Destroyer Electronics -- Then and Now

By E. H. Fitzgerald
and
J. L. Baker
Ship Type Electronics Engineering Branch,
Bureau of Ships

To appreciate the advancements made in the electronics installation in a fleet destroyer, it is only necessary to go back a quarter of a century and live again the "good old days" on a U.S. Navy "four-piper tin can."

The missions of the "tin cans" were comparable to some extent with the missions of the later destroyers: antisubmarine work, screening for the battle line, scouting, delivering high-speed torpedo attacks on enemy surface ships, gunfire assaults on attacking ships, and, to a much lesser extent, anti-aircraft fire. It can be truthfully said that the expression "they were expendable" applied to the old four-pipers.

To carry out its mission, the destroyer of 25 years ago had a very small electronics installation consisting primarily of three basic types: Radio, sound listening devices, and a direction finder.

The radio room on the main deck immediately below the bridge was approximately 8 by 10 feet. Installed in the radio room were the transmitters and receivers with position facilities for three operators.

The standard installation consisted of a model TU series transmitter for low-frequency coverage and a model TAD transmitter for medium-frequency coverage. Destroyers of that era had no requirement for a high-frequency transmitter and none was installed.

The frequency coverage of the TU was from 155 to 565 kilocycles and consisted of 7 electron tubes with a rated output of 2,000 watts. The TU had a two-wire flat top antenna 150 feet long with a downlead of approximately 40 feet. Many stories have been told of the amazing ranges obtained by the transmitter and antenna.

A typical story, which has been substantiated many times, is of a working contact between a ship in the Canal Zone and a shore station at San Diego, or even as far north as Bremerton, on the old ship-shore frequency of 355 kilocycles. Other ships have worked similar distances between the Canal Zone and east coast shore stations.

However, it must be remembered that those ships could have flattop antenna lengths of 150 feet, whereas the picture has changed drastically with the advent of later types of destroyers and greater quantities shipboard electronic equipment and associated antennas.

The TAD covered a frequency band from 2,000 to 3,000 kilocycles and had 2 electron tubes with a rated output of 100 watts. The TAD was, by its nature, a short-range medium-frequency transmitter used primarily for division or squadron communications during tactical maneuvering and for routine traffic when in port. It had a vertical wire antenna about 40 feet long for a radiator.

Three receivers were provided on those ships--models RE, RF, and RG, with a combined frequency coverage of 10 kilocycles to 20,000 kilocycles. The oldtimers will well remember these receivers for their wonderful "microphonic" response when they were tapped with a finger or hand, or while an operator was trying to copy a weak signal with a typewriter. The receivers had the "peanut" type of electron tubes, which were battery operated, with 2 volts on the filament and 45 volts on the plate.

The direction finder was a standard low-frequency receiver with some added refinements. It had a rotatable loop antenna that was mounted atop the after deckhouse. Its function was to determine the bearing of a received signal within the frequency range of the receiver.

The sound installation on a 1930 destroyer was very limited, consisting of several hull-mounted hydrophones on the port and starboard sides. The hydrophones were connected to a receiving device in the ship by which a good operator could obtain approximate bearings of contacts.

In the early thirties an underwater telegraph communication system was developed and installed. This equipment contained a total of 30 vacuum tubes and had two transmitting antennas and three receiving antennas.

The total cost of the electronic installation in a four-stack destroyer was about $30,000. The cost to install was approximately $7,000. These figures, it must be remembered, were the going price during the days of the depression, and no comparison between them and similar costs today is intended.

To maintain and operate the equipment on a typical 1930 destroyer, the ship was allowed, and usually had on board, a chief radioman, one radioman of each first, second, and third classes, and a striker.

The "chief," who was usually the material man, was charged with the maintenance and upkeep of the equipment. He was assisted in this job by the first-class radioman. The second- and third-class radiomen and the striker usually stood the operator watches except when more than one watch stander was required.

Maintenance was of a minor nature. It consisted primarily of battery charging, tube changing, occasional receiver repair, and once in a great while transmitter or motor generator repair.

In the mid-thirties the Navy acquired the first new destroyers built in about 15 years. These destroyers incorporated many improvements over the four-pipers in tonnage, hull length, beam, topside outline, engines, ordnance, and electronics. The new ships were grouped under classes that were determined by various differences in construction or equipment, but the electronics installation on all of them was essentially identical.

