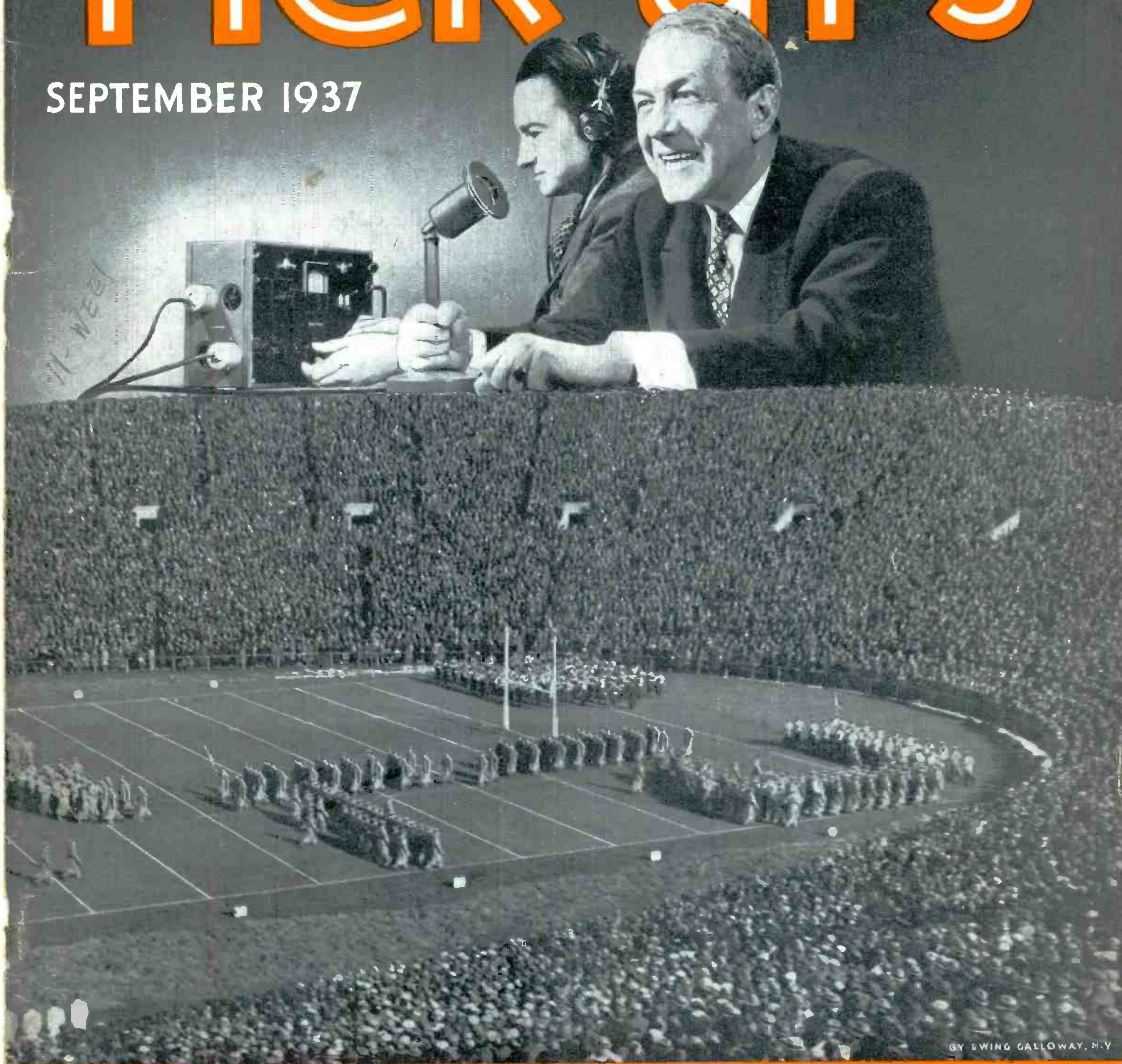
PICK-UPS

SEPTEMBER 1937


BY EWING GALLOWAY, N.Y.

Is Radio Developing Public's Appetite for "Better Music"?

First Use of Stereophonic Sound in Giant Pageant Creates New Thrills

Multi-Band Transmitter Smoothes Many Communication Kinks

Mixing Circuits for Speech Input Equipment

PUBLISHED BY . . . Western Electric . . . NEW YORK, N.Y.

— PICK-UPS —

BEING A PERIODICAL DEVOTED TO DEVELOPMENT IN SOUND TRANSMISSION. PUBLISHED BY THE

Western Electric Company

195 Broadway, New York, N. Y.

EDGAR S. BLOOM . . . . *President*
H. B. GILMORE . . . . *Secretary*
F. H. LEGGETT . . . . *Treasurer*

WILL WHITMORE, *Editor*
M. M. BEARD, *Assistant Editor*

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SEPTEMBER, 1937

Swing High — Swing Low

As the russet mantle of Autumn spreads over the American landscape, announcing the return of another Fall and Winter season what will be the changes in broadcasting?

Pick-Ups was particularly anxious to find out and, following the precedent it instituted some months ago when it made its survey on educational projects instituted by broadcasters scattered throughout the United States, it was decided to do a similar job in connection with music trends. There has been so much of a controversial nature with respect to the type of musical programs desired by listeners-in that during the summer months a survey was conducted to learn what sort of music will come out of the nation's loudspeakers. The results of this survey are presented as the leading article in this issue.

If you like your music hot and are learning to do "The Big Apple," Professor Benny Goodman and the rest of the boys will be doing their stuff for you this Winter at the same old stands, but if you like your symphonies, concertos and arias, you'll have your favorite conductors with Arturo Toscanini leading the list, as well as soloists of concert and opera.

Radio, like the movies, must appeal to everyone, and despite some carping critics, is doing a splendid job. The *Pick-Ups* survey shows that the amount of radio time devoted to good music is slowly but surely increasing. Radio has done much to develop the public's taste for good music and broadcasters everywhere are conscientiously working to further develop this desire.

The survey indicates that there is perhaps a larger audience of real music lovers than has been suspected—made up of the large group that never writes letters of appreciation. It further indicates that there is a need for an extensive survey to determine just what this audience is. Such a survey might well prove that commercial sponsors are overlooking a good bet in not sponsoring more worthwhile musical broadcasts. Perhaps someone, somewhere, some time, will make that survey.

For Technical Men Only

Pick-Ups devotes a great deal of its space this issue to a discussion of mixing circuits in speech input equipment. It's technical stuff of little interest to those of you who can't take a decibel in their stride, but it should be of absorbing interest to everyone who can.

This Issue

Is Radio Developing Public's Appetite for "Better Music"?

Answer is "Yes," Pick-Ups Survey Shows; Most Stations Increasing Time for Better Musical Programs

By M. M. BEARD

Is Radio making America "Better Music" conscious?

According to publicity recently given this subject, the old muse is being put through a strenuous I.Q. regarding its activities on the air. Magazine and newspaper articles are cropping up all over the place reviewing what has been done—forecasting what will be done along the musical air waves. The big networks are sending out feelers in the form of polls and field surveys. And broadcasters everywhere have their ears tuned to listeners' reactions to catch what faint murmurs they may, as to the reception accorded Better Music broadcasts. Can listeners take it and like it? That is what they want to know.

As a result of all this furor in the realm of music some revealing and somewhat amazing facts and figures flashed into print. And you read that—

N. B. C. (Red and Blue Networks) broadcast 51.9 per cent more classical and semi-classical music in 1936 than in 1935; WOR—Mutual 75 per cent more; Columbia 22 per cent more, and 48 per cent more in 1936 than in 1933.

32,000,000 listeners have tuned in on the New York Philharmonic programs and 35,000,000 on the General Motors Symphony.

The Ford Sunday Evening Hour audience was 70 per cent larger in 1936 than in 1935.

N. B. C.'s Music Appreciation Hour, broadcast to 70,000 radio equipped schools, has a classroom audience of 7,000,000.

The Metropolitan Opera series held an average weekly audience of 33,000,000.

There are 35,000 school orchestras and 35,000 school bands today in the United States.

On the heels of all this came the following two announcements which brought lusty cheers from music lovers all over the country:

"N. B. C. has underwritten the greatest musical venture in its history and is assembling a crack orchestra of its own under the direction of Arturo Toscanini to broadcast a series of ten programs

Out of the nation's loud speakers will come a "staggering lot of serious music during 1937-38," says Deems Taylor, chief consultant on music for CBS.

direct from an N. B. C. studio."

"Columbia has commissioned six outstanding American composers to write special music of a classical nature for radio."

When this big news broke *Pick-Ups* caught the "Better Music" fever—compiled a questionnaire—mailed it to over 200 broadcasting stations.

The first question concerned listeners, since they in the final analysis can turn thumbs up or down on broadcasting's big show. It reads:

Does fan mail show an increasing popularity of programs devoted to good music?

Twenty-nine per cent of the stations reporting came back with a definite "Yes."

The remaining 71 per cent were practically unanimous in stating that those who enjoy classical and semi-classical music are not the fan letter writers of the country. Therefore, no accurate check can be made along this line. However, other indications lead many stations to believe that serious music is gaining favor in American homes.

WOKO (Albany), KOMA (Oklahoma City), WCAE (Pittsburgh), and WQAM (Miami) cite some interesting reactions in the way of protest when better music broadcasts are interrupted or cancelled. Says WOKO, "For several months we were unable to carry the entire Philharmonic Orchestra program because of commercial commitments. Phones in the studio were kept busy and hundreds of times the question 'why' had to be answered." WCAE writes, "Let some mechanical breakdown occur in the middle of such programs and our station is swamped with calls and complaints." WQAM and KOMA both claim that they are deluged with questions if a scheduled symphony concert is cancelled.

Although KRE (Berkeley, Cal.) has been featuring three serious music programs daily there has been such a demand for more that the station recently added a "Melody Album" during which familiar light classics are explained as they are presented.

William Warren, program director of KOMO-KJR (Seattle) makes the following statement on the subject: "There is an increasing demand for better music from people who before the days of radio regarded classical music as highbrow. Now they are becoming accustomed to really listening to such music instead of merely hearing it."

KSFO (San Francisco) notes a definite increase in fan mail since the station started carrying CBS features of fine music.

Speaking for the Yankee Network foursome, WNAC-WAAB (Boston), WEAN (Providence), WICC (Bridgeport), R. L. Harlow, assistant to the president, says, "The fact that more symphonic music is being broadcast each year is a healthy sign that more and more people are learning to know and enjoy the classics. Twenty years ago in America not one person in 10,000 had ever heard a truly great symphony orchestra." WNYC (New York) calls attention to the fact that over 30,000 requests came in during the past seven months for their "Masterwork Hour" bulletin which lists "Masterwork Hour" schedules. "There has been a rapidly increasing interest in our classical programs," says Seymour N. Siegel, program director, "mail response is vastly enlarged—comments more vociferous."

KHJ (Los Angeles) points out that classical music fans do write letters but usually in the form of a protest that there is not more such music on the air.

WOR—Mutual gives concrete evidence that the classics are developing a new kind of fan writer. They report that over 1,000 letters were received by Alfred Wallenstein, general musical director, during his radio concerts. More than half the writers said that this was their first fan letter—that they were writing to prove that the radio audience expected intelligent entertainment—that they feared the constant reading of the usual type of fullsome fan letter might cause broadcasters to lower standards of music programs. They were, therefore, writing in self-defense.

Letters came from universities, schools, the Museum of Modern Art, the Bruckner Society of America, the Doctors Hospital, Scout Reservation.

