

# THE VOICE OF AMERICA...

by **GEORGE Q. HERRICK** and  
**RAYMOND KAPLAN** as told  
to *Cathode Press*

This article further develops, within security limitations, the activities of the radio phase of the U. S. International Information Program. In the first of these articles, on this State Department sponsored work, the purposes, programs, facilities, general background and audience of the Voice of America were described (Cathode Press, Summer 1952). The current discussion enlarges on transmitting needs, equipment and methods.

## GEORGE Q. HERRICK



*George Q. Herrick, Chief, Facilities Branch, International Broadcasting Division, graduated from New York University as an electrical engineer. He became Assistant Chief Engineer of Radio Station WINS, New York City, in 1935. In 1937 he became Chief Engineer of WINS and, later, was*

*Operations Chief. He has been Consulting Engineer to the Mutual Broadcasting System, to the Capitol Recording Company and to UN Radio. In May 1942 he was employed by the Department of State and became Chief of Facilities Branch, International Broadcasting Division, May 1948.*

## RAYMOND KAPLAN



*Raymond Kaplan attended Capitol Radio Engineering Institute and American University, Washington, D. C. Amateur radio operator 1925-28, and a Marine Radio Operator 1930-36. Broadcast station engineer at Radio Stations WNBF, Binghamton, New York and WOL, Washington, D. C.,*

*1936-42. Called to active duty in April 1942 and served as Radio Officer of the 12th Air Force. Upon return to the U. S. in 1944 he served as Radio Officer, Continental Air Force Command. Released from active duty as Major in February 1946 and rejoined the engineering staff at Radio Station WOL. Appointed Radio Engineer, Relay Base Section, Facilities Branch, Voice of America December 1948 and in June 1952, was appointed to his present position of Special Assistant to Chief, Division of Radio Facilities Plans and Development, International Broadcasting Service.*

# The development of a program of transmitting facilities and methods for reaching target areas around the world

In Mr. Kohler's recent article<sup>1</sup>, he described the broad policies which guide the Department of State's International Information Administration in presenting the United States to the peoples of other lands. The importance of radio as a major media in executing the Administration's responsibilities in the field of international mass communications and in the development of United States strategy to combat the psychological machinations of those whose basic aims and ideology are inimical to the United States was brought out in Mr. Kohler's discussion.

The radio phase of the U. S. International Information Program, commonly known as the "Voice of America," is the direct responsibility of the Administration's International Broadcasting Service, which provides the necessary mechanisms of facilities planning, development and operations and of program content and their transmission to the target areas in accordance with policies and priorities developed by the Administrator, other areas of the Department of State, and other agencies of the Government. Mr. Kohler also wrote of three basic technical problems confronting the organization in the development of an efficient Voice of America Program. These are:

- The vast distance between the U.S. and the target area.
- The geomagnetic disturbances encountered on the transmission paths from the U.S. to the important target areas of Europe and Asia.
- The electro-magnetic jamming activities of the Communist Bloc against the Voice of American program.

Mr. Kohler also described some of the methods and procedures by which his organization has, to a degree, overcome these obstacles. He described, in a general way, a facility expansion program aimed at an increasingly effective solution of the basic problems.

This article will, within the limits of security, describe the technical developments of these operating and planned facilities.

The development of the facility program can best be described as an evolutionary procedure with roots in the exigencies of World War II. The following is a discussion of the basic steps in this development.

<sup>1</sup> "This is the Voice of America," KOHLER, FOY D., *Cathode Press*, Summer 1952, p 8. Copies available upon request.

## U.S. International Broadcasting Requirements of World War II

The requirements of U.S. international broadcasting operations of World War II resulted in the expansion of U.S. international broadcasting facilities from some 13 domestic short wave transmitters to 38 such transmitters, plus a short wave relay base at Honolulu, as well as the establishment of bases in Asia and Europe, most of which were turned over to occupational forces and civilian governments after the cessation of hostilities. The domestic transmitters still in operation are of various manufacture ranging in power from 50 to 200 kw. They are concentrated on the northeast coast of the United States, in the midwest around Cincinnati and on the west coast around San Francisco, Sacramento and Bakersfield.

## Postwar Development of Overseas Relay Base Facilities

The operational experiences gained during the war years pointed to the need of efficient overseas relay bases to overcome the handicaps to direct broadcasting from the U.S. resulting from the disadvantageous geographical position of the United States with relation to the target areas in Europe and Asia. These handicaps were:

- (a) The distances involved limit direct broadcasts to the high frequencies thus leaving untapped the vast audience potential in the more popular standard and low frequency broadcasting bands.
- (b) The combined daylight/darkness paths during the best listening hours (evening in Europe and morning in the Orient) require a transmission frequency determined by the control point in the area of darkness, resulting in an operating frequency far below that which should be used to avoid high attenuation on the daylight portion of the path reducing the received fields in the target area.
- (c) The effects of geomagnetic disturbances which are prevalent on the great circle transmission paths from the United States to major target areas in Europe and Asia and which decrease the reliability of program delivery.

