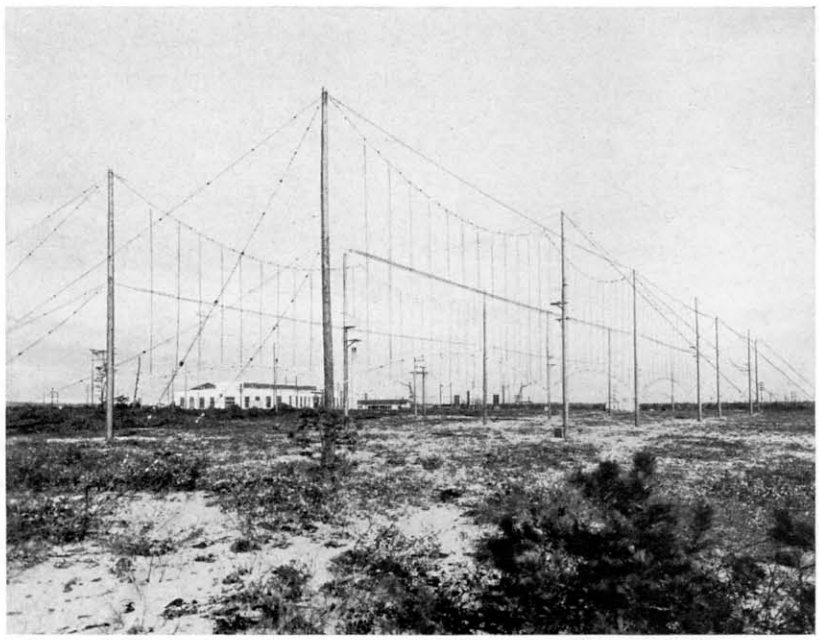
R.C.A.C. Diversity Telephone Equipment As Used In Its Addressed Program Service

By S. H. SIMPSON, Jr., Program Service Supervisor, RCA Communications, Inc.

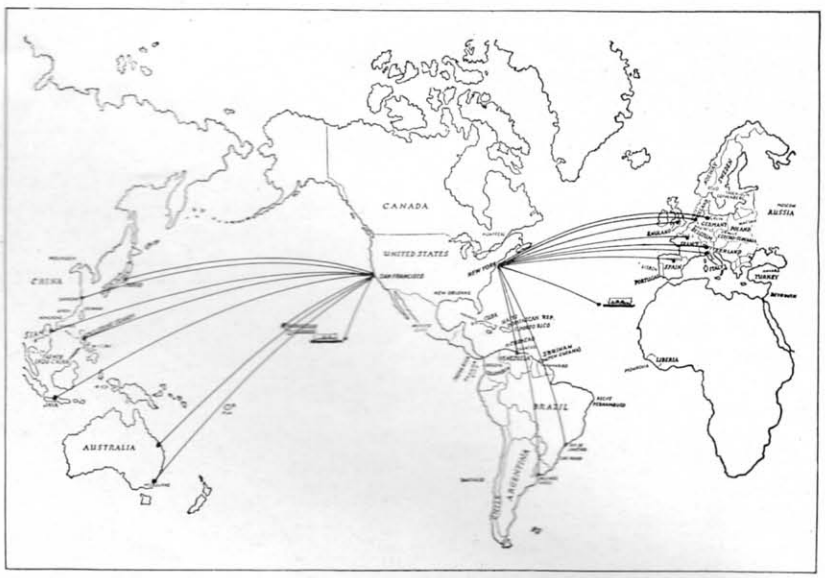
THE rapid advance of broadcasting not only brought on a natural desire to hear programs originating in foreign countries but the American Public almost demanded the right to hear first hand, the great operas, orchestras, speakers and news events of foreign countries.

Back in 1923-24 tests were made with the old well known British 5XX on 1600 meters. In fact, several programs were rebroadcast over the old WJZ of Aeolian Hall days, but only the novelty of the deed sustained the poor quality obtained.

