about 800,000 damaged.

While the bombardment of London continued, rescue and clean-up squads were doing a splendid job. It was surprising and stimulating to see how quickly they got debris cleared away, so that stricken areas presented some semblance of orderliness. Work went on in the big city very much as though nothing unusual was happening. The people showed a wonderful ability to adjust themselves to catastrophic changes.

Following the breakthrough into Brittany, I flew to Omaha Beach again on August 8, to inspect hospitals in Normandy and select hospital sites in Rennes, Brittany which had just been liberated by Patton's 3rd Army. Six days later, I flew back to the buzz bombs and counted fifteen flashes on the horizon as I drove through the night toward London from the airfield at Ramsbury.

It was my destiny to endure the buzz bombs but two weeks longer and no tears were shed when we made our permanent move to France. An LCT ferried us from the ship to Omaha Beach, where I waded ashore, carrying a 75-pound bedding roll about 300 yards to the beach assembly point. It was August 28, 1944, and our battle for hospital beds on the Continent was just beginning.

The buzz bomb assaults on London were diminishing. Soon Liege and Antwerp would receive their murderous impact. But that is another story, and there are many better qualified than I to tell it.



ABOUT OUR AUTHORS

Colonel William C. Braly now retired has also written a book on his experiences entitled *The Hard Way Home* which is now for sale by the JOURNAL. As Operations Officer for General Moore, Colonel Braly writes with authority on the events preceding the fall of Corregidor. (Page 2.)

Captain C. R. Tosti, as previously stated, is Assistant Chief for Administration at the Power Plant Laboratory, Engineering Division, Wright Field. He is closely associated with aircraft power plant research. (Page 10.)

Joseph B. Tuzen, also as previously stated, is Project Engineer on ram jet and pulse jet engines at the Power Plant Laboratory, Engineering Division, Wright Field. (Page 10.)

E. S. Thompson is Manager of the Aircraft Gas Turbine Division, Aviation Divisions of General Electric Company. He will be the General Electric representative at the Combine Royal Aeronautical Society and the Institute of Aeronautical Sciences Conference to be held in London in September of this year. (Page 15.)

Dr. Louis G. Dunn is now Director of the Jet Propulsion Laboratory of the California Institute of Technology. He

has been associated with the Laboratory since 1943 and the Institute since 1937. (Page 23.)

Dr. R. E. Lapp is Deputy Executive of the Committee on Atomic Energy of the Joint Research and Development Board. Before that, he was with the Research and Development Division, War Department General Staff. (Page 30.)

Captain Vance H. Taylor although an Air Corps officer obtained a very vivid impression of ground warfare and troops by making the D-Day assault with the 29th Division on Omaha Beach as a member of a detachment which controlled Ninth Air Force fighters and fighter-bombers. This is the background for his humorous story. (Page 34.)

Leonard J. Grassman who is becoming well known to JOURNAL readers is now Chief of Public Information, Army and Navy Munitions Board. (Page 45.)

Colonel Joseph Rogers Darnall was formerly Chief of Hospitalization, Office of the Chief Surgeon, European Theater of Operations. His different slant on the V-1 attacks should be interesting to the artillerymen. (Page 50.)

Lieutenant Colonel John G. Turner, as a member of AGF Board No. 4, is intimately acquainted with the subject on which he writes. (Page 58.)

SEACOAST SERVICE



TEST SECTION

Any individual, whether or not he is a member of the service, is invited to submit constructive suggestions relating to problems under study by the Seacoast Service Test Section, Army Ground Forces Board No. 1, or to present any new problem that may properly be considered by the Section. Communications should be addressed to the President, Seacoast Service Test Section, Army Ground Forces Board No. 1, Fort Baker, California.

Items pertaining to Antiaircraft Artillery should be sent to the Antiaircraft Test Section, Army Ground Forces Board No. 4, Fort Bliss, Texas.

Any recommendations made or views expressed herein are those of Army Ground Forces Board No. 1 and are not to be construed as representing the opinion of all War Department or Army Ground Forces Agencies.

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1ST LIEUTENANT WILLIAM WHETTON

Shore Cable Landing Equipment—The landing of shore cable for submarine mines and other underwater equipment always has presented a difficult problem in those locations where there is heavy surf, fast currents or a long, shallow approach to the beach. The usual method is to fasten the end of the cable to a yawl boat which then proceeds as close as possible to the beach while the mine planter "lays to" offshore and unreels the cable as the yawl boat goes in. When the yawl boat gets as close to shore as possible, a rope is tied to the end of the cable and thrown to a detail ashore which by truck or, more often, brute strength pulls a sufficient length of cable ashore. This method has several disadvantages: (1) heavy surf or large rocks prevent the yawl boat from getting close to the shore, (2) fast currents cause a large catenary in the cable in the direction of the current and thus make it difficult for the yawl and shore detail to pull, in addition to paying out an unnecessary amount of cable, (3) long, shallow approaches require the planter to "lay to" a long distance from the beach; also the yawl boat is prevented from getting in close and the shore detail has to wade out to get the cable, (4) dragging the cable along the bottom is difficult and the strain has many times broken the insulation or conductor.

Two kinds of amphibious vehicles, a DUKW and an LVT (4), were tested for use in cable landing work. Cable

reels and jacks were mounted in both vehicles. Otherwise, the vehicles remained unmodified. The LVT was found to be the more satisfactory, and was able to handle a 5-ton reel of cable (10,000 feet). When employed for shore cable landing, the LVT proceeds to shore from the mine planter and continues right up onto the beach to the desired place, unreeling the cable as it goes. In tests to determine comparative times, one operation which required 48 minutes to land a certain amount of cable by the usual method of yawl boat and shore detail, took only 5 minutes and one-fourth the personnel using the LVT.

It was recommended that the LVT (4) be adopted for use in shore cable landing operations for submarine mine projects.

Four-Man Motorized Pneumatic Boat—This Section was designated to perform certain tests in connection with a newly designed four-man pneumatic boat. The complete test of the boat is a project of Army Ground Forces Board No. 2.

Purpose of the tests by this Section is to determine the maximum ranges at which the gasoline outboard motor and the electric outboard motor can be heard by the unaided human ear; by standard listening devices and by ground radar equipment. The maximum pick-up range using underwater listening devices also will be ascertained. Tests

will be run under various surf and atmospheric conditions.

Percussion Primer Ammunition for 75mm Subcaliber Guns—In March 1947, a test of the 75mm HE subcaliber ammunition was completed by this Section. The test was discussed in the March-April issue of the JOURNAL.

The ammunition, which had ignition primers, was not entirely satisfactory. The primers failed to function in a number of cases and the pressures developed were high.

About the time the test was completed, it was decided to try firing a standard 75mm round with percussion primer in the M-25 subcaliber tubes of the 155mm M2 guns which had been used in the foregoing test. It was thought that the pressure blow caused by firing the percussion primer in the parent gun firing mechanism would be sufficient to set off the percussion primer in the subcaliber round. Limited tests were satisfactory, and a project was requested and au-

thorized to test this round with a view toward its possible adoption as the standard subcaliber round for all 75mm subcaliber tubes for seacoast artillery.

Action toward adoption of the 75mm subcaliber round with ignition primer has been suspended pending the outcome of this test. From a standpoint of procurement there would be a great advantage in using the standard 75mm round with percussion primer. This ammunition already exists in quantity, whereas the ignition primer ammunition must be specially manufactured.

Tests to date have included the firing of two hundred thirty-five rounds in Subcaliber Guns M-25. Ballistic performance has been entirely satisfactory and there have been no misfires. Further tests will be made firing the ammunition in subcaliber tubes for the other types of seacoast artillery armament.



Instrumentation And Analysis At A. G. F. Board No. 4

By Lieutenant Colonel John G. Turner, CAC

The instrumentation used in the conduct of service tests of antiaircraft artillery equipment has been brought to the foreground during the past year due to the adaptability of the same or similar type procedures and facilities to the guided missile program. The facilities for instrumenting antiaircraft artillery tests at Army Ground Forces Board No. 4 have been developed over a period of approximately twelve years and represent the end results of studies and experimentation of the best technically qualified officers in this branch of the service. Needless to say, the means for tracking and detection of guided missiles is an advanced step from the problem of dealing with conventional aircraft but the same principles are involved, and solution of the missile problem will likely be in the form of refinements to existing equipment. Because considerable interest has been shown by personnel of guided missiles ranges in the instrumentation and analysis facilities at this Board, it is believed that a review of these facilities will be of timely interest to all Coast Artillery officers.

INSTRUMENTATION AND METHODS OF OBTAINING DATA IN ANTI-AIRCRAFT SERVICE TESTS

While tests conducted at Army Ground Forces Board No. 4 include all types of antiaircraft artillery equipment, those concerned with fire control equipment require instru-

mentation which most nearly parallels that used on guided missile test ranges. In fire control equipment tests it is necessary to determine the accuracy of the present position system (Radar) as well as the function of the future position computer in predicting the travel of an aerial target. These tests normally employ the use of dual equipments; one, the comparison or standard equipment set and the other the new equipment to be tested. Data must be taken from each of these equipments simultaneously while they are engaging the same target and then compared in order to determine comparative accuracy. In addition, further comparison must be made with the true data values, obtained with precision theodolites, to find the actual errors.

The instrumentation required for such a test must include:

1. A means for recording elements of present position data, namely; azimuth, elevation and slant range of the target and elements of firing or predicted data, namely; firing azimuth, firing elevation and fuze time. The equipment used to record this data is known as a data recorder. Each data recorder has facilities for receiving six elements of data at one-second intervals and immediately providing a printed record of each.

2. A single frame motion picture camera which is mounted on the radar antenna to record the actual tracking

error. This camera, actuated by an accurate central timing system, takes pictures of the target at predetermined intervals and indicates lateral and vertical deviations from the true position of the target.

3. To determine the true position of the target at any time, two theodolite stations track the target and record photographically, at the same instant as other recording devices, the azimuth and elevation of the target. The theodolites currently in use at Army Ground Forces Board No. 4 are accurate to within 0.1 mil, and furnish data which may be used to solve a trigonometric problem giving the position of the target in space within an accuracy of approximately 1/20,000.

As a check of predicted data, the present position data is introduced into an electronic computer (Ballistic Computer) which provides an accurate means for comparing with proper ballistic tables, the data recorded from the equipment under test. The description of this computer rightly belongs in the following section on computation and analysis of data but is mentioned at this point to indicate that a standard computing device is available.

This description has been confined to facilities used to take data during a test of antiaircraft artillery equipment. No effort has been made to cite the accuracies required for orientation, synchronization and operation of instrumentation equipment although these factors are of prime importance in the actual conduct of service tests.

INTERMEDIATE STEPS IN PROCESSING OF DATA

After the acquisition of data and prior to final computation and analysis, it is necessary to perform certain intermediate steps. These procedures include the processing of film records, the previewing of all records and the assessment of data. This action must be completed as soon as practicable after the data is taken, in order to keep the test officer abreast of the probable results of his test and to enable correction of deficiencies in the test or instrumentation equipment which were not apparent from observation during the data-taking phase. In addition, target courses in which the data are extraneous or incomplete are eliminated prior to the start of actual reduction of data. It is during this phase that the mathematical data analyst must make a preliminary assessment of all data components and determine the value and probable end results of each course.

