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THE AIR BURST PROXIMITY FUZE

for

BOMBS, ROCKETS AND MORTARS

A brief story of the development, production, and use of these radio proximity fuzes, with some of the historical circumstances, is presented. The project was sponsored, administered and supported by the National Defense Research Committee jointly with the Army, with the National Bureau of Standards serving as the central laboratory.

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V. THE GENERATOR-POWERED ROCKET FUZE

After the bomb fuze development had passed into the manufacturing stage, the Navy proposed that the OSRD adapt this type for use on the new Navy 5" aircraft rockets. These rockets carry a modified five-inch shell as the warhead and are about six feet long. One type, the AR (aircraft rocket) weighs about 85 pounds and attains a velocity of about 700 feet per second, and the other type, the HVAR (high velocity aircraft rocket) weighs about 140 pounds and attains a velocity of 1300 feet per second. These rockets can be fired from airplanes with remarkable accuracy using launching equipment so small that it adds very little drag to the airplane. Eight of these rockets were mounted under the wings of airplanes, thereby providing them with the equivalent of heavy caliber guns. They were used with great effectiveness by both the Army and the Navy

Preliminary field tests at Blossom Point, Maryland, using bomb fuzes on these rockets, established the feasibility of using this type of fuze on the AR; however, some difficulties were experienced with the HVAR. Accordingly, in September, 1944, Division 4, NDRC, was requested to design a fuze suitable for use on the AR, which could be produced in a minimum of time.

Additional laboratory work and field testing established that the bomb fuze being manufactured by the Philco Corporation could be readily adapted to use on this rocket for either the air-to-air application or air-to-ground use. The major modification required was in the arming system. Whereas in the bomb fuzes, arming is accomplished by travel through the air, in rockets it is desirable to utilize the acceleration the rocket experiences in launching to provide additional safety. Accordingly, J. Rabinow of the Bureau Staff designed a switch which was physically interchangeable with the gear train used in the bomb fuzes, of such a nature that an acceleration of the order of 10 times the acceleration of gravity for a duration of 0.5 seconds accompanied by an air travel of about 300 feet was required for the fuze to arm.

Upon completion of the design of the electrical and mechanical modifications, pilot production was begun at Bowen and Company in October, 1944, and the design was proved in during the following weeks. In November Philco was asked to initiate production of the air-to-ground version of this fuze; and in December, 1944, General Electric, also manufacturing bomb fuzes, was asked to start production of the air-to-air version.

The air-to-ground fuze gave less trouble in production than did the bomb fuzes since it was necessarily less sensitive (to provide optimum burst heights over ground), and experience gained in manufacture of the bomb fuzes was fully utilized in manufacture of the rocket fuze. Production at the Philco Philadelphia Plant began in April, 1945, under a Signal Corps contract, and continued until the end of the war. A high field test quality level was maintained throughout production. Production of the air-to-air fuze by the General Electric Company at Schenectady began in July, 1945. Excellent cooperation and testing was furnished by the Naval Ordnance Test Station at Inyokern, California.

Development of a new rocket fuze meeting all service requirements was virtually complete in June, 1945. It featured an enclosed turbine drive for the generator and gear train, self-destruction and variable arming time as field options, and a change-over switch for air-to-air or air-to-ground operation. The mechanical design was similar to that for the mortar fuzes, there being considerable reduction in size over previous rocket fuzes.

VI. THE MORTAR FUZES

VT fuzes having been successfully developed and produced for all common projectiles except trench mortars, and designs having progressed to the point where a VT fuze small enough for the eight-pound mortar projectile appeared possible, Division 4, NDRC, and the National Bureau of Standards were asked to undertake this development. Preliminary design work started in the late spring of 1944, and the project was given top priority by the Army early in 1945. The Bureau of Standards contract with Division 4, NDRC, was taken over by the Ordnance Department on May 1, 1945, and the mortar fuze development project was carried out thenceforth under the joint direction of the Ordnance Department and Division 4, NDRC.

The design of a fuze for the eight-pound mortar required the solution of two major problems; ruggedness and size. Whereas the early rocket fuzes were designed to withstand a shock 1000 times the force of gravity and the bomb fuzes had to stand up under normal rough handling in use, a mortar fuze must withstand a firing shock of 10,000 times the force of gravity. In addition, mortar projectiles are so small that fuzes of the size of those used on bombs would spoil the flight of the projectile and make the round useless. Wind tunnel experiments indicated that if the VT fuze could be held to a diameter of 2-1/8 inches and a length of some 3 inches, satisfactory operation could be obtained. This required a reduction of 3 to 1 in volume as compared to bomb and rocket fuzes and yet the fuze was required to perform all the functions of these fuzes.

Early design work followed two general patterns. Globe-Union, Inc., cooperated with the National Bureau of Standards under Division 4, NDRC, contracts in a design of a fuze whose general features followed the earlier rocket and bomb fuzes, but whose detailed design represented a marked advance over earlier models. A novel and highly significant feature of this design, carried out by Globe-Union at the request of Division 4, NDRC, was the manufacture of circuit components, such as resistors and condencers and the connections between them, by a new process involving the use of ceramics, thereby obtaining a material saving in space. This is a radical departure in assembly technique and may relegate other methods to the museum.

The second design was prosecuted in its development stages by the University of Florida, and used a small loop antenna instead of the projectile body antenna. The circuit design and

power supply followed closely the designs of previous fuzes. A small number of models were constructed by the University of Florida and successfully tested. This design was taken over and engineered for production by the Zenith Radio Corporation.

A variation of the first design, developed by the Rudolph Wurlitzer Company in collaboration with National Bureau of Standards engineers, was externally similar to that built by Globe-Union, but differed from it in internal design.

The operating characteristics of the two types of fuzes differed in the same manner as the characteristics of the two types of bomb fuzes previously described. Since it was known that both would give good operation, and since no experimental evidence was at hand to demonstrate the superiority of one over the other, it was decided to build both types. Zenith Radio Corporation, Globe-Union, Inc., and the Rudolph Wurlitzer Company were asked to produce the fuzes on a large scale.

Again the urgency of the need for the fuzes dictated production prior to completion of development. Development and preparations for production proceeded simultaneously and in June, 1945, the Globe-Union Company, the first in the field, started their production schedule.

Extensive field testing was carried on from March through July, 1945, the test results furnishing the main guide to improvement in fuze quality.

Throughout the development and early production period, field testing was done at the National Bureau of Standards field station at Blossom Point, Maryland, under the direction of R. C. Tobey and at the University of Iowa field station at Clinton, Iowa, under the direction of C. E. Noble.

At the close of the war the Army production program for 100,000 mortar fuzes per month was beginning at the Globe-Union Company of Milwaukee and their subsidiary, Rewelec Mfg. Company of Lowell, Mass. Designs were complete at Zenith and Wurlitzer, and procurement was well under way for an additional 300,000 fuzes per month from these plants. The close of the war brought abrupt cancellation of all of these contracts which had been initiated against the contingency that war in the Pacific would last until mid 1946 or early 1947.