Antiaircraft JOURNAL

JANUARY-FEBRUARY, 1949

Featuring First Army AAA

REPORT ON AAA EXPANSION

Following is a list of units that have been activated at Fort Bliss, or will be activated there in the near future. This list contains those units previously reported in the November-December issue of the JOURNAL.

Brigades:

- 31st AAA Brigade
- 34th AAA Brigade
- 35th AAA Brigade

Groups:

- 5th AAA Group
- 10th AAA Group
- 11th AAA Group
- 12th AAA Group
- 19th AAA Group
- 68th AAA Group
- 80th AAA Group
- 267th AAA Group

Battalions:

- 4th AAA AW Bn (Mbl)
- 5th AAA AW Bn (Mbl)
- 39th AAA AW Bn (Mbl)
- 60th AAA AW Bn (Mbl)
- 450th AAA AW Bn (Mbl)
- 3d AAA AW Bn (SP)
- 8th AAA AW Bn (SP)
- 11th AAA AW Bn (SP)
- 15th AAA AW Bn (SP)
- 30th AAA AW Bn (SP)
- 59th AAA AW Bn (SP)
- 62d AAA AW Bn (SP)
- 82d AAA AW Bn (SP)
- 213th AAA AW Bn (SP) (Recently transferred from Orlando, Florida, will be reorganized and filled at date to be determined later.)
- 67th AAA Gun Bn (90mm) replaces 384th, which has been inactivated.
- 68th AAA Gun Bn (90mm)
- 70th AAA Gun Bn (90mm)
- 78th AAA Gun Bn (90mm)
- 95th AAA Gun Bn (90mm)
- 384th AAA Gun Bn (90mm)
- 504th AAA Gun Bn (90mm)
- 75th AAA Gun Bn (120mm)
- 79th AAA Gun Bn (120mm)
- 501st AAA Gun Bn (120mm)
- 502d AAA Gun Bn (120mm)
- 518th AAA Gun Bn (120mm)
- 519th AAA Gun Bn (120mm)
- 526th AAA Gun Bn (120mm) (Recently transferred from Orlando, Florida, and will be reorganized at a date to be determined later.)
- 88th Abn AAA Bn

In addition to the above AAA units, the 1st Guided Missile Regiment and the 2d Field Artillery Battalion have been activated at Fort Bliss.

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 toward 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.

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 Department of the Army.

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ACTIVITIES OF THE

"Watch on the Rhine"—First Army Style. (482d AAA AW Bn (SP) at the Remagen Bridge.)

By Lieutenant Colonel C. G. Patterson, CAC

FIRST ARMY AAA

FIRST ashore in Normandy, FIRST to break out of the Normandy beachhead at St. Lo, FIRST into Paris, FIRST into Germany, FIRST across the Rhine, FIRST to meet the Russians, FIRST combat unit to be redeployed to the Pacific—carrying out the traditions of the First Army that broke the Hindenburg Line in World War I.

North Carolina Maneuvers

Seems like a long time ago—that day in September 1941 when Lt. Gen. Hugh A. Drum, then commanding the First Army, ordered Maj. Gen. Sanderford Jarman to proceed to Hoffman, N. C., to take over the First Army Antiaircraft in the North Carolina maneuvers, the largest Army field training exercise since the days of World War I.

Many of the units had little better than wooden-barreled or stovepipe guns. But they lived in the field, worked hard and learned much, as they were soon to have to demonstrate at battle stations. Came the end of November, maneuvers were over, and weary units trekked back to home stations to clean equipment, all the while looking forward to a well-earned rest.

Hardly had the first red mud of the Carolinas been washed off the wheels, when—Pearl Harbor! Within a matter of hours, units were on the road from camps and stations to vital target areas from Boston to Norfolk. Of course, there weren't enough of them, and the equipment they had was woefully inadequate to deter—let alone destroy—an enemy bomber at any altitude and speed.

First Army and Eastern Theater of Operations

Early in December 1941, the area of the 17 eastern states was designated the Eastern Theater of Operations, under General Drum, Commanding General, First Army. On 14 December, the AA Command, First Army, and the Eastern Theater of Operations, under command of Major General Jarman, assumed responsibility for all AA defenses on the east coast. There was no shelter at battle stations; there was need for improvement and extension of communications; there were neither enough units nor sufficient equipment, to mention only a few of the myriad of problems to be solved.

Looking back, we see that they were trying times, particularly since the air attack for which units waited in the damp cold, never materialized. However, operating closely with the 1st Interceptor Command (later 1st Fighter Command) of the First Air Force, we gained valuable experience in joint operations. As units were alerted and moved to active theaters, new units arrived from training camps.

By March 1942, the threats of air attack diminished, and the east coast area was redesignated First Army and Eastern Defense Command. From time to time until the First Army departed for England in October 1943, sporadic periods of tension occurred, when it appeared possible that one-way Nazi raids on a limited scale might be launched from Spain or the Azores.

Since the attacks never materialized, the period at battle stations in the States served mostly as one of conditioning and training for AAA units. Men learned how to live in the field, learned the importance of maintaining constant alert, how to recognize aircraft, and last but not least, how to operate with the other members of the air defense team—the Aircraft Warning Service and the fighters. The lessons learned and the procedures established proved to be an extremely valuable guide for the participation of AAA units in European operations.

England

In September 1943, First Army Headquarters was alerted for early movement overseas. Arriving in Bristol, England on 19 October 1943, the headquarters personnel joined Gen-

461st AAA AW Bn 40 gives ground support in Germany. (Note combat photographer in foreground.)

eral Omar N. Bradley and a small group he had taken with him from Headquarters Second Corps.

Events moved rapidly. Practically overnight the new First Army Headquarters, composed of the battle-tested Second Corps contingent and the First Army personnel from the US, was a smoothly operating team. AAA units scheduled for operation OVERLORD began arriving early in November to join the few units already in England. Due to lack of bivouac areas, units were billeted in homes and facilities throughout England, with some in Ireland and Wales.

Although there was a possibility that some of the gun battalions might have to be deployed in the defense of Great Britain if the German V-1 program had been launched prior to D-Day, emphasis was placed on training for the amphibious task ahead. Every available space at British AAA firing centers was utilized to improve gunnery. Field Artillery practices were also conducted by gun battalions scheduled for the invasion.

Because of the limited amount of new equipment, such as SCR 584's, some of which was not available until just before D-Day, considerable shifting between units was necessary. At the same time, short course for operators and maintenance personnel were conducted with the aid of technicians borrowed from ETOUSA. Unfortunately, amphibious training facilities available were barely adequate to accommodate infantry assault units. Since a considerable amount of AAA was scheduled for the assault and early build-up, additional AAA amphibious and waterproofing training facilities were procured, and all AAA units scheduled to land on the continent through D plus 20 were given an opportunity to go through a short course. Those units scheduled to go in with the assault forces had an additional opportunity for realistic training at Slapton Sands, where they landed with the Corps and Divisions with which they would operate initially on the continent. Although the time was short, and facilities limited and crowded compared to US training camps, the standard of combat efficiency and morale improved steadily for the job ahead, and after the Slapton Sands exercise, it took but minor adjustments before the AAA troops could be declared ready.

The AAA Plan

While the AAA units and most of the Army AAA section were busy training and supervising the issue of equipment to units, the planning section of Army Headquarters was in London working on plans with the British 21st Army Group, SHAEF, the Navy, and the Ninth Air Force. As planning progressed from the Initial Joint Plan, through the Army Group and Army plans, the AAA plan was integrated into the over-all picture, and unit commanders with key staff officers from brigades, groups and battalions brought into the detail planning. In order to provide the scale of AAA effort considered essential, and to provide continuity of operations on the far shore, it was planned to utilize Army, rather than Corps or Division, AAA units in the assault and build-up. By the time forward echelons had moved beyond the range of the beachhead coverage of shipping, artificial ports, unloading facilities, beach exits, dumps and airfields, Corps and Division AAA units were to be phased in to move forward, thus not weakening or disrupting the defense of the most vital and most vulnerable targets. Regardless of claims and publicity to the contrary, the Air Force estimate placed the Luftwaffe capabilities at 1,750 sorties per day, falling off to a maximum of 1,000 sorties per day as allied fighter fields became operational on the continent. Based on this estimate, AAA requirements were predicated on the task ahead, rather than on a fixed scale of attachments.

Normandy to the Elbe

The story of the First Army assault in Normandy on 6 June 1944, the breakthrough near St. Lo, the dash to Paris, the pursuit across Northern France and Belgium to Germany, breaching the Siegfried Line, crossing the Rhine, closing the Ruhr pocket, and meeting the Russians at Torgau on the Elbe, is so well known that little can be added here. However, since the AAA was an organic part of all First Army operations, fighting on the continent from H plus 17 minutes until V-E Day, some of the highlights and lessons learned may be interesting to those who weren't there, and may bring back memories to those who were there.

Whether firing at the Luftwaffe, tanks, armored vehicles, personnel or artillery targets, hauling vital supplies, defending a river line, or occupying enemy territory, the motto was "whatever the task" (Courtesy of the 72d CA (AA)). Theirs was a 24-hour-a-day job for 337 days, since sufficient units were never available to permit relief for a well earned rest. As everyone who has experienced it knows, it becomes very monotonous waiting for days and nights, ever alert for the few seconds of fire possible at an enemy aircraft. The results attained indicate that they did not wait in vain.

The three AAA Batteries (.50 cal. AAA MG) of the 81st Antiaircraft/Antitank Battalion began landing with VII Corps elements on Utah beach at H plus 17 minutes, and the 397th Provisional AAA MG Bn (.50 cal. AAA MG) (Lt. Col. L. J. Staub) began landing with V Corps elements on Omaha Beach at H plus 30 minutes. The 49th AAA Brigade, commanded by Brig. Gen. E. W. Timberlake, consisting of the 16th AAA Group (Col. J. H. Madison), the 18th AAA Group (Col. T. W. Munford) and the 320th

AAA Barrage Balloon Bn (Very Low Altitude) (Lt. Col. Reed) less one battery, established the defenses in the V Corps, initially engaging in fire against strong points, fortifications, and ground targets of opportunity. The 11th AAA Group (Col. Harry P. Newton), with one battery of the 320th AAA Barrage Balloon Bn (VLA) attached, established the defenses in the VII Corps sector, reverting to 49th Brigade control after junction was made between the V and VII Corps at Carenton. Thanks to our overwhelming air superiority, complete tactical surprise, and the pre-assault attacks on airfields, the Luftwaffe was conspicuous by its absence on D-Day. Not until dusk on D-Day did the first enemy plane appear. The first attack came after our fighters had returned to the UK. The effort, concentrated mostly against shipping beyond the range of AAA ashore, was poorly coordinated and considerably harassed by the tremendous concentration of AAA fire from the 4,000 ships and craft lying off the beaches. How many aircraft were destroyed by ships' AAA probably may never be known accurately. To say the least, the volume of fire was terrific. At one time six aircraft were seen burning in the air and on the water. Credit for the first enemy aircraft destroyed by First Army units, a Ju88, went to Battery B, 197th AAA AW Bn (SP) (Col. C. T. McInery) at 0027 on the morning of D plus one. That was the first of the hundreds that fell to AAA before German capitulation 337 days and nearly 1,000 miles later.

As the beachhead expanded, airfields became operational and vital supplies began building up. AAA expansion kept pace with the build-up, thickening the density of protection until a density of 48 guns covered the most vital areas. When the storm hit on 19-23 June and it became obvious that ammunition would be a very critical item, gun batteries were restricted to 20 rounds per aircraft per engagement. Later this was reduced to 12 rounds. The result: more careful preparation of fire, more kills, and a higher percentage of kills—with less ammunition. All gun firing was at night with full radar control. Height finders were retained only as a standby in event SCR 584's became inoperable and for occasional visual recognition of targets during daylight hours.

All automatic weapons directors were left with rear echelons in the UK; hence fire control was by means of Stiffkey Stick, Peca Sight, or Forward Area Sights. Frequent and rapid movements subsequent to the St. Lo breakthrough, and the vital need for using trucks for general supply purposes, confirmed the decision not to take directors in the operation. By the time the situation stabilized on the Siegfried Line in October, transportation was too scarce to be used for bringing in directors, and the results attained without them had demonstrated that well trained troops who held their fire until aircraft were within hitting range could average better than 20% kills.

The quadruple machine gun mounts paid dividends throughout the entire operation. Because the M-51 trailers, with their limited clearance, would not be able to negotiate the Normandy beaches, and because they would not be able to keep up with the half-tracks and the towed 40mm cannon in rapidly moving situations, an excellent expedient was resorted to. Half of the M-51's were converted to modified M-16's, called "Wasps." Col. J. B. Medaris, Army Ordnance Officer, was more than glad to make this conversion, since the Ordnance was short a considerable number of 2½-ton trucks, and had an overage of M-2 and M-3 half-tracks. Changing the organization of 20 AW battalions to include 32 40's and 16 Wasps, utilized 320 surplus half-tracks, and released 320 2½-ton trucks to other units that needed them desperately.

The Wasps were employed as separate fire units, rather than as part of 40mm sections. They proved to be capable companion pieces to the 40's, and in many cases were superior in both ground and AAA roles. Four 40's and two Wasps were assigned to each platoon.

The other 16 M-51's taken from each of the 20 converted AW battalions were taken to Normandy with rear echelons and issued to gun battalions on the basis of 4 per battery in lieu of the four water-cooled machine guns. The M-51 could go any place a 90mm gun could go. After one Me 109 attempted to strafe a 90mm battery and was literally cut to pieces by M-51's, no further attempt was made to repeat that type of attack. As new AAA units joined First Army later in the operation, their first question usually was "when do we turn in our M-51's for M 16's?" Without exception, this increase in AW mobility and flexible fire power was welcomed at all echelons from the fire unit to Army Headquarters.

By the end of June, Cherbourg had fallen to VII Corps. In this operation AAA units, particularly SP's, fought in the ground role to capture the positions they were to occupy. The 47th AAA Brigade (Col. C. R. Finley) assumed responsibility for the AAA defenses of Cherbourg early in July. Despite the fact that Cherbourg was our only potential port at that time, the Luftwaffe again was conspicuous by its absence. Air attacks that did develop were shallow daylight penetrations of forward areas and night attacks on the beach installations. At no time did the scale of effort warrant committing the 90mm VT fuze, which had been issued to batteries having fields of fire that would assure duds falling in areas where they could not be recovered by the enemy.

In order to assure that First Army AAA units would not

Six down—count 'em! (Btry B, 103d AAA AW Bn at Sour-Brodt, Belgium.)

AAA UNITS ASSIGNED AND ATTACHED TO FIRST ARMY (6 JUNE 1944–8 MAY 1945)

AAA Brigades (3)—47th, 49th, 52d.

AAA Groups (23)—2d, 11th, 12th, 16th, 17th, 18th, 19th, 22d, 23d, 24th, 26th, 29th, 31st, 92d, 103d, 108th, 109th, 112th, 113th, 114th, 115th, 118th, 207th.

AAA Gun Bn (M&S/M) (34)—109th, 110th, 113th, 115th, 116th, 118th, 119th, 120th, 125th, 126th, 128th, 129th, 131st, 134th, 136th, 141st, 142d, 143d, 184th, 217th, 405th, 407th, 411th, 413th, 414th, 494th, 495th, 519th, 601st, 602d, 605th, 740th, 749th, 784th.

AAA AW Bn (M&S/M) (60)—80th AAA/AT, 81st AAA/AT, 103d, 204th, 376th, 377th, 385th, 386th, 391st, 397th, 397th Prov (M6), 430th, 438th, 440th, 444th, 445th, 447th, 448th, 449th, 451st, 452d, 453d, 455th, 456th, 457th, 459th, 460th, 461st, 462d, 463d, 480th, 481st, 491st, 531st, 535th, 537th, 542d, 549th, 550th, 552d, 554th, 555th, 557th, 559th, 563d, 580th, 581st, 633d, 634th, 635th, 639th, 776th, 784th, 787th, 788th, 789th, 792d, 795th, 839th, 863d.

AAA AW Bn (SP) (15)—195th, 197th, 203d, 387th, 467th, 468th, 473d, 474th, 482d, 486th, 489th, 574th, 777th, 778th, 796th.

BB Bns (VLA) (2)—320th, Flt A, 974th (RAF).

S/L Bns—225th, Btry C 226th.

AAA Opns Det (2)—148th, 149th.

have to be left behind to provide beach coverage after the breakthrough, the scheduled build-up of units was allowed to continue, even though the breakthrough was to be later than originally planned. As a result, more gun battalions became available than could be employed economically against the scale of enemy air effort. The high rate of accurate fire, the adequate supply of 90mm ammunition, and the fact that a Nazi armored thrust against the breakthrough area was a possibility, enabled the Army Commander to utilize several gun battalions to supplement field artillery fire and to back up the tank destroyers in sensitive areas. In addition, several automatic weapons units were employed in ground roles against selected pin-point targets, and for small-area neutralization by ground strafing. Experience gained and procedures established in these roles were put to excellent use during later operations, particularly during the first critical days of the Battle of the Bulge.

By 24 July, the day before the breakthrough near St. Lo, AAA strength had expanded to probably the largest number of units ever controlled by a single American Field Army. A total of 2 brigades, 15 groups, and 76 battalions (22 gun, 52 AW, 1 S/L, 1 BB) was assigned or attached and operating directly under First Army. As the breakthrough gained momentum, units in the beach area were released to the IX Air Defense Command. When the Third Army became operational at noon, 1 August, units operating in the sector taken by the Third were released to that Army.

At no time during the beachhead phase of operation NEPTUNE did the Luftwaffe present a threat that was serious enough to interfere with ground, air, or naval operations. In 57 days of combat, the Luftwaffe mounted 704 raids (125 day, 579 night) consisting of 1,249 aircraft of which 286 (24.7%) fell to First Army AAA units. Of these 138 (14.2%) were confirmed as destroyed and 130 (10.4%) were confirmed as probably destroyed. These losses, added to the Luftwaffe losses to IX TAC aircraft in flight and on the ground, dealt a serious blow to an already partially disorganized and demoralized Luftwaffe.

Northern France to Germany

As the breakthrough gained momentum and the Mortain counterattack failed, the scale of air attacks dwindled. In addition to combat losses, regrouping and movement to airfields farther back curtailed enemy air effort except for reconnaissance sorties and one abortive attempt to resupply troops caught in the Falaise-Argentan pocket. A futile effort to deny us the Seine crossing at Melun on 28 August resulted in 15 aircraft out of 35 being destroyed and another 6 probably destroyed by AAA fire. The attacking force made the mistake of dropping down to 1,500 feet—under their own flares—so were perfectly silhouetted, even for automatic weapons fire.

About the middle of August, it became obvious that the rapid pursuit would soon outdistance supplies still back near the Normandy beaches. To stop at that point would have allowed the German Army to reorganize and prepare for organized resistance while we moved our bases forward. The decision to continue the pursuit was dependent on utilizing every possible piece of transportation to bring forward vital gasoline, rations and ammunition. Without taking a single AAA weapon out of position, AAA units immediately implemented the truck company plan prepared prior to the breakthrough. An average of 350 2½-ton trucks per day, organized into provisional companies of 50 trucks each (1 company from an AW battalion and ½ company from a gun battalion) was made available to Army G-4 from AAA units not attached to Corps and Divisions. In addition, those AAA units with forward combat elements utilized their trucks to help alleviate the supply situation.

The command decision to utilize AAA transportation to augment the few truck companies on a greatly extended line of supply was a sound one. Certainly a commander would and should be severely censured if he allowed AAA units, with their abundance of transportation, to sit idly by while an offensive was stopped for lack of means to deliver available supplies to forward combat units. From August 1944 to V-E Day, Army AAA provisional truck companies hauled something over three-and-a-half million truck-ton-miles of supplies. In addition, AAA units with Corps and Divisions used their trucks to augment forward area supplies. At no time did this additional mission in any way interfere with the primary mission. On the other hand, it assisted materially in integrating the AAA as an inseparable organic part of the First Army.

Reacting to the attack on Aachen, the Luftwaffe mounted a 90-aircraft raid on the VII and XIX Corps fronts on 5 October. Coming in on a low-level strafing mission in four waves, they flew right into the AAA and lost 40 aircraft (18 Cat I and 22 Cat II). Several of the Cat II's were reported down in the Hurtgen forest where they could not be checked on the ground due to the density of land mines.

Except for the resurgence of the Luftwaffe during the Battle of the Bulge, only one other concerted daylight effort was attempted during this period. Early on the afternoon of 3 December, IX TAC fighters had to return to base because of deteriorating weather conditions in the air base area. The Air Warning broadcast advised all AAA units to expect an attack within an hour. Within the hour, and four minutes prior to the first sighting, a plot of 74 aircraft was broadcast to all units. The attack on the V and VII Corps sector was at very low altitude and right over the greatest density of automatic weapons. In the ensuing action, AAA units destroyed 45, and probably destroyed 13 more aircraft, or 79% of the entire flight. Days such as these were a welcome relief after the endless days of watching and waiting without ever seeing an enemy aircraft. In addition to bolstering the morale and pride of AAA units, these actions served to bring the AAA closer to the thousands of other combat troops who saw and applauded the results attained.

V-Weapons

At noon, 17 September 1944, the first V-2 (or A-4) rocket launched against a continental target landed in the First Army Headquarters in the vicinity of Huy, Belgium. Fortunately the point of impact was in a heavily wooded ravine about 250 yards from the enlisted men's mess. Had it been on level ground most of the enlisted personnel at dinner probably would have been casualties. Thereafter, helmets were very much in evidence at Army Headquarters! This was but the first of many trial rounds fired at targets in the Liege-Maastricht area prior to the opening of the Port of Antwerp. The daily average was between 1 and 15, with 32 representing the largest 24-hour effort. Except for gathering parts for intelligence purposes and reporting the location of impact and damage done, no action could be taken by AAA units against the supersonic speed rockets. At the request of the Army G-2, a small subsection consisting of one officer and four enlisted men was set up within the Army AAA section to handle spot reports and to collect, collate, and evaluate all action and technical data on V-weapons. The widespread AAA communications facilities and methods of operation were ideally suited for such an assignment.

On 20 October the last V-2 landed in the Liege area. At 0730, 21 October, the first V-1 (pilotless aircraft) winged its way over First Army Headquarters en route to Antwerp. Beginning with an average of 8 to 10 a day, the scale of effort rose rapidly to over 100 a day, with the malfunctions and stall-outs landing at random in the Army zone of action. On 21 November the target area shifted to Liege, where an average of 25-75 crashes per day were reported, a few of which did some damage to military installations.

Analysis of V-1 tracks and impacts prior to 21 November, and the certainty that the Nazis recognized the military importance of Liege, indicated that the weight of attack might be shifted from Antwerp to Liege at any time. A field survey was under way, and AAA units were alerted to move to establish a buzz bomb defense belt near Camp Elsenborn when the attack shifted. The area selected was such that V-1's hit by AAA fire would land in an area containing no concentrated military installations. By 24 November one gun and one AW battalion were in position. Within a few days four additional battalions (2 gun, 2 AW) were added to the defense. Despite the low altitude of the V-1's in that area (average 700 feet) and continuous snow, rain, and fog, 75 of the 354 V-1's engaged by AAA were destroyed. This was the same Ardennes weather the Germans were utilizing simultaneously to concentrate forces for the Battle of the Bulge. Those six AAA battalions in the buzz bomb belt were soon to feel the first armored thrusts of the last German counterattack.

FIRST ARMY AAA ASSAULT UNITS—NORMANDY

OMAHA BEACH (V CORPS)		*UTAH BEACH (VII CORPS)*
Force "O"	*Force "B"*	*Force "U"*
16th AAA Gp, Hq & Hq Btry	49th AAA Brig, Hq & Hq Btry 149th AAA Opn Det	11th AAA Gp, Hq & Hq Btry
397th AAA MG Bn (Prov)	18th AAA Gp Hq & Hq Btry	81st AAA/AT Bn (—3 Plns)
413th AAA Gun Bn (M)	457th AAA AW Bn (M)	116th AAA Gun Bn (M)
197th AAA AW Bn (SP)	110th AAA Gun Bn (M)	535th AAA AW Bn (M)
467th AAA AW Bn (SP)		474th AAA AW Bn (SP)
320th BB Bn (VLA) (—C Btry)		Btry C, 320th BB Bn (VLA)

Note: All AAA units in assault and pre-loaded build-up, except the 81st AAA/AT Bn (101st Abn Division), were Army units. Division and Corps Bns began arriving on D plus 6. Advance parties of 115th AAA Gp, Hq & Hq Btry (V Corps), and 109th AAA Gp, Hq & Hq Btry (VII Corps) landed with their respective Corps headquarters.

A 90 does antitank duty near Malmedy, Belgium.

Battle of the Bulge

Thousands upon thousands of words have been written about the Ardennes and the Battle of the Bulge. Without question, it was the bloodiest and most costly battle of the war to both sides—particularly to Germany. But when it was over, the road to the Rhine, and across the Rhine to the Elbe, lay wide open.

The AAA of the First Army is justly proud of the important part it played in this battle, against both ground and air attack. Some of the small unit actions are: Battery C, 197th AW Battalion (SP), going behind the German lines to recapture and evacuate the 47th Field Hospital; Battery A of the 197th AW Battalion (SP), holding in position and helping to distribute the ammunition in an ammunition dump; Headquarters and Headquarters Battery, 440th AW Battalion, organizing a task force and holding out at Gouvy Station for four days; Battery D, 634th AW Battalion, holding out to the last round when cut off with part of the 106th Division; and the two privates of Battery B, 143d Gun Battalion, using bazookas—loaned and loaded by a lieutenant with an Infantry platoon—to knock out tanks at Stoumont Station. These are but a few of the tales of heroism of small AAA units.

To tell the whole AAA story would require far more space and time. The glory and the credit rightfully belong to the gun crews who stood and fought it out on the ground, frequently against odds in the form of Royal Tiger Tanks, surrounded by German forces, or against paratroops dropped in the rear. The lessons learned in Normandy, and across France, Belgium, Holland and Luxembourg paid dividends. The AAA was found not lacking in ability or the will to fight. If there was ever doubt as to the necessity for AAA units as an organic part of a field Army, this doubt was dispelled by the results attained from 16 December 1944 to 1 January 1945.

Thanks to the cooperation of Brigadier Leslie K. Lockhart, Deputy Commander GHQ, AAA 21st Army Group, and Brig. Gen. W. L. Richardson, CG IX Air Defense Command, the entire 52d AAA Brigade (Brigadier General Burnell), plus seven other American AAA battalions, was turned over to First Army beginning on 17 December. T 52d was covering the Meuse crossing and airfields and car under Army control in position. The additional gun uni from the Antwerp X defenses left their AAA fire control the Meuse River and moved forward to fill the gaps and provide the backbone for the antitank defenses in front the German armored thrust toward Liege. The AW uni were employed to bolster the defenses covering the bridges across the Verviers River, the only supply line three Corps (V, VII, and XVIII).

In the air, the situation changed radically. For the fir time on the continent, the Luftwaffe had local air superiori because the weather had closed in over our fighter base while the German bases east of the Rhine remained ope From 16 December through 1 January, the Luftwaffe fle 1,178 sorties over the First Army area, or 22% of their tot effort during 337 days of combat. With AAA densitie greatest at the most critical points, the Luftwaffe cam out on the losing end. In 17 days, they lost 267 (22.7% aircraft to AAA with another 101 (8.6%) confirmed probably destroyed by AAA. As the weight and frequenc of air attack increased, the AAA effectiveness also increased accounting for 31.3% of all the German aircraft operatin over the area.

The highlight of the entire campaign came early on Ne Year's morning. In expectation of an attack at first light air units and First Army AAA units were placed on aler before dawn. About 0830, five Luftwaffe groups, totalin some 280 aircraft, came in low over the V and XVIII Corp front lines—destination IX and XXIX TAC airfields. With in 20 minutes, AAA units accounted for 92 of the Me 109' and FW 190's. At one airfield, Y-29, fighters and AA units, demonstrating superior joint action, accounted fo 52 of the 55 aircraft attempting to strafe the field, and with out the loss of a single U.S. aircraft. Altogether, the Luft waffe lost about 800 aircraft to Air Force and AAA alon the western front that morning. This was a blow that a already declining air force could ill afford to withstand particularly after the defeat of the ground forces in the Ardennes counterattack.

The Remagen Bridge

January and February were spent cleaning up the Ar dennes, and regrouping and equipping the First Army fo the last drive into the heart of Germany, and afforded little opportunity for AAA action. On 22-23 February, the VII Corps crossing of the Roer River was opposed by the Luftwaffe with the first appearance of the Me 262 jet aircraft in the ground attack role. Other than this attempt, opportunities to shoot were few and far between. The plan called for the First Army to stop on the Rhine, consolidate, and take over as an occupation force, while the 21st Army Group crossed the Rhine in the north, and the Third Army crossed upriver from Coblenz. Plans were prepared to convert AAA units to occupying forces.

However, on the afternoon of 7th March, the 9th Armored Division of the III Corps found that the Ludendorff Bridge at Remagen had neither been bombed out by our Air Forces nor destroyed by the Germans in their rapid retreat. The 482d AAA AW Battalion (SP), attached to the 9th Armored Division, established the initial AAA de fenses before last light on 7 March, and proceeded to destroy the first three aircraft (Ju 87's) which attempted a suicide mission against the bridge at first light on 8 March. Every available AAA unit in First Army was alerted and standing by to move by battery as space became available on the single road to Remagen. Holding this bridge long enough to establish a bridgehead on the east bank of the Rhine might save thousands of casualties in the planned assault crossing. An air restricted area was established giving AAA units freedom to fire up to 5,000 feet during daylight and to unlimited altitude at night. IX TAC fighters maintained air patrol over the area during daylight, while night fighters patrolled outside the area at night.

The Luftwaffe effort was a not too determined one made up of nearly every available operational type aircraft from Ju 87 to Me 262 jets. During the seven critical days the railroad bridge was in use, 372 sorties were flown against it with a net result of one hit on the western approach —which was repaired by a bulldozer in 15 minutes—63 aircraft destroyed and 36 aircraft probably destroyed by AAA fire. The bridge itself was never hit by air attack, although numerous artillery shells registered, and several V-2's landed near by. When the bridge collapsed due to structural failure on 17 March, there had been no traffic over it for three days. Repair work was in progress while floating bridges across the Rhine were utilized to support the five-division bridgehead on the east bank of the Rhine.

When the First Army drive east and thence north to Paderborn began on 25 March, the entire Rhine defenses in the First Army area were turned over to the 49th AAA Brigade. Using AAA units as a nucleus, augmented by searchlights, patrol boats, MP's, special tank units, RAF barrage balloons, and two smoke generator companies, the 49th had full responsibility for all air and ground defenses. As the Ruhr pocket developed and organized resistance decreased, the nearly defunct Luftwaffe diverted its attention to other areas and gave up the Rhine crossings as useless.

Finale In Europe

In early April, the IX Air Defense Command took over the Rhine defenses and all First Army AAA units were moved forward to the Weser River. However, due to lack of air targets or ground missions for gun battalions in the operations to the Elbe River, the AAA security organization approved by the Army Commander in January was placed in effect. Armament and fire control equipment, together with maintenance personnel, were concentrated for each battalion with a view to overhauling it prior to a possible redeployment to the Pacific. The balance of the battalion was assigned a security area using the regular four-battery organization. By the end of April, all resistance ceased (except the flying menagerie of nondescript planes carrying German escapees), and obviated further employment of gun units.

The 49th AAA Brigade, with two groups and six battalions organized under the security plan, was assigned a rear security mission in four Kreise (counties). The assignment proved to be less exciting than the AAA mission, but an interesting one nevertheless. Moving into an area where orderly administration did not exist, order was restored, displaced persons rounded up, and a degree of control gained over the enemy population. Meanwhile armament, communication and fire control equipment were being readied for possible movement to the Pacific by personnel from the AAA units, Ordnance, and Signal Corps.

On 1 May orders were received directing First Army Headquarters to turn over its troops and to be prepared to be redeployed to the Pacific by way of the US. At midnight, 8 May 1944, all troops were transferred to the Ninth Army—337 days and nearly 1,000 miles from Normandy. For the first time the situation report stated "no action." On 15 May, First Army Headquarters departed from Weimar for Le Havre, home, and then the Pacific; one war over, one more to go. The planning echelon of First Army Head-

M-16 and 40 team up against a ground target inside Germany.

quarters arrived in the Philippines early in August, 1945. It was hoped that the First Team of AAA units that had fought from Normandy to the Elbe would join us in the Pacific for the final assault on Japan. But the two atomic bombs on Hiroshima and Nagasaki obviated any need for redeploying AAA units—the war was over.

Results and Lessons Learned

The results attained and the lessons learned appear as valid today as they did three years ago. From the instant of the initial landings in Normandy, the guiding principle was to allocate AAA resources where they were needed the most. With the preponderance of Allied air strength striking deeper into Germany as operations on the Continent progressed, more of the Luftwaffe was retained for air defense operations. As a result, German air operations were usually concentrated in forward areas, and AAA units were pushed well forward to meet this threat. As indicated in the following tabulation, 72% of the aircraft accounted for by First Army AAA units were destroyed by units operating with Corps and Divisions:

CONFIRMED CLAIMS

AAA Units Attached to:	*Cat I*	*Cat II*	*Total*
VII Corps	266	126	392
V Corps	199	77	276
III Corps	67	59	126
XIX Corps	26½*	24	50½
VIII Corps	19½	8	27½
XVIII Abn Corps	17	7	24
XV Corps	1	0	1
Sub Totals	596 (74.7%)	301(67%)	897 (72%)
49th AAA Brig.	153	118	271
52d AAA Brig.	39½	25	64½
47th AAA Brig.	3	1	4
Others	6	4	10
Sub Totals	201½(25.3%)	148(33%)	349½(28%)
Total Army	797½	449	1246½

During the 337 days of action on the continent, the Luftwaffe mounted 5,372 sorties over the First Army area, of which 3,000 were during daylight and 2,372 during the hours of darkness. Twenty-three and two-tenths per cent (23.2% or 1,246½) were confirmed as definitely or probably destroyed by First Army antiaircraft fire—an attrition rate that no air force can endure over a period of time and still remain a serious operational threat. Add to this total the IX TAC confirmed claims of 1,060 aircraft destroyed and probably destroyed, plus another 429 damaged, and it becomes obvious that the First Army-IX TAC front was an unhealthy one for the Luftwaffe. The results speak for themselves.

Summing up the lesson learned, effective employment of antiaircraft artillery in the First Army was accomplished through:

Full utilization of an excellent warning service composed of the integrated facilities of the AWS and Army AAA units.

Flexibility of employment of AAA units through concentrating fire power at the most critical points with no attempt to disperse units throughout the entire Army area.

A joint Fighter Control-Antiaircraft operations room where the IX TAC Controller and First Army AAA Operations Officer sat side-by-side looking at the same picture. Outstanding coordination of effort was achieved by eliminating unwarranted duplication of plotting and by attempting to obtain coordination by telephone liaison.

Maintenance of a continuous high state of alertness at fire units, combined with gunnery proficiency attained through constant "on-sight" training. Gunnery teams and automatic weapons gunnery personnel were invaluable in assisting units to obtain maximum results from their equipment.

The exceptionally high state of preventive maintenance that assured the maximum number of fire units always being ready for instant action.

Communications facilities and discipline that were maintained at a high state of efficiency.

Integration of AAA units as an organic part of the Army—ever ready, willing and able to to take on any mission, from destroying enemy aircraft to hauling supplies, that would further success in battle.

Close coordination with the Air Force (IX TAC).

The will to fight and the will to win, regardless of the odds.

*One Cat I shared with Ninth Army AAA.

In antiaircraft gunnery, however, the main scientific triumph must go to the American scientists. They produced an admirable radar gun-layer which followed the target automatically by radar. With this and other American equipment, the flying bomb attacks of 1944 were defeated. Some 70 per cent of all the flying bombs were ultimately shot down, and for limited periods gunners shot down 100 per cent of the missiles coming within their range. —From *Science at War* by J. G. Crowther, Chairman, Association of British Science Writers, and R. Whiddington, Head, Department of Physics, University of Leeds, England.

Fort Bliss Provides For Its Children

Realizing the truth of the old saying that "Just as the twig is bent, the tree's inclined," Fort Bliss has organized to provide the children of its personnel with all the activities conducive to the training of upright and loyal citizens.

Major General J. L. Homer, Commanding General of the Post, Mrs. Homer, officers and enlisted personnel and their wives are all cooperating in this high-priority work.

To promote smooth cooperation between all phases of its children's program, to aid efficient operation of all organizations, and to prevent overlapping of activities, the Fort Bliss Children's Activities Committee was established. Col. Lester D. Flory is chairman.

The committee exercises over-all supervision and coordinates the programs of the Teen-Age Club, Boy Scouts, Girl Scouts, summer playgrounds, and Fort Bliss Pre-Kindergarten. It deals with questions of transportation to and from school for children living on the Post. Another of its functions is to supervise the special events which the Post yearly arranges for its younger personnel. These include an Easter egg hunt, a Halloween party, and a Christmas party.

The committee likewise cooperates with the El Paso City School System in the operation of the Fort Bliss Kindergarten and the Fort Bliss Elementary Schools, now established on the Post as part of the El Paso public school system.

The Children's Activities Committee meets once a month. Minutes of the meeting, along with recommendations on pertinent matters, are submitted, through the Deputy Post Commander, to the Commanding General of the Post.

Working under supervision of this over-all Activities Committee is a group of four other specialized committees. They are: The Fort Bliss School Committee, the Teen-Age Club Advisory Committee, the Committee for Girl Scout Activities and the Committee for Boy Scout Activities.

Floor mops make excellent wigs for these young Halloween party-goers at Fort Bliss. The announcer wears a double-faced clown mask. The Halloween party is one of the important parties which the Post stages each year for children of the garrison. *Seated at rear, left to right, are:* Mrs. J. L. Homer, Maj. Gen. J. L. Homer, and Brig. Gen. C. E. Hart.

Girl Scout work was initiated at Fort Bliss in 1932 when the Post formed the first Girl Scout Troop in El Paso to be registered with the National Girl Scout Council. Today there are two Brownie Troops, an Intermediate Troop and a Senior Troop that are nearly filled to capacity with more than sixty girls in the membership.

Activities of the various troops center around the Girl Scout Hut, a stone building which has a fully equipped kitchen, a large lounge with fireplace, a bath and a room for sleeping quarters.

Fathers of the girls recently built a stone barbecue pit which has already been the scene of many enjoyable "doggie and marshmallow" roasts.

The Fort Bliss Girl Scouts lend a helping hand in many ways on the Post. They assist with the Easter egg hunts by dyeing the eggs, and during the Centennial Celebration in November, they sold programs.

Senior Girl Scouts have adopted William Beaumont General Hospital as their project and assist the American Red Cross and the WBG Hospital radio station, as well as in occupational therapy work. They perform many office tasks and serve as information clerks in the American Red Cross Center. A second project of the older girls is the making of clothing kits for the children of Europe.

Scouting work for boys at Fort Bliss is threefold. The Cub Scout program is for boys from 9 to 12 years of age; the regular Boy Scout program is for those from 12 to 15 years; and the Senior Post is for youths of 15 to 19. Sixty-six boys are participating.

The Fort Bliss Scout Troop is novel in that most of the boys have done Scouting in many different parts of the world including Panama, Germany, Korea and Japan, as well as in all sections of the United States.

The Scout Troop participated in the Fort Bliss 100th Anniversary celebration, November 5-7, by building a large outdoor exhibit. Approximately 3,000 people visited the display which included a modern Scout camp, an Indian village, a pioneer campsite, rustic bridges, signal towers and handicraft exhibits.

A new building has been obtained for Boy Scout headquarters and the Scouts planned to furnish and decorate it for the annual Charter Night which was to be observed in January. A permanent campsite has also been set up on the Post reservation where the Scouts may sleep out overnight and cook their meals outdoors.

The Teen-Age Club had its inception in 1946 when Mrs. John H. Madison headed a group of women in sponsoring monthly entertainments for teen-age boys and girls of the Post.

As the movement grew, the use of a building for the Teen-Agers Club was secured in February, 1947.

Various organizations on the Post assisted the boys and girls in furnishing and decorating the clubhouse. Mothers of club members made slip covers for the furniture. The boys assisted in repairing furniture.

At present the clubhouse has a radio-phonograph, gift of the Women's Club, a juke-box, pool table and ping-pong

Santa Claus greets two of his little friends at the Christmas party traditionally given for Fort Bliss children during the holidays.

table. There is even a snack bar operated by Club members.

The Club is open on Friday and Saturday nights and holidays during school months, with a hostess on duty. In the summer months, the Club is open five nights a week.

Club activities include formal dances, square dances, bowling parties, swimming parties in the summer, and special-occasion parties at Halloween, Christmas, Easter, and graduation time. Dancing lessons and bridge lessons have been made available to the group.

Three schools are now operated on the Post with two more scheduled to open late in January. The Pre-Kindergarten is a Post activity, operated by Fort Bliss authorities. The Kindergarten and the Elementary School are part of the El Paso City School System by which they are operated.

Approximately 40 children, three to five years old, are enrolled in the Pre-Kindergarten, which has a waiting list. A moderate tuition fee is charged and the balance of the expenses is paid from nonappropriated funds raised for that purpose.

Both the Pre-Kindergarten and the Kindergarten are taught in buildings used on Sunday for Sunday School. In the summer the buildings were used in the supervised playground program.

The Pre-Kindergarten teacher is employed by the Fort Bliss School Committee. Sessions are held in the morning and the program includes the regular nursery school activities.

Teachers for both the Kindergarten and the Elementary School are employed by the El Paso City School System.

The Kindergarten has 34 pupils enrolled and is open for a morning session. Kindergarten pupils are approximately five and six years old and children of military personnel at Biggs Field attend, along with children from Fort Bliss. It is a tuition school.

Two teachers are required for the present Elementary School which instructs children in the first grade only. The 54 pupils are divided into two groups, one being taught in the morning and the other in the afternoon.

On 24 January, two other Elementary Schools were to be opened on the Post to care for children in the second and third grades who formerly attended the Crockett and Coldwell schools in El Paso, and for children being promoted from the high-first grade in the Post Elementary School. The new schools are to be operated as part of the El Paso School System.

This is the first school year that these school facilities have been made available on the Fort Bliss reservation and Post authorities are cooperating with the El Paso School System in all ways to make the schools successful.

Older children of Post personnel attend schools in El Paso.

Another children's project on the Post is the Nursery which is operated for the convenience of Post personnel. Here parents may leave their small children, under the care of a registered nurse and her assistants, while they are busy with shopping or entertainment. Fees are charged by the day or by the month as desired.

Two supervised playgrounds were operated at Fort Bliss the past summer, with nearly 100 children using them daily.

The grounds were open for supervised play four hours a day, five days a week with equipment available for use at other times. Five civilian supervisors staffed the playgrounds.

The playground project was under general supervision of an advisory council of representative Fort Bliss personnel.

Tentative plans call for a third playground to be provided this summer as a result of the expanded housing program on the Post.

Boy Scouts of the Fort Bliss troop are shown with some of their exhibits during the Centennial celebration at the Post in November. The Boy Scout display drew about 3,000 visitors.

Operational Aspects Of Guided Missiles

By Lt. Colonel Howard B. Hudiburg, General Staff Corps and
Lt. Colonel Richard G. Thomas, Coast Artillery Corps

PART I

Technical literature and information pertinent to the guided missile field is voluminous and increasing daily in quantity as research and development projects progress in this new art. The ANTIAIRCRAFT JOURNAL has, in recent issues, presented several articles of this nature and discussion with both military and civilian personnel indicates that they have been well received, indeed.

By contrast, strategic, tactical, and logistical information or, we might say, that pertaining to operational aspects of guided missiles, is lacking—practically to the point of being nonexistent. We must all agree that this is a quite normal situation, for development of tactics evolves from fundamental concepts, developed through the ages by experience, into which are integrated the capabilities of new weapons and new techniques. We do not have, today, in final operational form, these new, much-discussed weapons which encompass a field of such scope that we commonly refer to the over-all picture as an art—the guided missile art! Hence, it is quite natural that the Field Manuals on guided missile tactical employment have not, as yet, been published.

A discussion of the operational aspects of guided missiles may take three courses. First, we may take the easy way out and say that, since the operational weapons have not been standardized, it is too early in the game to do operational thinking. Secondly, we may go "all-out" in a frenzy of overenthusiasm, use a set of present-day comic books as field and technical manuals, employ a copy of some scientific fiction magazine as a strategic planning guide, discard present weapons, tactics and techniques, and start planning for the future "push-button" war which is "just around the corner." Thirdly, we may estimate and assume capabilities and limitations for future weapons and consider the methods and effects of integration of such hypothetical characteristics into the existing picture.

Obviously, the first approach is incorrect. We cannot, with the interest of National Defense before us, dismiss all thought of operational aspects at this time since such an attitude would undoubtedly result in inefficiency, incompletely planned training, and excessive delay in reaching our goal of maximum preparedness, consistent with the new weapons and techniques at our disposal. The military has been accused, in certain instances, of not taking full advantage of new capabilities at its disposal. This should not be the case in the guided missile field. Even if the development picture looked inky black—which it definitely does not—we must constantly bear in mind that the employment, and defense against, weapons "borrowed" from German World War II development would have a profound effect upon operations in any future conflagration.

The second approach, *overenthusiasm*, could probably be said to reflect some military, as well as scientific, thinking immediately following hostilities of World War II. It was thought by many at that time that the weapons for "push-button" warfare were truly "just around the corner"—a matter of two to three years at the most. However, since that time, the realistic approach to the development of these new weapons, occasioned by the need to take them from the mathematician's scratch pad, from the design artist's drawing board, and from reports of other developers, has been to initiate actual building and placing "hardware" in the air. This approach has rapidly matured the overenthusiasm of many of the first U. S. military and civilian guided missile proponents. However, even the most pessimistic, future developmental picture that can be conjured must include new weapons and new defensive and offensive capabilities.

It is apparent that we must approach our discussion from the third direction. That is, we must make estimates and assumptions concerning our new capabilities and, based upon these, develop sound planning, flexible in nature and adaptable to new weapons and techniques as they are developed.

Never has our military establishment so welcomed "new-idea" thinking by all its personnel as at the present time. This is, of course, a very healthy condition. Any individual, group of individuals, or military unit is encouraged to submit ideas for consideration by proper authority. With this same approach, we can seek the solution to many of the guided missile operational problems. That is, from the constructive thinking of many minds will emerge the most sound solutions to the problems. It is, therefore, the primary objective of the authors to attempt to stimulate thinking along the lines of guided missile operational aspects by presenting certain basic assumptions, or the basis upon which the reader may make his own basic assumptions, upon which to envision future operations as affected by these new weapons.