COMPUTATION AND ANALYSIS OF DATA

Reading of tracking and theodolite film is accomplished with commercial film viewers equipped with grids calibrated to the magnification power of the photographic lens used in the recording cameras. The corrections for earth curvature are now automatically applied to the new theodolites by misleveling of one station. A simple chart for direct read-

ing is used when the older type of theodolite is used. Secant corrections, for projecting the direct values given by the theodolite to the horizontal plane are made with the use of a locally constructed secant scale on a 24-inch slide rule. Application of corrections and minor computations which prepare data for the actual computation of the theodolite problem are performed with the use of commercial calculators. The solution of the theodolite data is accomplished by the utilization of a special type film slide rule consisting of 200-foot rolls of film upon which logarithmic scales of angular and numerical values are indicated. The film slide rule reduces the computing time of theodolite data to less than one-sixth of the time required for normal computations of the same problem. Parallax corrections are applied with a locally devised graphical parallax corrector.

In the handling of predicted data, the printed data recorder tapes containing present position and predicted data are sent directly to the ballistic computer. Here the printed data is converted into a perforated tape for introduction into the computer. The answers afforded by this machine are in the form of deviations of the test results from the theoretically perfect solution.

Data records, comprising simplified graphs or tabular data, are inspected to detect abnormal conditions. Finally, representative results are supplied to the test officer for further analysis in the preparation of test reports.

Despite the numerous time-saving devices that have been conceived at Army Ground Forces Board No. 4 over a long period of operation, the accuracy required and the highly detailed work necessary in the reduction of data still make the processing time of this section longer than that of other phases of service testing. A continuous program for improvement is essential in order to cope with the variations of data handling that are required with each test. It is also necessary to provide work incentives to personnel engaged in the exacting and difficult computing procedures. Such an incentive program has recently been put in effect and involves a rating system for each team of computers based on the amount of work completed and the accuracy of results.

SUMMARY

The experience of Army Ground Forces Board No. 4 in Instrumentation and Analysis has provided a valuable aid to newly organized guided missiles test ranges in the establishment of similar facilities. Procedures, as outlined in this article, have necessarily been confined to a general discussion of data taking and processing. The technical complexity of the instrumentation and computing equipment used at this Board are indicative of the efforts of the Army to provide the best obtainable equipment to the using organizations.



Coast Artillery Journal

Fifty-fifth Year of Publication

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The JOURNAL prints articles on subjects of professional and general interest to personnel of all the components of the Coast Artillery Corps in order to stimulate thought and provoke discussion. However, opinions expressed and conclusions drawn in articles are in no sense official. They do not reflect the opinions or conclusions of any official or branch of the War Department.

The JOURNAL does not carry paid advertising. The JOURNAL pays for original articles upon publication. Manuscripts should be addressed to the Editor. The JOURNAL is not responsible for manuscripts unaccompanied by return postage.

The United States Coast Artillery Association

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The purpose of the Association shall be to promote the efficiency of the Coast Artillery Corps by maintaining its standards and traditions, by disseminating professional knowledge, by inspiring greater effort towards the improvement of matériel and methods of training and by fostering mutual understanding, respect and cooperation among all arms, branches and components of the Regular Army, National Guard, Organized Reserves, and Reserve Officers' Training Corps.

News and Comment

This Issue's Cover

Since this JOURNAL features a story on Corregidor it is most appropriate that the cover should show General MacArthur at a flag raising ceremony on Corregidor after its recapture by his troops.

300 Cadets Visit Bliss

300 cadets from the United States Military Academy visited military installations in the El Paso area for a week in June. The West Pointers were greeted on their arrival by the 62d AGF Band and a delegation of Fort Bliss officers headed by Major General J. L. Homer and Brigadier General R. M. Montague.

The instruction program was under the supervision of the Antiaircraft Artillery and Guided Missile Branch of the Artillery School, and included demonstrations of antiaircraft artillery used in ground support and antimechanized roles as well as in action against aircraft. The Cadets visited all of the Fort Bliss Firing Ranges where they were given the opportunity to actually fire the various light and heavy antiaircraft artillery weapons. They also witnessed a rocket shoot at White Sands.

The El Paso visit of the West Pointers is part of the annual tour of U.S. Military Posts given Academy First Classmen the summer before their graduation. By visiting Army Ground and Air Force installations throughout the country, the Cadets are given a firsthand view of the activities that will soon become their lifetime work.

AGF's Task Force "Furnace" Begins Desert Tests

On 4 June, Task Force "Furnace" began the testing of hundreds of items of Army Ground Forces equipment in the searing heat of the Great American Desert, near Yuma, Arizona.

In daily temperatures normally exceeding 100 degrees, the 300 picked troops of the task force will, for three and a half months, subject new standard weapons and matériel to workouts designed to simulate the hardest wartime desert combat usage.

Along with guns and ammunition, tanks and tractors, test equipment includes rescue and repair apparatus, water supplying assemblies, mobile refrigeration plants and motors, radios, clothing and accoutrements.

Many of these items were combat tested in the last war and now bear new alterations suggested by officers and enlisted men on the basis of their African desert warfare experience. Other items are entirely experimental.

Lieutenant Colonel Walter B. Richardson, Beaumont, Texas, commands the task force. His technical staff is comprised of experts in desert fighting.

Task Force Furnace's tent camp is thirty miles north of Yuma, an area surrounded by rolling sand dunes and with no vegetation except sparse growths of cactus and brush.

80,000 National Guardsmen to Participate in Summer Training

Approximately 80,000 National Guard troops will receive summer training this year, the first time such training has been held since 1940, it has been announced by General Jacob L. Devers, Commanding General, Army Ground Forces.

It is estimated that 60,000 men will attend the regular 15-day training period which has been scheduled for all National Guard divisions and regimental combat teams which are self-sustaining in the field and able to muster at least 20 per cent of their table of organization strength. The other 20,000 men will attend special schools in lieu of field training.

The field training program will be directed by Army commanders in the various State areas and will include individual and specialist training. Small unit training, through the platoon level, will be conducted when practicable. The school program will be administered by Senior Army Instructors and will also emphasize individual and specialist training.

Coast Artillery Corps units will attend camps at the time and place designated for their respective states providing they meet the requirements.

Additional National Guard Units

The following National Guard Coast Artillery Corps units have been Federally recognized since the last issue of the JOURNAL:

Alabama—

Headquarters and Headquarters Battery, 226th AAA Group—Separate Detachment—, Mobile;
Headquarters & Headquarters Battery, 226th AAA Group—Separate Detachment—, Birmingham;
Battery "A," 464th AAA AW Battalion, Sylacauga;
Battery "C," 464th AAA AW Battalion, Arab.

California—

Headquarters & Headquarters Battery, 271st AAA AW Battalion, San Francisco;
Battery "A," 271st AAA AW Battalion, San Francisco;
Headquarters & Headquarters Battery, 272d AAA AW Battalion, San Diego;
Battery "A," 272d AAA AW Battalion, San Diego;
Medical Detachment, 272d AAA AW Bn., San Diego;
Medical Detachment, 728th AAA S/L Bn., San Francisco;
Headquarters & Headquarters Battery, 730th AAA Searchlight Battalion, San Diego;
Battery "A," 746th AAA Gun Battalion, San Diego;
Medical Detachment, 746th AAA Gun Bn., San Diego.

Connecticut—

Hq. & Hq. Battery, 208th AAA Group, New Haven.

Delaware—

Battery "B," 945th AAA AW Battalion, Georgetown.

Florida—

Battery "D," 712th AAA Gun Battalion, Arcadia.

Georgia—

178th AAA Operations Detachment, Savannah;
Battery "B," 950th AAA AW Battalion, Monroe.

Illinois—

Hq. & Hq. Btry., 396th AAA AW Bn., Bloomington.

Louisiana—

Hq. & Hq. Battery, 105th AAA AW Bn., Bogalusa;
Battery "A," 105th AAA AW Battalion, Bogalusa;
Battery "B," 105th AAA AW Battalion, Franklinton.

Maine—

Battery "B," 314th AAA AW Battalion, Belfast;
Battery "B," 703d AAA Gun Battalion, Bath;
Battery "C," 703d AAA Gun Battalion, Brunswick.

Minnesota—

Battery "B," 257th AAA AW Battalion, Virginia.

New Hampshire—

Hq. and Hq. Battery, 197th AAA Group, Concord;
Hq. & Hq. Battery, 744th AAA Gun Battalion, Laconia.

New Jersey—

Headquarters & Headquarters Battery, 309th AAA AW Battalion, Jersey City.

Pennsylvania—

Hq. & Hq. Battery, 218th AAA Group, Pittsburgh;
Battery "A," 899th AAA AW Battalion, Lancaster;
Medical Detachment, 899th AAA AW Bn., Lancaster.

Rhode Island—

Battery "B," 243d AAA AW Battalion, Newport.

South Carolina—

Headquarters & Headquarters Battery, 678th AAA AW Battalion, Anderson;
Battery "A," 678th AAA AW Battalion, Seneca;
Battery "B," 678th AAA AW Battalion, Easley;
Battery "D," 678th AAA AW Battalion, Williamston;
Headquarters & Headquarters Battery, 713th AAA Gun Battalion, Lancaster.

Texas—

Battery "A," 696th AAA AW Battalion, El Paso.

Washington—

Hq. & Hq. Battery, 236th AAA Group, Tacoma;
Hq. & Hq. Battery, 530th AAA AW Bn., Tacoma;
Battery "A," 530th AAA AW Battalion, Tacoma;
Battery "B," 530th AAA AW Battalion, Tacoma;
Battery "C," 530th AAA AW Battalion, Tacoma;
Battery "D," 530th AAA AW Battalion, Tacoma;
Medical Detachment, 530th AAA AW Bn., Tacoma;
Hq. & Hq. Battery, 770th AAA Gun Bn., Seattle;
Battery "A," 770th AAA Gun Battalion, Seattle;
Battery "B," 770th AAA Gun Battalion, Seattle;
Medical Detachment, 770th AAA Gun Bn., Aberdeen.

ROTC Artillery Units To Combine

Effective with the fall term of 1947, the three ROTC artillery courses (field, seacoast and antiaircraft) will be combined into one course.

This combined course will feature basic artillery instruction with indoctrination in all three types.

No reassignment of the PMS&T of any institution will be made solely on the basis of this change but a minimum of one Coast Artillery and one Field Artillery officer will be assigned to each senior ROTC unit now having either a Field Artillery or Coast Artillery Corps unit.

This summer, 150 advanced CAC ROTC students are attending summer camp at Fort Bliss, 400 at Fort Sheridan and 35 at Fort Scott but with the instigation of this new plan in the fall, changes will undoubtedly be made in the summer camp program for 1948.

ORC Units Activated

Since the last issue of the JOURNAL, the following ORC Coast Artillery Corps units have been activated:

Illinois—

Battery "C," 383d AAA AW Battalion (SP), Chicago;
Battery "D," 383d AAA AW Battalion (SP), Chicago.

New York—

364th CA Gun Battery (155mm), New York City;
368th CA Gun Battery (155mm), Brooklyn;
369th CA Gun Battery (155mm), Hempstead;
370th CA Mine Planter Battery, New York City;
371st CA Mine Planter Battery, Brooklyn;
372d CA Mine Planter Battery, Hempstead;
373d CA Searchlight Battery (HD), New York City;
401st CA Searchlight Battery (HD), Brooklyn;
405th CA Searchlight Battery (HD), Hempstead.

North Carolina—

Hq. Battery, 378th AAA AW Bn. (Mbl.), Wilmington;
Battery "B," 378th AAA AW Bn. (Mbl.), Wilmington.

AGF-Navy-AAF to Hold Amphibious Maneuvers In November

Plans have been completed for the second postwar joint Army Ground Forces-Navy-Army Air Forces amphibious exercise, to be conducted near Galveston, Texas, in November.

Development of the technique of loading and landing armed forces and equipment is the main training objective of the operation.