Then short waves were discovered. A few kilowatts of power reaching around the world—very little static so characteristic on long waves, but afflicted with the serious problem of fading. This may be classified under its periodicity and also under its depth. We have slow fading of from a few seconds to a few minutes duration or rapid fading of such speed as to modulate or superimpose the frequency of fading on the program being transmitted. This very rapid fading is called flutter or audio fading on account of the fluttering effect it produces in the signal.



SPECIAL ANTENNA SYSTEM DEVELOPED FOR THIS SERVICE AT ROCKY POINT, L. I.



THE DIRECTED PROGRAM CIRCUITS OF **THE RCA COMMUNICATIONS, INC.** A RADIO CORPORATION OF AMERICA SUBSIDIARY

Another troublesome form of fading is that known as selective fading in which one frequency out of the transmitted group fades out leaving the rest intact. If the frequencies which fade out are the so-called sideband frequencies no appreciable damage is done to the signal, but if the carrier frequency fades out leaving the sidebands intact the signal is badly distorted, the effect being the same as extreme overmodulation of the transmitter.

The first procedure was the application of an automatic volume control to the short wave receivers. This is normally accomplished by rectifying the amplified radio signal —or intermediate frequency signal in the case of a superheterodyne receiver—and passing the D.C. current so obtained through a suitable resistor. The resulting voltage drop across this resistor is used as grid bias voltage for the radio frequency amplifier. When the radio signal strength rises this bias voltage becomes more negative, reducing the R.F. amplifier gain, and vice versa, with the result that the audio frequency output of the receiver varies only slightly though the radio signal varies greatly. Such an arrangement, however, cannot provide additional carrier when the carrier fades. Neither can it improve the signal to noise ratio at times of weak signal. Noise level remains fairly constant over a given period but a weak signal produces only a weak bias for the R.F. ampli-

fiers and the receiver gain is increased. In amplifying the signal to normal level the noise is also amplified in proportion.

Experiments by the engineers of RCA Communications, Inc., showed that fading does not occur simultaneously on several antennas spaced some distance apart and that the antenna delivering the strongest signal normally produces the best quality at its receiver output. The next step was to apply this knowledge but the range of frequencies to be handled, and the quality expected, made the addition of two or more signals a real engineering problem due to phase distortion or cancellation.

The system developed and now generally used by RCA Communications, Inc., at Riverhead, N. Y., Point Reyes, California, and Koko Head, Hawaii, is very practical and efficient. A very serviceable and efficient superheterodyne receiver has been developed for this use. The signal from each antenna is fed through its receiver to bias type second detectors. The detector plates are all supplied from one common plate battery through a load resistance, the resistance being connected between the negative terminal of the battery and filament. The audio frequency output is taken from this load resistor and the D.C. voltage drop across the resistor is fed back to all R.F. amplifier grids as automatic volume control bias voltage.

By means of this connection, all receivers are kept at substantially equal gain. A strong signal output from one of the three receivers will reduce the gain of all receivers and thus lower the noise contributed by the other two. Obviously this is a very desirable condition.

The choice of the volume control time constant, i.e., the time required for the control to change from maximum to minimum and vice versa, is more or less a compromise. A time constant so small as to affect the amplitude of low frequency modulation is obviously unsuitable; and on the other hand too large a constant may not allow response to the more frequent rates of fading. Also, it is preferable to make the constant sufficiently small so as not to follow the faster rates of fading. For example in the latter case: the auto control may lag behind a deep, rapid fade to the extent of maintaining a high gain level after the signal returns to normal and a sudden "burst" of strength results in the output.

RCA SHORT WAVE TRANSMITTER HOUSE, BOLINAS, CALIF.

GERMAN RADIO CENTER—BERLIN (COURTESY REICHS RUNDFUNK AND NBC)

The well known flexibility and selectivity of the superheterodyne receiver accounts for the adoption of this type of receiver in the telephone diversity system developed by RCA Communications, Inc.

Fundamentally, the receiver consists of three parts, viz.: R.F. Amplifier, Heterodyne Tuner Unit, and I.F. Amplifier Detector Unit. The apparatus is capable of operating satisfactorily from approximately 42,800 KC (7 meters) up through the broadcast band, but the usual standard equipment for commercial use calls for operation only of from 20,000 KC (15 meters) to 5000 KC (60 meters). The load resistance and auto bias circuit, including the time constant circuit, are all inclosed in the Audio Amplifier Unit which controls the audio output levels fed to speakers or lines for distribution.