A great majority of the writers objected to the shortness generally of musical programs; pointed to the need of one and two-hour programs instead of the customary half hour. Their preference lay largely with the great music of the past rather than contemporary music.

Although N. B. C. has received many letters from amateur musicians in connection with their Home Symphony programs, the network contends that the more intelligent listeners seem "shame faced" about writing letters. "If you want better music write your local station," advises Ernest La Prade, Conductor of the Home Symphony.

If the classical muse is nosing up a bit on those popular favorites, swing and dance, *Pick-Ups* wanted to know what the gain has been and asked the question:

Has the ratio of classical and semi-classical musical broadcasts as against jazz and dance music increased?

Replies came back with a resounding "Yes" from 92 per cent of the stations reporting. Over 50 per cent answering in the affirmative state that the rate of increase is considerable—the others intimate it is slow but steady.

During the past few years KOMO-KJR have added to their lists of regular broadcasts the Seattle Symphony, University of Washington Symphony orchestra and concert band, Cornish School's Music Appreciation program and afternoon musicale.

KRE has increased its classical schedule 10 per cent during the past year. WENR, WMAQ (Chicago) trace a steady growth in serious music broadcasts over the past three years.

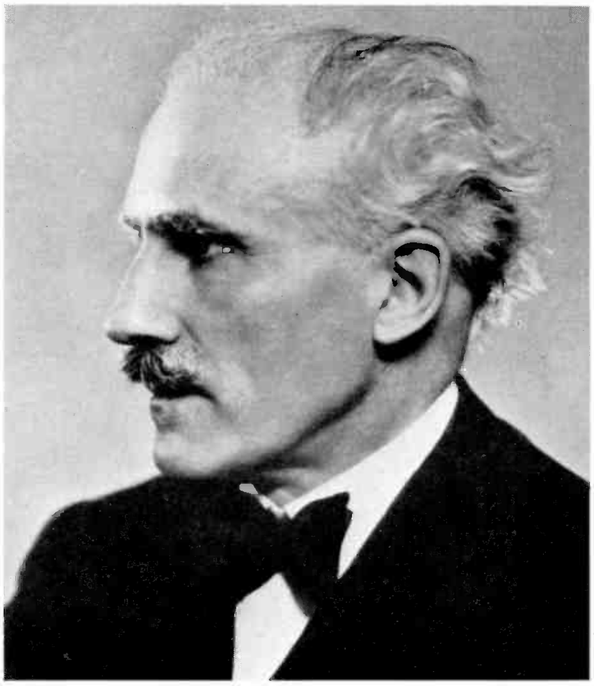
WOR—Mutual records show a 75 per cent increase over last year. N. B. C. broadcast 730 more hours in 1936 than in 1935; Columbia 156 more this year than in 1933.

To satisfy inquisitive *Pick-Ups*, broadcasters patiently browsed through their schedules to answer the question:

What percentage of musical broadcasts is devoted to classical music?

Average percentage of time devoted, by all stations reporting, to better music is 35 per cent of the total music time on the air.

Classical music over WNYC outweighs swing and dance with a ratio of 8 to 2. Over WQAM, WWJ (Detroit), KFAC (Los Angeles), KGB (San Diego, Cal.) it is running neck and neck with other types of music. KXRO (Aberdeen, Wash.), KDYL (Salt Lake City), WOL (Washington), KERN (Bakersville, Cal.), WFOY (St. Augustine) are carrying only a small percentage more of swing and dance.



When Toscanini picks up his baton in an NBC studio this fall, he inaugurates the greatest musical venture in the history of the company.

Following this inquiry came the question:

What time of day do you have the largest audience for better music?

A concensus of the stations answering shows that the best time for broadcasting music of this type is during late afternoon and early evening hours with a good bit of emphasis placed on Sunday afternoon and evening.

Up to this point the survey has touched on the past and present status of Better Music on the air. The networks have given us a peek into the future. What of the stations themselves? *Pick-Ups* sent out a feeler with:

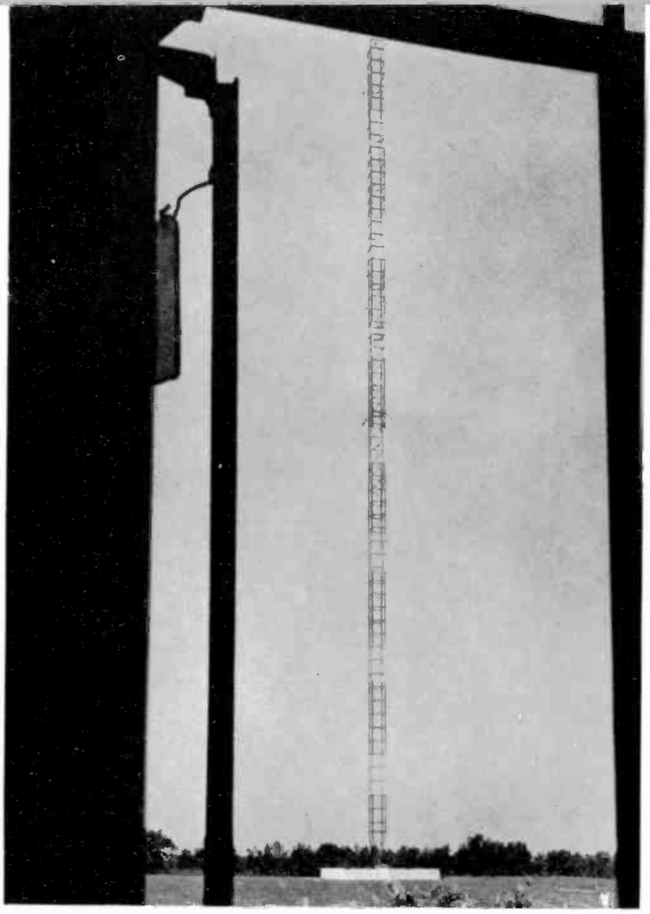
Are you planning to increase better music broadcasts?

Hurrah for 1938!—81.8 per cent say "Yes."

The majority of the stations reporting did not go into detail as to future schedules. Here are a few which did.

WOKO and KWK (St. Louis) are concentrating on Young America's musical education by cooperating with high and grade school officials. WOKO has installed lines in the Albany High School to pick up broadcasts by the school's symphony orchestra, glee club, band and chamber music groups. The station reports, "School heads welcome this opportunity of showing listeners just what is

(*Continued on Page 28*)



"Voice of the Ozark Empire" Speaks with New Station

From a composite transmitter feeding into an antenna stretched between two ordinary telephone poles, and a small studio located in one corner of a hotel lobby — to a completely Western Electric equipped station with a five-fold increase in power, a 450-foot vertical Blaw-Knox antenna, a new building devoted entirely to studios and offices and a modern, fully equipped transmitter building—such has been the metamorphosis of station KUOA in the past few months.

All equipment used at the old location at Fayetteville, Arkansas, was transferred to the radio laboratories of John Brown University, and now, from Siloam Springs, KUOA speaks with its new, and much more powerful, "Voice of the Ozark Empire."

A new Western Electric 355E1, 5KW transmitter working at reduced power delivers an output of 2500 watts to the 450-foot vertical Blaw-Knox antenna through a concentric transmission line 600 feet long, buried two feet below the ground. Transmitting equipment and antenna were tuned for test programs under the expert supervision of Orrin Towner of Bell Telephone Laboratories.

The new studio equipment consists of one 701A speech input bay, dynamic microphones, transcription turntables for both vertical and lateral recordings, and other associated apparatus.

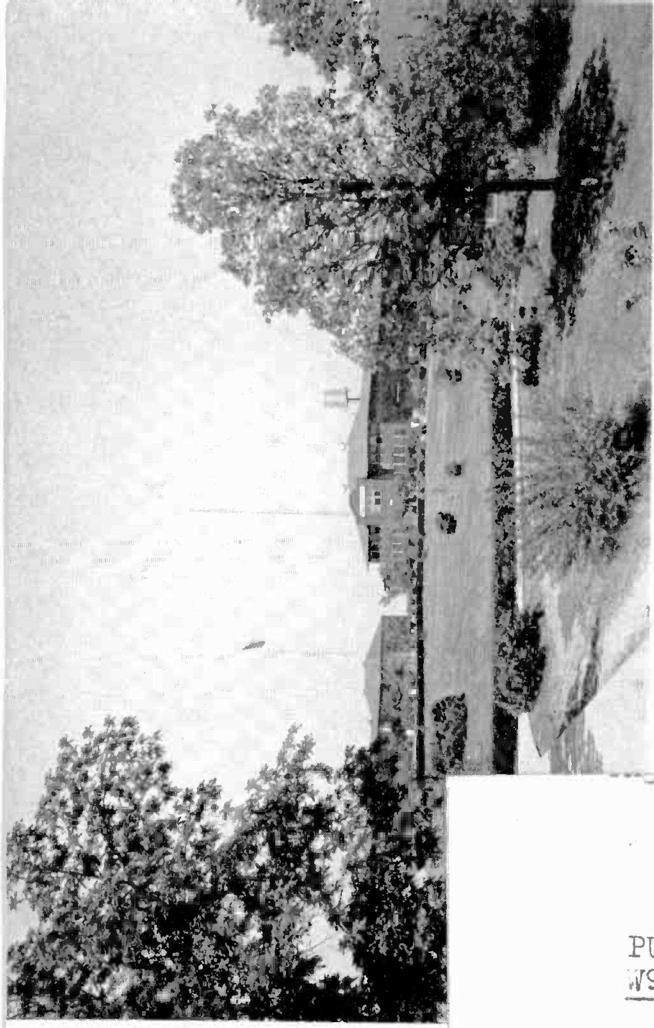
Designed for possible expansion, the transmitter building provides for future as well as present needs. It is of hollow tile construction with the outside finished in white stucco. The roof is a four-inch concrete slab covered by a special asphalt roofing compound and is supported by a steel framework resting on reinforced concrete columns. None of this weight is carried by the walls, so that when it is desired to enlarge the building, any or all of these

KUOA

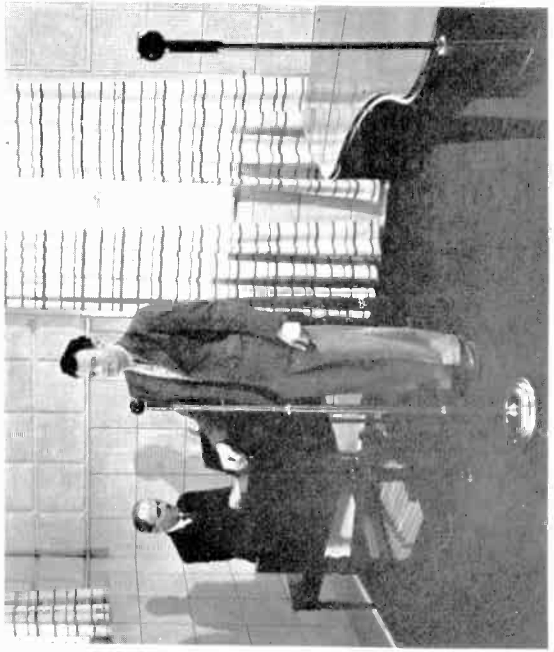
Siloam Springs, Ark.

Upper: KUOA's 450-foot Blaw-Knox vertical radiator framed by a window of the water pump room. The antenna coupling equipment in the tuning house at the base of the antenna is connected to the transmitter by a concentric line.

