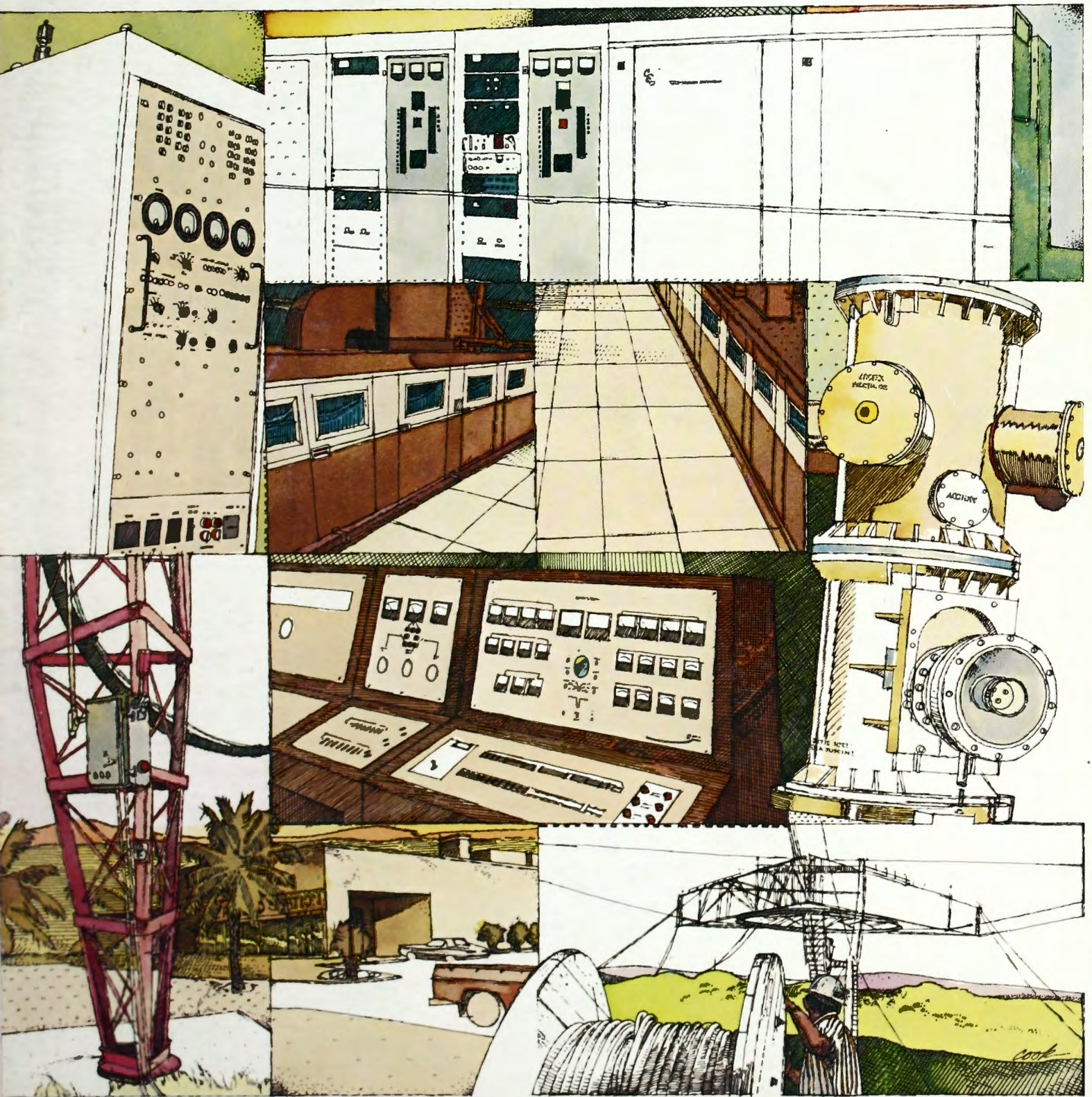
CONTINENTAL ELECTRONICS
SPECIALIST IN HIGH POWER



CONTINENTAL ELECTRONICS: SPECIALIST IN HIGH POWER RF EQUIPMENT

Continental Electronics Mfg. Co. is an engineering-oriented company that specializes in the design, development and production of high power radio frequency transmitters for communications, radio broadcast, radar and scientific research applications.

The Company was founded in 1946 with the express purpose of creating an extensive capability in high power product design. Continental Electronics is as unique today as it was at the beginning: specializing in building high power rf equipment.

Continental has established an unmatched record of achievement in the area of high power transmitters and amplifiers. Many of the Company's innovations have advanced the state-of-the-art; most of the work has been of a pioneering type; the kind of work normally associated with the leading edge of technology.

Continental's concentration on high power projects has resulted in the establishment of a unique reservoir of engineering knowledge and experience. The depth and continuity of this talent is singular and unusual in the electronics industry: Half of Continental's engineering staff have been working together an average of 22 years; half of the production work force have been together for nearly 19 years; the top management have been with Continental Electronics an average of 24 years.

Continental's commitment to excellence is reflected in workmanship, and in the operational performance of numerous radio/electronic equipments which bridge the spectrum from ELF to UHF, ranging in power from kilowatts to megawatts.

The Company has worked with many customers throughout the world; interfacing as prime contractor with total system responsibility; as sub-contractor with significant project responsibility; as joint partner; and as a member of a team of companies.

This brochure is a brief introduction to Continental's background and experience. For additional information on any work or to discuss project capability, contact the Marketing Department.

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HIGH POWER TRANSMITTERS

AM Broadcast LW MW SW

Continental transmitters are used throughout the world by commercial and government radio stations for local, regional, national and international broadcasting.

Continental's reputation as the world's most experienced designer and builder of high power broadcast equipment began with the development of five one-million watt long and medium wave transmitters, and eight 500,000 watt shortwave transmitters for use by the Voice of America. Built in the early 1950's, they were the most powerful broadcast transmitters in operation at that time.

While a few Continental transmitters are one-of-a-kind designs, most have become part of an ever-growing product line of broadcast transmitters that have been installed at radio stations throughout the United States, Canada, and in 45 countries around the world: a powerful testimonial to Continental's unique position in high power broadcasting.

(a) In 1976, Continental began work on the largest AM broadcasting complex yet awarded under a single contract: the Northern Stations Project for the Kingdom of Saudi Arabia. All civil engineering and construction work is being done by Continental's Joint Venture partners for the project: Edok, SA and Eter, SA of Athens, Greece. Continental is responsible for all electronic aspects of the job, including the directional antenna systems. The two stations use three Continental two-million watt MW transmitters and one Continental one-million watt MW transmitter. Similar projects near Jeddah and Dammam use two Continental two-million watt MW and one Continental one-million watt MW transmitters.

Other Continental two-million watt transmitter installations are in Egypt, Jordan and Yugoslavia.

In order to increase operating flexibility while improving maintenance factors, the transmitters are designed as modules of one-half the operating power level. Thus, the two-million watt transmitters are designed as two one-million watt units which can be operated individually or combined. A one-million watt unit is shown during factory test.

(b) The Voice of America East Coast shortwave broadcast facilities include two transmitting sites and a receiving site near Greenville, North Carolina. Dedicated in 1964, the complex utilizes 400 steel towers and 95 antenna systems to beam programs to South America, Europe, Africa and the Near East. Each of the two transmitting sites has three Continental 500,000 watt SW transmitters. Continental directed all electronic aspects of the pro-

(a)

(b)

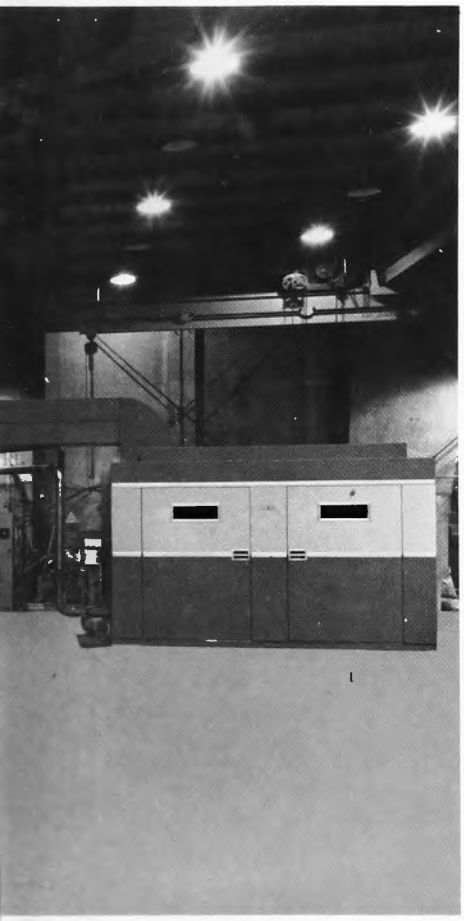
(c)

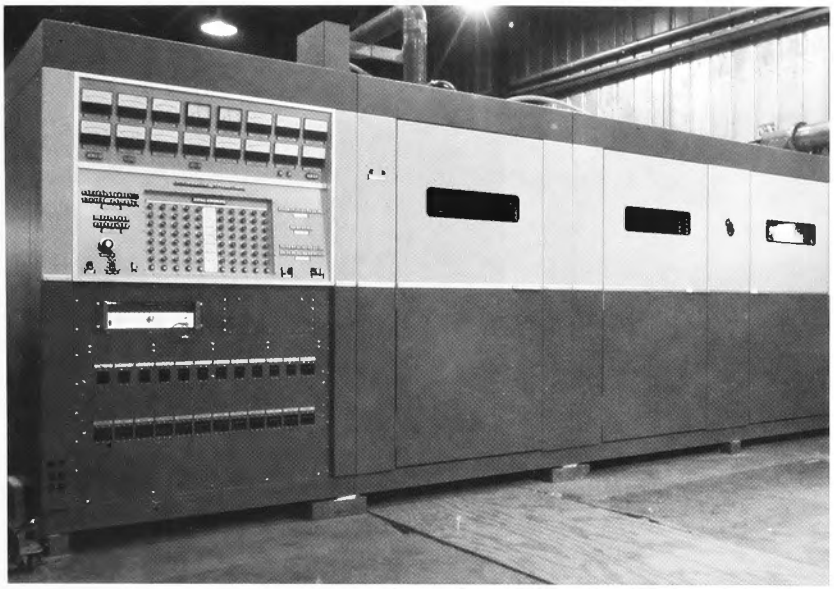
ject, and was in charge of the management of the operation. Other Continental 500,000 watt SW broadcast transmitters were installed for Radio Liberty near Barcelona, Spain. Ten Continental 250,000 watt SW broadcast transmitters are used by the Voice of America installation near Kavala, Greece.