A very unique unit, namely, the I.F. Monitor Unit, is included in each diversity receiver installation to

facilitate quick and exact tuning. This piece of apparatus utilizes a constant frequency oscillator, tuned exactly to the middle of the I.F. band, the output of this oscillator being fed into a special balanced detector. This balanced detector also receives a small amount of the I.F. signal through a "bleeder" tube in the I.F. Unit. Now by tuning the main heterodyne oscillator until zero beat with the monitor unit oscillator is obtained, the receiver operator knows that the signal is exactly in the middle of the I.F. band pass filter and the receiver is precisely in tune.

This diversity equipment which has been described is in use at the Hawaiian end of the San Francisco-Honolulu telephone circuit.

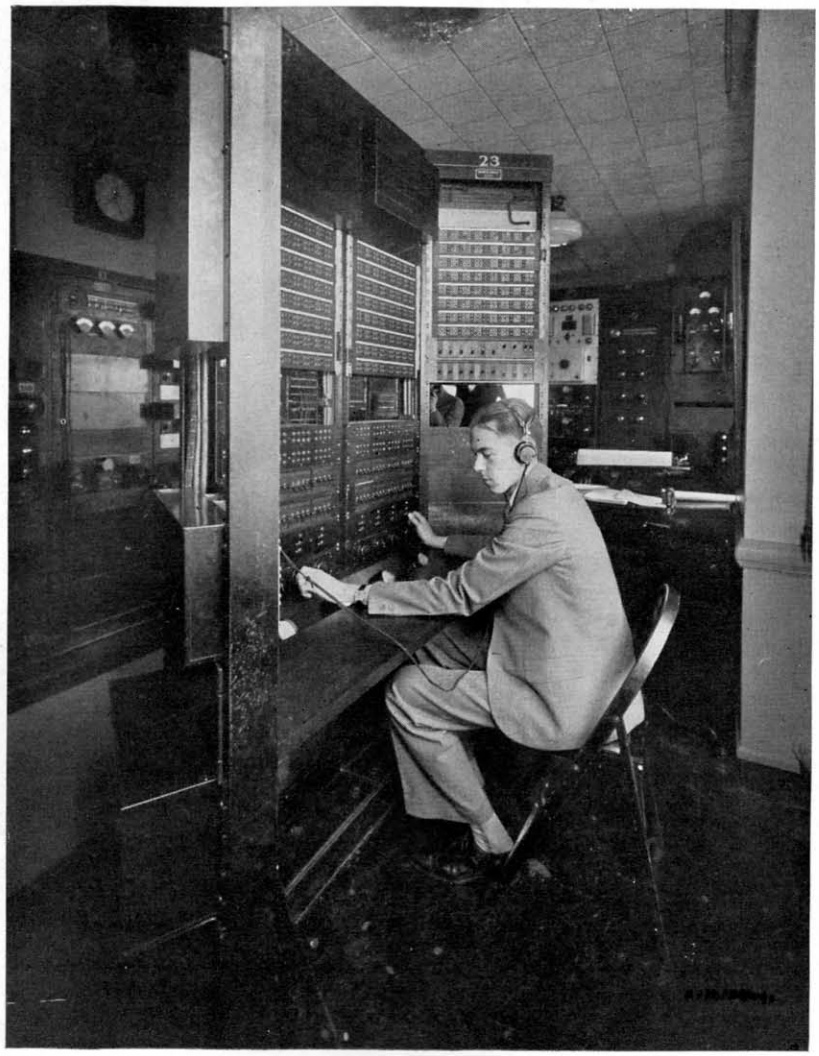
The foregoing refers particularly to the reception of programs from abroad to be broadcast in this country for the entertainment of American listeners, but RCA Communications, Inc., has gone still further and has provided facilities, in conjunction with its world wide radio telegraph installations, for transmitting American programs to broadcasting organizations in many foreign countries.

