

FIVE OF THE TWELVE 200-FOOT STEEL TOWERS supporting the giant antenna network of the Jim Creek Transmitter Station are viewed through the framework of another tower. Six towers were erected on Wheeler Mountain and six on Blue Mountain, with ten spans of antenna strung between them across the valley.

# THE NAVY'S MIGHTY VOICE

## Most Powerful Transmitter Procured by Bureau of Ships

After a little more than seven years of planning, design, and construction, the Bureau of Ships has completed its assignment from the Chief of Naval Operations to procure a high-power, low-frequency radio transmitter and to select a site from which such a radio "voice" could transmit messages instantaneously to all naval operating units located throughout the world.

On 18 November 1953 a 1,000,000-watt transmitter, located at

Jim Creek Valley in the Cascade Mountains of Washington, 55 miles northeast of Seattle and 20 miles inland from Puget Sound, went into operation. It is the most powerful transmitter in the world, having an output more than twice that of any existing military transmitter and 20 times greater than any United States commercial radio station.

Operating on a very low frequency, close to the border line where radio signals begin, the Jim

Creek transmitter can flash radio signals to Navy forces or establishments operating in any of the seven seas. Signals will penetrate to submarines cruising below the surface.

### Puget Sound Area Chosen

This transmitter also insures reliable arctic communications despite frequent magnetic storms and ionospheric disturbances. The combination of high power and very low frequency means that the transmitter's broadcast is far less affected by interference, jamming, and irregular wave propagation than the normally employed higher frequencies. It will also overcome

the handicap of those ships, particularly submarines and smaller surface craft, which do not have efficient receiving antenna systems. Now, any naval force operating independently or submarines on war patrol can receive combat orders and information promptly.

Planning for this facility began at the close of World War II when it was recognized that the Naval Communications System was inadequate to support the missions of world-wide naval operating forces. In March, 1946, CNO advised the Bureau of Ships of the need for modern high-power, very-low-frequency facilities which would particularly serve the far western and northern Pacific Ocean areas. In July of that year CNO further requested the Bureau to investigate the Puget Sound area as a possible location for such a facility. At the same time the Bureau was also directed by CNO to design and procure a one-million watt transmitter for this facility.

One month later the Bureau initiated extensive field exploration surveys to find a site in the Puget Sound area which would fulfill the basic engineering requirements. These requirements included the use of a mountain-span catenary-type antenna to be strung between two peaks approximately equal in height and with the intervening valley floor at least 2,000 feet lower than the peaks.

#### Large Power Supply Necessary

Another factor which had to be considered was the availability of a main power supply of great capacity. It was also necessary to find a location that would not only lend itself to satisfactory logistical support but provide the most security in the event of hostilities. Another requirement was that the ground conductivity of the area be nearly ideal, which was a necessity for the ground net required for a system of this type.

After complete electronic tests had been accomplished, the site at Jim Creek was finally selected as offering the best location from both

the technical and logistic viewpoints. In July, 1947, CNO concurred with the Bureau's recommendation of this site and requested the Bureau of Ships and Bureau of Yards and Docks to expedite this important project.

In the spring of 1949 construction of the station was begun on the site, a mountainous canyon area encompassing 725 acres. Nearly a year was spent in cutting thousands of Douglas firs from the valley slopes. An important reason for this, aside from eliminating the possibility of forest fires, was to improve transmitter efficiency since trees tend to absorb large quantities of the energy radiated by the antenna.

#### Transmitting Equipment Installed

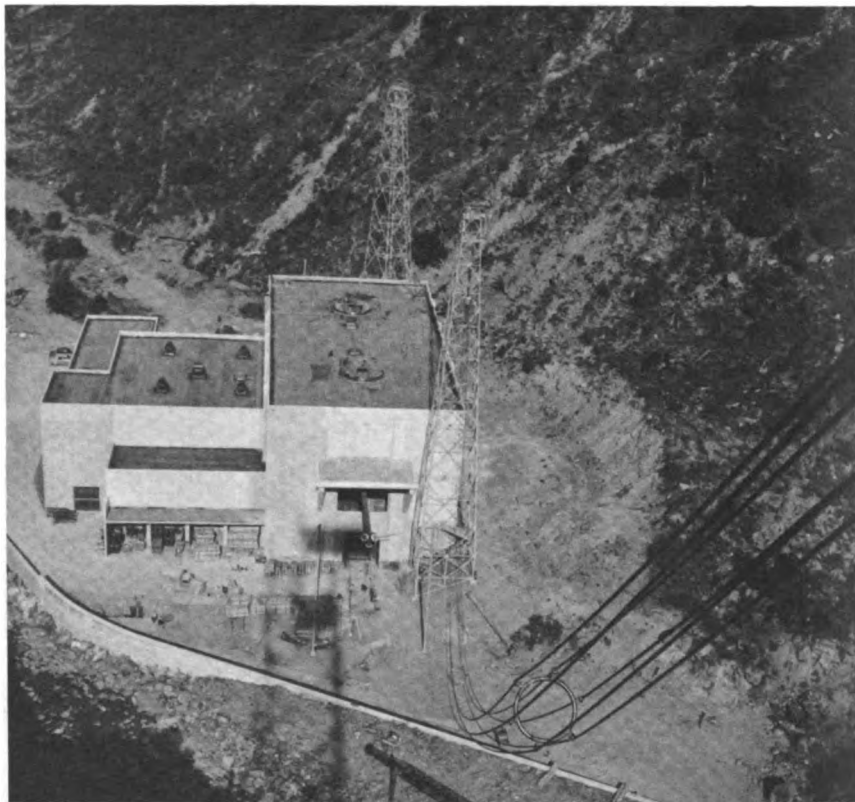
The transmitter building, a functional concrete building without windows and several stories in height, was then constructed. Its foundation extends 35 feet below