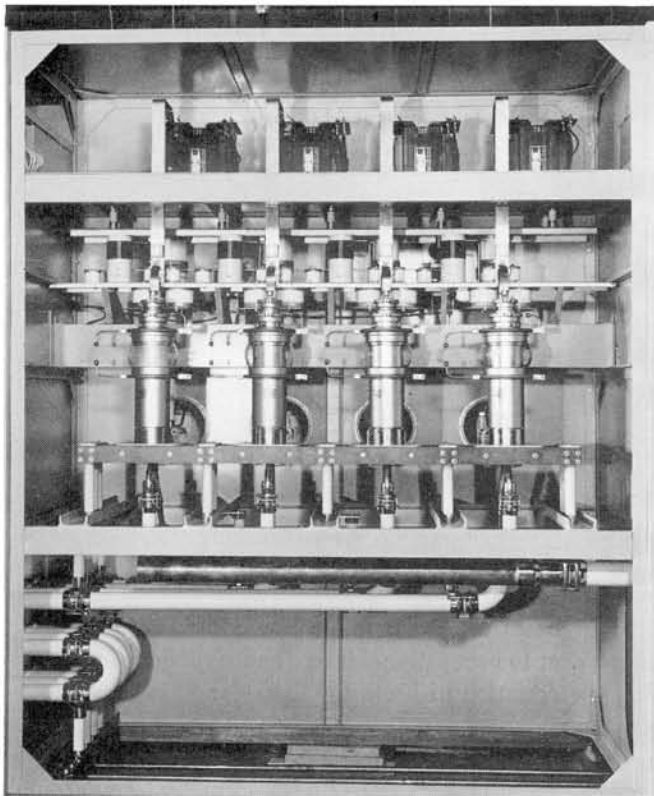


Figure 1—Right bank of Doherty 500 KW high efficiency amplifier showing four ML-5682's.

To provide a degree of relief to these problems, the Department of State, which was delegated operational responsibility for the Voice of America program upon the cessation of hostilities, was provided funds for the second step of VOA facilities development which, over a period of several years, made possible the following overseas relay base facilities:

#### I—MUNICH

- (a) Repaired and made operable four high frequency transmitters of Czech manufacture used by the German Government during the war. Two of these transmitters are rated at 100 kw carrier power and the other two at 75 kw.
- (b) Installed an antenna farm of 10 rhombics and 9 doublets to provide short wave coverage of all Europe, the Eurasian areas, of the Soviet Union, Near and Middle East, and Africa.
- (c) Constructed a receiving plant, using triple diversity receiving systems<sup>2</sup> to receive program transmissions from the United States for rebroadcast over the Munich transmitters. The receiving plant also serves as master control and recording point.

<sup>2</sup> A system to reduce signal fading by using three antennas each spaced several wavelengths apart.

- (d) Installed an RCA BTA-150 150 kw standard band broadcast transmitter to which was later added a duplicate unit paralleled through a combining network to obtain 300 kw of carrier power at the operating frequency 1196 kc. The antenna system uses a four element array and a switching system to provide three antenna patterns, each beamed towards a desired target area. The major lobe of Beam No. 1 provides a field of 600 MV/M/KW at one mile on a bearing of 60° true for sky wave service to Czechoslovakia, Poland and Eastern Russia.

Beam No. 2 is a modified figure 8, which provides a field of 348 MV/M/KW at one mile on a bearing of 5° true for sky wave service to the north, and a field of 348 MV/M/KW at one mile on a bearing of 105° true for sky wave service to Hungary and other Balkan countries.

Beam No. 3 is the reciprocal of Beam No. 1 laying down 600 MV/M/KW at a mile on a bearing of 240° true for sky wave service to Western Europe.

#### II—SALONIKA, GREECE:

- (a) One WE 407A1 50 kw transmitter operating on 791 kc into directional antenna and switching arrangement to provide a reversible cardioid pattern. Beam No. 1 is directed towards the north to provide sky wave coverage of the Balkans. Beam No. 2 is directed south to cover Greece.
- (b) A receiving plant, similar to the Munich installation.
- (c) Two 35 kw Collins 207B-1 high frequency transmitters and rhombic antennas beamed to cover the Balkans, Central Europe and Western USSR.