Each ship had a low-frequency transmitter model TAJ covering a range from 175 to 600 kilocycles; a medium-frequency, high-frequency transmitter covering 2,000 to

18,000 kilocycles; a low-frequency receiver model RAA covering 10 kilocycles to 1,000 kilocycles in five bands; and a medium-frequency, high-frequency receiver model RAB covering 1,000 kilocycles to 30,000 kilocycles in eight bands.

The RAA and RAB models were the first superheterodyne receivers installed in destroyers. They were the first receivers that could be operated from the ship's powerline, a capability that eliminated the need for batteries.

In addition to the radio transmitters and receivers, each ship had a low-frequency direction finder and an improved underwater sound installation. For the first time, a sonar equipment with echo-ranging capabilities was installed in destroyers. The first of these equipments was designated model QC.

The QC equipments, plus later models such as the QCA and QCB, were the mainstays of U.S. antisubmarine warfare all through World War II. Many refinements and some improvements in presentation of information, such as the bearing deviation indicator (BDI), were installed as rapidly as they were produced and furnished to the Fleet.

When World War II began, and as equipments became available, destroyers and other Fleet units were outfitted with a new development in electronics--radar.

The first types of radar to be installed on destroyers were the SC series air search radar, the SG series surface search radar, and the FD (later designated mark 4) fire control radar. All of these radars did yeoman work throughout World War II. U.S. superiority in radar equipment and operating personnel were major contributing factors to success in surface and air-surface battles.

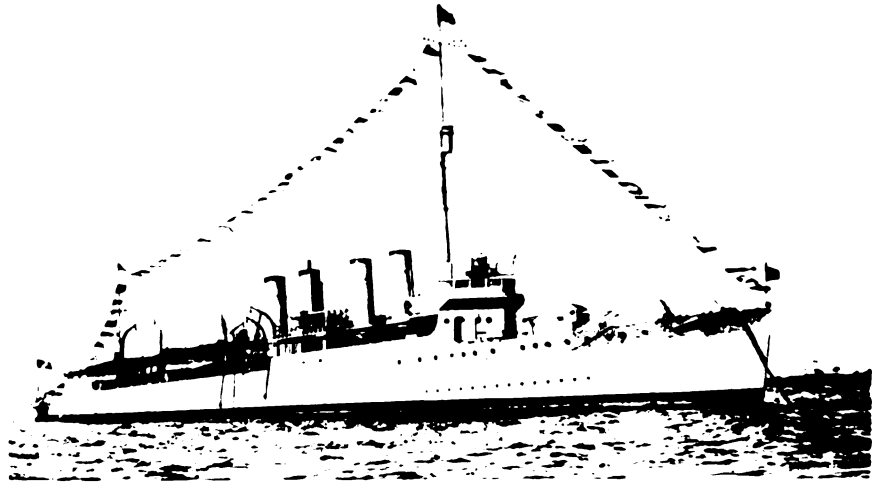
However, as most oldtimers will remember, it was sometimes difficult to persuade skippers and gunnery officers of the value of the new device. But later, when these officers were alerted to the presence of an enemy surface or aircraft long before human lookouts spotted them, and when, after proper acquisition of the fire control radars, the enemy was fired on and hit or sunk, even before the optical rangefinder could come into operation--who then could deny radar capabilities?

In the night battles of the war, radar really came into its own. For at night, no other method than radar can detect approaching enemy craft, and no other method can obtain range, bearing, course, and speed.

Before the close of World War II, many other new techniques appeared in destroyers and in other types of ships. An electronic method of identification in which the principles of radar were used was introduced. It proved satisfactory, particularly in the identification of approaching aircraft.

The cost of the electronics installation (not including that of fire control radars) on a Fletcher-class type of destroyer at the end of World War II was about $150,000. The cost to install the equipment was about $50,000. The total number of electron tubes in a typical installation was many times the number contained in a four-stack destroyer; the two radars alone had more than 100 tubes.

The number of technicians allowed, and on board, had not at that time been increased commensurate with the increase in quantity and complexity of equipment. Many destroyers had on board only one or two qualified technicians to



Top: The USS Gamble (DD-123) before her conversion to a high-speed minelayer in 1929. The Gamble was typical of the four-stack destroyers of World War I. Bottom: A broadside view of the USS Forrest Sherman (DD-931), the first in the latest class of Fleet destroyers.

maintain all of the electronics equipment, including the fire control radars. This situation has, unfortunately, deteriorated even more in the past few years.

From the close of World War II until the present the Bureau of Ships has been constantly striving to place the latest types of electronic equipments in destroyers. Improvements have been made in all fields of the art.