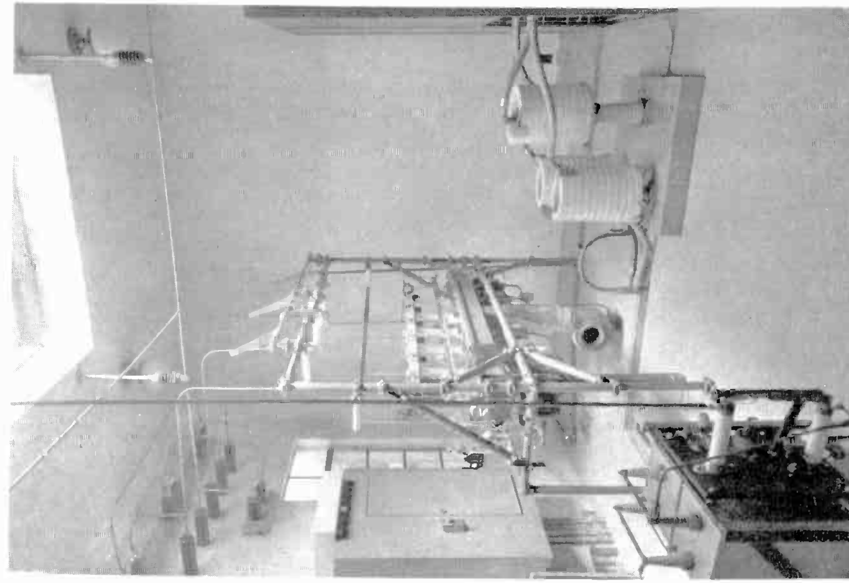
Left: Transmitter Engineer Lester Harlow at the control desk in the transmitter room. The panel on the extreme right is blank, thus providing room for another amplifier in case of an increase in power.



Right: John Brown University campus scene with KUOA's antenna in background. Studios are in the small building behind the trees in the lower right of photograph.



Center: This attractive interior is typical of KUOA's up-to-date studios. Eight-ball microphones are used throughout the entire studios.



Below: Rectifier room. Note orderly arrangement of equipment Plenty of space makes everything ... the tubes. Blower, pilot light, fuses, chassis and switches.

PUBLISHED MONTHLY BY THE SOUTHERN INDIANA AMATEUR RADIO CLUB NOT INC.
W9GKA. EDITOR. 1724 S. BEDFORD AVENUE, PHONE 8513.

PHONE SPLATTER

W9BBC has probably got some splatter since the wind blew the tower for the rotary beam. Somebody said he has a rig going over in Centralia now. DGA is going to town on ten and is working some five meters it has been said. Uia Has a five and ten meter beam up now. Some of the members think the club would be better off if UIA would come to the meetings on meeting nite instead of staying home working his rig. CXO is working on quality. CCG es CEG have built a new rig (portable) the tube line up is 6K6-6K6-6L6 Mod.-6L6 powered by dynamotor. CCG is back on 160 meter fone running 60 watts to a TZ40 UNI from Tell City and RVI from Willow Hill, Ill. were down last Sun. and visited some of the gang. Glad to have you Ray and Johnny, come back soon and meet the rest of the gang. Gene O'Brien has just rec'd his ticket W9LDR. Hgj antenna blew down.

Multi-Band Transmitter Smoothes Many Communication Kinks

With 10 Frequencies at the Twirl of a Dial, It Serves...

Point-to-Point Traffic

State Police

Steamships

Aviation

By R. V. FINGERHUT

During the Italian conquest of Ethiopia, the American Legation in Addis Ababa, in order to communicate with the British Legation only five miles away, found it necessary to relay the message through Washington, D. C., whence it was transmitted to London and rebroadcast to the British Legation in Addis Ababa. A typical example of the problems so often encountered in radio communication.

Sunspots, magnetic disturbances, electrical discharges in the atmosphere, severe storms, all have an adverse effect on high frequency radio transmission. Seasonal changes, even the change from day to night, help to make regular communication on any one frequency unreliable. The signal strength of one frequency may rise at night and fall with the coming of day. One wave band will afford perfect reception during the summer months, yet during other seasons will not give support to even the strongest signal. Different distances will require different frequencies since one wave band may produce a strong signal in one distance range and fade away completely in another.

These conditions formerly necessitated the operation of more than one transmitter, or provision for manually changing from one frequency to another where such equipment was available. Neither method was satisfactory. The first was too expensive, the latter involved complicated, time-consuming adjustments. Furthermore, with these methods the number of frequency changes was limited and the shifting could not be accomplished without interruption to service.

The American Telephone and Telegraph Company, encountering these difficulties in their point-to-point and ship-to-shore radio telephone service came to the engineers of Bell Telephone Laboratories with their problem. This organization, with years of experience in telephone and radio development for the Bell System, tackled the problem. After a long period of intensive research and experiment, the apparatus designated as the Western Electric 14 type transmitting equipment was completed.

By having a transmitter with a wide enough frequency range and by making ten different frequencies available for instantaneous selection on one transmitter, this equipment does away with all difficulty and delay in frequency shifting.

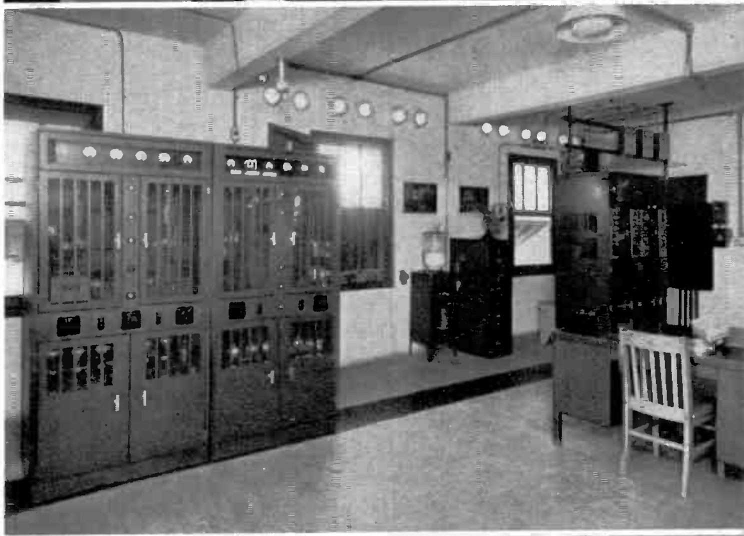
Each of these frequencies is accurately controlled by its own crystal oscillator. Any one of the ten frequencies can be selected by a single twirl of a standard telephone dial mounted on the front of the cabinet. The time it takes for this dial to return to its normal position—a minimum of one-half second on number one, a maximum of one and one-half seconds on number ten—is all that is consumed in this shifting operation.

Engineers engaged in other radio activities, learning of this new type of equipment, saw in it the cure for some of their own troubles. This multi-frequency feature with its automatic selection, they reasoned, could well be applied to other fields. The aviation industry tried it and gave it their unqualified approval. It has become so popular in aviation that this field has outstripped all others. Police departments, wishing to make use of a number of frequencies in their radio divisions, have also tried and accepted it.

Radio-equipped airlines had always been faced with the necessity of using a number of frequencies. For efficient operation of their planes at least two frequencies are essential, one for day and another for night. Congested areas require additional frequencies and many airlines make use of the entire ten frequencies made available by the 14 type transmitter.

A number of these versatile transmitters are in continuous operation in countries all over the world. The Chilean Airways operates two of them, at Puerto Montt and Mejillones, more than thirteen hundred miles apart. These are constantly aiding planes in their flights up and down that long and narrow country. Norway's newest airdrome at Oslo is equipped with a 14 type transmitter that keeps well under control the air traffic flowing about this busy airport. There is one in Russia and one in Japan, products of American engineering in far-away homes.

In the United States five of the nation's greatest airlines have installed 27 of these transmitters. Of these Eastern Airlines has six, at Newark, Washington, D. C., Atlanta, Miami, New Orleans and Chicago; Chicago and Southern has three, at St. Louis, Memphis and Jackson (Miss.); Transcontinental and Western has two, at Newark and Kansas



The panel of photographs at right shows (from top to bottom):

Radio room at Eastern Airlines' ground station at Atlanta, Georgia. The dial on the panel in front of the operator is part of the remote control equipment which enables him to operate the 14 type transmitter while seated at his desk.

The transmitting station of the Radio Corporation of Porto Rico at San Juan. The two panels at the left constitute the Western Electric 12 type transmitter, while the 14 type transmitter is visible at the right.

American Telephone and Telegraph Company's receiving station at Hialeah, Florida. These highly directional rhombic antennas are aimed directly at the various transmitting stations far to the southward.

The 14 type transmitting equipment at Hialeah. The transmitter is on the right and the 9 type rectifier is in the center with the 100 type coupling unit mounted between them.

City; Delta Airlines has two, at Atlanta and Dallas.

Pan-American Airways, famous for its pioneering and development of trans-Pacific air travel, operates fourteen of the 14 type transmitters. One of these is installed at Brownsville, Texas, the northern end of the Mexican and Central American routes, two at Miami, whence the clipper ships hop off for their flight over the Caribbean to South America. Three of Pan American's most important airports in South America—Rio de Janeiro, Santiago and Lima—are equipped with this multi-frequency apparatus. In San Francisco two are in operation, and at Honolulu, Midway Island, Wake Island, Guam, and Manila on the trans-Pacific route, these transmitters aid the "China Clippers" on their flight to the Orient.

For point-to-point communication the 14 type transmitter is ideal. Because in this service the signal is usually sent over long distances, the waves are especially influenced by the abnormalities of atmospheric conditions and the instability of the short wave frequency bands. However, with ten frequencies always instantly available, there never need be any interruption to continuous service.

Thus into the American Telephone and Telegraph Company's receiving station at Hialeah, Florida, flow voice currents originating from widely separated locations in South and Central America and the neighboring islands in the Caribbean Sea. Twenty or more of the 14 type transmitters are continually performing their part of the task of linking these many points.

From Panama City, Honduras, Haiti, Salvador and Santo Domingo, these transmitters forward the spoken word direct to Hialeah. Spotted in various cities in Colombia are seven of them, forming a network that feeds into the city of Bogota, whence the signal is rebroadcast to the northern continent. The National Railways of Colombia have installed a 14 type transmitter at Buena Ventura that well demonstrates the flexibility of this multi-frequency equipment. Not only is it used for short wave contact with various points about the country, but with it the company communicates with its radio equipped airplanes and converses with its freighters at sea.

In the far distant Philippines there are three, one each at Iloilo, Cebu and Davao, which relay to Manila for further transmission, business and personal calls from these populous islands.

Police radio, as with all other radio activities in the United States, is under the direct supervision of the Federal Communications Commission. Realizing that eventually the country will be covered by a network of municipal, county and state police radio systems, this government organization has set up comprehensive regulations to govern their use. It has divided the entire country into sections, or zones, each of which will have a number of zone stations and one inter-zone station. The zone stations may communicate only with other stations in the same zone, the inter-zone station being used for communication between zones. For this purpose, nine frequencies have been set aside for telegraph transmission.

Kansas City, with an eye to the future, has just completed the installation of the first 14 type transmitter to be used for police work. This inter-zone station is now able to talk to its cruising cars on one frequency, or, on others, to communicate by telegraph with police departments in different cities. Whenever it becomes necessary, the operator can switch from one frequency to another in less time than it takes to reach for his microphone.

In ship-to-shore radio service, due to the continually changing distance between the transmitter on board ship and the receiving station ashore, skip distance plays an even more prominent part in the story of transmission difficulties. Four or five frequency shifts must be made as vessels move across the ocean from one skip zone to another. Before the development of this apparatus it always was necessary to interrupt service for extended periods while changing from one transmitter to another, or while performing the operations involved in manually shifting the frequency.