In our thinking, let us keep an open mind and not be shackled by present concepts. A mental trip into the realm of Buck Rogers will do no harm, if tempered with a touch of realism. The concept of strategic and operational planning today officially includes consideration of very advanced thinking. It was announced some months ago that our Chief of Staff had directed that a group be organized whose primary mission was to think far into the future, with no "tight reins" applied to their imaginations. Truly, it behooves all of us to consider these new weapons so that we may contribute our share when called upon to do so.

Strategic plans or tactical concepts cannot definitely be stated, because, in the first place, the present state of the guided missile art leaves many vital questions unanswered and, in the second place, security obviously calls for classification of those details that do exist.

The plans, statements and opinions expressed herein must be accepted as entirely those of the authors, and in no manner or intent reflect official planning, thought, weapons or techniques of the National Military Establishment or its component Departments of Army, Air Force and Navy.

This discussion will attempt to cover: (1) assumed weapons and their characteristics, (2) tactical employment, (3) strategic and tactical considerations, (4) organization and training aspects, and (5) logistics and supply problems.

Assumed Weapons and Their Characteristics

A proper approach to a study of the operational aspects of guided missiles appears to follow a course of assuming mythical missiles, and integrating these hypothetical weapons into our present capabilities, tactics and techniques in a logical sequence.

Research and development personnel and evaluation groups within the Army must ever be alert to follow technical trends in the art and keep abreast of all development projects, keeping those planners, who are developing tactics and techniques, constantly informed, since no person can say at this time which development project will produce the missile of any given type or what its final characteristics will be. New technical developments and normal development attrition both result in the present state of the art presenting an ever-changing picture, intriguing and interesting as it is complicated and confusing.

First of all, let us review the general missile classification system, as employed in common usage today, in order to assure a common basis for the discussions which follow.

A complete guided missile is classified in accordance with its operational characteristics. That is, its launching site and the target location. Hence, we find a development of eight fundamental types, or categories, of guided missiles, namely:

Surface-to-Surface Missile
Surface-to-Air Missile
Air-to-Surface Missile
Air-to-Air Missile
Surface-to-Underwater Missile
Air-to-Underwater Missile
Underwater-to-Surface Missile
Underwater-to-Air Missile

These type designations are normally abbreviated in the literature by the use of the following contractions:

SSM	SUM
SAM	AUM
ASM	USM
AAM	UAM

We may here note that, since the writers expect the majority of readers of this presentation to be ground personnel, the first two types of missiles listed (SSM and SAM) will receive emphasis during the discussions that follow.

In amplifying our fundamental classification, additional subdivisions of categories must be considered. Coastal defense missiles, obviously, may be SHORE-TO-SHIP or SHORE-TO-UNDERWATER. SAM may differ in tactical capabilities leading to further classification of ANTIAIRCRAFT (AA), for employment against high-performance, conventional aircraft and ANTIMISSILE (AM), for employment against extremely high-performance, supersonic, aerial, enemy targets, these both being considered in the basic SAM category. ASM may be subdivided into FREE-FALL and PROPELLED types, the propelled type obviously giving greater over-all tactical flexibility. AAM may be subdivided as OFFENSIVE and DEFENSIVE, the offensive type to be employed by fighter aircraft in attacking enemy aircraft, and the defensive type employed in self-defense by our bombers. However, the over-all fundamental classification is encompassed by the eight basic categories: SSM, SAM, ASM, AAM, SUM, AUM, USM, and UAM.

Now that we have divided our vehicles into fundamental tactical types, let us give a thought to the further classification which stems from inherent technical differences and which enters the operational aspect picture from the standpoints of both tactical employment and logistics. The outstanding technical characteristics in which our missiles differ are the guidance and propulsion systems, each of which we shall discuss.

It is generally agreed that the greatest technical problems facing those engaged in guided missile development are those presented in the field of guidance. Obviously, this field is the most vital for, as has often been said, "There can be no guided missile without guidance." In this field, some of the best technical minds in the country are engaged today. We shall limit our thoughts on guidance to the extent that they may influence our consideration of the operational aspects of the art.

The guidance of a guided missile in flight is generally considered to be effected in three phases: *initial, mid-course*, and *terminal*. The *initial* phase is that portion of the trajectory which takes the missile from the launcher and places it in such position that the *mid-course guidance system*, which takes the missile to the target vicinity, can assume control. The *terminal guidance system* controls the missile during the last phase of its flight when the missile is conducted from some point in space in the general target vicinity to the point of burst or impact.

There is a great complexity of specific guidance systems usable in the various guidance phases discussed in the preceding paragraph. However, all of these may generally be classified into five fundamental types, namely:

1. Preset
2. Command
3. Beam Rider
4. Navigational
   a. Beam Follower
   b. Celestial
   c. Terrestrial Reference
5. Homing

A "preset" guidance system is "set," or its course determined, prior to launching. Such a system employs modified, conventional, auto-pilot technique and simply maintains the missile on a desired course. This is the system that was employed by the Germans in their V-2 weapon. The system is important from the tactical standpoint by virtue of its operational simplicity, the fact that any number of missiles may be launched at a given target without mutual interference and the fact that, once the missile is launched, the launching crew is entirely relieved of the necessity of further control of that vehicle. The trajectory of a missile guided by a true preset system cannot, of course, be altered by exterior means once the missile is "on the way." Lack of control means, obviously, reduced accuracy. Hence, this type of system finds tactical application in attack of long-range, large, or area, fixed targets. This system is relatively free of vulnerability to countermeasures and dependable equipment of this type is now available.

A "command" guidance system, also as the name implies, is a system of guidance wherein the missile responds to "commands" transmitted to it by some communicative means: radio link, radar beam, or some other suitable means. The Germans employed wire on some of their missiles, the wire unreeling from the launcher and serving as a communication link; the system was limited, of course, to short ranges. The commands may be determined by human judgment, based upon visual or instrument observation or the entire system may be fully automatic with the commands being computed by electronic or mechanical means. From the tactical standpoint this system lends to trajectory correction capability but requires that attention be directed to each individual missile. Command systems are capable of engaging moving targets, air, water or ground. Such systems, lending to after-launching trajectory correction, of course, present greater accuracy capabilities but possess inherently the tactical disadvantages of requiring extensive ground control facilities and of having a low traffic capacity, that is, fewer missiles in the air at one time per launching site. Further, most modifications of this system are quite vulnerable to countermeasures.

"Beam riders" are missiles capable of following a defined beam in space, for example, a radar beam tracking an aerial target. Tactically, it may be realized, these systems present many advantages. Among them is the capability of the missile to compute its own commands and, hence, elimination of the necessity for ground control equipment. This system lends to greater traffic capacity and its accuracy is potentially very high. Range is limited to useful beam ranges and the missile is vulnerable to countermeasures. This system is especially attractive as a SAM guidance system.

"Navigational" guidance systems "navigate" to their targets. These systems are attractive for SSM guidance. Traffic capacity is unlimited. The system evolves into three basic subdivisions:

1. The "beam follower" follows a defined navigational path, for example, a Shoran or Loran type course. Accuracy is suitable for employment against area targets but the missile is highly susceptible to countermeasures or capture, that is, the enemy taking over control of the missile.

2. In a "celestial" navigation system, the missile follows a predetermined celestial course. This system is not vulnerable to countermeasures and accuracy is suitable for area targets.

3. A missile guided by "terrestrial reference" uses some characteristic of the earth, or its surrounding medium, to gain intelligence as to its position. It can then be caused continuously to navigate to another desired position. The system is not vulnerable to ordinary countermeasures and accuracy is suitable for employment against area targets.

4. The "homing" system is that system which "seeks" the target, or guides the missile to its objective. Such a system accomplishes its mission by having the capability of differentiating some characteristic of the target and controlling the missile to the source of that factor. For example, the vehicle may seek heat, light, source of radar reflectivity, sound, or any one of the many other inherent characteristics of some particular target. Tactically, such a system relieves the control situation but has the definite disadvantage of susceptibility to countermeasures and the requirements of different seeker means for each type target. Tactical considerations indicate application in engagement of pin-point and maneuvering targets, particularly in combination with other systems, the homing system taking over the target "run-in," or terminal guidance phase of the trajectory.

In actual practice, a given missile would, in all probability, utilize a combination of these systems in the various phases of its flight from launcher to target. For example, a given SSM would possibly employ "preset" initial guidance, "command" mid-course guidance and "homing" terminal guidance.

It may readily be appreciated that guidance offers many complex technical problems.

The second technical characteristic that classifies our missiles is the propulsion system employed. In general, we can say that essentially all our missiles will be propelled by means of some form of jet, or reaction motor. This requirement is set forth by two factors. First, we must employ weapons of high speed, trans- or supersonic, to reduce countermeasures to a minimum or successfully to counter the enemy and second, only reaction motors are capable of giving us the speeds we desire. Reaction motors may be generally classified as "atmospheric" and "self-sustaining"; differentiated by their source of oxygen for the combustion process. Atmospheric motors, or those requiring oxygen from the earth's atmosphere—*and hence, restricted to the earth's atmosphere in flight*—may be classified generally as follows:

TURBO-JET-PROPELLER COMBINATIONS (TURBO-PROPS)
TURBO-JETS
DUCTED TURBO-JETS
PULSE JETS
RAM-JETS

Self-sustaining motors—*unrestricted in flight with respect to the earth's atmosphere*—obviously of the rocket category which carry their own oxygen, may be classified as follows:

SOLID-FUEL
LIQUID-FUEL
(PRESSURE FEED)
(PUMP FEED)

The type of power plant employed has a great effect upon the tactical characteristics of a missile, involving such factors as altitude, speed, range and type trajectory.

The study of the selection of the proper power plant for a given application is a highly complex field in itself and should not be discussed in a paper of this type in which an attempt is being made to stress the tactical aspects. However, we may generally bear in mind that in the speed consideration, we must pay dearly for what we gain. In missiles, as in an automobile, we simply cannot avoid the fact that, within the ranges involved, the faster we traverse a given distance, the greater will be the over-all fuel requirement.

From the logistic and supply standpoint, the type of power plant employed will be of tremendous importance. In turbo, pulse, and ram-jet types, it is probable that conventional type fuels (gasoline and kerosene) will be largely utilized, and these will present no particular problems. However, rocket fuels, in general, have the characteristic of being quite "nasty" to handle. In many cases, the fuels are highly toxic or otherwise injurious to personnel, are highly inflammable, and, in most cases, self-igniting, and some may have the bad habit of not lending readily to storage over extended periods of time. You may easily visualize the problems that a guided missile service unit would encounter moving a huge, mobile liquid-air generator and a train of tank trucks transporting red, fuming nitric acid over a difficult road net under enemy fire. However, problems of equal or greater magnitude have been encountered, and successfully resolved, in the past.

In addition, the search for newer and better fuels is being pursued diligently. It is not only possible but highly probable that many of the new fuels, while giving our missiles higher performance and greater capabilities will at the same time give our guided missile service units more headaches.

The guidance and propulsion characteristics discussed in the preceding paragraphs will be evaluated by research and development groups and we can assume that the final missiles to be employed tactically will be presented to the using troops as "finished packages." However, an understanding of the technical fundamentals as outlined above is essential; certainly, an artilleryman should know artillery theory as well as practice.

So much for types, classification, and abbreviated tactical implications. Let us now direct our attention to the first goal of this paper—that of making certain assumptions. Let us assume that certain mythical missiles having certain hypothetical characteristics are delivered to us, one type at a time, in neatly tied, "finished packages" with orders to integrate them into our existing equipment array and to "pull out of our hats" those new tactics and techniques which will currently maintain our capabilities at peak operating efficiency, with full operational utilization of what our research and development efforts have produced for us.

The airman will require AAM and ASM, and these weapons, since this discussion is to emphasize the ground employment requirements, we shall dismiss with the statement that such weapons will, obviously, supplement or replace conventional aerial machine guns and cannon as well as conventional bombs, and will greatly increase both defensive and offensive capabilities in the field of aerial warfare. Very long range surface-to-surface missiles will supplement strategic bombers.

Let us now activate our imaginations and assume certain weapons of direct application to ground force tactical employment. Certainly, we shall encounter missiles of the SAM and SSM types, these weapons to supplement AAA and field artillery and tactical support aircraft. In the SAM field, let us assume that we are first given an antiaircraft guided missile followed at some later date by an antimissile missile. The hypothetical characteristics of this weapon along with a brief summary of auxiliary equipment may be as follows. Again let us emphasize that the statements which follow discuss purely hypothetical equipment, "pulled out of the hats" of the authors and bearing no direct or indirect semblance or relationship to actual equipment, existing or anticipated, developed or being developed by any element of the National Military Establishment. These equipments are, then, purely fictional and have been "dreamed up" only to serve as a basis for a tactical discussion.

ANTIAIRCRAFT SAM (SAM-AA): A liquid-fuel, rocket-propelled, supersonic vehicle, approximately 20 feet in length 18 inches in body diameter, 3 feet in control surface span, weighing 1,000 pounds assembled and fueled, employing a preset initial guidance, command mid-course guidance, and homing terminal guidance systems; the over-all *terminal-guidance-fuze-warhead* combination such that the single shot kill probability of a single missile employed against a single conventional, high-performance aircraft is 0.25. The missile employs a liquid-fuel propulsion system which fuel is shipped to the launching site assembled within the missile subassembly, the oxidizer being packaged separately in containers that constitute the missile oxidizer tank with the assembly being effected at the launching site. A 1,000-pound solid-fuel booster is required to launch the missile, the booster assembly being 4 feet in length, the over-all booster stabilizer span being 12 feet.

This missile is shipped in heavy wood and plastic containers, five containers per complete missile round. It is in this preassembled condition that the missile is received by the using unit, a guided missile battalion (SAM-AA). Distribution of preassemblies is made to the actual launching site, manned by the guided missile section, the basic fire unit, where final assembly of rounds is made. A description of the five containers is as follows:

(1) *Warhead and fuze:* 1½′ x 3′ x 6′, weighing 400 pounds, may be stored in any position and stacked eight deep.

(2) *Forward body, guidance equipment and aerodynamic surfaces:* 3′ x 3′ x 12′, weighing 600 pounds, may be stored in any position and stacked four deep.

(3) *Aft body, propulsion system and aerodynamic surfaces:* 3′ x 3′ x 12′, weighing 700 pounds, may be stored in any position and stacked four deep.

(4) *Oxidizer container:* 1½′ x 3′ x 6′, weighing 175 pounds, may be stored in any position and stacked eight deep.

(5) *Booster, disassembled:* 3′ x 3′ x 6′, weighing 1,500 pounds, may be stored in any position and stacked four deep.

These containers, in addition to basic components listed above, contain all accessories required in assembly and preflight testing of the missile. The entire packaged, disassembled round, it may be noted, has an over-all weight of 3,375 pounds, an over-all volume of 324 cubic feet and may be stacked in crated condition as an integral assembly in a space 3′ x 9′ x 12′ or the subassemblies may be stored separately as warehouse and assembly area facilities dictate. One missile component group may be transported with suitable crate modifications, in one of a number of standard Army transport vehicles.

The firing unit equipment consists of, in addition to standard T/E equipment, accessory warning and control radars, a computer-director that computes "commands" and, hence, controls the missiles in flight as well as a number of mobile launchers, the control equipment having tactical mobility approximately equivalent to present AA gun battery control equipment and the launchers having tactical mobility approximately equivalent to the 155mm howitzer. In addition, further equipment consists of suitable matériel handling equipment for local movement of crate-containers and assembled missiles, similar to a conventional, mobile crane.

The above, then, is our new weapon, our SAM-AA, purely hypothetical, your guess as good as ours! The enumeration of assumed container specification was made with a definite purpose in mind: we wish to impress upon you that, when handling guided missiles in the field, you will not be dealing with "small potatoes." These weapons will be large, cumbersome, heavy, and will present new equipment-handling problems to the using unit as well as to those concerned with the over-all logistical problem.

We shall now assume that our next missile will be a short-range SSM with capabilities of high accuracy, surface-to-surface employment at targets at ranges to 150 miles:

SHORT-RANGE SSM: A liquid-fuel, rocket-propelled, supersonic missile, approximately 35 feet in length, 3 feet in body diameter and 10 feet in control surface span, weighing 15,000 pounds assembled and fueled, employing preset initial, and command mid-course and terminal guidance, the over-all accuracy capability at full range being a circular probable error of one-half mile. That is, 50% of the impacts falling within a circle of one-half mile radius. We shall assume that the missile carries a 1,000-pound warhead. The missile employs a liquid rocket propulsion system utilizing alcohol and liquid oxygen, being fueled at the launching site. This missile is shipped assembled, less fuel and warhead, and is shipped by conventional ship or rail equipment to depots from which specially designed truck transports move the assembled missiles to the launching sites, these transports having tactical mobility approximating a loaded semitrailer with tractor.

These missiles are fired by a guided missile battery provided with suitable control and auxiliary equipment. They will, of course, supplement conventional field artillery weapons and tactical bombardment aircraft.

We shall assume that we next receive two additional missiles: *A LONG-RANGE SSM* with range capabilities to 500 miles and an *ANTIMISSILE MISSILE (SAM-AM)*. For the sake of simplicity and since tactical considerations will be broadly similar to missiles previously discussed, we shall not discuss these weapons further, other than to assume that they have suitable characteristics and accuracy to perform their missions and that they present logistical problems comparable to tactical employment of the German V-2.

These, then, are our new assumed weapons:

SAM (AA): Antiaircraft
SSM: 0- to150 -mile range
SSM: 150- to 500-mile range
SAM (AM): Antimissile

Our problem is to develop tactics and techniques for employing these new weapons with maximum effect in augmenting our present capabilities. Some of the considerations in reaching this goal will be discussed in subsequent issues of the JOURNAL.

Australian Rocket Range

Operational experiments, including the development of supersonic defensive rocket weapons, have begun in the prohibited 3,000-square-mile area in Southern Australia of the British-Australian Long-Range Weapons Organization.

The research base is located at Salisbury near Adelaide, the capital of the state, where already immense stores and equipment have been accumulated. This base is expected to become the Empire's main research center for the development of supersonic weapons.

The rocket range is at Woomera, 240 miles northwest of Adelaide in one of the world's loneliest, most arid and hottest regions. No trees grow on the range's 3,000 square miles and there is only a sparse incidence of brush. From Woomera it extends across the desert for 1,200 miles toward the northwest coast of western Australia.

A further extension is planned of 1,500 miles over the Indian Ocean toward Christmas Island.—*From the New York Times.*

Widows and Children—Forgotten People

By One of Them

This is the factual story of the financial difficulties of one Army family after the death of the husband—a Colonel with 32 years of service in the Regular Army. It is hoped that its readers will be moved to take careful stock of their own financial provisions to avert the possibility of similar or much worse experiences for their own dependents. Under present laws, the only real security for service widows and children is that acquired from their own family resources during the lifetime of the husband and father. However, present and past pay scales cannot bear the expense of really adequate savings and insurance for this purpose. Government benefits may, under certain circumstances, be paid to the more fortunate ones but are sufficient to cover only a small fraction of the minimum cost of present-day living.

I saw an article recently in a Washington paper about a young widow who had had trouble collecting government money which was her due. The writer remarked that that sort of thing would not have happened to any of the "Brass." Although I am not clear on the exact definition of the oft-used term "brass," I feel that since the same thing happened to me, the widow of a fairly high-ranking officer of long service, it could happen to almost anyone.

Most of the articles along this line that I have read are about the young widow, who, after her husband is killed in action, is left with several children to support. My story is somewhat different, for I am not a young woman. I am middle-aged with two children to support through the most expensive years of their lives. For 23 years I have led the life of an average Army wife. I have been trained for nothing in the money-making world, and now at middle age, I have had to go to work, and to scrape in every imaginable way, to squeeze out a bare living, because the small government compensation plus the maximum savings my husband and I were able to accumulate is nowhere near enough to get us by in this day and age.

Had my husband lived the expected number of years and had the children been grown, educated, and on their own I could have managed somehow. In his planning and saving for our security he could not be expected, nor did he foresee to how great an extent the present era of fantastically high prices would nullify his efforts.

Ten years ago we lived happily in big quarters on a beautiful old Army post with our two children, 4 and 8 years of age. Our position might have been called favorable for many reasons. I was the wife of a Colonel in the R. A. I had had time to learn the Army well, to love it, and to depend upon it. We lived comfortably, never extravagantly, and like other Army folks, had the advantage of travel and living in foreign countries, where we saw new sights and met interesting people. We always felt reasonably secure in our future, thinking of the strong and rich Government behind us, which had assured us of the retired pay that would be ours when our days of active service ended.

Then out of the blue, death struck, and my husband was taken away from us at the age of 51. And the security? Our equity in our retirement pay? It was gone. The security was there only so long as my husband lived.

Why, you may ask, should all this come as such a shock? Did we not understand and anticipate this possibility in our planning? Of course we did, and my husband tried his utmost to avert the very thing that happened to us. We had no real right to feel such a comfortable sense of security in anything so uncertain as my husband's retirement income. I think we allowed the term "retirement income" to mislead us. To most people it means an income derived from resources which they *own* and have acquired either as the fruits of years of hard work, lucky breaks or, probably inclusive in the latter, by inheritance. At any rate the basic thought is one of something *owned*. As such it belongs to the owner and, in event of his death, to his family. An Army officer supposedly "earns" his retirement income by devoting thirty years or more of his life to the service of his government—as did my husband—but upon his death, it does *not* belong to his family.

The fact that retirement income is lost when the husband dies seems strange, since Congress has always considered retirement benefits as a part of the pay of service people, and since it is so considered by some insurance men.* In fact I was told by one insurance man that his company would charge a premium of $100 monthly in order to match the government's retirement plan. As a result of this common attitude the active pay of service people has consistently been held below that normally commensurate with their responsibilities, since they do not, at least in theory, have to set aside a part of their earnings to provide for themselves *and their dependents* in their old age. I agree with this except for the italicized words. Aside from small benefits payable only in certain cases, the Government makes no appreciable provision for the dependents. For the retired serviceman himself, the Government undertakes only to pay *him* a monthly stipend, and that only for as many months as he shall *live* in retirement. He *may* receive such payments for many years, or he may receive none at all. In the latter case, there is no lump-sum settlement such as would be made by an insurance company to compensate for the difference between an equity actually earned and that actually paid.

My husband lived two months after he was retired for

*The Hook Commission on Service Pay felt likewise, for in a press conference at the Pentagon on the occasion of the release of their very fine report, Chairman Hook and his associates said that no effort was made to coordinate service pay above the grade of lieutenant colonel with pay received by civilian counterparts because virtually all officers who attain such a grade are entitled to retirement benefits far more liberal than those provided for their opposite numbers in civilian life. See Report of Hook Commission, p. 58.

physical disability and received only $824.00 of the equity that he built up over a period of 32 years.

Based on my own experience therefore, I strongly maintain that the present service retirement plan is inequitable to its beneficiaries and is in no way comparable to retirement income based upon owned resources such as may be achieved by successful private citizens.

When my husband died, I had no parents, brothers or sisters to whom to turn; neither had my husband. We had some cousins, and an aunt, who wanted to help but could not. Our monthly compensation from the Government was $60 for me, $18 for my first child, and $15.60 for the second. (This has since been raised to $75, $25, and $15.) The allowances for the children were to continue until they became 18 years of age, at which time they would cease, unless, I am told, the child remains in a VA accredited school, in which case, the allowance will continue until age 21.

However, this necessitates an application each year, with no assurance that the allowance will be authorized. My older child was 18 last August and in school. I applied immediately, and although five months have gone by, I have received nothing for her since her birthday.

Government insurance gives us $57.50 per month for 20 years. I found out too late that my insurance payments could have been set up in slightly smaller payments for life rather than for only 20 years. Now these payments will stop when I am in old age and will need them badly.

Altogether then, we had $151.10 a month. We could have moved to any part of the country—one move—at government expense. And so, with one place being as objectionable as another to me, we settled on Florida for its lower fuel and clothes bills.

Renting was out of the question—anything for rent was out of our reach. We decided to buy. We managed to find a small house on a not too bad street, convenient to school and shopping areas. Because the house was old, and the owner anxious to sell, I was able to raise the down payment. It took all our government bonds that we had scraped and saved for during a period of many years. It was not the type of house that we had been used to, but it was comfortable, and we were in no position to be choosy.

The monthly payments on the house were $40. That left $111.10 of our income to take care of all other expenses. The most careful buying could not keep our food and milk bills under $90. That left about $20 to take care of everything else: utilities, clothes, carfare, school fees, dentist fees, doctor bills, and the countless other things that constantly come up. And no cushion was left to care for any kind of serious contingency.

The checks normally come in regularly—almost to the day, but our existence is completely dependent upon the prompt receipt of them, and if a check gets misrouted—as can easily happen—you are sunk. Mine was almost a month overdue one time, so I wrote to a friend in the Washington area and asked him to investigate. He found that the check had been addressed to Colorado instead of Florida and had come back marked "Unknown," to be pigeonholed in Washington. Another time, it was sent to an Indiana address, and the same friend had to take care of it again. There is no telling how long it would have taken to straighten out such a mix-up if inquiry had to be made by mail to a government agency rather than by a friend on the spot. These errors do not necessarily represent inefficiency on the part of the Government. I mention them only to indicate how very precarious such an existence can be.

The $20 just didn't stretch. I consulted the Army Relief Society, whose function is to care for the widows and orphans of Regular Army personnel who are in need, and I learned that in my present circumstances I could be considered one of the plutocrats among Regular Army widows—that many widows, left with babies and small children, are not entitled to a pension, and are physically unable to work.

And so—I went to work. This is not easy at middle age when you haven't worked for 32 years. I should not say that I have not worked—an average army wife works all the time. She has to. She rears a family, manages the quarters, and in the last ten years has usually done all the marketing, cooking, housework, sewing—even the washing and ironing—and, of course, the certain amount of necessary entertaining, and devoting time to other post activities her husband's position may demand. I have organized and presided over two large and actively working officers' wives' clubs. This took hours of planning, desk work, speech making, and administration.

All of these things are work—but not the kind that prepares one for the business world. I found it was not easy to go out among utter strangers to get a job. I also found that it was not easy to hold a job once obtained. I became very tired in my new role as family head and breadwinner: 8 hours a day, 6 days a week, running the classified page of a weekly paper, then home—usually after 6:30—to prepare dinner and clear things away with the help of the children. Needless to say something has to be neglected in a set-up like this. It was the children, and the house. This worried me constantly.

Even with the job, I have not had enough money to meet all the bills, and have had to work out other ways to make money. I have been able to rent out a room in our house by having my daughter share mine. This has helped. Recently I sold some linens acquired in China years ago at comparatively small cost when we were stationed in the Far East. Their comparatively small financial value had in my circumstances to outweigh a far greater sentimental one so now they are gone—to our dentist to pay a dental bill for the children—my teeth will have to wait. Perhaps my other small treasures will have to go.

Here is another consideration: When the husband is gone, all post privileges—except medical care—are taken away from the dependents. Thus, when every penny counts tremendously, and you need commissary and Post Exchange privileges most, they are denied you. I have heard that the reason is that facilities are inadequate to take care of all the widows. If this is the reason, it is not valid. Commissaries are provided to fill a need for service personnel, and if anyone has a need, it is the widow. In some government hospitals, you are treated well. In others you get no treatment at all. Army Regulations provide that dependents and widows will get treatment as far as facilities and bed space permit. In some kinds of treatment—especially dental—service facilities are already overtaxed, and have backlogs of active-duty personnel who have first priority—in short, it is unavailable to us.

Fortunately, we have thus far had nothing but minor ailments, and the medical authorities have been cooperative and helpful. I have heard, however, that some hospitals have been indifferent to the families of retired personnel, and in some cases have denied them hospitalization.

All of this has come as a shock to me, and most people—service as well as civilian—are pitifully ignorant about what often happens to Army widows and their children. One of my cousins wrote to me: "Doesn't the Army give you a pension and a house? Why do you need a job?" Another cousin, the head of a fairly large industrial plant, wrote that he was sorry that he did not have a job for me, but "you know Army people don't need jobs, anyway."

Some may say that the widow's pension or compensation is a sharing in the husband's retirement income. If this is so, why are many widows denied pensions? It is difficult to determine upon just what the pension is based. Certainly it's not based on the husband's retired pay, and it's certainly not based on actual need—else it would be adequate to cover minimum living expenses. If it is not based on something that we have earned, then it can only be charity, and we do not want to be objects of charity. We only want what is our due.

I realize that mine is the story of an Army widow who at the present time may be considered to be in much better circumstances than most. But it is a precarious existence at best, with little hope for the future. What will happen when the insurance payments run out? What will happen if my health should fail and I could no longer work? And when I am too old to work, will I be dependent upon my children? Or relatives? Or will it be an institution for the aged?

You Will Not Find Perfection

...In your Army of today, you will not find perfection. You will not find that every officer is an Eisenhower or a Bradley or even a competent practitioner in the difficult art of leading his fellow soldiers. But you will find that the doors and windows of the Army are open and that a clean, invigorating wind is blowing away the accumulated cobwebs of a narrow and fruitless traditionalism. A good start has been made. It cannot be continued without the interest, the understanding, and the support of the American people. It cannot succeed if your sons come to us imbued with a hatred of their Army and a contempt for the corps of officers. It cannot succeed if these young people have not learned that there are some values in this world worth fighting for and, if need be, worth dying for since the alternatives are too dreadful for the free man to contemplate. Affirmatively, they must understand the world in which they live and their part in that world; they must feel deeply the spiritual bases of our national philosophy; they must learn that every privilege, every right, every freedom carries a corresponding obligation; and, finally, they must bring with them the knowledge that tyranny in Bulgaria, starvation in Greece, treason in Malaya, or civil war in China, are of intimate and deadly concern to every man in every corner of the earth. Somehow they must learn the lethal significance of that lethal line, "Ask not for whom the bell tolls. It tolls for thee." Given that clarity of perception and that moral strength, neither we nor the world need go in fear of the future. It is a fearful and a fateful task. May you be equal to it.—Brigadier General CHARLES T. LANHAM in an address before the 28th annual meeting of the National Council for the Social Studies.

Your Survivors May Be Eligible For Death Benefit Payments

Your survivors may be eligible for death benefit payments—whether you die in service, or after retirement, or after discharge—if you are:

(1) A veteran whose death was caused by disease or injury incurred in, or aggravated by, service in wartime or peacetime, or

(2) A veteran of World War I, or

(3) A veteran of World War II with some disability incurred in, or aggravated by, your service whether that disability caused your death or not, or

(4) A veteran of World War II and die within three years of your discharge and before July 26, 1951.

Because there is a great deal of misunderstanding, and considerable lack of information disseminated concerning benefits that are payable to the survivors of ex-servicemen, a digest of these benefits is reported below:

In the payment of benefits to survivors, a "veteran" is a person who has served at any time in the armed services of the United States. Benefits are of two kinds: *death compensation,* applicable to (1) above, is payable to widows, children, or dependent parents; and *death pension,* applicable to (2), (3), and (4) above, payable to widows and children. The term "service-connected" that is used in connection with benefits refers to death, injury, or disease incurred or aggravated while in service, and not due to the veteran's own wilful misconduct. (Examples: A soldier on duty contracts a disease. He is later cured and accepts a discharge. At some later date, the disease reappears and contributes to his death. His disease—and his death—would be service-connected. If his disease were originally contracted in wartime, his survivors would be eligible for compensation at wartime rates. Another example: A soldier in active service on furlough is injured in an automobile accident not due to his own wilful misconduct. He is cured and later retires. If his death at a later date is related to this injury, his survivors would be eligible for service-connected death compensation.) The death of a veteran who was injured subsequent to discharge or retirement, however, and who dies from these injuries, would not be classified service-connected. Death or injuries incurred while AWOL, or while otherwise in wilful misconduct, probably would not be considered service-connected. In determining whether death was service-connected, it is not material whether the veteran was at the time of death on an active-duty, retired, or discharged status, but in all cases of discharged veterans, discharge must have been other than dishonorable, and in case disease or injury in service is a factor, it must have been caused other than by the veteran's own wilful misconduct. Payments may be made to widows unless they remarry, to unmarried children under 18 (with extension to age 21 if attending schools approved by VA). Dependent parents are eligible to receive *compensation,* but not *pensions.*

Rates for Service-connected Death. Regardless of whether the veteran served during wartime or not, if his death is attributable to causes incurred or aggravated during active service, his survivors will be eligible for compensation. The size of the payments, however, is different if his injury or disease was incurred or aggravated during wartime service whether his death occurred during or subsequent to active service. *Wartime rates:* Widow without children, $75 per month. Widow with children, $75 plus $25 for the first child and $15 for each additional child. No widow but dependent children: One child, $58; two, $82; three, $106; more than three, $106 plus $20 for each child more than three in number. One dependent parent, $60; two dependent parents, $35 each. *Peacetime rates:* These payments are equal to 80 per cent of wartime-service rates, as follows: Widow without children, $60. Widow with children, $60 plus $20 for the first child, and $12 for each additional child. No widow but dependent children: one child, $46.40; two, $65.60; three, $84.60; more than three children, $84.60 plus $16 for each child more than three in number. One dependent parent, $48; two dependent parents, $28 each.

Wartime rates are payable in peacetime cases if the disability or death resulted from injury or disease received as a direct result of armed conflict or while engaged in extra-hazardous service, including such service simulating war.

Rates for Non-service-connected Death.

a. Survivors of veterans of World War I whose deaths are judged to be non-service-connected are still eligible for pensions, if the veteran at the time of his death is receiving, or is entitled to receive, compensation, pension or retirement pay for a service-connected disability, or if the veteran served for a period of 90 days or more during the period April 6, 1917 to July 2, 1921 (90 days service is not required if the veteran was discharged for physical disability). Payments in monthly rates are: Widow but no child, $42. Widow with children, $42 plus $12 for the first child, and $6 for each additional child. No widow but dependent children: one child, $21.60; two, $32.40; three, $43.20; more than three children, $43.20 plus $4.80 for each child more than three in number. A limitation on payments under this pension, that does not apply on the service-connected compensation mentioned before, is the stipulation that the pension cannot be paid to a widow without children whose annual income is greater than $1,000, or to a widow with children if her annual income is more than $2,500. Government insurance payments are not considered income for purposes of this limitation.

b. Survivors of veterans of World War II whose deaths are judged to be non-service-connected are eligible for a pension of the same amount and income limitations mentioned in *a* above under certain conditions: The veteran must have served 90 days or more in World War II, must have been discharged under conditions other than dishonorable, and at the time of death (1) must be receiving, or be entitled to receive, compensation for a service-connected disability, or (2) must have a definitely ascertainable service-connected disability. In the latter case, the disability may be as little as 1% or less, provided the condition is of such nature that compensation could be paid if it were 10% or more disabling. (Example: A soldier on active duty breaks his ankle while playing football with his son. The ankle heals with only slight loss of agility. He retires or is discharged from the service, at which time his ankle is determined to be too slight a disability to bring compensation, but is still somewhat of a disability, say, 1%. Subsequent to his service, he is killed in an automobile accident. Because the broken ankle is a type of disability that might bring compensation if the degree of disability were 10% or more, his survivors would be eligible for a pension.)

An official of the Veterans Administration, who handles pension cases, states that many persons having slight service-connected disabilities retire or accept discharges without having their disabilities made a matter of record, and that many widows have been deprived of pensions because they were unable to produce evidence of those disabilities. The VA official advised that any serviceman having a service-connected disability at the time of discharge insure that it be made a matter of record, and that he apprise his dependents of their rights under this law.

He further advised those who have already retired or who have been discharged and who have service-connected disabilities not already a matter of record to procure evidence to document their survivors' requests for pensions. In the example of the broken ankle cited above, it was recommended that the veteran procure affidavits—from medical officers if possible—as proof that he has a disability, and that it was service-connected.

Other veterans' benefits:

Survivors of veterans of World War II who are not eligible for any of the compensation or pensions described above, may still be eligible for benefits under a 1946 amendment to the old-age and survivors insurance program of the Social Security Administration. It is a temporary law that gives protection to the survivors of veterans who die within a period of three years following the veteran's discharge if he is discharged prior to July 26, 1951.

Payments to widows without children might be as large as $33 a month, and with dependent children might be as large as $66.

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Lt. Col. James H. Farren, CAC, has had wide airborne AAA experience. At present he commands the only active airborne AAA unit in the Army, the 503d Airborne AAA Battalion of the 82d Airborne Division. During the war, he had considerable combat experience as commanding officer of the 152d Airborne AAA Battalion of the 11th Airborne Division. We are pleased to report that he is preparing a longer article on lessons learned in airborne AAA for a future issue of the JOURNAL.

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Lt. Col. David B. Parker, GSC, is assigned to the Office of Deputy Director for Atomic Energy, Plans ond Operations Division, General Staff, United States Army. Many readers will remember him for his "Death Takes a Sleeping City," published in the May-June 1947 issue of the JOURNAL, which was reprinted in the *Reader's Digest,* and "What Every Officer Should Know About the Atom Bomb," published in the January-February 1947 issue of the JOURNAL.

Major William L. Molo, USAF-Res, is a member of the staff of the Climatic Analysis Branch, Military Climatology Division, Headquarters Air Weather Service. From 1942 to 1945, he served in an active duty status on the staff of Headquarters Air Weather Service in Washington, D. C.

Col. Harry A. Markle, Jr., CAC (PNG), is commanding officer of the 213th AAA Group, Pennsylvania National Guard, with headquarters at Allentown, Pa. During World War II, he served as S-3 of the 38th C.A. Brigade (AA) at Camp Stewart, Ga.; as Chief, Ordnance Issue Branch, Distribution Division, Headquarters, Army Service Forces; and at the end of the war, as Director, Distribution Division, Headquarters, Army Service Forces. Before assuming his present command, he was Executive Officer, 51st AAA Brigade.

Air Force photo

Ninth Air Force Defensive Measures Against German Flak*

Flak Analysis Developments

Development of mathematical solutions to the flak problems of a tactical air force was the continual and ingenuity-testing goal of flak analysis officers in this theater. "Approved solutions" were produced, but as the campaigns rolled on it became more evident that the best flak analyses in the rapidly shifting tactical areas were very seldom the mathematical solutions.

The eternal question in the tactical operational area was, "Where are those German flak positions?" and because flak analysis is founded on an exact knowledge of the weapon locations and characteristics, the problem became extremely nebulous. There always appeared to be more unknowns than equations. In addition, in a tactical air unit targets were selected and attacked with such dispatch that formal analysis systems, especially with fighter-bomber organizations, were applied only when time allowed. It was with these limitations that flak personnel approached the subject and evolved the procedures briefly described in the following paragraphs.

Medium Bombardment

Essentially the analysis method in use throughout the Bomber Command was that system originally devised for the strategic high-level bombers in this theater, slightly revised to accommodate the lower bombing altitudes (10,000 to 14,000 feet) employed on the B-26, A-20, and A-26 missions in the tactical area. Often because of the typical unbalanced defenses of the tactical area it was possible to choose the proper bombing axis and route without resorting to the flak clock. However, if any doubt existed, due to gun density, wind, possibility of shifts in the mobile defenses, etc., the flak defenses were thoroughly analyzed in conjunction with other operational factors of sun, drift, etc.

In order better to evaluate and record flak experience for future use, overlays of each mission route with flak experience as to location, intensity, planes damaged, quality and type of fire, etc., were composed at group level and forwarded to Command for analysis. This method of presenting flak fire experiences proved very successful in providing intelligence of enemy dispositions in areas for which there was no photographic cover.

Fighter-Bombers

With due regard to the enormity of the vagaries, the possible errors, the unknown quantities, and the flexible conditions that haunt the fighter flak problem, efforts were made to produce a workable "gadget" that would indicate best routes into and out of light flak areas for the particular benefit of fighter-bomber aircraft. In May, 1944, flak analysis officers of the IX and XIX Tactical Air Commands produced the first dive-bombing and low-level bombing flak computers for light flak analysis.

Flieger-Abwehr-Kanonen

Early in 1944 flak replaced enemy aircraft as the principal cause of loss and damage to Allied aircraft. Flak production moved into high gear and the Hun built up powerful de-

*Reprinted from *Flak Facts*, by Hq Ninth Air Force.

HEADQUARTERS UNITED STATES ARMY
NINTH AIR FORCE
Office of the Commanding General
APO 696, U. S. Army
9 May 1945

With the successful accomplishment of complete and total victory in the European campaigns comes the period for reflection on and analysis of the activities of the months past. This booklet is a brief record of the efforts of airmen and flak officers to combat the major opponent of this Air Force—German flak.

It must be remembered that the Ninth was a tactical air arm. After annihilation of the Luftwaffe, our schedule was mainly designed toward isolation of the ground battle area and cooperation with the ground forces of the Twelfth Army Group. In addition the situation frequently demanded air operations in the area of and in cooperation with all Army Groups in Europe. These missions defined all activities of the many staff sections of this complex air organization—including the flak section. These pursuits constituted a great challenge to the Ninth.

In the final analysis this challenge was most important, not only to the flak sections, which existed because of it, but to the tremendous striking force of the Ninth—the pilots and their aircraft. Flak intelligence was a part of the insurance taken out for their protection. The flak officers' proudest claim is that they were able to help assure this protection.

It is hoped that this record of their efforts, together with the lessons learned by our airmen, may contribute to the great remaining task—total defeat of Japan.

/s/HOYT S. VANDENBERG,
/t/HOYT S. VANDENBERG,
Lieutenant General, USA,
Commanding.

fenses throughout the Reich for the protection of his cities, industries, and military installations.

During the heyday of the German Air Force, flak was considered a minor and annoying evil, like a mosquito that buzzed around and sometimes bit. The greatest proportion of loss and damage to Allied aircraft during this early period was caused by enemy fighter planes. Formations, tactics and other defensive measures aimed at reducing the destructive power of enemy aircraft—and flak was hardly considered worthy of special treatment.

That was before the back of the GAF was finally broken in the early months of 1944, forcing it to rely almost completely on flak defenses for protection against the air supremacy enjoyed by the Allies.

Production of flak equipment, which had the same priority as did production of aircraft, increased in tempo, and by the end of 1944 the already formidable defenses had increased to 16,000 heavy guns, 50,000 light guns, 7,500 searchlights, and 1,500 balloons, manned by a total of more than 1,000,000 personnel. Moreover, in December 1944, production of flak equipment was given higher priority than all aircraft except jet-propelled planes.

Around his most important industries the Hun amassed the greatest concentration of flak guns the world has ever known. The Ruhr defenses, greatest of the great, were capable of hurling 200 tons of metal and explosive into the air every minute; the Cologne defenses, 80 tons; the Berlin defenses, 70 tons.

The total defenses of Germany, firing the one minute, could have put 5,000 tons of shells into the sky.

Everywhere, on everything, flak guns were found: on the ground, on buildings, towers, trucks, tanks, submarines, barges, small boats, warships, and railway cars.

Fire control equipment, both optical and radio, directed accurate fire to heights seven miles above the earth's surface.

These, plus deceptive tactics, tricks, and traps engendered of German ingenuity, all joined in a desperate battle against the crushing blows of the bombers and the deadly sting of the fighter-bombers.

This was the enemy against which flak sections were established. This was the enemy that was, after the demise of the GAF, the primary cause of loss and damage to our aircraft.

PHENOMENA

Any unusual and not readily explainable observations made by flying personnel on missions over enemy territory were classified as "phenomena." Some of these were German experiments proposing to find some further means of combating Allied air superiority, and some were pilot optical illusions or misidentities of matériel used by the Allies.

Most of the phenomena reported were resolved into five general classes:

(1) Cable Type Flak—Included in this class were rocket projectiles which emitted wires or cables on exploding, cables suspended from parachutes, and small balloons supporting cables to which were attached dark objects. Investigation revealed that a number of the small balloons with appendages were either radio or meteorological devices. No evidence was ever received that any aircraft of this Air Force were damaged by cable flak, though it is believed that such phenomena did possess a real lethality. However, such flak must be used in great densities in order to achieve any effectiveness.

(2) Translucent Balls—Variously described as appearing like fishbowls, baseballs, snowballs, silver balls, and soap bubbles, reports of such phenomena were rather common. Since none of our aircraft ever flew or fired into these balls, nothing definite was ever learned about their potential lethality. However, it was believed that many of these reports were actually observations of "window" units which failed to disperse, and which, spinning in the sunlight, might quite reasonably have appeared to be silvery or transparent spherical objects.

(3) Rocket Flak—It was definitely known that the Germans were experimenting with rocket flak, and the varying colored bursts and occasional "streamers" were most likely

variations of already known rockets. Rocket flak was fired at high and low altitudes. Though rockets are inexpensive, they are also inaccurate, and large numbers must be employed to achieve a semblance of effectiveness. It is believed that many reports of rocket flak stemmed from observations of trails of smoke bombs dropped by our planes, of light flak tracer, and of exhaust from jet-propelled aircraft.

(4) Electrical Disturbances—On several occasions pilots experienced electrical disturbances in their engines and radios. At first, flak officers thought this might have tied in with reports from PW's and other sources that the Germans were trying to develop high-frequency electrical methods of knocking aircraft out of the sky. However, in one instance investigation revealed that malfunctions of the electrical systems of the aircraft involved had caused the disturbances. Because of the tremendous amounts of energy that would be required to create a magnetic field capable of damaging aircraft in flight, it is not believed that such a weapon ever actually operated.

(5) Flares or Unusual Bursts—Since these were generally very bright and directed near large formations of our planes, it was believed that for the most part they were either signals to German fighter aircraft or possible designation of zones of fire for flak batteries. One type of burst, called the "scarecrow," resembled a plane which had exploded in mid-air, and was used for a deterrent morale effect on bomber crews.

Though none of the phenomena demonstrated effectiveness, some were potentially lethal, and all unusual observations were carefully studied with a view to keeping abreast of experiments and developments in German air defense equipment.

Whereas from January 1944 to January 1945 the number of balloon barrages was reduced one-half, the number of smoke screen installations doubled to approximately 75. These were employed chiefly for concealment of communication and industrial targets. Use of smoke screens around dams and bridges was not begun until the latter part of 1944. Almost all synthetic oil and rubber plants and oil refineries had elaborate smoke defenses, as did several ball-bearing plants and the more vulnerable airplane engine factories.

In the last months of the war the Germans, having increased considerably the efficiency of their smoke defenses, were able to accomplish an effective density in 20 minutes.

Deception was also practiced, such as the use of dummy screens short of the target and dual screens—one over the target and another over a prominent landmark.

Actually the smoke screens proved to be more of a nuisance than an effective defensive measure. The area coverage by smoke was necessarily limited and, although bombardiers' aiming points were obscured sometimes, no mission failed solely as a result of its use, since off-set aiming points or blind bombing methods could be used.

German AAA Deployment

Since the Germans realized early in the war that they had not enough flak equipment, they adopted the policy of concentrating defenses around their most important targets and maintaining a mobile strategic reserve to rush to the defense of undefended areas that became subject to Allied air attacks. A large part of such reserves were railway-mounted flak guns which, because of their easy mobility, were especially suited for the purpose. Often some of the guns were taken from large active defenses to provide protection for a threatened and undefended area.