(c) Transmitter room of the Broadcasting Corporation of China—Taiwan shows Continental Electronics' one-million watt MW transmitter consisting of two 500,000 watt units. They can be operated individually and simultaneously on two frequencies, or combined for one million watt operation on either of the two frequencies.

(d) The broadcast station of Trans World Radio on the island of Bonaire in the Netherlands Antilles uses Continental 500,000 watt MW: 250,000 watt and 50,000 watt SW transmitters. Continental also supplied antennas and ancillaries, and built a shortwave receiving facility for rebroadcasting programs from Holland. Other Continental 500,000 watt MW broadcast transmitters are installed in Greece, Korea, Nigeria and on the Isle of Rhodes.

(e) One of 11 Continental Type 419F 250,000 watt SW transmitters purchased by Radio Free Europe/Radio Liberty. The transmitters will be used to upgrade and improve RFE/RL Inc. broadcasting services in Europe.





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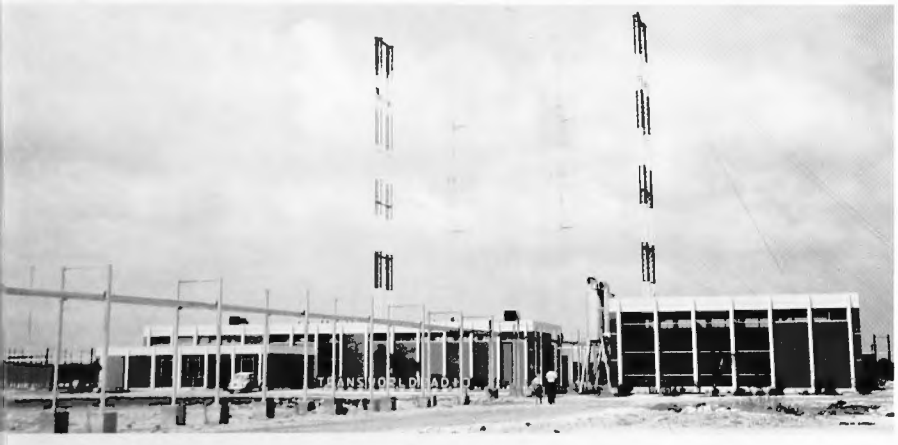

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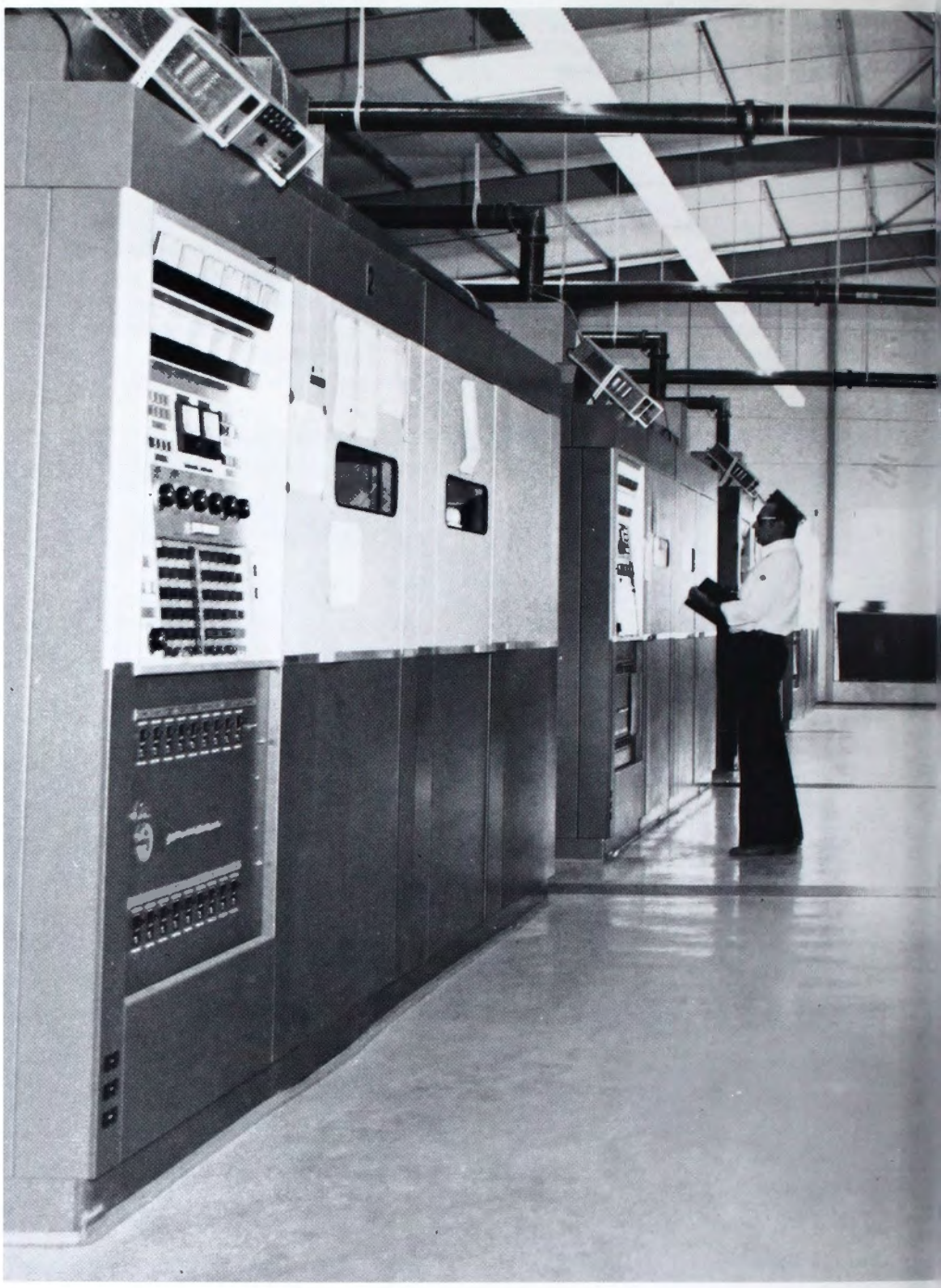
(f) Partial view of the Radio Free Europe/ Radio Liberty transmitter room at Biblis, West Germany, shows several Continental 100,000 watt SW broadcast transmitters. Continental delivered transmitters to RFE/ RL in 1976 and 77, for installation at Biblis and Lampertheim, West Germany. The RFE/RL organization broadcasts news and information about their own countries to the people of Eastern Europe and the Soviet Union in 22 languages up to 24 hours a day; more languages and for longer hours than any other external broadcaster to the area.

(g) Power Amplifier section of Continental 1,000,000 Watt MW Broadcast Transmitter. This new generation transmitter incorporates advances in technology which provide high efficiency and superior performance. Only two tetrode tubes are used in a 1,000,000 watt Screen/Impedance Modulated (SIM) amplifier.

Other Continental 100,000 watt SW transmitters have been installed in Bangladesh, Iraq, Lesotho, Malagasy Republic, Mozambique, Oman, Pakistan, Portugal, Seychelles, Swaziland, Taiwan and the United States.