the surface, and it is stabilized against earthquakes. The building is copper sheath-lined throughout to shield it against the intense electromagnetic field.

Installation of the transmitting equipment and the antenna system was completed in the summer of 1953. The giant antenna network, in effect, forms a "roof" over Jim Creek Valley supported by twelve 200-foot towers located on the crests of twin mountains. Six towers were erected on 3,200-foot Wheeler Mountain and six on 3,000-foot Blue Mountain. Ten spans of antenna were strung between them across the valley to form a zigzag pattern.

The lengths of the catenary cables range from 5,640 to 8,800 feet. From the midpoint of each catenary or span, other cables lead straight down to the towers of the bus system. The 145-foot bus towers located along the mountain side

SET IN A VALLEY between two 3000-foot mountains, the windowless transmitter building is a functional concrete construction several stories in height. Two towers on either side of the building lead the antenna into two integral helix rooms where huge coils lead it.



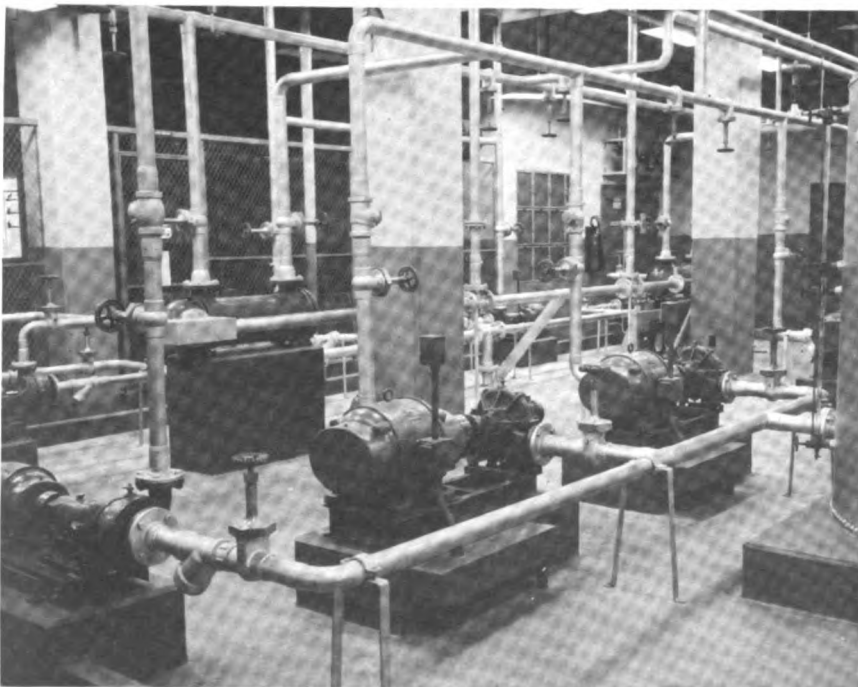
tie the giant transmitter to its antenna. On the valley floor are other towers which support the down leads and counterweights which keep the down leads in tension. There are a total of 23 towers in addition to the 12 main antenna towers.

#### **Two Thousand Kilowatts Required**

The antenna spans are designed as standing rigging to withstand 1/2-inch radial ice in a 65-mile-per-hour gale. To allow for the ice and wind conditions expected in the area, the spans are permitted to sag as much as 1,063 feet at their center point.

Both the transmitter and the antenna system are divided into two independent and isolated halves, each made up of five catenaries. This arrangement makes possible the operation of one half of the transmitter and one half of the antenna in the event that the other half of the antenna should for any reason be out of service. Under normal circumstances, however, both halves of the transmitter and antenna are operated, in which case

**A VIEW OF THE PUMP ROOM, located on the ground floor of the transmitter building, shows the pumps that circulate the distilled water used in the cooling system of the electronic tubes.**



the antenna system is subjected to a potential of 200,000 volts.

Two thousand kilowatts are required to power the transmitter and other facilities. Primary source of power is the transmission line from Bonneville Dam. A separate substation within the reservation transforms the incoming high voltage to 4,160 volts, three-phase, and lower voltages for use by the transmitter and other station use. A projected Diesel-electric plant will provide emergency power.