Heavy Flak in Ring Defense

If sufficient numbers of heavy guns were available, flak batteries were sited to give an all-round defense at the probable bomb release line. Batteries were close enough together so that the firing ranges of adjacent batteries overlapped, eliminating flak-free gaps in the defenses. If there were insufficient guns to provide such a defense at the bomb release line, the guns were moved in toward the objective until their firing arcs overlapped.

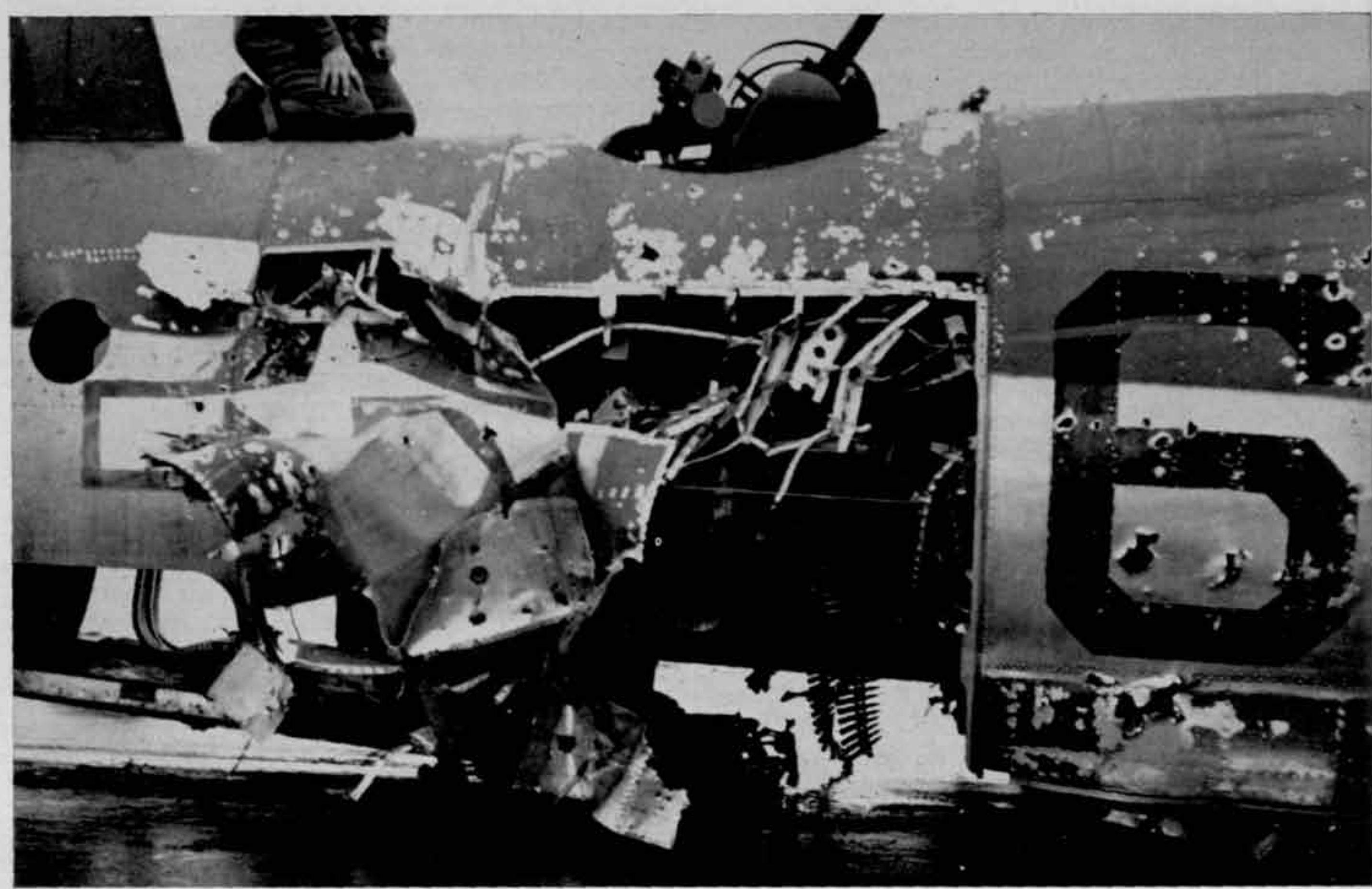
Balanced defenses were always the aim, but terrain features and size and shape of objectives often unbalanced the Germans' defenses, leaving weak spots, which flak officers capitalized on. Further unbalancing resulted during the first part of the war from the policy of concentrating guns along the most likely avenues of approach to the target. Since flak officers directed bombers away from such well guarded approaches and took advantage of an approach that was weakened by this policy of concentration, the Germans discontinued that system.

The number of guns to be used in a particular defense depended on the priority of the target area, the number of guns available, and the number needed to provide an all-round defense without gaps.

Around strongly defended cities generally there was a double ring of heavy flak guns—the outer ring attempted to break up bomber formations before they reached the vital area, and the inner ring engaged the bombers prior to and during the bomb run. Cologne and Munich are two examples of the double ring defense.

Air Force photo

Flak Victim over Germany



Air Force photo

This Martin B-26 Marauder was crash landed with a full bomb load after being hit by German flak over the Saar area. The explosion killed one crew member and stranded two more in the tail section. Because of a seriously wounded member, the crew could not abandon the plane.

In the strategic area, heavy flak guns were primarily concerned with the protection of cities and heavy industries.

Tactical Flak

In the tactical area heavy guns defended also communication centers, marshalling yards, bridges, large troop areas, and major supply points. When the main line of resistance became static, as it did along the Roer River in the fall of 1944, heavy gun defenses were built up in depth and breadth. In effect this tended to large area coverage, as opposed to ring defenses at specific points throughout the strategic area.

During periods when the front lines moved rapidly, as in the race across France, what heavy guns could be saved fell back to a defensible line and were deployed in a dual role for protection of forward Army installations. Such a line was that of Chalons-Reims-Laon-Amiens during August 1944.

The basic heavy flak unit was the four-or-six-gun battery complete with fire control equipment. The four-gun battery was emplaced in the shape of a square about 50 yards on a side. Fire control equipment was situated in the center of the square prior to the addition of radar for fire direction; after that, the Wurzburg and Kommandogerat were moved to a position approximately 150 yards from the guns to protect the delicate radar from the concussion of the guns when firing.

Light Guns in Great Numbers

The manner in which light flak was deployed depended upon the objective to be defended. In defending an airfield or similar point objective, an all-round defense was the aim. This paralleled the policy for siting heavy guns. The Germans formed defense for a bridge by placing an arc of guns at each end. If a length of road was defended, guns were emplaced on either side and parallel to it.

Light guns in the tactical zone formed strong and extensive flak areas, not only during periods when the battle lines were relatively static, but also, because of the easy mobility of such weapons, when the then front line moved rapidly forward as in the Ardennes offensive. The basic light flak unit consisted of three guns emplaced to form an equilateral triangle whose sides were 25 to 50 yards long.

Deception

Deception of one sort or another was as much a stock in trade of flak batteries as was their ammunition, and the Germans became quite proficient in deceptive tactics.

Frequent Changes of Positions

Accuracy of Allied air reconnaissance compelled flak batteries to make frequent changes of positions. Movements were mostly at night, and often a two-hour fire silence in the new positions was enforced for the purpose of "sucking in" unwary fighter-bomber pilots.

Dummies

In the vacated positions dummy guns were left, and detection of the dummies was an extremely difficult and often impossible task for photo interpreters because of the height from which pictures were taken. Since this German policy was well known to flak officers, it was no surprise when a ground inspection of overrun defenses revealed a number of dummy positions which had been plotted as "occupied" positions. Though not elaborate, the dummy guns and fire control equipment contained all the component parts of the simulated matériel and were often realistic even from 1,000 feet.

Traps for Fighter-Bombers

In the German handbook of tricks there was always a chapter on luring fighter-bombers within easy range of flak guns. Various types of bait were used.

In Western Germany a section of highway had foxholes dug every fifty feet, and moving back and forth along the road were three trucks. When fighter-bombers dived in for an attack, the truck drivers dove into the foxholes, and light flak opened fire from positions on both sides of the road.

Sometimes the bait was a locomotive with steam up, but unmanned. Planes that went in for an attack received strong light flak fire.

Another trick was to drive two trucks down a highway. If they were attacked, one truck, a van type, dropped its sides, exposing light flak guns.

Very seldom were heavy gun emplacements camouflaged, probably because the expense and difficulties involved were not worth the results. Frequently light gun emplacements were camouflaged for the purpose of surprising low level attackers. Guns around a flak trap were always concealed.

Flak With the Army

Whereas flak units in the rear areas were usually static or semimobile and concerned only with defense against Allied aircraft, flak with the armies, particularly those units well forward, were equipped as highly mobile and powerful striking forces. The versatility of the 88mm and 20mm weapons was exploited offensively and defensively.

During the African Campaign, 88mm flak guns were used to seek and destroy Allied tanks. Though such offensive action was infrequent during the European campaigns, these weapons always reverted to antitank roles when Allied armies approached gun positions before they could be evacuated. Their use, and subsequent sacrifice, in road blocks and strong points were often planned rear guard, delaying actions to allow withdrawal of main German forces from untenable positions. A prime example of this was the enemy's retreat from the Ardennes region in January and February 1945.

As major flak defenses were approached by Allied ground forces, a great lessening of fire was noted by flak officers studying pilots' reports of fire received over the defenses. The principal reason for this decrease was not that the guns had been withdrawn to positions farther beyond the battle lines, but, rather, that they had been redeployed in a ground role. Army commanders studied such redeployment of flak guns and ascertained from it the keynote of the German defensive preparations.

German Panzer Army spearheads that drove deep into the Ardennes in December 1944 fairly bristled with light flak guns to protect the crack armored units from the much feared and respected "Jabos." Close behind the advancing troops came large numbers of heavy flak guns to protect vital crossroads and communication centers. Flak weapons were allotted top priority in the offensive, even though it was planned to take advantage of weather prohibitive to flying.

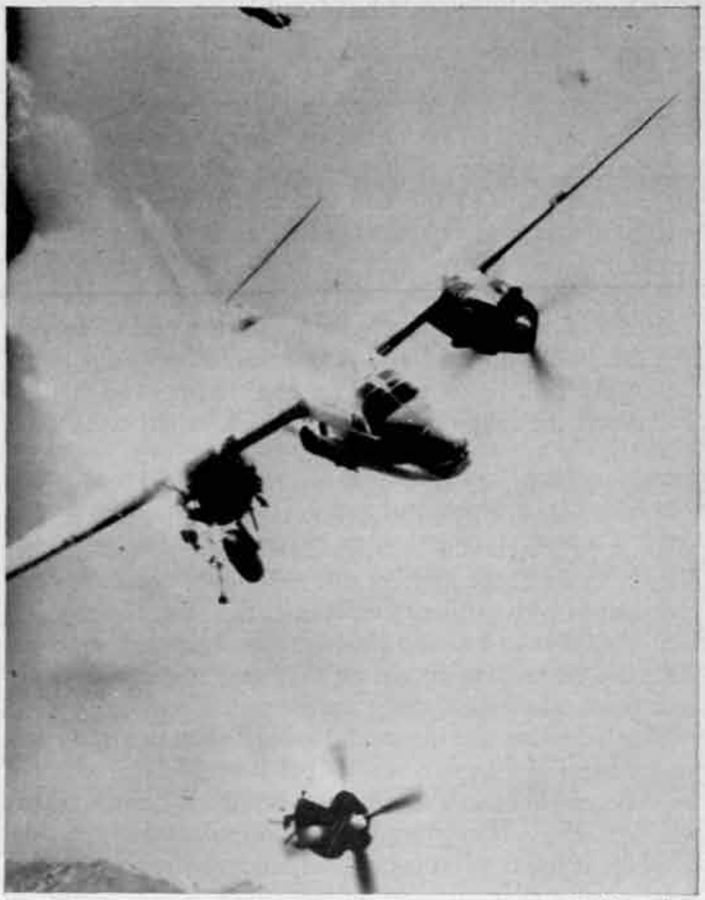
The crisis created by the First Army's capture of Remagen bridge and establishment of a foothold on the east bank of the Rhine was met with a strong holding force of mobile 88mm and 20mm flak guns pulled from active defenses of Cologne and the Ruhr and redeployed in a half circle around the bridgehead area.

Mobility and high muzzle velocities of flak guns made for flexible adaptability to the many purposes necessarily consigned them by the Germans. However, the vacillating policies of the higher command in deploying their AA in air, ground, air-ground roles so frustrated the flak field commanders that they were among the first Germans to realize the futility of their further resisting the Allied hordes which were striking them mercilessly and unrelentingly from the air and the ground.

Flak Countermeasures

Because personnel and equipment will always have certain capabilities and limitations, no single person nor military weapon in this war ever proved infallible or invincible. So it was that the threat of the German flak defense was mas-

(Continued on page 68)



Air Force photo

This B-26 has just received a direct hit by an 88mm flak shell during an attack on enemy coastal defense guns in France. With the right engine sheared off but still turning and the wing ablaze, the plane crashed a few minutes after this photograph was taken.

Limitations Of The Long-Range Missile*

By Willy Ley

The new rockets are only added weapons to our arsenal of arms—they can never be a substitute for any or all of the others

The technology of a period has always influenced its wars, but for many centuries technological innovations evolved piecemeal and so slowly that military men as a whole always felt themselves to be self-sufficient. Until about the end of the Civil War, technology merely influenced but never dominated the military "art."

But then the picture began to change, and partly because of some inventions that had been made during the Civil War, technology and engineering began to emerge as the dominant factors. The problem for the military man no longer was how he could use technological innovations to his advantage but how he could adapt tactics and strategy to the existing facts of technology.

A by-product of this profound change since then was the ever-recurring but ever-mistaken belief that all, or at least nearly all, hope could be placed in a new weapon.

The most spectacular developments of World War II were the atomic bomb, radar, the proximity fuze, and the long-range missile. And now one more group of prophets begins to appear, trying to tell us that the long-range missile, guided by radar, with an atomic war head and a VT fuze, is spelling (a) the end of artillery, (b) the end of surface fleets, and (c) the end of surface structures in general.

Although it is probably true that the fission bomb itself, if used in large quantities, would spell the end of surface structures both on land and sea, it might be useful to examine the limitations placed by engineering and natural laws upon the long-range missile which might carry such a bomb.

The emphasis is on the term "long range," which is meant to comprise any distance beyond a minimum of 200 miles, a figure chosen because 200-mile-range missiles are already in existence and because this figure eliminates any comparison with artillery fire. It is, at this moment, more or less impossible to design a 200-mile gun. If it could be done, we could be reasonably certain that such a gun would not be a practical weapon.

The reduction of a target 200 miles distant can at present be accomplished in two ways. One is aerial bombardment by piloted bombers. It is comparatively unimportant whether the air-to-ground weapon released from the bombers consists of conventional uncontrolled bombs, of gravity-powered controlled missiles like Azon, Razon, or Roc, or of missiles with self-propulsion after being released. That is a choice exclusively determined by the nature of the target.

*Reprinted from *Ordnance* magazine.

The other method is the long-range missile of which there are two specific types that are fundamentally different. The fundamental difference consists in whether they are, or are not, aerodynamically supported while traveling, *i.e.*, supported by the atmosphere. The German V-1 was an example of an aerodynamically supported missile, while the German V-2 is an example of an aerodynamically unsupported missile. This difference determines whether the missile travels along a "flight path" like an airplane or along a trajectory like an artillery projectile.

The aerodynamically supported missile will travel most of the way at a predetermined altitude, and the ascending and descending path, just after take-off and just prior to impact, will account for only a small percentage of the range. Because such a missile has to stay at altitudes where the atmosphere affords support to its wings, it follows that defending fighter craft can go to the same altitudes. And no matter how high or how fast such a missile can travel, the fighter aircraft of the same period will be superior. This is true not only because the fighter plane is manned by a skilled pilot but also because it is slated to return to base after its mission. Its propulsion unit therefore can be made of much more costly materials and hence have a performance superior to that of the throw-away missile. The aerodynamically supported missile can also be intercepted by artillery and rocket fire from the ground.

At first glance, the aerodynamically supported missile looked like a very cheap weapon; the production of a V-1 was accomplished by the Germans at a price of between 800 and 900 man-hours. The production of a V-2 rocket cost them 13,000 man-hours. But if the rate of interception is nearly 95 per cent, the price of the missile which "gets through" is no longer 900 but 18,000 man-hours, which means that the work expended on two such successful missiles equals the work required to build three V-2 rockets. Thus bomber squadrons with good fighter escort might do much better than aerodynamically supported missiles.

This consideration does not eliminate the aerodynamically supported missile completety, however. So far we have considered it, without specifically saying so, as a ground-to-ground missile with mostly land under its flight path where there are numerous possibilities for interception. And, of course, as the range increases, the interception gains the upper hand, mile for mile.

Things are likely to be different if such a missile is considered as a ship-to-ship weapon because the possibilities for interception at sea do not increase simply with the range as they do on land. It seems, therefore, that such missiles might become naval weapons rather than land-based ordnance, with the possible exception of specialized uses as shore batteries. Fired in the opposite direction as a ship-to-shore weapon, it would be almost as badly handicapped as it was in its original role as a ground-to-ground weapon.

The aerodynamically unsupported missile, the long-range rocket, follows a trajectory which differs not too much from the trajectory of a heavy projectile. There is practically no horizontal flight at all, but simply an ascending path which then changes into a descending path.

But while an artillery projectile falls at an angle which is not much steeper than the elevation of the gun from which it was fired, the long-range rocket falls almost vertically. This is caused mainly by the action of the external stabilizing fins against air resistance after the rocket re-enters denser layers of the atmosphere on its downward path.

If a long-range rocket were fired at an angle like a gun, the ascending path would differ from that of a projectile by being much straighter as long as the rocket motor is working. But very large rockets cannot be fired at an angle for a number of reasons. They are fired vertically and are then slowly eased into the 45-degree angle for maximum range after they have acquired a sufficiently high velocity.

The most important advantage of the long-range rocket as compared with the V-1 was that it could not be intercepted once it had left the ground. Theoretically it might be possible to intercept long-range rockets by countermissiles, but it will probably be a long time until this theoretical possibility is translated into a workable reality.

Even interception at the source proved almost impossible since the long-range rocket did not require a long and stationary launching ramp like the V-1 but could be fired from any piece of reasonably hard ground measuring twenty by twenty feet and accessible to heavy motor transport. A motor transport could arrive somewhere, set up equipment, fire three rockets, and be on the move again in little over two hours.

Because of its mobility and high velocity the long-range rocket is far superior to the aerodynamically supported missile as a long-range weapon. Actually it is hardly more expensive than the V-1 type, and it is even cheaper than bombardment aircraft which need ground crews, hangars, runways, maintenance, and a host of auxiliary services. But at present, and for a number of years to come, bombardment aircraft holds the edge as far as range is concerned. One might say that bombardment aircraft is the best long-range weapon, now and for the immediate future, but that the best long-range missile will be the long-range rocket.

The long-range rocket itself is also subject to a number of limitations. Its range, like the range of a projectile, depends on the velocity which it attains. A projectile is accelerated for the distance from gun breech to gun muzzle; the rocket is accelerated until fuel cutoff.

It is therefore necessary to compare the muzzle velocity of a projectile to the rocket velocity at motor cutoff and the rocket here has the advantage of having already traveled some distance toward the target when that moment occurs. All the aiming or guiding has to be done during this time interval, which in the case of the V-2 rocket is just short of 70 seconds and which is not very likely to exceed 120 seconds in any instance.

If we had a rocket for very long range, say 600 miles, it would still be accelerating at a considerable distance from its take-off-point. The distance measured along the trajectory, which such a rocket would travel up to motor cutoff may be estimated to be as high as 80 miles, and it would require some rather powerful controls to do additional guiding beyond this distance.

After motor cutoff no guiding is possible until the rocket enters denser layers of the atmosphere again. And although guiding on the downward path is possible, the problem becomes increasingly difficult because the missile is in enemy territory and below the horizon, which eliminates control by short-wave radar beams.

If the problem of guiding over very long ranges is one of the limitations of the long-range rocket, the danger of "incineration" is another one. While London was under V-2 fire, some ARP men reported on occasion that they had seen a descending V-2 rocket glowing a dull red.

If the stories of these sharp-eyed air-raid wardens were doubted at first, subsequent investigation vindicated them. It was found that such a rocket might heat up to temperatures at which it would be just visible. As a matter of fact, the choice of the explosive, Amatol, which is rather insensitive to heat, had been prompted by this consideration.

Naturally it will be possible to insulate the explosive charge to some extent, and the problem of "incineration" may not present insurmountable difficulties for ranges of 600 and 1,000 miles, maybe not even at 2,000 miles. But they may become insurmountable if ranges of 8,000 miles or more are contemplated.

Finally there is a limitation in practical take-off size. To attain high velocities for long ranges the rocket needs a large fuel supply.

A range of over 250 miles would require a mass-ratio (ratio of total weight to the weight without the fuel) of almost 4 to 1, while a shot over 630 miles would require a mass-ratio of about 6 to 1. If we could simply assume that the empty rocket with a war head weighs 4 tons like the V-2, the respective take-off weights would be 16 and 24 tons. But larger tanks for a larger fuel supply naturally weigh more, so that the empty rocket with war head would probably weigh 4½ tons in one case and 6 tons in the other. This means that the take-off weights would be 18 tons in one case and 36 tons in the other.

These rockets would still carry only a one-ton war head. If we wanted three-ton war heads with proportionately heavier rockets the empty weights would jump to about 10 tons and 14 tons. This would result in take-off weights of 40 tons for the 250 mile shot and 840 tons for the 630 mile shot. Both these take-off weights are still in the realm of possibility.

Like any other weapon, the long-range rocket is subject to a number of inherent limitations. Because of these limitations the long-range rocket is an additional weapon in the arsenal, but cannot replace either artillery or bombardment aircraft.

AIRBORNE THOUGHTS FOR FUTURE AIRBORNE AAA DEVELOPMENT

By Lieutenant Colonel James H. Farren, CAC

The battalion commander of the only active airborne AAA battalion in the Army, who has both combat and peacetime experience with airborne antiaircraft artillery, makes some recommendations for improvements in airborne AAA organization and equipment. A longer article on airborne AAA will be published in the JOURNAL in a future issue.

Headquarters, 82d Airborne Division
Fort Bragg, North Carolina
27 November 1948.

* * *

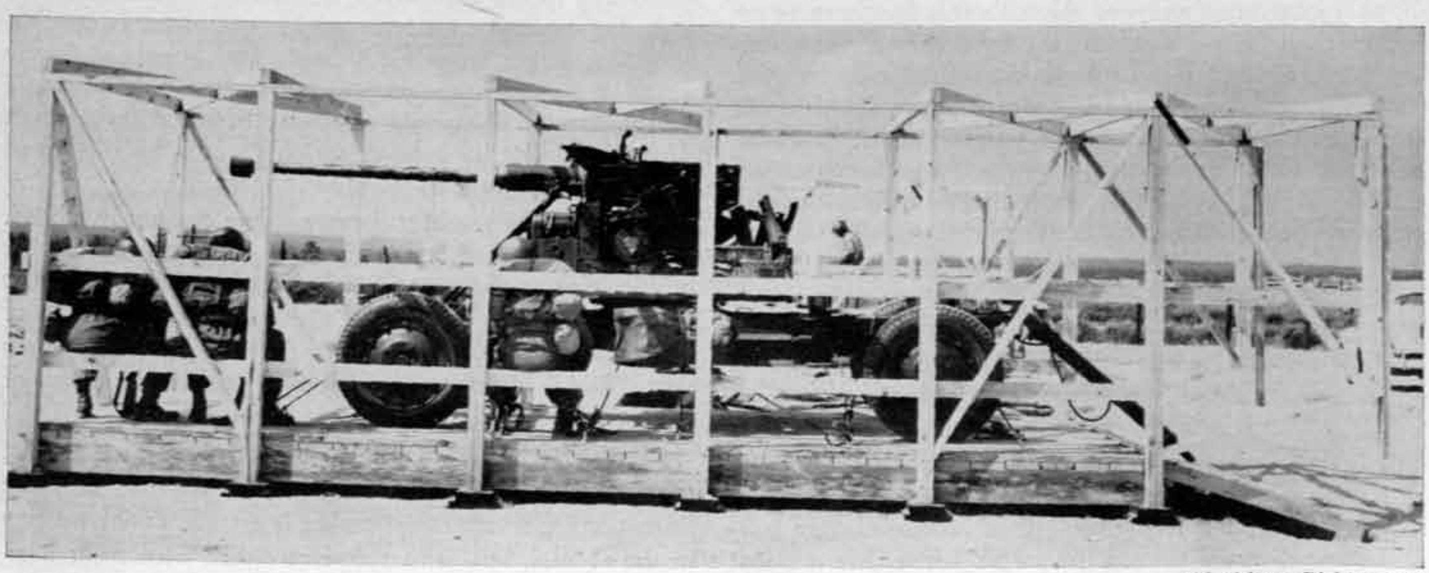
The antiaircraft Automatic weapons battalion is not suitable as presently organized. It is urged that consideration be given to restudying the organization, fire power, and flexibility of this battalion. The inclusion of an additional AAA (AW) battery in the battalion and of a machine gun platoon in each AAA (AW) battery suitable for parachute delivery in the assault, and the addition of radar equipment should be considered carefully.

C. E. BYERS
Major General, USA
Commanding

The above is an excerpt from a letter from the Commanding General of the 82d Airborne Division to the Chief, Army Field Forces. It is an indication of a long-felt need for improvement in airborne antiaircraft artillery. I have listed below some of the facts that led to General Byers' recommendation, and then following that, some recommendations of my own which I feel will make airborne antiaircraft artillery a more effective adjunct to airborne organization.

The Antiaircraft Artillery Committee of the 82d Airborne Division Board in preparing the "Report of Test Loading and Analysis," for the T/O & E for Headquarters and Headquarters Battery and the T/O & E for Lettered Firing Batteries, continually made comparison between the airborne antiaircraft battalion and the self-propelled antiaircraft battalion organic to the Infantry Division. The Committee after careful study concluded that the present organization of the airborne antiaircraft battalion should be modified to approach more closely the mobility, fire power, versatility and tactical capabilities of the self-propelled antiaircraft battalion organization.

The Board considered the fact that the weight limitations imposed by present-day aircraft seriously affect the type of equipment with which an airborne organization can be equipped, but it felt that with modifications on certain type carriages, track, half-track, and wheeled vehicles, the air-



82d Airborne Division photo

40mm Gun in glider mock-up.

82d Airborne Division photo
C-82's each towing two gliders.

borne antiaircraft battalion could be equipped more efficiently and effectively to carry out the tactical missions in its airborne role, and subsequent ground roles assigned it, and thus approach more closely the capabilities of the self-propelled battalion, particularly in its ability to support the combat team organization of an airborne division.

The Board, in making this report, realized the keen and precise study and testing that is conducted in drawing up a T/O & E. The Board believes that with the present T/O & E as written the battalion was capable of performing the mission as conceived at time of publication. Since that time, the development of aircraft, parachute delivery, and gliders has advanced to the point where the mobility and versatility of the airborne division as a whole have increased and a need now exists for an airborne antiaircraft organization which will adequately support the ever-changing airborne division. The following comparison has been made between the present airborne antiaircraft battalion and the self-propelled battalion and is presented for the information and consideration of interested readers:

Comparison

SELF-PROPELLED ANTI-AIRCRAFT BATTALION (T/O & E 44-75)	AIRBORNE ANTIAIRCRAFT BATTALION (T/O & E 44-275S)

a. *FIRE POWER*

TYPE	NO.	TYPE	NO.
Twin 40mm Gun	32	40mm M1A1 or M5	16
.50 Cal. Quad	32	.50 Cal. Quad M55	16
.50 HB Flexible on M63 Mount	27	.50 HB Flexible on M63 Mount	36
.30 Cal. MG on Tripod M2	17		

b. *MOBILITY (Weapons)*

TYPE	NO.	TYPE	NO.
Carriage Motor Twin 40mm Gun	32	2½-Ton Truck 6x6 LWD W/W	16
Carriage Motor Multiple Gun M16	32	(These vehicles tow 40mm, and carry M55 in the body plus carrying 12 men and ammunition for both 40mm's and .50 Cal's.)	
Vehicle, utility armored M44	17		

c. *CROSS-COUNTRY MANEUVERABILITY*

Sufficient Power and flotation for nearly any type of terrain.	Limited trafficability—Generally to hard ground or average country roads.

d. *PROTECTION MARCH CAPABILITIES*

Can disperse through column and fire on the march.	Generally limited to defense of critical points; must shuttle to and continually disperse forward.

e. *VERSATILITY*

Can shift position rapidly, and provide close Infantry support cross country.	Cumbersome; must go from traveling to firing position. Limited in ability to support Infantry.

f. *TACTICAL SUPPORT*

Can adequately support the 3 combat team formation. Possesses adequate fire power for concentrated fire.	Number of Batteries and of weapons insufficient to provide combat team support. Limited fire power for good AA concentration.

g. *AIR LOADING*

T/O & E equipment too heavy to load in present-day aircraft.	T/O & E equipment can be air-loaded in C-82, C-119, Transports or glider loaded in CG 20, CG 18 gliders.

These comparisons are broad, and it is realized that weight is the principal factor, and the increased ammunition load with increase in weapons necessitates a keen balance between air load capacity limitations and an adequate organization to perform the antiaircraft mission on the ground.

Recommendations

Mobility: That a type vehicle be considered for the airborne antiaircraft artillery battalion that will transport the 40mm Gun and crew, and a type vehicle to transport the multiple machine gun mount and crew, gross weight not to exceed 20,000 lbs., height not to exceed 94 inches, width not to exceed 105 inches, length immaterial since the cargo compartment of the XCG 20 glider is 420 inches long. The 20,000-lb. weight limit is up to maximum overload for the XCG 20, since its normal cargo load is 16,000 lbs. Type vehicles that might be considered are: Carriage, motor, multiple gun, M16, and carriage, motor combination gun M15A or M20. These are now classified as limited standard and beyond the weight limitations but development is recom-

82d Airborne Division photo
Hit the Silk! Mass jump from C-82 "Flying Boxcars."

82d Airborne Division photo

¾-ton truck emerges from YCG 18 Glider.

mended along these lines. The armor should be sacrificed to reduce weight to the minimum for C 119 transport and XCG 20 glider loading.

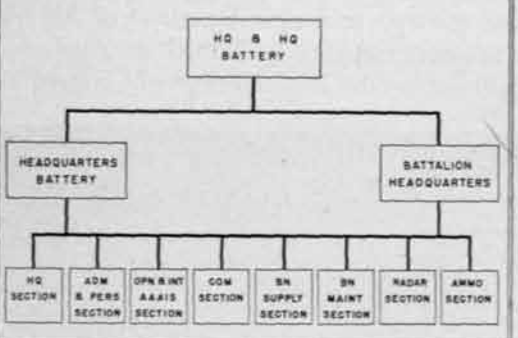
Fire Power: Antiaircraft fire power of the airborne antiaircraft battalion, although sufficient for a static defense of one small DZ, LZ or landing strip, is deemed insufficient by the board for the airborne antiaircraft need. Therefore, it is considered necessary that an additional firing battery be added to the airborne antiaircraft battalion. This addition would provide a battery for each of three combat teams and if the battalion were employed as a unit, would increase the concentration of antiaircraft fire to the point of effectiveness at the priority objective.

Versatility: Approval of the two recommendations above would satisfy this requirement.

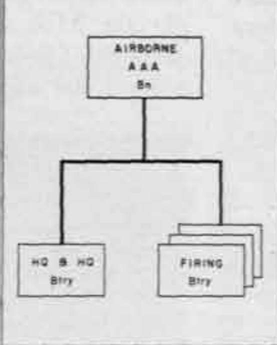
The need for *early-warning equipment* is vital in the airborne antiaircraft battalion and it is recommended that a lightweight surveillance type radar capable of being transported in a maximum of two trucks, 2½-ton, 6x6, LWB, and having a surveillance range of 100 miles be provided for headquarters battery, and, one for each of the firing batteries to provide adequate early warning for the division whether committed as a whole or in combat teams. Also the lack of radar in the division seriously necessitates that the airborne antiaircraft battalion carry such equipment for early warning. In this regard the committee considered that radar sections are needed in the present organization.

Type Organization: The schematic diagrams below show basically the type organization recommended by the board for consideration. In general the major changes suggested are: One additional firing battery added to the present battalion. This would give the airborne division an AAA battalion consisting of headquarters battery and three firing batteries capable of filling the airborne AAA requirements. In each firing battery there would be three platoons. One platoon would be capable of being completely parachuted (to be dropped by parachute early in the airborne assault phase with light AAA armament).

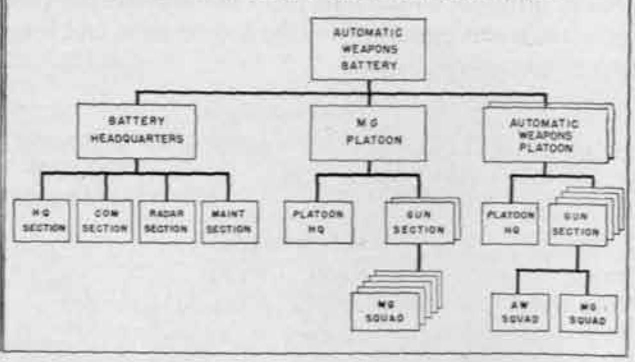
PROPOSED ORGANIZATION HQ & HQ BATTERY
AIRBORNE ANTIAIRCRAFT BATTALION ... (war)



PROPOSED ORGANIZATION
Abn AAA Bn...(war)



PROPOSED ORGANIZATION AUTOMATIC WEAPONS BATTERY
AIRBORNE ANTIAIRCRAFT BATTALION .... (war)



GLOSSARY OF GUIDED MISSILE TERMS

The JOURNAL is furnishing this GLOSSARY as a special service to subscribers. The GLOSSARY was prepared by the Committee on Guided Missiles of the Research and Development Board of the National Military Establishment. The JOURNAL has been informed that quantity distribution by the NME is contemplated in about six months after additions and revisions have been made. Recommendations for additions, changes, and suggestions as to format or material are encouraged. If these recommendations are sent to the JOURNAL, we shall forward them to the proper authorities.

Antiaircraft JOURNAL

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PURPOSE

The definitions in the *Glossary of Guided Missile Terms* have been carefully selected to provide an easily accessible reference for the meanings of technical terms which are in daily usage in the guided missile and associated technical fields. This compilation of definitions reflects current usage; however, since new terms and meanings are constantly evolving, the *Glossary* should be considered as advisory, in somewhat the same manner as a regular dictionary is for usage of general terms.

The *Glossary* makes no attempt to replace general or scientific dictionaries for words or phrases of general meaning. Rather, the aim has been to define:

(1) New words coined for the guided missile art.

(2) Words currently in general usage but with different meanings when applied to the guided missile field.

(3) Certain general technical terms for which a convenient reference might be useful to those engaged in the guided missile field. Cross reference has been used only where no clear preference, or obvious relationship in terms, exists.

Abbreviations: The use of abbreviations and letter symbols for terms has been held to a minimum in the *Glossary* consistent with a clear and understandable word definition. The study, evaluation, and selection of letter symbols for terms is a major field of endeavor in itself, and is currently being undertaken for the various fields of science by the American Standards Association.

Source Material: Material, where available, has been consolidated and re-edited from reports and documents issued by Government laboratories or civilian concerns engaged in guided missile work under Service contracts.

The *Glossary of Guided Missile Terms* is an outgrowth of a smaller, classified monograph of the same title compiled by Lt. Col. John A. White in September 1947, while stationed at the Applied Physics Laboratory, Johns Hopkins University as Army Liaison Officer.

The general interest and recognition of need for an expanded vocabulary of accurate terminology in the guided missile field led to the appointment of an Ad Hoc Subcommittee on Glossary by the Committee on Guided Missiles, Research and Development Board, The National Military Establishment, which has prepared the *Glossary*.

ACCELERATION, AXIAL—Acceleration in the direction of the longitudinal axis of the airframe.
ACCELERATION, LATERAL—Acceleration perpendicular to the longitudinal axis of the airframe.
ACCELEROMETER—An instrument that measures one or more components of the accelerations of a vehicle.
ACOUSTIC VELOCITY—The speed of sound, or similar pressure waves.
ADIABATIC—Occurring without gain or loss of heat; a change of the properties, such as volume and pressure of the contents of an enclosure, without exchange of heat between the enclosure and its surroundings.
AERODYNAMIC CENTER, WING SECTION—A point about which the moment coefficient is practically constant.
AERODYNAMICS—That field of dynamics which treats of the motion of air and other gaseous fluids and of the forces acting on solids in motion relative to such fluids.
AEROPULSE—A pulse jet; a device producing thrust intermittently, from intake of air, as distinct from hydropulse. See Pulse-Jet.
AEROSTATICS—The science that treats of the equilibrium of gaseous fluids and of bodies immersed in them.
AFTERBURNING—(1) The characteristic of certain rocket motors to burn irregularly for some time after the main burning and thrust have ceased. (2) The process of fuel injection and combustion in the exhaust jet of a turbojet engine (after the turbine).
AGC—Abbreviation for automatic gain control.
AILERON—A hinged or movable surface on an airframe, the primary function of which is to induce a rolling motion on the airframe. It is usually part of the trailing edge of a wing.
AIRCRAFT—Any weight carrying vehicle designed to be supported by the air either by buoyancy or by dynamic action.
AIRFOIL—Any surface, such as an aircraft wing, aileron, or rudder designed to obtain reaction from the air through which it moves.
AIRFOIL SECTION—A cross section of an airfoil parallel to the plane of symmetry or to a specified reference plane.
AIRPLANE—A mechanically driven fixed-wing aircraft, heavier than air, which is supported by the dynamic reaction of the air against its wings.
AIR SCOOP—A scoop or hood designed to catch the air and maintain the air pressure in ballonets, internal-combustion engines, ventilators, etc.
AIR SPEED CALIBRATED—The air speed as read from a differential-pressure air-speed indicator which has been corrected for instrument and installation errors. Equal to true air speed for standard sea level conditions.
AIR SPEED EQUIVALENT—The product of the true air speed and the square root of the density ratio ρ/ρ_0. Used in structural design work to designate various design conditions.
AIR SPEED, INDICATED—The air speed as indicated by a differential-pressure air-speed indicator, uncorrected for instrument and installation errors.
AIR SPEED, TRUE—Calibrated air speed corrected for altitude effects, i.e., pressure and temperature, and for compressibility effects where high speeds are concerned. Not to be confused with ground speed.
AIR-SPEED HEAD—An instrument which, in combination with a gage, is used to measure the speed of an aircraft relative to the air. It usually consists of a pitot-static tube or a pitot-venturi tube.
ALIGN—In radio or electronics, the process of lining up or adjusting of two or more resonant circuits, so they will give satisfactory response to the given frequency.
ALTIGRAPH—A recording altimeter.
ALTIMETER—An instrument that measures the elevation above a given datum plane.
ALTITUDE, ABSOLUTE—The height of an aircraft above mean sea level.
ALTITUDE CRITICAL—(1) In aircraft terminology, the maximum altitude at which a supercharger can maintain a pressure in the intake manifold of an engine equal to that existing during normal operation at rated power and speed at sea level without the supercharger. (2) In Guided Missile practice, the maximum altitude at which the propulsion system performs satisfactorily.
ALTITUDE SIGNAL—The radar signal returned to an airborne radar set by the ground or sea surface directly beneath aircraft.
AMBIENT—Environmental conditions; may pertain to pressure, temperature, etc.
AMPLIFIER—A device for increasing the magnitude of a quantity. Used in radio, electrical, pneumatic, audio, and hydraulic systems.
ANGLE, AILERON—The angular displacement of an aileron from its neutral position. It is positive when the trailing edge of the right aileron is below the neutral position.
ANGLE, CRAB—The angle between the direction in which an aircraft is heading and its true course.
ANGLE, DEPRESSION—The angle measured downward from the horizontal to the axis of an airborne radar beam directed at a target. This is the complement of the incidence angle of the beam at the target plane.
ANGLE, DIHEDRAL—A dihedral angle is formed by two intersecting planes. In aeronautical usage one of these is the perpendicular to the plane of symmetry and parallel to the longitudinal axis of the airframe, and the other a plane containing the wing axis and the longitudinal axis of the airframe.
ANGLE, DRIFT—The horizontal angle between the longitudinal axis of an aircraft and its path relative to the ground.
ANGLE, ELEVATOR—The angular displacement of the elevator from its neutral position. It is positive when the trailing edge of the elevator is below the neutral position.
ANGLE, FLIGHT-PATH—The angle between the flight path of the aircraft and the horizontal.
ANGLE, GLIDING—The angle between the flight path during a glide and a horizontal axis fixed relative to the earth.
ANGLE OF ATTACK—The angle between a reference line fixed with respect to an airframe and the apparent relative flow line of the air.
ANGLE OF ATTACK, ABSOLUTE—The angle of attack of an airfoil, measured from the attitude of zero lift.
ANGLE OF ATTACK, CRITICAL—The angle of attack at which the flow about an airfoil changes abruptly, as evidenced by abrupt changes in the lift and drag.
ANGLE OF ATTACK FOR INFINITE ASPECT RATIO—The angle of attack at which an airfoil produces a given lift coefficient in a two-dimensional flow. Also called "effective angle of attack."
ANGLE OF ATTACK, INDUCED—The difference between the actual angle of attack and the angle of attack for infinite aspect ratio of an airfoil for the same lift coefficient.
ANGLE OF INCIDENCE—Same as angle of wing setting. In British terminology the angle of incidence is equivalent to the American term "angle of attack."
ANGLE OF PITCH (AIRCRAFT)—The acute angle between two planes defined as follows: One plane includes the lateral axis of the aircraft and the direction of the relative wind; the other plane includes the lateral axis and the longitudinal axis. The angle is positive when the nose of the aircraft is above the direction of the relative wind. (In normal flight the angle of pitch is the angle between the longitudinal axis and the direction of the relative wind.)
ANGLE OF ROLL—The angle through which an aircraft must be rotated about its longitudinal axis in order to bring its lateral axis into the horizontal plane. The angle is positive when the left side is higher than the right. Commonly called angle of bank.
ANGLE OF STABILIZER SETTING—The acute angle between the longitudinal axis of an airplane and the chord of the stabilizer. The angle is positive when the leading edge is higher than the trailing edge.
ANGLE OF WING SETTING—The acute angle between the plane of the wing chord and the longitudinal axis of the airplane. The angle is positive when the leading edge is higher than the trailing edge.
ANGLE OF YAW—The acute angle between the direction of the relative wind and the plane of symmetry of an aircraft. The angle is positive when the aircraft turns to the right.
ANGLE, RUDDER—The acute angle between the rudder and the plane of symmetry of the aircraft. It is positive when the trailing edge has moved to the left with reference to the normal position of the pilot.
ANGLE, ZERO-LIFT—The angle of attack of an airfoil when its lift is zero.
ANGSTROM UNIT—A minute unit of length equal to one ten-thousandth of a micron, or one hundred-millionth of a centimeter. Used to express lengths of extremely short waves.
ANTENNA—A device, i.e., conductor, horn, dipole, etc., for transmitting, or receiving radio waves, exclusive of the means of connecting its main portion with the transmitting or receiving apparatus.
ANTENNA ARRAY—Designates two or more antennas coupled together in a single mounting, such as to give desired directional characteristics.
ANTENNA, DIPOLE—A center-fed antenna, which is constructed to be approximately one-half as long as the wave length it is designed to transmit or receive.
ANTENNA, DISH—See—DISH, RADAR.
ANTENNA, HORN—The flared end of radar wave-guide, which has been matched to the surrounding space for efficient radiation of energy from within the guide to space.
AREA, EFFECTIVE—The exposed area of the wing (or tail) plus that portion of the area inclosed by the aircraft fuselage which is effective in providing lift.
AREA, EXPOSED—The area of the wing (or tail) outside the fuselage.
AREA, EQUIVALENT FLAT-PLATE—The area of a square flat plate, normal to the direction of motion, which offers the same amount of resistance to motion as the body or combination of bodies under consideration.

ARMING—As applied to fuzes, the changing from a safe condition to a state of readiness for initiation. Generally a fuze is caused to arm by acceleration, rotation, clock mechanism, or air travel, or by combinations of these.

ARTIFICIAL HORIZON—(1) A device that indicates the attitude of an aircraft with respect to the true horizon. (2) A substitute for a natural horizon, such as a liquid level, pendulum or gyroscope, incorporated in a navigating instrument.

ASKANIA—The name of a German company which manufactured theodolites, and other precision instruments.

ASPECT RATIO—The ratio of the square of the span to the total area of an airfoil. In wingless missiles such as Azon or Razon, the ratio of bomb diameter to its mean length.

ASPECT RATIO, CHAMBER—The ratio between the length of a combustion chamber and its diameter.

ATMOSPHERE, STANDARD INTERNATIONAL—The atmosphere used as an international standard presumes for mean sea level and a temperature of 15°C., a pressure of 1,013.2 millibars, lapse rate of 6.5°C. per kilometer from sea level to 11 kilometers, and thereafter a constant temperature —56.5°C.

ATMOSPHERE, STANDARD, US—An arbitrary atmosphere which is used for numerous aeronautical purposes, but chiefly for comparing performance. The Standard Atmosphere recommended by NACA, and adopted in 1925 by all interested US Government departments for official use, is based on the following assumptions: The air is a dry perfect gas. Ground temperature t = 15°C. = 59°F. Temperature gradient in the troposphere a = 0.0065°C./m = 0.003566°F./ft. Stratosphere temperature (11 km to 100 km) t = —55°C. = —67°F.

ATTENUATOR—A device designed to cause a loss in energy in a system without introducing appreciable distortion in the desired frequencies.

ATTITUDE—The position of an aircraft as determined by the inclination of its axes to some frame of reference. If not otherwise specified, this frame of reference is fixed to the earth.

AUDIO—Pertaining to frequencies of audible sound waves between about 20 and 20,000 cycles per second.

AUGMENTOR—A duct usually enclosing the exhaust jet behind the nozzle exit section to provide increased thrust.

AUTOMATIC GAIN CONTROL—A circuit, also called the Automatic Volume Control, which automatically varies the over-all amplification, inversely proportional to input signal strength changes, such that the output volume of the receiver remains constant. Commonly abbreviated as AGC.

AUTOMATIC PILOT—An automatic control mechanism for keeping an aircraft in level flight and on a set course. Sometimes called "gyro pilot," "mechanical pilot," or "robot pilot."

AUTOSYN—A Bendix-Marine trade name for a synchro, derived from the words: AUTOmatically SYNchronous. See SYNCHRO.

AXES OF AN AIRCRAFT—Three fixed lines of reference, usually centroidal and mutually perpendicular. The horizontal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the longitudinal axis; the axis perpendicular to this in the plane of symmetry is called the normal axis; and the third axis perpendicular to the other two is called the lateral axis. In mathematical discussions, the first of these axes, drawn from rear to front, is generally designated the X axis; the second, drawn downward, the Z axis; and the third, running from left to right, the Y axis.