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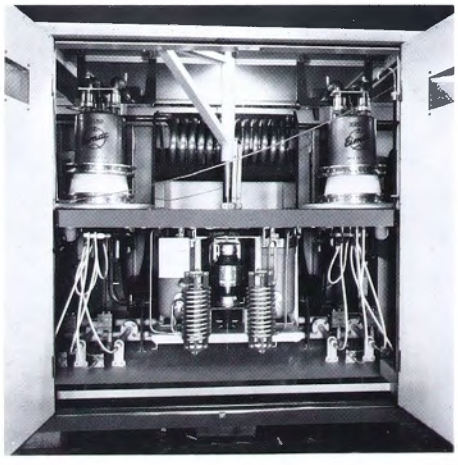

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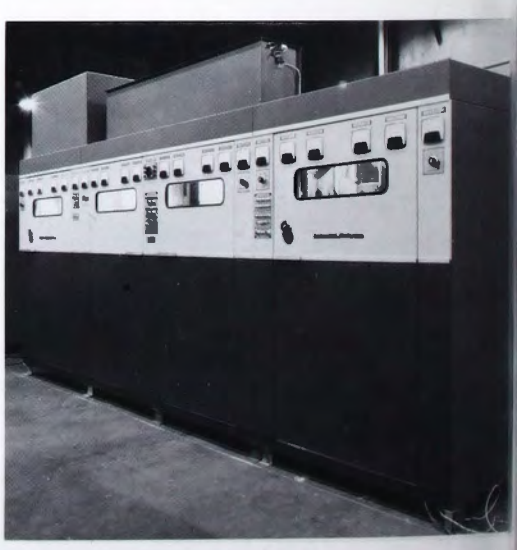

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(h) Continental's 150,000/100,000 watt MW broadcast transmitter is shown during final assembly and test. 150,000 watt MW transmitters are in service in Brazil, Colombia, Mexico and for the Armed Forces Network Europe. Continental 100,000/150,000 watt MW transmitters have been installed in Brazil, Colombia, Mexico, Pakistan, Taiwan, Venezuela and Zambia.

(i) Transmitter test area for Continental 50,000 watt MW broadcast transmitters going thru factory testing. Continental's unique patented concept of Screen/Impedance modulation was introduced in the Type 317C 50,000 Watt MW Transmitter. This design set industry standards of performance and reliability that made it the most popular 50,000 watt MW Transmitter used in radio stations in the United States and Canada. It is also in service in 21 other countries of the world.

(j) Transmitter assembly area for Continental 5,000/10,000 watt MW broadcast transmitters. These transmitters are as popular as the 50,000 watt transmitters, and have the flexibility of offering either 5,000 watt or 10,000 watt operation in the same package. They are currently in use in 19 countries around the world.

(i)

(j)

(k) Transmitter assembly area. Continental offers broadcasters a complete line of AM and FM transmitters from 1,000 to 50,000 watts; combiners, diplexers, phasing, coupling and antenna systems and related rf equipment.

(l) Assembly of FM exciter.

(m) Continental 40 kW FM transmitter during factory test.

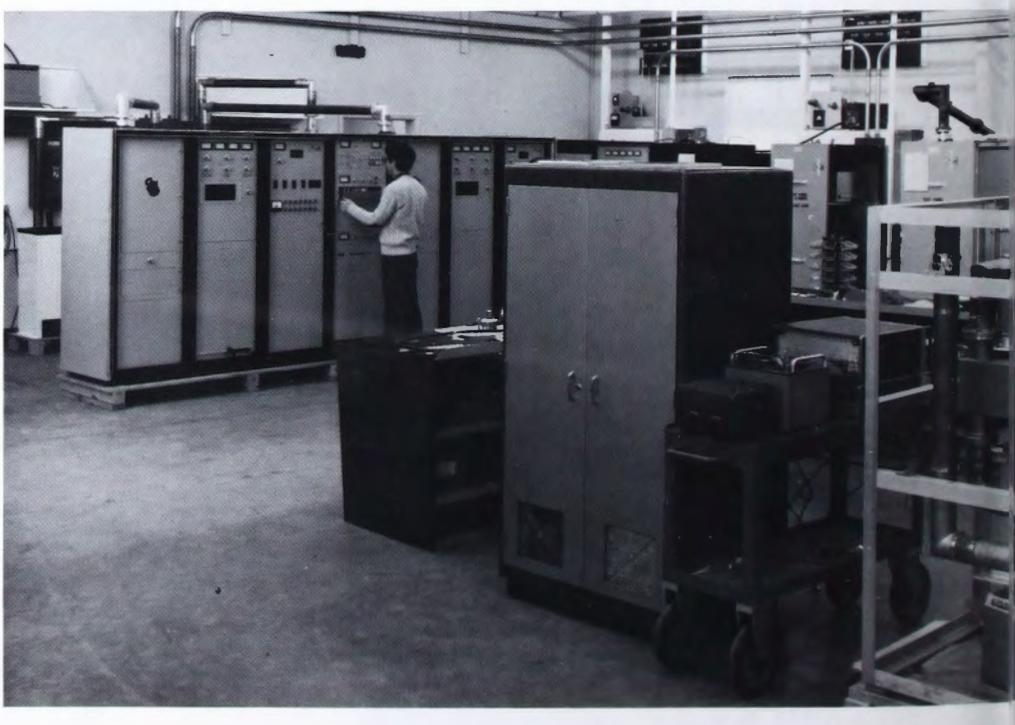
(n) Factory test area, with line-up of 1 kW AM, 5 kW AM and 2.5 kW FM transmitters.

(o) Continental 10-channel audio console on test bench.

(p) Assembly of 50 kW AM transmitter.

(k)

(l)



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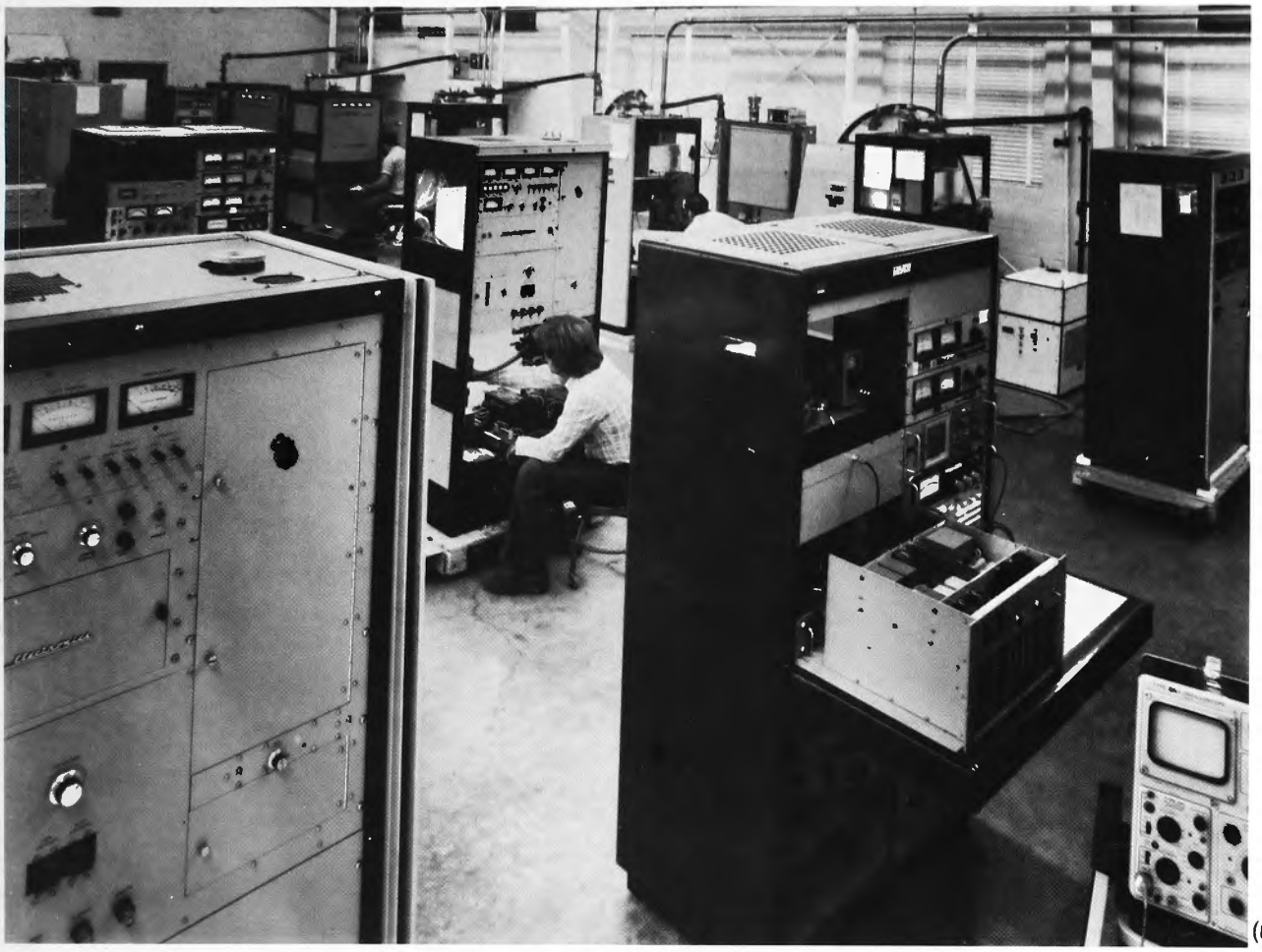

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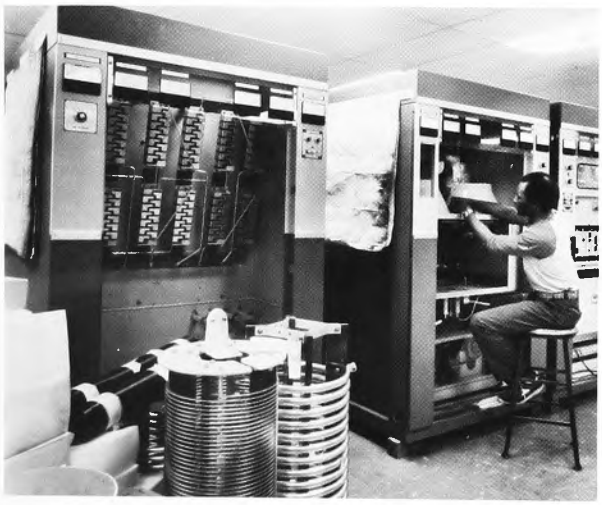