Combat Command "A" of the Second Armored Division, Camp Hood, Texas, will be the principal ground unit engaged. The maximum possible participation of National Guard and Organized Reserve Headquarters units and personnel will be sought.

Prior to the exercise, the Navy's Troop Training Unit, Amphibious Training Command, Little Creek, Virginia, will assist in the training of Ground Forces units in embarkation and debarkation procedures.

For the actual exercise, a situation will be assumed wherein an infantry division operating as part of an amphibious force has secured a beachhead, and Combat Command "A," reinforced, will go ashore as a buildup force in support of the previously landed infantry division.

Embarkation of the Combat Command is expected to be from Galveston. The definite landing site has not been selected but is expected to be in the vicinity of Galveston.

General Jonathan M. Wainwright, Commanding General, Fourth Army, has been named over-all commander for planning the exercise.

The November exercise follows by a year, maneuvers held off San Clemente Island, California, first joint AGF-Navy-AAF amphibious maneuvers in the United States since the end of World War II.

AAF Announces New, Most Powerful Jet Engine

The most powerful American turbo-jet engine yet announced, producing a rated thrust up to 5,000 pounds, has been developed for the Army Air Forces. Packing more power than a Diesel electric railroad engine into less than one-fifth of one per cent of the Diesel's weight, the new engine has been designated the XJ-37.

41 Per Cent of National Guard Units Organized in 1947

Approximately 41 per cent of the 6,388 units planned for the postwar National Guard were given federal recognition during the fiscal year 1947, according to Major General Butler B. Miltonberger, Chief of the National Guard Bureau.

"From June 30, 1946, when the first recognition was granted the 120th Fighter Squadron of Denver, Colorado, through June 30, 1947, the National Guard Bureau has granted recognition to 2,358 ground units and 257 air units, a total of 2,615," he said.

"The Adjutants General of the several States, the Territory of Hawaii, Puerto Rico and the District of Columbia, have done a remarkable job. It should be remembered that the entire National Guard was called into Federal service during World War II, and its personnel were discharged directly to civilian status.

"Actually, approximately 44 per cent of the units will be in the record as recognized during the first fiscal year of the reorganization when the necessary approvals are given for units which already have been inspected for federal recognition. Approximately 140 ground units and 40 air units are in this group, and their dates of recognition will be in the fiscal year 1947," General Miltonberger stated.

When federal recognition is given a unit, its personnel receive federal pay for each of the 48 weekly training periods and the 15-day summer encampment. They also begin actual training as part of the National Guard which the War Department plans will be an M-Day force immediately available for service in the event of enemy aggression.

General Nichols Retires

Brigadier General Harold F. Nichols, Director of Personnel for the Sixth Army area since May 1946, retired from the Army 21 July after 40 years of Army service.

In World War I he earned two battle stars for Meuse-Argonne and the Defensive Sector for service overseas with a heavy artillery brigade.

Shortly after Pearl Harbor, General Nichols was assigned as Commanding General, Hawaiian Antiaircraft Command on Oahu, where he was responsible for the antiaircraft defenses.

Returning to the United States in April 1944, he was assigned command of the Antiaircraft Replacement Training Center at Camp Haan, California.

He first came to the San Francisco area in April 1945 to serve as Army coordinator for the United Nations conference. He joined the Western Defense Command here in July of 1945, and was assigned to the Sixth Army upon its activation in March 1946.

Unit Histories

The following unit histories have been received at the JOURNAL office since publication of the May-June issue:

197th CA (AA) Regiment

Eighth Army Narrative Report of Antiaircraft Artillery Operations in the Pacific Theater.

Other units which have published histories or contemplate doing so, are urged to send copies to the JOURNAL for our permanent file.

Bronze Star Award Rules Revised

Additional recognition for men who won commendation during combat for meritorious or exemplary achievement in ground action against the enemy was assured today with release of new War Department rules for award of the Bronze Star Medal.

The new rules, embodied in a circular changing the Army Regulations respecting decorations, provide that all persons who in the period between Pearl Harbor and V-J Day were cited individually for their part in ground combat will be eligible for award of the Bronze Star.

In many cases, orders granting the Combat Infantryman's or Combat Medical badges will be sufficient supporting evidence to a man's claim for the medal. However, the combat badges must have been awarded in the period between December 7, 1941, and September 2, 1945. Frequently during combat field units issued general orders or formal certificates to individuals for their acts, and these, judged individually by the War Department on their merits, may also be used as support for the medal award.

Reason for the revision of rules regarding award of the Bronze Star Medal was that prerequisites for award of the Combat Infantryman's and Combat Medical Badges were altered after V-J Day. Since the combat badges are not decorations, additional awards of the Bronze Star Medal to those persons considered deserving of it are expected to give recognition of services not heretofore rewarded with a distinctive decoration.

In announcing the revised rules, the War Department pointed out that inasmuch as the citations on which awards will be made must be individual, award of the Distinguished Unit Citation or mention of the applicant's unit in General Orders will not suffice.

Applications for award of the Bronze Star Medal must be submitted to The Adjutant General, Washington 25, D. C. The application must cite Paragraph 15.1 e, Army Regulations 600-45, and a copy of the citation or order awarding the Combat Infantry or Combat Medical Badge must be enclosed.

Subterranean Power Plant

A subterranean power plant invulnerable to air attack is being planned in Norway by the Vinstra Power Company of Oslo. The plant will be blasted out of a mountain at a depth of 3,000 feet and will be the first of its kind in the country. Water will be channeled to the generator room through a conduit more than 14 miles long. The plant will have a power of more than 180,000 kilowatts. Preliminary work on the project already is under way, and it is scheduled to be completed by 1954. Cost of excavation alone is put at \$5,925,000.

80th Division Reunion

The 28th Annual Reunion of the 80th Division will be held in Greensburg, Pa., August 14, 15, 16 and 17th, 1947. Headquarters will be at the Penn-Albert Hotel.

Any veteran of the 80th Division of both world wars who is interested in attending the annual reunion or in the 80th Division Veterans Association, should write to National Headquarters of the 80th Division Veterans Association, 313 Plaza Building, Pittsburgh (19), Pa.

Young Officers to be Integrated by New Competitive Program

The War Department has announced a new program for bringing large numbers of young officers into the Regular Army. Although the program for bringing wartime officers into the Regular Army has almost been completed there now remain a great many vacancies for young officers. For the next five years approximately 2000 appointments a year will be made available. Officers rejected in the present integration program during the remainder of 1947 will not be excluded from applying for this new program.

Applications will be accepted for competitive tours of active duty of one year duration. This is very much similar to the Thomason Act in existence before World War II except that the chances of getting a Regular Army commission will be very much enhanced by the large number of vacancies available. The first competitive tour of this new program began on 1 July. Former AUS officers who are not on active duty must file their applications by 15 June and those still on active duty must file by the 20th.

Applicants must have completed two years of college and be between the ages of 21 and 25 years and six months at the time their application is filed. In addition, they must agree to remain on active duty for a minimum period of two years. In the future, applications must be filed 60 days prior to 1 July or 1 January, which will be the starting dates of all competitive tours of duty.

During the period of the competitive tour each candidate must demonstrate his fitness for appointment. If successful, and subject to the number of vacancies existing at semi-annual periods, the candidates will be commissioned in the Regular Army the July 1st or January 1st following completion of the one-year tour. Those officers who are not selected at the completion of their competitive tour will be required to remain on active duty until the completion of the two-year period for which they agreed to serve. Or, if still eligible, may elect to try another competitive tour during their second year.

The forms for application for these competitive tours are available at all posts, camps, and stations, U.S. Army Recruiting Offices, and Military District Headquarters.

"Winged Victory" Division to Hold Convention

A three-day convention of the 43d Infantry Division Association will be held September 12, 13 and 14, at the State Camp, Niantic, Connecticut, according to Brigadier General George E. Cole, National Guard (Retired), secretary-treasurer of the association.

1st Armored Division Historical Association

The Washington Branch of the 1st Armored Division Historical Association desires to affiliate itself with the 1st Armored Regiment Association, the 13th Armored Regiment Association, the 91st Field Artillery Association, the 701st Tank Destroyer Association and all other branches of the 1st Armored Division Historical Association that have been or may be formed, in order to expedite and facilitate activation of the national association.

Individuals desiring to join in furthering this worthy cause may write to the Association, c/o *The Armored Cavalry Journal*, 1719 K Street, N.W., Washington, D. C.

Coast Artillery Newsletters



ANTIAIRCRAFT SECTION, GHQ, FEC

TOKYO, JAPAN, APO 500

BRIGADIER GENERAL WILLIAM F. MARQUAT, *Antiaircraft Officer*

On 12, 13, and 14 June, Headquarters, Far East Air Forces, conducted an Air Defense Conference in Tokyo, Japan. Representatives of the Antiaircraft Artillery units and the Air Forces in the Marianas, Philippines, Okinawa, Korea, and Japan were present. The highlight of the conference was a talk given by Brigadier General W. F. Marquat. General Marquat reviewed the air defense situation in the early days of the war in the Pacific on Corregidor and Bataan; emphasized the importance of an adequate air defense establishment "in being" during peacetime; and discussed the necessity for constant progressive development of the operation of the Fighter-Antiaircraft Artillery Team.

Because of the difficulty attendant upon organizing a range and records section for use during antiaircraft artillery target practices, it was recently recommended that the War Department publish a training circular on the use of the present personnel and equipment in an operations detachment to perform these duties. A standardized procedure for forming records sections should simplify considerably the training problem and relieve the firing unit commander of many harassing details.

The Commanding General, Army Ground Forces has indicated that because of pending developments in automatic weapons matériel it is not considered advisable at

this time to augment the T/O & E of a searchlight battery to facilitate its operation separately, when providing illumination for automatic weapons battalions. The recommendation to augment the battery by the addition of two radar sections and sufficient personnel and equipment to permit the battery to operate separately was made to the Commanding General, Army Ground Forces, by General Headquarters, Far East Command, in April 1947.

WD SO 65, dated 2 April 1947, as modified by WD SO's 103 and 108, should complete the assignment to the Far East Command of all WD AAA Technical Instruction Teams trained by the AAA and Guided Missile Branch of the Artillery School. Instructions for the use of the teams have been disseminated and detailed schedules of instruction tours are nearing completion by the major commands.

Utilizing civilian technical specialists, of the Philco Corporation now serving the Far East Air Forces, as instructors, the Eighth Army Signal Corps Radar School has allocated quotas of four antiaircraft artillery students per month to the Philippines-Ryukyus Command and the Marianas-Bonins Command. The establishment of courses in maintenance of both the SCR-584 and the AN/TPL-1 is a step toward providing the many trained antiaircraft artillery technicians presently required.



All Regular Army, Reserve and National Guard CAC Brigades, Groups and Unattached Battalions are encouraged to send in letters for this section of the JOURNAL.



OKINAWA, APO 331-6

COLONEL VOLNEY W. WORTMAN, *Commanding*

On 12 April 1947, Colonel Volney W. Wortman assumed command of the 87th AAA Group (PS), including all Antiaircraft Artillery organizations on Okinawa. His last station was San Marcelino, Philippine Islands, where he commanded in turn, the 1st AAA Group (PS) (PROV), 81st AAA Group (PS), and 70th AAA Group of the Philippine Ground Force Command.

During the period of this report, antiaircraft artillery training was given top priority. The MTP training of all antiaircraft artillery organizations showed a marked improvement after the relief of the Group from additional duties in connection with the operation of the Awase Housing area on 7 May and by the discontinuance of various other additional overhead duties about that time.