AXIS, ELASTIC (STRESS ANALYSIS)—The locus of all points through which a force may be applied to a structure without causing torsional deflection.

AXIS, WING—The locus of the aerodynamic centers of all the wing sections.

AZIMUTH—The angle measured clockwise between the direction north and whatever other direction is being described.

B

B PLUS—The positive terminal of a B battery or other plate voltage source for electron tubes.

BABBLE—The resultant interference, or cross-talk, from a large number of interfering channels.

BACKGROUND, RADAR—See—CLUTTER, RADAR.

BACK-SCATTERING—Refers to the scattering of energy of the radar reflected signal.

BALANCED SURFACE, AERODYNAMIC—A control surface that extends on both sides of the axis of the hinge or pivot, or that has auxiliary devices or extensions connected with it in such a manner as to effect a small or zero resultant moment of the air forces about the hinge axis.

BALANCED SURFACE, STATIC—A control surface whose center of mass is in the hinge axis.

BALLADROMIC—Heading to hit; leading (from ballein, to hurl, to hit; dromos, course).

BAND—In electronics, a range of frequencies between an upper and a lower limit.

BANDWIDTH, ATTAINED—That portion of the band covered by the total frequency deviation of a subcarrier oscillator or pickup with full range applied stimulus.

BANDWIDTH, DESIGN—The frequency deviation any device is intended to achieve with full range stimulus.

BANG-BANG—See—CONTROL, BANG-BANG.

BANK—To incline an aircraft laterally; i.e., to rotate it about its longitudinal axis.

BEACON, RADAR—A nondirectional radiating device, containing an automatic radar receiver and transmitter, that receives pulses ("interrogation") from a radar, and returns a similar pulse or set of pulses ("response"). The beacon response may be on the same frequency as the radar, or may be on a different frequency.

BEAM DIRECTION—In stress analysis, the direction parallel to the plane of the spar web and the plane of symmetry of an airplane (cf. chord, drag, lift and side forces).

BEAM JITTER—The small oscillatory, angular movement induced into the radar antenna array, and consequently into the radar beam. This movement is caused by: (1) the necessity of having to develop an error signal, when in automatic tracking before the antenna will change its position (2) the circuitry intentionally made "tight" to obtain plus and minus tracking errors rather than only lagging errors and (3) gear play in the radar tracking head.

BEAM RIDER—See—GUIDANCE, BEAM RIDER.

BEATS—Periodic variations in amplitude, which may be described as a superposition of disturbances having different frequencies.

BEEPER—An individual who "flies" a pilotless aircraft by remote control.

BIAS—The voltage applied between the control grid of a vacuum tube and the cathode, to provide the correct tube operating point.

BLACKBODY—A perfect absorber of all radiant energy that falls upon it; does not reflect radiant energy, but radiates energy solely as a function of its temperature.

BLANKETING—The process of having a desired signal "blanketed," or eliminated from reception, by the presence of an overriding, stronger, undesired signal.

BLOW-OUT DISC—A mechanism, consisting generally of a thin metal diaphragm, sometimes installed in a jato, as a safey measure against excess gas pressure.

BOLOMETER—A very sensitive type of metallic resistance thermometer, used for measurements of thermal radiation. See DETECTOR, INFRARED.

BOOSTER—(1) A high-explosive element, sufficiently sensitive to be actuated by small explosive elements in a fuze, and powerful enough to cause detonation of the main explosive filling. (2) An auxiliary propulsion system, which travels with the missile and may or may not separate from the missile, when its impulse has been delivered. See JATO.

BORE SIGHTING—The aligning of armament and aiming or steering systems on an airframe.

BOUNDARY LAYER—A layer of fluid, close to the surface of a body placed in a moving stream, in which the impact pressure is reduced as a result of the viscosity of the fluid, and through which a velocity gradient exists ranging from the velocity of the body to the velocity of the free stream.

BRACHYDROMIC—Heading short; slanting to pass through wake (from brachys, short; dromes, course).

BUFFETING—The repeated aerodynamic forces experienced by any part of an aircraft, caused and maintained by unsteady flow arising from a disturbance set up by any other part of the airframe or accessories. See FLUTTER.

BUMP—A sudden vertical acceleration of an aircraft caused by a region of unstable atmosphere characterized by marked local vertical components in the air currents.

BUNCHING—In electronics, any process which introduces an rf convection current component into a velocity modulated electron stream as a direct result of the variation in electron transit time which the velocity modulation produces.

BURBLE—A term designating the breakdown of the streamline flow about a body; the change of laminar flow conditions to turbulent flow conditions, or flow separation.

BURN OUT—(1) To overheat a combustion chamber to such an extent that the walls weaken and rupture. (2) Indicates the time at which a jet motor exhausts its fuel supply.

BURNER DRAG—Total drag due to the presence of a combustion system; usually includes the drag forces on the igniter, flame holders, combustion chamber wall, etc.

C

CAMBER—The rise of the curve of an airfoil section, usually expressed as the ratio of the departure of the curve from a straight line joining the extremities of the curve to the length of this straight line. "Upper camber" refers to the upper surface; "lower camber" to the lower surface; and "mean camber" to the mean line of the section. Camber is positive when the departure is upward, and negative when it is downward.

CANARD—A type of aircraft having the horizontal stabilizing and control surfaces forward of the main supporting surfaces.

CAPACITANCE—Is measured by the electrical charge which must be communicated to a body to raise its potential one unit. Thus a capacity of one farad requires one coulomb of charge to change its potential one volt. Synonym: capacity.
CAPACITOR—In electricity, a device consisting essentially of two conducting surfaces separated by an insulating material or dielectric. The electrical size is generally specified in some fraction of a farad. Commonly called condenser.
CARDAN-MOUNTED—Gimbal mounted.
CASSEGRAIN MIRROR—A plane mirror mounted between the surface of a spherical (or parabolic) mirror and its focus. The purpose is to project the image formed by the out of the incident rays. Named after Cassegrain, the astronomer, who invented it.
CATAPULT—A fixed structure which provides an auxiliary source of thrust to a missile or aircraft; must combine the function of directing and accelerating the missile during its travel on the catapult; serves the same function for a missile as does a gun tube for a shell. See LAUNCHER.
CATHODE RAY TUBE—A rather long, funnel-shaped vacuum tube having in its neck an electron gun, that directs a beam of electrons onto a screen at the opposite end of the tube. The screen is coated with a fluorescent material called a phosphor, which glows when struck by the electrons. Electrostatic deflecting plates, or electromagnetic deflecting coils are placed around the path of the electron beam, and serve to sweep the beam over the screen, thereby causing the beam to trace on the screen a visible waveform of a voltage, or current, or produce a pattern, or complete image.
CAVITATION—The formation and collapse of vapor pressure bubbles due to a moving body, or the effects of this action.
CAVITY RESONATOR—A space totally enclosed by a metallic conductor, and excited in such a way that it becomes a source of electromagnetic oscillations. The size and shape of the enclosure determine the resonant frequency. Cavity resonators can have a Q-factor as great as 50,000. They are used in ultra-high-frequency systems in place of conventional resonant circuits.
CEILING, ABSOLUTE—The maximum height above sea level at which a given aircraft would be able to maintain horizontal flight under standard air conditions.
CENTER, ELASTIC—In stress analysis a point within the wing section at which the application of a single concentrated load will cause the wing to deflect without rotation and, conversely, a point within the wing section about which rotation occurs when the wing is subjected to pure torque.
CENTER OF GRAVITY—See—CENTER OF MASS.
CENTER OF MASS—The point at which all the mass of a body may be regarded as being concentrated, so far as motion of translation is concerned. Commonly called center of gravity.
CENTER OF PRESSURE COEFFFICIENT—The ratio of the distance of the center of pressure from the leading edge to the chord length.
CENTER OF PRESSURE OF AN AIRFOIL—The point on the chord of an airfoil, prolonged if necessary, which is at the intersection of the chord and the line of action of the resultant air force.
CHANNEL—The band of frequencies, within which a radio transmitter must maintain its modulated carrier signal.
CHANNEL, TELEMETER—Designates the complete route for transmission of a telemetered function, including pickup, commutator, modulator, transmitter, receiver, demodulator, decoder, and recorder.
CHARACTERISTIC LENGTH—In propulsion, the ratio of the chamber volume to its nozzle throat area. A measure of the length of travel available for the combustion of the propellants.
CHOKE COIL—An inductor inserted in circuit to offer relatively large impedance to alternating current.
CHOKING—The condition which prevails in compressible fluid flow when the upper limit of mass flow is reached, or when M = 1 is reached in a duct.
CHORD—An arbitrary datum line from which the ordinates and angles of an airfoil are measured. It is usually the straight line tangent to the lower surface at two points, the straight line joining the ends of the mean line, or the straight line between the leading and trailing edges.
CHORD DIRECTION—In stress analysis, the direction parallel to the intersection of the plane of the internal wing truss with the plane of symmetry of the aircraft. When a wing has two internal trusses in nonparallel planes, the plane bisecting the dihedral angle between those two planes should be used (cf. beam, drag, lift and side directions).
CHORD FORCE, OR COMPONENT—In stress analysis, a force, or component, in the chord direction; i.e., parallel to the intersection of the plane of the internal wing truss with the plane of symmetry of the aircraft (cf. beam, drag, lift and side forces).
CHORD LENGTH—The length of the projection of the airfoil profile on its chord.
CHORD, MEAN AERODYNAMIC—The chord of an imaginary airfoil which would have force vectors throughout the flight range identical with those of the actual wing or wings.
CHORD, MEAN, OF A WING—The quotient obtained by dividing the wing area by the span.
CHUFFING—The characteristic of certain rockets to burn intermittently and with an irregular puffing noise. Sometimes called "chugging."
CIRCLE OF CONFUSION—The circular image of a distant point object as formed in a focal plane by a lens.
CLAMPING CIRCUIT—A circuit which maintains either amplitude extremity of a wave form at a certain level of potential.
CLINODROMIC—Heading at a constant lead angle (from klinein, to lean or to incline; dromos, course).
CLINOSCOPIC—Looking aslant, specifically sighting to lead a target (from klinein, to lean or to incline; skopos, target, aim).
CLIPPING CIRCUIT—In electronics, a pulse-shaping network which removes that part of a wave form which tends to extend above (or below) a chosen voltage level.
CLUTTER, RADAR—The visual evidence on the radar indicator screen of sea return, or ground return, which if not of particular interest, tends to obscure the target indication.
COAXIAL LINE—A cable having concentric conductors. Used as a transmission line for audio, radio, radar, and television signals.
COEFFICIENT OF DRAG—A dimensionless coefficient, equal to the total drag divided by the dynamic pressure and the reference area. ($C_D = D/qS$.)
COEFFICIENT OF LIFT—A dimensionless coefficient, equal to the total lift divided by the dynamic pressure and the reference area. ($C_L = L/qS$.)
COEFFICIENT OF MOMENT—The coefficients used for moment are similar to coefficients of lift, drag and thrust, and are likewise dimensionless. However, these must include a characteristic length, in addition to the area. The span is used for rolling or yawing moment, and the chord is used for pitching moment.
COEFFICIENT OF THRUST—A dimensionless coefficient, equal to the thrust divided by the product of dynamic pressure and reference area. ($C_T = T/qS$.)
COMBUSTOR—A name generally assigned to the combination of flame holder, igniter, combustion chamber and injection system of a ram-jet.
COMPRESSIBILITY, MODULUS OF—The modulus of compressibility is the fractional change in volume per unit change of pressure.
CONCENTRATION—Relative amount of a particular constituent in a mixture.
CONDENSER—See—CAPACITOR.
CONFIGURATION—The relative distribution, or arrangement, of parts in a structure.
CONICAL SCANNING—Defines a radar scanning system wherein a point on the radar beam describes a circle at the base of a cone, and the axis is the generatrix of the cone.
CONSTRICTOR—The exit portion of the combustion chamber in some designs of ram-jets, where there is a narrowing down of the tube at the exhaust.
CONTRA-INJECTION—The injection of fuel into the air stream in a direction opposite to the flow of air.
CONTRAST—The degree of difference in tone between the darkest and lightest areas of a visual reproduction.
CONTROL—(1) Concerning missiles in general, the entire processes of intelligence and maneuver intended for reaching a specified destination, with special connotation on changes in course due to data which may be observed and computed either in the missile or externally. (2) Concerning an airframe, a device for effecting a change in motion.
CONTROL, BANG-BANG—A control system used in guidancé, wherein the corrective control applied to the missile is always applied to the full extent of servo motion.
CONTROL-PLANE—The qualifying term which describes the transmitting antenna on an aircraft which radiates the control signal by which a guided bomb is steered.
CONTROL, PROPORTIONAL—Control in which the action to correct an error is made proportional to that error.
CONTROL SURFACE—A movable airfoil designed to be rotated or otherwise moved by control servo mechanism in order to change the attitude of the aircraft.
CONTROLLABILITY—The quality of an aircraft that determines the ease of operating its control and/or the effectiveness of displacement of the controls in producing change in its attitude in flight.
CONVECTION—Motions resulting within a fluid due to differences in temperature and density.
COUPLING—In electrical circuits, a mutual relationship between two circuits such that a transfer of energy between them is permitted.
CRAB-ANGLE—See—ANGLE, CRAB.
CRITICAL PRESSURE RATIO—In cold flow (missile not burning), is the ratio of the critical cross-section pressure (where M = 1) to the stagnation pressure.
CROSS TALK—The interference due to magnetic, or electrostatic induction between near-by conductors, wherein signals in one conductor are undesirably reproduced also in another, or other conductors.

CRUCIFORM—A configuration being in form of a cross with equal legs, 90° apart.

CRYSTAL, PIEZOELECTRIC—A crystal which, when strained, produces on its surface an electric charge; or will deform or bend when a voltage is properly applied. When driven by an alternating voltage at proper frequency, as determined by the dimensions, material and axes of crystal, it will resonate and stabilize the applied frequency.

D

DAMPING—The effect of friction or its equivalent in reducing oscillation of a system.

DECCA NAVIGATION—See HYPERBOLIC NAVIGATION.

DECIBEL—Commonly abbreviated as "db" is a unit for expressing the magnitude of a change in sound level. One db is approximately the amount that the power of a pure sine wave sound must be changed in order for the change to be just barely detectable by the average human ear. Precisely, the difference in decibels between two signals is ten times the common logarithm of the ratio of their powers or twenty times the logarithm of the ratio of the voltages.

DEFINITION—Refers to the fidelity with which a visual recording device forms an image. Definition is good, when the image is sharp and clear.

DELTA WING—A triangular shaped, low aspect ratio airfoil with tapered leading edge and straight trailing edge.

DEPRESSION ANGLE—See—ANGLE, DEPRESSION.

DERIVATIVES, LATERAL RESISTANCE—Resistance derivatives expressing the variation of moments and forces due to small changes in the lateral, yawing, and rolling velocities.

DERIVATIVES, LONGITUDINAL RESISTANCE—Resistance derivatives expressing the variation of moments and forces due to small changes in the longitudinal, normal and pitching velocities.

DERIVATIVES, ROTARY RESISTANCE—Resistance derivatives expressing the variation of moments and forces due to small changes in the rotational velocities of the aircraft.

DERIVATIVES, STABILITY—Quantities expressing the variation of the forces and moments on aircraft due to disturbance of steady motion. They form the experimental basis of the theory of stability, and from them the periods and damping factors of aircraft can be calculated. In the general case there are 18 translatory and 18 rotary derivatives.

DERIVATIVES, TRANSLATORY RESISTANCE—Resistance derivatives expressing the variation of moments and forces due to small changes in the translational velocities of the aircraft.

DESTRUCTOR—An explosive or other device for destroying a missile, or component thereof, intentionally.

DETAIL—In video and photographic usage, the distinction between slight differences in tone of the visual reproduction of an image. To some extent the opposite of "contrast." Good detail implies poor "contrast." See—CONTRAST.

DETECTOR—In radio, the receiver stage at which demodulation takes place.

DETECTOR, INFRARED—Thermal devices for observing and measuring infrared radiation, such as the bolometer, radiomicrometer, thermopile, pneumatic cell, photocell, photographic plate and photoconductive cell.

DETONATION—An extremely rapid reaction, in which an oxidizer and a fuel (which may be in a loose chemical combination or in a mixture) combine with large evolution of heat. A true or "high order" detonation proceeds at very high speed, generally several thousand feet per second, and is not to be confused with deflagration, which may consume the same explosive materials, but at a rate normally measured in inches per second. Neither must detonation be applied to rupture of rocket motors or other containers from the effects of gas pressure, even when applied rapidly because of fragmentation of burning propellant.

DETONATION, LOW ORDER—A partial or slow explosion. As applied to military explosives, generally caused by accidental or inadequate initiation.

DETONATOR—An explosive device, sensitive to electrical or mechanical impulse. Generally used to set off a larger quantity of explosive.

DEVELOPMENT—(1) The application of known scientific facts, techniques, materials, and physical laws to the creation of new or improved matériel or methods of military use. (2) In photography, the bringing to view of a latent image on a photosensitive surface.

DIELECTRIC—A substance capable of sustaining an electric field, and of undergoing electric polarization. All electric insulators are dielectrics.

DIFFERENTIATING CIRCUIT—A circuit which produces an output voltage substantially in proportion to the rate of change of the input voltage or current.

DIFFUSER—A duct of varying cross section designed to convert a high-speed gas flow into low-speed flow at an increased pressure.

DIFFUSER EFFICIENCY—(1) The ratio of the actual pressure increase realized by the diffuser, to the theoretical pressure increase realized in an isentropic process, or (2) The ratio of the stagnation pressures after and before the diffuser. (3) The ratio of actual change in enthalpy to the ideal change in enthalpy for passage from ambient to diffuser pressure.

DIFFUSER, KANTROWITZ-DONALDSON—A type of supersonic diffuser, which first contracts to a throat and then expands. Under proper operating conditions a normal shock occurs near the throat at decreased gas stream velocity, thereby decreasing the shock-wave strength and the pressure losses which would occur if the normal shock had occurred at the lip of the diffuser.

DIFFUSER, OSWATITCH OR FERRI—A type of supersonic diffuser for ram-jet, with an inner body projecting forward of the diffuser lip, designed to permit pressures to be raised gradually through a series of conical shocks. The pressure recovery possible to this type of diffuser at high Mach numbers is considerably greater than could be obtained by a single normal shock.

DIFFUSER, AREA RATIO OF—The ratio of the outlet cross-sectional area of a ram-jet diffuser to the inlet cross-sectional area, commonly expressed as 2/1, 2.5/1, 3/1, etc.

DIGITAL COMPUTER—A computer in which quantities are represented numerically, and which can be made to solve complex mathematical problems by iterative use of the fundamental processes of addition, subtraction, multiplication, and division.

DIHEDRAL—See—ANGLE, DIHEDRAL.

DISCRIMINATOR—A device used to convert input frequency changes to proportional output voltages. For example in a radio receiver, that stage which converts the frequency-modulated signals directly to audio-frequency signals.

DISH, RADAR—The parabolic reflector which is part of certain radar antennas.

DITCHING DEVICE—A device designed to effect an automatic landing or deliberate crash landing of a pilotless aircraft, should remote control be lost.

DITHER—A signal of controlled amplitude and frequency applied to the servo motor operating a transfer valve, such that the transfer valve is constantly being "quivered," and cannot stick at its null position.

DIVE—(1) A steep descent, with or without power, in which the air speed is greater than the maximum speed in horizontal flight. (2) In stress analysis, a design condition for the wings representing a steady state of flight characterized by high speed and an angle of attack approximately that of zero lift. See—PULL-UP.

DOPPLER EFFECT—The apparent change in frequency of a sound, or radio wave, reaching an observer, or a radio receiver, caused by a change in distance, or range, between the source and the observer, or receiver, during the interval of reception.

DOUBLER—An electronic circuit for doubling the input frequency. This may be done by tuning the plate circuit to twice the grid frequency, or in several other ways.

DOUBLE-TAPER—Taper of an airfoil in planform and in cross-section thickness from root to tip.

DOUBLE WEDGE—A diamond-shaped cross section.

DOUBLE WEDGE, MODIFIED—Diamond-shape cross section with flat parallel upper and lower surfaces making a six-sided shape.

DOWNWASH—The vertical downward component of an airflow induced by an airfoil.

DRAG—That component of the total air forces on a body, in excess of the forces due to ambient atmosphere, and parallel to the relative gas stream but opposing the direction of motion. It is composed of skin friction, profile, induced, interference, parasite, and base drag components.

DRAG, BASE—Drag component caused by the reduction of pressure across the base of a guided missile to below the ambient pressure.

DRAG, DIRECTION—In stress analysis, the direction of the relative wind. See beam, chord, lift and side directions.

DRAG FORCE, OR COMPONENT—In stress analysis, a force or component, in the drag direction, i.e., parallel to the relative wind. See beam, chord, lift and side forces.

DRAG, INDUCED—The part of the total drag induced by the lift.

DRAG, NOSE—Drag due to the pressure on the nose of the body.

DRAG, PARASITE—The portion of the total drag of an aircraft exclusive of the induced drag of the wings.

DRAG, PROFILE—The difference between the total wing drag and the induced drag.

DRAG, PROFILE, EFFECTIVE—The difference between the total wing drag and the induced drag of a wing with the same geometric aspect ratio but elliptically loaded.

DRAG, SKIN FRICTION—That component of drag tangent to the surface of a body and due to the friction between the air particles. It is a function of the total wetted surface and varies with the smoothness of the surface.

DRAG-WEIGHT RATIO—The ratio of the drag of a missile to its total weight.

DRONE—A pilotless aircraft of conventional design, frequently a man-carrying type modified, for unmanned operation.

DUTY CYCLE—In electronics, the ratio of the pulse duration time to the pulse repetition time.

DYNAMIC FACTOR—The ratio between the load carried by any part of an aircraft when accelerating and the corresponding basic load.

DYNAMIC PRESSURE—The product $\frac{1}{2} \rho V^2$, where P is the density of the ambient air and V is the relative speed of the air. Commonly called dynamic head, and designated by the letter "q."

DYNAMOTOR—A combination electric motor and d.c. generator having two, or more, separate armature windings, and a common set of field poles. One armature winding, receiving direct current, operates as a motor producing rotation, while the others operate as a dynamo or generator, generating voltage.

E

ELECTROMAGNETIC—Pertaining to the combined electric and magnetic fields associated with radiation or with movements of charged particles.

ELECTRON GUN—A group of electrodes which produces and focuses an electron beam of controllable intensity.

ELECTRONICS—A broad field pertaining to the conduction of electricity through a vacuum or through gases, and circuits associated therewith.

ELECTROSTATIC—Pertains to stationary electrical charge, such as exists on the plates of a charged condenser.

ELEVATOR—A movable auxiliary airfoil, the function of which is to impress a pitching moment on the aircraft. It is usually hinged to the stabilizer.

ELEVONS—Wing flaps combining the functions of ELEVators and aileronONS.

EMMISIVITY—The rate at which the surface of a solid, or a liquid emits electrons, when additional energy is imparted to the free electrons in the material by the action of heat, light, or other radiant energy, or by the impact of other electrons on the surface.

END INSTRUMENT—An instrument used in telemetering, which converts the physical quantity to be measured, into electrical output. Commonly called pickup, or end organ.

ENERGY—Work, or its equivalent, in any form.

ENERGY, CHEMICAL—Energy obtainable from oxidation or other chemical reaction.

ENERGY, INTERNAL—The total quantity of energy in a material, i.e., the chemical and thermal energy, which may be considered as in the material itself, but not the potential and kinetic energies, which must be referred to conditions outside the material.

ENERGY, KINETIC—The capacity of a body for doing work by virtue of its motion. Quantitatively, it is one-half the mass times the velocity squared.

ENERGY, MECHANICAL—The composite of kinetic and potential energy, and of energy expended by moving forces.

ENERGY, POTENTIAL—The capacity of a body for doing work by virtue of its position, or distortion.

ENERGY, RADIANT—Energy consisting of electromagnetic waves, such as light, infrared, radio and radar.

ENTHALPY—The sum of the internal and pressure energies, often called the total heat. Change in enthalpy is the change in heat content of a substance or system in going from one state to another under constant pressure.

ENTROPY—A quantity depending on the quantity of heat in a substance and on its temperature which, when multiplied by any lower temperature (the minimum available), gives the unavailable energy, or the unavoidable waste, in deriving mechanical work from the thermal energy of the substance.

ENVELOPE—In electronics (1) The glass or metal housing of a vacuum tube (2) A curve drawn to pass through the peaks of a graph showing the wave form of a modulated radio-frequency carrier signal.

EQUIVALENCE RATIO—The ratio of the stoichiometric air-to-fuel ratio to the experimental air-to-fuel ratio.

EXPANSION RATIO—The ratio of the nozzle exit section area to the nozzle throat area.

EXPLOSIVE TRAIN—That portion of a fuze or fuze system consisting of explosive components, such as primer, detonator, booster, etc., necessary to cause functioning of a warhead or destructor.

F

FACTOR OF SAFETY—In stress analysis, the ratio of the ultimate load to any applied load. This term usually refers to the probable minimum factor of safety, which is the ratio of the ultimate load to the probable maximum applied load.

FADE, IN (OUT)—To vary gradually, increase or decrease, in signal strength, in a sound or television channel.

FAIRING—An auxiliary member or structure whose primary function is to reduce the drag of the part to which it is fitted.

FEEDBACK—The electrical or acoustical return of a portion of the amplifier stage output to the input of that stage, or a preceding stage, such that there is either increase or reduction in amplification depending upon the relative phase of the return with the input signal.

FILTER—In electricity, a device or selective circuit network designed to pass signals within a specified frequency range while greatly reducing the amplitudes of signals at undesired frequencies.

FIN—A fixed or adjustable airfoil, attached to an aircraft approximately parallel to the plane of symmetry, to afford directional stability; for example, tail fin, skid fin, etc.

FINENESS RATIO—The ratio of the length to the maximum diameter of a streamlined body.

FLAME HOLDER—A device, inserted in a moving fuel-air mixture which is designed to stabilize a flame.

FLAP—A hinged or pivoted airfoil forming the rear portion of an airfoil, used to vary the effective camber.

FLAP, SPLIT—A hinged plate forming the rear upper or lower portion of an airfoil. The lower portion may be deflected downward to give increased lift and drag; the upper portion may be raised over a portion of the wing for the purpose of lateral control (cf. upper-surface aileron).

FLAPERONS—Control surfaces, integrally or differentially operated in certain missiles, which combine the braking effect and increased lift from the flaps with the altitude control of ailerons.

FLIGHT PATH—The path of the center of gravity of an aircraft with reference to the earth or with reference to a coordinate frame fixed relative to the aircraft.

FLOW, LAMINAR—A particular type of streamline flow in which fluid in thin parallel layers tends to maintain uniform velocity. The term is usually applied to the flow of a viscous fluid near solid boundaries, when the flow is not turbulent.

FLOW, STREAMLINE—A fluid flow in which the streamlines, except those very near a body and in a narrow wake, do not change with time.

FLOW, TURBULENT—Any part of a fluid flow in which the velocity at a given point varies more or less rapidly in magnitude and direction with time.

FLUTTER—An oscillation of definite period but unstable character set up in any part of an aircraft by a momentary disturbance, and maintained by a combination of the aerodynamic, inertial, and elastic characteristics of the member itself (cf. buffeting).

FLUTTER, 2 DEGREE—Flutter of an airfoil having two degrees of freedom as in wing flap and wing rotational flutter.

FLUTTER, 3 DEGREE—Flutter of an airfoil having 3 degrees of freedom as in the case of a wing having 2 degree flutter upon which is superimposed aileron flutter.

FREQUENCY, CARRIER—The frequency of the unmodulated radio-wave emanated from a radio, radar, or other type transmitter.

FREQUENCY, INFRARED—The range of invisible radiation frequencies which adjoins the visible red spectrum and extends to microwave radio frequencies.

FREQUENCY, INTERMEDIATE—In superhetrodyne reception, the intermediate frequency is one resulting from the combination of the received frequency with a locally generated frequency, and is usually equal to their difference.

FREQUENCY, PULLING—The tendency of a modulation stage to change the frequency of a direct-coupled master oscillator.

FREQUENCY, RADIO—The frequencies of electromagnetic radiation used for the transmission of radio signals through space, generally ranging from between 90,000 cycles per second, in long-wave transmission, to 400,000,000 or more cycles per second in short-wave transmission.

FUSELAGE—The body of approximately streamline form, to which the wings and tail unit of an aircraft are attached.

FUZE—A mechanism to initiate detonation of explosive upon proper conditions of impact, elapsed time, external command or proximity, but generally with safeguard against initiation prior to arming.

G

GANTRY—A large crane-type structure, traveling on rails, which may be used for erecting and servicing large bombardment type missiles. Can be positioned directly over the launching site, and rolled away just prior to firing.

GATE—(1) In radar or control terminology, an arrangement to receive signals only in a small, selected fraction of the principal time interval. (2) Range of air-fuel ratios in which combustion can be initiated.

GEE NAVIGATION—See—HYPERBOLIC NAVIGATION.

GIMBAL—A mechanical frame containing two mutually perpendicular intersecting axes of rotation (bearings and/or shafts).

GLIDE—To descend at a normal angle of attack with little or no thrust.

GLIDE BOMB—A winged missile powered by gravity. The wing loading is so high that it is incapable of flight at the speeds of conventional bombardment aircraft. Such a missile must, therefore, be carried rather than towed.

GLINT—The pulse-to-pulse variation in amplitude of reflected radar signal, due to the reflection of the radar beam from a body which is changing its reflecting surface in an extremely rapid manner, such as would exist in pulses reflected from a rapidly spinning airplane propeller.

GRAIN—As applied to propellant, means one piece, which may be used separately, cemented to other grains, or collectively with other grains.

GRAYBODY—An imperfect "blackbody." See—BLACKBODY.

GROUND—An electrically conducting connection, accidental or intentional, to the earth, or to some other conducting body at zero potential with respect to the earth.

GROUND WAVE—A radio wave propagated over the surface of the earth.

GROUP—In telemetering, designates a number of subcarrier oscillators.

GUIDANCE—Concerning missiles, the entire processes of intelligence and of maneuver intended for reaching a specified destination, with special connotation on the flight path and on the information for determining the proper course.

GUIDANCE, BEAM RIDER—A system for guiding missiles in which there is produced from the ground a beam directed into space, such that the center of the beam axis forms a line into space along which it is desired to direct a missile. The beam, which may be either fixed in elevation and azimuth, or moving, may be basically a radar beam, a light beam, or a beam of some other type. Equipment is built into the missile, such that the missile can determine when it is in the center of the beam, or the direction and magnitude of the error when it has deviated from the center of the beam. Also built into the missile are suitable electronic circuits, servo motors, movable aerodynamic surfaces, and/or other equipment, such that the missile, by its own initiative, will return to the center of the beam when it has deviated therefrom for any reason.

GUIDANCE, COMMAND—A guidance system wherein intelligence transmitted to the missile from an outside source causes the missile to traverse a directed path in space.

GUIDANCE, HOMING—A system wherein devices built into a missile enable it to maintain its velocity vector toward a specific target, or to maintain a constant lead angle toward the target.

GUIDANCE, HOMING, ACTIVE—A system of homing guidance wherein both the source, for illuminating the target, and the receiver are carried within the missile.

GUIDANCE, HOMING, PASSIVE—A system of homing guidance wherein the receiver in the missile utilizes natural radiations from the target.

GUIDANCE, HOMING, SEMIACTIVE—A system of homing guidance wherein the receiver in the missile utilizes radiations from the target which has been illuminated from a source other than in the missile.

GUIDANCE, INERTIAL—A system independent of information obtained from outside the missile, the sensitive elements of which system make use of the principle of Newton's second law of motion.

GUIDANCE, MIDCOURSE—The guidance applied to a missile between the termination of the launching phase and the start of the terminal phase of guidance.

GUIDANCE, TERMINAL—The guidance applied to a missile between the termination of the midcourse guidance and impact with, or detonation in close proximity of the target.

GUIDED MISSILE—An unmanned vehicle moving above the earth's surface, whose trajectory or flight path is capable of being altered by a mechanism within the vehicle.

GUTTER—Portion of a flame holder which is grooved for better operation.

GYROSCOPE—A wheel, or disc, mounted to spin rapidly about an axis, and also free to rotate about one, or both, of two axes, perpendicular to each other, and to the axis of spin. The spinning gyroscope either offers considerable resistance, depending upon its angular momentum to any torque, which would tend to change the direction of the spin axis or, if free, changes its spin axis in a direction perpendicular both to the torque and to the original spin axis.

GYROSCOPE, DIRECTIONAL—A gyroscopic instrument for indicating direction, containing a free gyroscope which holds its position in azimuth and thus indicates angular deviation from the course.

GYROSCOPE, FREE—A gyroscope mounted in two, or more, gimbal rings so that its spin axis is free to maintain a fixed orientation in space.

GYROSCOPE, RATE—A gyroscope with a single gimbal mounting, such that rotation about an axis perpendicular to the axis of the gimbal and to the axis of the gyro, produces a precessional torque proportional to the rate of rotation.

GYROSCOPIC HORIZON—A gyroscopic instrument that indicates the lateral and longitudinal attitude of the airplane by simulating the natural horizon.

H

HARMONIC—A component having a frequency which is an integral multiple of the fundamental frequency. For example, a component, the frequency of which is three times the fundamental frequency, is called the third harmonic.

HELICODROMIC—Heading along bent skew spiral.

HINGE MOMENT—The moment tending to restore a control surface which has been displaced from a position of equilibrium.

HOMING—See—GUIDANCE, HOMING.

HUNTING—A condition of instability resulting from overcorrection by a control device, and resultant fluctuations in the quantity intended to be kept constant.

HYGROSCOPIC—Descriptive of a material which readily absorbs and retains moisture.

HYPERGOLIC—Capable of igniting spontaneously upon contact.

HYPERSONIC—See—SONIC, HYPER.

I

IGNITER—A device used to initiate burning of the fuel mixture in a ram-jet or rocket combustion chamber. A pilot burner in a ram-jet may serve the same purpose.

IGNITION, MULTISTAGE—An ignition system in a ram-jet in which a portion of the fuel is ignited, and these products used to ignite the remainder of the mixture.

IMPACT PRESSURE—See PRESSURE, IMPACT.

IMPEDANCE—The total opposition offered by a circuit to the flow of a varying current at a particular frequency. Impedance in ohms is equal to the square root of the sum of the resistance of the circuit squared plus the reactance of the circuit squared.

IMPULSE, SPECIFIC—See—SPECIFIC IMPULSE.

IMPULSE, TOTAL—The thrust developed by the motor times the burning time in seconds.

INCLINOMETER—An instrument that measures the attitude of an aircraft with respect to the horizontal.

INERTIA—The property of any material to resist change in its state of motion. Also, see—MOMENT OF INERTIA.

INJECTION PRESSURE—The pressure difference between the total pressure at the fuel outlet orifice and the pressure in the combustion chamber.

INJECTOR—A device designed to introduce fuel into the combustion chamber.

INNER BODY—Any closed body located in the ram-jet duct, around which the air taken into the diffuser must flow.

INTEGRATING CIRCUIT—A circuit whose output voltage is proportional to the product of the instantaneous applied input voltages and their duration. Some such circuits are made to give output proportional to input frequency and amplitude.

INTERFERENCE—(1) The aerodynamic influence of two or more bodies on one another. (2) In physics, the effect of superimposing two or more trains of waves. The resulting amplitude is the algebraic sum of the amplitudes of the interfering trains. When two sets of spherical waves interfere, a system of stationary nodes and antinodes is formed, which, in optics, is known as interference fringes. See—INTERFEROMETER.

INTERFEROMETER—An apparatus used to produce and show interference between two or more wave trains coming from the same luminous area, and also to compare wave lengths with observable displacements of reflectors, or other parts, by means of interference fringes. An interferometer is frequently used to obtain quantitative information on flow around bodies in wind tunnels. See—INTERFERENCE.

INTERLACING—A technique in television scanning wherein, if the lines are sequentially numbered, all the odd-numbered lines are scanned first, following which all the even-numbered lines are scanned.

INVESTIGATION—The preliminary work leading to the initiation of development of new or improved matériel of methods.

ION—An electrically charged particle formed when one or more electrons are gained or lost by either a neutral atom or a group of atoms. An ion is positive when it has lost electrons, and negative when it has gained more electrons than it normally has.

IONOSPHERE—That portion of the earth's atmosphere, beginning about thirty (30) miles above the earth's surface, which consists of layers of highly ionized air capable of bending or reflecting certain radio waves back to the earth.

ISENTROPIC—Without any change in the entropy.

ISOBAR—(1) A line on a chart or diagram drawn through places or points having the same barometric pressure. (2) Curve of constant acceleration loading of a pursuing aircraft flying a true pursuit course.

ISOTHERMAL—Indicating changes of volume, pressure or other property at constant temperature.

J

JACK STRIP—A strip of insulating material upon which the female electrical terminal connectors are mounted, into which may be inserted male plug-type connectors for circuit continuity.

JAMMING—Intentional transmission of r-f energy, in such a way as to interfere with reception of signals by another station.

JATO—An auxiliary rocket device for applying thrust to some structure or apparatus.

JET—The exhaust stream, or rapid flow of gases from a small opening or nozzle.
JET HORSEPOWER—The power of the exhaust jet equal to the product of thrust and effective jet velocity.
JET STREAM—The stream of combustion products expelled from jet motor.
JET VANE—A vane made of some highly heat-resisting material placed in the jet stream for use in guidance of a missile.
JITTER, BEAM—See—BEAM JITTER.
JOULE'S CONSTANT—The mechanical equivalent of heat, 778.26 ft.-lb. per Btu or 4.18 joules per calorie.

K

K—The ratio of propellant surface to nozzle throat area.
K-BAND—A radio-frequency band of 11,000 to 33,000 megacycles with wave lengths of from 2.73 to 0.91 centimeters, respectively.
K, INTERNAL—The ratio of propellant surface which must discharge past any constricted region to the area at that region, at the most constricted portion of a rocket motor.
KLYSTRON—A vacuum tube for converting direct current energy into radio-frequency energy by alternately slowing down and speeding up an electron beam, utilizing the transit time between two points to produce a velocity-modulated electron steam to deliver radio-frequency power to a cavity resonator. The term is applicable to an ultra-high-frequency amplifier, or generator, that combines the velocity-modulation principle with one or more cavity resonators to produce and/or utilize a velocity-modulated beam of electrons.

L

L-BAND—A radio-frequency band of 390 to 1,550 megacycles with wave lengths of from 77 to 19.35 centimeters, respectively.
LATITUDE—The range in brightness of a scene over which fidelity of response of a television pickup tube (or photographic emulsion) is maintained.
LAUNCHER—A mechanical structure which gives control to a missile during initial motion by constraining the missile to move in the desired direction of flight, but does not itself propel the missile. See—CATAPULT.
LAUNCHER, ZERO LENGTH—A launcher which supports the missile in the desired attitude prior to ignition, but which exercises no control on the direction of the missile's travel after ignition.
LEAD PREDICTION—The act of directing a missile (or projectile) ahead of a moving target—leading in aim—to a predicted collision point.
LEADING EDGE—The foremost edge of an airfoil.
LEAKANCE—A reciprocal of insulation resistance.
LEVELING CIRCUIT—An r-c filter circuit used to level out fluctuations of a bias voltage.
LIFT DIRECTION (STRESS ANALYSIS)—The direction in the plane of symmetry perpendicular to the relative wind (cf. beam, chord, drag, and side directions).
LIFT/DRAG RATIO—The ratio of the lift to the drag of any body.
LIFT, AERODYNAMIC—The component of the total aerodynamic force of a body perpendicular to the relative wind.
LIFT FORCE OR COMPONENT—In stress analysis, a force, or component, in the lift direction (cf. beam, chord, drag, and side forces).
LINEAR—A linear relationship exists between two quantities when the change in one quantity is exactly proportional to the change in the other quantity.
LOAD, BASIC—In stress analysis, the load on a structural member or part in any condition of static equilibrium of an airplane. When a specific basic load is meant, the particular condition of equilibrium must be indicated in the context.
LOAD, DESIGN—In stress analysis, a specified load below which a structural member or part should not fail. It is the probable maximum applied load multiplied by the factor of safety. Also, in many cases, an appropriate basic load multiplied by a design load factor.
LOAD FACTOR—In stress analysis, the ratio of two loads (the second being a basic load) that have the same relative distribution. The first load may be the load applied during some special maneuver, the maximum probable load on the airplane or part, the design load, or the ultimate load. Whenever a load factor is mentioned, the context should indicate clearly what load is being compared with the basic load. If the context does not so indicate, the load factor is usually the ratio of the design load to the weight of the airplane.
LOAD, FULL—Weight empty plus useful load; also called gross weight.
LOAD, SPAN—The ratio of the weight of an airplane to its equivalent monoplane span.
LOAD, ULTIMATE—In stress analysis, the load that causes destructive failure in a member during a strength test, or the load that, according to computations, should cause destructive failure in the member.
LOADING, POWER—The gross weight of an airplane divided by the rated horsepower of the engine computed for air of standard density, unless otherwise stated.
LOADING, UNSYMMETRICAL—In stress analysis, a design loading condition for the wings and connecting members, representing the conditions as, in a roll.
LOADING, WING—The gross weight of an airplane divided by the wing area.
LOBE—One of the three-dimensional portions of the radiation pattern of a directional antenna.
LOCAL SPEED OF SOUND—The velocity of propagation of acoustic waves over a small region as determined by the conditions there.
LONGERON—A principal longitudinal member of the framing of an airplane fuselage or nacelle, usually continuous across a number of points of support.
LORAN—Derived from LOng RAnge Navigation. See—NAVIGATION, HYPERBOLIC.
LUBBER MARK—A mark on the casing of a compass which gives the heading of an aircraft or vessel carrying the compass.

M

MACH ANGLE—The angle between a Mach line and the path of a body moving with supersonic speed. The sine of this angle is the ratio of the speed of sound to the projectile velocity.
MACH NUMBER—The ratio of the velocity of a body to that of sound in the medium being considered.
MACH NUMBER, CRITICAL—The Mach number at which sonic velocity is attained at some point on the airframe.
MACH LINE—An imaginary line drawn at an angle to the path of a rapidly moving body. It represents theoretically the shock wave which would be produced by a microscopic point moving with the speed of the body. The angles of very weak shock waves closely approximate the angle of the Mach Line.
MAGIC TEE—A particular radar wave guide configuration, so-called because its physical aspect resembles a double letter "T." The use of this configuration permits the coupling of a radar transmitter and receiver to a common antenna without the use of an "anti-t-r" box.
MAGNETOMETER—An instrument for measuring the magnitude and direction of the earth's magnetic field, or other types of magnetic fields.
MAGNETOSTRICTION—The change in the dimensions of a ferromagnetic object when placed in a magnetic field.
MAGNETRON—A high vacuum thermionic tube capable of producing high output power in the microwave region of the frequency spectrum. This tube consists of a heater, cathode, usually a multisegment anode, and an external magnet (electro or permanent) for controlling the uni-directional current flow in the tube.
MANEUVERABILITY—That structural or aerodynamic quality in an aircraft which determines the rate at which its attitude and direction of flight can be changed. Commonly expressed in "g's."
MANOMETER—A gauge for measuring pressure by fluid level.
MARGIN OF SAFETY—In stress analysis, the difference between the ultimate load and applied load.
MASS FLOW—The mass of fluid flowing past or through a particular reference plane, per unit time.
MATCHING—In electrical circuitry, the connecting of two circuits in such way that correct impedance to insure maximum transfer of energy, exists in each circuit.
MEADOW—Ranges of air-fuel ratio within which smooth combustion may be had.
MEAN LINE—Concerning an air-foil profile, an intermediate line between the upper and lower contours of the profile.
MICROWAVES—Extremely short radio waves, which are not more than a few centimeters in wave length.
MIXTURE RATIO—The ratio of the weight of oxidizer used per unit time to the weight of fuel used per unit time.
MODIFICATION—A major or minor change in the design of an adopted item of matériel, which is effected in order to correct a deficiency, facilitate production, or to improve operational effectiveness.
MODULATION—The process of varying the amplitude, frequency, or phase of a carrier wave with time, to transmit information.
MODULATION, AMPLITUDE—A method of modulating a radio frequency carrier by causing the amplitude of the carrier to vary above and below its normal value in accordance with the audio, or other signal to be transmitted. The frequency of the carrier remains constant. Commonly abbreviated as AM.
MODULATION, FREQUENCY—A method of modulating a radio frequency carrier by causing the frequency of this carrier to vary above and below the no-modulated value, at a rate determined by the audio, or other modulating signal to be transmitted. The amplitude of the carrier remains constant. Commonly abbreviated as FM.
MODULATION, VELOCITY—Defines a form of electron modulation in which the electrons passing through a resonant cavity in a tube, such as a klystron, are acted upon by a modulating field in such a manner that their velocities cause them to pass through the collector cavity in groups.

MODULATOR, BALANCED—A device in which a carrier frequency is controlled by a signal frequency in such a manner as to generate sum and difference frequencies while suppressing the carrier, or signal, or both.
MODULUS OF ELASTICITY—The force per unit area which would be required to stretch a substance to double its normal length, on an assumption that the body would remain perfectly elastic; the ratio of stress to strain within the perfectly elastic range.
MOMENT, HINGE—See—HINGE MOMENT.
MOMENT OF FORCE—The effectiveness of a force to produce rotation about an axis. It is measured by the product of the force and the perpendicular distance from the line of action of the force to the axis of rotation. Also known as Torque.
MOMENT OF INERTIA—A measure of the resistance offered by a body to angular acceleration; the products of mass and the distance squared from the axis of reference, summed over all particles in the system or body.
MOMENTUM—The product of the mass of body and its linear velocity.
MOMENTUM, ANGULAR—The product of the angular velocity and the moment of inertia of a body. Also called: MOMENT OF MOMENTUM.
MONOCOQUE—A type of fuselage relying for its rigidity upon the surface or skin, which may be of sheet metal or of layers of veneer.
MOTORBOATING—An audio system is said to be "motorboating" when it emits pulsating audio sounds resembling those made by a motorboat. These pulsating sounds are caused by feed-back at audio-frequency in the amplifier or receiver.
MULTIPATHS—The several paths by which, due to reflections, a radiated signal, may reach the receiving antenna from the transmitter.
MULTIPLEX—Denotes the simultaneous transmission of several functions over one link without loss of detail of each function, such as amplitude, frequency, phase, or wave shape. Very high speed commutation that would satisfy these conditions could in special instances be correctly classified as multiplexing. However, to prevent confusion the term "commutation" is still to be preferred whenever a switch is used.
MULTIPLEXER—A device by which simultaneous transmission of two, or more, signals may be made using the same common carrier wave.
MULTIVIBRATOR—A type of oscillator circuit consisting of two vacuum tubes joined by the proper resistance-capacitance coupling so that the output of the tubes is caused to oscillate back and forth between the tubes. The output produced is essentially a square wave having many strong harmonics of the fundamental frequency.