- Surface search radars have been improved to the point that commanding officers rely on them almost exclusively for bad weather navigating and close quarters operations.
- Longer ranges and better methods of presentation have been incorporated into the air search radar and associated equipment.
- Remote indicators of radar equipments are now installed in all the vital spaces of a Fleet destroyer.
- Facilities are provided to operate practically any one of the radars installed in the ship. Thus the radar information can be used by responsible officers at strategic locations throughout the ship without interfering with the operations at any other location.

In addition to the improved air and surface search radar facilities, a third type of radar has been installed in certain destroyer types. It is referred to as a height-finding radar and is used in antiaircraft defense almost exclusively.

However, in case of a failure of the conventional air search radar, the height-finding radar can be used for that purpose and still continue to function as a height-finder. This radar determines range, bearing, and height of any aircraft from which it receives an echo. It has a high-power radiofrequency output and provides reliable long-range capabilities.

New and greatly improved methods of electronic identification have been incorporated into the electronics installation in destroyers. They function in a manner similar to their predecessors but have many refinements and advantages.

Great strides have been made in electronic countermeasures, and the very latest of these equipments are installed in our Fleet destroyers. Enemy electronic transmissions of practically any type can be intercepted and analyzed without the enemy's being aware that he has been detected. Further, through special circuits and antennas, his bearing and range from the intercepting ship can be determined.

Perhaps the greatest strides in destroyer electronic installations have been made in the underwater sound field--principally since one of the primary missions of a destroyer is antisubmarine warfare.

The Navy is constantly striving to obtain greater reliable underwater detection ranges. Longer ranges are necessary because of increase in speed capabilities of submarines during the past few years. However, long-range detection is not the only improvement in the sonar field.

The Navy has made many improvements in the methods of presentation of information obtained through sonar equipment. New concepts of antisubmarine warfare have been developed that require the utmost in coordination between the equipment and other departments in the ship.

Underwater communication capabilities have been vastly improved during the past few years, and for navigation purposes Navy depth-determining equipments are the best.

Other important improvements have been made in the communications field on a new Fleet destroyer. An example is the very latest class, the DD-931. In these ships, the class allowance consists of four medium-frequency, high-frequency transmitters, with variable power output and flexible frequency coverage adequate to meet the requirements of present-day communications.

In addition to the MF/HF transmitters, the ship has a large number of manually and automatically operated ultra-high-frequency transmitters. Two very high-frequency transmitters are installed, but they will eventually be replaced with UHF equipment. To operate with these transmitters are an equivalent number of manually and automatically operated receivers covering the same frequency range.

To connect the transmitters and receivers properly many transmitter and receiver switchboards have been installed in the main radio room, in the combat information center, and in auxiliary radio. This arrangement gives maximum flexibility of use of the equipment from any space on the ship that has the necessary remote control facilities. Some spaces so equipped are the pilothouse, the open bridge, the underwater battery plot, and, of course, the radio central and the CIC.

The modern destroyer also has three teletypewriters and associated terminal equipment providing for transmission and reception of printed page messages at 60 words a minute. The teletypewriters are in radio central and CIC.

The space required to install the radio communication equipment on a DD-931-class destroyer is about 300 square feet, not including that required at the remote operating positions nor for all the bulkhead-mounted components. Large though this may seem to the old destroyer man, the "shack" is still cramped for space. Without miniaturization and compactness, the space requirements would be absolutely prohibitive on this type of ship.

However, reduction in size by miniaturization techniques has placed an almost unbearable burden on the technical force of the ships. No longer is it possible to make repairs and test the receivers and transmitters with a "pair of gas pliers" and a "borrowed multimeter."

The total cost of the electronics installation (not including fire control) on a DD-931-class destroyer is about $700,000, and the cost of installation $355,000.

To illustrate the increase in the maintenance load, the number of electron tubes used today can be compared with a World War II destroyer, and, even farther back, the old "four pipers." The complete electronic installation on the DD-931 class takes approximately 4,000 electron tubes and the circuits necessary to operate with

them. When the 4,000 tubes are compared with the 30 on the old destroyers and with about 250 on the World War II destroyers, the increase in maintenance is readily apparent.

The technical force allowed for the DD-931 is a chief electronics technician, three lower ratings, and a striker. However, the technical force problem is acute, and a ship of the DD-931 class is fortunate to have three technicians actually on board.

These three, or possibly four, men are responsible not only for keeping all the installed equipment operating, but for the proper use and maintenance of some 40 pieces of extremely complicated test equipment.

FEATURES INDEX

November 1956 Through April 1957