The 532d AAA Gun Battalion (PS), Lieutenant Colonel F. T. Berg commanding, utilized the month of April in conducting Trial Fire with its 120mm Guns from the excellent range on Bolo Point. The first week in May saw the 511th AAA AW Battalion (PS), Lieutenant Colonel C. U. Bradley commanding, conducting its first Automatic Weapons firing at towed flag and OQ-3 radio-controlled targets from the same location. The results of this firing were most pleasing to all concerned.

A novel sight to most newcomers on Okinawa has been the recent searchlight illumination drills conducted by Battery A, 541st AAA Searchlight Battalion (PS), First Lieutenant T. L. Bennett commanding. These drills, held twice weekly, have excited much comment and have been quite successful.

In addition to other drills, day and night tracking missions were held twice each week for Gun and Radar personnel.

The Group parades held each Saturday morning are at-

tracting more and more visitors and are the nearest to pre-war ceremonies that most officers and men have seen in recent years, as are the daily retreat ceremonies conducted in front of Group Headquarters.

The 11th AGF Band (PS) was attached to the Group on 14 April, thus filling an urgent need for music. The Band, commanded by First Lieutenant Alphonso Lea, is an outstanding unit. A new schedule of hours adopted during May has solved the ever-present problem in a training cycle of providing time for athletics. By starting the day at 0730, troops and officers alike are now able to devote the last hour of each day to participation in an extensive athletic program.

The month of May also saw a change in geographical location of one of the antiaircraft units. Following the footsteps of departing Marines, Battery A of the 541st AAA Searchlight Battalion (PS), took over the Marine Barracks area near Tengan. The battery is quartered in the new area and after a brief resettlement period will resume MTP training at its new location.

One of the most interesting events of recent weeks was the Barrio Fiesta and associated May Day activities on the third and fourth of May. The center of the Fiesta was the Group Service Club, "Typhoon Terrace," which featured displays and drawings created by Group personnel, displays of articles and pictures of the Philippine Islands, a dance attended by over a hundred Okinawan girls, cock fights, and a pig barbecue in true Philippine style. The Service Club was attractively decorated for the celebration, the most striking exhibit being a Nipa hut constructed near the front entrance.

Departures and arrivals have been numerous. Departures included: Lieutenant Colonel and Mrs. R. H. Kessler, Mrs. I. A. Peterson, Major and Mrs. W. W. Mize, Major and Mrs. W. H. Barnett, Captain G. H. Farne, Captain J. F. Mangan, all returning to the United States. Lieutenant Colonel I. A. Peterson and First Lieutenant J. P. McDermott were transferred to the 8104th Service Detachment on Okinawa; First Lieutenant T. Sandeno was transferred to the 226th Ordnance Base Depot; First Lieutenant H. C. Carlson (MC) was transferred to the 9th Station Hospital and First Lieutenant W. V. Sinkovic and CWO R. Hair were transferred to the 44th Infantry Regiment.

Arrivals were: Colonel V. W. Wortman; Major and Mrs. E. A. Grambort, Mrs. C. L. Hall, Mrs. W. J. Sinkovic, Mrs. R. L. Wood, Major W. F. Shaver, Jr., Captain J. C. Howard (MC), First Lieutenant J. D. Ingham, and Second Lieutenants L. Aben, F. Yambao, Z. M. Johnson, A. W. Cruz, A. M. Mendaros, F. E. Ricafort, J. N. Agtarap, and J. M. Maxino.

Mrs. W. C. Barlow is expected to arrive in the near future while Major and Mrs. H. J. Turner, Captain and Mrs. D. C. Cabell, Major J. D. Healy, and Captains J. L. Smith and G. Fitzpatrick are expected to depart for duty in the United States.





138TH ANTI-AIRCRAFT ARTILLERY GROUP

YOKOHAMA, JAPAN, APO 503

COLONEL D. C. TREDENNICK, *Commanding*

During the past two months there has been no change in the mission of furnishing security guard for the Yokohama Area. Because of the inactivation of the 82d Chemical Mortar Battalion, which had been attached for operational control only, the burden of security guard for the remaining units has been increased. Since 4 September 1945, the 138th AAA Group and its predecessors, the 68th and 40th AAA Brigades, have made 5619 apprehensions in connection with security guard duties. One thousand five hundred fifty of these apprehensions have taken place since 25 May 1946 when the 138th AAA Group moved from Sugamo Prison and relieved the 40th AAA Brigade in Yokohama. Another change occurred on 20 May 1947 when the 209th AAA AW Battalion (SP) was inactivated. The 76th AAA AW Battalion (SP) was activated on the same date and took over Camp McNeely. All the officers of the 209th were transferred to the 76th.

On 8 May 1947 twenty-six officers completed the Troop Officers' course conducted in the 753d AAA Gun Battalion area. Certificates of completion were awarded by the group commander. The second session began 12 May 1947 with 30 officers attending. Officers are placed on TDY with the gun battalion and are relieved of all duties while in attendance at school.

All units participate fully in the Troop Information and Education Program carried on by the group. Copies of the *TIE-A&R Bulletin*, a weekly publication, are sent to the various staff sections of Eighth Army.

Under the latest group training directive, afternoons so far as is possible, are devoted to supervised athletics. During the last week in April the group conducted a series of informal games in Fryar Gym, Yokohama, with all battalions represented.

The group furnished a composite AAA battalion under the command of Lieutenant Colonel R. A. Stevens, Jr., to march in Yokohama's colorful Army Day Parade on 7 April 1947. This battalion consisted of one battery each of guns, half-tracks, and automatic weapons.

As this newsletter goes to press, the 138th AAA Group is preparing to move from its present location in central Yokohama to an area outside the City of Yokohama, pin-pointed two miles south of the Tomioka Seaplane Base.

The 209th AAA AW Battalion (SP), prior to its inactivation, was honored by the presence of Major General Clovis E. Byers, Chief of Staff, Eighth Army, at a retreat parade. The general commented favorably on the parade and on the

brief inspection which followed it. Specifically mentioned was the superior condition of "A" Battery barracks, "C" Battery supply room, the Post Exchange, and the Dispensary. Music for the occasion was furnished by the 124th AGF Band. Separate motor marches were made by "A" and "C" Batteries to Chigasaki Beach for training in driving and maintenance. The batteries bivouacked on the beach overnight and returned to Yokohama early the next morning. The two new BOQ's previously reported under construction have been completed and will be occupied shortly.

An "Open House" and artillery drill demonstration were held by the 753d AAA Gun Battalion on 18 April 1947. Visitors were conducted to the various battalion installations by guides who pointed out and explained items and points of interest. A firing battery, made up of graduates of the battalion's Noncommissioned Officers School and commanded by Captain Robert K. Routh, gave a demonstration of the selection and occupation of a gun battery position in the field. At the conclusion of the demonstration certificates of proficiency as Second-Class Gunners were presented to the graduates of the class. The field kitchen of the demonstration battery served refreshments to the guests and the 124th AGF Band under the direction of CWO L. Y. Harkness furnished music for the occasion. On 22 May 1947 Major General Clovis E. Byers, Eighth Army Chief of Staff, inspected and reviewed the 753d AAA Gun Battalion. He praised "A" Battery's supply room and mess and was enthusiastic about the general camp arrangement.

Battery "B," 933d AAA AW Battalion (SM), spent three weeks at Mito during the target practice phase of their MTP schedule. This battery was the first in the battalion to fire 40mm guns and the first to fire at radio-controlled target planes. Satisfactory results were obtained in both cases. As enlistments expire, the battalion continues to lose men for whom replacements are not forthcoming. This loss of personnel has forced temporary discontinuance of MTP training as all men are needed for security guard.

Sixteen men of the 538th Searchlight Battery (Sep) were commended by the Director of Operations, 1539th AAFBU, Western Pacific Wing, Pacific Division, Air Transport Command, APO 226, for exhibiting fine military bearing, pride, and interest in their work in connection with the operation of searchlights sited at Haneda Army Air Base. Captain Robert C. Dufault assumed command of the 538th AAA Searchlight Battery (Sep) on 8 May 1947 when Captain William Beveridge was placed on TDY in connection with AA liaison duties with the 314th Composite Wing.

Lieutenant Colonel Ralph A. Stevens, Jr., Director of Training, 138th AAA Group, has been detailed to the War Crimes Commission, Yokohama Division. Lieutenant Colonel Russel M. Nelson, who recently arrived from Manila, P. I., has replaced Colonel Stevens as Director of Training.

The group commander and his S-3, together with all the battalion commanders, completed a six-day inspection and reconnaissance of airfields assigned to this command for anti-aircraft artillery protection. They traveled by rail and motor to fields located in Kyushu and southern Honshu.

The months of April and May were banner months for

the arrival of dependents. The number of families of officers and men in the group now in Japan has risen from 27 to 45, with many more expected in June and July.

The following officers arrived during April and May and were assigned as shown below:

138th AAA Group: Lieutenant Colonel Russel M. Nelson; Captain Clair B. Penzkofer.

753d AAA Gun Battalion: Chaplain Primus Bennett.

933d AAA AW Battalion: Captain Freeman M. Gause;

Lieutenant Basil R. Osgood; WOJG William Wallace. 76th AAA AW Battalion: Major Winfield H. Sage; Captain Paul G. Chilton; Lieutenant Jacob J. Berg; Lieutenant Jake Humble, Jr.; Lieutenant Harold R. Hill; Lieutenant Jack Meiss; Lieutenant Edo G. Venditti; CWO Clarence L. Larkin; WOJG Otis G. Lamb.

Departures: Lieutenant Edgar L. Denniston, Asst. Group S-3 sailed for the U. S. on 28 May 1947 for separation from the service.



32D ANTI-AIRCRAFT ARTILLERY BRIGADE

LUZON, P. I., APO 707

BRIGADIER GENERAL FRANK C. McCONNELL, *Commanding*

By General Order No. 52, Headquarters Philippines-Buyukyus Command, dated 7 May 1947, the 32d Antiaircraft Artillery Brigade was inactivated on 30 May 1947. This action brought to an end the activities of the last AAA Brigade in the United States Army.

The colorful and creditable war record of this unit has been recited in a recent feature article in the JOURNAL and will not be repeated here.

Needless to say, the past few weeks have been occupied in the multitudinous duties all units have on inactivation, such as turning in property, reassigning personnel and submitting final reports.

Following are the new assignments of all remaining personnel on the date of inactivation:

Brigadier General McConnell—Headquarters, 8th Army. Lieutenant Colonel William M. Hoke—670th Medium Port for return to the Zone of Interior.

Captain Nicholas J. Bruno—Headquarters, Marianas-Bonins Command, APO 246.

Lieutenant Verdie B. Presley—Headquarters, 8th Army.

ENLISTED MEN

First Sergeant Clyde A. Lowery—Headquarters, 8th Army.

Sergeant Charles A. Farrell—738th M.P. Bn.

Tec 4 Norbert C. Edwards—Paranaque Repl & Disp Ctr.

Tec 4 Max R. Keesey—Paranaque Repl & Disp Ctr.

Tec 5 Bronislaus J. Moskal—Paranaque Repl & Disp Ctr.

Tec 5 Charles W. Nimmo—Paranaque Repl & Disp Ctr.

Tec 5 Dwight L. Nichols—8115th Service Detachment.



69TH ANTI-AIRCRAFT ARTILLERY GROUP

SAIPAN, APO 244

COLONEL WILLIAM C. McFADDEN, *Commanding*

The 69th AAA Group with its attached battalions at greatly depleted strength, both in officer and enlisted personnel has been managing to sustain a reduced training schedule, to include radar tracking missions and automatic weapon firing practices at balloon targets, however, the outlook for the future remains bright with the expected arrival of enlisted replacements.