With the use of ship-to-shore telephone service increasing daily and with ship's passengers growing more and more accustomed to making business and personal calls while far at sea, steamship lines are becoming increasingly desirous of maintaining uninterrupted communication between ships and shore stations. With the 14 type transmitter this is now possible.

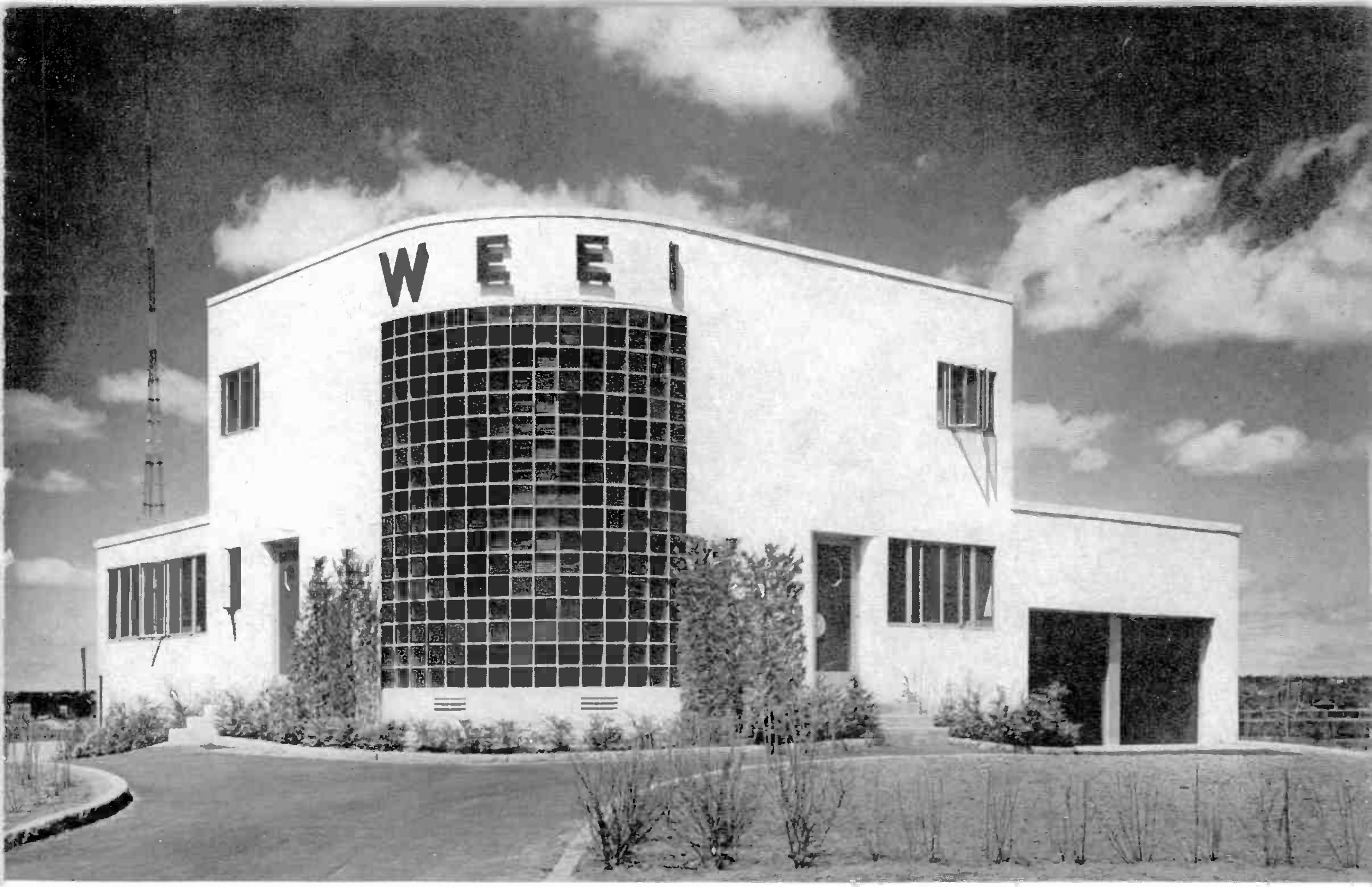
To all of these branches of radio service, this new equipment, designed to increase the reliability of radio transmission, is of great assistance. No longer need airlines go to the expense of installing duplicate ground station transmitters to insure constant communication with planes. No longer need important police calls be delayed. No longer need telephone conversations be even momentarily interrupted. Extra frequencies, instantly and automatically selected, make interruptions due to frequency shifting a thing of the past.

KUOA, Siloam Springs, Ark.

(Continued from Page 7)

All materials used in the construction of power lines, an eight-mile line to a remote studio, telephone cable, building wiring materials and lighting fixtures, were purchased from the Graybar Electric Company.

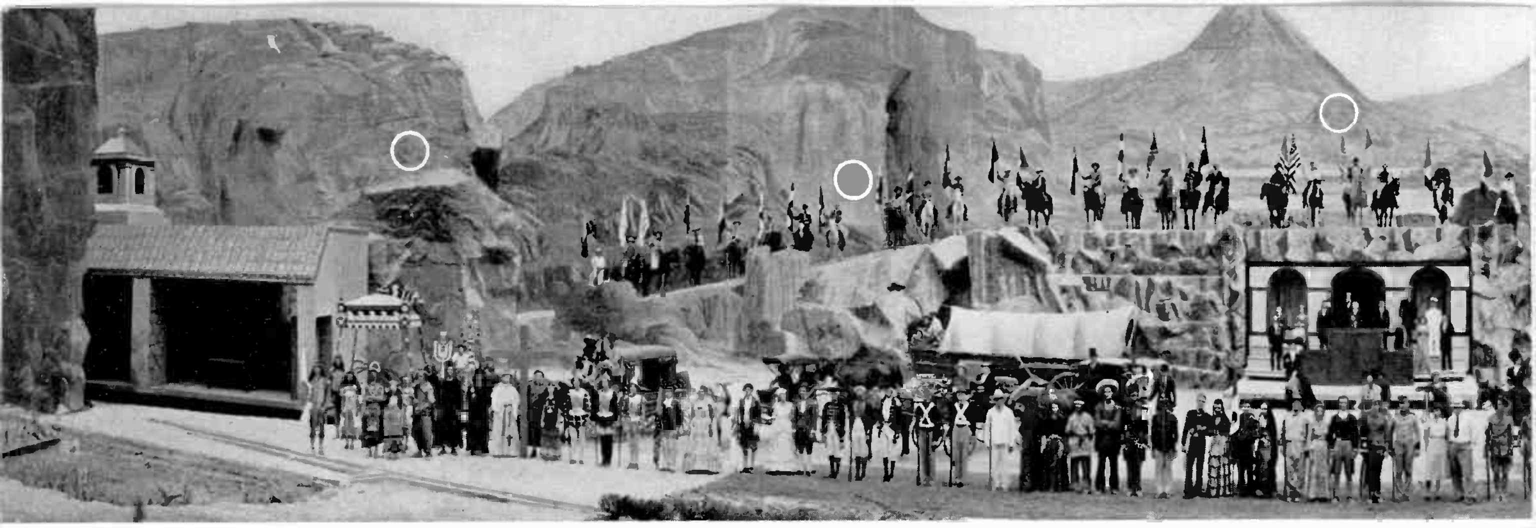
When Station KUOA was purchased by John Brown University two years ago it was operated by a staff of four. Today with Storm Whaley as manager and Jesse Miller as chief engineer an efficient staff of 26 is responsible for this modern station.



WEEI

BOSTON

Broadcasting is developing a new school of functional architecture, a fine example of which is the new WEEI transmitter building. Today's architect believes in two cardinal principles—simplicity and utility. Follow them and beauty is the result, he says. Surely, it is the result here, where the architect built his building around a Western Electric 5 KW High Fidelity Transmitter, workshop, and operating quarters. Bordered with shrubbery, the building is of white stucco and hollow glass bricks.



First Use of Stereophonic Sound in Giant Pageant Creates New Thrills

Last year the Texas Centennial thrilled millions of visitors with one of its spectacular shows called "The Cavalcade of Texas," a giant pageant depicting high spots in Texas history. This year the fair, now called The Pan-American Exposition, is giving visitors an even greater thrill with "Cavalcade of the Americas."

Pick-Ups in its November, 1936, issue, described last year's mighty pageant, and told how reproduced sound was used on a tremendous scale to pack thrills and punches into the show. It was the first time high fidelity vertical-cut recordings were used for background music and for dialogue keyed to action and pantomime of the great cast of actors. Everyone who saw last year's show marveled at the beauty of the music, and the skill with which dialogue was reproduced and brought to the 3,500 spectators who witnessed each performance.

This year reproduced sound plays a greater and more spectacular part in "The Cavalcade of the Americas." For the first time stereophonic reproduction has been employed in a show of this kind, and the result is fairly startling in its beauty and realism. Again as last year unseen persons speak the lines for the actors on the set, but unlike last year's performance, the voices produce a perfect illusion in that they seem to be coming from the lips of the actors no matter where they may be on the giant stage. It is a realism never before achieved.

In one scene, a member of the cast walks from one end of the set to the other, while his voice follows him with complete illusion of coming from his lips, although his lines are being spoken by another person into a microphone in a sound proof booth 300 feet away.

Stereophonic reproduction is a development of Bell Telephone Laboratories. It is achieved in "Cavalcade of the Americas" by having five complete and separate public address channels. Five Wide Range speaker systems are located behind the great scenic 300-foot background of the outdoor set. Sound coming from the unseen dialogue readers or from vertical cut records is fed into any or all of the speaker systems. Expert cueing and mixing are required and is done so cleverly few people in the audience ever realize that the performers on the set are not speaking their lines.

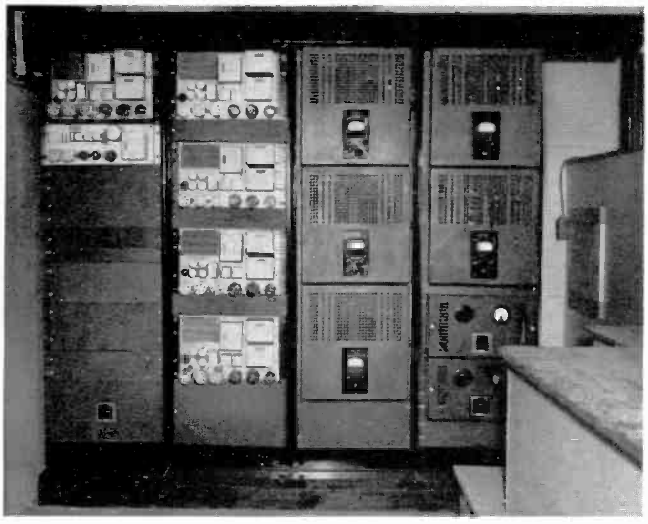
The entire sound system was laid out and installed by the C. C. Langevin Company. The same company has also this year designed and installed sound systems for the Fort Worth, Texas Show, and Billy Rose's "Aquacade" at the Great Lakes Exposition.

A few years ago Carl Langevin was unknown outside of San Francisco where he operated a small radio and public address business. Today he is the country's premier sound impresario. Langevin, in the early days of radio, became dissatisfied with the poor quality afforded by even the best radios of that time, and so designed an amplifier of his own. People in San Francisco came for miles to hear it. Almost before he knew it, he was manufacturing sets in quantity. Gradually he began to use them for public address work and in a few years this business had greatly developed.