N

NAVIGATION, CELESTIAL—Navigation by means of observations of celestial bodies. A system wherein a missile, suitably instrumented and containing all necessary guidance equipment, may follow a predetermined course in space with reference primarily to the relative positions of the missile and certain preselected celestial bodies. Determination of the vertical to the earth's surface may be necessary in addition.
NAVIGATION, HYPERBOLIC—A general method for determining lines of position by measuring the difference in distance of the navigator, or navigating apparatus, from two or more stations of known position. The difference in distance is determined by measuring the difference in time of arrival of signals transmitted from two or more stations. Although a great variety of signaling methods are theoretically possible, only radio waves are now commonly used in hyperbolic navigation. One system, using continuous wave signals, is known as DECCA. LORAN and GEE are systems using signals transmitted as pulses. One transmitting station is the master station, with the other station or stations, separated from 75 miles to 1200 miles, being slave stations. The cycle of transmission always begins at the master station and the signal travels out in all directions. The arrival of the master signal at the slave station "triggers off" the slave which, in turn, transmits a signal. Points of constant difference in time of arrival of the two or more signals will fall on hyperbolas, with the transmitters at the foci. The accuracy of the line of position which can be established by the navigator or the navigating apparatus varies from 200 yards to 2 miles depending upon the distance of the observer or the receiver from the base line between stations and upon the type of system and equipment used. Although the navigator's equipment differs in details for GEE, DECCA and LORAN, nevertheless, the fundamental characteristics are all the same. In the DECCA and GEE systems, the master station operates in conjunction with two or more slave stations. In the LORAN system, the master station operates with one slave station. SHORAN is a short range system.
NOISE LEVEL—The strength of noise signals at a particular point in the electrical or electronic circuit; usually expressed in decibels.
NOSE-DOWN—To depress the nose of an airframe in flight.
NOSE-HEAVY—The condition of an airframe in which the nose tends to sink when the longitudinal control is released in any given attitude of normal flight (cf. tail-heavy).
NOSE-UP—To elevate the nose of an airframe in flight.
NOZZLE—A duct of changing cross section in which fluid velocity is increased. Nozzles are usually converging-diverging, but may be uniformly diverging or converging.
NULL—Used in the electrical and electronics fields to mean zero.
NUTATION—The oscillation of the axis of a rotating body. In radar, the familiar situation where, with the radar reflector stationary, the center of the dipole, which has its longitudinal axis fixed, is caused to describe a circle centered at the focus of the paraboloid, and lying in a plane perpendicular to the axis of the paraboloid.

O

OGIVE—A shape familiar on the nose of projectiles; the surface of revolution generated by rotating a line segment and the arc of a circle about an axis parallel to the line.
OGIVE, CONICAL—A cone plus cylinder; an ogive generated by a line segment plus an arc of infinite radius.
OGIVE, SECANT—An ogive generated by an arc not tangent, but intersecting at a small angle a segment which forms the cylindrical surface. A secant ogive may have any radius of curvature greater than that of the tangent ogive, on up to an infinite radius of curvature (i.e., a straight, conical ogive) but unless otherwise specified a secant ogive has approximately twice the radius of curvature of a tangent ogive.
OGIVE, TANGENT—Generated by arc, tangent to segment forming the cylindrical surface. See—OGIVE.
OPERATIONAL RESEARCH—See—RESEARCH, OPERATIONS.
OPERATIONS ANALYSIS—See—RESEARCH, OPERATIONS.
OPERATIONS EVALUATIONS—See—RESEARCH, OPERATIONS.
OPERATIONS RESEARCH—See—RESEARCH, OPERATIONS.
ONE-DIMENSIONAL FLOW—Flow in which it is assumed that static pressure, MACH number and other characteristics are uniform over any cross section perpendicular to the direction of fluid flow. Interpretations based on this assumption, although not exact, work out remarkably well in problems of duct flow.
ORTHOGONAL—The property of being at right angles, or more generally, independent. EXAMPLES: The X, Y, & Z directions, or the R, ϕ & Θ directions in polar coordinates are orthogonal. Functions represented by the electric intensities of two radio signals, the ratio of whose frequencies is irrational, are orthogonal.
OSCILLATION, PHUGOID—A long-period oscillation characteristic of the disturbed longitudinal motion of an aircraft.
OSCILLATION, STABLE—An oscillation whose amplitude does not increase.
OSCILLATION, UNSTABLE—An oscillation whose amplitude increases continuously until an attitude is reached from which there is no tendency to return toward the original attitude, the motion becoming a steady divergence.
OSCILLATOR—Any nonrotating device designed to set up and maintain oscillations of a frequency determined by the physical constants of the system.
OSCILLATOR, MAGNETOSTRICTION—An oscillator whose frequency is controlled by a magnetostrictive resonator.
OSCILLOGRAPH—A device for making a graphic record of the instantaneous values of a rapidly varying electric quantity as a function of time or some other quantity.
OSCILLOSCOPE—An apparatus for showing visually on the screen of a cathode-ray tube, the wave form of a rapidly varying quantity, such as an alternating current or a changing electric potential.

P

P-BAND—A radio-frequency bank of 225 to 390 megacycles with wave lengths of 133 to 77 centimeters, respectively.
PAD—A nonadjustable attenuator. See—ATTENUATOR.
PARAMETER—A quantity which may have various values each fixed within the limits of a stated case or discussion.
PAYLOAD—Warhead, fuze, and container. In the case of research and test vehicles this includes equipment for taking data and transmitting or recovering it.
PHASE—A quantity that specifies a particular stage of progress in any recurring operation, such as a vibration or an alternating current. Phase is often expressed as an angle, or a part of a circle, in which case the complete cycle of operation is equal to 360° (one complete rotation). When two alternating quantities pass through corresponding zero values at the same time they are said to be in phase.
PHOSPHORS—Materials used in coating the viewing screen in radar, or other cathode-ray, indicator tubes, to transform the energy of the electron beam into visible light. In use are two types: (1) the single layer (short persistence) phosphor producing visible green light of rapid decay (to about 1% of initial value in about 0.05 sec.), and (2) the double layer cascade (long-persistence) phosphor producing visible yellow light with a decaying time of several seconds.

PHOTOGRAPHY, SHADOW—An optical system for recording shadows, generally utilizing a short, high intensity light source. When used in supersonic wind tunnel work, photographs secured by this method reveal the locations and relative intensities of shock waves. Shadowgraphs are primarily sensitive to the second derivative of the densities existing in a supersonic stream over a model, and thereby reveal sharp changes in density as in shock waves. See—SCHLIEREN.

PHOTOGRAPHY, SPARK—Photographs by the use of a high intensity electric spark as a light source. Frequently used as a "loose" synonym for shadow photography.

PHUGOID—In aeronautics, pertaining to or representing variations in the longitudinal motion or course of the center of mass of an aircraft.

PICK-UP—A sensing instrument such as a pressure gage, strain gage element, position indicator, etc., also called end instrument or end organ.

PIEZOELECTRIC—The property of certain crystals in developing electrical charge or potential difference across certain crystal faces when subjected to a strain by mechanical forces, or conversely to produce a mechanical force when a voltage is applied across the material. Examples: quartz, tourmaline, and Rochelle salts.

PILOTING, SELF—Concerning ram-jets, an ignition system which utilizes a portion of the fuel and air as a pilot flame, which pilot in turn serves to ignite the remainder of the air-fuel flow.

PILOTLESS AIRCRAFT—An aircraft which is equipped to function without a human pilot aboard.

PIP—A peak, or protrusion, on the pattern appearing on the screen of a cathode-ray tube, or radar viewing scope.

PITCH—An angular displacement about an axis parallel to the lateral axis of an airframe.

PITCH INDICATOR—An instrument for indicating the existence and approximate magnitude of the angular velocity about the lateral axis of an airframe.

PITOT-STATIC TUBE—A parallel or coaxial combination of a pitot and a static tube. The ratio of the impact pressure to the static pressure is a function of the velocity of flow past the tube.

PITOT TUBE—A cylindical tube with an open end pointed upsteam, used in measuring impact pressure.

PITOT-VENTURI TUBE—A combination of a pitot and a venturi tube.

PLAN FORM, DEVELOPED—The plan of an airfoil as drawn with the chord lines at each section rotated about the airfoil axis into plane parallel to the plane of projection and with the airfoil axis rotated or developed and projected into the plane of projection.

PLAN FORM, PROJECTED—The contour of the plan form as viewed from above.

PLUMBING—Commonly used to describe the wave guide-coaxial line hookup in a radar set.

POLARIZATION—(1) In optics, the act or process of making light or other radiation vibrate in a definite form so that the paths of the vibrations, in a plane perpendicular to the ray, are straight lines, circles, or ellipses, giving respectively, plane polarization, circular polarization, or elliptical polarization. (2) In radio, a term used in specifying the direction of the electric vector in a linearly polarized radio wave as radiated from a transmitting antenna.

PRECESSION—A change in the orientation of the axis of a rotating body, such as a spinning projectile or gyroscope, the effect of which is to rotate this axis (axis of spin) about a line (axis of precession) perpendicular to its original direction and to the axis (axis of torque) of the moment producing that change.

PRESSURE—Force per unit area.

PRESSURE, BASE—The aerodynamic pressure exerted on the base or rear end of a missile in flight.

PRESSURE, IMPACT—The pressure existing when a moving stream of gas strikes a surface which brings part of the gas abruptly to rest. This recovered pressure is roughly equivalent to the stagnation pressure, for subsonic flow.

PRESSURE, RECOVERED—The pressure actually obtained when the static pressure is increased by the conversion of a portion of the kinetic energy in the stream of gas to pressure energy. The maximum recovered pressure would be stagnation pressure were it not for losses in the conversion process.

PRESSURE, STAGNATION—Stagnation or total pressure is the static pressure that could be realized if the flow could isentropically be brought to rest. It depends upon the static pressure, the Mach number, and kind of gas. At low Mach numbers, it approaches the sum of the static pressure and the incompressible velocity head, but is increasingly greater than this sum at higher Mach numbers.

PRESSURE, STATIC—The pressure exerted by a gas at rest, or which would be indicated by a gauge placed in the stream and moving with the same speed as the stream. The static pressure for a given gas is determined by the density and the temperature.

PRIMARY STRUCTURE—The main framework, including fittings and attachments. Any structural member, the failure of which would seriously impair the safety of the aircraft, is a part of the primary structure.

PROFILE THICKNESS—The maximum distance between the upper and lower contours of an airfoil, measured perpendicularly to the mean line of the profile.

PROPAGATION—Extending the action of; transmitting, carrying as forward in space, or time; or through a medium; as the propagation of sound or light waves.

PROPAGATION, VELOCITY OF, RADIO—The velocity of radio propagation, within the accuracy demanded of radar equipment is usually taken as the velocity of light, 2.998×10^8 m/sec., or 299.8 m/micro-sec. The following table gives the unit propagation velocities:

Velocity (travel/unit time)	Reciprocal (time/unit travel)
299.8 m/micro-sec.	0.003336 micro-sec./m.
983.6 ft./micro-sec.	0.001017 micro-sec./ft.
327.9 yd./micro-sec.	0.003050 micro-sec./yd.
0.1863 statute mi./micro-sec.	5.368 micro-sec./statute mile.
0.1618 nautical mi./micro.	6.180 micro-sec./nautical mile.

PULL-OUT—The act of changing from a power dive to level (or climbing) flight.

PULL-UP—A maneuver in the vertical plane in which the aircraft is forced into a short climb, usually from approximately level flight. See—ZOOM.

PULL-UP, SUDDEN—In stress analysis, a loading condition resulting from a sudden application of up-elevator. Also called Sudden Pull-out.

PULSE—A single disturbance of definite amplitude and time length, propagated as a wave or electric current.

PULSE-JET—A compressorless jet propulsion device which produces thrust intermittently.

Q

Q-FACTOR—(1) A rating applied to coils and resonant circuits, equal to reactance divided by resistence. (2) The ratio of energy stored to energy dissipated per radian in mechanical or electrical systems.

R

RADAR—A term contraction for RAdio Detecting And Ranging. The operation of radar is based on the principle that ultra-high frequency radio waves travel at a definite speed and are reflected from objects they encounter.

RADAR, CONTINUOUS-WAVE—System in which a transmitter sends out a continuous flow of radio energy to the target which re-radiates (scatters) the energy intercepted, and returns a small fraction to a receiving antenna. Since both the transmitter and receiver are operating simultaneously and continuously, it is impractical to employ a common antenna, and usually two similar structures are employed, side by side, and so oriented that only a small fraction of the transmitted power leaks directly into the receiver. The reflected wave is distinguished from the transmitted signal by a slight change in radio frequency. The c-w method while not so adaptable to military needs has many interesting properties: (1) its ability to distinguish moving targets against a stationary reflecting background and (2) more conservative of band width than pulse radar.

RADAR, GPI—Ground position indicator.

RADAR, MTI—Moving target indicator.

RADAR, PULSE—Radar in which sharp bursts of radio energy, somewhat like the bursts of acoustic energy from the barrel of a machine gun, are sent out from the transmitter. When these bursts or "pulses" encounter a reflecting object, they are reflected as discrete echoes which are detected by the radar receiver during the interval between the transmitted pulses. The pulse method has the ability to measure distances and engage several targets simultaneously.

RADAR, RANGE OF—The maximum usable distance to target of a radar system which, under free-space conditions, varies as the fourth power of (1) the transmitted power, (2) the receiver power sensitivity, (3) the target echo area and (4) the square of the antenna gain.

RAM-JET—A compressorless jet propulsion device which depends for its operation on the air compression accomplished by the forward motion of the unit.

RANGE, SLANT—The line-of-sight range from the source (radar, missile launching apparatus, etc.) to the target.

RANGE-TRACKING ELEMENT—An element in a radar set which measures range and its time derivative. By means of the latter, a range gate is actuated slightly before the predicted instant of signal reception.

RASTER—A system of luminescent lines traced on the phosphor of a cathode-ray tube by motion of the cathode-ray beam. The changes of brightness in the lines produce a picture as a television picture or a radar map. This word is of German origin and is used in particular in television.

RATE-OF-CLIMB INDICATOR—An instrument that indicates the rate of ascent or descent of an aircraft.

RATIO, EFFECTIVE ASPECT—The aspect ratio of an airfoil of elliptical plan form that, for the same lift coefficient, has the same induced-drag coefficient as the airfoil, or the combination of airfoils, in question.
RATIO OF SPECIFIC HEATS—The ratio of specific heat at constant pressure to specific heat at constant volume.
RATRACE—A particular type of radar wave guide configuration which serves the same purpose as the "Magic Tee," but allows the handling of greater power.
REACTANCE—That component of the impedance of an electrical circuit, not due to resistance, which opposes the flow of alternating current. The reactance is the algebraic sum of: (1) That due to inductance in the circuit with a value in ohms equal to the product of 2 π, the frequency in cycles and the inductance in henries and (2) that due to capacitance in the circuit with a value in ohms equal to the reciprocal of the product of 2 π, the frequency in cycles and the capacitance in farads.
REACTANT RATIO—The ratio of the weight flow of oxidizer to fuel in a rocket.
REACTOR—A device that introduces either inductive or capacitive reactance into a circuit.
REDUNDANCE—The property of an equation which permits a plurality of solutions; therefore, in a mechanical or electrical system describable by such an equation, the property which permits a plurality of modes of action.
REFLECTION INTERVAL, RADAR—The length of time required for a radar pulse for travel from the source to the target and return to the source, taking the velocity of radio propagation to be equal to the velocity of light, 2.998 x 10^8 m./sec., or 299.8 m./micro-sec. Since the pulse must travel, in all, twice the distance to the target (out and back), the apparent velocities obtained are only one-half of the true velocity of the pulse. Likewise, the reflection intervals are just twice as great when target ranges are considered. The following table, as calculated, takes into consideration both travel to the target and return:

APPARENT VELOCITY (Travel/Unit Time) Radar Ranges	REFLECTION INTERVALS
149.9 m./micro-sec.	0.006671 micro-sec./m.
491.8 ft./micro-sec.	0.002033 micro-sec./ft.
163.9 yd./micro-sec.	0.006101 micro-sec./yd.
0.0932 statute mi./micro-sec.	10.735 micro-sec. statute mile
0.0809 nautical mi./micro-sec.	12.361 micro-sec./nautical mile

REFRACTIVE INDEX OF AIR—The ratio of propagation velocity in a vacuum to the velocity in the atmosphere for electromagnetic radiation. At sea level, the refractive index is approximately 1.0003, decreasing at the rate of approximately -1.2 x 10^{-8} per foot with gain in altitude.
REGENERATIVE—Feeding back. A regeneratively cooled rocket motor is one in which one of the propellants is used to cool the motor by passing through a jacket, prior to combustion.
RELATIVE HUMIDITY—The ratio of an actual partial pressure of water vapor in air to the partial pressure at saturation.
RELAY—A device, usually electro-mechanical in operation, generally operated by a change in one low-powered electrical circuit, thereby controlling one or more other electrical circuits.
RESEARCH—A continued process of scientific investigation prior to and during development. It has for its aim the discovery of new scientific facts, techniques, and natural laws.
RESEARCH, APPLIED—Research aimed at specific application of scientific laws, principles, and phenomena. In contrast to basic research, the prospect of practical application of the results is a primary motive for applied research. Frequently even the methods to be used are clear before work is begun.
RESEARCH, BASIC—The theoretical or experimental study directed toward the increase of knowledge. It may result in the discovery of new scientific phenomena, principles, techniques or significant data which add to the store of scientific knowledge. Immediate practical application is not necessarily a direct objective.
RESEARCH, NONMATERIEL—Concerns research directed toward development or improvement of techniques, rather than toward the development of matériel. It includes such subjects as the application of psychology or of analytical and statistical methods to the study of military problems.
RESEARCH, OPERATIONS—The scientific, qualitative, and quantitative study of warfare by military agencies with the objective of improving the weapons, tactics, and strategy of future operations through analysis and evaluation of past operations and maneuvers, and operations trials. Also known as Operational Research, Operations Analysis, and Operations Evaluations.
RESISTOR—A device which conducts electricity but converts part of the electrical energy into heat. Resistors are used in an electric circuit for protection, operation or control.
RESONANCE—A condition in which an actual oscillation occurs at approximately the natural frequency of a system. At resonance a small input of energy produces a large amplitude of oscillation, which is limited primarily by the amount of damping present.
RESONATOR, MAGNETOSTRICTIVE—A ferromagnetic rod so designed and arranged that it can be excited magnetically into resonant vibration at one or more definite frequencies.
RETURN, SEA OR GROUND—See—CLUTTER, RADAR.
REYNOLDS NUMBER—A nondimensional coefficient used as a measure of the dynamic scale of a flow. Its usual form is expressed by the fraction $\rho\frac{VL}{\mu}$ in which ρ is the density of the fluid, V is the velocity of the fluid, L is a linear dimension of a body in the fluid, and μ is the coefficient of viscosity of the fluid (cf. scale effect).
RIPPLE—Any alternating-current component superimposed upon, or present in, a direct-current supply.
RISE TIME—In electronics, the time required for a pulse to rise to an arbitrary fraction (usually 90%) of its amplitude.
ROCKET—A thrust-producing system or a complete missile which derives its thrust from ejection of hot gases generated from material carried in the system, not requiring intake of air or water.
ROLL—An angular displacement about an axis parallel to the longitudinal axis of an airframe.
ROUGH BURNING—Pressure fluctuations frequently observed at the onset of burning and at the combustion limits of a ramjet or rocket.
RUDDER—A hinged or movable auxiliary airfoil on an aircraft, the function of which is to impress a yawing moment on the aircraft.

S

S-BAND—A radio-frequency band of 1,550 to 5,200 megacycles with wave lengths of 19.35 to 5.77 centimeters respectively.
SABOT—A thrust-transmitting attachment which positions a projectile in the bore of a firearm.
SCALAR QUANTITY—Any quantity that can be described by magnitude alone, such as temperature. See—VECTOR QUANTITY.
SCALE EFFECT—The change in any force coefficient such as the drag coefficient, due to a change in the value of Reynolds number.
SCAN, AXIS OF—In a scanning system, the axis about which information as to the target location is collected, and with reference to which target displacement is measured.
SCAN, RADAR—Denotes the motion of a radio-frequency beam through space in searching for a target. There are many types of scanning used, which are denoted by the path described in space by a point on the radar beam, such as circular, conical, spiral, and helical.
SCAVENGER SYSTEM—The evacuation system in a wind tunnel for disposing of the products of combustion liberated from a burning model in the tunnel.
SCHLIEREN—Gradients or variations in gas density, or striae, from the German word. Schlieren are made visible by an optical system, bearing the same name, which either cuts off or passes a large change in light intensity due to the slight refraction of the light passing through the gas. This system is often used in wind tunnels making visible turbulence and weak shock waves by showing the first derivatives of gas density directly.
SCOPODROMIC—Heading as looking; homing (from skopos, target, aim; dromos, course).
SELF-DESTRUCTION EQUIPMENT—Primacord, or some other type of explosive, in a circuit such that it may be exploded by (a) time-delay mechanism, (b) radio command link, (c) an automatic trip mechanism on the roll-stabilization gyro, or other signal.
SELF-PILOTING—See—PILOTING, SELF.
SELSYN—A General Electric Company trade name for a synchro; derived from SELF-SYNchronous. See—SYNCHRO.
SENSITIVITY—(1) That characteristic of a radio receiver which determines the minimum strength of signal input capable of causing a desired value of signal output. (2) In a telemeter pickup, full range sensitivity is the input required to give attained bandwidth.
SEPARATION—The phenomenon in which the boundary layer of the flow over a body placed in a moving stream of fluid separates from the surface of the body.
SEPARATION POINT—The point at which the separation of the boundary layer begins.
SERVO-LINK—A powerful amplifier, usually mechanical, by which signals at a low power level are made to operate control surfaces requiring relatively large power inputs; e.g., a relay and motor driven actuator.
SERVO-SYSTEM—A closed cycle automatic control system so designed that the output element or output quantity follows as closely as desired the input to the system. The output is caused to follow the input by the action of the servo controller upon the output element in such a way as to cause the instantaneous error or difference between output and input to approach zero. All servo systems are dynamic systems containing at least one feed-back loop; this property distinguishes servo systems from

ordinary automatic control systems. In general, servo-mechanisms exhibit the following properties: (1) Include power amplification; (2) They are "Error Sensitive" in operation; (3) They are capable of following rapid variations of input.
SHADING—The appearance of dark areas in a received television picture which sometimes covers the entire screen.
SHOCK WAVE—An extremely thin wave, or layer of gas, generated by the relative supersonic movement of the gas stream and a body, or generated by an explosion. Free stream gas upon passing through this wave, experiences abrupt and discontinuous changes in pressure, density, velocity, temperature and entropy. These changes are irreversible due to some of the pressure energy being lost to heat. Shock waves are commonly called compressive waves, and may be either normal or oblique to the gas stream direction. The stream upon passing through a normal shock always has its velocity reduced from supersonic to subsonic. In passing through an oblique wave, the velocity is reduced but is still supersonic. In both cases the total stagnation pressure is reduced, while the density, static pressure, and free stream temperature are increased in the gas stream.
SHOCK WAVE, LIP—The shock wave obtained from the lip of a free jet nozzle due to the failure in matching of the stream pressure and the ambient exhaust pressure.
SHORAN—Derived from SHOrt RAnge Navigation. See—NAVIGATION, HYPERBOLIC.
SIDE DIRECTION—(STRESS ANALYSIS). The direction perpendicular to the plane of symmetry.
SIDE FORCE OR COMPONENT—(STRESS ANALYSIS). A force, or component, perpendicular to the plane of symmetry.
SIEMANS—A Siemans and Halske trade name for a synchronous device. See—SYNCHRO.
SIGNAL—Any wave form or variation thereof with time serving to convey the desired intelligence in communication.
SIMULATOR, YAW (PITCH)—A test instrument used to derive and thereby permit study of probable aerodynamic behavior in controlled flight under specific initial conditions. Certain components of the missile guidance system, such as the receiver, servo loop, etc., are connected into the simulator circuitry. Also certain aerodynamic parameters of the specific missile must be known and set into the simulator. Most simulators are applicable to a single plane, which in case of the yaw simulator is the yaw plane. The missile is assumed to be completely roll stabilized.
SINK—A point or element in a system where energy is dissipated or otherwise removed from the system.
SINUSOIDAL—Varying proportionally to the sine of an angle or time function. Sometimes written "sinoidal."
SKIDDING—Sliding sidewise away from the center of curvature when turning. It is caused by banking insufficiently and is the opposite of sideslipping.
SKID FIN—A longitudinal vertical surface, usually placed above the upper wing to increase the lateral stability.
SKIN FRICTION—The tangential component of the fluid force on a surface.
SKY WAVE—A radio wave propagated by reflection from the ionosphere.
SLAT—A movable auxiliary airfoil, attached to the leading edge of a wing, which when closed falls within the original contour of the main wing and which when opened forms a slot. See—SLOT.
SLOT—The nozzle-shaped passage through a wing whose primary object is to improve the flow conditions at high angles of attack. It is usually near the leading edge and formed by a main and an auxiliary airfoil, or slat. See—SLAT.
SONDE—In telemetering, the complete airborne telemetering system in the vehicle.
SONIC, HYPER—(1) High supersonic velocities, of the order of $M = 5$ or greater. (2) Velocities at which time of missile passage is of the order of the relaxation time; that is, the time for gas molecules to reach equilibrium after sudden change in conditions. In such a domain, gases must be treated as discrete particles rather than continuum. Measurements of relaxation times of gases are incomplete, but there are indications that Mach numbers of the order of ten must be regarded as hypersonic. Velocities that are not hypersonic at sea level may become so at high altitude, as relaxation times will be longest when densities are relatively low.
SONIC SPEED—The speed of sound. In ambient air with ratio of specific heats assumed 1.4 and the air following the gas law, with temperature in degrees Rankine, the speed of sound is $33.42 \sqrt{T}$ miles per hour, or $29.02 \sqrt{T}$ knots; with temperature in degrees Kelvin, the speed of sound is $44.84 \sqrt{T}$ miles per hour, or $38.94 \sqrt{T}$ knots.
SONIC. SUB—Less than the speed of sound, or less than a Mach number of one.
SONIC, SUPER—Faster than the speed of sound. When supersonic speed is attained by a moving object, no advance information in the form of advance pressure waves, can be given to the advancing air, as the body is moving faster than the pressure waves emanating from the body can propagate themselves forward. As a result, shock waves are formed, which move with the body, attached or unattached depending on conditions.
SONIC, TRANS—The intermediate speed in which the flow patterns change from subsonic flow to supersonic, i.e., from Mach numbers of about .8 to 1.2, or vice versa.
SPAN—The maximum distance, measured parallel to the lateral axis, from tip to top of an airfoil, of an airplane wing inclusive of ailerons, or of a stabilizer inclusive of elevator.
SPECIFIC GRAVITY—The ratio of the weight of any volume of a substance to the weight of an equal volume of water at 4°C.
SPECIFIC HEAT—The heat capacity of a substance as compared with the heat capacity of an equal weight of water; the number of calories required to raise the temperature of one gram of a substance 1°C.
SPECIFIC IMPULSE—Pounds thrust developed per pound of propellants (fuel plus oxidizer) consumed, or the ratio of thrust to propellant mass flow.
SPECIFIC IMPULSE, AIR—The ratio of the critical stream thrust (at $M = 1$) to the air mass flow.
SPECIFIC IMPULSE, AIR-FUEL—The ratio of the stream thrust to the mass of air plus fuel flowing per unit time.
SPECIFIC IMPULSE, FUEL—The thrust developed by burning one pound of fuel in one second, or the ratio of the thrust to the fuel mass flow.
SPECIFIC IMPULSE, OVER-ALL—Impulse per unit total weight of system.
SPECIFIC THRUST—The ratio between the thrust of a jet reaction motor and the total propellant flow rate producing the thrust.
SPECTROPHOTOMETER—An instrument for measuring transmission, or apparent reflectance of light as a function of wave length, permitting accurate color analysis, or accurate comparison of luminous intensity of two sources at specific wave lengths.
SPECTRUM—The entire range of electromagnetic radiations from the longest radio waves to the shortest cosmic rays and including the spectrum of visible light.
SPIKE—In electronics, a spike is a transient of short duration during which the amplitude considerably exceeds the average amplitude of the pulse.
SPILLOVER—That portion of the air in the stream-tube which flows to the side of a ram-jet intake, rather than through the intake. This takes place under conditions of detached shock. Under conditions of attached, or, swallowed shock, there is no spillover.
SPIRAL—A maneuver in which an aircraft descends in a helix of small pitch and large radius, the angle of attack being within the normal range of flight angles.
SPOILER—A surface which is projected into the wind stream surrounding an airfoil and "Spoils," or interrupts the airflow, reducing the lift.
SQUIB—A small pyrotechnic device which may be used to fire the igniter in a rocket, or for some similar purpose. Not to be confused with a detonator, which explodes.
STABILITY—That property of a system which causes it when its equilibrium is disturbed, to develop forces or moments tending to restore the original condition.
STABILITY, ARROW—The partial derivatives of yawing and pitching moments with respect to angles of attack in yaw and pitch.
STABILITY, DIRECTIONAL—Stability with reference to disturbances about the normal axis of an aircraft, i.e., disturbances which tend to cause yawing.
STABILITY, INHERENT—Stability of an aircraft due solely to the disposition and arrangement of its fixed parts; i.e., that property which causes it, when disturbed, to return to its normal attitude of flight, without the use of the control or the interposition of any mechanical device.
STABILITY, LATERAL—Stability with reference to disturbances about the longitudinal axis; i.e., disturbances involving rolling or side-slipping. The term "lateral stability" is sometimes used to include directional and lateral stability, since these cannot be entirely separated in flight.
STABILITY, LONGITUDINAL—Stability with reference to disturbances in the plane of symmetry, i.e., disturbances involving pitching and variation of the longitudinal and normal velocities.
STABILITY, STATIC—That property of an aircraft which causes it, when its state of steady flight is disturbed, to develop forces and moments tending to restore its original condition.
STABILIZER—Concerning aircraft, any airfoil whose primary function is to increase the stability of an aircraft. It usually refers to the fixed horizontal tail surface of an airplane, as distinguished from the fixed vertical surface.
STAGE—In electronics, that portion of a circuit contained between the control grid of one tube and the control grid of the next adjacent tube.
STAGNATION POINT—A point at which moving fluid comes entirely to rest.
STALL—The condition of an airfoil or airplane in which it is operating at an angle of attack greater than the angle of attack of maximum lift.

STANDING WAVES—Also called stationary waves. The wave-like distribution of potential along a conductor, when electric waves are reflected from the end of the conductor to form stationary nodes and loops; a condition of equilibrium, or zero motion, at certain lines, points, or surfaces, called nodes, with regions of vibration between, produced by interference between similar wave trains traveling in opposite directions.

STATIC GEARING RATIO—The ratio of the control surface deflection in degrees to angular displacement of the missile which caused the deflection of the control surface.

STEADY STATE—The condition of a system which is essentially constant, after damping out of initial transients or fluctuations.

STING—A rod or type of mounting attached to, and extending backward from, a model, for convenience of mounting, when testing in a wind tunnel.

STOICHIOMETRIC—Means that the components involved in a burning process are present in exactly the quantities needed for reaction without an excess of any component.

STRAIN GAUGE—A strain-sensitive element, which permits recording, via a bridge circuit, of displacements between selected places.

STREAM THRUST—The sum of the pressure force transmitted across a specified cross section and the time rate of momentum flow across the same cross section. Defined by $F = PA + \rho AV^2$, where F is the stream thrust, P is pressure, A is cross-sectional area, ρ is the density of the fluid, and V is the fluid velocity.

STREAM TUBE—In fluid flow, an imaginary tube whose wall is generated by streamlines passing through a closed curve.

STREAMLINE—The path of a particle of a fluid, supposedly continuous, commonly taken relative to a solid body past which the fluid is moving; generally descriptive only of such flows as are not eddying.

STREAMLINE FORM—The form of a body so shaped that the flow about it tends to be a streamline flow.

SPOILER—A type of airframe control in which the smooth flow around an airfoil is interrupted or "spoiled," or is disturbed as to destroy, in part, the lift.

SUBCARRIER—In telemetering, an intermediate frequency that is modulated by intelligence signals, and in turn is used to modulate the radio carrier, either alone or in conjunction with subcarriers on other channels.

SUBSONIC—See—SONIC, SUB.

SUPERSONIC—See—SONIC, SUPER.

SUSTAINER—A propulsion system, which travels with, and does not separate from the missile. Usually applied to solid propellant rocket motors when used as the principal propulsion systems as distinguished from an auxiliary motor, or booster.

SWEEPBACK—The acute angle between a line perpendicular to the plane of symmetry and the plan projection of a reference line in the wing.

SYNCHRO—The universal term applied to any of the various synchronous devices as the Selsyn, Autosyn, motor torque generator, mag-slip, and Siemans. Theoretically a synchro device is treated as a salient-pole, bipolar, alternating-current excited synchronous machine. The standard signal and control synchro has a two-pole, single-phase, rotor field and a Y-wound, single-phase, variable-voltage stator. The transmitter of the synchro, whose rotor is geared to, or otherwise linked with mechanical equipment, is also called a generator, synchro-generator, or Selsyn-generator. The indicator, also called a motor, synchro-motor, or Selsyn-motor, has a motor that is free to rotate, and is damped to prevent excessive oscillation, before coming into correspondence with the rotor of the transmitter.

T

TAB—An auxiliary airfoil attached to a control surface for the purpose of reducing the control force or trimming the aircraft.

TAIL, AIRPLANE—The rear part of an airplane, usually consisting of a group of stabilizing planes, or fins, to which are attached certain controlling surfaces such as elevators and rudders; also called "enpennage."

TAIL SURFACE—A stabilizing or control surface in the tail of an aircraft.

TANK CIRCUIT—A resonant circuit consisting of an inductor and a capacitor in parallel.

TAPER IN THICKNESS RATIO—A gradual change in the thickness ratio along the wing span with the chord remaining constant.

TARE EFFECT—In wind tunnel testing, the forces and moments due to support assembly and mutual interference between support assembly and model.

TARGET, RADAR—Any reflecting object of particular interest in the path of a radar beam, whether or not such object has any military significance as a target.

TELEMETERING SYSTEM—The complete measuring, transmitting, and receiving apparatus for remotely indicating, recording, and/or integrating information.

TEMPERATURE—A measure of the level at which thermal energy may be added to substance, or taken from it.

TEMPERATURE, ABSOLUTE—Scales based upon zero degrees as the lowest temperature attainable even theoretically. Absolute zero is approximately —273.18°C. or —459.7°F.

TEMPERATURE, CENTIGRADE (C)—A temperature scale divided into 100 degrees, in which freezing point of water is regarded as 0° and the boiling point as 100°.

TEMPERATURE COEFFICIENT OF PRESSURE AT CONSTANT K—The relative change in pressure per degree (C. or F. as stated) change in ambient temperature at a constant ratio (K) of propellant surface to throat area.

TEMPERATURE, FAHRENHEIT (F)—A temperature scale in which the freezing point of water is 32° and the boiling point 212°.

TEMPERATURE, IMPACT—The temperature in a gas after impact, which impact had caused the conversion of a portion of the kinetic energy into heat energy, with a resultant rise in temperature from the ambient.

TEMPERATURE, KELVIN—The absolute centigrade scale, in which zero is the lowest possible temperature and the freezing and boiling points of water are separated by 100 degrees.

TEMPERATURE, RANKINE—The absolute scale corresponding to Fahrenheit, in which the freezing and boiling points of water are separated by 180 degrees. The freezing point is 492° Rankine, and the boiling point 672° Rankine approximately.

TEMPERATURE, STAGNATION—The temperature of the stream which would be realized by conversion of all the kinetic energy of the stream into heat energy.

TEMPERATURE, STATIC—The temperature that would be measured by a thermometer moving with the gas at the gas velocity, and having no radiation losses.

TEST, ENGINEERING—Tests conducted by developing agency comprising examinations, investigations, or other observations necessary to determine the technical adequacy of the matériel undergoing test. Pilot or experimental models are subjected to those tests at the various laboratories and proving grounds, prior to initiation of procurement of a production model.

TEST, SERVICE—Tests of development matériel to determine suitability of the matériel for military use. Such tests are normally conducted by a using agency, following completion of engineering tests.

THEODOLITE—An optical instrument for measuring horizontal and vertical angles with precision.

THERMAL CONDUCTIVITY—Heat flow rate per unit of area per degree per unit length.

THERMISTOR—A contraction of THERMal resISTER. A resistor whose value varies with temperature in a definite desired manner. Used in circuits to compensate for temperature variations in other parts, or to measure temperatures, or as a nonlinear circuit element.

THERMOCOUPLE—A pair of dissimilar conductors in contact, forming a thermo-junction which when heated develops a potential difference between the parts; used for measuring temperature differences.

THERMOJET—Air duct type engine in which air is scooped up from surrounding atmosphere, compressed, heated by combustion, and then expanded and discharged at high velocity.

THERMOPILE—An instrument consisting of several thermocouples so arranged as to give, when heated, a multiplied thermoelectric current; often used for detecting very slight variations in temperature. See—DETECTOR, INFRARED.

THICKNESS RATIO—The ratio of the maximum thickness of an airfoil section to the length of its chord.

THREE-DIMENSIONAL FLOW—A flow in which three Cartesian coordinates are necessary to specify conditions. Examples are: flow around a finite wing, or around an inclined body of revolution. See—TWO-DIMENSIONAL FLOW.

THRUST—The resultant force in the direction of motion, due to the components of the pressure forces in excess of ambient atmospheric pressure, acting on all inner surfaces of the vehicle parallel to the direction of motion. Thrust less drag equals accelerating force.

TOMODROMIC—Heading to cut; intersect (from tomos, a cutting; dromos, course).

TRACK IN RANGE—To adjust the gate of a radar set so that it opens at the correct instant to accept the signal from a target of changing range from the radar.

TRAILING EDGE—The rearmost edge of an airfoil.

TRANSCEIVER—A combination of radio transmitting and receiving equipment in a single housing, with some of the electronic circuit components being used dually for transmitting and receiving.

TRANSDUCER—A device which converts the energy of one transmission system into the energy of another transmission system. A loud-speaker and a phonograph pickup are two examples of transducers, the former changes electrical energy into acoustical energy and the latter changes mechanical into electrical energy.

TRANSFER FUNCTION—The function relating the output of a closed-cycle, servo system to its error.

TRANSMISSION LINE—A system of material boundaries forming a continuous path from one place to another, and capable of directing the transmission of electromagnetic energy along this path.

TRANSMISSION LINE, MATCHED—A transmission line is said to be matched at any plane if there is no reflected wave at that plane.

TRANSSONIC—See—SONIC, TRANS.

TRAP—Part of a jato or other solid propellant rocket motor which functions to prevent loss of propellant.

T-R BOX—Common abbreviation for transmit-receive switch or tube. This switch, or tube, permits the use of a single antenna on a radar for transmission and reception. The t-r box prevents the absorption of the transmitted pulse into the receiver system, thereby protecting the receiver circuit from damage, and also prevents the transmitter circuits from absorbing any appreciable fraction of the reflected echo signal. There are various types of t-r boxes, or tubes, graduating to fairly complex devices in microwave systems.

T-R BOX, ANTI—A second t-r switch used in the antenna system of a radar system to minimize absorption of the returned echo signal in the transmitter circuit, during the quiescent period between transmitted pulses.

TRIM—(1) In electronics, denotes a small change or necessary adjustment of the tuning capacity. (2) Concerning aircraft, the attitude with respect to wind axes at which balance occurs in rectilinear flight with free controls.

TROPOSPHERE—That part of the earth's atmosphere from the earth's surface up to about six (6) miles in altitude.

TUMBLING—The act performed by a two-frame free gyroscope when both frames become co-planar. Under these circumstances, the gyro wheel rotates about a diameter as well as about its polar axis, resulting in loss of control.

TURBULENCE—Irregular fluctuation in speed or direction of airflow, the intensity of which may be measured by the root-mean-square speed fluctuations relative to the mean speed.

TURN AND BANK INDICATOR—An instrument combining in one case a turn indicator and a lateral inclinometer.

TWO-DIMENSIONAL FLOW—A flow in which two Cartesian coordinates are sufficient to specify conditions. The fluid undergoes a change of direction in one plane only, at right angles to the direction of the flow, such as in the case of flow over a wing of infinite span, and wind tunnel tests are facilitated by observations with uniform conditions along any line perpendicular to the windows of the tunnel.

U

ULTRAVIOLET—Electromagnetic radiation extending from the visible spectrum at the violet end up to the region of low-frequency x-rays, with wave lengths from about 136 to 4000 Angstrom units.

UMBILICAL CORD—A cable fitted with a quick disconnect plug at the missile end, through which missile equipment is controlled and tested while missile is still attached to launching equipment or parent plane.

V

VAPORIZATION, HEAT OF—The enthalpy difference between vapor and liquid at saturation; the amount of heat required to vaporize a unit mass under normal pressure without changing its temperature.

VECTOR QUANTITY—A quantity which requires for description both magnitude and direction, such as displacement or velocity of a particle. See—SCALAR QUANTITY.

VELOCITY, CHARACTERISTIC—The velocity attained by exhaust gases in the throat of a rocket motor. The ratio of the product of the chamber pressure and the throat area to the mass rate of gas exhaust.

VELOCITY, EFFECTIVE JET—A calculated average velocity of the exhaust gases as they leave the motor nozzle.

VELOCITY, FLAME—Flame velocity is the velocity of the flame front perpendicular to its surface, relative to the unburnt gas where it is at initial conditions; under stationary conditions of one-dimensional flow, the flame velocity is equal to the mass flow of unburnt gas through a unit area of the flame front divided by the initial density.

VELOCITY, TERMINAL—The hypothetical maximum speed that a body could attain along a specified straight flight path under given conditions of weight and thrust, if diving an unlimited distance in air of specified uniform density. If the term is not qualified, a vertical path angle, normal gross weight, zero thrust, and standard sea-level air density are assumed.

VENTURI TUBE—A short tube of varying cross section. The flow through the venturi causes a pressure drop in the smallest section, the amount of the drop being a function of the velocity of flow.

VIDEO—The term "video" is applied to the frequency band or circuits by which visual signals are transmitted.

VISCOSITY—The resistance to shear in a fluid.

W

WARHEAD—The portion of a missile ultimately useful against military targets; normally fuze, casing, explosive and/or chemical or incendiary agents, etc.

WAVE, EXPANSIVE—Such an oblique wave or zone is set up in supersonic flow, when the change in direction of the air flow is such that the air tends to leave the new surface, such as flow around the juncture of a cone and a cylinder. This condition is called flow around a corner. The air on passing through an expansive wave or zone has lower density, static pressure, and free stream temperature, and has higher velocity and Mach number.

WAVE GUIDE—A guide, consisting either of a metal tube or dielectric cylinder, capable of propagating electromagnetic waves through their interiors. The widths or diameters of such guides are determined by the frequency to be propagated. The metal guides may be evacuated, air filled, or gas filled, and are generally rectangular or circular in cross section. The dielectric guides consist of solid dielectric cylinders surrounded by air.

WEATHERCOCK STABILITY—See—STABILITY, ARROW.

WETTED SURFACE—In aerodynamics, that surface of a body which comes into contact with the fluid through which the body is moving.

WIND, RELATIVE—The velocity of the air with reference to a body in it. It is usually determined from measurements made at such a distance from the body that the disturbing effect of the body upon the air is negligible.

WIND TUNNEL—An apparatus producing a controlled wind or air stream, in which objects can be placed for investigating the air flow about them and the aerodynamic forces exerted on them.

WING—A general term applied to the airfoil, or one of the airfoils, designed to develop a major part of the lift of a heavier-than-air craft.

WING, EQUIVALENT—In stress analysis, a wing of the same span as the actual wing, but with the chord at each section reduced in proportion to the ratio of the average beam load at that section to the average beam load at the section taken as the standard.

WING PROFILE—The outline of a wing section.

WING RIB—A chordwise member of the wing structure of an airplane, used to give the wing section its form and to transmit the load from the fabric to the spars.

WING SECTION—A cross section of a wing parallel to the plane of symmetry or to a specified reference plane.

WING TIP—The outer end of an airplane wing.

WING TIP RAKE—A term referring to the shape of the wing when the tip edge is sensibly straight in plan but is not parallel to the plane of symmetry. The amount of rake is measured by the acute angle between the straight portion of the wing tip and the plane of symmetry. The rake is positive when the trailing edge is longer than the leading edge.

X

X-BAND—A radio-frequency band of 5,200 to 11,000 megacycles with wave lengths of 5.77 to 2.73 centimeters respectively.

Y

YAW—An angular displacement about an axis parallel to the normal axis of an aircraft.

Z

ZOOM—To climb for a short time at an angle greater than the normal climbing angle, the airplane being carried upward at the expense of kinetic energy.

High Command—A Comparison

By Colonel Robert Alan, USAF

High command means, for the purposes of this discussion, the two top levels of Theater Command; that is to say, the Theater Commander himself, and those in the next echelon below him. In an active theater, the insignia of these distinguished gentlemen would be in the three-, four-, or even five-star category.

The Concepts Vary

There is a difference between the American and British views of these offices. In essence, the difference may be said to be "command" *versus* "cooperation." Americans appear to have a definite leaning toward the principle of solid, unqualified command of the "Don't ask him—tell him!" variety, whereas the British display a preference for conducting their high-level military command by the principle of mutual cooperation.

Let us pass now to a brief discussion of each system, reserving comparison and comment until both concepts have been set forth.

The British begin with a "Supreme Allied Commander" in the top spot. That is his title, and he is the boss. Although his is power of a very great order, he rarely exercises it. Rather, he remains somewhat aloof, and acts, as far as military matters are concerned, as a coordinator, a court of last resort. Because he cannot do otherwise even if he chose, he concerns himself as much with political and diplomatic maneuvers as with purely military ones. Soothing Allied generals, placating irate statesmen, receiving Very Important Persons, he pours essential oil on the always-troubled waters of Allied Endeavor.

"But what about the battle?" one may well inquire. For its planning and conduct, the British provide three, known as the Commanders in Chief of the Allied Land, Sea and Air Forces. Meeting together, they jointly plan the battle. Fighting together, they jointly win or lose it. No one of them is boss—they just cooperate in carrying out the agreed plan.

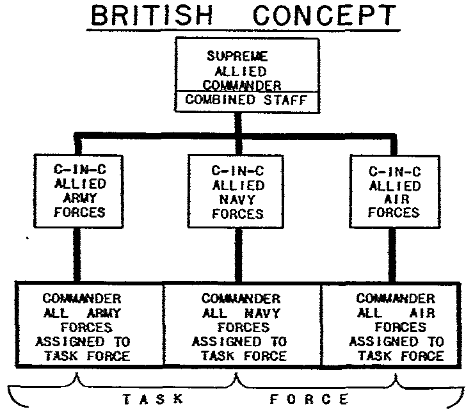
The Americans, on the other hand, prefer to start by designating the Theater Commander "Allied Commander in Chief." They view him as a commander in every sense, not as a coordinator. They envisage him exercising firm and continuing control of military as well as political matters. From the military standpoint, he is in no sense a figurehead.

