THE AERIAL BOMB

by Col. S. R. STRIBLING

Aviation ordnance has progressed far since World War I days, when a flyer tossed his bombs overboard by hand.

The bombing airplane might be classified, with but little stretch of the imagination, as artillery. The difference between the projectiles (that is, a bomb dropped by an airplane and a high explosive shell thrown by a cannon), is mostly one of size. The airplane could be considered either as a gun which fires a projectile, or as a compound projectile fired from a gun in the form of an air base. In the latter case, gasoline is the propelling charge in place of the smokeless powder used to fire projectiles from cannon. The range, however, is many hundreds of miles as compared to the 10 or 20 mile limited range for artillery.

The principal difference between aerial bombs and artillery shells originates from the two contrasting means to keep them from tumbling in their flight through the air. The artillery shell is rotated by rifling in the gun, while the bomb has tail fins. Both are provided with fuses by which the moment of explosion is controlled.

Both are developed and produced by the Ordnance Department of the US Army.

When bombing was first conceived, the airplane was young and there were no antiaircraft guns. Therefore, flying low, all a bombardier had to do was to throw bombs over the edge of the cockpit onto a close and defenseless target. This condition did not last long, and as antiaircraft artillery of progressively longer ranges was developed, bombers were driven...
higher and higher. This made accurate bombing increasingly difficult. Bomb sights were developed and improved for bombing from high altitudes, others for bombing while diving on the target.

There are two distinct types of bombing, level flight and dive bombing. A whole science known as ballistics has been built on artillery fire: an entirely new science on bomb projection. We say projection advisedly, because a bomb, released during level flight, has the forward impetus of the plane and travels horizontally while it drops vertically. The horizontal travel is called the range and this distance varies with the height and speed of the plane, and design and weight of the bomb. The path actually traveled (trajectory) approximates a parabola. (The path in dive bombing is different.) However, the air speed of a plane may often vary from its ground speed. While a plane may be rated at 300 mph and actually reel off land miles at this rate on a still day, a head or tail wind decreases or increases ground speed. Also, a cross wind will cause a drift and impart a sidewise movement to the forward movement of the bomb.

All this must be taken into consideration when releasing bombs on
streamlined. The streamline design of demolition bomb was an earlier development and has been supplanted by the modern, cylindrical bomb. The lighter ones are used against such targets as ammunition dumps, airplanes on the ground, hangars, small buildings, railroads and railway equipment, sea vessels such as submarines, destroyers, transports, etc. The medium weight bombs are designed for use against steel and reinforced concrete bridges, approach spans, docks, subways and sea craft such as light cruisers. The larger ones are effectively destructive to massive structures such as the largest bridges and dams, etc. and seacraft on the order of battle cruisers and battleships.

As a maximum charge of explosive is desired, the steel body is made as light as consistent with the strength necessary to withstand impact stresses. Usually the explosive charge is about half of the total weight of the bomb. Demolition bombs are fused to explode on impact or the detonation is delayed long enough for penetration to the interior of the target (as an airplane hangar or building). For full penetration of targets such as reinforced concrete structures, battleship decks, the ground, etc., the walls must be thicker.

When a thin-walled demolition bomb on the order of 2,000 pounds in weight, six feet in length and filled with TNT explodes, the rate of detonation is about 18,000 feet per second. Only about one three-thousandths of a second is required to change the explosive into a gas exerting a pressure exceeding a million pounds per square inch. This gas travels in all directions at a velocity that attains from 10,000 to 15,000 feet per second within a few feet. However, as the velocity increases, the pressure drops rapidly and it is the velocity (not the pressure) that is most destructive.

In other words, it is the destructive power of, a wind traveling at a speed on the order of 7,000 miles per hour. Contrast this with the demolition effect of a typhoon or tornado traveling at only 100 or 150 mph and you have a very inadequate conception of what happens. However, the velocity of the gases, and therefore the blast effect, becomes small at about 50 feet. At the same time a partial vacuum has been created within the gas mass. If the bomb has penetrated a building, two actions occur, pressure against the walls and roof tending to push them out immediately followed by a suction tending to pull them in as the gases rush back to fill the vacuum. If the building withstands the first, it is often so weakened as to succumb to the latter.

Demolition bombs fragment into splinters ranging in number from around 1,400 to 6,000 (most of which weigh less than an ounce). These splinters fly in all directions at from 4,000 to 7,000 feet per second and, if in the open, travel to distances of from 100 yards to nearly a mile. If penetration of the target is first achieved their travel is limited thereby. Cratering, or the blowing out of a hole in the ground, varies with the type and size of bomb. The amount of earth blown out depends upon the character of the soil but varies from about 25 cubic yards for a 100-pound bomb to something like 1,000 cubic yards for a 4,000 pound bomb. The mining effect is a wave pressure through solid material, similar to that produced by mines. This wave pressure, set up by bombs exploding below the surface of the ground, if strong enough will undermine the foundations of buildings and damage underground utilities such as water and gas mains, electric cables, etc.