#### III—TANGIER, MOROCCO:

This plant is designed primarily as the "Voice's" main gateway to Europe. Experience has shown that the transmission paths from the East Coast of the United States to Tangier are much more favorable than the more northerly direct paths to North and Central Europe. At the same time, the transmission paths from Tangier to the main target areas of Europe, the Near and Middle East and Western Asia, are excellent and provide reliable program feeds to other European relay bases and good direct short wave service to the target areas. The major facilities of the Tangier plant are:

- (a) Four 100 kw General Electric Type 100-C high frequency transmitters; two 50 kw RCA 50 SW high frequency transmitters; four 35 kw Collins 207-B1 high frequency transmitters.
- (b) An antenna farm of 24 rhombic antennas on appropriate beams to the desired target areas.
- (c) A receiving plant employing triple diversity receive-

ing systems, capable of exalted carrier<sup>3</sup> and single side band selection.

- (d) Diesel electric power machinery at the transmitter and receiving plants, providing the necessary power for full operation of the entire relay base.

In the Pacific Area a relay base was constructed in the Philippines near Manila and this, together with the Honolulu relay base, provided a retransmission service to the Orient.

#### IV—MANILA

- (a) A Western Electric 407A1 50 kw transmitter operating on 920 kc into a six element DA providing three beams, 335° for sky wave coverage toward China, 155° for Philippine service and 275° for sky wave service to Southeast Asia.
- (b) Two RCA 50 SW 50 kw high frequency transmitters and a 7½ kw auxiliary high frequency unit.
- (c) An antenna field of 10 rhombic antennas for short wave service to Japan and the Asiatic mainland.
- (d) A receiving plant similar to the Munich and Salonika installations.
- (e) Diesel electric plants to provide power for full operation of the relay base.

#### V—HONOLULU:

- (a) Two GE 100-C 100 kw high frequency transmitters.
- (b) An antenna field of nine rhombic antennas beamed to the Orient.
- (c) A receiving station using triple diversity reception.

The overseas plants described above supplemented the 38 domestic high frequency transmitters and could be considered as the second step of the Voice of America's facilities expansion program.

#### Present Facilities Expansion Program

The present, or third step in the "Voice's" facilities expansion program which is still under way, was embarked upon by the Department of State when it became apparent that what might be termed pre-war "normalcy" would not recur, at least in the foreseeable future. Since the world appeared to be moving towards two distinct ideological poles with the United States assuming leadership of one and the Soviet Union the other, it became obvious that the United States must not only maintain, but augment, its most effective means of mass communications, its Voice of

<sup>3</sup> Exalted carrier operation is a process by which a receiver separates a carrier from its side bands, exalts or amplifies the carrier to constant and higher amplitudes then re-combines the carrier in proper phase with one or both side bands. This process reduces distortion due to selective fading of carrier and/or side bands which occur when side band to carrier signal ratios reach values greater than those required for 100% modulation. Exalted carrier reception, in effect, therefore, limits the value of modulation in the received signal to the same or lower value at the receiver to that developed in the transmitting system, minimizing the effect of ionospheric selective fading in the transmission path.

America's international broadcasting operations. Added impetus to the program was given by the Congress on January 27, 1948 when it passed Public Law 402, the U. S. International and Educational Exchange Act.

The inception of the Russian jamming effort late in 1948 and its progressive increase to its present intensity added further impetus to the program and at the same time dictated the need for adequate research and boldness in planning and development of facilities. Development proceeded along two primary lines:

- (a) The improvement of the operating facilities.
- (b) The establishment of new facilities in a basic plan of action called the "Ring Plan" which, in itself, is broken down into three phases.

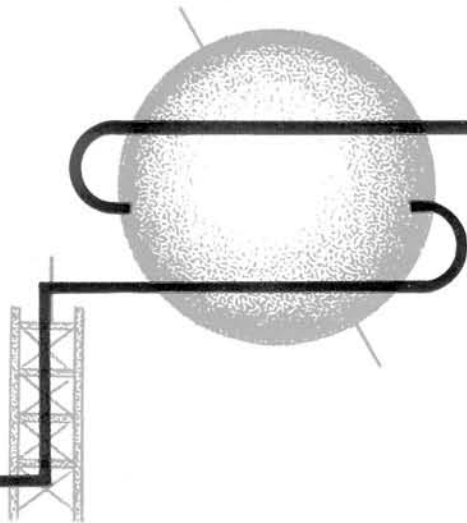
I—Basic "Ring" which provides for the establishment of extremely high powered relay base facilities which, consistent with security and political considerations, are sited at locations where it is possible to take maximum advantage of radio propagation conditions in the various broadcast bands utilized by receivers in selected target areas and, at the same time, provide the maximum strain to the



Figure 2—Three unit assembly associated with each 500 KW transmitter; (left) 15 KV rectifier tube assembly, (center) 3 bias rectifiers, (right) audio and RF driver.

jamming mechanisms. Each such facility is self-contained as to power source, is capable of program origination or of acting as a relay base performing instantaneous or delayed retransmission. It provides multiple antenna patterns which both complement and supplement patterns of other facilities

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to provide a prime service area pattern as well as to provide additional service in areas covered by other facilities. In general, these basic "Ring" plants have main transmitters capable of carrier powers of 1000 kw (1 megawatt).