Under the Allied Commander in Chief, the Americans would place administrative Land, Sea and Air Commanders for both British and American forces. These would be six in number. Their duties would be heavy, comprising responsibility for administration, logistics, training, command of those units not committed to Task Forces, and local defense. They would not, however, hold any responsibility for either planning or fighting the main battles.

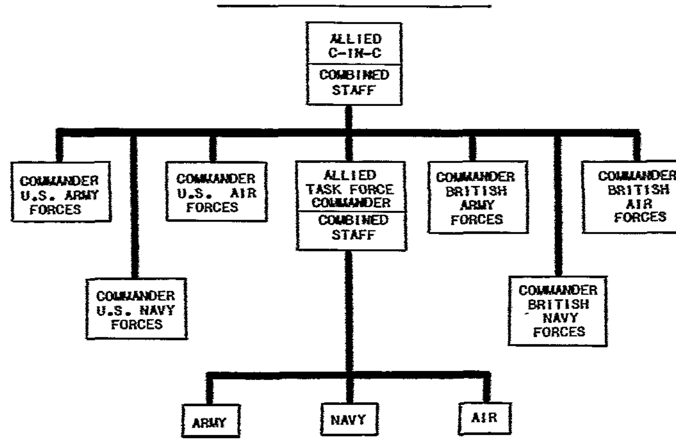
Now once again it may be asked, "What about the battle?" The Americans, too, have given thought to the battle, resulting in the triphibious Task Force Commander. He is on the same level as the administrative commanders. He may be an Army, Navy or Air officer. He is given those Army, Navy and Air forces which the Commander in Chief considers are sufficient to do the job at hand. He is provided with a combined staff if his forces include units of both nations, or with a joint staff if they are all of one nation. Each Army, Navy, and Air element of his task force is commanded respectively by an Army, Navy or Air officer who reports directly to him and to no one else. He exercises his command through these commanders, and limits himself to the assignment of tasks, the designation of objectives, and such other authoritative direction as may be essential to success of the mission. Normally, therefore, he would not concern himself with such matters as administration, discipline, internal organization, logistic support, and unit training except when his commanders requested assistance. He would always, however, have the power to take definitive and immediate action in any of these fields should the normal conduct of affairs appear to endanger success of the main enterprise. Thus, having been given the means to

COMBINED THEATRE COMMAND ORGANIZATION

BRITISH CONCEPT



U. S. CONCEPT



carry out his task, together with the clear, unquestioned authority to commit his forces to battle when and as he chooses, to fight them as he pleases, and to withdraw them as he sees fit, he alone is held responsible for the outcome.

Having seen what the British and American concepts of high command are, let us endeavor to compare them. Both concepts can be defended.

The first difference is in the roles of the British Supreme Commander and the U. S. Commander in Chief. In defense of their view, the British might begin by saying that it is realistic, which indeed it is. It recognizes frankly that the Supreme Commander of an Allied Theater is inevitably involved as much in political matters as in military, and therefore must be left free to devote a large portion of his time to such affairs, confining his participation in the purely military realm to the resolution of differences between his Commanders in Chief. General Eisenhower, for example, writing about the North African campaign in *Crusade in Europe,* states: "Politics, economy, fighting—all were inextricably mixed up and confused one with the other."

Recall his personal and time-consuming concern with Giraud, Darlan, and De Gaulle in the North African venture. Note carefully his frequent exhaustive interviews with political advisers—all necessary, all tiring, and combined with his arduous efforts in the military realm. These manifold activities—political, economic, and military—seem too much for one man, who, no matter how robust of body, how great in capacity, or how experienced in conducting affairs of magnitude, will sooner or later approach the limit of human endurance. For this reason, the British view of the role of the top commander seems sounder.

And for the same reason, *i.e.,* that one man can only do so much, the American concept of the second echelon of theater command appears more reasonable. The American concept, it will be recalled, places in each theater so-called administrative commanders of the Army, Navy, and Air Force, one each for the respective British and American forces of each Service, totaling six. On the other hand, the British concept envisages only three commanders under the Supreme Commander—the Allied Commanders in Chief of the Land, Sea, and Air Force. Whereas the Americans limit their six commanders to responsibility for administration, logistics, training, command of those forces not assigned to task forces, and local defense, the British heap up on their three the complete military burden—all the functions named above, plus the planning and conduct of the battle. This is a heavy load. In defense of it, one is forced to admit that the Allied Army, Navy, and Air commanders exercise full authority over all the units and functions that make up an effective fighting force. Nevertheless, no matter how wise or competent the commanders, the job seems too complex for one man.

The third notable point of difference is the organization of a Task Force. In the British system the Allied Commanders in Chief of the Land, Sea, and Air Forces work out and agree upon a plan for a specific operation, assign forces to it, then proceed to carry it out with no over-all commander short of the Supreme Commander himself. They designate no Task Force Commander as the Americans do but employ three independent commanders who cooperate. The British offer in behalf of their system that they have experts—Army, Navy, Air—running their respective parts of the show, whereas in the American system, the Task Force Commander could not possibly be expert in the operations of all three Services. The Americans, for their part, every time they view the British concept of cooperation, see under the bed those old bugaboos Divided Responsibility and Lack of Firm Authority. They say that operations of magnitude and complexity require a strong driving force, which cannot be imparted by a committee. They state that in battle, conflicts of opinion arise which require immediate resolution on the spot. They conclude that only a single Task Force Commander can effect such resolution. In support of their argument they recall the words of General Fox Connor, spoken to General Eisenhower long before World War II: "We cannot escape another great war. When we go into that war it will be in company with allies. Systems of single command will have to be worked out. We must not accept the coordination concept under which Foch was compelled to work. We must insist on individual and single responsibility—leaders will have to learn how to overcome nationalistic considerations in the conduct of campaigns."

In this controversy, it seems that the decision should go to the Americans. The U. S. task force system described above provides experts to command the Army, Navy and Air elements. Although the Task Force Commander himself might not be an expert in the employment of each of the three Services, his staff, because of its combined or joint nature, would have the required degree of accomplishment.

The British view appears to have more merit with respect to the Theater Commander's activities, whereas the American plan recommends itself with respect to the next commanders and the task force organization. It appears that either the American or the British concept would be a suitable high command arrangement, however. It is to be doubted whether a war fought under either system would be lost because one was adopted and the other was not. Both views have merit, both have been used successfully, both are put forward by men not only experienced in war but also well versed in the difficulties, frustrations and complications of high command. With a knowledge of these complications clearly in mind, it is suggested that either system, or even a mixture of both, would be an adequate vehicle for high command arrangements.

The real crux of the matter, then, is the commanders themselves. The right men could make either system work: but obstinate, stuffy, overbearing, shortsighted, unsympathetic commanders of limited perception and no pliability could ruin either concept. What will be needed is men like General Omar Bradley, who in war seems to have displayed the same sterling characteristics and ability to work with other high commanders that he now retains in peace.

Determining the Nationality of High Commanders

How to determine the nationality of the high commanders is the next question. Should they be British or American? At stake is very great power and few men and no nations pull their punches when battling for these prizes.

In endeavoring to determine which nation should furnish the high commanders, certain factors come quickly to mind. First is the relative contribution of forces. This is an age-old factor. It occurs frequently in recorded discussions about the naming of commanders, and appears to be generally accepted as a sound basis for determining their nationality.

A second factor is the relative contribution of the means to fight a war. The United States may become more of an "arsenal of democracy" than it was in World War II. If so, what weight should this have in the determination of the high commanders? It is not inconceivable that a theater manned preponderantly by the British might be entirely equipped and fed from American sources. Who then should command? The British, probably. Dollars cannot outweigh death, nor can the sweat, labor, shortages, discomfort, rationing and inconvenience that enable America to build the stuff and deliver it ever outweigh the grim reality of fighting the battle itself.

The next factor is the relation of the scene of action to the national security of each country. Consider, for instance, the North Atlantic. Through those waters plough the ships that bear the means of life itself to the British Isles. Sever those sea lanes and England would wither away in weeks. Should an Englishman command in those waters even though American forces outnumbered British? It would seem so.

Consider now a serious conflict of these factors. Assume, for example, that the British Isles were to come under such intense air and rocket bombardment as to preclude mobilization, training and equipping of armed forces. Invasion threatens. Assume that the United States were prepared for conflict, and that she could save the British Isles, and that the Americans actually arrive early, in force sufficient to do the job. They outnumber their British comrades in arms in every category; they bring their own weapons; they eat their own food; they bury their own dead—of which they have many more than the British. Here we have the basic factor of preponderance of forces versus the basic factor of the relation of the scene of action to the national security. In this instance, and despite the more numerous American forces, the High Command appears to belong to the British. They have experienced and competent commanders, so that the job should not be bungled. It is their land, which they would doubtless defend with the same competence and heroism they achieved in the Battle of Britain, and the same doggedness they displayed under the V-1's and V-2's.

Turning back again from fantasy, we come face to face with the economic factor. Should a combined operation be undertaken in an overseas possession, mandate or area of influence, it appears logical to give serious consideration to selection of a commander from the parent nation because of that nation's primary economic interest. Economic ties can be strong, even vital. In addition, unexpected benefits might accrue—benefits in the form of high commanders with great political and military experience in the area.

Another factor is the psychological one. Due regard should be had for the psychological effect of a commander's nationality on both enemy and friendly peoples. This is perhaps more important during the "cold" phase of an international struggle, when power politics affect both the future alignment of allies and the actions of the enemy. For example, if the United States were to join with the countries of Western Europe in a military pact of some sort, publicly announce it, and then assign an officer of great prestige and demonstrated ability like General MacArthur to command forces in Western Europe, it could be inferred that the United States intended to give its full support to any Allied activity in that area. This inference might be a strong deterrent in some quarters. By the same token, the appointment of a man like General MacArthur would serve to encourage any nations of Western Europe who might be wavering. The actual appointment of Field Marshal Montgomery as Chairman of the Western Union Chiefs of Staff has doubtless had a favorable psychological effect. Another but different favorable effect might be achieved by appointing some mutually acceptable French officer to the position now held by Field Marshal Montgomery. This would be an expression of confidence in France which might solidify the French national will in a badly needed manner.

Serious complications can arise from clashes in personality. On the other hand, close personal relationships between high commanders have often served to make a bad organization work. Such was that between Eisenhower and Tedder, and between Tedder and the leading U. S. and British airmen, which alone made the complicated air organization work in the Normandy invasion. And it did because of close personal relationships between high commanders—which will go far toward making any command arrangement work. However, the inevitable insulating effect of very high rank usually prevents high commanders from attaining any great degree of personal friendship.

Anglo-American Handicaps

If the portents of the future continue to pile up in impressive array, the British and Americans will probably meet again as they did early in World War II to place their combined military affairs in order. Not necessarily soon, however, because their governmental structures and traditional outlooks prevent both nations from acting at a sufficiently early date or in a vigorous enough fashion in these matters.

It will be remembered that prior to U. S. entry into World War II, there were U. S.-British conferences held in March 1941, which provided the basis for discussion between Prime Minister Churchill and President Roosevelt in late December 1941 and early January 1942 in Washington—the so-called Arcadia Conferences—at which the Combined Chiefs of Staff were born.

All Is Calm

Fortified by these and other bits of pertinent wisdom, it appears that the Americans and the British might sit down together and hammer out the fundamental principles of Anglo-American high command. Having done that, they could then proceed to cast the pure light of reason on the problems of organization and the selection of commanders. In most instances, application of principle should settle the problem.

The Americans could do worse than to consider carefully the responsibilities as well as the privileges of greatness. Having done this they may be expected to assume with grace their new-found responsibilities, to shun the common inclination to grasp every high command in sight merely because theirs is the power and the British have come upon bad times. Only thus will Americans demonstrate, through the exercising of understanding and restraint, that they have indeed come of age.

Here Is Your Atomic Energy

By Lieutenant Colonel David B. Parker, GSC

Part II

"It is the duty of every citizen, and particularly of every soldier to understand what atomic energy is and how it is being harnessed by man."

Last spring when Joint Task Force Seven conducted the full-scale tests of improved atomic weapons at Eniwetok, the Task Force Commander found that many of his staff were amazingly ignorant of the basic facts of atomic energy. These facts have been publicized many times in many different forms, but the average soldier and citizen still does not have a grasp of the meaning of such terms as "atomic pile," "fissionable material," or "U-235." In his first installment that appeared in the November-December issue of the Journal, *Lieutenant Colonel Parker explained the basic theory and history of atomic energy up to the discovery of isotopes.*

We have emphasized that isotopes are similar chemically, because this fact has been of the greatest importance in the development of atomic energy. It is obvious that two substances which are chemically alike cannot be separated, once mixed, by chemical means; therefore, it is impossible to derive a pure isotope from a natural mixture by any chemical process. We shall see that the Manhattan Project spent hundreds of millions of dollars to develop *physical* (rather than chemical) methods for isotope separation.

The only thing that distinguishes one isotope from another is the difference in atomic weight. This difference is all in the nucleus, for the outer electrons are similar in number (and their weight is insignificant anyhow). Some way of turning this nuclear weight difference to advantage had to be found. The first step utilized the cathode tube in which Thompson had already identified electrons. Thompson now modified the tube as shown in Figure 9; the negative electrode (the one which the electrons *leave*) now has a hole through it, and a photographic plate is mounted behind it. Thompson argued that, as the electrons moved toward the positive electrode, the atoms from which the electrons had been stripped, being now positively charged, would move toward the negative electrode. They would move fast enough to coast on through the hole in the electrode, and the photo plate would register their arrival.

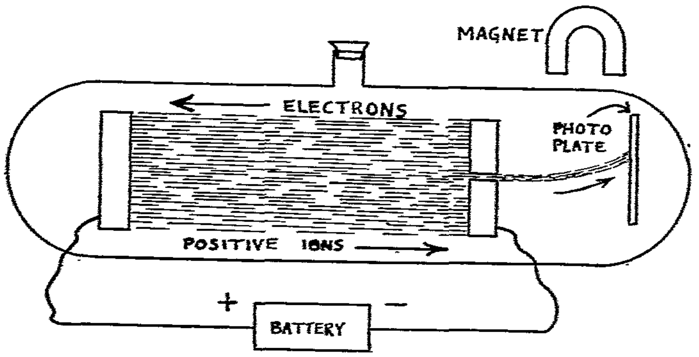


Figure 9

The stream of particles going through the hole toward the photo plate can be subjected to either a magnetic field or an electrical field, and the path of the particles thus bent. The deflection produced by a magnet will depend on the mass of each particle. Therefore, if the particles are the nuclei of an isotope mixture, the nuclei of each isotope should be bent a different amount from those of any other isotope. This theory was first verified with neon gas. When the cathode tube was filled with a very pure neon, the positive particles were deflected by a magnet in such a way as to show one dense spot corresponding to an atomic mass weight of 20, and another, much lighter, spot corresponding to a weight of 22. Natural neon, then, with a weight of 20.18 is a mixture of neon-20 and neon-22, with the former greatly predominating.

This method of investigation was quickly refined and applied to all the elements. Nearly every element was found to be a mixture of isotopes; for the first 92 elements, some 250 isotopes were found. One newly discovered isotope should be mentioned in particular, for it figures largely in our story. This is a heavy isotope of hydrogen, with an atomic weight of 2. The existence of heavy hydrogen had been theorized for a long time before it was actually produced in the laboratory. Urey finally separated hydrogen-2 from hydrogen-1 by making a gallon of liquid hydrogen, and allowing it to evaporate very slowly until only a fraction of an ounce remained. He hoped that the light isotope would evaporate more rapidly than the heavy, so that in the residue he would have a much higher concentration of hydrogen-2 than is found naturally. He was right, for when the residue was analyzed in the mass spectrometer—as the improved cathode tube method of separating isotopes is called—the particle with weight 2 appeared on the photo plate.

Since hydrogen-1 and hydrogen-2 are isotopes, they are chemically similar, and therefore both can combine equally well with oxygen to make water. The water formed from hydrogen-2 is called heavy-water; just as a matter of interest, it weighs 1/10th more than ordinary water. It has special uses in connection with release of atomic energy.

The puzzle of the proton-electron combination inside the nucleus was solved by Chadwick in 1932. He bombarded atoms with alpha particles and examined closely the particles which came out of a stricken nucleus. Some of them turned out to be very penetrating, and of neutral electric charge since they could not be deflected by an electric field. They were also found to have a mass of 1, the same as the proton. He called them neutrons. It was soon evident that the extra mass of heavy nuclei was composed of neutrons. Uranium, for example, has 92 outer electrons and therefore 92 nuclear protons; the other 146 mass units in the nucleus, contributing to the total atomic weight of 238, are neutrons.

Before we go on to split the atom and start a chain reaction, we must turn once more to the matter of atomic weights. We now know the weights of all the particles that make up even the most complex atom; let us see if the weight of the atom is not indeed the sum of the weights of its parts. The helium atom consists of 2 protons and 2 neutrons in the nucleus, and 2 electrons in the outer cloud. Considering the nucleus only,

the weight of 2 protons is 2.01516
the weight of 2 neutrons is 2.01786
total is 4.03302

But the weight of a helium nucleus (which we already know is called an alpha particle) is actually 4.00280—a difference of .03022, which is very large in view of the extreme accuracy of the measurements. Yet the helium nucleus can be broken up into its 4 constituent parts, and their weights will total 4.03302; they can then be assembled again into a helium atom (as happens in the sun) and the rebuilt atom weighs .03022 mass units less than the sum of the weights of its parts.

Einstein suggested the answer to this weight loss problem when he proposed that energy and mass are interchangeable, and that their equivalent values may be stated by the equation

$$E = m c^2$$

which may well be the most important equation of all science.

Einstein's equation means that the loss of mass, or weight, in the assembly of a helium atom is accompanied by an *emission of energy* during the assembly process, the energy release being equivalent to the weight loss according to the relation $E = m c^2$. The constant c in this equation is the velocity of light, a tremendously large figure (186,000 miles per second in English units, 30 billion centimeters per second in metric units). Therefore, the loss of .03022 mass units per atom means that each *ounce* of helium has gained over 18000 million billion ergs of energy, enough to supply the current for 200,000 light bulbs of 100 watts each for 12 days.

The loss of mass when an atom is formed from protons and neutrons is called *packing loss.* It varies for each type of atom. Obviously the packing loss of the hydrogen nucleus, which consists of only one proton, is zero—it cannot be broken down into any smaller parts. If the packing loss for all the elements is plotted against the atomic number (ranging from 1 to 96, for each of the 96 elements, this number being equal to the number of electrons in the cloud, as well as the number of protons in the nucleus), the result is the curve shown in Figure 10. The highest point on the curve is near the middle, where nickel lies; the packing loss of elements which are *either heavier or lighter* than nickel

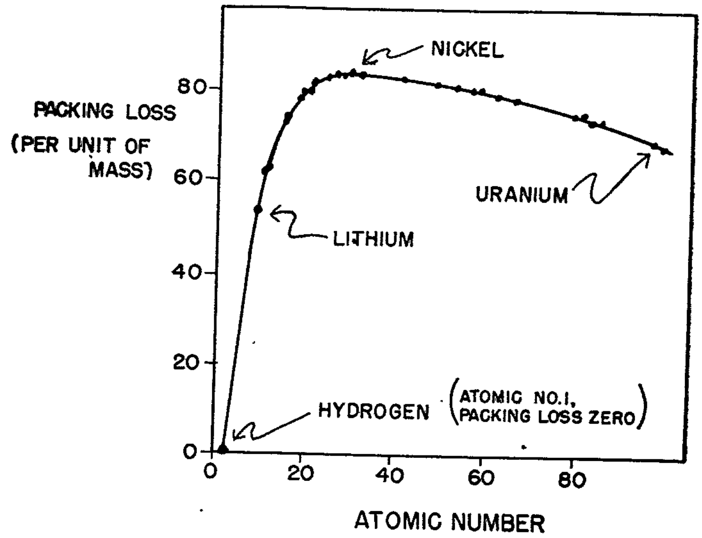


Figure 10

is less than that of nickel itself. The highest point on the curve shows that atom whose loss of weight is the *maximum* —meaning that the *maximum energy has been emitted* in the formation of the atom.

Consider any two atoms on the left half of the curve. If they are combined, or *fused,* to form a *heavier* atom like nickel, additional weight is lost and the packing loss is greater. The fusing of two light elements then results in the emission of energy. On the right half of the curve, the situation is reversed; a heavy atom which is *split up* or *fissioned* into two *lighter* atoms like nickel, loses weight in the fission, and energy is emitted. To get at the energy locked in every atom, then, we must either fuse together two light elements or break up a heavy element. In either case, we obtain a resultant atom or atoms whose weight is less than that with which we started, and whose packing loss is greater.

As we shall see, the fusing of two light elements is much more difficult than the splitting of a heavy atom, and that is why the splitting of the heaviest atom, uranium, first allowed us to release atomic energy.

But before the uranium atom was split, a large number of experiments were carried on with various atoms. The procedure was to bombard the atom nucleus with fast moving particles; these could be either protons, neutrons, or alpha particles (which are the nuclei of the helium atom, thus having a mass of 4 and a positive charge of 2). When a particle hit a nucleus, a variety of things could happen. A couple of examples will illustrate the trend. First, aluminum was bombarded with alpha particles, as shown in Figure 11. Here we have a nucleus of charge 13 and mass 27 hit by a

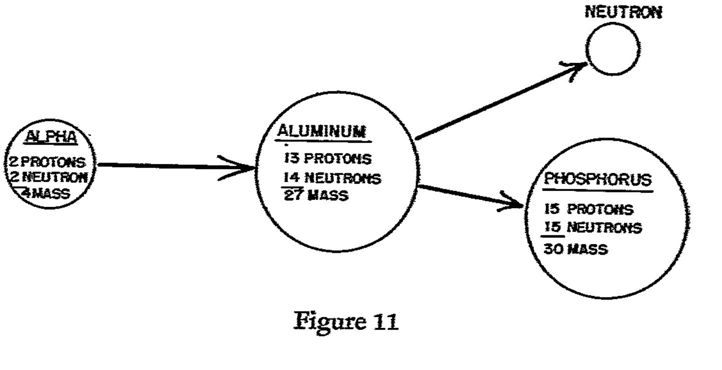


Figure 11

particle of charge 2 and mass 4; the result was that the aluminum nucleus captured the alpha particle, and then the combination emitted a single neutron (of zero charge and mass 1). The symbol combination had a new nucleus of charge 15 and mass 30; the element phosphorus has a charge of 15, and therefore any atom whose nuclear charge is 15 is an isotope of phosphorus. However, natural phosphorus has an atomic weight of 31, not 30, and no other isotope had been found in nature. Apparently the laboratory bombardment of aluminum by an alpha particle had created an entirely new isotope of phosphorus. This was exactly what had happened; and similar new artificial isotopes were soon made from other atoms.

But this new phosphorus-30 vanished a few minutes after it had been created, and still another substance remained: silicon. The reaction, shown in Figure 12, that occurred spontaneously after the phosphorus-30 had been created, was that it quickly emitted a positive electron, called positron, and became ordinary silicon.

Since the new isotope phosphorus-30 spontaneously emitted particles and rays from its nucleus, its was *radioactive;* it was an artificially produced radioactive substance which had never been found in nature.

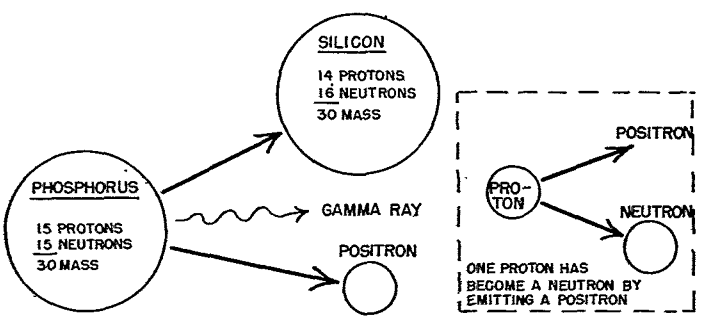


Figure 12

A great number of other artificial radioactive isotopes have now been produced. Almost every element has been found to have at least one radioactive isotope. The use of these isotopes in research, medicine, and elsewhere, is a very important part—probably the most important part—of the story of atomic energy, but in this article we must confine ourselves to the development of the atomic bomb and atomic power. One scientist has said that "the development of artificial radio-isotopes, such as carbon-14, at low cost, is more significant to mankind than the discovery of nuclear fission itself."

The experiment just described was performed with alpha particles as the bombardment missiles. The positive charge on the alpha particle tended to repel it from the positive charge of the atom nucleus against which it was directed, so the particle had to be sent at high speed to overcome the force of repulsion and hit the nucleus sharply. Proton bullets acted similarly. Electrons were not so effective, since their mass is only 1/1840th that of a single proton or neutron. But the neutron, having no charge, was not repelled by the atomic nuclei; so it made an ideal missile for atom bombardment. The neutron did not have to be sent so fast, either; in fact, better results were obtained in many instances by slowing down the neutron before it was allowed to hit the nucleus.

The drama of the atom bomb really begins with the splitting of uranium by neutrons. The excitement came with the first discovery that a uranium atom, hit by a slow neutron, broke into several fragments of which one was barium. Uranium has 92 protons in the nucleus; barium has but 56, leaving 36, which number corresponds to krypton. Referring back to the packing loss curve of Figure 10, we see that the packing loss of both barium and krypton is *greater* than that of uranium; in other words, weight had been lost in the split, and a corresponding amount of energy had been released.

Now, such a result had been achieved before, but it had not been important because more energy had to be added to the bombardment particle than was obtained in the split, so the *net* energy release was less than zero. We had to keep up the supply of missiles or the energy release stopped; we were constantly adding more energy than we got back in the splitting.

But uranium offered an exciting new possibility. To see why, let us first try to account for all the neutrons in the uranium splitting process. The original uranium nucleus has 146 neutrons, to which we have added 1 (the bombardment missile). The neutrons in the barium and krypton products total only 129, so there are 18 left over. It seemed entirely possible that at least some of these neutrons would be scattered separately, and therefore would be available to split any adjacent uranium atoms. If so, then a number of atoms could be split by starting with a single neutron; and energy would be released each time, soon totaling much more than the energy supplied in the original neutron splitting-missile.

In pursuing this idea, physicists soon found that uranium occurs naturally in three isotopes, the atomic weight of the natural mixture being 238.07. The proportions, which never vary in nature, are:

U-234......	0.006%	(uranium with mass 234)
U-235......	0.7 %	(uranium with mass 235)
U-238......	99.294%	(uranium with mass 238)
	100.000%	(average mass of 238.07)

U-235 was the isotope that split, or fissioned. U-238 merely captured a neutron, and later changed into another element. but did not fission. U-234 appears in such small quantity that its action is unimportant. To obtain a chain reaction of splitting atoms, therefore, it was necessary to depend on U-235 only. The U-235 atom splits best when hit by a slow neutron; the U-238 captured only fast neutrons.

This state of affairs made the chain reaction very difficult to achieve. If a slow neutron split a U-235 atom, the extra neutrons produced, which were needed to split other atoms and keep up the reaction, were fast neutrons, and therefore much more easily captured by the U-238 atoms than by the U-235. Since natural uranium has 140 times as much U-238 as U-235, it looked like the former would absorb all extra neutrons and stop the reaction immediately. The obvious solution was to separate the two uranium isotopes. and work with pure U-235. But we have already pointed out how difficult it is to separate isotopes, which are identical chemically. They can be separated in the mass spectrometer, but not in large quantities.

But if isotope separation was so difficult, another solution

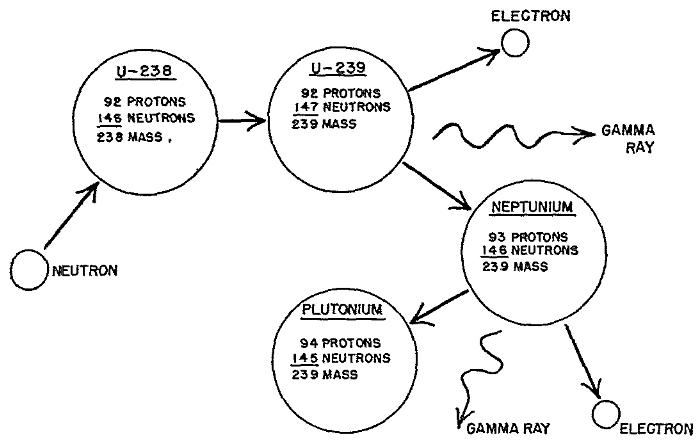


Figure 13

presented itself. Look at Figure 13. The U-238, it developed, after capturing a fast neutron turns into U-239, which is radioactive. The U-239 emits an electron and becomes a new substance called neptunium; neptunium is also radioactive, and by spontaneous emission of an electron and some gamma rays quickly turns itself into plutonium, with charge 94 and mass 239. Plutonium has the same fissionable qualities as U-235, and therefore can be used itself for a chain reaction. Also, being chemically different from uranium, it can be separated easily after it has been formed among the uranium atoms. U-238 being so much more abundant than U-235, it appeared that a fairly large amount of plutonium could be produced from natural uranium as long as the reaction could be kept going. The problem was to keep it going.

If some of the fast neutrons resulting from the fission of the first U-235 atom could be slowed down, they would be able to split additional U-235 atoms. Fast neutrons can be slowed down by spreading through the uranium a light element like hydrogen or carbon; the neutrons bounce against these light atoms and thus lose their momentum.

But the neutrons coming from the first fission, even if slowed down by a moderator, can be lost in two other ways. If there are impurities in either the uranium or the moderator, they can be captured and thus prevented from continuing their useful role. Or, they can escape from the whole reaction by flying out of the uranium pile in which the reaction is to take place.

This last possibility leads to what is known as the "critical size" of a uranium reactor. The neutrons which escape do so through the surface of the uranium pile, and therefore the proportion which escapes depends on the surface area. The proportion of neutrons which strike other atoms inside the pile depends on the mass, or *volume*, of the pile. Now,

surface area is proportional to r^2, where r is the radius of a spherical pile

volume is proportional to r^3, in the same pile.

Therefore, the ratio of those which escape to those which remain to be useful is r^2 divided by r^3 which then equals $\frac{1}{r}$. Obviously, by increasing r, the proportion of neutrons which escape becomes smaller. In other words, the bigger the pile, the smaller the proportion of neutrons which escape. By making the pile large enough, and by using a proper moderator and keeping out impurities, we should be able to get a uranium pile which will maintain a continuous chain reaction.

The first successful chain reaction was achieved in a large pile of uranium on December 2, 1942—a very important date. A diagram of the first pile is shown in Figure 14.

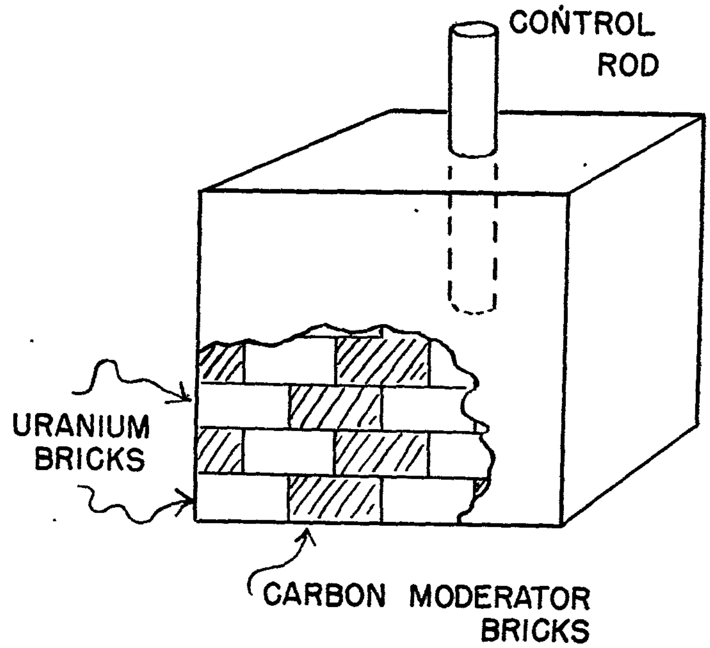


Figure 14

The control rod shown in the diagram is necessary to keep the reaction from running away with itself. All the reactions we have been discussing take place very rapidly; even a slow neutron moves many miles per second. If the pile is well over critical size, a large number of U-235 atoms will be split in the first fraction of a second; each split releases energy in the form of heat whose expansion could soon blow the pile apart. The control rod absorbs neutrons, blocking them from hitting new U-235 atoms; it is in effect an *artificial impurity* in the pile. When it is thrust clear into the pile, it absorbs so many neutrons that the reaction stops. As it is withdrawn, the number of useful neutrons increases, and it can be adjusted so that the number of atoms split per second is any desired quantity.

The approximate critical size of a pile of pure natural uranium (containing all three isotopes in the proportions already stated) was calculated fairly easily before the uranium bricks were assembled, along with the chunks of carbon moderator. Actually, the pile began to work before the expected size was reached, so the control rod proved to be a very necessary safety device.

The success of the first pile chain reaction proved two things. First, U-235 could sustain a chain reaction; and, second, in such a pile, plutonium is formed from the U-238. But what was wanted was a bomb—a lump or pile of fissionable material in which the chain reaction would proceed through all the atoms of the pile in the shortest possible time. It was obvious that such a "fast reactor" could be made of either pure U-235 or pure plutonium. Which was best? Which could be produced in the largest quantity? These questions being unanswered in 1942, it was decided to manufacture both U-235 and plutonium.

Plutonium could be made only in a chain-reacting pile, as we have already noted; it does not occur in nature. Accordingly, plans were made for the construction of huge atomic piles at Hanford, Washington. The terrible need for speed during the war required that the design of these massive installations be made on the laboratory evidence from less than a millionth of a pound of plutonium, produced in small experimental piles and in cyclotrons. That the Hanford plants worked at all is proof of the miraculous skill and energy of the engineers and scientists who, under the direction of General Groves, completed them in time to make plutonium for the bombs dropped on Japan.

The U-235 had to be made in a different way. Several ways of digging this isotope out of natural uranium were proposed; the two most important methods are illustrated in Figures 15 and 16. The first, electromagnetic, method is simply a refinement for large-scale production of the cathode tube principle we have already described. Streams of uranium atoms were shot through a powerful magnetic field; the lighter U-235 atoms were more easily deflected by the magnet than the heavy U-238, and they could be caught in a separate receptacle. Actually, complete separation is very difficult to achieve, and the first stage of the process produces a uranium mixture only slightly enriched in U-235. Successive runs through the magnetic field built up a mixture whose proportion of U-235 was greater and greater, until a mixture was finally obtained that was almost entirely U-235.

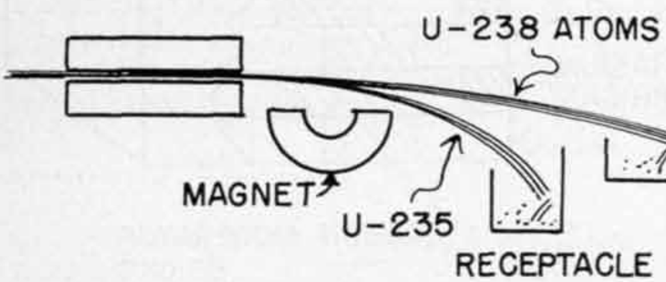


Figure 15

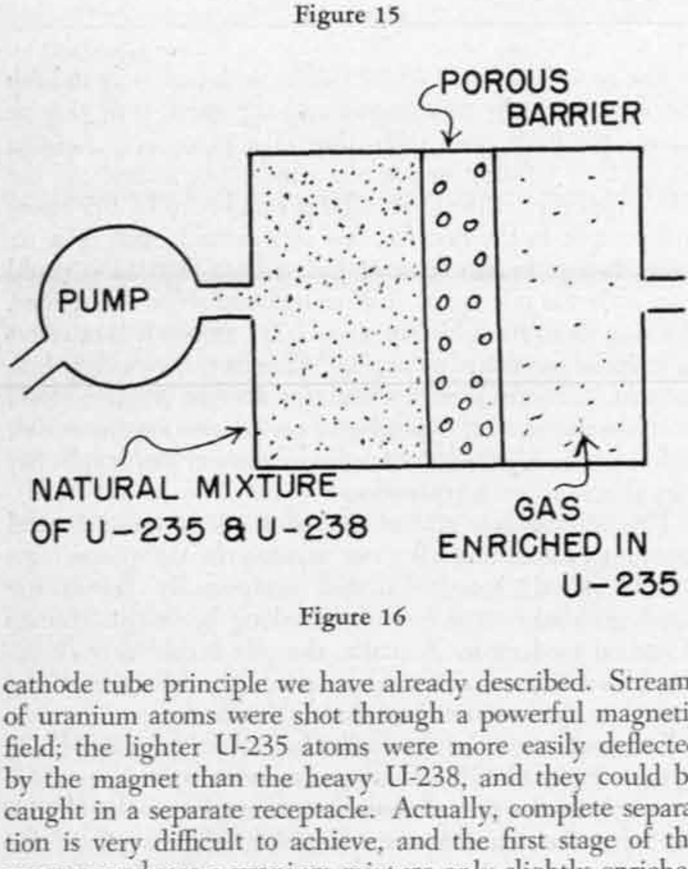


Figure 16

In the gaseous diffusion process, the uranium was converted to a gas, and then forced through a porous barrier wall. The lighter atoms went through the barrier more easily than the heavier, so on the right-hand side of the barrier the gas was slightly enriched in U-235. This process, too, had to pass through many stages, with a gradual enrichment of U-235 at each stage, before a sufficiently pure U-235 product was obtained.

The production of "fissionable material" by each of these processes was a complicated, expensive job. All the large plants had to be built before their complexities were fully understood. In some instances, hundreds of millions of dollars were expended in a gamble that the plants would work when completed. Every one of them worked, however, and in 1945 we had both U-235 and plutonium available for bombs.

The bomb itself is simply a chain-reacting pile in which the reaction is allowed to proceed very rapidly through as many atoms of the pile as possible before it blows itself apart. The reader may find one puzzle here: we stated that in the first experimental pile, the fast neutrons were captured by U-238, and that they had to be slowed down before they were useful in splitting more U-235 atoms. Does this mean that a fast neutron cannot split a U-235 atom? Obviously, in a bomb made of pure U-235 with no moderator, only fast neutrons are available for splitting. No, fast neutrons *do* split U-235 atoms—but when U-238 is present, they are *more easily* captured by the U-238, especially when this heavier isotope outnumbers the U-235 by 140 to 1. When the competition for fast neutrons is removed in a pure U-235 pile, the fast neutrons go to work on the U-235 atoms.

The "critical mass" principle applies to the bomb just as it does to a controlled pile, except that with the competition from U-238 removed, the critical mass is much smaller. The pile that first worked in 1942 was room size; but the bomb, as everyone knows, can be carried in an airplane even when attached to the mechanism that sets it off. To make a bomb, then, one must have enough fissionable material to form a critical mass and also a means of assembling it into the critical mass when the explosion is desired. Obviously the fissionable material must not be assembled before the bomb is dropped from the plane. Obviously also it must be assembled very rapidly, for a slow assembly would permit a slower chain reaction to start which would blow the material apart before more than a fizzle explosion was produced.

One method of assembly that immediately suggests itself is shown in Figure 17. Half the fissionable material is placed at the end of a gun barrel; the other half in the gun breech is then fired against the former. The speed of the bullet should be fast enough to achieve an assembly considerably overcritical in the shortest possible time; such fast assembly should start a very sudden and fast chain reaction.

As each atom in the critical mass splits, there is a loss in total weight of the atom's parts. Each such loss corresponds to an emission of energy, in the form of gamma rays, speeding particles of all sorts, and heat and light. We measure the power of such a sudden energy release by saying that an atom bomb has a blast equivalent of 20,000 tons of TNT; the blast equivalent refers only to the heat expansion, creating a pressure or shock wave, and does not account for the energy released in the form of gamma rays, neutrons, and electrons.

The bomb is 100 per cent efficient when every atom of the fissionable material is split. Of course, the heat expan-

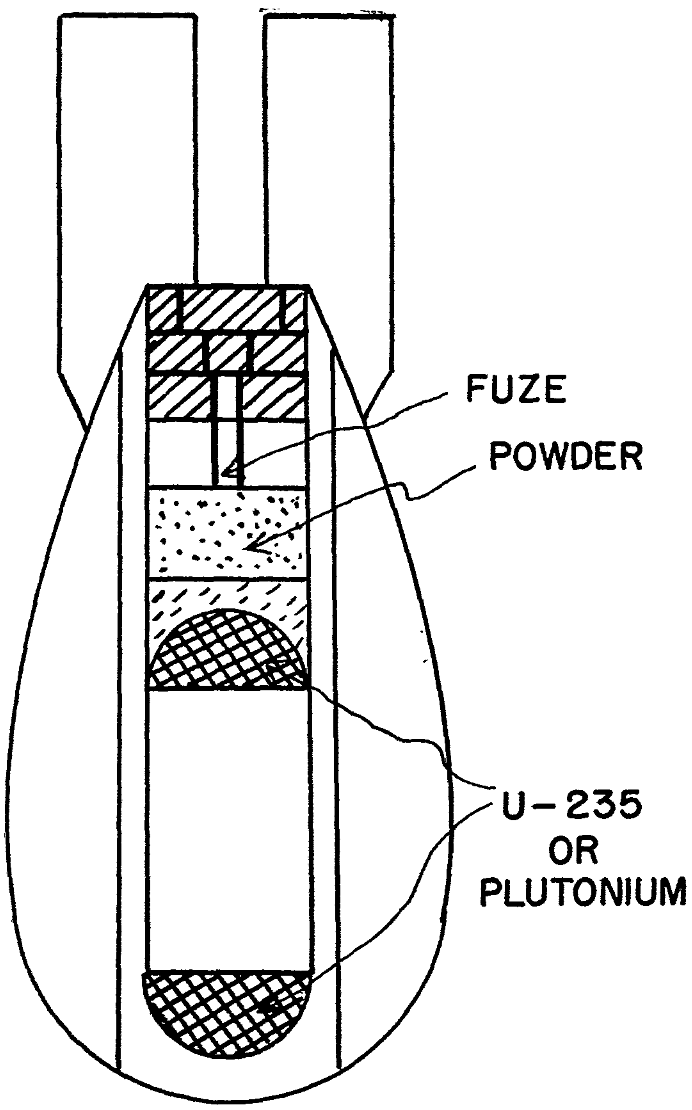


Figure 17

sion from the splitting of the first few atoms begins to blow the critical mass apart, so that the whole reaction stops before more than a comparatively small fraction of all the atoms have been split. Improvements in the uranium and plutonium bombs are of course aimed at holding it together longer, so a greater fraction of atoms is split.

The packing loss curve we studied in Figure 10 shows that a similar energy release might be achieved by fusing light elements together instead of breaking up a heavy element. In fact, the packing loss for light elements is so much smaller than that for uranium, that a light element bomb theoretically would have much greater power. Naturally, this fact has been considered by our atomic energy experts, but all reports on such work are top secret.

We have now traced the development of the first atom bombs. Such bombs are undoubtedly the most important military factor today; but there are some by-products of their development which may be even more significant. Nuclear energy is being studied for use in power (which is simply a way of using the *heat* energy from a chain-reacting pile to drive a turbine or piston), in medicine, chemistry, biology, and hundreds of other fields. We may look to marvelous achievements in a few decades, even though our daily life has not yet been revolutionized by the work of the Manhattan Project.

This article has covered all the technical part of the story which the average citizen needs to know; from here, thoughtful persons should now proceed through a study of the effects of atomic bombs when delivered to a target to consideration of the great political and military consequences of atomic weapons. Until international control becomes a reality, atomic weapons will continue to be manufactured in increasing quantities; therefore each of us, after becoming thoroughly acquainted with the characteristics of such weapons, must evolve his own opinions on what their possible nature may portend.

It is the people that make the Army and its Department. The success of both can be largely measured by the intelligence and spirit and general effectiveness of their personnel. The backbone of our Department is the soldiers and civilian employees who man the weapons and the supply lines, and who in headquarters and in offices turn the needed wheels of a great organizational machine.—Secretary of the Army Kenneth C. Royall.

THE HOOK REPORT

Secretary of Defense Forrestal and the members of the Advisory Commission on Service Pay met the press on December 23, 1948, to answer questions on the "Hook Report." Charles R. Hook, Chairman of the Commission, who is chief executive of the Armco Steel Company of Middletown, Ohio; Keith S. McHugh, who is Vice-President of the American Telephone and Telegraph Company; and Lawrence Whiting, who is President of Whiting and Company and of the American Furniture Mart Building Company, were present along with the Secretary of Defense. The Reverend John J. Cavanaugh, who is President of Notre Dame University, was absent from the conference.

Mr. Forrestal stated at the beginning of the conference that the Commission's recommendations made up one of the most comprehensive and the most painstaking reports that we have had in the Military Establishment. He stated further that the Secretaries of the Army, Navy and the Air Force are in general agreement with the broad major provisions of the report.

In giving the background of the report, Mr. Hook explained that two of the most important factors indicating the necessity for the study were: (1) No over-all study and change had been made in service pay in some 40 years, and (2) The loss of competent personnel to private business because of inadequate service pay.

He said, "The number and caliber of men who have left the services in the past year, and the continuing number of such separations, indicate the possibility that the services are not in a position to compete on an equal basis with industry and the professions because of a disparity in the income offered. . . . The services require, just as any successful business enterprise does, men of real ability."

The study, he continued, has taken months of most careful investigation, and cooperation on the part of the Chief Executives of our major industrial institutions, to gather this information.

Mr. Hook stated, "We believe conscientiously that we have recommended a program that is sound and in the interest of the services and the taxpayer."

The following questions and answers are printed verbatim because they are considered to be of special interest to servicemen:

MR. WHITING: The whole pay scale was based on the fact that we were asked to consider basic pay for men engaging in the military career on exactly the same basis as you would consider it if you were in civil life.

If two brothers start out together, Dallas, Georgia, Iowa, wherever they may happen to come from, and one went into civil life in a bank or railroad or insurance company or packing house or any other industrial company, and the other went into the military services, it was our chore, we understood it, to try and find a pay system, a basic pay system and allowances, which would give the man in civil life and the man in military life exactly the same opportunities and pay for the work which he had accomplished, or was capable of accomplishing.