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HIGH POWER TRANSMITTERS

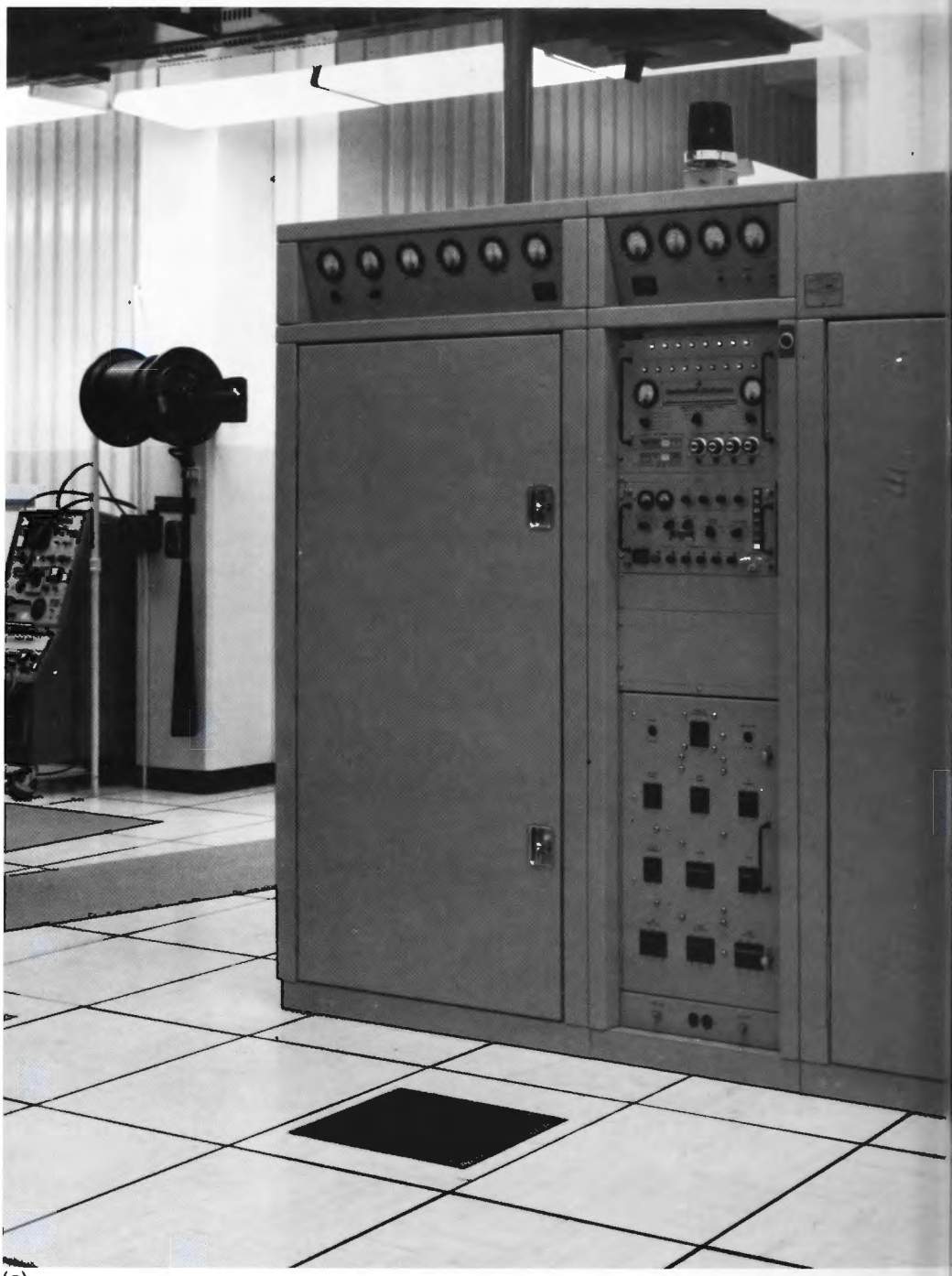
Communications ELF VLF LF MF HF UHF

By 1960, Continental had designed, developed and supplied the United States Air Force, Army and Navy with the most powerful communications transmitter they had ever used: the AN/FRT-33, a 600,000 watt HF transmitter for world-wide communications and research projects.

Other Continental transmitters are designed to power a variety of communications applications: ELF transmitters for communications to deeply submerged submarines; VLF transmitters for world-wide navigation, communications to submerged submarines and time/frequency standards broadcasts; LF transmitters for point-to-point communications; MF transmitters for short to medium range communications and navigational applications; HF transmitters for point-to-point and long distance communications.

Continental transmitters were the first high power transmitters to meet the United States Defense Communications Agency (DCA) specifications for advanced, highly sophisticated, state-of-the-art, ISB communications transmitters.

Continental has participated in high power VLF projects in the United States, Australia, England, France, Germany, Italy, Japan and Norway.



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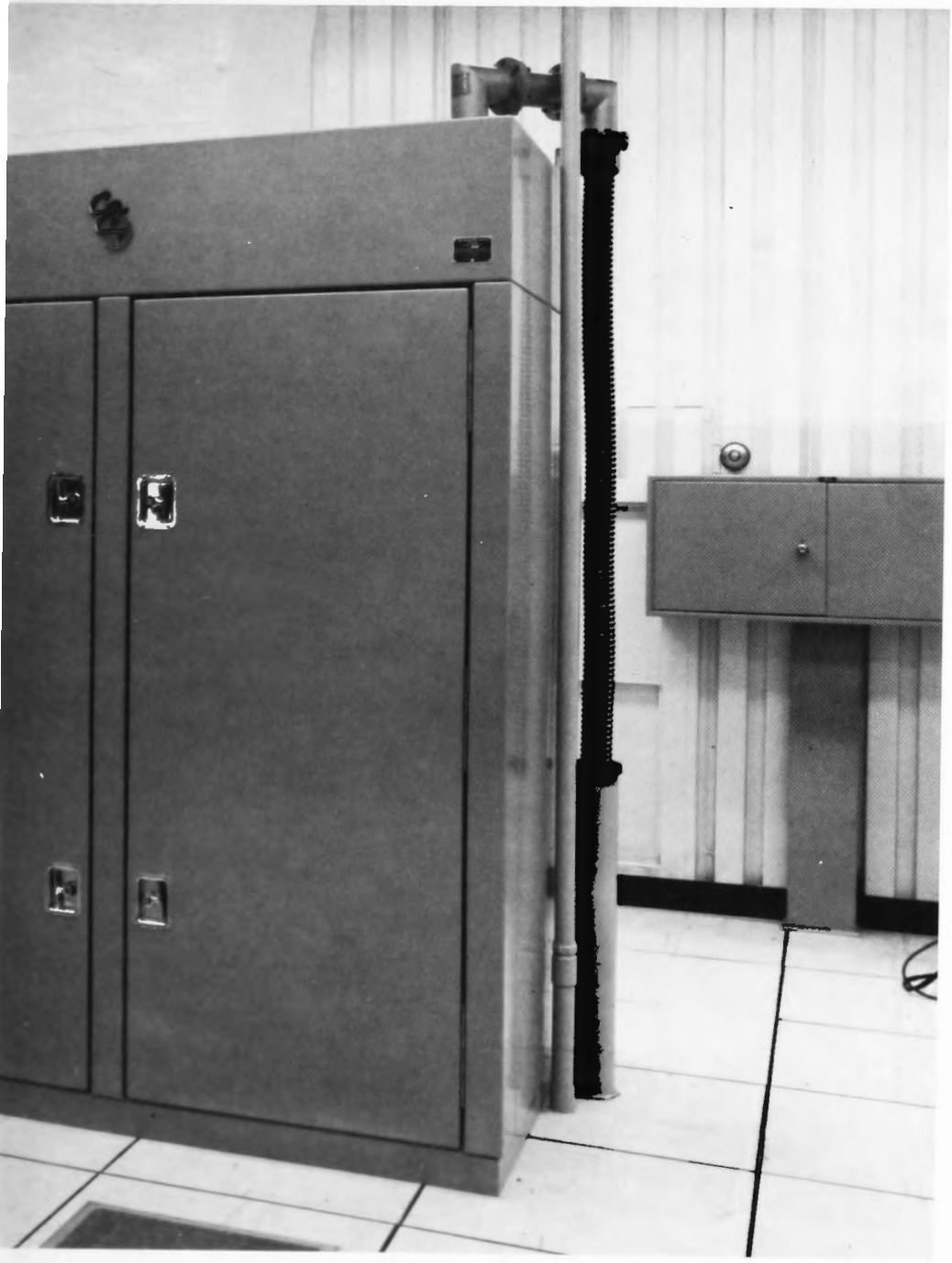

(a) Continental AN/FRT-85 40,000 watt PEP HF ISB transmitter was the first high power transmitter to meet the operating specifications set by the United States Defense Communications Agency (DCA). This highly sophisticated, state-of-the-art design uses an ultra-linear amplifier for transmission of high-rate digital data. Continental delivered 128 AN/FRT-85's to the United States Navy.