Directive transmission is used throughout in conjunction with high quality high power transmitters, ensuring a high degree of reliability in service. These transmissions are received by the foreign receiving stations cooperating with RCA Communications, Inc. in program service and delivered over suitable wire lines to the addressee for broadcasting.

The transmitters consist of three main units, a crystal controlled frequency doubler type of exciter unit with an output of 1 KW, a power amplifier using either 4 UV-207 or 2 UV-858 watercooled tubes in a push-pull circuit, with a maximum output of from 20 KW at 14 metres to 40 KW at 45 metres, and a 3 phase full wave rectifier for plate supply to the power amplifier. A.C. filament supply is used throughout.

These transmitters are normally engaged in telegraph service but can be readjusted for program transmission in a few minutes, the major change being the application of Husing type modulation to the output of the exciter unit. The modulators are small compact units mounted on wheels so they may be moved around from one transmitter to another as required. They incorporate one resistance coupled stage of amplification driving 4 to 6 UV-849 modulator tubes and are entirely self-contained, with one flexible two conductor cord and plug for making connection to the line amplifier output and another cord and 5 terminal plug for A.C. supply for the filaments, 3000 volt plate supply for the modulator, modulated plate supply to the exciter output stage and a ground connection.

The transmitter output is carried to the directive transmitting antenna over a transmission line consisting of two bare copper wires approximately one-quarter inch in diameter about one foot apart. Many of these transmission lines are more than a half mile long as even the most compact types of highly directive antenna occupy quite a large area of land and must not be placed so closely together as to interfere with each other. The large transmitter buildings at Rocky Point and Bolinas, with their combined total of 44 short wave transmitters, and their surrounding networks of transmission lines and antennas occupying a total of several square miles of land are most impressive sights, that must be seen for realization of the extent to which international radio communication has been developed.