Now to do that we took not only all of the pay systems in the Government, but we went out into civil life and for the first time, as the Chairman spoke to you about a few minutes ago, we actually went to these hundreds of corporations and said to them: "Will you let us have your actual pay schedules? What do you pay a secretary starting? What do you pay a telephone operator starting? What do you pay a young engineer just out of college? What do you pay this man and that man and that man?" From great packing houses, railroad companies, shipping companies, radio companies, and all of these corporations in the United States we got their pay schedules—General Electric, General Motors, all of these companies—and we have them in the files of the Commission. Then we went to management and we said: "Now for the first time, because of the S.E.C. requirements, you can expose the salaries of your highest priced men." You can find this in books, as you know, or in the S.E.C. rulings. And we took those, what management got in civil life. Then we took all of them and folded them into one great mathematical computation and took the mean average of what men drew in civil life and what they got in pay in the Army, Navy, Marine Corps and other services. Then we tried to match those up; and between the grade of lieutenant and lieutenant colonel, we have matched them up so the man in civil life and the man in military service get approximately the same treatment. Above that, from the grade of lieutenant colonel on—just below the grade of colonel and from then on—the man in civil life goes away from the military man.

THE PRESS: And why?

MR. WHITING: Because the retirement system of the Army, Navy, Marines and other military services is so much better than any retirement system in civil life, that from then on he has an interest which is in his advantage and favor. If a man stays until he is a lieutenant colonel in the service, he can hardly afford to leave the service. He must leave it sometime by the time he is 45, 46 years old or he will be much better off in the service.

If you started in the newspaper world and your brother started in the Army, both of you become very successful, the man in the Army would have just as much opportunity as you have in the newspaper world, because after he got to the grade of lieutenant colonel or colonel he had the retirement system available to him, which made it a very attractive thing. Nothing in civil life can compare with the Army's retirement—Army, Navy, Marine Corps.

THE PRESS: At the same time, Mr. Whiting, doesn't that run contrary to your emphasis throughout this thing that pay should be commensurate with responsibility?

MR. WHITING: No, it does not. It does not do that at all. It makes the service more attractive for the skilled man that you get who, by the time he is 42, 43, 45, 48 years old, can go into civil life, at the grade of lieutenant colonel and colonel, and get $40,000 and $50,000 a year, because —look at this—if a man becomes a major general under our pay scale and gets to $12,000 base pay and then is retired at 75 per cent, he gets $9,000 a year. Now capitalizing that at 3 per cent, that means a man in civil life will have had to have produced, saved and invested $300,000 to get the same income, and very few men in civil life can save $300,000 during their lifetime.

THE PRESS: Was there an effort made—this has been coordinated, I see, with some people—was there an effort made to coordinate your pay scales for top level military people with this pay commission that Mr. Hoover has had working? They came out this morning, I notice now, with some rather low level Government civilian employees who will be drawing more money than the Chief of Staff of the Army. Now from the degree of responsibility, there is certainly no comparison, and yet the pay of the civilian employee of the Federal is far more than the Chief of Staff of the Army, or any of the services, will ever draw, even with the increases.

SECRETARY FORRESTAL: There are no retirement features with those jobs.

MR. WHITING: No retirement features with those jobs.

SECRETARY FORRESTAL: How well I know (laughter).

MR. WHITING: As the Secretary said, in reply to your question, I can tell you that not only did we consider all these studies made by the other Commission, but they asked us to make some of the studies for them.

We have the most comprehensive pay study ever made in the United States, or anywhere in the world. We have had approximately 100 men, some of the best actuaries, the best statisticians, the best pay and wage men in the country, plus the reports of all the seven services, plus men who are skilled in this work.

If I might be allowed to say just one kindly thing here, Mr. McHugh's company employs 664,000 people. They have the finest studies on pay that they could have.

A COMMON CAUSE*

In conclusion I should like to reemphasize two thoughts implicit in this report. The first is that this Nation has endeavored constantly to maintain peace. The United States came out of the war with the atomic bomb, the most deadly and devastating weapon that man ever devised. As proof of our good faith and peaceful intentions, we have offered voluntarily to deny ourselves the use of this lethal instrument. We have proposed that it be placed under international control and have offered to surrender our proprietary rights, including the right of visitation and inspection of atomic energy plants, to an international commission. This proposal, still pending before the United Nations, has been continuously blocked by the exercise of the veto power in that organization.

Our ownership of the atomic bomb undoubtedly engendered to a wide extent the mistaken sense of security and complacency which pervaded the public mind immediately after the war and which was in some measure responsible for demobilization. The atomic bomb does not give us automatic immunity from attack, as some people would like to believe, nor does its mere possession guarantee victory if war should come. With or without the atomic bomb, there can be no absolute security for the United States or for any other nation in the world until all nations agree to the regulation of armed forces and the substitution therefor of peaceful methods in the settlement of international disputes.

The second thought I should like to reemphasize is that true unification of the armed might of the United States cannot spring from legislation alone. The spark generated by the Unification Act must be fanned into flame by the thoughts and actions of generals and admirals, ensigns and lieutenants, soldiers, sailors, and airmen, and civilians. We must all learn that we are working together for a common cause—the security of our country—and that the good of all transcends that of the few.

*From the introduction to the First Report of the Secretary of Defense.

PREVAILING WINDS IN AIR ATTACK AND DEFENSE

By Major William L. Molo, USAF-Res

In an article entitled "An Antiaircraft Defense of Washington," in the July-August 1948 issue of the JOURNAL, Col. Earl W. Thomson wrote: "The effect of prevailing winds should be considered in planning an (air) attack, or in planning the defense against an attack."

To illustrate the effect of wind on air attack and air defense, Colonel Thomson analyzed the effectiveness of an assumed air defense of Washington during an enemy attack on the Pentagon, made from 20,000 feet at an air speed of 250 m.p.h. A target-centered flak-position computer with a gun circle of 10,400 yards at 20,000 feet was used to analyze the defenses under two conditions: (1) with no wind, and (2) with a wind of 50 m.p.h. from 150°.*

The relative effectiveness under no-wind conditions along each of 12 courses was computed as follows:

Course	*Effectiveness of Defense*	*Course*	*Effectiveness of Defense*
180	1264	0	1842
210	1419	30	1847
240	1800	60	1806
270	1858	90	1842
300	1946	120	2184
330	1744	150	1936

It should be noted that course 180° is in from the north. The best approach from the standpoint of attack would be from due north on course 180° and the worse possible approach wold be from the northwest on course 120°. This course would give at least 75 per cent greater casualties.

The relative effectiveness with a wind of 50 m.p.h. from 150° at 20,000 feet was computed as follows:

Course	*Effectiveness of Defense*	*Course*	*Effectiveness of Defense*
180	1517	0	1603
210	1603	30	1718
240	1836	60	1842
270	1728	90	2081
300	1693	120	2621
330	1453	150	2420

The best course is now with the wind, from the southeast, that is, course 330°. The worst entrance, with a 20 per cent increase in effectiveness of the guns, still remains in the northwest on course 120°.

These examples show the important effect which the winds aloft have on air attack and air defense. In the first case, assuming no-wind (*i.e.*, calm) conditions, the best approach for attack would be from the north. In the second case, assuming a given wind of 50 m.p.h. from 150°, with the same defense network, the best approach was clearly with the wind.

Granting the importance of the wind on attack and defense, the next question is, how significant is the prevailing wind in long-range defense plans? Colonel Thomson states that the significance of the prevailing wind in long-range planning has been disputed in the belief that upper wind directions are actually not persistent. It is our purpose to show that, along the east coast of the United States, the prevailing wind directions in certain areas are quite persistent in the upper levels in which air operations are conducted during certain times of the year and that, therefore, the direction of prevailing wind is of special importance in planning defense against high-level air attacks. Because of the complexities of the wind regime, however, a defense network taking into account the upper winds will necessarily be a flexible one.

THE GENERAL WIND PATTERN

The wind pattern at upper levels is, in general, much simpler than the pattern at the surface. Surface winds are directly exposed to the influence of the ground surface over which they move, and to the complex effects of adjacent bodies of land and water. For instance, a valley may channel a stream of air in a direction quite different from what it would be in an airflow free from the disturbing effects of topography, or the proximity of a lake or ocean may result in a sea-breeze—land-breeze circulation with different directions from that of the free airflow. These influences of the ground surface become more and more modified with elevation above the surface. Freedom from these surface distortions of the airflow is partly responsible for the simpler pattern of winds aloft. Actually, the entire circulation pattern often changes with altitude; thus, winds aloft are frequently quite different from surface wind, not only with respect to wind speed, but with respect to direction as well.

Between sea level and 10,000 feet, the complex surface wind pattern gives way to the simpler pattern of still higher levels between 10,000 and 30,000 feet. At a height of 10,000 feet above sea level there is a widespread zone of prevailing westerlies (*i.e.*, winds from westerly directions) in the Northern Hemisphere, the southern limit or boundary of which is usually between 20° N. and 30° N. This boundary is farthest south in the winter; and equatorward to the south of this boundary prevailing easterlies are the rule. The greatest persistence of westerly winds occurs in the zone of about 30° N. to 60° N.

This zone of prevailing westerlies covers most of the so-called temperate-climate latitudes and the most heavily

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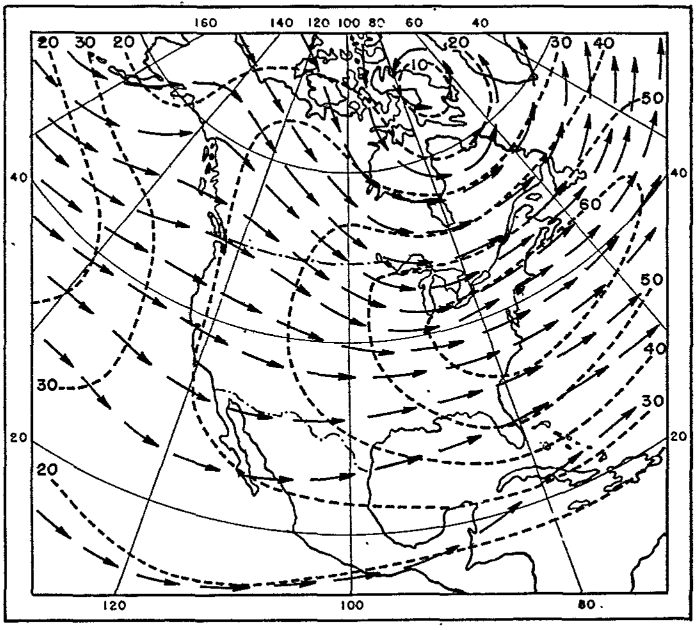
*Winds are described by the direction from which they are blowing, while courses of attack are described by the direction toward which they proceed; thus, course 330° proceeds in the same direction as a wind of 150°.

populated areas of the earth, and consequently embraces the most important military targets. South of 20° N. (and farther north in the summer) these prevailing westerlies give way to prevailing easterlies at the same level. These upper-level easterlies are characteristic of the circulation over tropical areas of the earth's surface.

With respect to elevations above 10,000 feet, the prevailing winds in the zone of westerlies generally increase in strength and persistence within the ordinary air operating levels and at the same time spread northward and southward. As a result, the tropical easterlies at 10,000 feet frequently give way to westerly winds, or at least weaken in persistency, at some level between 10,000 and 20,000 feet. There is a tendency for the easterlies to extend to greater heights equatorward.

Although the foregoing discussion is oversimplified, it will, at least, serve to show that while the upper-air wind pattern generally simplifies with altitude, it does not simplify uniformly over the earth's surface nor is the wind pattern the same from season to season: the persistence and strength of the westerlies in the zone of prevailing westerlies will change with latitude and season, and the depth of prevailing easterlies in the zone of prevailing easterlies will likewise change both with latitude and season.



LEGEND

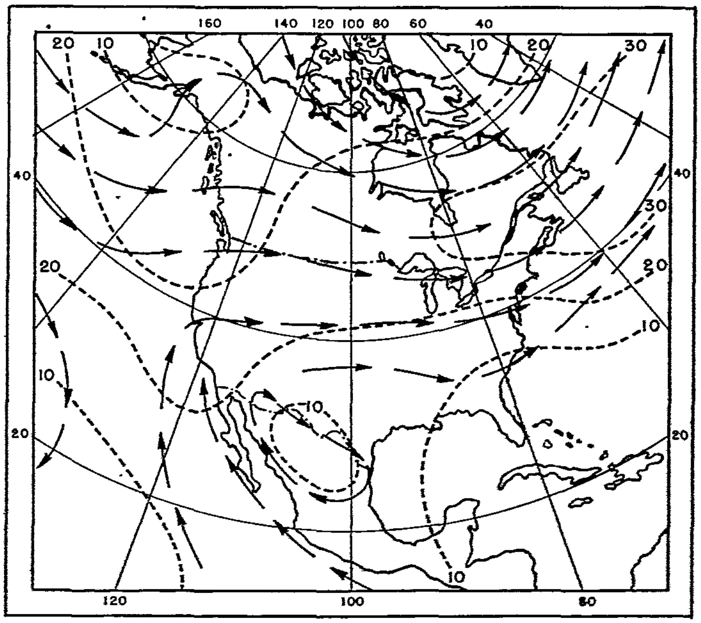
------------ Isograms of Wind Speed (mph)

——→ ——→ ——→ Stream-Lines

Figure 1—Resultant winds in January, 20,000 feet.

Resultant Winds

In order to get a bird's-eye view of the circulation of the upper air, it is, for practical purposes, frequently necessary to resort to resultant winds. The resultant wind at any one point is the sum of all wind velocities over a given period of time. The term "velocity" here includes both wind speed and direction; for example, the sum of an east wind at 10 m.p.h. and a west wind at 10 m.p.h. is zero. If winds over a period of a month were to be observed only from these two directions, but the west winds occurred somewhat more frequently than east winds, then the net, or resultant, wind would be from the west and of small magnitude. In the levels in which air operations are usually conducted, that is, up to 30,000 feet, many other wind directions than those from due west and due east are usually observed; but the resultant wind takes all of these into account, and thus gives a true picture of the net airflow. Usually the direction of the resultant wind corresponds fairly closely with the prevailing wind direction, but since the prevailing wind direction is obtained from actual wind observations and the resultant wind may be obtained through indirect methods, there is sometimes a discrepancy between the two. One reason for this is that actual observations for many years have been based on pilot balloon observations which could not be made in bad weather, or which would be cut off by clouds. The resultant wind direction, however, may be obtained by indirect methods which take into account conditions on poor-weather days as well. Hence, any discrepancy between the two may often be resolved in favor of the resultant wind direction as being the more representative.



LEGEND

------------ Isograms of Wind Speed (mph)

——→ ——→ ——→ Stream-Lines

Figure 2—Resultant winds in July, 20,000 feet.

Figures 1 and 2 show the resultant winds in the form of stream lines over the North American Continent at 20,000 feet in January and July, respectively. It will be observed that in midwinter the westerlies are strongest along the east coast of the United States. In summer, the resultant winds are still westerly along the east coast, but they are much weaker than in winter, and the center of strongest winds moves northward over the mouth of the St. Lawrence River.

Upper Winds at Selected East Coast Stations

As an illustration of the change in the wind pattern with altitude, latitude, and season along the eastern coast of the United States, wind roses are given for Boston, Washington, Charleston, and Miami, at levels of 3,300, 10,000, and 20,000 feet above sea level, for the winter and summer seasons. A *wind rose* is a diagram showing the frequency with which principal wind directions occur at or over a given station. Lines emanating from a central circle have lengths proportional to the mean percentage frequency of occurrences of the winds that they represent.

At Boston (Figure 3) wind roses for the winter at 3,300 feet show that winds may occur from any direction at this low level, but are predominantly from the west-northwest and northwest. At 10,000 feet, most of the winds are from westerly directions, especially from west-southwest through northwest. There are no winds reported from most easterly directions, except infrequently from the north-northeast. At 20,000 feet, no winds are reported from the east, and west-

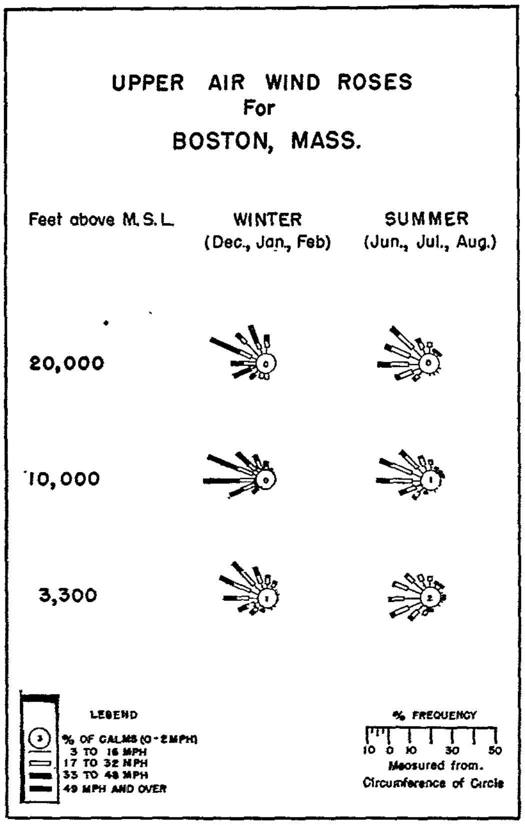


Figure 3.

northwest and northwest winds are predominant. In summer, the pattern is much the same, except that high wind speeds occur less frequently than in winter, and there are some winds reported from easterly directions even at high levels.

At Washington (Figure 4) wind roses for the winter at 3,300 feet show that winds may occur from any direction at this low level, but are predominantly from the west-northwest and northwest. At 10,000 feet, most of the winds are from westerly directions, especially from due west. In January, for example, 33 per cent of the winds reported at 10,000 feet are from due west, and 25 per cent from west-northwest. At 20,000 feet, practically all the winds are from directions between west-southwest and northwest. In summer, the westerlies also increase in persistence and strength with height, but are neither as persistent nor as strong as in winter.

At Charleston (Figure 5) wind roses for the winter at 3,300 feet show that winds may occur from any direction at this level, although winds with a westerly component are more frequent than those with easterly components. At

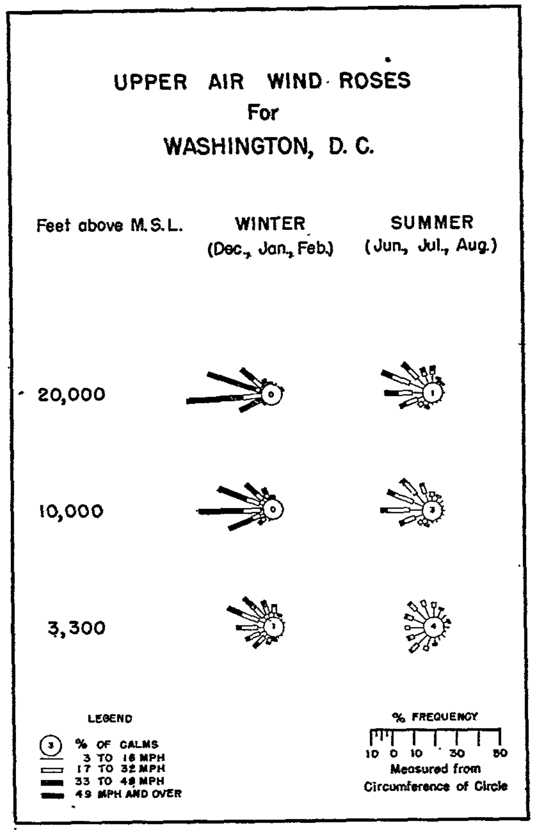


Figure 4.

10,000 feet, most of the winds occur from between west-southwest and northwest, by way of west. At 20,000 feet, west and west-northwest winds are markedly predominant. In summer, winds have been reported from all directions at all three levels. During the summer, Charleston is in a

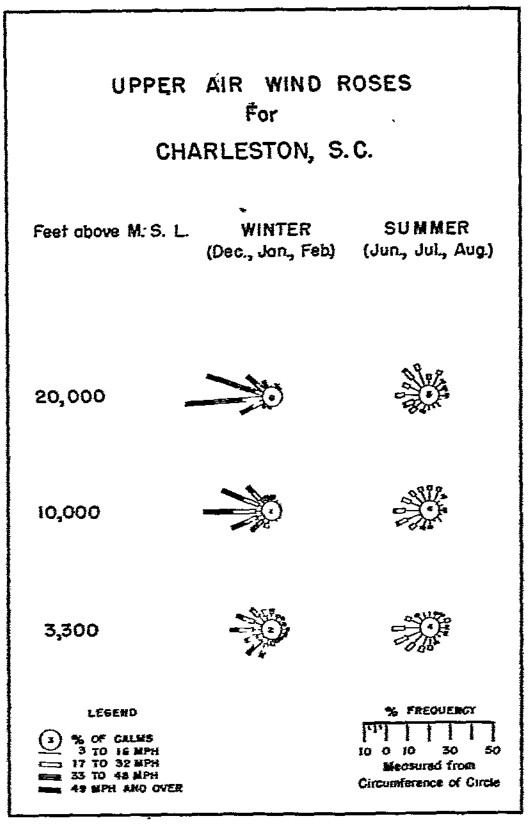


Figure 5.

transitional zone between westerlies to the north and easterlies to the south. It will be remembered from the foregoing discussion that upper-level easterly winds, characteristic of tropical air circulation, spread northward in the summer; the weakening of the predominance of westerly winds over Charleston in the summer, and the corresponding increase in easterly winds, are a reflection of the northward spreading influence of easterly winds at this time of year.

At Miami (Figure 6) wind roses for the winter at 3,300 feet show that winds may occur from any direction at this low level, but are predominantly from easterly directions. Thus, in winter there is a transition from prevailing westerlies at Charleston to prevailing easterlies at Miami at this level. At higher levels, the prevailing easterlies over Miami are replaced by westerlies. Thus at 10,000 feet, west and west-northwest winds are predominant, though other directions may occur. At 20,000 feet, the predominance of the west wind is very pronounced. Summer, however, shows a different picture. Easterlies prevail at all levels in the first 20,000 feet although they are less predominant at 20,000 feet than at the two lower levels. The prevalence of these easterlies is not as pronounced as that of the westerlies at the stations we have examined to the north.

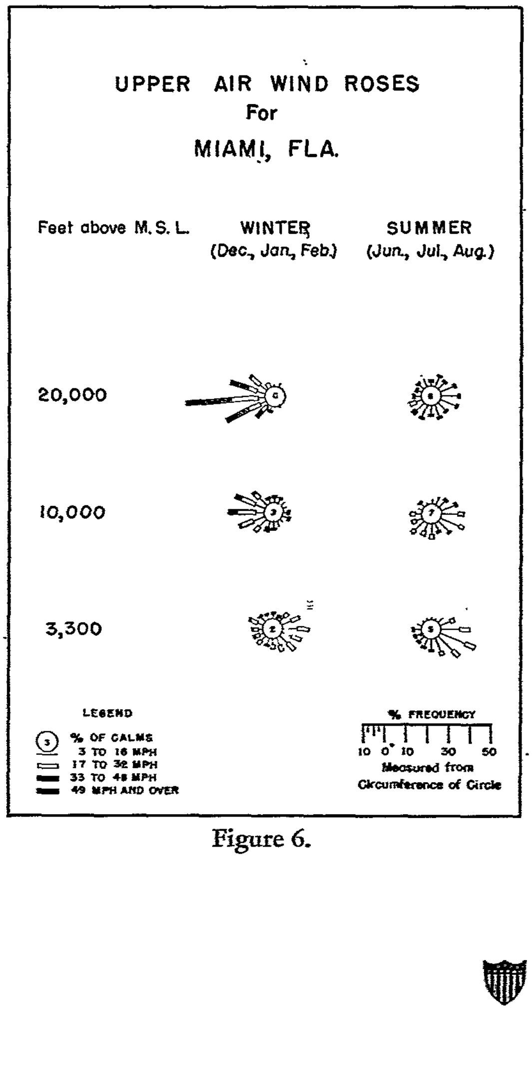


Figure 6.

From Figures 3-6, it can be seen that the most persistent prevailing winds are those from due west at 20,000 feet in the winter at Washington, Charleston, and Miami. However, it is significant that the prevailing winds in summer do not occur as frequently as those in winter.

Conclusion

If, as Colonel Thomson suggests, the effect of prevailing winds is to be considered in planning defenses against an air attack, it is obvious that such a consideration will require a knowledge and understanding of the wind regimes at various altitudes and at different seasons of the year. The prevailing wind direction at one season of the year is not necessarily the same as in another season, or, if it is, the frequency with which it occurs varies seasonally; accordingly, its importance in the defense pattern varies. Further, the prevailing wind is usually not the same at all air operating levels. The meteorologist and antiaircraft planner must work in close cooperation in effecting a well-rounded and *flexible* defense which can take into account the wind pattern at different seasons of the year.

The knowledge of the wind regime is chiefly of importance in long-range antiaircraft planning. In short-range planning, it is chiefly a question of what the wind direction will be on a given day. Thus, even with a knowledge of the prevailing wind, one cannot forestall the possibility of an attack from other than the prevailing direction. The actual wind is not always from the prevailing direction.

The Air Weather Service is equipped with the scientifically observed weather data which are required for both long-range planning and short-range forecasts for wide expanses of the earth's surface. It is to be hoped that, in future planning, antiaircraft experts will be able to make full use of the facilities of the Air Weather Service.

German Shock-Wave AA Gun

Before the end of the war, the Germans had developed a shock-wave antiaircraft gun capable of breaking a 24mm board at over 200 yards range, it has been reported. The purpose of this gun was to produce a sudden rush of air and gas at the time an airplane passed by, thus sending it out of control. The air cannon was to be used for the protection of certain vital objectives against the attacks of hedgehopping planes, a type of attack that makes it very difficult for ordinary antiaircraft cannon to hit the target.

An explosive mixture of oxygen and hydrogen was put into the bent portion of a tube which was pointed at the plane. Ignition of the charge produced a powerful jet of gas.

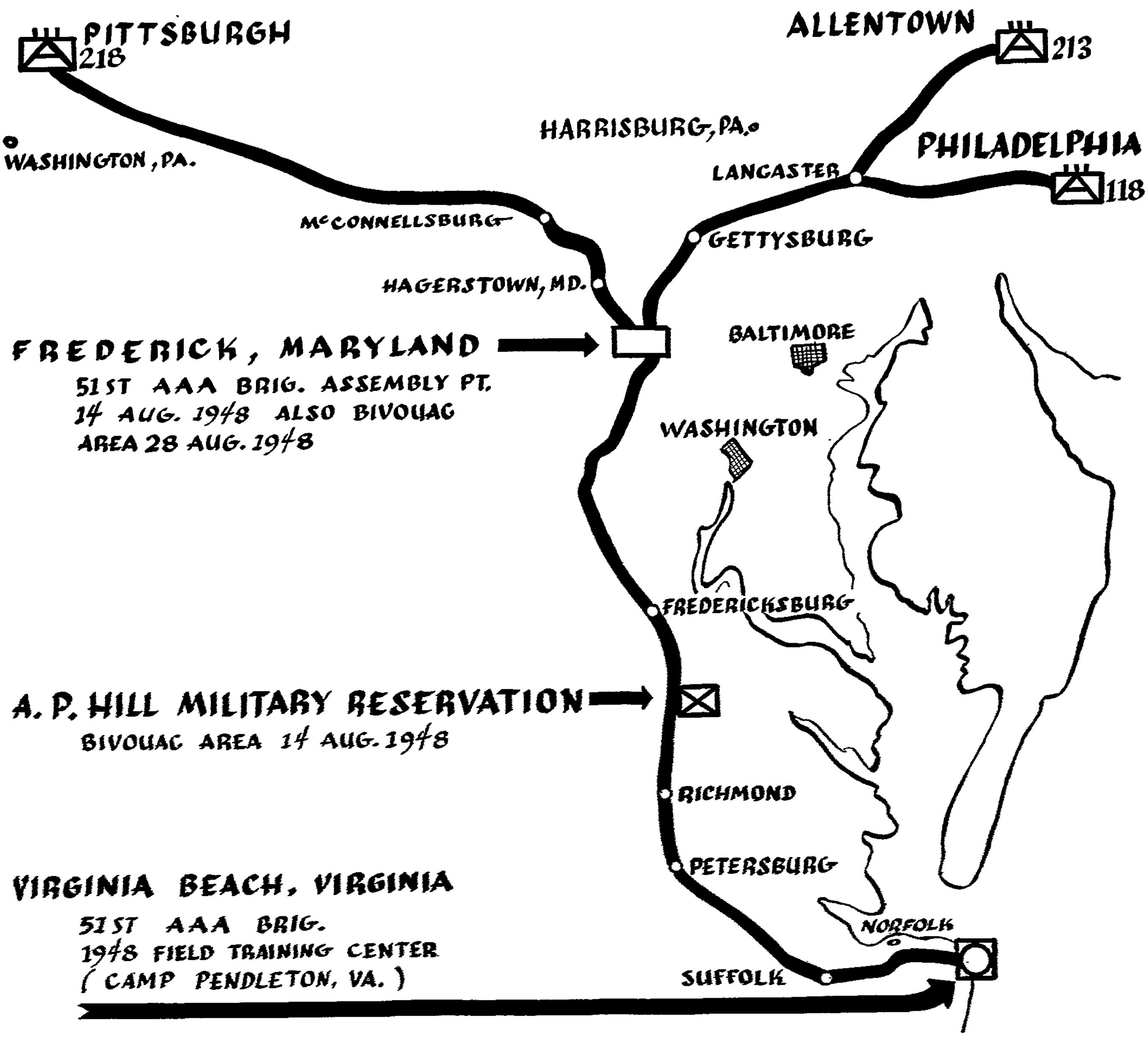
WE DID IT—BUT

By Colonel Harry A. Markle, Jr., CAC (PNG)

A National Guard Commander with a splendid war record departs from the usual "success-story" type of reporting summer maneuvers to illustrate lessons learned in training civilian component units in peacetime. This story was received concurrently by the JOURNAL and the *National Guardsman* so it appears in identical form in both magazines.

Many times have I had the pleasure and satisfaction of either planning or participating in truck convoys. Not until last summer, however, was I given the opportunity to plan and execute a convoy on brigade level.

My Group Headquarters was given the mission of conducting a 950-mile overland march to and from summer field training exercises in which 233 vehicles were to participate. Of these vehicles, 109 towed either antiaircraft weapons, radars, or one-ton trailers. The distance was to be covered in two days each way. The convoy had to be conducted over a week-end period. It started from three widely separated points—Allentown, Pa., for elements of the 213th AAA Gp., Philadelphia for elements of the 118th AAA Gp., and Pittsburgh for elements of the 218th AAA Gp.—and



converged at Frederick, Md., the Assembly Point, 150 miles from the start. The size of the convoy and the number of personnel involved—700 officers and men—precluded the possibility of selecting an overnight bivouac area anywhere other than on military reservations or substantially large public properties along the route. The march was completed with a fair amount of success. A few vehicles failed to make the movement under their own power, and one accident involved civilians.

This article is not a success story, but is written for the purpose of highlighting errors in planning, the value of pre-convoy driver training, the necessity for constant vigilance on the part of the serial commanders to insure that the participating personnel are thoroughly familiar with the problems and are trained to carry out their part of the mission, and that absolute control of the column is maintained at all times.

When this headquarters was given the mission of planning and executing the march, the problem was attacked with all the energy and thoroughness we could muster. All concerned with planning were wartime officers, who therefore tempered their decisions and made assumptions based on convoys conducted during the war. We failed adequately to consider the state of training of the personnel making the road march. Later investigation revealed that most drivers were in their first convoy. Secondly, we had assumed that drivers and assistant drivers for the vehicles were being trained in accordance with directives from Brigade Headquarters. Thirdly, we assumed that all vehicles recently received from supply depots were in combat serviceable condition. These assumptions were all erroneous.

The road march of 475 miles was to be conducted in two days. The first day's march was approximately 300 miles from the starting points. It was thought that a long march would be possible the first day. We know now that until drivers become thoroughly seasoned, a day's march in excess of 200 miles should not be attempted.

As the first day of the march spent itself, it appeared that all the pitfalls (as mentioned in FM 25-10, Motor Transport) paraded before the eyes and in the minds of all officers who had anything to do with the planning of this movement. Sometimes these pitfalls revealed themselves one by one and at other times appeared in the form of whole chapters.

According to reports, the various serials started from their initial points in fine shape. The columns were well organized, the trucks appeared to be in good condition, and everyone seemed to know his job. It was not until the three columns converged at Frederick that the errors in judgment in our planning began to show up. Most of the serials arrived at the assembly point on time and substantially intact.

Bugs Begin to Develop

One serial arrived at Frederick considerably later than expected. It was found that this serial commander had lost control of the column some time during the march because the tail radio control truck took too literally the orders to stay in the rear. One of the trucks in that column had to pull out of line because of mechanical difficulties. The rate of march of the column soon caused the head radio control truck to outdistance the range of the tail radio. When the commander found that he no longer was on contact with the tail of the column, he pulled the serial to the side of the road and waited until the tail closed up.

Another column failed to arrive at the assembly point until quite a few hours had elapsed, because the column commander failed to distribute his five-gallon gas cans throughout the trucks of the column as ordered. All of the gas for that column was on one truck. Unfortunately it broke down, and it was quite some time until it was prepared to continue the march. Meantime, some of the larger trucks needed extra gas to proceed, and had to wait by the side of the road for the gas truck.

The assembly point was at the entrance of Frederick, a fairly large town which could not be by-passed. The outskirts were also the noonday lunch and gassing point for the head of the column.

It was at this point that our first great error in planning revealed itself. We were issued plenty of five-gallon gas cans to provide for the first day's run. However, we had neglected to take into consideration, in establishing 30 minutes for lunch and gassing, the fact that to replenish the fuel supply in a prime mover and similar vehicles after a run of 150 miles requires 12 to 15 cans. Obviously not more than two cans can be emptied in a vehicle at one time.

The second planning error loomed before us when we started to move through Frederick at the noon hour on Saturday. The farmers for miles around flocked to town. Although Frederick is only two or three miles long, it took 30 minutes for each group of 30 vehicles to clear, even with the Herculean efforts of the city police escort.

During the afternoon of the first day's march our convoy hit hills, winding roads, high-crowned roads, and narrow roads. In our planning we had failed to take into consideration the fact that many of the drivers were neophytes, that this was possibly the first time that any of them had driven loaded trucks for such a distance. Our rate of march was established at a uniform 25 miles per hour. As the day wore on, the drivers and their assistants grew weary. No longer could they hit the 25 mph average on unfamiliar roads. The column arrived at the end of the march several hours later than planned.

Planning to maintain a uniform rate of march for an entire day of say 20, 25 or 30 miles per hour is not good practice. The rate of march must be geared to the road conditions that will be met at various periods of the day. The table should not be set too tight in time, as the slightest delay will throw the entire convoy behind schedule and cause unnecessary speeding and chance-taking on the part of drivers to make up lost time.

When dusk fell we found some of the serial commanders had not paid too close attention to the details of preparation for the march. The entire route from home station to the bivouac area on A. P. Hill Military Reservation in Virginia had been marked with road markers, and guides had been placed at dangerous intersections. Unfortunately, when dusk fell these signs appeared conspicuous by their absence, unless the drivers were fully alert and looking for them. Because of fatigue and unfamiliarity with the route, some of the serials strayed and became lost. Investigation revealed that not all drivers had been fully informed of the route, or the conditions and rules governing the march.

Suffice to say that by 2400, all of our struggling drivers and straggling vehicles were assembled, the serials re-formed, ready for the second day.

Food Causes Trouble

Prior to the start of the next day's march, all personnel were briefed on the previous day's shortcomings and were oriented on the 175-mile march ahead to the field training center at Camp Pendleton, Va. That day's march was executed without incident.

It was on the return from field training that the lesson in mess management and thorough preparation of food for consumption on the march was most forcibly brought home. According to the almanac and previous experience, the weather in the latter part of August should have given us days that were not too hot and nights that were comparatively cool. Unfortunately, the day before we started the trek back to Pennsylvania, the daytime temperature stood close to 100, and the night temperature not much lower.

We left Camp Pendleton in the early hours of the morning with two days' rations apparently safely and satisfactorily stowed for consumption during the march. During that day, however, the thermometer rose to 105 degrees and in that sweltering heat, and with the now known inadequate precooking of the meat, we arrived at the end of the first day's march with the meat spoiled, and the eggs and vegetables carried on the march unfit for feeding.

We ended our first day's march on the return trip at Frederick. All 233 trucks arrived over a period of approximately an hour. Upon arrival, the medical officer for the convoy inspected the larders and condemned all the food. It was then about 2000 on a Saturday evening. Through the goodness of heart of several of the restaurateurs, all 700 men were fed by 2300. For the next day's breakfast, we bought half a dozen crates of eggs and a couple of thousand pints of milk.

Luckily, we were not plagued on the homeward movement with the problems of convoy control and discipline. However, a new and different type of problem struck shortly after 2100 on the first day of the homeward trip. This time we found the small Medical Detachment suddenly confronted with 30 or more cases of heat exhaustion, upset stomachs, and whatnot. Six cases had to be evacuated to a hospital.

The possibility of evacuating men to a hospital while en route had not been considered in our planning; therefore, we were not prepared to give a prompt answer concerning where these sick men should be taken. Through the offices of the local police, we found that they could be taken to an Army post not too many miles distant—a Chemical Service post hospital at Frederick.

The march from our bivouac area to home stations was completed by late noon the next day, without incident.

While the foregoing might appear to the casual reader to be a prefabricated story, it is a true statement of facts. These facts were not stated in the sequence of their unfolding, but do represent events that happened during the journey.

At times the unending series of events was irritating. However, the training obtained and the lessons learned during this movement were ample reward for the anxious hours spent "sweating out" the movement. Experiences like those related make life worth while. Errors of omission or commission can be reconciled—if not repetitive.

In planning and conducting future road marches, we will stress the following:

That all vehicles be in serviceable condition and capable of completing the march with minimum of maintenance other than first and second echelon.

That serial commanders be fully aware of their responsibilities, and duties, and be capable of exercising control of the column.

That all drivers and assistants are qualified, and are thoroughly trained in their responsibilities and their duties. (Pre-convoy driver training cannot be overemphasized.)

That the length of a day's march be set on the basis of the state of training. (With the limited training time available to National Guardsmen, the distance should not exceed 200 miles under present conditions.)

That march tables be computed on the basis of a uniform rate of march provided sufficient time is allowed for:

1. Refueling (rate set based on time required to refuel vehicle with greatest gas consumption).
2. Passing through cities and towns. (Time allowed based on escort facilities available and maximum number of vehicles that can be escorted simultaneously.)

That replenishment gas and oil be distributed throughout each element of the column based on the fuel consumption of the various vehicles in that element. Replenishment gas in five-gallon cans will suffice for refueling en route except for vehicles over 2½-ton rated capacity. Fifty-five-gallon drums will be required for refueling larger vehicles.

That all available mobile radio sets be spaced equitably throughout the full length of the column to insure maximum column control by the various serial commanders.

That personnel evacuation points be specified and that prior arrangements be made to insure no delay in hospitalizing those who may require such treatment. Evacuation points should be established at 50-mile minimum intervals.

That food required for consumption during the march be carefully prepared, and that all requirements specified for the preparation of each item of food be met. Improvised food coolers, if necessary, should be provided for each kitchen in the column.

That prior to the march, all officers, drivers and assistants, maintenance personnel, and all others who have responsibilities and duties incident to the march should be fully briefed on the road march to be conducted.

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 Field 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 Field Forces Board No. 1, Fort Baker, California.

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

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

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Modified Distribution Box Boat: On 16 August 1948, this Section was assigned a project to service test the modified Distribution Box Boat L-73.

The Distribution Box Boat L-73 is a small diesel-operated vessel of 30 gross tons, 64 feet long, 18-foot beam and 6-foot draft. It is capable of raising an assembled Distribution Box from the bottom of the ocean and placing it on deck. A 2½-ton travelling crane (fore and aft) and a capstan are installed on the forward deck to handle the equipment described above.

The following approved modifications to the standard Distribution Box Boat L-73, have been made in a local shipyard in the San Francisco area:

Reducing the dimensions of the pilot house and deckhouse to gain working deck space on the main deck both forward and aft.

Removing and replacing the capstan with one of higher horsepower.

Installing a duplicate set of steering and engine controls on top of the pilothouse to provide increased visibility for control by the coxswain during mine planting operations.

Other minor space and machinery modifications related to the foregoing.

The present distribution box boats (L-Type) were first issued to the service beginning in 1940. It was basically a satisfactory vessel, but as a result of World War II experience, certain deficiencies became apparent which limited its usefulness and at times, made its operation in the mine field hazardous.

The most important of those deficiencies was lack of working deck space particularly in the forward areas of the vessel. As a result, personnel and the equipment were congested when working around the distribution box. There also existed the danger of losing personnel overboard during certain stages of the planting cycle. Similar criticism is applicable to the afterdeck space to a lesser degree. The visibility from the pilothouse was not satisfactory when working around floating equipment close to the boat. More power on the capstan was also required in some instances.

The L-73, which was delivered to this Section 7 September 1948, is undergoing test in all phases of work in the mine field. Other portions of the service test will include observations to determine if:

Deck platform is reasonably stable under all working conditions.

Handling characteristics of vessel underway have changed.

Space and equipment are adequate under service conditions.

Heating facilities are adequate for colder climates.

Spring Lay Wire Rope: A second project was assigned this Section during August. This project is the service testing of spring lay wire rope.

The purpose of the test is to determine if spring lay wire rope is suitable as a substitute for standard raising rope in controlled submarine mine operations.

Standard raising rope is made up of steel wire strands covered with worsted cord called marline. It usually consists of five outer strands wound around a central core, each of the outer strands consisting of 19 galvanized steel wires twisted together and wound securely with marline. The breaking strength of raising rope, one-inch in diameter, is approximately 29,000 pounds, and the safe load is approximately 6000 pounds assuming a 5 to 1 safety factor.

Spring lay wire rope consists of six wire strands wrapped with three strands of marline. Each of the six wire strands contains 19 steel wires. Breaking strength of one-inch diameter is approximately 30,000 pounds with a rated safe load of 6000 pounds. The major advantages of spring lay wire rope over standard raising rope are that it is more flexible, uses less marline, requires less operations in manufacture, and is in wide commercial use, thus simplifying procurement.

Seacoast Artillery Firing by Offset Methods: Continuing the project on offset firing, a target practice was conducted during August, using two 75mm M25 subcaliber guns mounted in 155mm M2 guns. An AN/MPG-1 radar, M8N gun data computer combination furnished fire control data.

Thirty-two rounds were fired on a right to left, crossing course, at 6400 yards average range. Target speed was 15 mph. Recording was accomplished by connecting a second remote spotting scope into the AN/MPG-1 radar and photographing "splash" presentations on the scope with a motion picture camera. This phase was in conjunction with a project for remote recording of target practice firings.

The results of the firing were very satisfactory. However, the recording system did not function properly. The difficulties encountered will be discussed in the note on that subject.

Personnel shortages in the Artillery Detachment, Seacoast Branch of the Artillery School, have delayed completion of this project. Newly assigned troops are being trained and it is anticipated that additional firings will be conducted in the near future which will provide a basis for formulating an offset firing system.

Remote Recording System for Service and Target Practice Firings: Since this project was last reported upon, considerable progress has been made toward developing a means of recording data for offset firing.

The first system employed utilized a second remote spotting scope, connected into an AN/MPG-1 radar, on which range and azimuth counters, duplicates of those on the radar and powered by selsyn motors, were installed. Recording was accomplished by photographing the counters and the "splash" presentation on the scope with a standard 16mm motion picture camera mounted in a bracket over the scope-counter assembly.

This first system proved to be unsatisfactory due to the selsyn motors having insufficient torque to operate counters properly.

A second system has been developed which employs disks instead of the counters. Range and azimuth disks, graduated for both coarse and fine readings, were manufactured in the Section's machine shop and installed in place of the counters. Selsyn motors are still used to turn these disks directly from the radar. Photographic recording is accomplished in the same manner as described above.

The new system promises to be a decided improvement over the original approach to the problem. It was used during the offset firing reported in the above note. Positioning of the disks was positive, photographs were clear and legible, and the entire system operated satisfactorily.

Ninth Air Force . . .

(Continued from page 27)

tered by the prudent and skillful use of countermeasures. The measures described in the following paragraphs allow a brief insight into the major methods used in this Air Force —an air force which met the full fury of German flak and came through a winner.

Routing

Medium Bombers

In the absence of enemy aircraft, the principal routing problem was to avoid all known or suspected flak defenses. This was usually possible, although at times the bomber range did not allow the use of the best circumferential routing. In the Ninth Bombardment Division, both flak officers and air crews were so flak conscious that routes were sometimes changed to avoid a spot where flak fire had been reported but once previously.

Under blind bombing conditions the planners had little latitude because the final 30-mile run could be made on only two different headings at the most, and often on only one, depending on the location of the ground control stations with relation to the target. However, as was pointed out elsewhere, the unseen fire of enemy batteries could in no way compare in accuracy to visual shooting. In routing the ships the chief worry was that visual fire would be encountered through breaks in the cloud, and this actually happened on various occasions.

In routing over a visual target, many conflicting problems were considered and balanced against each other. The ideal conditions were to have the wind and sun at the tail of the formation and the flak deployed in such a way that on this heading the bombers came in over the weakest sector. However, such a combination of conditions was seldom achieved. In the presence of very strong flak defenses other considerations were occasionally made secondary. However, it was very seldom that flak was considered of sufficient import to send the planes in on a heading where bombing accuracy would have been very low due to sun glare or poor visibility. In most cases a compromise was arranged.

Fighter-Bombers

On armed reconnaissance missions fighter-bomber pilots were briefed on the major flak zones in their area, but in general they depended on aircraft maneuverability and knowledge of enemy flak deployment tactics to keep themselves out of trouble. Light flak was so mobile in the close-up tactical area that it was not possible to brief fighters with the same degree of accuracy as the bombers. Our experienced fighter pilots soon got to know where flak was and where it could be expected, and the low damage and loss figures proved they used this knowledge to good advantage. On more specific target missions, fighter-bombers of course took advantage of altitude and careful routing to reach their targets undamaged.

Troop Carriers

In operation of troop carrier transport and gliders, flak was always one of the most important considerations. As a result of the altitude of formations (500-1500 feet) and the speed flown (110-140 mph), troop carriers were very vulnerable to antiaircraft fire of all categories. It was usually not possible to take the formations over absolutely flak free routes, because this required a zigzag course of detours around individual gun positions which was impossible for the unwieldy transport and glider teams. In addition, the tactical mission of Troop Carrier Command required the element of surprise, and formations had to go in on as short and as direct a route as possible. Therefore the best route in regard to flak was always a compromise with other important factors, such as navigation, nature of the mission, and length of route over enemy territory.

Evasive Action

Medium Bombers

In the early days of the war evasive action was usually left up to the individual fancy of the formation leader. As studies were made and tactics developed, it was found that very carefully planned evasive action would invariably lead to lower loss and damage and therefore better bombing.

It is now known that change of altitude has very little effect on evasive action unless it is violently made, and unless it is incorporated with evasive action in course. On the approach to the target this Air Force used altitude changes on but few occasions.