The Group has bid, or is about to bid adieu to the following officers and their families: Lieutenant Colonel Joseph C. Moore, Major Jack G. Sweek, Major Elmer P. Cutis, Major Adellon F. Hanson, and Captain Woodrow A. Jones.

Recent arrivals include the families of the following: Captain John S. Farra and Captain Herbert W. Conklin.

Officers who have recently arrived for duty include the following: Lieutenant Colonel Leslie J. Staub, Major John Downey, Jr., Captains Thomas L. McNerney, Jabez A.

Smith and Merle E. Campbell, First Lieutenant Gordan Boswell, Jr., Second Lieutenants Richard H. Bacon, Jr., Lawson D. Bramblett, John J. Byrne, James E. Carter, Edward W. Jones, Jack B. Hagel, Ralph A. Meola, John Marberger, Paul A. Kelley, John W. Gillespie, Jr., Thomas E. Pfeifer, Richard L. Ruble, Robert S. Daniel, Jr., Francis M. Pelmatier, Stanky D. Fair, Daniel J. Finnegan, and James L. Andrews, Jr.

This "Paradise of the Pacific," and this description is by no means an exaggeration, is rapidly taking on the appearance and activities of a stateside garrison. Intensive efforts are being made to improve the welfare of all personnel, military or dependent. Saipan with an average temperature of 78 degrees, with its cooling breezes and its delightful swimming beaches, is one of most healthful spots in the Pacific. Numerous recreational facilities have been made available to all. Many fine clubs are now in operation and the group is particularly proud of the recently opened stateside soda fountain. A Saipan Boosters' Club would have no difficulty gathering material for discussion, for the attractions and inducements are many.

South Sector Command

FORT RUGER, HAWAII, APO 956

BRIGADIER GENERAL JAMES E. MOORE, *Commanding*

The South Sector Command, charged with incorporating Oahu's seacoast and antiaircraft operations into the overall ground forces defenses of the island, experienced many staff changes during the months of April and May.

Colonel Leonard L. Davis, who was relieved as Chief of Staff early in May for reassignment on the mainland, was replaced by Colonel Earl J. Murphy, former Chief of Staff of the Hawaiian Artillery Command.

The month of May saw the departure of 17 officers. In this group, many branches of service other than Coast Artillery were represented from the ten posts of the command. Although the officers departed before their replacements arrived, the command continued to function efficiently until

an influx of new officers in late May brought the command up to its full strength.

Enlisted strength dwindled during this period because of the expiration of short-term enlistments and the return of selectees to civilian life. It is expected that units will increase in enlisted strength in the near future as new men arrive from the mainland.

In the army motor show at Schofield Barracks in early May, prizes were given in a variety of contests to test the skills of drivers and mechanics. Members of the South Sector Command placed first in two contests and third in two others. The motor show is planned to be an annual event for the Army Ground Forces of the Pacific.



35TH COAST ARTILLERY MAINTENANCE DETACHMENT

FORT RUGER, HAWAII, APO 956

COLONEL DONALD C. HAWLEY, *Commanding*

With the completion of family quarters for noncommissioned officers and their families at six seacoast battery positions of the 35th Coast Artillery Maintenance Detachment, and the withdrawal of the small caretaking detachments formerly located at these positions, three roving maintenance teams are performing all maintenance. These teams are located at Batteries Hatch, Burgess and Demerritt and provide necessary maintenance there and at the other adjacent areas.

On 10 June 1947, Colonel Donald C. Hawley assumed

command of the 35th and the posts of Ft. Ruger and Ft. Hase, replacing Lieutenant Colonel Charles G. Young who is scheduled to return to the mainland for reassignment in early July.

Other 35th officers include: Major Maurice J. Palizza, Executive Officer; Captain George McCarty, Artillery Engineer; Captain Andrew Daly, Communications Officer and Captain John A. Padenburg, Commanding Officer of both Headquarters and Headquarters Detachment and the 35th CA Maintenance Detachment.

A new arrival is First Lieutenant Leonard K. Olvis, who until recently was stationed at Ft. Stevens, Oregon. Captain Robert B. Graham left the command in May to return to civilian life.



98TH ANTI-AIRCRAFT ARTILLERY GROUP

FORT KAMEHAMEHA, HAWAII, APO 956

COLONEL JOHN HARRY, *Commanding*

The 98th AAA Group, with headquarters at Ft. Kamehameha now numbers the following among its units: 97th AAA Gun Battalion, Ft. Kamehameha; 867th AAA Automatic Weapons Battalion, Ft. Ruger; 88th Searchlight Battery, Schofield Barracks; 1st AGFPAC Radio-Controlled Target Unit, and the 31st Operations Detachment both at Ft. Kamehameha.

During April and May, there were many personnel changes throughout the 98th Group. In the 97th, Lieutenant Colonel Raymond C. Cheal recently succeeded Lieutenant Colonel Kenneth E. Tilton as battalion commander. Colonel Tilton, who had commanded the 97th since October 1946, returned to the mainland for duty with Fifth Army headquarters in Chicago.

Other new 97th staff officers include: Major Frank L. Coleman, Executive Officer, vice, Major Charles Odenweller, Jr., another stateside returnee; Major Woodrow J. Steichen, S-3; Captain James F. Beers, S-2; Captain Jesse

H. Colley, Medical Officer; Captain Benson Grant, S-4 and First Lieutenant Archie D. Brown, Radar Officer.

New 97th line officers are: Captain Karl W. Lehman and First Lieutenant William M. Dicke, Jr., Headquarters Battery; First Lieutenant Harry J. Kammel, A Battery; Captain Norman E. Fine, B Battery and Captain Delbert Carpenter, C Battery.

In the 867th, new staff officers are: Major Charles F. Bracken, on detached service as Executive Officer of Ft. Armstrong and Camp Sand Island; Major Joseph C. Cox, Executive Officer; Captain Walter A. Chavet, S-3; Captain Hugh R. Waters, Medical Officer; First Lieutenant Alexander E. Berger, Communications Officer; First Lieutenant George J. Coleman, First Lieutenant William Wempere and Second Lieutenant Gordon M. Cheatham. In the 867th lettered battery arrivals are: Captain William S. Wall, First Lieutenant Louis P. Kershinar, First Lieutenant William P. Riggs and First Lieutenant Anthony D. Serpe, of A Battery. Captain Bob G. Olsen is new B Battery commander and First Lieutenant Paul V. Wolf, new commanding officer of C Battery.

Newcomers to the 88th are: First Lieutenant Kenne

R. Balsley and First Lieutenant Ralph B. Raperto, as are Captain Leo P. Ticheli and First Lieutenant Alvin E. Fort of the RCTU and First Lieutenant Cyril C. Disney of the 31st.

The greatest change, however, has been in the group staff itself, which has had a complete turnover in the officer personnel in the past few months. New Group Commander is Colonel John Harry, formerly Commander of US Army Forces, New Caledonia, who succeeded Colonel William L. McPherson early in May. In addition to his duties as group commander, Colonel Harry is commanding Officer of Ft. Kamehameha, Ft. Weaver, Ft. Barette and Camp Malakole, and artillery officer in charge of Oahu's antiaircraft defenses.

New Executive Officer for the group is Lieutenant Colonel Harry F. Townsend, who is also post Executive Officer. Other new group staff members are: Lieutenant Colonel

Charles W. Stewart, S-3; Major Theodore Johnson S-4; Captain Edgar A. Kneese, S-1; and First Lieutenant Leo Lemberg, S-2. Rounding out the list of recent arrivals are: Captain Howard F. Cue, assistant S-4; Captain Arthur D. Douglas, assistant S-3; Captain Harry A. Filmer, CE, Post Engineer; First Lieutenant Vincent D. Earl, SC, Communications Officer; First Lieutenant Weldon G. Lawrence, Special Service Officer and First Lieutenant Franklin H. Tuscany, Group Food Supervisor.

Other 98-ers who left recently for the mainland include: Major Thomas H. Mayers, who had served on Oahu since November 1944, with the 793d AW Battalion (now inactivated) and was until his departure, group S-4; Lieutenant (jg) Lloyd E. Schwartz, Group Dental Officer on detached service from the Navy and First Lieutenant Donald E. Smith, formerly Commanding Officer of Headquarters Battery, 97th AAA Gun Battalion.



305TH ANTI-AIRCRAFT ARTILLERY BRIGADE

NEW YORK, NEW YORK

COLONEL H. RUSSELL DROWNE, JR., *Commanding*

The 305th AAA Brigade to which all Coast Artillery Reserve units in the New York Metropolitan area are assigned, was organized 1 Nov. 1946 with Colonel H. Russell Drowne, Jr., commanding. During the war, Colonel Drowne was Executive Officer of the 102d AAA Brigade with which he served from the date of Federalization until he left it to return to the States after VJ Day. Activation ceremonies were held for Brigade Headquarters and Headquarters Battery in conjunction with those for the Headquarters 77th Infantry Division and XXII Corps Artillery Headquarters at City Hall, New York City on 20 February 1947. Colors were presented to the Brigade Commander by The Secretary of War.

All organizations under 305th Brigade have been activated and all major units organized and personnel assigned. They are:

<i>Unit</i>	<i>Commanding</i>
313th CA Harbor Defenses	Col. Thomas F. Byrne, CA-Res
315th CA Harbor Defenses	Col. Rowland K. Bennett, CA-Res
316th CA Harbor Defenses	Col. Walter A. Heesch, CA-Res
138th Group	Col. John S. Mayer, CA-Res
145th Group	Col. Julius F. Mercandino, CA-Res
153d Group	Col. George L. Clarke
160th Group	Col. Vincent A. Lane, CA-Res
397th AAA AW Battalion (SP)	Lt. Col. John C. Clark, CA-Res
430th AAA AW Battalion (Mob)	Lt. Col. Wm. F. Nelson, CA-Res
326th AAA Operations Detachment	Maj. John F. Boyer, CA-Res

Activation ceremonies were held for the above units at Times Hall, New York on 19 June 1947 at which the colors were presented by Major General James A. Van Fleet, U.S.A. Deputy Commander, First Army and Commander New York-New Jersey-Delaware Military Area. Brigadier

General Bruce C. Clarke, Asst 4, G-3, Army Ground Forces, gave the principal speech of the evening on "Future Warfare."

In addition to the above units, those organized comprise three 155mm C.A. Gun Batteries, three Mine Planter Batteries, three C.A. Searchlight Batteries, two 16" Gun Batteries, one 8" Gun Battery, and a H.D. Headquarters Battery.

The 397th AAA AW Battalion (SP) had service in the war as a semimobile battalion. It will be remembered as the unit from which a provisional machine-gun battalion was formed for attachment to the 1st Infantry Division for the Normandy landing on Omaha Beach, the balance of the battalion providing antiaircraft protection for the landing from the Phoenix barges that formed the artificial harbor. An unusual coincidence was noted that Colonel Mayer who was the last Commanding Officer of the old 397th was a participant in the ceremonies reactivating it.

The only other unit reactivated in the same form as its counterpart in World War II is the 430th AAA AW Battalion. The 313th, 315th and 316th Harbor Defenses were formerly the 103d, 105th, and 107th AAA Groups respectively. The 326th Operations Detachment saw war service as the 144th AAA Operations Detachment.

A brigade training program has been issued and is being followed by all the organized units, each of which has had two or three monthly meetings. Plans are being formed by a number of units to visit Fort Hancock during the summer to conduct a simple CPX or inspect the Harbor Defenses, finishing up with a beach party and social evening. The 313th Harbor Defenses was the first unit to follow this program, visiting Fort Hancock on 28-29 June.