II—Baker Installations provide reliable primary program channels from the United States to the overseas relay bases and secondary direct target area coverage as a security measure. These installations are designed for multiple high-frequency transmitter operation, with basic units of 500 kw carrier power operating into broad band curtain arrays having gains averaging about 20 DB referred isotropic radiators. With synchronized operation on a single frequency it is possible to obtain extremely effective radiated powers, something in the order of 200,000 kw with two 500 kw units operating into two phased arrays.

III—Vagabond facilities provide siting flexibility in the over-all facility plan. The relay base installed aboard the USCG cutter "Courier" is one such facility, providing a self-contained relay base using a standard broadcast band transmitter of 150 kw and two 35 kw high frequency transmitters as well as a receiving station and radio teletype communications equipment. A discussion of the Vagabond operational plan as well as further details of the "Courier" installation will be described later in the text.

To adequately control and direct such a world-wide broadcast operation, the "Ring Plan" includes an integrated communications system.

The three basic steps in the development of the operating and planned installations through which the Voice of America now reaches and plans to augment its vast world-wide audiences have been described above, together with a brief description of the operating overseas relay bases.

Unfortunately, security considerations do not permit detailed discussion of those facilities presently under construction or of those which are planned for future installation. It can be said, however, that research plays a vital part in the establishment of the "Voice's" facilities. It would not be prudent to overlook newly developed devices and engineering procedures that can be advantageously used in these broadcasting installations which have become a basic arm of the United States in combatting the psychological machinations of the Soviet Union, the major threat to world peace. It also would be extremely unfortunate not to subsidize basic research investigations which may develop these new devices or procedures. The Administration, through its International Broadcasting Service, has established a research program utilizing the services of such organizations as the Massachusetts Institute of Technology, Radio Corporation of America, the Research organizations of other Government Departments and Agencies, as well as many other commercial and institutional organizations having experience in research activities along lines most important to the "Voice's" technical development. In general, this research program explores the broad field of electronics and radio propagation.

The operations of the standard band transmitting plants used by the VOA differ in many ways from those of the commercial broadcasters in the United States. One of the fundamental differences is, with the exception of certain relatively short salt water paths, the dependence upon sky wave rather than ground wave to cover the primary service area. The reason for this, of course, is that the VOA audience is not concentrated in the vicinity of the transmitting plant as are the audiences of the United States commercial broadcaster, who, while in many cases does direct some of his attention to his secondary night time sky wave coverage, depends for his main source of revenue on his audience in his primary ground wave area. In the operation of the Voice of America plants, the ground wave service is in

general a secondary service. In many cases the ground wave service is used by the sovereign government on whose soil a plant is located to serve indigenous populations during the time a facility is not useful for Voice of America programming, usually during the daylight hours.

So that adequate sky wave signals can be consistently developed to distances of over a 1000 miles, transmitter powers of 1000 kw are used. The antenna patterns are in the form of directed beams towards the target areas, although many of these beams must be modified and minor lobes suppressed so as not to provide serious interference to other co-channelled and adjacent channelled stations, much the same as the U. S. broadcaster affords protection to others.

The establishment of a 1000 kw standard band broadcasting station anywhere in the world, and the selection of an appropriate frequency, is not only a major engineering project but one with considerable international political ramifications. It requires delicate diplomatic negotiations with the sovereign government in whose territory a plant is to be located for permission to install an American radio station on its soil. Since, in general, no provisions have been made for American broadcasting operations in many areas, it requires further delicate negotiations with other governments operating co-channelled and adjacent channelled stations whose service areas must be protected. In many cases a frequency must be chosen which has been assigned on a clear channel basis by area agreements to a certain country. That country, which may be very friendly to the United States and her objectives, nevertheless invariably views with alarm even the slightest encroachment upon her right to operate an interference-free broadcast service. Obviously, it is necessary to reach a friendly understanding on the matter if our relationship with that country is not to suffer in many matters which may be far removed from the problems of broadcasting. The establishment of a Voice of America plant overseas, therefore, is a very lengthy, delicate procedure and at all times the United States must assure herself that the operation of such a plant would not cause difficulties with her friends even though the programming is designed to advance the well-being of the international community of nations.

### "Vagabond"—Mobile Transmitters

One of the most interesting phases of the International Broadcasting Service's facilities development is project "Vagabond." This project provides sea-going mobile units necessary to assure a well rounded facility set up for Voice of America programming. "Vagabond" is not a cure-all. It has certain basic technical disadvantages relative to fixed facilities. Most of these are the result of antenna limitations and limitations on the size of the transmitter complements that are not inherent in fixed facilities. On the other hand, there are definite advantages to "Vaga-

bond," some of these are immediately apparent, others are not.