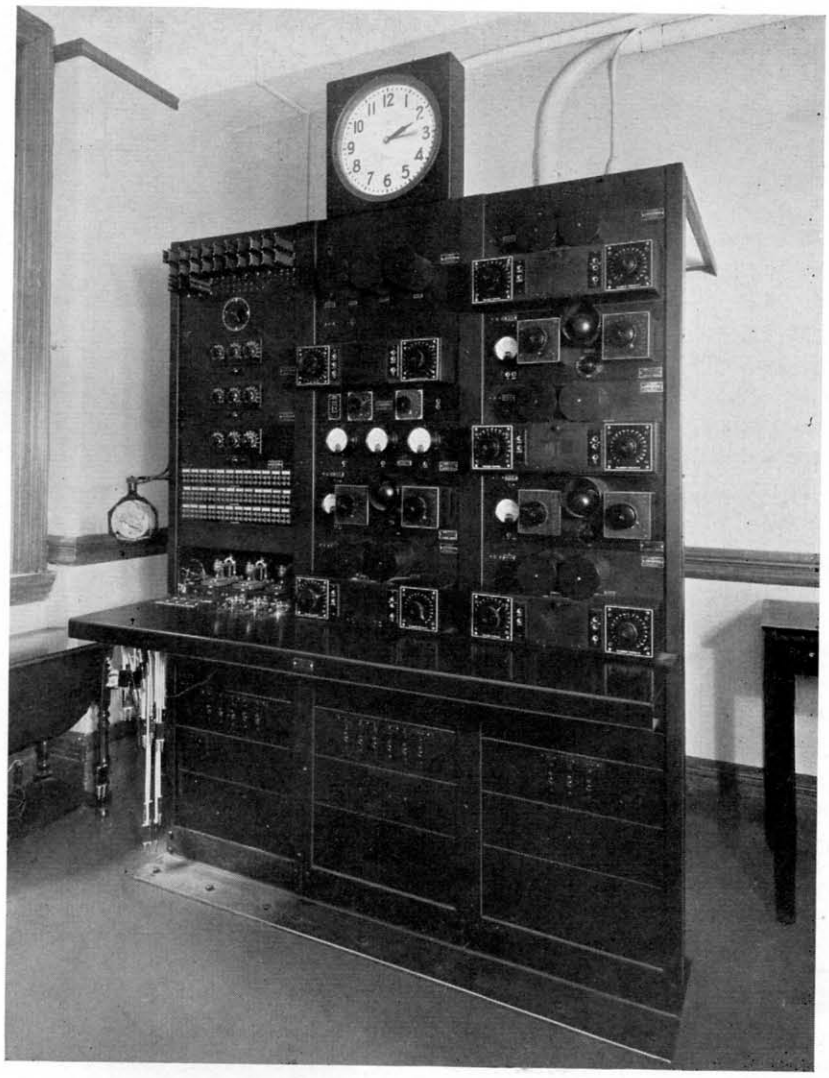


MASTER CONTROL BAY THROUGH WHICH ALL PROGRAMS ARE ROUTED TO NETWORK

The focul point of this program service on the Atlantic coast is at 64 Broad Street where the high quality connecting lines to the Riverhead Receiving Station, from the Rocky Point Transmitting Station, and the lines to and from the broadcasting companies, taking advantage of this service, are connected together through suitable amplifiers and monitoring devices. On the Pacific coast, the focal point is at 28 Geary Street, but in Hawaii where there are only two broadcasters, KGU and KGMB, connections are made directly between the studios and the Koko Head Receiving Station and the Kahuku Transmitting Station.

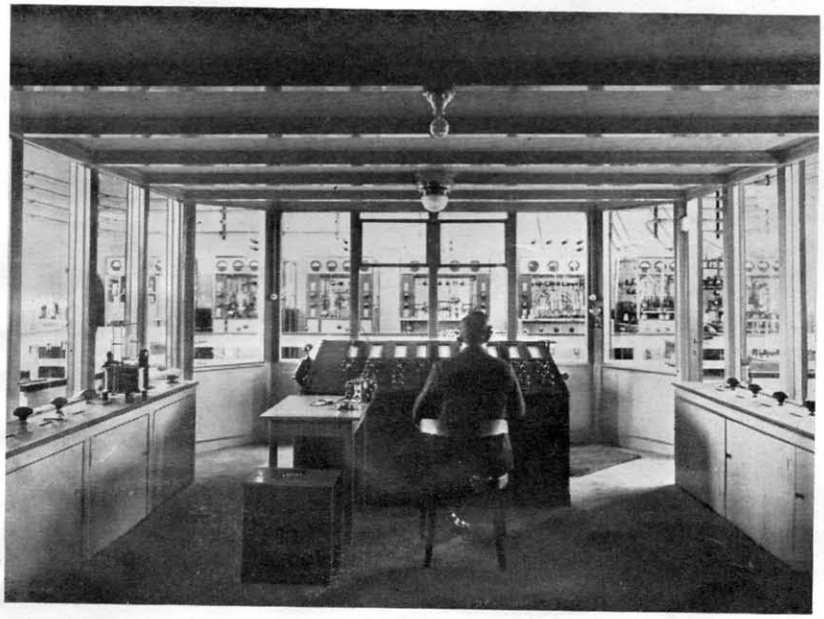
Many foreign countries do not permit sponsored programs and will only take American programs of the sustaining type on an exchange basis or events of international public interest. Others, particularly in South America, do permit sponsored programs, in various forms; and broadcasting of American produced programs should help American manufacturers to greatly expand their market in such countries.

NBC and CBS programs have been regularly sent to Honolulu, Hawaii, for many months with a high degree of success but the high lights in transmission abroad to date occurred during the recent Olympic Games, when a series of fourteen daily one hour programs in the Japanese language was successfully transmitted to Japan and broadcast throughout that country.



THE MONITOR BOARD IN NEW YORK

As to broadcast in the United States of foreign programs, received by RCA Communications, Inc., many will long remember such outstanding events as the Inauguration of the Vatican City Radio Station, two way conversation with Senatore Marconi on his yacht, Elettia, off the coast of Italy, two way conversation with Admiral Byrd in New Zealand, excerpts from the London Naval Conference and the recent Geneva Disarmament Conference, Floyd Gibbons from Mukden, China, etc.



DUTCH CONTROL ROOM AND TRANSMITTERS (COURTESY NBC)

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