Most all major units have had one or more officers on fifteen or ninety days' active duty at Coast Artillery Reserve Headquarters, 90 Church Street which has proved invaluable in the organization and preparation of training schedules and records of their organizations. It is hoped that enlisted Reservists, recently assigned will also take advantage of this duty as the permanent staff assigned to this Headquarters is far too small to handle the mass of detail necessary for administration and training.

74TH ANTI-AIRCRAFT ARTILLERY BRIGADE

CHICAGO, ILLINOIS

COLONEL THOMAS F. MULLANEY, JR., *Commanding*

Headquarters and Headquarters Battery, 74th AAA Brigade, activated as a Reserve Unit in Chicago, Illinois 14 November 1946, is the first Reserve Unit in Illinois to seek classification in the "B" unit category. On the basis of the unit's current assigned strength of fourteen officers and seventeen enlisted men, Acting Commanding Officer, Colonel Thomas F. Mullaney, Jr., CA-Res, has petitioned the War Department for advancement into "B" category.

Since activation, members of the Brigade staff, ably assisted by this area's Regular Army Instructors for the Organized Reserve, Colonel Wilfred H. Steward and Major Willis F. Whitaker, have conducted a widespread campaign to interest former commissioned and enlisted antiaircraft personnel in the Brigade, and in three other recently activated Chicago antiaircraft units. These are the 564th AAA Composite Group, commanded by Colonel Joseph B. Vlack, CA-Res.; the 383d AAA AW Battalion (SP), commanded by Lieutenant Colonel William F. Moehle, CA-Res.; and the 168th Operations Detachment, commanded by Major John R. Reynolds, CA-Res.

Personnel of the four units have been conducting joint monthly meetings since activation. Although facilities adequate for training are not as yet available, the meetings have proven instructive and interesting. A contributing factor has been the almost exact balance between personnel whose service was in the Pacific Theater and those serving in the European. Of the 74th Brigade's staff, for example, seven officers saw service in Europe, six in the Pacific, and one in the American Theater. For this reason, alternate meetings have been given over to discussions of the various antiaircraft problems encountered in the different theaters. Both War Department and personal films have been utilized in these discussions.

The present staff of the 74th AAA Brigade is as follows: Acting C.O., Colonel Thomas F. Mullaney, Jr.; Executive Officer, Lieutenant Colonel Charles L. McGee; S-1, Captain Hervey R. Jenkinson; S-2, Major James W. Switzer; S-3, Lieutenant Colonel Henry B. Coleman; Asst. S-3, Captain Ralph P. Rickman; S-4, Major Bernard L. Hirsh; Asst. S-4, Captain Edwin L. Morris; Rad Off, Major James R. Keach; Asst. Rad Off, Captain Harry L. Sayles; and Hq Btry C.O., Captain Alan Bihlmeier. Attached, as Asst. S-3 are Lieutenant Colonels Jesse L. Butler and Theodore H. Kuyper, and as Asst. Radar Officer, Captain Robert V. Suhrke.

**260TH ANTI-AIRCRAFT ARTILLERY GROUP**

WASHINGTON, D. C.

COLONEL LEROY S. MANN, *Commanding*

The 260th Antiaircraft Artillery Group, District of Columbia National Guard, is now installed in the immense new District of Columbia National Guard Armory, located about a mile and a half east of the Capitol. Although this building was completed in 1941, various bureaus and offices of the Executive Department, including the Federal Bureau of Investigation, occupied it until early in June, 1947.

The new Armory was eloquently dedicated "to the glory of God and the use of the District of Columbia National Guard" by Brigadier General Albert L. Cox, Commanding General of the District of Columbia Militia, at a large gathering of official and private friends of the Guard held in the two hundred by four hundred foot drill hall of the armory on Sunday, 29 June 1947, after the troops were formed. General Cox, who acted as host and master of ceremonies, introduced the speakers, who included Lieutenant General LeRoy Lutes of the War Department General Staff, Colonel Edward J. Geesen, Acting Chief of the National Guard Bureau, and Brigadier General Claude E. Ferenbaugh, Commanding General of the Military District of Washington.

Certificates of Service were awarded during the ceremony to all members of the District of Columbia National

Guard who were inducted into Federal Service in 1941 during the emergency mobilization.

After the ceremony, the troops, commanded by Colonel Mann for the occasion, were reviewed by General Cox and the distinguished guests on the reviewing platform. Detachments of the 260th AAA Regiment Association and the 121st Engineer Regiment Association marched in the review immediately behind the 260th AAA Group. In addition, several Air Forces and other units of the District of Columbia Guard also marched.

The 260th occupies all of the South Building, leading off the drill hall, and part of the West Building. The State Staff and Headquarters of the District of Columbia Guard are located in the North Building. The Military Police Battalion occupies the greater portion of the West Building and Air Forces units occupy the East Building.

The District of Columbia Guard, and particularly the 260th, for the first time in District of Columbia history, now have adequate quarters. Their attractiveness is expected to speed the activation and Federal recognition of the many batteries of guns, searchlights and automatic weapons on the table of organization of this old and tried organization.

Just recently, the 104th Antiaircraft Ordnance Maintenance Company, commanded by Second Lieutenant Ben H. Watkins, received Federal recognition and "A" Battery of the 260th AAA Gun Battalion, which is commanded by Captain Abram L. Greene, has been inspected preparatory to being granted Federal recognition.



51ST ANTI-AIRCRAFT ARTILLERY BRIGADE

ALLENTOWN, PENNSYLVANIA

BRIGADIER GENERAL CHARLES C. CURTIS, *Commanding*

Units of the 51st AAA Brigade, Pennsylvania National Guard, which include such types of anti-aircraft artillery troops as 90mm Gun Battalions, Automatic Weapons Battalions, Searchlight Battalions, AAA Ordnance Companies, Engineer Searchlight Maintenance Units, Signal Radar Maintenance Units, Group and Brigade Headquarters, and an AGF band, are steadily increasing their strength in answer to the country's need for a strong citizen reserve force. To date, over 700 enlistments have been received, and more are coming in daily.

Recruiting has been greatly aided by the financial and moral support of many patriotic firms and individuals, who realize the importance of the National Guard to the community and to the nation as a whole.

At the present time "D" Battery, 690th AAA AW Battalion, First Lieutenant Joseph C. Buggy commanding, is showing the way for the entire State of Pennsylvania in number of men federally recognized.

With enlistments gaining momentum during the months of April, May, and June, the present strength of anti-aircraft artillery troops in Pennsylvania has surpassed the pre-

World War II strength by a goodly margin. Strong efforts are being made to strengthen all units for the coming summer encampment.

Armory training activities throughout the State have increased greatly since units began receiving their equipment. Ninety millimeter guns, 40mm half-tracks and .50-cal. machine guns have been the main items received by individual outfits. A great deal of communication equipment has been distributed throughout the Brigade. Radar sets are expected to arrive this summer.

Specialist schools are being conducted in radio, motor vehicle maintenance and administration. Capable veteran instructors are in charge of these classes as well as other military subjects.

The 243d AGF Band, first Pennsylvania National Guard unit to be federally recognized (August 1946), received its instruments in April and is now staging regular rehearsals under WO Wilbur Moyer. The band will supply the martial music when units of the 51st AAA Brigade head for summer training at Indianatown Gap, Pennsylvania, in August of this year.

In the only major Brigade reassignments, Colonel John H. Brubaker has been made Brigade Executive Officer, and Colonel Harry A. Markle has assumed command of the 213th AAA Group.

**ANTI-AIRCRAFT SECTION, HEADQUARTERS EIGHTH ARMY**

YOKOHAMA, JAPAN, APO 343

COLONEL M. A. HATCH, *Antiaircraft Officer*

The anti-aircraft section of the Eighth Army was inactivated as a special staff section on 25 June with the departure of Colonel M. A. Hatch to Headquarters Fifth Army and Lieutenant Colonel K. C. Smith to the Command and General Staff College. Major C. O. Loos was transferred to the G-1 Section. The last major project of the section was the preparation of the Eighth Army directive on passive defense measures against air attack.

The newly formed artillery division in the G-3 Section is charged with anti-aircraft matters at army level with Lieutenant Colonel R. M. Nelson in charge.

There is a sizable contingent of Coast Artillery officers on duty with the army staff in the sections indicated:

Col. J. G. Devine	Military Government
Col. George Easterday	Judge Advocate
Col. A. L. Ramon	Judge Advocate
Col. H. S. Tubbs (GSC)	G-3
Lt. Col. E. S. Bibb	Judge Advocate
Lt. Col. J. A. Butler	Judge Advocate
Lt. Col. E. P. Clay	G-4
Lt. Col. J. C. Conell (IGD)	Inspector General
Lt. Col. R. C. Dougan (GSC)	G-4

Lt. Col. C. D. Hill	Judge Advocate
Lt. Col. F. A. Liwski (GSC)	G-1
Lt. Col. A. L. Sanford	G-4
Lt. Col. J. T. Snodgrass	Military Government
Lt. Col. T. H. Watkins	Army Exchange Service
Lt. Col. R. A. Stevens	Judge Advocate
Maj. W. M. Brunner	Army Exchange Service
Maj. R. E. Burt	Troop Information and Education
Maj. B. C. D'Ewart	Engineer
Maj. C. J. Hutson	Judge Advocate
Maj. C. C. Ringwalt	Judge Advocate
Maj. W. H. Sage	Judge Advocate
Maj. M. H. Schultz	Engineer
Maj. W. B. Smith	Engineer
Capt. C. D. Campbell	Special Service
Capt. H. S. Dolsey	Military Government
Capt. A. O. Ellis	Military Government
Capt. W. F. Gilfillan	Provost Marshal
Capt. W. T. Hendricks	Judge Advocate
Capt. J. W. Jacobson	Military Government
Capt. H. H. Landers	Military Government
Capt. P. N. McCarthy	Military Government
Capt. J. A. Norton	Adjutant General
Capt. C. F. O'Donnell	Military Government
Capt. W. P. Weiss	Army Exchange Service
Capt. J. W. Wycoff	Military Government
1st Lt. R. S. Bennett	Ordnance
1st Lt. J. F. Sansom	Special Service



65TH ANTI-AIRCRAFT ARTILLERY GROUP

FORT AMADOR, PANAMA CANAL DEPARTMENT

COLONEL HAROLD A. BRUSHER, *Commanding*

Brigadier General F. P. Hardaway reviewed all Pacific Sector troops for the last time, prior to leaving for the States and retirement, at a review held at Fort Clayton on 24 May at which many prominent military, naval, diplomatic and government figures were present to pay their respects. General Hardaway will be remembered by many as Commanding General of the Panama Coast Artillery Command at the time it was inactivated and the present Sector organization instituted. He has been succeeded as Sector Commander by Colonel P. B. Rutledge, his former Deputy Commander.

A distinguished visitor during May was General Cipriano Olivera, Chief of Staff of the Uruguayan Army who visited anti-aircraft artillery installations as part of his tour of the Isthmus while en route to the U. S. as a guest of the War Department.

At Fort Amador on 6 May, officers of Headquarters 65th AAA Group, 764th AAA Gun Battalion, and 903d AAA AW Battalion, tendered a farewell party to Colonel M. G. Armstrong, Group Commanding Officer, and CWO M. T. Tulley, Group Adjutant, both of whom have since left for the States for reassignment. Lieutenant Colonel C. H. Tanner, Executive Officer, succeeded to command of the Group and First Lieutenant Evert V. Youngs, replaced CWO Tulley as Group Adjutant.