Langevin saw that his success was due

(*Continued on Page 30*)

C. C. Langevin,
Impresario of Sound



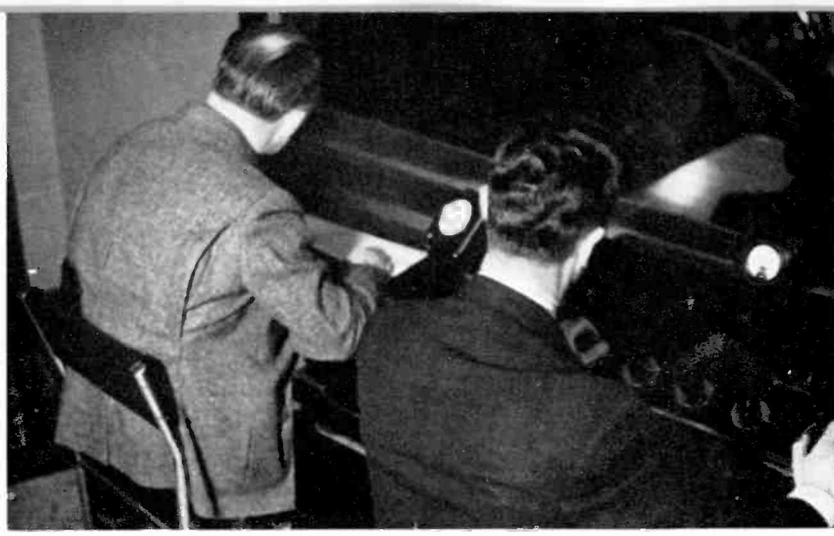
Top: The great set for "Cavalcade of the Americas," giant pageant depicting high spots in the history of both Americas, a part of the Pan-American Exposition, Dallas, Texas. The five circles indicate the positions of the loud speaker units which provide Stereophonic Sound Reproduction for the music and dialogue.

In circle: Melvin LaKrapes at the transcription turntables which reproduce vertical cut recordings of all music for the spectacle.

Top right: These unseen persons read the dialogue of pantomime actors on the set in perfect synchronism with their actions. So perfect is the timing and sound reproduction the audience never knows that the actors on the set do not talk.

Center Right: The five-channel amplifiers and associated equipment.

Bottom right: R. H. Mantle at the controls of the five-channel Stereophonic Sound System. His duty is to mix the entire program and cue music and dialogue. A busy job.



Mixing Circuits

for Speech Input Equipment

By J. E. TARR

Commercial Products Development,
Bell Telephone Laboratories

The mixing circuit used in speech input equipment performs two functions, namely, to combine the outputs of several program sources into a single program channel and to provide a means for independently controlling the contribution from each source. While mixing circuit designs of almost endless variety have been developed and used, their differences are largely superficial, and result from the fact that each circuit has been designed to meet a specific set of operating requirements; the two basic functions of mixing and individual control are common to all mixing circuits. Let us therefore examine the design of mixing circuits in its broader aspects with a view to clarifyng the relation between circuit design and circuit performance.

Design Factors

The program sources used with mixing circuits are ordinarily microphones or the outputs of microphone pre-mixing amplifiers, but a mixing circuit may be required to operate from transcription machines and remote pick-up lines as well. The common program channel receiving the combined output is usually the input of an amplifier, although auxiliary devices such as master gain controls or filters are sometimes inserted between mixer output and amplifier input.

The fundamental operating requirements for a mixing circuit are simple; it must afford the control essential to the production of programs, and it must satisfy the electrical requirements of other parts of the system in which it is used. The factors which enter into any specific design, however, are many; the principal ones are:

Number of input channels
Insertion loss
Impedance considerations
Control range
Interaction of controls
Leakage and susceptibility to noise pick-up
Frequency response

Each of these factors is discussed briefly in the following paragraphs.

Number of Channels

The number of input channels required determines, to a degree, the circuit design; since, as will be shown, some designs are suitable only for a limited number of channels. The most common number is four, and emphasis will therefore be placed on four-channel circuits throughout this discussion; but mixing circuits having six or even eight channels are sometimes required, and so require consideration. In any given circuit type the number of channels may also affect the insertion loss.

Insertion Loss

The transmission loss introduced by the mixing circuit between any source and the common load has a definite minimum value determined by the type of circuit, the type of control potentiometers used and the number of channels. In determining the total gain required in the associated amplifiers the mixer insertion loss has a definite bearing on the signal-to-noise ratio of which the over-all system is capable.

Across the terminals of any resistance exists a small voltage, containing components of every

MIXING CIRCUITS


FIG. 1A PARALLEL MIXING CIRCUIT

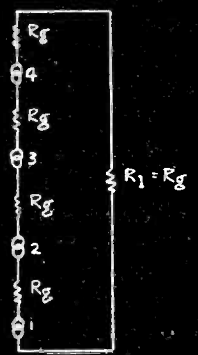


FIG. 1B SERIES MIXING CIRCUIT

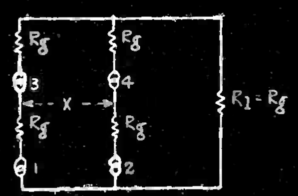


FIG. 1C SERIES-PARALLEL MIXING CIRCUIT

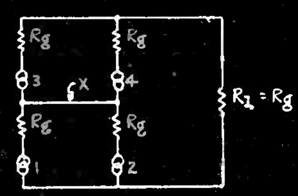


FIG. 1D PARALLEL-SERIES MIXING CIRCUIT

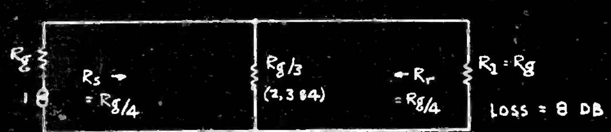


FIG. 2A EQUIVALENT TO FIG. 1A

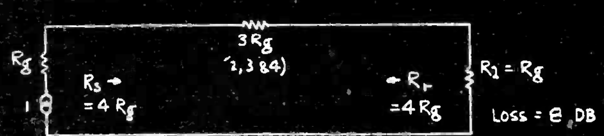


FIG. 2B EQUIVALENT TO FIG. 1B

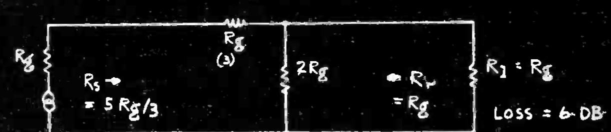


FIG. 2C EQUIVALENT TO FIG. 1C


FIG. 2D EQUIVALENT TO FIG. 1D

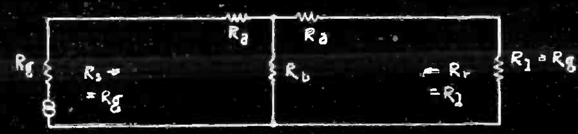

$R_s = R_r = R_g = R_1$ WHEN $R_a^2 + 2R_aR_b = R_g^2 = R_1^2$

FIG. 3A SYMMETRICAL "T" NETWORK

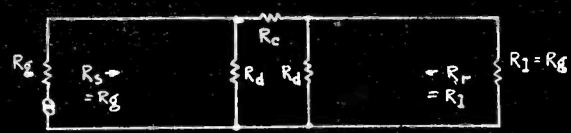

$R_s = R_r = R_g = R_1$ WHEN $R_cR_d^2/(R_c+2R_d) = R_g^2 = R_1^2$

FIG. 3B EQUIVALENT "π" NETWORK

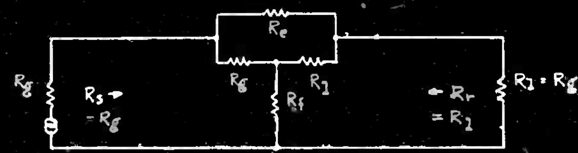

$R_s = R_r = R_g = R_1$ WHEN $R_eR_f = R_g^2 = R_1^2$

FIG. 3C EQUIVALENT "BRIDGED-"T" NETWORK

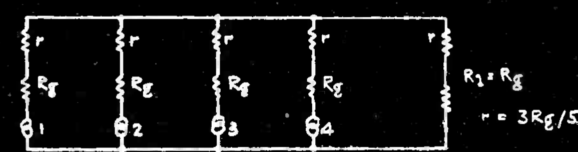


FIG. 4A COMPENSATED PARALLEL CIRCUIT

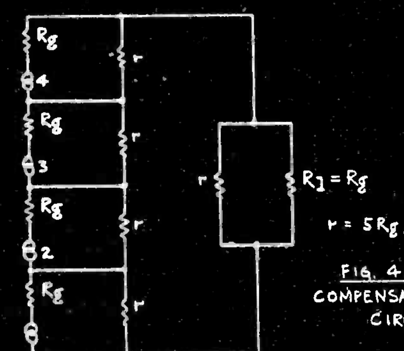


FIG. 4B COMPENSATED SERIES CIRCUIT

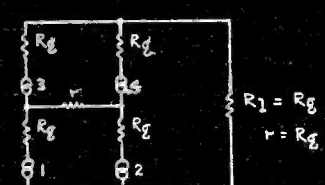


FIG. 4C BRIDGE MIXING CIRCUIT (DERIVED FROM FIGURES 1C & 1D BY INSERTING r)

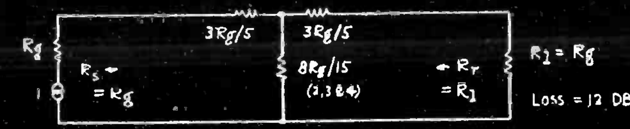


FIG. 5A EQUIVALENT TO FIG. 4A

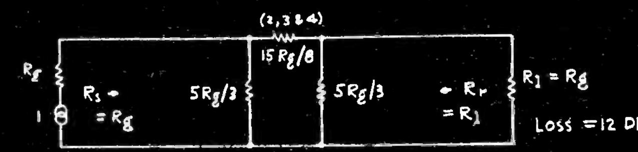


FIG. 5B EQUIVALENT TO FIG. 4B (ALSO INTERCHANGEABLE WITH FIG. 5A)

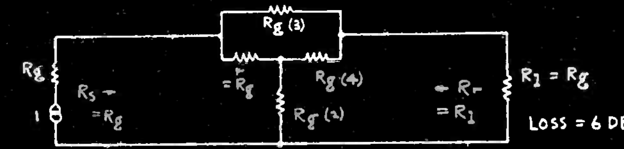


FIG. 5C EQUIVALENT TO FIG. 4C (ALSO EQUIVALENT TO FIGS. 5A & 5B EXCEPT FOR LOWER LOSS)