#### **Engineering Achievements Listed**

Among the engineering achievements in the design of the transmitting equipment are the following:

(a) A conservatively rated 1,000,000-watt output from four superpower electron tubes designed specifically for this type of service. This represents a fourfold advance from older equipments which use eight tubes to develop 500 kw.

(b) Microsecond fault protection developed specifically for this Navy equipment. This electronic

device relieves overload faults in the superpower amplifier tubes in the fantastically short time of seven millionths of a second and prevents the buildup of currents that could damage the tubes.

(c) Elimination of tuning controls in all low-power stages through the penultimate amplifier. Tuning adjustments are confined to remote pushbutton control of the antenna and power amplifier tuning.

(d) Simplification of complex control functions such as the mimic bus controls on the operator's supervisory console which tell at a glance (by means of lighted lamps) which units are in use and which are in an idle or a test status.

(e) Development of a variable frequency oscillator having a frequency stability of 0.001 percent. Advanced development based upon experience with binary computer circuitry resulted in this extremely stable frequency source which may be set to any frequency in the 14.5 to 35 kilocycle band.

#### **Flexible Controls Arrangement**

The transmitter itself is contained within an enclosure 80 feet wide and 50 feet deep. The transmitter is actually a dual 500-kw. transmitter arranged in the shape of the letter U. Between the wings of the U is the supervisory control console including the operator's desk. On each side are the main rectifiers followed by the exciters and 500-kw. power amplifiers.

For full power operation both power amplifiers are driven by either exciter. Either frequency generator-monitor may be used to furnish keyed signals to the exciter in use. The main rectifiers have sufficient capacity for either unit to supply plate power to both power amplifiers. The idle units are thus in a reserve status and available for maintenance and testing. When desired, either power amplifier of the transmitter may be operated with either exciter to provide an output of 500 kw. The idle amplifier can then be simultane-



CDR. G. W. WARREN, officer in charge of the Naval Radio Station at Jim Creek, looks on as an electronics technician operates the code perforator machine. To the right, a radioman receives teletype tape from another machine.

ously operated with its test load up to 500 kilowatts.

The central supervisory console contains the extension controls and instruments for tuning the amplifier and antenna circuits. Both frequency generator-monitor units are grouped with the supervisory console to provide a central operating position from which the more important instruments may be observed. This assembly also includes the CW (continuous wave) or FSK (frequency shift-keying) teleprinter tone-keying equipment. The master control panel contains meters for the switch gear, water temperature and flow, pressure pumps, and other auxiliary equipment.

All side units of the transmitter are enclosed by a continuous steel front in two-tone cobalt blue enamel. Each rectifier, exciter, and power amplifier is compartmentalized for r-f shielding by aluminum panels attached to structural aluminum framing behind the front enclosure. An elaborate safety system for operating personnel is provided. Alum-

inum interconnection wiring ducts and catwalks are mounted on top of the shielding structure just behind the upper section of the front enclosure.

The transmitter is situated on the second floor of the transmitter building. Power transformers, switchgear, pumps, distilled-water tanks, heat exchangers, shops, and telephone-cable terminals are located directly below on the ground floor. At the rear of the transmitter and machinery spaces are two integral helix houses, each 75 feet square and 60 feet high, housing the loading inductances and variometers used to tune the antenna circuits.

The megawatt transmitter has been designed around a special 500-kw. high-vacuum triode. Each of the two power amplifiers employs two in the push-pull circuit with the third available as a spare. The tubes are cylindrical with disk electrode connections. They are about 10 inches in diameter and 38 3/4 inches in length and weigh 135 pounds.

### Amplifiers Deliver One Megawatt

The anode, grid supports, and cathode beam former are water cooled. The six-volt filament structure of thoriated tungsten will require approximately 13 kw. heating power. Each tube requires about 500 watts grid drive for 285 kw. output at 80 percent plate efficiency. Plate voltage is 11.5 kv. The four operating tubes in both power amplifiers will deliver 1,000 kilowatts to the antenna system.

The transmitter begins with a crystal variable oscillator which is monitored and automatically controlled by crystal-controlled circuits. It is capable of either on-off keying or frequency-shift keying. The oscillator output is approximately one watt. By coaxial cable either of two such oscillators may excite either of the exciters that follow. Only one oscillator is in use at a given time.

The power amplifiers are push-pull circuits, with mica tank capacitors, Litzendraht-cable variometer tank inductances, and inductive antenna couplers. Normally the left power amplifier will drive the left half of the antenna and the right side similarly will drive the right. Provision is made, however, so that either power amplifier may be connected to either half of the antenna or to its own water-cooled dummy load for test purposes.

The intense electromagnetic field around the transmitter necessitates an elaborate grounding system for the entire structure, including a ground screen around the building. More than 200 miles of copper wires, cables, and screens are buried in an intricate pattern across the valley floor to provide efficient grounding.

### A First At Coral Sea

The World War II battle of the Coral Sea was the first major naval engagement in history in which surface ships did not exchange a single shot.