(b) 25,000 watt LF transmitters built and installed by Continental in Nova Scotia and at Alert N.W.T. Continental also supplied the antenna systems for DND.

(c) Continental 250,000 watt LF transmitters are installed in Nova Scotia and British Columbia as part of the Canadian Department of National Defense (DND) communications system. Continental also built the associated antenna systems for both installations.

(d) The Continental AN/FRT-89 2000 watt LF/MF is the U.S. Coast Guard's first all solid-state high power transmitter, and is also used by the U.S. Navy.

(d)

(e) Transmitter control console and partial view of Continental's 2,000,000 watt VLF communications transmitter built for the U.S. Navy and installed at Northwest Cape, Australia. Continental high power transmitters have been used to power new and to upgade existing VLF stations around the world.

(f) Continental AN/FRT-72 is a sophisticated, broad band communications transmitter designed and built for the United States Navy. Developing 50,000 watts average and 100,000 watts peak power over the frequency range of 30 to 150 kHz. Continental delivered 38 of these transmitters to the Navy. The AN/FRT-72 is shown in a van-mount configuration.

(g) Continental's AN/FRT-86 200,000 watt PEP HF ISB transmitter is similar to the AN/FRT-85. Built to meet DCA specifications, the transmitter can be tuned automatically in less than 30 seconds. 17 of these transmitters were built for the United States Navy.

(h) Continental's Type 616B 10,000 watt PEP HF ISB transmitter is a high performance, sophisticated communications transmiter designed to meet DCA specifications. 23 of these transmitters were built for the Spanish Government. Design of this transmitter is based on the concept of the AN/FRT85 and AN/FRT-86.

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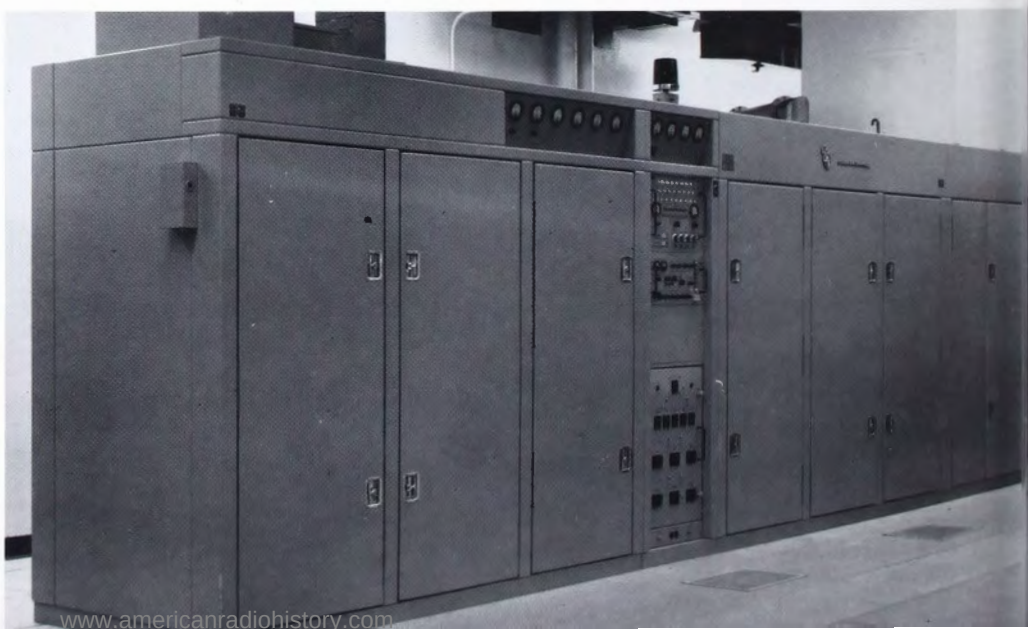

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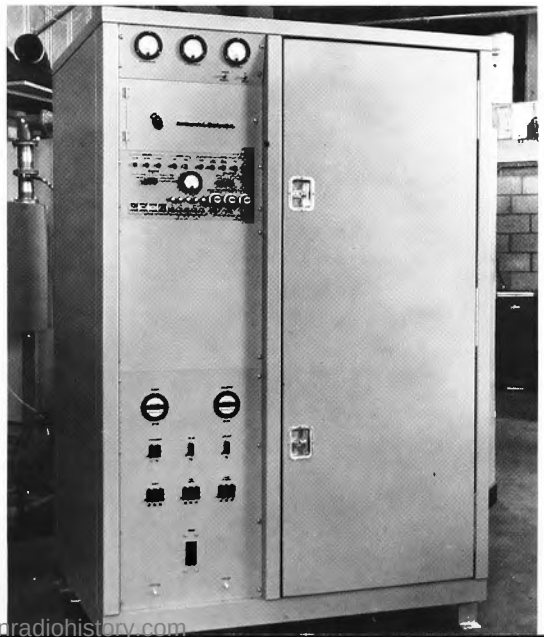

HIGH POWER TRANSMITTERS

Radar
HF VHF UHF

In 1958, MIT's Lincoln Laboratory Millstone Hill research station sent and received radar signals from Venus. Signals were transmitted by a transmitter designed and built for the project by Continental. The UHF radar transmitter used high power klystron tubes manufactured to Continental specifications.

Since the early 1960's Continental has designed and built high power radar transmitters for many of the world's most advanced radar stations including the following unique installations.

- **Lincoln Laboratory missile tracking ranges in Canada and British West Indies**
- **Lincoln Laboratory Solar Research site at El Campo, Texas**
- **BMEWS (Ballistic Missile Early Warning System) all sites; for General Electric and RCA**
- **ZAR Nike-Zeus acquisition radars; for Western Electric**
- **Stanford University and Stanford Research Institute's joint radar telescope project**
- **ABRES White Sands Missile Range instrumentation radar; U.S. Army**
- **NRL (Naval Research Laboratory) VHF radar research project**
- **ALTAIR VHF radars for GTE/Sylvania**
- **SAMTEC DPR (Deployment Position Radar) U.S. Air Force**
- **440L OTH radars; for Raytheon**
- **White Sands Missile Range S-band transmitters—for U.S. Army**
- **NSF Arecibo Observatory S-band transmitter; for Cornell University**
- **414L OTH-B for Electonic Systems Division of the Air Force Systems Command for General Electric**

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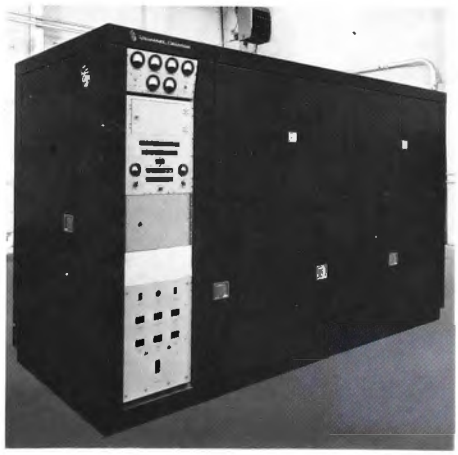


(b)

(a) In 1974, Continental built and installed a 450,000 watt S-band radar transmitter for Cornell University at the National Science Foundation Arecibo Observatory The installation was part of an equipment upgrading program to increase sensitivity of the giant radio/radar telescope.

(b) One of the 100 kW HF Sophisticated Broadband Transmitters manufactured by Continental Electronics under subcontract from General Electric for the U.S. Air Force Over-the-Horizon (OTH) Radar Project.

(c) Radar systems developed by Continental for the Ballistic Missile Re-entry Study Program (ABRES). Continental was responsible for site preparation, construction of buildings and antennas, design, manufacture and installation of the transmitters and receivers, as well as the interface system and all instrumentation.

(d) BMEWS transmitter during test. Continental built and installed all high power transmitters used for tracking and surveillance radar at all BMEWS sites.

(d)

HIGH POWER TRANSMITTERS

RF Energy Sources

Continental's experience in high power transmitters led to a complementary and related area: the design and development of high power energy sources, modulators and power supplies.

In 1962, Continental developed and manufactured the rf power source to generate five million watts peak power at 200 mHz, for the injector to the gradient synchrotron at the Argonne National Laboratory.