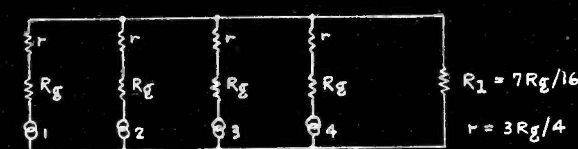


FIG. 6A VARIATION OF FIG. 4A

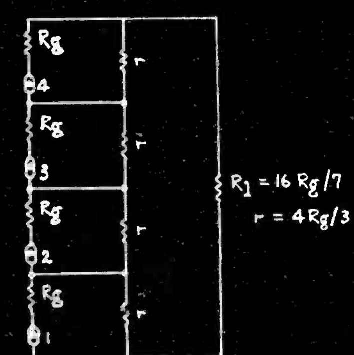


FIG. 6B VARIATION OF FIG. 4B

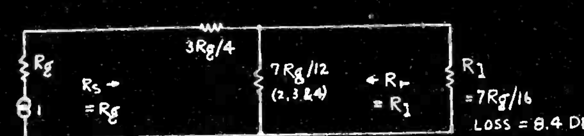


FIG. 7A EQUIVALENT TO FIG. 6A

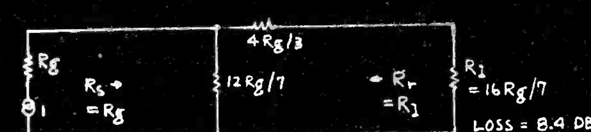


FIG. 7B EQUIVALENT TO FIG. 6B

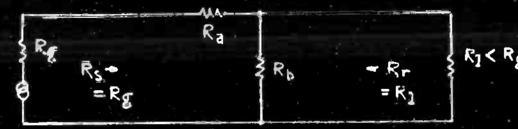


FIG. 7C UNSYMMETRICAL "T" NETWORK (FOR MATCHING UNEQUAL IMPEDANCES WITH MINIMUM LOSS)

$R_s = R_g$ AND $R_r = R_1 < R_g$ WHEN

$R_a^2 = R_g^2 - R_gR_1$

AND $R_b^2 = R_gR_1^2/(R_g - R_1)$

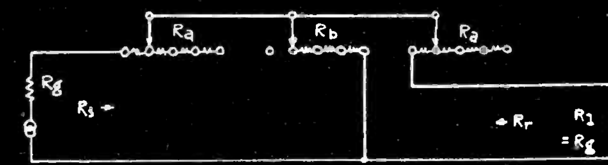

$R_s = R_r = R_g = R_1$ WHEN $R_a^2 + 2R_aR_b = R_g$

FIG. 8A BASIC VARIABLE-"T" NETWORK

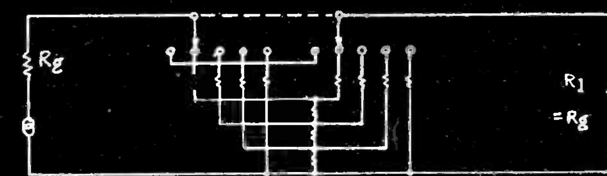


FIG. 8B SIMPLER EQUIVALENT OF FIG. 8A

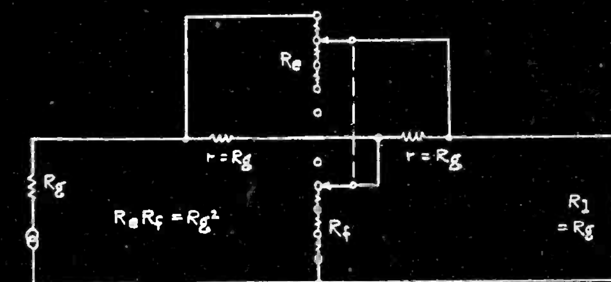


FIG. 8C VARIABLE "BRIDGED-T" NETWORK (SIMPLEST EQUIVALENT OF FIGS. 8A & 8B)

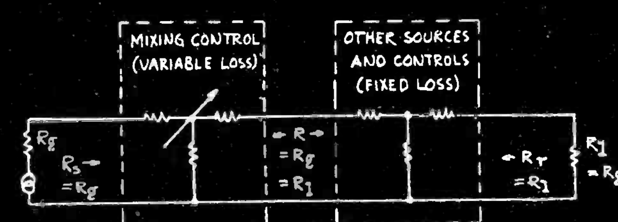


FIG. 8D EQUIVALENT OF MIXER WITH VARIABLE-"T" CONTROLS

(*Continued from Page 15*)

ometer, is bridged on the secondary of the input transformer; and the effect of this load on the transformer primary makes the amplifier input impedance substantially resistive and of moderate value, such as 500 ohms. While the gain-frequency characteristic of such an amplifier is not greatly affected by reasonable variations in the source impedance, a value for the latter equal to the input impedance is usually optimum. The second type uses an input transformer designed to work with no secondary load except the grid circuit of the first-stage vacuum tube and to give the desired frequency response when operated from some arbitrary source impedance, such as 500 ohms. The input impedance of such an amplifier is usually high and substantially reactive over a major part of the audio-frequency range, and can ordinarily be considered infinite insofar as it affects the mixing circuit; the frequency characteristic of this type amplifier is moreover much more sensitive to changes in the source impedance. The need for considering these factors in the design of mixing circuits is therefore apparent.

Control Range

In any mixing circuit the range of control available, or the amount by which the attenuation of any single source can be varied, is determined in the design of the mixing controls or potentiometers. The controls in general use have a range of about 45 db, often supplemented by one or two large steps next to the "off" position. The "off" position should theoretically give infinite attenuation or complete cut-off, but realization of this ideal in practice is impossible; this is true partly because the mutual impedance in the control and its wiring cannot be reduced actually to zero, but more often because of the presence of leakage which is discussed below.

Interaction of Controls

Completely independent operation of each mixing control would mean that the transmission loss effective in any one channel is controlled exclusively by its own potentiometer, regardless of the setting of other channel controls. While this ideal is closely approached in some circuit designs, some interacting of the control functions is inevitable in others. The cause of this interaction, when present, is the use of a type of control whose output impedance varies with the attenuation setting, although such controls may be used in some circuits without causing this effect.

Leakage and Susceptibility to Noise Pick-Up

The transmission of program from a source to the common channel through stray capacitances or spurious couplings not subject to control by the potentiometers is called "leakage." The presence of leakage limits the degree of cut-off obtainable when the controls are in their "off" positions and, since the spurious transmission favors the higher frequencies, leakage which does occur is especially objectionable because of its "tinny" quality.

The same forms of stray coupling which give rise to leakage generally also make the mixing circuit more vulnerable to noise pick-up from stray currents flowing in the ground system; this sometimes causes troublesome power hum or, if the system is installed near a radio transmitter, radio-frequency pick-up resulting in crosstalk or singing.

Mixing circuits in which some of the input circuits are entirely above ground potential, such as the familiar series arrangement, are more subject to leakage and noise pick-up caused by spurious coupling.

Frequency Response

Since a mixing circuit usually contains only resistance elements it should not directly affect the frequency response of the overall system. Indirectly however it may, through improper or widely varying terminal impedances, upset the normal frequency response of associated amplifiers; or by permitting appreciable leakage, which is worse at higher frequencies, it may give the system a rising response characteristic when the controls are set near maximum attenuation. Both of these defects can be minimized by proper design of the mixing circuit.

Basic Mixing Circuits

Any given mixing circuit whose controls are set for minimum attenuation can be replaced by a simpler equivalent network which embodies the mixing function alone, without the control function. Since the properties of any variable mixing circuit are limited and, to a degree, controlled by those of the equivalent fixed mixer, let us first investigate the design and performance capabilities of fixed mixing circuits; the additional problems involved in the variable control feature will be considered separately in a later section.

Assume that a fixed mixing circuit is required to combine the outputs of four sources into a common load, and that the resistance of each source, R_g, equals that of the load, R_l. Figure 1 shows the four simplest arrangements for such a circuit in which the sources are connected, respectively (A) in parallel, (B) in series, (C) in series-parallel and (D) in parallel-series. When these four circuits are redrawn in simplified form, as in Figure 2, the transmission path from any one source to the load is seen to contain a network of series or shunt resistances, or both, which represent the resistances R_g of the three other sources. The form of this intervening network determines, in each circuit, the insertion loss, the input impedance R_s and the output impedance R_r. These values are given for each of the four circuits in Figure 2.

Some transmission loss is inevitable

(*Continued on Page 21*)

conceivable frequency, which is caused by the effect known as "thermal agitation." Its magnitude in the normal audio-frequency range represents an apparent power level of about —140 db in the resistance referred to .006 watts. When amplified sufficiently and reproduced as sound this thermal agitation voltage appears as a hissing noise which is often mistakenly referred to as "tube hiss."

Since thermal noise is a property inherent in the atomic structure of all materials it cannot, like noise from other sources, be reduced or controlled by any practical means. The internal resistance of a microphone is thus, in itself, a noise generator. Because the apparent power level of thermal noise is a constant under ordinary conditions, the signal-to-noise ratio at the output of a microphone is fixed by the signal level; and the low sensitivity characteristic of present-day high-quality microphones results in a signal-to-noise ratio at the microphone output little if any better than the best operating standards require.

The resistances composing a mixing circuit also generate thermal noise which is present in the mixer output at the same level of about —140 db, so if the signal and noise from a microphone are fed through a mixer the signal will be attenuated by the mixer loss, while the noise after being attenuated will be obscured by noise generated in the mixer itself. The thermal noise at the output of a low-level mixer is therefore constant, and the signal-to-noise ratio obtained at the microphone terminals will be degraded by an amount equal to the mixer loss.

If, on the other hand, the signal and thermal noise from a microphone are fed through an amplifier they will be amplified equally, preserving the original ratio, assuming that the noise generated in the amplifier is too small to be of consequence. If the amplifier output is then fed through a mixer the signal will be attenuated by an amount equal to the mixer loss; this will also be true of the noise, except that the latter cannot be brought below the level of noise generated in the mixer. If the original noise after having been amplified and then attenuated is still at a level substantially above the noise generated in the mixer, the signal-to-noise ratio at the mixer output will be practically that delivered by the microphone; this gain in noise ratio possible with pre-mixing amplifiers is the fundamental reason for using them, and its realization requires that the mixer loss under practical operating conditions be substantially less than the gain of the pre-mixing amplifiers.

The great practical importance of achieving the lowest mixing loss compatible with other requirements is thus firmly established.

Impedance Considerations

The internal impedance of the sources with which a mixer is to be used determines the constants which the mixing circuit must have to achieve the minimum possible insertion loss. The internal impedance seen at the input of the main amplifier system, which is ordinarily the load into which the mixer works, determines not only the optimum circuit constants but also the fundamental circuit design. The input impedance of the mixer channel facing each source must satisfy the requirements of the source if abnormal frequency distortion is to be avoided; when the sources are pre-mixing amplifiers, moreover, incorrect impedance at this point may also cause increased harmonic distortion in the associated amplifier. The output impedance of the mixer, which is a source supplying the input to the main amplifier, must be kept within proper limits if the frequency response of the main amplifier is not to be adversely affected. These considerations are among the most important in the design of mixing circuits and therefore merit more complete discussion.

The source impedance to be considered in the design of a mixing circuit for low-level operation is that of the microphone; and since microphones of various makes and types differ widely in this respect, such a mixer must usually be designed especially for the type of microphone to be used. This restriction does not apply to high-level mixers, however, since the output impedance of the pre-mixing amplifier is determined by the amplifier design and is independent of the microphone impedance. The output impedances of other sources can usually be made equal to that of the microphones or pre-mixing amplifiers used with the same mixer, requiring only a suitable design of the pad normally required with such sources for level equalization.

To secure minimum mixing loss the input impedance of the mixing circuit facing each source should equal the source impedance, but considerable variation from the value of the source impedance is often permissible. A dynamic microphone may ordinarily be worked into any reasonable load resistance provided this is not less than the microphone impedance. A source other than a microphone including a pad next to the mixer input can ordinarily tolerate wide variations in mixer input impedance. The pre-mixing amplifier is the most critical source in this respect, since a load impedance greatly different from the optimum not only affects the frequency characteristic of the amplifier but may limit seriously the output level which the amplifier can deliver with tolerable harmonic distortion; and since this amplifier, working without any gain control, must handle the entire range of output levels delivered by microphones under various studio conditions, anything tending to reduce its volume range capability is to be avoided.