The detonation of a bomb is through what is known as an explosive train. This consists usually of the fuse, primer, detonator, booster, and the explosive charge proper. This combination detonates on impact. If delay is desired, a delay element is interposed between the primer and detonator. High explosive must be comparatively inert so that it will not explode while penetrating a target or from machine gun bullets. TNT and amatol fulfill this mission so well that they will not detonate without the explosive train described above, each element progressively more sensitive, down to the primer which fires when hit by the firing pin, a small metal striker. Tetryl is commonly used in the booster and fulminate of mercury or lead azide in the primer although there are other military explosives that can be used in their stead. Usually, and for reasons of safety, fuses are shipped separate from the bombs and are assembled just before using. The delay element, interposed in the train, may be a pellet of black powder or an increment of slow burning fuse. Delays are on the order of 0.025 second, 0.10 second on up to 45 seconds.

Demolition bombs are equipped with fuses in both the nose and tail but fragmentation bombs have only the nose fuse. The box type of fin
assembly permits the insertion of the tail fuse without removal of the fins. Bomb fuses are provided with devices to make them safe in handling and loading. The safety devices are of two main types (arming vane type and arming pin type) and may be employed in either nose or tail fuses. Nose fuses act upon impact by driving the firing pin into the primer, but the firing pin of the tail fuse is carried on a plunger which continues its forward motion to strike the primer when the bomb is stopped by the target. Fuses arm (throw off the safety) only when released from the plane. This is accomplished by an arming wire extended from the safety mechanism of the fuse to the bomb rack, and when the bomb is released, the safety wire is jerked out of the fuse which is then ready to function.

In the case of the arming vane type of fuse there is a small propeller or windmill which the arming wire maintains immovable until jerked loose. However, the bomb is still unarmed (safe) until the rush of air, during the descent of the bomb, has turned the vanes a sufficient number of times. The rotation of the vanes unsecrews another safety device which drops out at a safe distance below the plane, leaving the firing pin free to strike the primer on impact. The arming pin type of fuse may be designed to arm immediately after the arming pin is ejected, or a time delay may be initiated when the pin is ejected.

One of the main reasons for having both nose and tail fuses is to have one in reserve in case the other fails to function. Another is selectivity. While some nose fuses can be set for "instantaneous" or "delay" by the bombardier, no tail fuse is equipped for instantaneous action. The firing pin of a tail fuse, as already stated, is on a plunger which throws it forward into the primer when the bomb hits the target. This takes slightly longer than when the firing pin is driven by the target into the primer as in the nose fuse. The short delay is for target penetration while delays up to a minute are designed to allow a low flying bombing plane time to get away before the explosion. Delays of hours or days are used to "close" territory and for their effect on morale.

The classification chemical embraces aerial bombs loaded with any type of chemical such as incendiary, smoke, gas, etc. Incendiary bombs are standardized in two and four pound weights and are magnesium or thermite. They are carried in clusters and are scattered over effective areas. Also standard is a 100-pound incendiary bomb. There are other incendiaries of various weights and inflammable fillers. For instance, there is a smoke bomb weighing 30 pounds and filled with phosphorescent which can be used to produce a smoke screen or for its incendiary effect. In addition, there are practice bombs, classified as "inert" and used in training. The most effective type of incendiary bomb commonly used abroad in the present war is the so-called thermite bomb. It is a magnesium alloy tube filled with thermite or a similar mixture and weighs a little over two pounds. Thermite is a mixture of iron oxide and aluminum (both powdered). The thermite is fired with a priming mixture and in turn sets fire to the magnesium case. While the burning thermite creates a temperature of around 5,000 F., it lasts only 40 to 50 seconds so the principal incendiary is the magnesium alloy tube which creates only about half the temperature, but burns for from 10 to 20 minutes, and ignites anything inflammable within a few feet of it. There are also the "calling cards" of the British, discs of absorbent paper dipped in a phosphorus solution. These are kept moist and thus harmless, but soon dry out after being dropped on enemy territory and ignite spontaneously.

Under the heading of pyrotechnics are included signals and flares with a number of varying missions. Signals are of various types and colors, and may or may not have parachutes. Also they may be fired from an airplane or from the ground. Flares are released from the airplanes for reconnaissance, for taking night photographs, to illuminate the ground for landing and to show up a target in night bombing. These flares range in brilliancy up to a million candle power. Bombardment flares are commonly provided with time fuses so that regardless of the altitudes at which they are released they will function at a predetermined height above the target, usually some 3,000 to 5,000 feet. At this point the flares are ignited and parachutes opened. Descent thereafter is on the order of 10 feet per second and they burn for approximately five minutes.

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