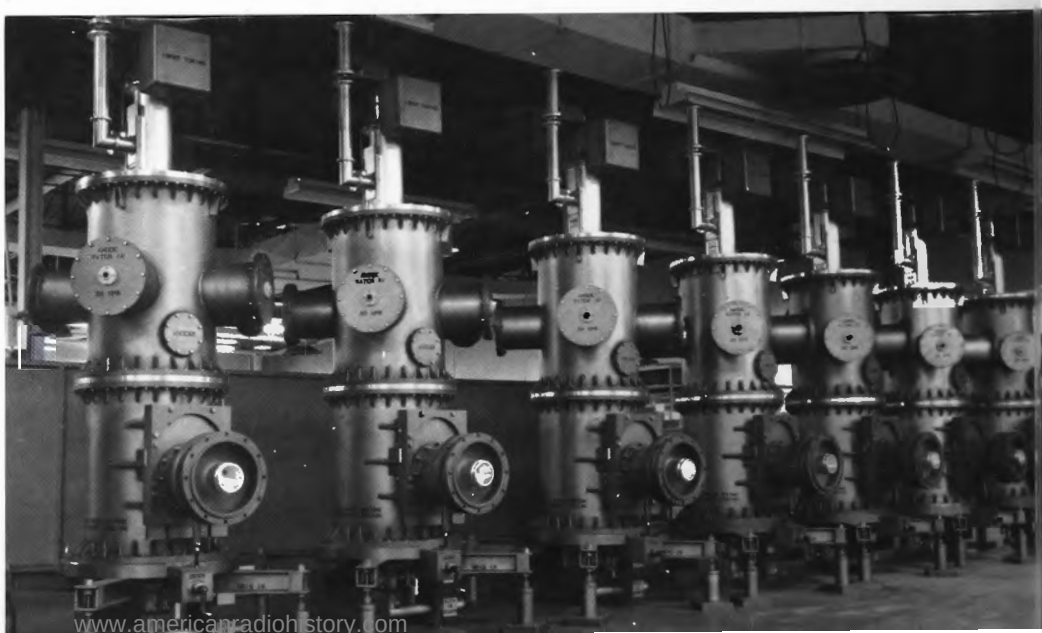
Since the completion of the Argonne project, Continental has been consultant, designer and builder of rf energy sources for a number of particle accelerator facilities:

Brookhaven National Laboratory Alternating Gradient Synchrotron;
Los Alamos Scientific Laboratory Linear Accelerator;
Texas A & M University Variable Energy Cyclotron;
Cornell University Electron Synchrotron;
FERMILAB Linear Accelerator;
TRIUMF Meson Facility;
Comitato Nazional per L' Energia Nucleare, Frascati Laboratories, Cavity Resonator;
McGill University Cyclotron Facility;
Chalk River Nuclear Laboratories, Proton Linear Accelerator.

(a) FERMILAB's Linac, a linear accelerator 500 feet long, is powered by nine Continental rf Amplifiers. Continental also furnished anode modulators, power supplies and drivers. The FERMILAB Linac accelerates protons from 750,000 volts to 200 MeV.

(a)

(b)



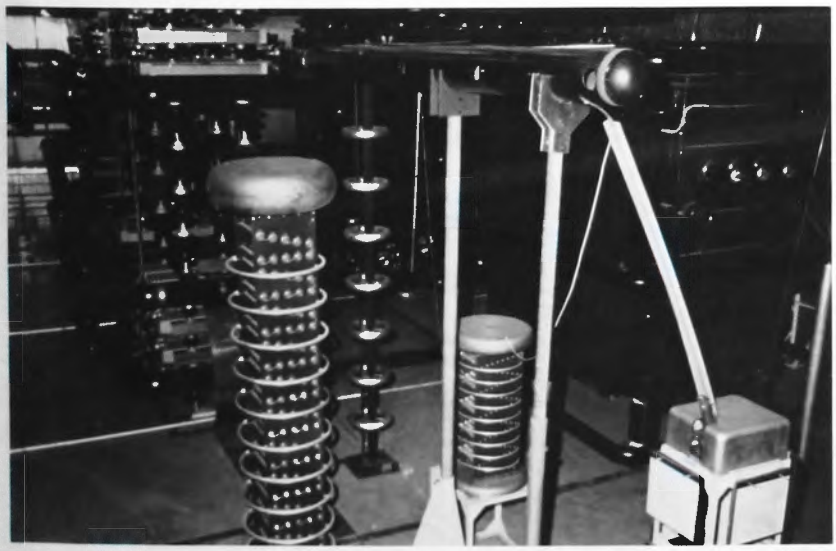
(c)

(b) One of four Continental 450 kW rf Amplifiers built for the Tri-University Meson Facility (TRIUMF); a project jointly funded by the Atomic Control Board of Canada and three universities. The four amplifiers are combined to produce a total output of 1.65 megawatts at 22.6 mHz.

(c) Continental developed a high power triode amplifier for the Brookhaven National Laboratory Alternating Gradient Synchrotron as part of an upgrading program for their 200 mHz injector. The new injector uses nine amplifiers.

(d) Continental designed, manufactured and supervised installation and construction of a high power tube testing facility for the Rome Air Development Center at Griffiss Air Force Base in New York. As part of the contract, Continental designed, built and installed a 180 megawatt spark-gap line modulator, and two power supplies: one supply produces variable voltages from zero to 140 kV DC at an average current of 9 amperes; the second supply produces variable voltages from zero to 65 kV at 54 amperes.

(e) Continental designed and built this single tube amplifier test set for development and production testing of the EIMAC super power tetrode tube X2159. The amplifier is capable of an output of 2,000,000 watts over the range of 15 to 30 mHz.



(d)

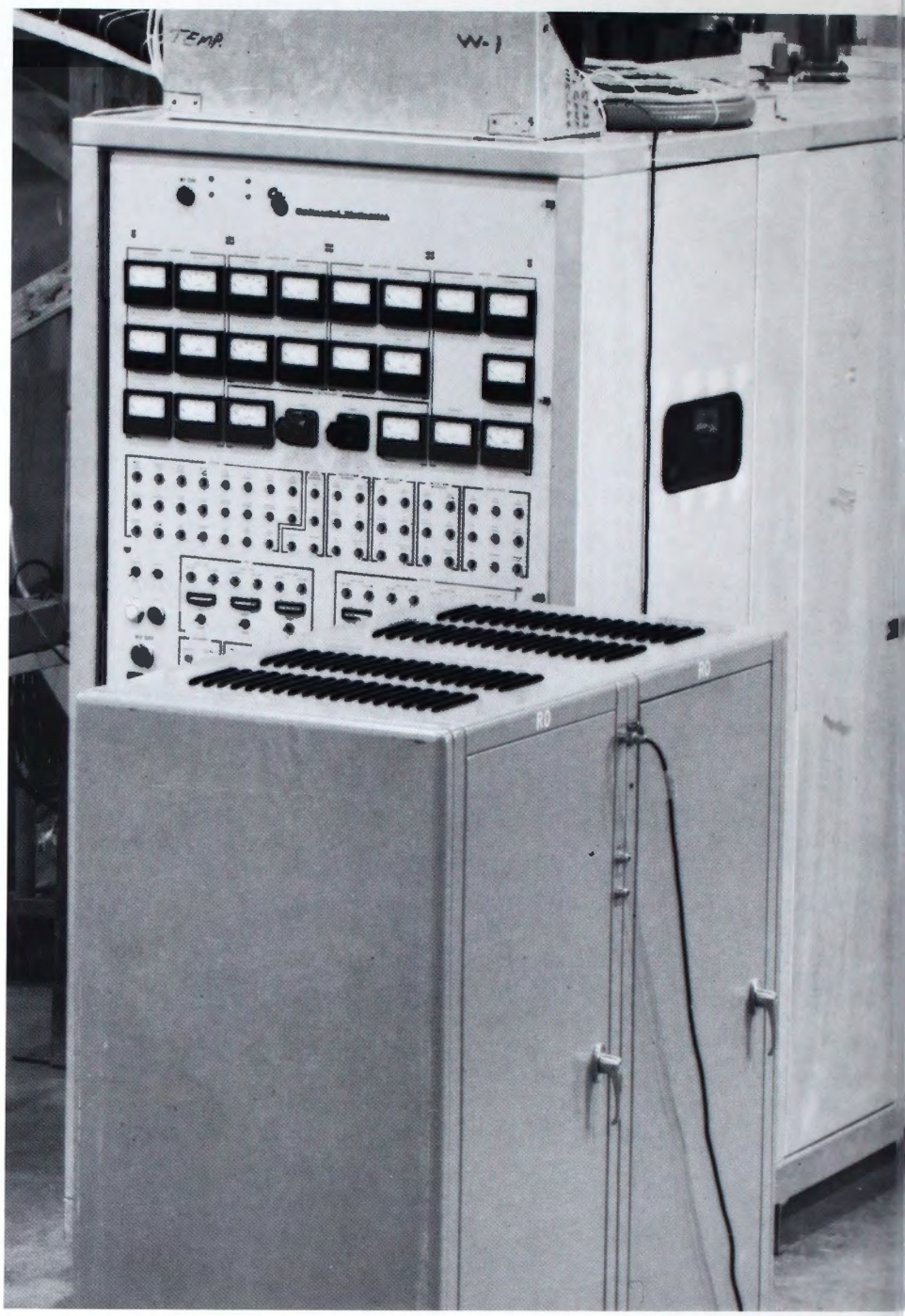
(e)

(f) Factory test of prototype power amplifier: Continental is building 17 power amplifiers under a contract from Los Alamos National Laboratory. Each amplifier will deliver 600 kW of continuous power at 80 MHz. The rf amplifiers will be used in engineering experiments designed to solve some of the problems in moving fusion out of the laboratory and into the practical production of electricity.

Each 600 kW amplifier system consists of three cavity-type amplifiers; 13.8 kV switchgear; high voltage power supplies; a crowbar and filter unit; a final power amplifier (FPA) filament power supply unit; control and monitoring equipment.

(g) New England Nuclear's linear accelerator facility uses three Continental high-power amplifier systems. The amplifiers operate at 201 MHz and develop 200 kW average, 5 MW peak power, and are used to drive NEN's 45 MeV, 5mA Proton Linear Accelerator. Continental also provided power supplies, HV modulator, ac distribution system, control and monitor systems, prime power switchgear and crowbar protective systems.

(h) FPA filament power supplies.