Atlantic Sector sponsored a review on 26 April at Ft. Wm. D. Davis which had added color in the participation of Navy personnel. Lieutenant General W. D. Crittenger, Theater Commander, reviewed the troops accompanied by Admiral W. E. Shafer, Commander of the 15th Naval District. Following the parade, Lieutenant General Crittenger presented the Department baseball championship cup to the winning Navy team through Admiral Shafer who in turn presented individual awards to the several members of the team. Among other awards, a cup for the outstanding day-room of field units was accepted by First Lieutenant Werner, Battery Commander of Battery "B," 764th AAA Gun Battalion.

Three hundred and seventy continental troops, mainly young enlistees, who arrived on 29 April, practically brought the Group up to T/O strength, whereas it had been de-

creasing rapidly, as men in various categories had been returned to the States for separation or reassignment in recent months.

At a Battalion parade on 5 May 1947, Staff Sergeant Elmer N. Knutson, Headquarters Battery, 903d AAA AW Battalion, was the recipient of a Bronze Star for meritorious service in connection with military operations in the ETO from 1 May 1944 to 10 May 1945, during which time he served with the 634th AAA AW Battalion, then assigned to the Third Army. The Battalion was reviewed by Colonel M. G. Armstrong, Commanding Officer of the 65th AAA Group, and Lieutenant Colonel Jack Schrader, Battalion Commander, while Major R. S. Harlan acted as commander of troops. As the citations were read by CWO B. J. White, Colonel Armstrong also presented American Defense Service Medals to several members of the Battalion. At a similar ceremony on 20 May Technical Sergeant Robert L. Haldeman, Headquarters Battery, 65th AAA Group, was presented an American Defense Service Medal by Lieutenant Colonel C. H. Tanner, Group Commander. Sergeant Haldeman was in Hawaii when the Japs struck and continued through Pacific operations with the Headquarters Battery, 176th CA Battalion.

The departure of Colonel Wayne L. Barker, Commanding Officer of the Corozal General Depot since May 1946 for Washington, D. C., was announced on Friday, 13 June at Quarry Heights. Colonel Barker will remain in Washington for a brief period for orientation and instruction pending issuance of orders directing his assignment to Europe in connection with the administration of the United States loan to Greece. Colonel Barker arrived in the Canal Zone for duty in October 1945, and at that time was assigned to duty with the Coast Artillery Command.

The following newly arrived CAC officers have recently been assigned to the 65th AAA Group: Captains W. G. Trigg, J. C. Cole, Jr., and J. P. Wilson, and Second Lieutenant Robert T. Wagner.

Three reserve officers have recently completed active duty tours with the 903d AAA AW Battalion—Major C. E. Brame (CAC), now an employee of Navy Supply Branch; Major D. M. Anderson, FA, who is a civilian employee with Pan Canal Engineer Office, and First Lieutenant J. H. Loftis, FA, an employee of Panama Air Depot.

Major Brame formerly served here with the 615th CA Regiment and the 903d AAA AW Battalion, prior to his separation from the active service.



EDITOR'S NOTE: Information has just been received that Colonel Tanner died suddenly on 4 July while witnessing a golf match. His loss is mourned by all who knew him. Colonel Tanner was given a full military funeral on 8 July at which last respects were paid by the multitude of his friends.

Colonel Harold A. Brusher assumed command of the Group following the untimely passing of Colonel Tanner. Colonel Brusher joined the Group from the Panama Canal Department where he was Chief of the Special Service Division.



The Seacoast Branch, The Artillery School

MAJOR GENERAL ROBERT T. FREDERICK, *Officer In Charge*

The courses of instruction officially designated by Army Ground Force Headquarters for the Seacoast Branch of The Artillery School during the coming school year, commencing September, 1947, are as listed below:

Officer Courses

Associate Basic	13 wks.
Seacoast Artillery Gunnery	18½ wks.
Seacoast Electronics	18½ wks.

Enlisted Courses

Seacoast Artillery Tech.	18½ wks.
Casemate Electrician	18½ wks.
Submarine Mining Operations	18½ wks.

On 22 June, ninety-seven Reserve Officers from throughout the eight western states which comprise the Sixth Army area arrived at the School for attendance at the Indoctrination Course No. 1. This Reserve Officer Refresher and Indoctrination course, outlined by AGF Headquarters, was well calculated to present the big picture of current Army operations, and the latest developments in weapons and materiel.

Twelve hours of classroom time was devoted to committee studies of important battles of World War II. Four committees were formed and they conducted extensive research on the operation assigned to them for study. During the last four days of the classes, the committees, each in turn, gave the entire class an analytic digest and critique of the operation they had studied.

Two other Reserve Officer Indoctrination Courses, similar to the one outlined above, are scheduled for the months of July and August, respectively.

Sixteen students from Fordham and fourteen from the University of Washington arrived on 23 June to attend

ROTC, CAC (Seacoast) Summer Camp at Fort Baker. The camp is scheduled for six weeks of training.

On the afternoon of 28 June, the School was host to some 45 officers of the 112th AAA Brigade, National Guard, of California. After a greeting by Colonel Daniel W. Hickey, Jr., Director of Instruction for the School, they went on a guided tour of the electronics laboratories and inspected the radar and other equipment used in the school for instructional purposes.

The Faculty members of the School and the officers of the 112th AAA Brigade dined together that evening at the SBAS Officers' Mess. Brigadier General David P. Hardy, Commanding the 112th AAA Brigade, spoke to the assembled group briefly, and then introduced Major General Robert T. Frederick, Commandant of the School, who made the principal address of the evening.

General Frederick visited the UMT Experimental Unit at Fort Knox early in June. On his return trip to Fort Scott, he was the guest of Major General Clift Andrus at Fort Sill for the graduation of the first Officers' Advanced Class since World War II from the Artillery Center.

Colonel Kenneth G. Wickham, former Inspector of the School, left on a 60-day leave early in June. At the conclusion of his leave he will report to the Armed Forces Staff College.

The following changes occurred during the month of May 1947:

DEPARTURES

Name	Destination
Capt. James F. Beers	Trfd to O/S Repl Depot
Capt. Walter A. Chavet	Trfd to O/S Repl Depot
1st Lt. Ira S. Eintracht	Trfd to O/S Repl Depot
1st Lt. Hugh W. Flenniken	Trfd to O/S Repl Depot
WOJG Edward V. Sargent	Trfd to O/S Repl Depot

The following changes occurred during the month of June 1947:

ARRIVALS

Name	Department
CWO Ira L. Roach	Administrative Assistance, Sc Sv Test Section
1st Lt. Edward D. Dahill	Casemate Officer, Mine Detachment

DEPARTURES

Name	Destination
Col. Kenneth G. Wickham	Trfd to Stu Det, Armed Forces, Staff College, Norfolk, Va.
Maj. Thomas P. Caulfield	Trfd to Stu Det, Hq 2d Army, Baltimore, Md.
Capt. Richard Pullen	Trfd to Stu Det, Mine Sv Language Sch, Presidio of Monterey, California
WOJG Joseph T. Fuss	Camp Stoneman, Pittsburg, California





The Antiaircraft Artillery and Guided Missiles Branch, The Artillery School

FORT BLISS, TEXAS

MAJOR GENERAL JOHN L. HOMER, *Officer In Charge*

The following changes occurred during the month of May 1947:

ARRIVALS

Name	Department
Maj. John E. Campbell	Not yet joined
Capt. James F. Keenan	Personnel
Capt. Robert G. Pickins	Not yet joined
Capt. Thomas E. Ramsey	Not yet joined
Capt. Charles Stoetzer	Research and Analysis
1st Lt. Alden W. Hibbard	Not yet joined
CWO Harry L. Staley	Electronics Dept.
CWO Louis J. Arnau	Director of Instruction
WOJG Frank Dudowicz	Gunnery Dept.
WOJG Joseph Gravel	S-4

DEPARTURES

Name	Destination
Lt. Col. Wm. M. Branan, Jr.	Separated from Service
Lt. Col. Kermit R. Schweidel	CMB, Washington, D. C.
Maj. Joseph Zimmerman	Separated from Service
Capt. Carmine J. Cianfrocca	Separated from Service
Capt. James M. Bouton	Separated from Service
Capt. Karl W. Lehmann	ORD, Camp Stoneman, Calif.
Capt. Edward F. Keevan	OC of S, Wash., D. C.

Capt. Edward T. Maguire Separated from Service
1st Lt. Wm. H. McDermott RTC, Ft. Dix, New Jersey
1st Lt. William Wempren ORD, Camp Stoneman, Calif.

The following changes occurred during the month of June 1947:

ARRIVALS

Name	Department
Col. Lawrence W. Bartlett	Not yet joined
Maj. Maurice A. Mathews	Research & Anal
Maj. Linus P. Word	TL & VA
Maj. Franklin A. Ayer	Ext Crses
Maj. Peyton R. Lucas	Training Literature & Visual Aids
Maj. Joseph P. Mastrucci	Not yet joined
Maj. Frank D. Pryor, Jr.	Gunnery Dept.
Maj. Constantine Vardus	Not yet joined
Capt. Frederick L. Schumm	Gunnery Dept.
Capt. John P. Tawes	Not yet joined
Capt. Reno A. Mayzucchi	TDY, Pasadena, Calif.
Capt. Howard W. Feindel	Electronics Dept.
Capt. Carl G. Weeks	Not yet joined
Capt. Louis S. Francisco	Not yet joined
Capt. Charles M. Mell	Not yet joined
Capt. Robt. H. Williamson, Jr.	Training Literature & Visual Aids
Capt. James J. Kelleher	Not yet joined
1st Lt. John L. West	Training Literature & Visual Aids
1st Lt. Harry E. Clark	Not yet joined
WOJG William J. Fayne	Not yet joined

DEPARTURES

Name	Destination
Maj. Jack K. Boyer	4001st ASU, Ft. Bliss, Texas
Capt. Thomas E. Ramsey	Hq, Sixth Army
Capt. Forrest B. Tilson	Hq, Sixth Army
Capt. Jack W. Bradley	Det of Pnts WBGH, El Paso, Texas
Capt. Wm. P. McKinney, Jr.	Separated from Service
Capt. Walter G. Andrews	Separated from Service
CWO Carlton T. Freese	Ground General School, Ft. Riley, Kans.
WOJG Newton F. Freeland	Ground General School, Ft. Riley, Kans.
WOJG Joseph M. Gravel	284th AAA AW, Ft. Bliss, Tex



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COAST ARTILLERY ORDERS

WD and AGF Special Orders covering the period 3 May 1947 through 20 June 1947. Promotions and Demotions are not included.

BRIGADIER GENERAL

Nichols, Harold F., to be retired.

COLONELS

Schrens, Henry R., to be retired.
Boudreau, Napoleon, to RTC, Ft. Ord, Calif.
Grey, George R., to Stu Det, Armed Forces Staff College, Norfolk, Va.
Julao, Esteban B., to be retired.
Diastel, Chester J., to Hq, AGF, Ft. Monroe, Va.
Gleim, Robert F., to Sixth Army SFPE, Ft. Mason, Calif.
Hampton, William A., to Arty Sch, Ft. Sill, Okla.
Henig, William H., to Stu Det, Armed Forces Staff College, Norfolk, Va.
Holmes, Henry B., Jr., to be retired.
Holt, Roger H., to Stu Det, Armed Forces Staff College, Norfolk, Va.
Johnson, Dwight B., to Office, Chief of Staff, Washington, D. C.
Kohn, Joseph P., detailed at 3210th ASU ROTC, Hillsborough County High Schools, Tampa, Fla.
Nelson, Christian G., rld from detail in CAC.
Patterson, Charles G., to Armed Forces Staff College, Norfolk, Va. for dy w/Staff and Faculty.
Schoonmaker, Lucas E., to be retired.
Simmons, Joe F., to be retired.
Skidmore, Wilbur M., to Stu Det, Armed Forces Staff College, Norfolk, Va.
Stanton, Tom V., to Hq, AGF, Ft. Monroe, Va.
van Buskirk, Robert J., to be retired.
Waters, Fred B., to 6701st ASU, Calif.-Nevada ORC Instr Gp, Presidio of San Francisco, Calif. w/sta Ft. Rosecrans, Calif. Detailed as CAC Instr.
Weber, Milan G., to Stu Det, Armed Forces Staff College, Norfolk, Va.
Whipple, H. Bennett, resigned.
Wickham, Kenneth G., to Stu Det, Armed Forces Staff College, Norfolk, Va.
Wing, Charles K., to be retired.
Young, Ellsworth, to War Assets Adm., Kansas City, Mo.