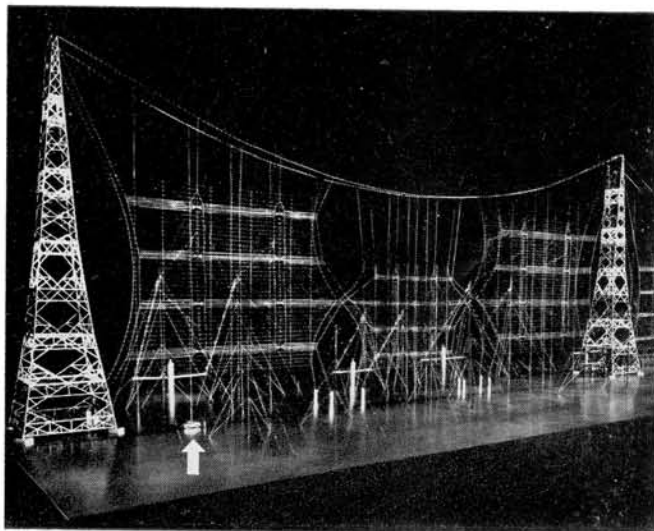
The ability to move into an operating location and commence broadcasting is an apparent advantage, as is the ability to leave an area when circumstances dictate.

There is one other advantage which is as important as the degree of mobility. That is the time necessary to construct one of these facilities. Use is made of available vessels suitable for this type of service. The time required for modification of a vessel to permit the installation of equipment and the installation itself is about nine months. Experience has shown that the construction time involved in an extensive fixed plant in an overseas area can exceed 18 months. Further, construction of a fixed plant cannot commence until such time as all the necessary diplomatic arrangements and negotiations for a site are completed. The important element of construction time is on the side of the "Vagabond" installations.

One important premise in the establishment of the "Vagabond" project is the possibility of using this type of facility as a temporary substitute for a fixed plant pending completion of construction of such a plant. By using "Vagabond" in the sovereign waters of a nation which has granted permission for the construction of a permanent base, effective operations can commence without awaiting completion of the fixed installation.

At present one of these "Vagabond" facilities is in operation. This is the United States Coast Guard cutter "Courier," now stationed at the Island of Rhodes, providing standard band and high frequency coverage of the Middle East and part of the Balkans with the short wave coverage extended over much wider areas.

*Figure 3—Model of high-gain curtain-type directional antenna used with Voice of America transmitters. The scale-size automobile in the left foreground above arrow indicates the comparative size of a curtain antenna installation, which is as tall as a skyscraper building and about as long as two standard city blocks.*



The announcement of the activation of the "Courier" caught the imagination of many people. Several articles appeared in popular, as well as technical, publications. Almost invariably the assumption was made that this ship was intended to operate on the high seas, or perhaps off enemy coasts, traveling back and forth broadcasting its messages. This is not the case.

The "Courier" is a completely self-contained broadcasting unit, from its independent diesel electric system to its transmitting antennas. It has a receiving system capable of simultaneous operation with all three of its broadcast transmitters operating at full power. It has recording and studio facilities. There is, therefore, no technical reason why this ship could not operate while under way, anywhere. The limitations are those of basic United States policy and of international law.

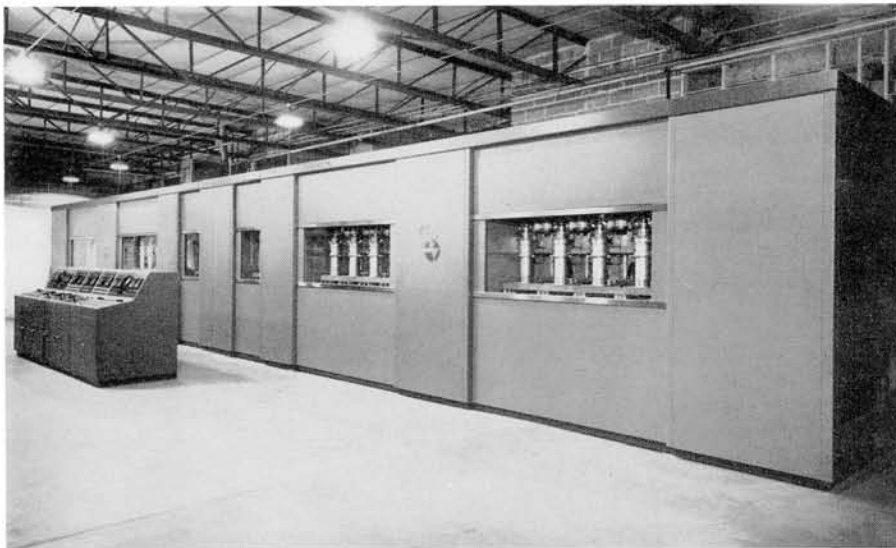
To operate such a facility while under way would be contrary to the provisions of the existing International Telecommunications Treaties to which the United States is signatory. Further, operation in other than the most friendly waters would make security questionable with attendant risk of embroilment in serious incidences.