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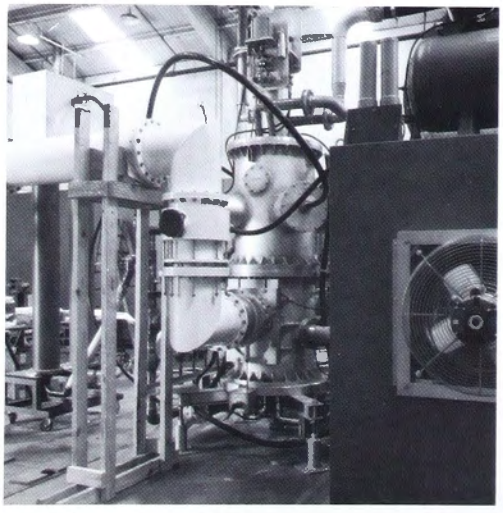
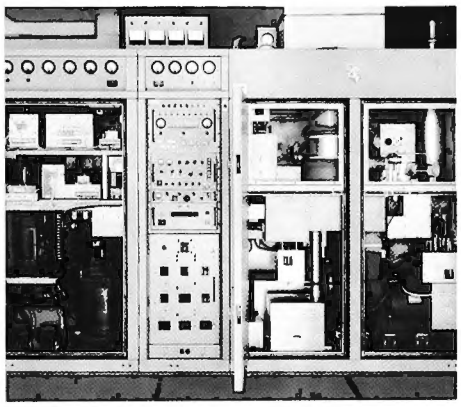


(g)

(i) 13.8 kV switchgear modules.
(j & k) Continental modified their 40 kW (AN/FRT-85) and 200 kW (AN/FRT-86) HF transmitters for use in Ion Cyclotron Resonance Heating (ICRH) of the plasma in the Elmo Bumpy Torus Programs.

(i)



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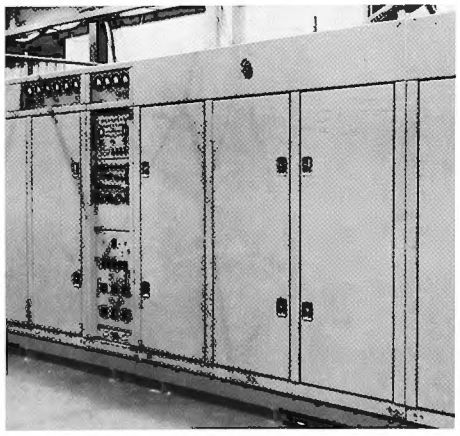

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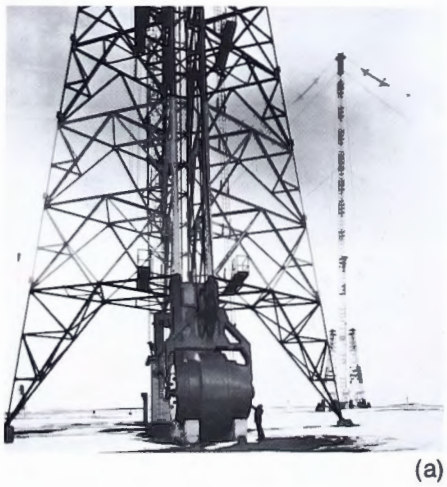
(h)

HIGH POWER TRANSMITTERS

Sub-Systems

A logical extension of Continental's high power transmitter capability is the design and construction of related sub-systems and equipment, including special antennas, phasing and coupling equipment, transmission lines, and transmitter dummy loads. Designed and manufactured to meet a wide range of power requirements, this equipment is installed in a variety of environmental extremes throughout the world.

Continental evaluates the entire transmitting system within its operating and performance parameters to determine sub-system requirements. Components and sub-systems are then matched to transmitting requirements, and combined into an effective operating system.



(a)

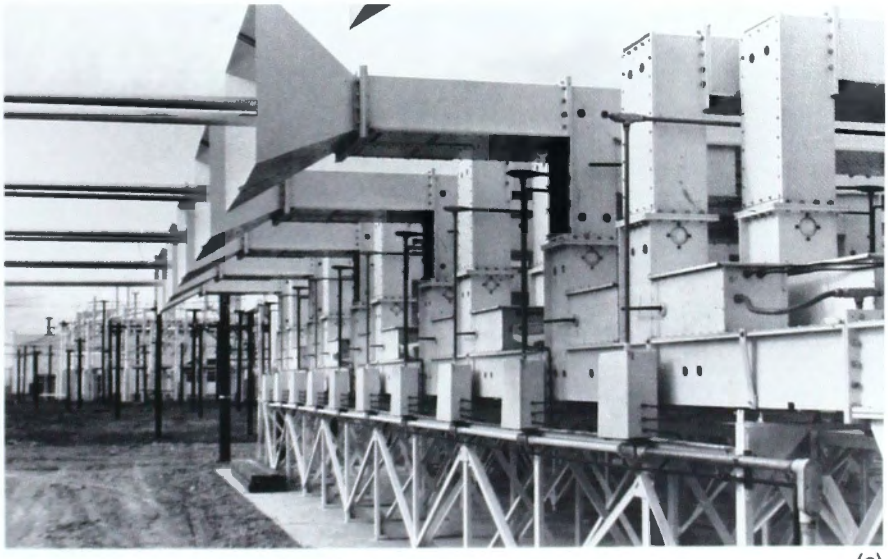
(b)

(a) The United States Navy's VLF Station at Cutler, Maine, uses large counterweights which gently lower the entire antenna web when ice and sleet form on the antenna cables. An electrical de-icing system is used to remove the ice and sleet.

(b) Curtain antenna designed and installed by Continental Electronics for the Voice of America broadcast stations near Greenville, North Carolina. Similar HF antennas have been installed on Bonaire and in Korea.

(c) Transmitter and line switching matrix developed and installed by Continental for the United States Information Agency. The system handles ten 250,000 watt SW broadcast transmitters into twenty-two antennas.

(d) Antenna phasing equipment for 50,000 watt AM broadcast station, designed and manufactured to meet customer requirements.



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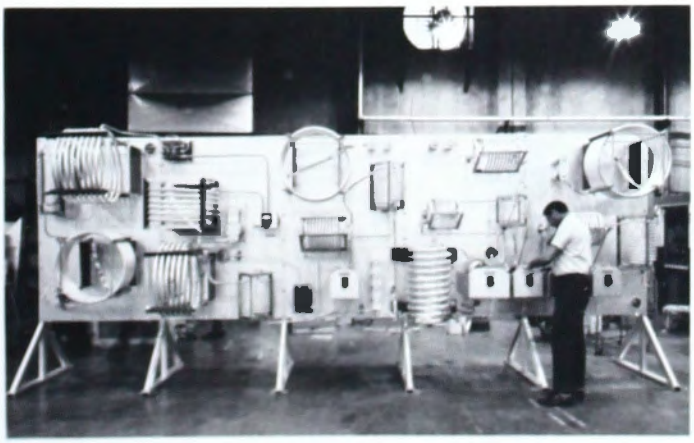

(d)

HIGH POWER TRANSMITTERS

RF Components

High power transmitters require unusual, high voltage and high current components. Continental has developed the capability to design and fabricate high power sub-assemblies and component parts not generally available.

The state-of-the-art design of Continental's specialized, high power transmitters, depends upon the availability and reliability of such unique components. The parts and assemblies themselves enhance or make possible the extraordinary performance of the transmitting system.

(a) Variometer coil provides inductance variation for VLF antenna tuning. Wound with 3½-inch Litz wire, it is 18-feet tall; has a 10-foot diameter stator with an 8-foot diameter rotor.

(b) Fail-safe guy insulator, during test. Strength 840,000 lbs, 150 kv.

(c) Torusolenoid: a self-shielding, high Q, adjustable inductor.

(d) Base insulator for a 1500′ tower. Strength exceeds 10,000,000 lbs.

(e) 100,000 watt Chebishev bandpass filter is an essential element of a highly sophisticated, band-switched, broadband, frequency-agile transmitter designed for digital communications and radar applications.

(f) GAS-CAP fixed and variable pressure capacitors are used in high power VLF, LF and MF transmitters and antenna systems.