The input circuit of the main amplifier system may be either of two general types. In the first type a shunt resistance, usually a gain-control potenti-

(*Continued on Page 18*)

Note: All diagrams referred to in this article appear on the following two pages and page 19.

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(*Continued on Page 18*)

Note: All diagrams referred to in this article appear on the following two pages and page 19.

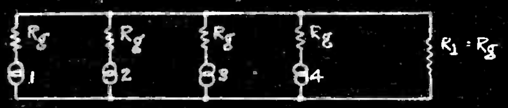


FIG. 1A PARALLEL MIXING CIRCUIT

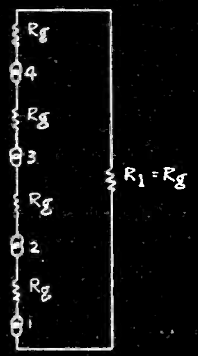


FIG. 1B SERIES MIXING CIRCUIT

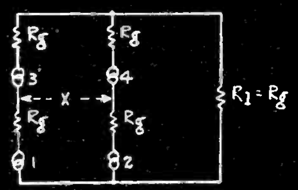


FIG. 1C SERIES-PARALLEL MIXING CIRCUIT

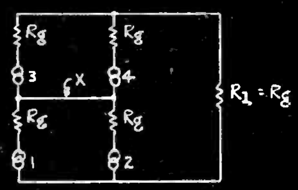


FIG. 1D PARALLEL-SERIES MIXING CIRCUIT

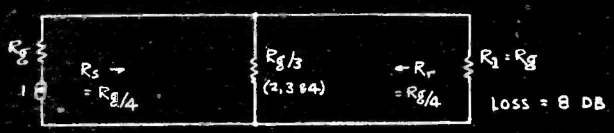


FIG 2A EQUIVALENT TO FIG. 1A

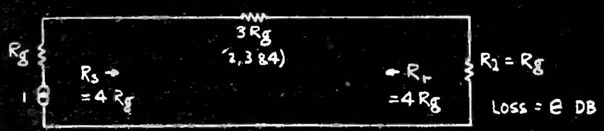


FIG. 2B EQUIVALENT TO FIG. 1B

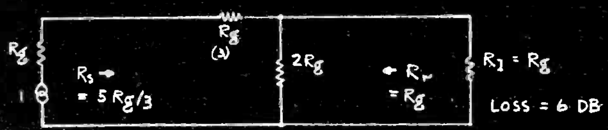


FIG. 2C EQUIVALENT TO FIG. 1C

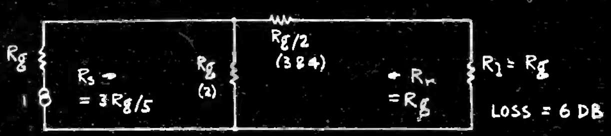
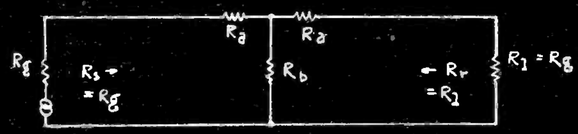
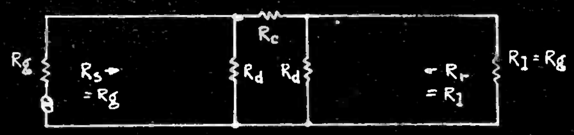


FIG. 2D EQUIVALENT TO FIG. 1D



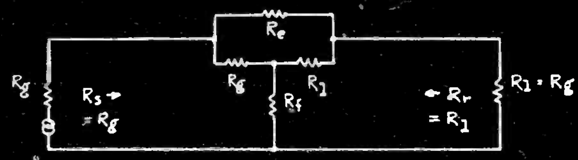
$R_s = R_r = R_g = R_l$ WHEN $R_a^2 + 2R_aR_b = R_g^2 = R_l^2$

FIG. 3A SYMMETRICAL "T" NETWORK



$R_s = R_r = R_g = R_l$ WHEN $R_cR_d^2/(R_c+2R_d) = R_g^2 = R_l^2$

FIG. 3B EQUIVALENT "π" NETWORK



$R_s = R_r = R_g = R_l$ WHEN $R_eR_f = R_g^2 = R_l^2$

FIG. 3C EQUIVALENT "BRIDGED-"T" NETWORK

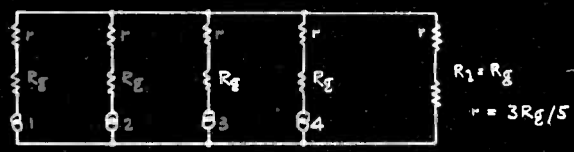


FIG. 4A COMPENSATED PARALLEL CIRCUIT

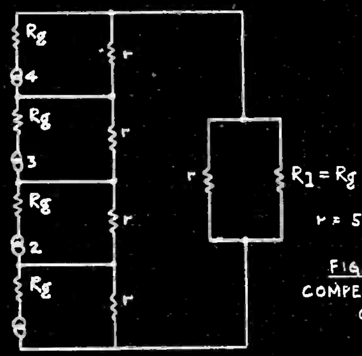


FIG. 4B COMPENSATED SERIES CIRCUIT

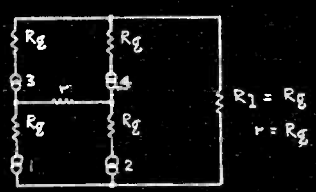


FIG. 4C BRIDGE MIXING CIRCUIT (DERIVED FROM FIGURES 1C & 1D BY INSERTING r)

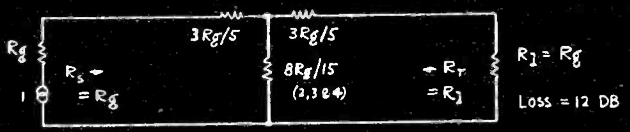


FIG. 5A EQUIVALENT TO FIG. 4A

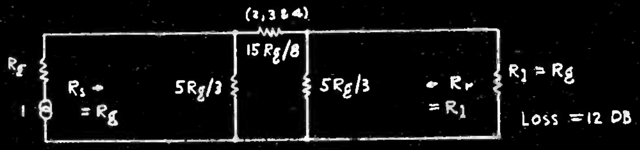


FIG. 5B EQUIVALENT TO FIG. 4B
(ALSO INTERCHANGEABLE WITH FIG. 5A)

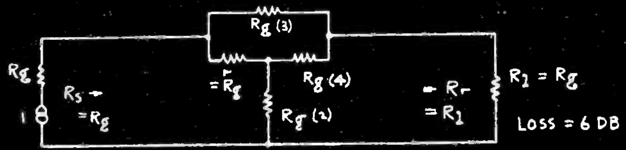


FIG. 5C EQUIVALENT TO FIG. 4C
(ALSO EQUIVALENT TO FIGS. 5A & 5B
EXCEPT FOR LOWER LOSS)

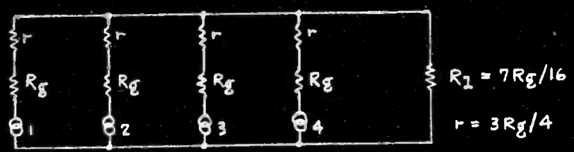


FIG. 6A VARIATION OF FIG. 4A

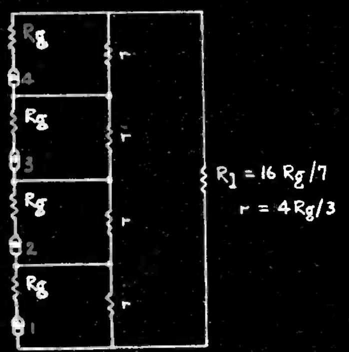


FIG. 6B
VARIATION OF
FIG. 4B

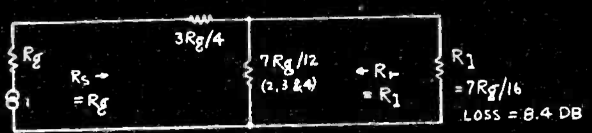


FIG. 7A EQUIVALENT TO FIG. 6A

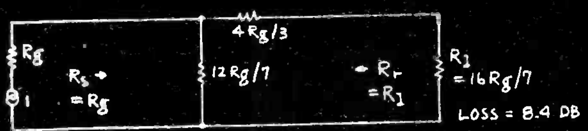


FIG. 7B EQUIVALENT TO FIG. 6B

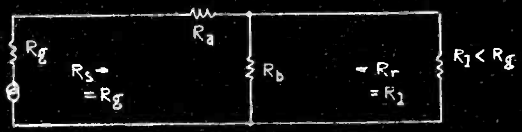
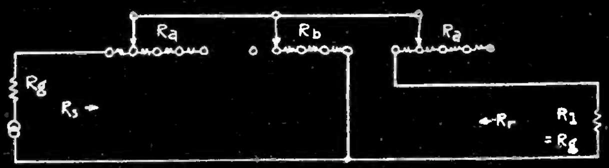


FIG. 7C UNSYMMETRICAL "T" NETWORK
(FOR MATCHING UNEQUAL IMPEDANCES
WITH MINIMUM LOSS)

$R_s = R_g$ AND $R_r = R_1 < R_g$ WHEN

$$R_a^2 = R_g^2 - R_g R_1$$

AND $R_b^2 = R_g R_1^2/(R_g - R_1)$



$R_s = R_r = R_g = R_1$ WHEN $R_a^2 + 2R_aR_b = R_g$

FIG. 8A BASIC VARIABLE-"T" NETWORK

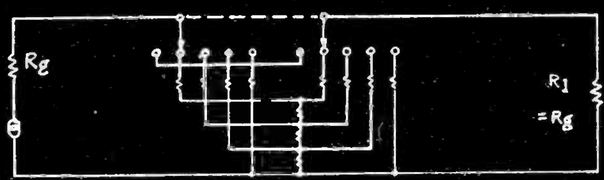


FIG. 8B SIMPLER EQUIVALENT OF FIG. 8A

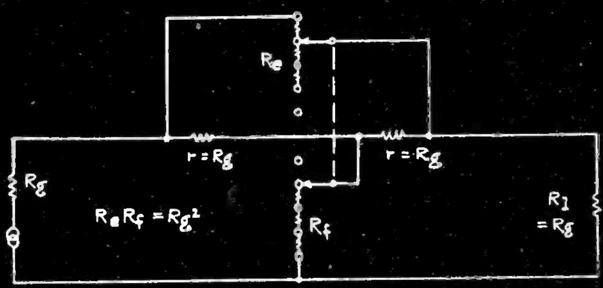


FIG. 8C VARIABLE "BRIDGED-T" NETWORK
(SIMPLEST EQUIVALENT OF
FIGS. 8A & 8B)

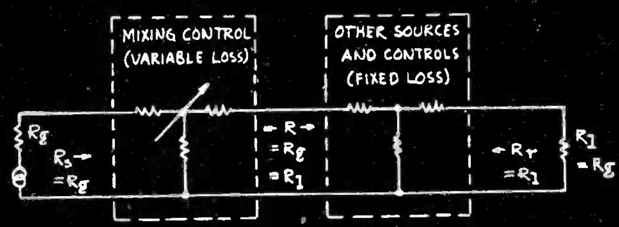


FIG. 8D EQUIVALENT OF MIXER
WITH VARIABLE-"T" CONTROLS

(*Continued from Page 15*)

ometer, is bridged on the secondary of the input transformer; and the effect of this load on the transformer primary makes the amplifier input impedance substantially resistive and of moderate value, such as 500 ohms. While the gain-frequency characteristic of such an amplifier is not greatly affected by reasonable variations in the source impedance, a value for the latter equal to the input impedance is usually optimum. The second type uses an input transformer designed to work with no secondary load except the grid circuit of the first-stage vacuum tube and to give the desired frequency response when operated from some arbitrary source impedance, such as 500 ohms. The input impedance of such an amplifier is usually high and substantially reactive over a major part of the audio-frequency range, and can ordinarily be considered infinite insofar as it affects the mixing circuit; the frequency characteristic of this type amplifier is moreover much more sensitive to changes in the source impedance. The need for considering these factors in the design of mixing circuits is therefore apparent.