The operational plan for this facility is quite similar to the operations of fixed overseas relay bases. The vessel is intended to operate at fixed locations in safe harbors in the sovereign territory of friendly nations which have granted permission for such operation. The frequencies used in the operation must also be authorized by the nation holding sovereignty over the site. The same fundamental precautions as to protection of the service areas of other stations that are adhered to by the fixed facilities of the Voice of America are also part and parcel of the "Vagabond" concept. This latter consideration is in a sense a limiting factor in mobility of "Vagabond" facilities.

Confining ourselves for the moment to the medium wave service, the vessel is equipped with a balloon-supported

antenna that can be raised to optimum heights. Such an antenna, being omnidirectional, does not afford protection in any direction. In certain areas this is not an insurmountable problem, as perhaps the distances to the service areas of other stations are great enough, or the channel sharing pattern is such that the vessel's transmitters would have no appreciable effect to the services of co-channel or adjacent channel users. In some cases, certain hours of operation may require reduction in power of the ship's transmitter. In many cases, however, sites may be perfectly satisfactory in all respects except that it is not possible to use an omnidirectional antenna without causing serious interference to other broadcasters. Not only is it necessary in these cases to provide some degree of protection to stations, but it is highly desirable in all cases to transmit the maximum amount of effective radiated power towards a desired target area. Both these requirements can be met only by the use of multielement directional arrays which obviously cannot be installed on the vessel, even with the help of balloons. The use of the balloon-supported antenna is, therefore, considered a temporary measure at most locations.

Should it be desirable to operate an appreciable length of time from a given location, a secure anchorage is found close to shore, or a pier is constructed to which the ship is tied. A directional antenna is erected ashore which is then fed through a specially designed transmission line by the ship's transmitter. The mechanics of laying a transmission line from vessels that are subject to rise and fall of tides, is not as difficult as it appears at first glance. High power capacity flexible coaxial line is available from several sources. This cable can be laid on the harbor bed in the manner of a submarine cable or it can be brought ashore using a series of floats. Methods for using open wire lines when piers can be made available have been worked out by the use of a self adjusting system to compensate for changes in line tensions with the tides.



*Figure 4—General view of the front panel of the megawatt transmitter and the centralized control console.*

Not only can the medium wave antennas be erected ashore, but so can the receiving plant. By so doing, efficient directional receiving antennas of the rhombic type are erected to provide adequate space diversity reception and appreciable antenna gain. The receiving system aboard ship is a good one but, of course, does not reach the efficiency that can be achieved through shore based antennas. Incidentally, a program picked up by a shore based receiving facility is transmitted to the vessel via an SHF-STL<sup>4</sup> link which is part of the vessel's electronic complement.

Space is provided in the holds for the storage of medium wave antenna towers and a knocked-down "pre-fab" hut to house the shore based receiving station.

The short wave transmitting antennas are of rather novel design and are permanently located atop the ship's fore-castle. These antennas were specially designed for this project and have extremely broad band characteristics, maintaining a relative constant input impedance and good radiation efficiency over a wide frequency range. Two of these antennas cover the entire high frequency broadcast spectrum lying between 6 and 26 megacycles.

In addition to the main broadcast transmitter, the standard band 150 kw, two 35 kw transmitters are installed on the "Courier." There is also a 5 kw transmitter installed which is used for radio teletype communications. A separate teletype communications room, independent of the ship's normal radio room is available for heavy traffic loads.

Three 500 kw synchronized diesel generators provide the power supply to the ship's broadcasting facilities. Two diesels provide power for full simultaneous operation of all transmitters. The third engine is a spare.

The United States Coast Guard operates the "Courier" for the Department of State, providing its complement of officers and crew and arranging for other services incidental to the vessel's operation. The International Broadcasting Service supplies three engineers to supervise the transmitter operations and the selection of relayed programs in accord-

<sup>4</sup> Super-High-Frequency Studio-Transmitter Link.

ance with instructions from their New York headquarters.