(a)

(b)

(c)

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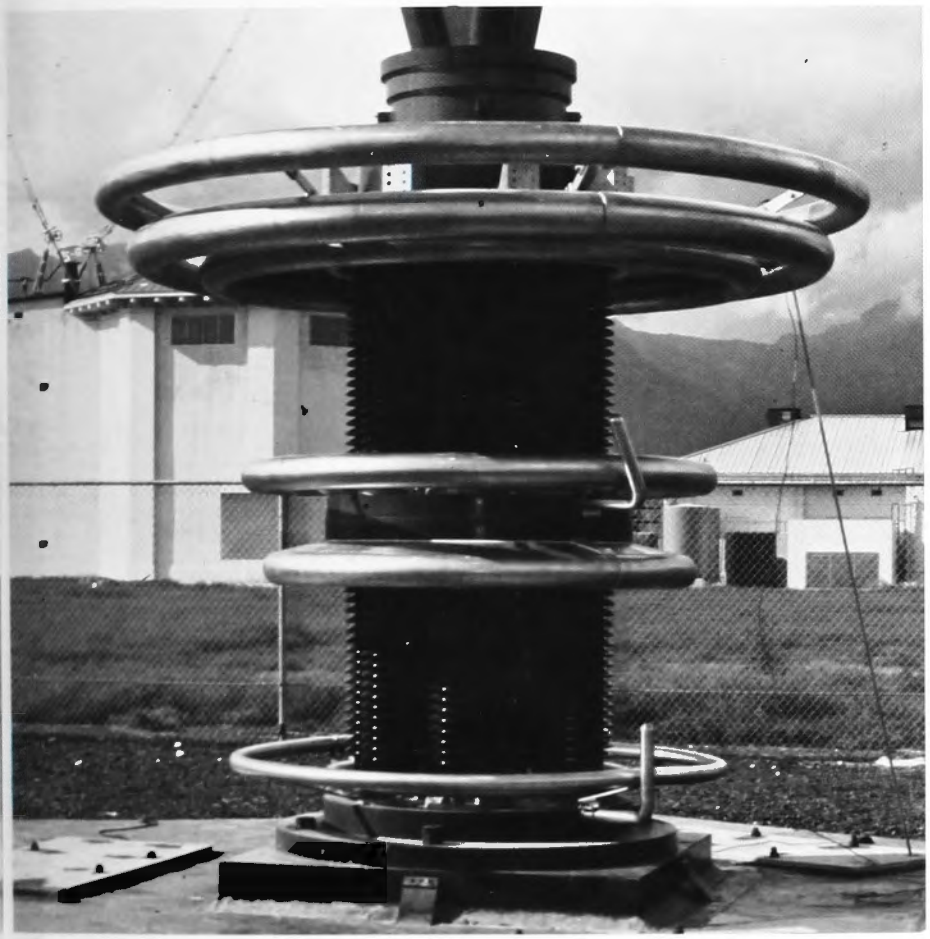
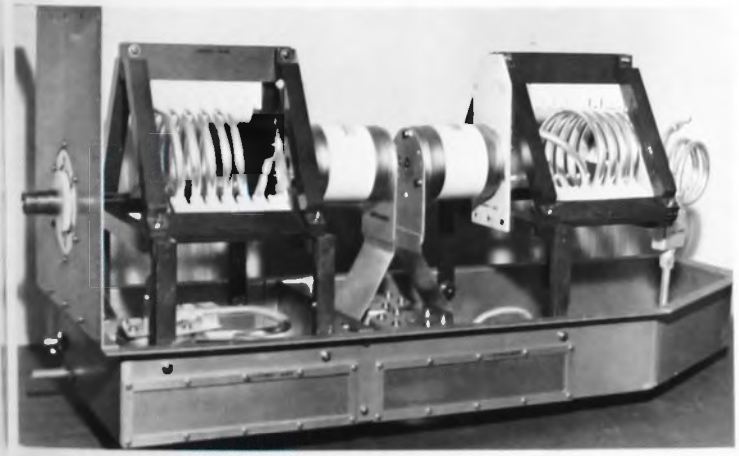


(f)

(e)



HIGH POWER TRANSMITTERS
Systems

The U.S. Navy VLF Station at Cutler, Maine, transmits directly to the USN surface ships and submerged submarines with a power of two-million watts. Dedicated in 1962, it is the most powerful communications facility on the North American continent. Twenty-six steel towers reaching from 800 to 1000 feet into the sky, carry a giant web-like antenna system that covers two square miles. Site preparation included the excavation of 100,000 yards of rock and another 2,500,000 yards of earth; clearing and grubbing 3,000 acres of land for the antenna system. Construction of the antenna system required 12,000 tons of steel for 26 antenna towers; 50,000 cubic yards of concrete for tower and anchor foundations; 3,000 tons of bridge-strand cable for guys and halyards. The facility is virtually self-sustained, having operations and maintenance buildings and equipment in addition to the transmitter and antenna systems. Continental Electronics was prime contractor for this project, and earned an award of merit from the U.S. Navy for completing the station one year ahead of schedule.

(a)

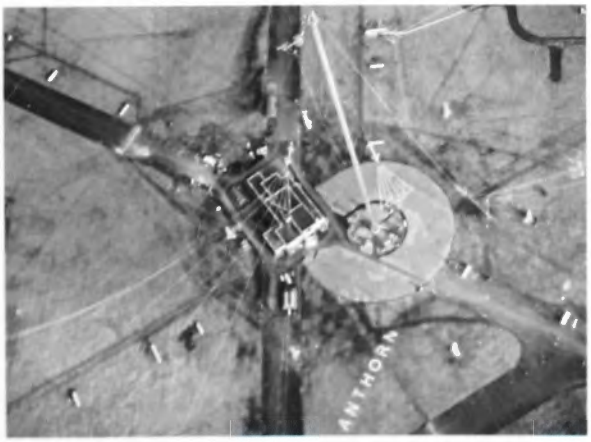
(b)

(a) Forms for antenna counterweight towers at the U.S. Navy VLF Station near Cutler, Maine. Weights roll up and down on concrete ramps to maintain proper antenna tension during antenna ice conditions, and in winds up to 150 knots. Each weight weighs 202 tons; the system uses 42 counterweight towers.

(b) Continental modified an existing antenna for RTB in Belgrade, Yugoslavia to permit full power operation with a Continental two-million watt MW transmitter.

(c) Continental's contract with the Italian Navy to build a NATO VLF station on the island of Tavolara included the design and construction of a 3,500-foot triangular antenna array. The entire antenna was assembled in the air, 500 feet above water, using special rigging techniques developed by Continental.

(d) The NATO VLF transmitting station near Anthorn, England, was a turnkey project performed under contract with the British Government. Continental constructed the facility on an abandoned air field.



(d)

(e) The NATO VLF station near Novik, Norway, is located deep within a mountain located above the Arctic Circle. The antenna system utilizes two mountains as anchor points; spans 7,000 feet, 3,000 feet above sea level. The antenna is designed to survive 120 knot winds and heavy icing. As prime contractor, Continental was responsible for all aspects of the turnkey project.

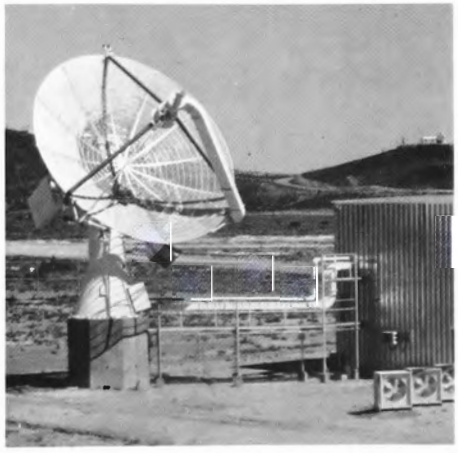
(f) Continental's contract for two instrumentation radars on the White Sands Missile Range under the U.S. Air Force ABRES Program included design, construction and installation responsibility for transmitters, antenna systems, receiving system, interface systems for integration with range operations, and all facilities associated with the project. Additional contracts covered operation, maintenance and upgrading of facilities.

(g) Helix house for U.S. Navy VLF station at Cutler, Maine. House is eight stories high and contains antenna coupling and automatic antenna de-icing equipment.

(h) One of the master control desks for the Northern Stations Project for the Kingdom of Saudi Arabia. The desk controls and monitors two two-million watt MW broadcast transmitters.

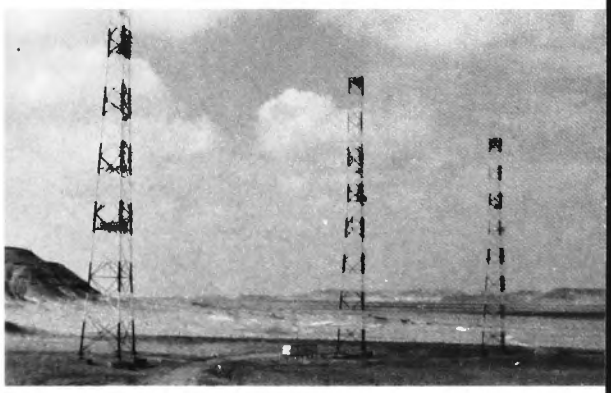
(i) Early site and antenna system construction at the Northern Stations Project for the Kingdom of Saudi Arabia.

(e)

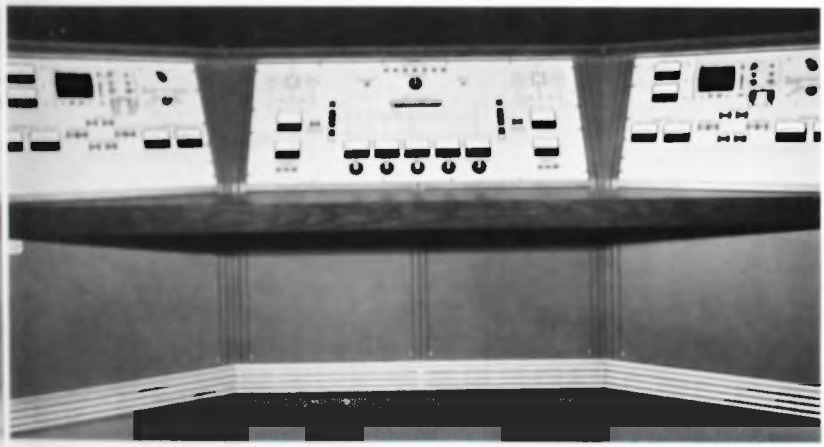


(f)

(g)



(i)



(h)