Planned evasive action was usually begun 40 seconds or more before coming within range of the heavy flak. S-turns were attempted and later abandoned, because it was found that planes were often hit by predicted bursts when coming back over the original straight course line. Instead of these, a definite but irregular series of turns was used, the minimum rate being about 2° per sec. The straight portion between turns became progressively smaller as the target was approached, varying from 20 seconds down to 5 seconds. Because of operational requirements the turns themselves usually were between 15° and 45°. This action continued until the start of the bomb run. It was also found that the last turn into the bomb run should be as large and sharp as possible.

When an 18-ship box arrived at the initial point, the inside flight made the turn first. The lead flight and outside flight continued on the same course for 10 seconds, at which time the lead flight made the same turn. The outside flight continued on for 10 seconds and then it also made the same turn. From there until the start of the bomb run, these flights flew parallel courses and executed the same evasive maneuvers. The bomb runs were therefore convergent, provided the three flights had the same aiming point, thus also employing saturation tactics against the flak gunners.

As the ships were most vulnerable while on the bomb run, shorter runs were attempted, but assessment of bombing damage proved that proper synchronization could not be made, and a run of 45 to 60 seconds was highly advisable. A sharp turn away and loss of as much as 1,000 feet altitude

Air Force photo

Flak-filled skies. The white cloud is all that remains of a bomber that was hit by flak over a target in Germany.

Air Force photo

A pilot is examining the damage inflicted on his P-47 Thunderbolt by a direct hit from 88mm flak. The P-47, with supercharger, hydraulic system and rudder controls battered, held together. The pilot managed the crippled plane back to his base, circled the field for fifteen minutes while ambulances, crash trucks, and firemen assembled, then made a belly landing, skidding 500 yards. As servicemen were towing the plane away, the entire tail assembly fell away.

after bombs away has long been a standard procedure. The evasive turns were then begun again until the ships were out of range of the defenses.

FIGHTER-BOMBERS

Ninth Air Force fighters have developed some novel and also extremely successful evasive tactics. In a low level strafing attack, for instance, the first principle is surprise. This is mainly accomplished by staying low and making use of terrain features. After passing over the target the pilots were taught to stay low and head out of the area, as climbing would expose a large surface to enemy gunners. Another ruse was to split up into elements of two or three planes each, which came in on different headings from 30° to 120° apart. This tactic confused and tended to saturate the defense in a similar manner to bomber practices, as the gunners could only fire at a small percentage of the attacking planes. Another bit of deception used was to send one flight over the target area just out of light flak range. This flight simulated a dive-bombing attack and drew fire, and while the flak gunners were thus engaged, the other flights sneaked in on the deck in a surprise sweep.

Very little other planned evasive action was necessary, as the maneuverable fighters could perform what aerial acrobatics were necessary as the occasion arose.

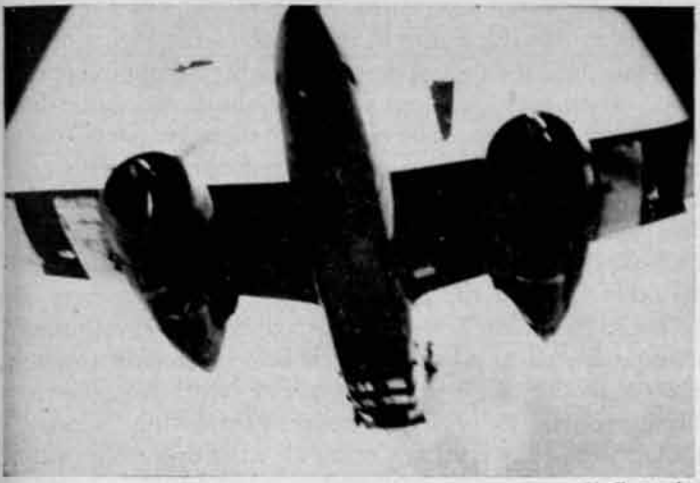
TROOP CARRIER

Evasive action by troop carriers was often difficult or impossible. While tugging gliders and carrying paratroopers, tug planes could not "jink" all over the sky, as the very nature of the equipment did not permit it. The landing and drop zones were small areas which required very precise navigation to find. When coming in for paratroop or glider drops the run resembled a bombing run, and evasive action at this critical stage was inconceivable.

After the transports released their loads, more evasive action was possible. Going into a slight dive, thus gaining speed to leave the area quickly, was found to be one good expedient, as loss or gain of altitude often confused flak gunners. Steep banks were not advised as these exposed a large surface of the plane. Profitable use was made of cloud cover, as well as defilade caused by hills or trees. However, the maximum use of low altitude flight increased the hazard of small-arms fire. In view of vulnerability under all conditions, troop carrier missions which did not sustain some damage or loss were rare, yet the complete success of such missions flown over the battlegrounds of Europe at extremely low loss is a tribute to the pilots and to flak intelligence.

COUNTERFLAK (AIR)

Air power is not as powerless to hit back against flak as was originally supposed. Various methods of neutralizing flak from the air have been developed and used in this Air Force with excellent results.



Air Force photo

An A-20 hit by flak over enemy territory. Wreckage of the tail section is visible between the left engine and the fuselage. Its tail section severed, the plane went down.

MEDIUM BOMBERS

The mediums employed high explosive and fragmentation bombs with good success against heavy flak batteries. Clusters of three 260-lb. frag bombs or six 90-lb. bombs were used. The former cluster parted upon release, whereas the latter had either an instantaneous or a delayed release mechanism. Usually a box of 12 ships went out slightly ahead of the main bombing formations and did this work. Of course, direct hits put the flak out of business completely, but near misses often discouraged the flak personnel or ruined the delicate directors. Crew experience proved that this antiflak measure worked well, provided that timing was correct, since fire received was often far below the unhindered capabilities of the defenses.

FIGHTER-BOMBERS

Concerning fighter operations, the standard procedure was to assign several fighters the task of strafing the emplacements around a target, while the remainder went about the business of strafing or bombing the target itself. Here again it was found that the average flak gunner took cover first and worried about his job later, so this system became standard on all well-defended targets such as airfields or ordnance depots. The fighters also carried 90-lb. frag bombs under the wings, and these were used against flak positions in a manner similar to bomber tactics. Proximity fused antipersonnel bombs were used in the last months of the war, and showed great promise.

CALAIS COMBINED OPERATION

On the 9th of May 1944, the first combined air operation in this theater simultaneously employing medium and fighter-bombers at the same target was successfully accomplished. The general plan was to achieve the best possible medium bombing accuracy against a target strongly defended by heavy flak.

Obviously the major problem was to achieve such timing that the short bombing periods of the fighter-bombers would occur during the critical period just before and during the mediums' bombing run on the two main targets, Calais and Sangatte. In the actual attack the entire medium and fighter-bomber force rendezvoused at North Foreland, proceeded generally to a landfall five miles west of Dunkirk, thence to the B-26 initial point east of Calais where the mediums started their bombing run. To obtain the timing necessary, the medium bombers gave a radio signal on landfall indicating they would bomb six minutes later, and again a signal at the IP meaning they would bomb one minute and forty seconds later. Excellent timing resulted.

The attack proceeded according to plan, the medium bombers starting their bomb runs just as the first flak positions were being dive-bombed. Immediately upon the dive-bombing of flak positions, the flak over the entire area went from "intensely accurate" to "nil." Medium bombing results were generally excellent; there were no losses and flak damage was received by only a few aircraft from a flak battery that was attacked slightly behind schedule. This reaction was quite different from a previous attack when 3.5% of the mediums were lost and 57% damaged against the same target similarly protected. Bomber and fighter crews were all very enthusiastic. Two of the comments were:

Bombers: "As our group approached the target on the bombing run, moderate to intense flak was seen coming from the Calais defenses, apparently directed at the bomb group ahead. At that moment the P-47's dive-bombed and the flak appeared to stop in the entire area."

Fighter-bombers: "It is my opinion that this is a very effective type of attack. The coordination with the bombers was perfect. The flak was firing at the fighter-bombers when they attacked gun positions. We smothered practically all ground opposition. There was no flak to interfere with the bomb run of the medium bombers. Results, so far as attack by fighter-bombers and medium bombers, declared excellent."

COUNTERFLAK (GROUND)

Shortly after the beachhead was established in Normandy, Allied ground artillery fire was directed against certain dense flak areas in the immediate battle line in attempts to neutralize some of the German AA positions. These early artillery missions proved so beneficial to our air effort that, in the late fall when the flak situation was again stabilized as at Caen and Brest, counterflak artillery missions were again employed and definite operating procedures between air units and the ground artillery were established.

During these operations every caliber of gun and howitzer from 90mm to 240mm was used to blast the enemy flak positions while our medium and fighter-bombers were in the area. In many cases our artillery could not reach all of the flak batteries within range of the air targets, but even partial neutralization often allowed the lay-on of a mission which would otherwise have been beyond the capabilities of our aircraft flying at very low and medium altitude against tremendous flak densities.

AIRCRAFT FORMATIONS

MEDIUM BOMBERS

As the Luftwaffe became neutralized, bomber formations were gradually altered more successfully to counter the potent flak hazard. Aircraft spacing in any formation has been the subject of many discussions and studies. If the ships fly too closely together, one shell burst may damage more than one plane, or a shot aimed at one may miss but still hit another. If, however, the ships are spaced too widely apart, the battery will be able to get in more shots at a given number of planes because they will take longer to cross over the effective area of fire. On the other hand bombing accuracy requires a tight pattern which cannot be achieved in our type of bombing if the ships are in a widely scattered formation.

An optimum solution had, therefore, to be determined. Distance between planes of each flight had to be sufficient to provide protection against one flak burst's hitting more than one ship. However, since this spacing did not achieve a tight bomb pattern, the two Vee's of three contracted in breadth and trail while on the bomb run. Thus a satisfactory pattern was attained.

Spacing between the three flights of a box was also a problem. Each 1,000 feet of altitude above 10,000 feet diminishes the probability that an aircraft will be hit. Hence as flights are stacked down from maximum altitude to reduce the single shot probability, this probability increases at a high rate. A limited amount of stacking was therefore advisable, and 500 feet between flights was agreed upon.

Some reduction in flak loss and damage was accomplished by saturating the defenses. This was done by moving the attacking forces across the target area in the shortest possible time. Under simultaneous attack by different formations the flak batteries were forced to choose one as a target, thus allowing the others to fly almost flak-free. Saturation of continuously pointed or predicted concentration of flak fire was accomplished by closing up in trail so as to reduce the time between attacks of successive bombing formations. Our boxes were usually 2 miles apart (40 seconds). When encountering barrage fire, risk to aircraft was reduced by increasing the formation spread in altitude and breadth.

Fighter-Bombers

In fighter operations it was also found that the use of small numbers of aircraft worked out best. Except for an occasional low angle engagement by heavy guns, fighter aircraft were for the most part concerned with light flak weapons which, with their high rate of fire, could do serious damage to any large group of planes within range. Therefore the fighters frequently operated in pairs or trios.

One squadron of fully bombed fighter-bombers was the largest unit used. Here, too, the larger formations drew more fire and also caught grossly inaccurate shots, as well as near misses aimed at aircraft in the same group. If planes had to stay in the vicinity of the target while waiting to bomb, the pilots were carefully briefed on all heavy flak positions within range.

Radio Countermeasures (RCM)

Radio countermeasures have played an important part in neutralization of enemy flak. Under "unseen" fire conditions the enemy was completely dependent on his radar for direction of his AA guns, and with effective use of RCM he was forced to resort to the inefficient barrage method of fire. When "seen" conditions prevailed the usual method was to use radar for range finding, but optical sighting for elevation and azimuth. Here again with RCM in use the enemy's radar was denied him, and he had to use optical range finders.

This Air Force used three "window" ships per medium bomber group. One ship flew in each of the flights of the lead box until the time approached for their dropping operation. Then they went out one mile ahead and 1,000 feet below the lead ship. The position of these "window" ships varied slightly depending on the wind direction with relation to the direction of attack. The usual procedure was for the "window" ships to leave the formation at the IP. They each dropped 12 bundles of "window" every 6 seconds, while all other ships in the group dropped 6 bundles every 30 seconds. "Window" can well be credited with saving many a ship, as well as allowing much better bombing through great reduction of the flak hazard. The Ninth Air Force has been credited by POW statements as employing "window" more successfully than any other air force operating in this theater.

The jamming, or "carpet," technique used by the Eighth Air Force was experimented with in this Air Force, but it was found that our smaller bombers could not carry the necessary equipment to make it effective, nor did our A-26 aircraft, to which our entire Bomber Division was slowly converting, have the air crew necessary to operate the "jammer."

Proof of the Pudding

That the Ninth's Flak Intelligence section enjoyed considerable success in appreciably reducing effectiveness of German defenses was clearly demonstrated by aircraft loss and damage rates. It was no vagary of chance or beneficent smile of Lady Luck that carried the bombers and fighters through day after day of loss-free operation over the most powerful antiaircraft defenses the world has ever known. One had but to see the formations of planes treading lightly among the danger zones, making planned maneuvers, tossing out bundles of "window," bombing or strafing flak positions, to realize that there was more than good fortune involved in keeping the bombers and fighters from being shot from the sky or badly holed.

Low Loss-Damage Rates

Records show that for every 1,000 Ninth Air Force bomber that flew missions over German-defended territory, only 4 were lost to flak, and for every 1,000 fighter-bombers, only 3¾ were lost to flak, and that only 117 out of every 1,000 bombers, and 22 of every 1,000 fighter-bombers, which were over the enemy defenses, received flak damage.

These very low rates of loss and damage to the Ninth's aircraft did not reflect an impotency of German flak defenses, but, rather, indicated success of an intensive and aggressive study of flak, and development of means of "beating flak."

The over-all loss figure (4/10 of 1%) and damage figure (6%) was especially low in light of the realization that the Ninth, as a Tactical Air Force, operated continuously over fluid battle areas of great flak densities, necessarily at altitudes very favorable to flak gunners.

Loss by Type Mission

An analysis of bomber loss by type mission showed that medium altitude visual bombing sustained the highest rate of loss. This was the logical expectancy, since if atmospheric conditions permitted visual bombing, optical determination of firing data for the flak guns was also possible, since "seen" fire was more accurate than "unseen" fire.

Next in order of vulnerability was medium altitude blind bombing. An analysis of fighter-bomber loss by type mission revealed that:

(1) Dive-bombing missions had by far the highest rate of loss. This resulted from the increased exposure to flak incident to the low "dropping" altitude and the vulnerable "pull-out," well within the effective ceiling of light flak fire.

(2) Escort missions experienced the lowest rate of loss. What with the higher altitude flown and the fact that the aircraft being escorted were the primary targets of the flak defenses, this was normal.

(3) Armed reconnaissance, area support, and fighter sweep missions were more than twice as hazardous as escort missions, but only about two-thirds as dangerous as dive-bombing missions.

Flak Loss versus Total Loss

During the period of operations of the Ninth Air Force in the European Theater flak was responsible for approximately half of all aircraft losses and almost all damage suffered.

The following shows the breakdown of total loss and damage by cause:

Medium Bombers

	Loss	*Damage*
Flak	53.4%	97.3%
Enemy Aircraft	8.9%	.8%
Other	37.7%	1.9%
Total	100.0%	100.0%

Fighter-Bombers

	Loss	*Damage*
Flak	45.8%	88.5%
Enemy Aircraft	15.1%	3.4%
Other	39.1%	8.1%
Total	100.0%	100.0%

"Other" includes crash landing, accidents, loss or damage due to combination of flak and enemy aircraft, and loss or damage with reason either unknown or unreported.

Despite the fact that Germans were able to take only about 40% of their flak defenses with them during their many retreats into the shrinking Reich, gun densities tended to increase, rather than decrease. Not only was there less territory to defend, but production of flak weapons was maintained at a level sufficient to replace most or all of the losses.

Fighter loss rate in January, 1944, was the highest for any period, but because of the low number of sorties flown (325), that month did not present a good statistical study. However, beginning in February both medium and fighter-bombers operated on a much larger scale.

Total sorties flown by the Ninth's medium bombers from January 1, 1944, to May 7, 1945, were 114,707, or a monthly average of approximately 7,000. Fighter-bomber sorties totaled 263,704 for that same period, for a monthly average of more than 16,000.

Damage to bombers reached the highest level in April 1944, and losses of bombers and fighters rose, as attacks on the stoutly defended pilotless aircraft launching sites constituted our principal effort.

June, July and August of that year saw fighter-bomber losses rise steadily as maximum effort was mounted for the historic invasion and subsequent close support of the Armies during the critical weeks that followed.

Flak defenses not actually overrun, however, continued to react fiercely to bomber attacks, and German flak was never "kaput" until it died with the rest of the Wehrmacht May 7, 1945.

Finale

Though flak was the greatest menace to the Ninth's medium bombers and fighter-bombers, only one was lost to the enemy's antiaircraft defenses for every 250 sorties flown, and that was the proof of the pudding.

I know that a better citizen is a better soldier. While we are training a soldier, we intend to reinforce his earlier citizenship training. And in so doing, we are going to adhere to the basic principles of free inquiry and self-discipline that have been the essence of modern American democratic education.—General Omar N. Bradley.

News and Comment

The Cover

The cover of this issue shows 90mm guns of Battery A, 413th AAA Gun Battalion, on Omaha Beach on D plus 3. They are here firing an artillery concentration for the 2d Infantry Division attack on Trevieres, France.

The 413th was the first AAA gun battalion ashore in Normandy. The Battery Commander of Battery A was Capt. (now Maj.) H. E. Osthues, and the Battalion Commander was Lt. Col. Donald MacGrain.

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Coast Artillery Association Election

Three officers were reelected, and one new member was added, to the Association Executive Council, as a result of the balloting conducted in the September-October and November-December issues of the JOURNAL.

Lt. Gen. LeRoy Lutes was reelected President, and Brig. Gen. John C. Henagan, and Col. Charles M. Boyer were reelected as Council Members. Newly elected to the Council was Major Bergen B. Hovell, GSC, who is currently assigned to the Logistics Division, General Staff, United States Army.

The Council as it is now constituted may be seen in the masthead on the contents page.

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Wins CA Association ROTC Medal

Cadet David A. Brissette has been announced the winner of the 1947 Coast Artillery Association ROTC Medal at the Boston College, Chestnut Hill, Massachusetts, according to Col. James M. Lewis, FA, PMS&T.

Cadet Brissette was in the Army Air Forces during World War II from June 1943 to November 1945. He attained the rank of Flight Officer.

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Age-in-grade Limits for Recall to AD

Effective January 1, age-in-grade limits for recall of Army officers to extended active duty are: Second Lt., 32; First Lt., 37; Captain, 42; Major, 47; Lt. Col., 52. No quotas are available for recall of Colonels or Warrant Officers. Requirements generally have been met, with only limited vacancies available.

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Third National Industry-Army Day

The Third National INDUSTRY-ARMY DAY was held in Boston, Massachusetts, on February 4, 1949. The purpose of Industry-Army Day is twofold: first, to promote and continue the splendid cooperation between industry and the technical services of the Army which was so evident in the last war; and second, to keep each group abreast of new developments and new requirements by providing an opportunity for the exchange of ideas, discussion of mutual problems, and airing of individual views by industrial and military leaders.

Industry-Army Day had its inception in 1947. A group of civic-minded leaders, as a result of valuable experience gained during World War II, realized the importance of complete understanding between industry and the Army's technical services. These men asked industrial representatives to sit in conference with the chiefs of the technical services so that each group might be brought up to date on changing conditions in both fields. This first conference was held in Chicago, and it proved so successful that a second meeting took place in Dallas, Texas, last year.

Representing the Coast Artillery Association at the conference was Colonel Harold R. Jackson, CAC, PMS&T at the Massachusetts Institute of Technology.

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New Army Court-martial Manual Available

The new ARMY COURT-MARTIAL MANUAL is now available. Those who wish to purchase a personal copy may do so from the ANTIAIRCRAFT JOURNAL BOOK SERVICE for $1.75.

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"Officers' Call"

The first issue of a monthly pamphlet, *Officers' Call*, designed for distribution to all Army officers on active duty, will come from the presses in February.

Placing in effect a program studied for some months by the Department of the Army, it will initiate a series of monthly discussions of topics of interest to officers.

The program contemplates Army-wide officer assemblies conducted in "town-meeting" manner, in which commanding officers will present the information furnished in the pamphlet, and then lead an open discussion in which the entire audience will participate.

Early topics scheduled for presentation include: "Current Problems of the Army," "The Mission of the Army," "The Officer's Career," and "The Officer's Code of Personal Conduct."

Prepared by the Army-Air Force Troop Information and Education Division, the pamphlets will provide a valuable medium for bringing to officers current, authoritative information from the Department of the Army to be supplemented by local commanders.

The pamphlets will also feature reviews of books of interest to officers, and a letters-to-the-editor page to which officers may write directly concerning the program.

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Comment on Antiaircraft Firing

Upon receiving an inquiry concerning the accuracy of Antiaircraft fire as reported in Mr. Preston R. Bassett's "Antiaircraft Artillery Has an Assured Place in America's Forces," in the November-December 1948 issue of the JOURNAL, we consulted an officer under whom the firing was done.

Although his answer indicates an error in the number of rounds fired and in the altitude reported in the article, he in no way detracts from the story of what was probably the best AA shooting of the war. His letter follows:

To the Editor:

This will acknowledge receipt of your letter of 13 December containing the quote from Mr. Bassett's article regarding the effectiveness of AAA fire which has been challenged.

I well remember the shoot referred to, as it was for me the highlight of the entire war and a perfect way of celebrating the 4th of July.

I was executive officer of the 9th Defense Battalion which was organized in February 1942.

The Battalion was then assigned as an element of the Task Force for the New Georgia operation. The first echelon landed on Rendova Island on 30 June 1943 and moved to position to support the operation by providing AAA protection for the harbor area and dumps located on Rendova.

The mud encountered almost defies description and resulted in considerable delay in getting the AAA batteries into position. We underwent a heavy bombing attack on 2 July 1943 without being able to reply effectively as none of the 90mm guns were in position and the range was beyond the capabilities of the 40 and 20mm guns, although they all fired.

On the 4th of July, 1943 "Easy" Battery (90mm) was in position and ready. The attack came at approximately 1400 hours from the same direction and in the same manner as the previous attack on 2 July. The force consisted of 18 Jap "Bettys" in very tight formation accompanied by an unknown number of Jap "Zeros" which were diving on the formation apparently to give the impression that our planes were attacking the formation and for that reason we would hold our fire. They maintained a straight incoming course with constant altitude of 14,200 feet. "Easy" Battery opened up at near maximum range, the first salvo bringing down two of the lead planes. The Japs continued their straight course and constant altitude, closing their formation as planes were knocked out. Some bombs were dropped but damage was negligible. Fourteen planes were knocked down on this run, all confirmed and all credited to "Easy" Battery (90mm). All 40mm and 20mm guns fired; however it was definitely established that the targets were beyond their range and reluctantly the commanders of these guns admitted that it had been a 90mm day.

The altitude was constant and was obtained by height finder. Eighty-eight (88) rounds were expended during the engagement.

Colonel W. J. Scheyer was commanding the 9th Defense Battalion and Captain W. Tracy was Battery Commander of "Easy" Battery.

Incidentally, friendly fighters arrived sometime during the attack and took care of the four remaining bombers; none returned to base.

It is notable that if the Japs believed AAA was not present they would execute their bombing missions at from 12 to 14 thousand feet but where AAA was known to be present the attacks would come in at from 24 to 27 thousand feet with the resultant decrease in their bombers' accuracy.

Sincerely,
/s/ W. O. Thompson,
/t/ W. O. THOMPSON,
Colonel, U. S. Marine Corps.

Progress In Army Historical Program

The Historical Division of the Department of the Army has announced the following particulars concerning forthcoming volumes of the Official U.S. ARMY IN WORLD WAR II series:

Okinawa: The Last Battle is now in the process of being published.

Guadalcanal, Lorraine Campaign, The Cross-Channel Attack, The Gilberts-Marshalls Campaign, Operations Division, WDGS, and *World War II Order of Battle, Vol. III,* are now in various stages of production.

All of the above may be purchased through the ANTIAIRCRAFT JOURNAL when published.

RA Commissions for Vet College Grads

Regular Army commissions as Second Lieutenants are being offered to college graduates between the ages of 21 and 27 who served in the Armed Forces during World War II. Appointments will be made in two groups during March and August.

Restricted FM's and TM's May Be Purchased

The JOURNAL has received so many requests of late from persons desiring to purchase FM's and TM's that are classified "Restricted," that Department of the Army instructions for their purchase are reported below.

We discourage the purchase of government-printed manuals until every effort has been made to procure them without cost. If they are not available from the headquarters of the requesting party, we try to get them without cost for our subscribers. If that is not possible, then we buy them from the Government Printing Office for resale to our subscribers.

Service journals and the Book Departments of service schools, according to paragraph 10, TM 38-405 and DA Circular 346, 1948, are authorized to sell FM's and TM's and other Department of the Army publications classified as "Restricted" to interested officers and enlisted men of all components of the Army desiring to improve their professional knowledge. Purchases may be made either in writing or in person.

The Department of the Army requires, however, that certain identification be required of purchasers in each case.

Purchases made in writing:

An *officer on active duty* will have his request countersigned by his commanding officer or adjutant.

A *National Guard officer* not on active duty will have his request approved by the Adjutant General of the State or by an officer instructor or advisor detailed with the National Guard, who will certify that he is acquainted with the purchaser and knows him to be an officer of the National Guard.

A *Reserve officer* not on active duty will have his request approved by an officer instructor detailed with the Organized Reserve Corps, who will certify that he is acquainted with the purchaser and knows him to be a Reserve officer.

An *ROTC cadet* will have his request approved by an officer instructor detailed with the ROTC unit, who will certify that he is acquainted with the purchaser and knows him to be an ROTC cadet.

An *enlisted man on active duty* will have his request countersigned by his immediate commanding officer.

A *National Guard* or *Reserve enlisted man* not on active duty will forward his request through his immediate commanding officer, who will forward it for the approval and certification prescribed for National Guard or Reserve officers.

Purchases made in person:

If purchases are made in person, TM 38-405 prescribes:

An *officer on active duty* will be required to present his identification card.

A *National Guard* or *Reserve officer* not on active duty will be required to present a current identification card.

An *enlisted man* will be required to present identification tag, together with a statement in writing from his immediate commanding officer authorizing the purchase of specific publications.

Following is a selected list of FM's and TM's that may be of interest to antiaircraft and seacoast artillerymen. We have been unable to ascertain prices as yet, but none will probably cost more than 25 cents each. Prices will be published when they are received by us.

Antiaircraft:

FM 4-100 Antiaircraft Artillery: Organization and Tactics.
4-110 Antiaircraft Artillery: Gunnery.
4-121 Fire Control: Guns.
4-126 Antiaircraft Artillery: Service of the Piece—90mm AA Gun on M1A1 Mount.
4-127 Antiaircraft Artillery: Service of the Piece—90mm AA Gun M2, on Mount M2.
4-128 Antiaircraft Artillery: Service of the Piece—4.7-inch AA Gun.
4-144 Antiaircraft Artillery: Service of Radio Set SCR-584.
4-146 Antiaircraft Artillery: Service of Radio Set SCR-545.
4-155 Service of the Piece—Caliber .50 AA Machine Gun.
44-2 Employment of Antiaircraft Artillery: Automatic Weapons.
44-4 Employment of Antiaircraft Artillery: Guns.
44-8 Antiaircraft Operations Room and Antiaircraft Artillery Intelligence Service.
44-11 Gunnery for Antiaircraft Artillery Automatic Weapons.
44-36 Service of Antiaircraft Directors M9, M9A1, M9A2, and M10.
44-51 Fire Control: Antiaircraft Artillery Automatic Weapons.
44-57 Multiple Machine Gun Mounts.
44-59 Service of the Piece—Multiple Gun Motor Carriage M-15 and M15A1.
44-60 40mm Fire Unit.
44-61 Service of the Piece, 40mm Air Transportable 40mm Fire Unit.
44-62 Service of the Piece Twin 40mm Gun Motor Carriage M-19.
TM 44-225 Orientation for Artillery.

Seacoast:

4-5 Tactics.
4-6 Seacoast Artillery: Tactics and Technique of Controlled Submarine Mines, Buoyant.
4-7 Tactics and Technique of Controlled Submarine Mines, Ground.
4-10 Gunnery.
4-15 Seacoast Artillery: Fire Control and Position Finding.
4-20 Firing Preparations, Safety Precautions, Care and Service of Matériel.
4-24 Service of the Piece—155mm Gun M1.
4-29 Service of Seacoast Searchlight.
4-32 Seacoast Artillery: Service of the Base-End Data and Gun Data Transmission Systems.
4-74 Service of the Piece—6-inch Gun M1903A2 or M1905A2 on BC M1 and M2 6-inch Gun M1 on BC M3 and M4.
4-75 Seacoast Artillery: Service of the Piece—6-inch Gun Barbette Carriage.
4-91 Coast Artillery—Service of the Piece—90mm Gun M1 on 90mm Mount M3.
4-97 Service of the Radio Set SCR-682-A.
TM 4-305 Coast Artillery Gunners' Instruction, Fixed Seacoast Artillery First and Second Class Gunners.
4-310 Coast Artillery Gunners' Instruction, Fixed Seacoast Artillery, Expert Gunners.
4-315 Coast Artillery Gunners' Instruction, Mobile Seacoast Artillery, First and Second Class Gunners.
4-320 Coast Artillery Gunners' Instruction, Mobile Seacoast Artillery, Expert Gunners.

Field Artillery:

FM 6-20 Tactics and Technique.
6-40 Field Artillery Gunnery.
6-101 Tactics and Technique, Battalion and Battery, Motorized.
6-105 Armored Division, Artillery.
6-130 Field Artillery Intelligence.
6-135 Forward Observation.
6-140 The Firing Battery.

Outposts in "Space" Under Serious Study

The possibility of creating a military outpost hanging like a tiny "moon" far up in the skies—an "earth satellite vehicle program"—is being studied by the National Defense Establishment, Defense Secretary James V. Forrestal has revealed.

Instruction Hours

Department of the Army Circular No. 217 authorized a reduction in the 40 hours of instruction per week in the Army service schools. In courses running more than three months, reduction to 30 hours, not including study time, is permitted. For courses shorter than three months, a 35-hour week has been established.

Radar-Repellent Paint

To prevent enemy radar installations from accurately spotting U. S. Bombers, a new paint has been developed that is a poor reflector of radar waves, just as dull paint poorly reflects light waves.

Army Commissions Open to Members of Other Services

Regulations are being prepared permitting Army ORC appointment of individuals holding Reserve commissions in other Armed Services or the Public Health Service, when better utilization or training of the personnel can be effected.

Submarines Launch Missiles

Guided missiles were launched from the submarines *Ponidon* and *Diodon* during recent maneuvers off the California coast. Targets for the missiles included surface vessels as well as shore positions. Operating under simulated battle conditions, the two high-speed submarines demonstrated their effectiveness in this new phase of naval warfare. Missiles were launched while the submarines were surfaced.

Officers Applying For Extended Active Duty

Effective immediately all applications for extended active duty will be submitted *direct* to The Adjutant General, ATTN: AGPR-D, Washington 25, D. C. This includes Chaplains and Medical Officers. Warrant Officers and Enlisted Men now in active service and National Guard Officers will continue to submit their applications through military channels. The forms to complete and submit are:

DA, AGO Form 160 (Application)
WD, AGO Form 63 (Final Type Physical)
DA, Form 643B (Short Personal History)

All forms submitted in single copy. No interviews now required.

Applicants under 40 years of age may get final type physical at any recruiting main station or Army and Air Force medical facility. Those 40 and over may get their final type physical *only* at nearest Army and Air Force Medical facility. The Adjutant General will notify all officers direct by telegraph of final decision. Orders to active duty or notice of rejection will follow by mail within one week.

Additional Reserve Units

The following Reserve units have been activated since the last issue of the JOURNAL:

Indiana
- Headquarters & Headquarters Battery, 303d AAA Group, Lafayette.

Louisiana
- 449th AAA Gun Battalion (Mobile), Shreveport.

Maryland
- Headquarters & Headquarters Battery, 307th AAA Group, Baltimore.
- 372d AAA Gun Battalion, Baltimore.
- 457th AAA AW Battalion, Baltimore.

West Virginia
- 455th AAA AW Battalion (SP), Huntington.

New Retired Pay Regs Published for Reserves

A special set of regulations governing the requirements for nondisability retirement pay for the Organized Reserves was published recently by the Department of the Army. They are Special Regulations 140-60-1.

These regulations covering the retirement pay of Reserves who have completed 20 years of honorable Federal service will be the official guide to all Reserve applicants for retirement and will be distributed to all Army installations, reserve headquarters and to Unit Instructors.

Industrial College Course for NG and Reserve Officers

Special training courses in economic mobilization, conducted by the Industrial College of the Armed Forces, are being offered to 255 selected National Guard officers and the same number of Army Reserve officers during the current fiscal year. Seventeen two-week courses will be given in principal cities throughout the country. The Army has authorized attendance of fifteen Guard officers and fifteen Reserve officers for each course.

Retain Guard Status While On Active Duty

Under provisions approved by the Army and Air Force Chiefs of Staff, National Guard officers may retain their Guard unit status while on extended active duty with the armed forces.

First National Guard Training Manual Published

Publication of a 725-page National Guard Basic Manual has been announced.

Developed by the Army Organization and Training Group of the National Guard Bureau, it is the first complete manual written specifically to meet the training requirements of the National Guard.

Designed primarily for use by instructors, the manual is available for study by all members of the National Guard. It contains reference material required for conduct of the new three-year training plan of the National Guard. It covers in detail such essential subjects as leadership, drill and exercises of command; hygiene and first aid; maps and aerial photographs; military organization; individual weapons and marksmanship; small unit tactics; military teaching methods.

Distribution of the manual to the several States for the use of Army units of the National Guard will begin in February.

Additional National Guard Units

The following National Guard units have been Federally recognized since the last issue of the JOURNAL:

California
- Battery D, 272d AAA AW Battalion, Escondido.
- Battery D, 730th AAA Gun Battalion, El Cajon.
- Battery C, 746th AAA Gun Battalion, San Diego.

Connecticut
- Medical Detachment, 745th AAA Gun Battalion, Norwich.

Illinois
- Headquarters & Headquarters Battery, 229th AAA Separate Battalion, Chicago.
- Headquarters & Headquarters Battery, 768th AAA Gun Battalion, Chicago.

Louisiana
- Battery D, 105th AAA AW Battalion, Covington.

Washington
- Headquarters & Headquarters Battery, 240th AAA Gun Battalion, Seattle.

Coast Artillery Newsletters

1329th AAA TRAINING BRIGADE

New York, N. Y.

Brig. Gen. H. Russell Drowne, Jr., *Commanding*

In accordance with the new troop basis list which required the elimination of the four AAA Reserve Brigades, the 305th AAA Brigade became the 305th AAA Group on 1 Dec. 1948. On the same date the 1st Provisional AAA Brigade was organized, but on 10 December 1948 it became the 1329th AAA Training Brigade, with T/O & E 44-10-1, dated 21 October 1948. The Headquarters personnel and location at 30 West 44th St., N.Y.C. remain the same.

The Brigade now has attached 4 Groups, 1 Operations Detachment, 9 AW & Gun Battalions and 1 Provisional Guided Missile Battalion. Coast Artillery (HD) units which have previously been attached to the Brigade will soon function under their own Headquarters.

Increased interest, both by officers and also enlisted personnel, is evident through a larger attendance at the scheduled meetings of all units.

197th AAA GROUP

National Guard of New Hampshire

Colonel Albert S. Baker, *Commanding*

Recent weeks have seen major improvements in opportunities for training of units of the 197th AAA Group. Through cooperation of The Adjutant General of New Hampshire, armories now housing units of the 210th AAA AW Bn have been reinforced to permit emplacement of 40mm guns on the armory floors, thus making them available for use at weekly drills while one 90mm gun has been emplaced in a fenced in enclosure outdoors, for Battery A of the 744th AAA Gun Battalion.

All units of this Group have been conducting recruiting campaigns at a stepped up tempo since the temporary lifting of ceilings, but enrollment of new men continues to be a major problem with discharges for all causes, including enlistment in the regular services almost equal to intake.

All units of all arms and branches cooperated with the 197th Group in an "open house" ceremony at the Concord Armory on the night of 4 January which attracted 150 young men to the armory where a special educational program was presented as a part of the effort to interest young men in National Guard opportunities. This was effective and resulted in some new enlistments.

It has been announced that the 1949 field training will be held at Fort Edwards, Massachusetts, as was the case in 1948 and that it will be held during the period 30 July-14 August. Plans are now being developed to utilize recently authorized week-end training on a pay status to accomplish familiarization and preliminary fire with individual weapons in order to reduce the amount of time devoted to that type of training during the field camp. Available state ranges will be utilized for that purpose.

302d AAA GROUP

Cincinnati, Ohio

Colonel John M. Welch, *Commanding*

Effective 21 September, 1948, general orders from Hq. Second Army were received, redesignating the 113th AAA Brigade, Class "B" unit activated 12 February, 1947, as the 302d Group. Reassignments of officer and enlisted personnel have been made in compliance with new TO & E's.

After returning from summer camp, the Group, and attached 301st Operations Detachment under the command of Capt. Newton A. Brokaw, have resumed intensive armory training. All personnel are actively participating in the conduct of a continuing problem involving the hypothetical antiaircraft defense of the city of Cincinnati.

The current phase of this problem finds the organization conducting training in all phases of AAOR operations. Because the training policy of this unit has constantly insisted on learning by doing, all personnel are receiving practical work in the actual construction of permanent plotting and situation boards. As these pieces of equipment are completed, they will be used as training aids in the conduct of tactical exercises.

In addition to the regular training program, another activity of the unit is the annual encampment, which will take place in February. It involves a motor march to the home of the Group Commander, where a party will be held to celebrate the anniversary of the unit's activation.

COAST ARTILLERY ORDERS

Adams, Herman H., Capt., to Far East Comd., Yokohama, Japan.
Anderson, Charles A., Lt. Col., to 6707th ASU, ORC Instr. Gp., Seattle, Wash.
Armstrong, Jack, 2d Lt., to 17th FA Bn., Ft. Sill, Okla.
Armstrong, George J., Capt., to 2314th AUS, 2d Army Rctg. Dist., Richmond, Va.
Baisley, Thomas M., 1st Lt., to CIC Det., Whitehall St., New York, N. Y.
Barney, James M., Capt., to Far East Comd., Yokohama, Japan.
Barrett, John T., Lt. Col., to Armed Forces Staff College, Norfolk, Va.
Barrow, Emmett W., Maj., to 35th AAA Brig., Ft. Bliss, Tex.
Barry, Thomas P., 1st Lt., to 15th AAA Automatic Wpns. Bn. (SP), Ft. Bliss, Tex.
Beaumont, Charles R., Lt. Col., to US Army Gp., Athens, Greece.
Betts, George, Capt., to CIC Cen., Cp. Holabird, Md.
Blizzard, Joe W., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Broillet, Eugene H., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Brown, Charles B., Capt., to Ryukyus Comd., Okinawa.
Buchanan, James R. T., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Caldwell, Ralph W., Capt., to US Army, Caribbean, Quarry Heights, C. Z.
Carey, Howard H., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Chenney, John P., 1st Lt., to Ryukyus Comd., Okinawa.
Churchill, L. G., 2d Lt., to Arty. Sch., Ft. Sill, Okla.
Cooksey, Cecil H., 2d Lt., to US Army, Caribbean, Quarry Heights, C. Z.
Cooper, Avery J., Lt. Col., to Ft. Lawton Pers. Cen., Seattle, Wash.
Cordell, Ben E., Col., to Fourth Army Hq. Rctg. Dist., Alexandria, La.
Crews, Leonard R., Col., to Hq. Sixth Army, San Francisco, Calif.
Cubbage, Ransom B., Capt., to 450th Automatic Wpns. Bn., Ft. Bliss, Tex.
Cupps, Cecil C., 1st Lt., to 34th AAA Brig., Ft. Bliss, Tex.
Davis, Francis A., 1st Lt., to 4052d ASU, AAA and GM Br., Ft. Bliss, Tex.
Dickens, Fletcher P., 1st Lt., to Ryukyus Comd., Okinawa.
Donnelly, James J., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Dutton, Donald L., Col., to 1274th ASU Off. of the Sr. Instr., NG of Del., Wilmington, Del.
Epperson, Wallace H., 1st Lt., to Pers. Cen., Cp. Stoneman, Calif.
Faulhaber, George B., 1st Lt., to 15th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Ferguson, Lawrence P., 2d Lt., to Ryukyus Comd., Okinawa.
Finnegan, Daniel J., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Fladmark, Lorentz W., 2d Lt., to Ryukyus Comd., Okinawa.
Fort, Alvin E., 1st Lt., to AA and GM Br., Arty. Sch., Ft. Bliss, Tex.
Fonielle, John A., Col., to Hq., Sixth Army, San Francisco, Calif.
Ford, Clarence B., Capt., to I & E, Ft. Sam Houston, Tex.
Forteau, Maxwell B., 1st Lt., to 503d A/B AAA Bn., Ft. Bragg, N. C.
Fowler, Harold J., 2d Lt., to Ryukyus Comd., Okinawa.
Frederick, Robert T., Maj. Gen., to Fourth Inf. Div., Ft. Ord, Calif.
Fuller, William M., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Furman, Hezekiah W. C., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Gagnon, Nelson C., 1st Lt., to Ryukyus Comd., Okinawa.
Gelsthorpe, Francis D., 1st Lt., to Pers. Cen., Cp. Stoneman, Calif.
Gifford, James R., Lt. Col., to 15th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Graham, D. M., 2d Lt., to Arty. Sch., Ft. Sill, Okla.
Green, Harry F., 2d Lt., to US Army, Caribbean, Quarry Heights, C. Z.
Green, Russell, 1st Lt., to I & E, Chicago, Ill.
Gunlack, Philip J., Maj., to Pers. Cen., Cp. Stoneman, Calif.
Hamer, Charles F., 1st Lt., to Ryukyus Comd., Okinawa.
Hamer, Valcus W., 1st Lt., to Pers. Cen., Cp. Stoneman, Calif.
Hamscher, George M., 1st Lt., to 34th AAA Brig., Ft. Bliss, Tex.
Harnett, Robert W., Lt. Col., to Cp. Gordon, Ga.
Harrington, Lonnie E., 2d Lt., to Ground Gen. Sch., Ft. Riley, Kans.
Harrison, W. R., 2d Lt., to Arty. Sch., Ft. Sill, Okla.
Harwood, Dewey S., Maj., to 15th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Heard, Walter S., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Hemenway, Robert W., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Hendrix, Raleigh R., Col., to OC of S, Washington, D. C.
Hengtgen, Arnold W., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Hinson, Mason W., 1st Lt., to Pers. Cen., Cp. Stoneman, Calif.
Hock, Leo J., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Holt, Roger H., Lt. Col., to 450th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Homme, Herbert T., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Hoehn, George R., 1st Lt., to Ryukyus Comd., Okinawa.
Huntsman, James C., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Hutter, Robert J., 1st Lt., to Far East Comd., Yokohama, Japan.
Inskeep, James H. W., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Jones, Harry T., 2d Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Jones, J. W., 2d Lt., to Arty. Sch., Ft. Sill, Okla.
Jones, William J., Capt., to CIC Det., Second Army, Ft. Meade, Md.
Kallis, Stephen A., Lt. Col., to Fourth Army Hq., Ft. Sam Houston, Tex.
Kean, J. P., 2d Lt., to Arty. Sch., Ft. Sill, Okla.
Kelley, Stanley, Lt. Col., to Sr. NG Instr. for Mass., Boston, Mass.
Klech, William S., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Koscielniak, Adam A., Lt. Col., to Hq., First Army, Governors Island, N. Y.
Kuchera, E. A., 1st Lt., to EUCOM, Bremerhaven, Germany.
Kull, Francis C., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Ladd, Leon H., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Lane, Alton L., 1st Lt., to Ryukyus Comd., Okinawa.
Lane, John J., Lt. Col., to GSC, GSUSA, Washington, D. C.
Laplue, James C., 1st Lt., to Far East Comd., Yokohama, Japan.
Lederman, Milton D., Maj., to Fourth Army, AAA and GM Br., Ft. Bliss, Tex.
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Neuer, Arthur, 1st Lt., to Ryukyus Comd., Okinawa.
Niehoff, John J., 1st Lt., to Pers. Cen., Cp. Stoneman, Calif.
Nolan, William A., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Oakley, Ward S., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Ogden, Milton L., Lt. Col., to Cp. Kilmer, N. J.
Owens, Ednor L., 1st Lt., to Far East Comd., Yokohama, Japan.
Pajunas, Albert, Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Palmer, Robert E., Capt., to 35th AAA Brig., Ft. Bliss, Tex.
Parrish, Cleon, 1st Lt., to Ryukyus Comd., Okinawa.
Pechulis, Frank V., Capt., to 450th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Peterson, William H., Maj., to Hq., Sixth Army, San Francisco, Calif.
Piram, Joseph S., Lt. Col., to Hq., Fifth Army, Chicago, Ill.
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Redlinger, M. J., Jr., Maj., retired.
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Sage, Alfred E., 1st Lt., to Ft. Riley, Kans.
Salter, James D., Maj., to 35th AAA Brig., Ft. Bliss, Tex.
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Scott, John J., 1st Lt., to 15th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Sette, Edward F., Capt., to 15th AAA Automatic Wpns. Bn., Ft. Bliss, Tex.
Seward, John R., Col., to US Army, Pacific, Ft. Shafter, T. H.
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Shugert, James M. H., 1st Lt., to Far East Comd., Yokohama, Japan.
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Sinkovic, William V., 1st Lt., to 15th AAA Automatic Wpns Bn., Ft. Bliss, Tex.

Skitsko, George, Capt., to 34th AAA Brig., Ft. Bliss, Tex.
Snodgrass, John T., Lt. Col., to OC of S, Washington, D. C.
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Stoker, Lyle D., 1st Lt., to Ryukyus Comd., Okinawa.
Soule, John L., Capt., to Ryukyus Comd., Okinawa.
Tarves, Harry J., Capt., to Far East Comd., Yokohama, Japan.
Telman, Harry, 1st Lt., to Hq., Fifth Army, Chicago, Ill.
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Tongue, Robert C., 1st Lt., to 35th AAA Brig., Ft. Bliss, Tex.
Toth, David, 1st Lt., to 34th AAA Brig., Ft. Bliss, Tex.
Turner, Robert A., Lt. Col., to 35th AAA Brig., Ft. Bliss, Tex.
Uldrick, John R., 1st Lt., to US Army, Caribbean, Quarry Heights, C. Z.
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Underwood, Vernon L., 1st Lt., to US Army, Caribbean, Quarry Heights, C. Z.
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Upp, Waldeen, Capt., to Far East Comd., Yokohama, Japan.
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Wilson, James H., 1st Lt., to Ryukyus Comd., Okinawa.
Winters, William W., 1st Lt., to Far East Comd., Yokohama, Japan.
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