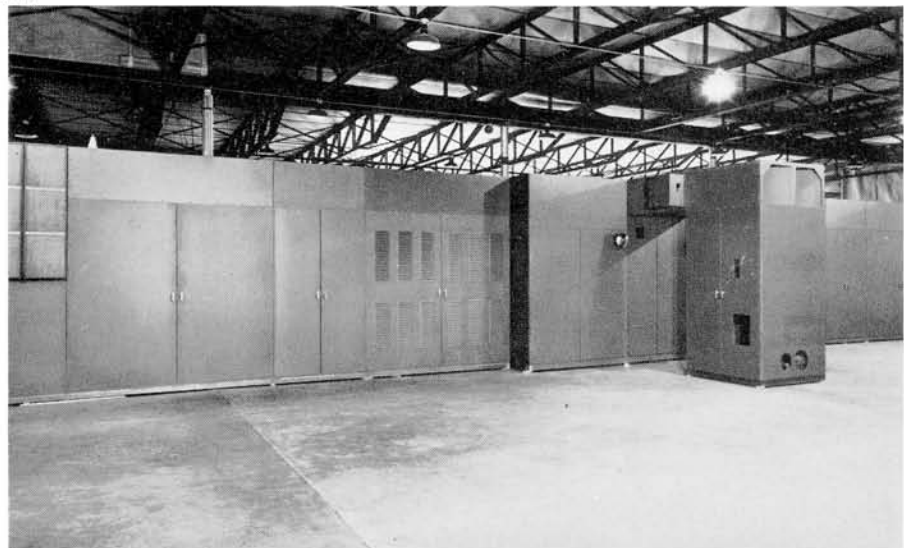
It can be said from the foregoing discussion that the "Vagabond" facilities are used as though they were "transportable" units rather than fully "mobile" units, though the latter type of operation is entirely possible from a technical standpoint.

### Super-Power Broadcasting—Megawatt Transmitters

Another development which may be of interest to the reader, is the 1000 kw standard band broadcast transmitters manufactured for the Department of State by the Continental Electronics Company of Dallas, Texas. The limits of security will not permit too detailed an examination but the major points of interest can be described. The transmitter, Continental Type 105B, is in reality two separate and complete 500 kw transmitters using one oscillator of either unit to drive the remaining stages of both 500 kw units, the output of each being fed into a phasing bridge device to develop 1000 kw at the input terminals of a transmission line.

The 500 kw amplifiers use the Doherty high efficiency linear amplifier, four Machlett Type ML-5682 electron tubes in the carrier position and four more in the peak position. Each 500 kw amplifier is driven by a grid bias modulated amplifier using one ML-5682. The RF chain is completed by an 807 followed by an 813 which drives the grids of two ML-357B tubes, providing an output of up to 2 kw to drive the modulated amplifier. The audio amplifier consists of two 807's followed by an 845 followed by four 845's in parallel as a cathode follower for grid bias modulating the ML-5682 modulated amplifier. Each 500 kw transmitter has its own filament, plate and bias power components, making it possible with some minor changes to split the two units for installation at two separate locations, if desired. A dummy load capable of dissipating 750 kw is supplied with each 105B transmitter. This permits the testing of each 500 kw unit under full modulating conditions.

Figure 5—Rear view of the complete transmitter.





Some pertinent data relative to the characteristics of the 105B transmitter, which may be of particular interest, are enumerated below:

1. The high efficiency linear amplifier has a power gain of 33 using triode tubes. The tubes are newly developed, have thoriated tungsten filaments and high transconductance.
2. All metering, tuning controls and power controls are centralized on a console type of control and tuning unit.
3. Over-all conversion efficiency from power source to antenna is slightly better than 50% at carrier conditions, rising to approximately 54% with 100% tone modulation.

Performance characteristics are:

Residual Carrier Noise

Level.....60 DB below 100% modulation

Carrier Shift.....Zero at any modulation to 100%.

Sustained Tone Modu-

lation Capability.....100% at any frequency 30 to 10,000 CPS.

Final Power Amplifier

Efficiency.....62%

### Communist Bloc Countermeasures—Jamming

No discussion of the radio facility development which the International Information Administration is undertaking

*Figure 6 — The Voice of America's floating radio station "Courier." Some of the special antennae can be seen in this view. From the raised platform amidships captive barrage balloons may be released to carry antennae hundreds of feet above the ship.*



to increase the effectiveness of its Voice of America operations would be complete without some attention being given to the technique used by the Soviets and their satellites to blot out our programs.

The overloading of the medium and low frequency broadcasting bands, and the difficulty in obtaining an interference free service in these bands nearly everywhere in the world, have already been discussed. Additionally, the high frequency broadcasting bands also are overcrowded to the point where it is extremely difficult to deliver a service that is relatively free from interference. To describe the condition prevalent in these broadcasting bands, at an International Conference at Mexico City held in 1949, a total of 15,000 frequency hours were submitted as minimum broadcast requirements of the different nations. Using the most lenient standards, the spectrum can support a little in excess of 5,000 hours.

To these frequency difficulties, and to the difficulties inherent in the disadvantageous geographical position of the United States which have been previously discussed, has been added the jamming effort of the Soviet Bloc against the Voice of America operations of the United States as well as against similar operations of the BBC and other friendly broadcasters.