LIEUTENANT COLONELS

Adams, Arthur A., to Antilles Dept.
Bailey, William W., to 284th AAA AW Bn, Ft. Bliss, Texas.
Barton, Chester T., to 4405th ASU, Texas NG Instr Der, Austin, Texas, w/sta El Paso, Texas.
Bigelow, Arland E., to Third Army, 3330th ASU, S. C. Mil Dist, Federal Land Bank Bldg, 1401 Hampton St., Columbia, S. C.
Borden, Nathaniel E., to First Army, Hq and Hq Det, HD of Narragansett Bay, Ft. Adams, R. I.
Brassell, Alfred L., to OC of S, Washington, D. C. for dy in SS & P Div, WDGs.
Burt, William T., Jr., to 3319th ASU, Tenn. ORC Instrs., Room 214, Stahlman Bldg., Nashville, Tenn. Detailed as Asst to Sr Instr.
Crotthers, Earl M., to Stu Det, Comd and Staff College, Ft. Leavenworth, Kans.
Darling, Francis W., relieved from active duty.
Denby, Roland F., to Philippine-Ryukyuu Command, Manila, P. I.
Ea, Clayton M., detailed in Sp S.
Francis, William H., to Stu Det, Comd and Staff College, Ft. Leavenworth, Kansas.
Gilchrist, Malcolm F., Jr., to OC of S, Washington, D. C., for dy w/Plans & Operations Div.
Gressang, John V., to Hq, AAF, Washington, D. C., for dy in OAC of AS-4, Procurement & Industrial Planning Div.
Hillberg, Lauri J., to USMA, West Point, New York.

Howard, Charles E., to 5252d ASU, Office III, State Sr Instr ORC, 1660 E. Hyde Park Blvd., Chicago, Ill., w/sta Marion, Ill., for dy as CAC Instr.
Janowski, Raymond A., to USMA, West Point, N. Y.
Keisler, David S., to 3333d ASU, S. C. NG Instr, Columbia, S. C., w/sta Newberry, S. C.
Leary, Thomas H., to The Arty Sch, Ft. Sill, Okla., for dy w/Staff & Faculty.
Lodge, Edwin B., detailed in TC, OCT, Washington, D. C.
Murray, Douglas B., detailed at 6802d ASU, ROTC, Oregon State Agricultural College, Corvallis, Oregon.
Nunamaker, Royal O., to Third Army, 3310th ASU, Tenn. Mil Dist, Nashville, Tenn.
Ogilvie, John M., Jr., to AGF Pacific, Ft. Shafter, TH.
Regis, James E., to 5257th ASU, Office Mo. State Sr Instr, ORC, St. Louis Med Depot, 12th and Spruce Sts., St. Louis, Mo. Detailed as Asst to Sr Instr.
Schmidt, Victor G., to First Army, 1202d ASU, Rctg Det 10, Springfield, Mass.
Schouman, Hazen C., to 6701st ASU, Office Calif. State Sr Instr Gp, ORC, Presidio of San Francisco, Calif., w/sta at Los Angeles, Calif. Detailed as CAC Instr.
Segarro, Rafael A., to Antilles Dept.
Shepardson, Frank H., to c/o 203d ASU, Office Sr Ground Instr, Iowa NG, Des Moines, Iowa.
Smoak, William M., Jr., detailed in JAGD, JAGO, Washington, D. C.
Smith, James P., to Stu Det, Arty Sch, Ft. Sill, Okla.
Swain, Oren, to The Arty Sch, Ft. Sill, Okla.
Tiffany, Kenneth E., to 5206th ASU, Office Sr Ground Instr, Minnesota NG, St. Paul, Minn., w/sta Cloquet, Minn.
Van Court, Lloyd P., to The Armd Sch, Ft. Knox, Ky.
Yarnall, Kenneth L., to Seacoast Br, Arty Sch, Ft. Winfield Scott, Calif.
Young, Charles G., to 2502d ASU, Pa. NG Instr Det, Room 208, 201 S. Office Bldg., Harrisburg, Pa. Detailed as CAC Instr, Pa. NG.
Young, Courtney R., to Fifth Army, 5302d ASU, III. Rctg Dist, 158 W. Harrison St., Chicago, Ill.

MAJORS

Abbott, Argyle C., to The Ground Gen Sch Ctr, Ft. Riley, Kansas.
Ayer, Franklin A., to The Arty Sch, Ft. Bliss, Texas.
Bennett, Alan, to be retired.
Bozges, Kenneth L., detailed as Asst to Sr Instr, ORC, State of Conn., Hartford, Conn.
Barber, George C., to 3339th ASU, S. C. ORC Instr Gp, 1401 Hampton St., Columbia, S. C., w/sta Anderson, S. C. Detailed as CAC Instr.
Bowman, James W., to Stu Det, Arty Sch, Ft. Sill, Okla.
Boyer, Jack K., to Fourth Army, 4001st ASU, Ft. Bliss, Texas.
Bruns, Stockton D., to The Arty Sch, Ft. Winfield Scott, Calif.
Burnham, Lee H., to Second Army, 2316th ASU, Columbus Rctg Dist, Ft. Hayes, Ohio, w/sta Marion, Ohio.
Burrell, Walter E., to The Arty Sch, Ft. Sill, Okla.
Butts, Robert E., to The Arty Sch, Ft. Winfield Scott, Calif.
Cerar, Paul R., to Stu Det, Hq, First Army, Governors Island, N. Y., w/sta Columbia University, New York, New York.

Crowe, John H., to Second Army, Ft. George G. Meade, Md.
Evans, John E., to AGO Casuals, Washington, D. C., for dy w/WD Pers Records Board.
George, Claude D., Jr., to The Arty Sch, Ft. Sill, Okla.
Geotti, John P., to The Arty Sch, Ft. Sill, Okla.
Gerard, Max H., Stu Det, Arty Sch, Ft. Sill, Okla.
Hall, Robert E., to Stu Det, Arty Sch, Ft. Sill, Okla.
Hall, Samuel B., to Antilles Dept.
Hansen, George R., to 5261st ASU, Office Wis. State Sr Instr, ORC, Milwaukee, Wis., w/sta at Milwaukee, Wis. Detailed as CAC Instr.
Hawes, Milton D., to Third Army, N. C. Mil Dist, Raleigh, N. C.
Horton, William F., to Stu Det, Arty Sch, Ft. Sill, Okla.
Kidd, Elbert M., to Antilles Dept.
Lattal, Anton, Jr., to OC of S, Washington, D. C., for dy in Office Dir of Intelligence.
Leffingwell, William M., to Panama Canal Dept.
Lepesqueur, Raymond A., to 1243d ASU, Office State ORC Instr for N. J., Trenton, N. J. Detailed as CAC Instr.
Lockwood, William W., to 1242d ASU, Office Sr State ORC Instr for N. Y., New York, N. Y., w/sta Queens, N. Y. Detailed as CAC Instr.
Lucas, Peyton R., to The Arty Sch, Ft. Bliss, Texas.
McCord, Max, to Hq, AGF, Ft. Monroe, Va.
McKee, Raymond, to AGF Pacific, Ft. Shafter, TH.
Mangum, Cledous, detailed in AC.
Marcelynas, Anthony F., to 1122d ASU, Mass. ORC, PO & Courthouse Bldg., Boston, Mass., w/sta New Bedford, Mass. Detailed as CAC Instr.
Mastrucci, Joseph P., to the Arty Sch, Ft. Bliss, Texas.
Mathes, Edward S., to Stu Det, Arty Sch, Ft. Sill, Okla.
Meyer, Arthur L., to Stu Det, Arty Sch, Ft. Sill, Okla.
Olhausen, James N., to Stu Det, Arty Sch, Ft. Sill, Okla.
Page, Benjamin N., to Marianas-Bonin Command, Guam, Marianas.
Pigue, Paul E., to Stu Det, Arty Sch, Ft. Sill, Okla.
Pride, Ronald I., rld from detail in CAC.
Pryor, Frank D., to The Arty Sch, Ft. Bliss, Tex.
Reed, William P., to OC of S, Washington, D. C., for dy w/Troop I & E Div.
Reagon, Paul R., to Stu Det, Arty Sch, Ft. Sill, Okla.
Regan, James L., to Hq, AGF, Ft. Monroe, Va.
Roach, Richard R., to Stu Det, Arty Sch, Ft. Sill, Okla.
Roberts, Sam A., to Stu Det, Arty Sch, Ft. Sill, Okla.
Salmon, Eugene H., detailed as Member GSC and asgd to WDGs.
Schwartz, Elwood G., to 4310th ASU, Office Sr Instr ORC, State of Texas, Austin, Texas, w/sta Waco, Texas. Detailed as CAC Instr, State of Texas.
Smith, Eugene, to Stu Det, Arty Sch, Ft. Sill, Okla.
Sternberg, Frederick, relieved from active duty.
Strother, Tom B., to Far East Command, Tokyo, Japan. Mailing Address: Casual Pers Sec, Central Mail Directory, APO 503, c/o PM, San Francisco, Calif.
Terry, Frank E., to 1122d ASU, Office Sr State ORC Instr for Mass., Boston, Mass., w/sta Boston, Mass. Detailed as CAC Instr.

Tilson, George E., to Stu Det, Hq, Sixth Army, Presidio of San Francisco, Calif., w/sta Univ of Calif., Los Angeles, Calif.
 Twitchell, Richard M., detailed in Sp S.
 Vardas, Constantine, to AA & GM Br, The Arty Sch, Ft. Bliss, Texas.
 Williams, James W., to The Arty Sch, Ft. Sill, Okla.
 Willis, Henry J., to 1242d ASU, Office Sr Instr ORC State of N. Y., 90 Church Street, New York, N. Y., w/sta Jamaica, N. Y. Detailed as CAC Instr.

CAPTAINS

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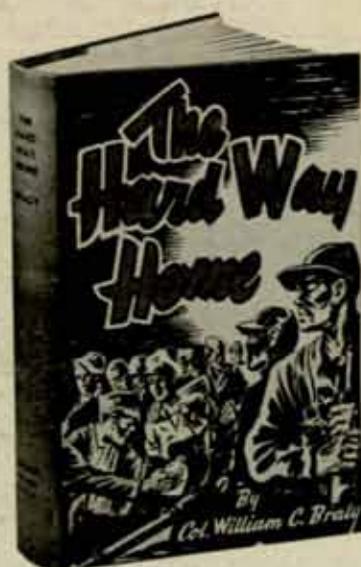
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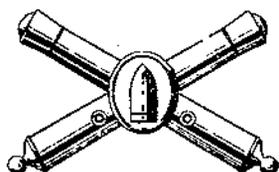
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