Evidence gathered over the years indicates that over a thousand jammers are being used in this destructive service. The observers of both the BBC and VOA have identified over 250 high-powered sky wave jammers by means of their call indicators. Further investigation has disclosed that, in addition to the sky wave jammers, there is a tremendous number of ground wave jammers serving heavily populated urban areas. Best estimates of both BBC and VOA are that there are nearly a thousand of these.

The operational procedure of these jammers would appear to make necessary complex control networks and centers. That they do not operate under a haphazard procedure is evidenced by the ability of a large number of jammers to "zero in" on a previously unannounced frequency within minutes after commencement of a program that the Soviets desire to jam.

Such a jamming mechanism is obviously expensive not only in material costs, but in the expenditures of trained man power and communications facilities—all of which, undoubtedly, are as important to the Russian economy as they are to ours. Based on comparisons with known equipment costs, the capital investment in the physical components of the jamming mechanism now operating against us is estimated to be in the neighborhood of \$70,000,000. This figure is exclusive of the cost of such things as wire lines, radio links and other apparatus which are inherent in as complex a control network as must be established to control such a vast number of jamming transmitters. Included in the transmitting facilities involved in the jamming mechanism—and this further shows the degree of importance the Soviet Bloc places on their Electronic Curtain



Figure 7—Transmitter room aboard "Courier."

as a vital element of their Iron Curtain—are many of their high-powered broadcasting stations. Observers have noticed that when VOA programs are directed to certain areas behind the Iron Curtain, a noticeable decrease in the volume of internal broadcasting occurs followed by a great increase in jamming on VOA frequencies. Many of these jammers obviously are broadcast transmitters removed from their normal service for the purpose of jamming the "Voice's" programs.

The operating costs of the jamming operation, if based on rather conservative figures, are \$2.00 per transmitter hour, exclusive of personnel. Most commercial companies average \$3.00 per transmitter hour for small transmitters in the point-to-point service. Actual operating costs, using the two dollar figure would be in excess of \$17,000,000.00 per year.

The cost in trained man power, if we were to be conservative and say that one technician operates two transmitters, which is doubtful since the Soviets have shown great facility in meeting changes in frequencies of a program transmitter, would be over 2,000 men. Not an inconsiderable number of trained technicians for any country to assign to one project.

To counteract the effects of jamming of our present operating facilities, we are undertaking many different techniques. For example, at certain times BBC and VOA join forces and mass all available transmitters to carry out a Russian operation. At other times we shift frequencies and engage in general diversionary tactics. An effective procedure also is to engage in round-the-clock repeat broadcasts over certain facilities, that is, repeating certain specific broadcast schedules so that a given program may be heard at several definite times during the day and night to permit a listener to tune in at other times if the original broadcast was unheard because of jamming. In passing we might mention that fifteen different types of jammers have been

observed from the old and very familiar "German bagpipe" to highly sophisticated noise jammers of rather recent vintage.

We have described the basic problems facing the United States in the field of international broadcasting.

The question may be asked as to the extent these problems have been solved by the present day facilities of the Voice of America. Whether the "Voice," with its facilities now on the air, has been able to pierce the wall that has been placed around Soviet dominated areas, despite the natural and man-made obstacles in its path. The evidence is that it is getting through, and getting through to an appreciable degree. Monitoring reports indicate that, despite the concentration of jammers in the area, a good many of our programs are even getting through to Moscow. A much larger percentage are getting through to the rural areas of Russia which are not as efficiently covered by the jammers.

Despite these jammers, Radio Moscow felt obliged to attack the "Voice" 312 times during 1951 in an effort to discredit and refute the broadcasts, while TASS carried 23 separate attacks which were printed in 100 provincial newspapers. Even if it were assumed that the answer to the "\$64" question is negative and we are not getting through, the Communist radio and press in their efforts to refute the Voice of America, repeat enough of it to make the effort very worth while indeed. Reports from other Iron Curtain countries, just as important if not more important targets than Russia herself, also prove that the "Voice" is heard with good effect.

Circumstances have placed upon the shoulders of the United States the heavy responsibilities of leadership of the free world. We are faced with a ruthless opponent determined to dominate the world, using whatever weapons she may find expedient, and the most effective weapon she has used to date has been the ideological approach—Communism itself—in the psychological war she is waging against the free world to achieve her major objective, imperialistic expansion and domination.

Do the strategists in the Kremlin fear the Voice of America? The existence of the jammers testifies to that! In a general way, the Voice of America can claim a considerable share of the credit for fostering the growing determination of the free world to resist encroachment upon their liberties and instill hope and equal determination in the peoples of Communist dominated lands to regain their lost liberties.

The stakes are much too high for the United States not to meet the constantly growing challenge to its best of all weapons of psychological warfare—truth. That is why the Department of State and its International Information Administration have embarked upon a bold, sound plan of radio facility expansion—to assure that the Voice of America is not drowned out in an electronic sea of noise and discord.