Control Range

In any mixing circuit the range of control available, or the amount by which the attenuation of any single source can be varied, is determined in the design of the mixing controls or potentiometers. The controls in general use have a range of about 45 db, often supplemented by one or two large steps next to the "off" position. The "off" position should theoretically give infinite attenuation or complete cutoff, but realization of this ideal in practice is impossible; this is true partly because the mutual impedance in the control and its wiring cannot be reduced actually to zero, but more often because of the presence of leakage which is discussed below.

Interaction of Controls

Completely independent operation of each mixing control would mean that the transmission loss effective in any one channel is controlled exclusively by its own potentiometer, regardless of the setting of other channel controls. While this ideal is closely approached in some circuit designs, some interacting of the control functions is inevitable in others. The cause of this interaction, when present, is the use of a type of control whose output impedance varies with the attenuation setting, although such controls may be used in some circuits without causing this effect.

Leakage and Susceptibility to Noise Pick-Up

The transmission of program from a source to the common channel through stray capacitances or spurious couplings not subject to control by the potentiometers is called "leakage." The presence of leakage limits the degree of cut-off obtainable when the controls are in their "off" positions and, since the spurious transmission favors the higher frequencies, leakage which does occur is especially objectionable because of its "tinny" quality.

The same forms of stray coupling which give rise to leakage generally also make the mixing circuit more vulnerable to noise pick-up from stray currents flowing in the ground system; this sometimes causes troublesome power hum or, if the system is installed near a radio transmitter, radio-frequency pick-up resulting in crosstalk or singing.

Mixing circuits in which some of the input circuits are entirely above ground potential, such as the familiar series arrangement, are more subject to leakage and noise pick-up caused by spurious coupling.

Frequency Response

Since a mixing circuit usually contains only resistance elements it should not directly affect the frequency response of the overall system. Indirectly however it may, through improper or widely varying terminal impedances, upset the normal frequency response of associated amplifiers; or by permitting appreciable leakage, which is worse at higher frequencies, it may give the system a rising response characteristic when the controls are set near maximum attenuation. Both of these defects can be minimized by proper design of the mixing circuit.

Basic Mixing Circuits

Any given mixing circuit whose controls are set for minimum attenuation can be replaced by a simpler equivalent network which embodies the mixing function alone, without the control function. Since the properties of any variable mixing circuit are limited and, to a degree, controlled by those of the equivalent fixed mixer, let us first investigate the design and performance capabilities of fixed mixing circuits; the additional problems involved in the variable control feature will be considered separately in a later section.

Assume that a fixed mixing circuit is required to combine the outputs of four sources into a common load, and that the resistance of each source, R_g, equals that of the load, R_1. Figure 1 shows the four simplest arrangements for such a circuit in which the sources are connected, respectively (A) in parallel, (B) in series, (C) in series-parallel and (D) in parallel-series. When these four circuits are redrawn in simplified form, as in Figure 2, the transmission path from any one source to the load is seen to contain a network of series or shunt resistances, or both, which represent the resistances R_g of the three other sources. The form of this intervening network determines, in each circuit, the insertion loss, the input impedance R_s and the output impedance R_r. These values are given for each of the four circuits in Figure 2.

Some transmission loss is inevitable

(*Continued on Page 21*)

MIXING CIRCUITS

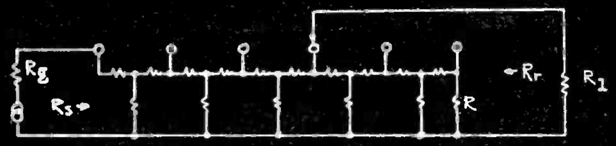


FIG. 9A BASIC CIRCUIT OF LADDER-TYPE CONTROL

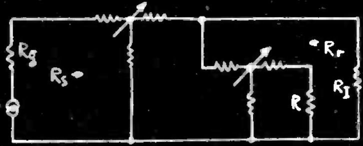


FIG. 9B

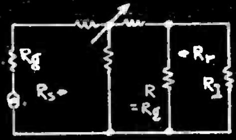


FIG. 9C

CIRCUITS EQUIVALENT TO FIG. 9A

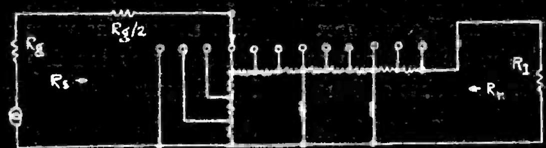


FIG. 9D CIRCUIT OF TYPICAL LADDER CONTROL

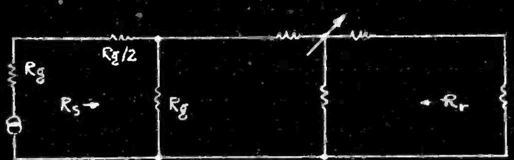


FIG 9E CIRCUIT APPROXIMATELY EQUIVALENT TO FIG. 9D

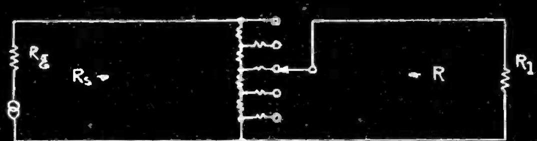


FIG. 10 TYPICAL COMPENSATED POTENTIOMETER CIRCUIT

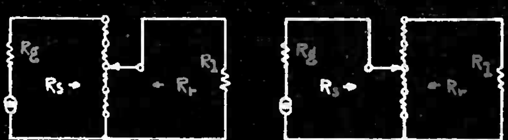


FIG. 11 SIMPLE POTENTIOMETER CIRCUITS

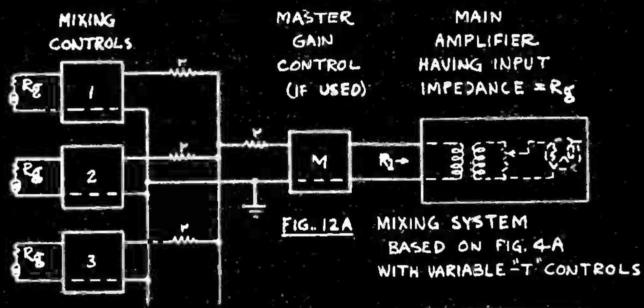


FIG. 12A MIXING SYSTEM BASED ON FIG. 4-A WITH VARIABLE "T" CONTROLS

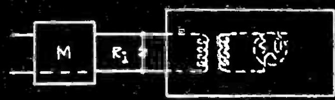


FIG. 12B MODIFICATION FOR HIGH-IMPEDANCE AMPLIFIER INPUT DESIGNED TO WORK FROM SOURCE IMPEDANCE = Rg/2

CIRCUIT CONSTANTS	NUMBER OF MIXING CHANNELS, n						
	2	3	4	5	6	7	8
MINIMUM LOSS $= 20 \log_{10} n$ DB	6	9.5	12	14	15.6	16.9	18.1
$r = R_g(n-1)/(n+1)$	$R_g/3$	$R_g/2$	$3R_g/5$	$2R_g/3$	$5R_g/7$	$3R_g/4$	$7R_g/9$

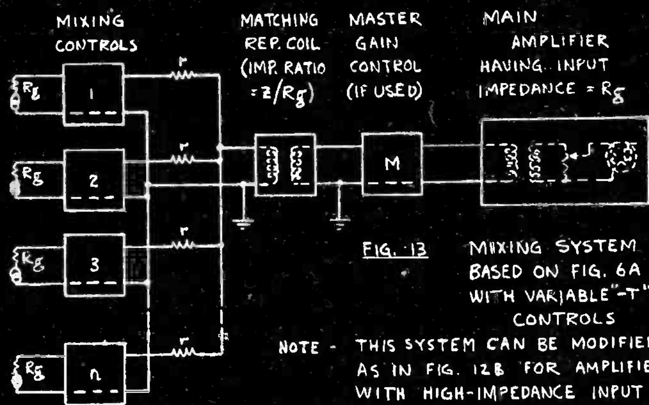
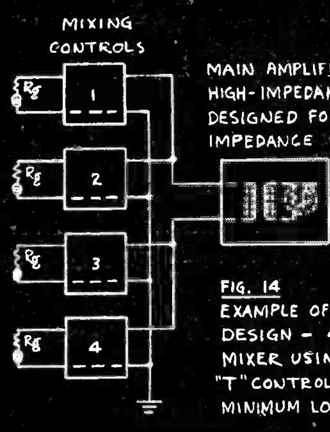


FIG. 13 MIXING SYSTEM BASED ON FIG. 6A WITH VARIABLE "T" CONTROLS

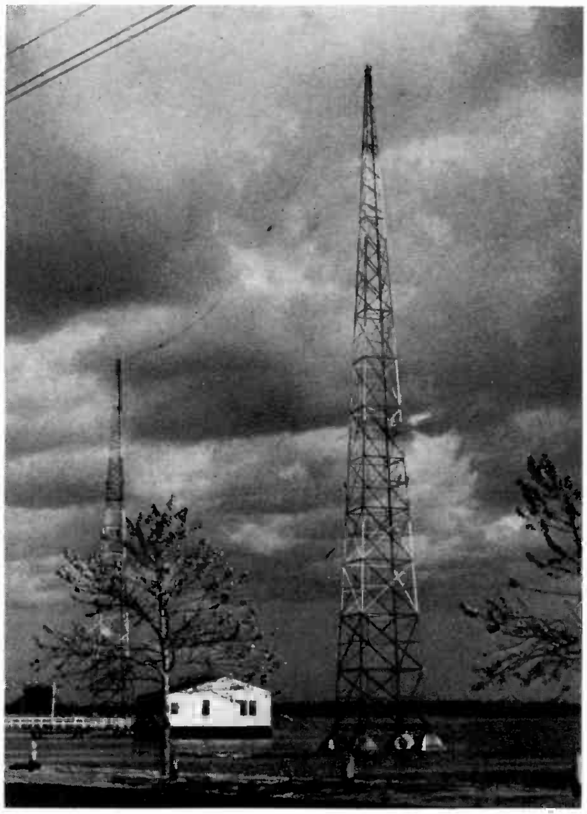
NOTE - THIS SYSTEM CAN BE MODIFIED AS IN FIG. 12B FOR AMPLIFIER WITH HIGH-IMPEDANCE INPUT

CIRCUIT CONSTANTS	NUMBER OF MIXING CHANNELS, n						
	2	3	4	5	6	7	8
MINIMUM LOSS $= 10 \log_{10}(2n-1)$ DB	4.8	7	8.4	9.5	10.4	11.1	11.8
$r = R_g(n-1)/n$	$R_g/2$	$2R_g/3$	$3R_g/4$	$4R_g/5$	$5R_g/6$	$6R_g/7$	$7R_g/8$
REP. COIL PRIMARY IMPEDANCE Z $= R_g(2n-1)/n^2$	$3R_g/4$	$5R_g/9$	$7R_g/16$	$9R_g/25$	$11R_g/36$	$13R_g/49$	$15R_g/64$

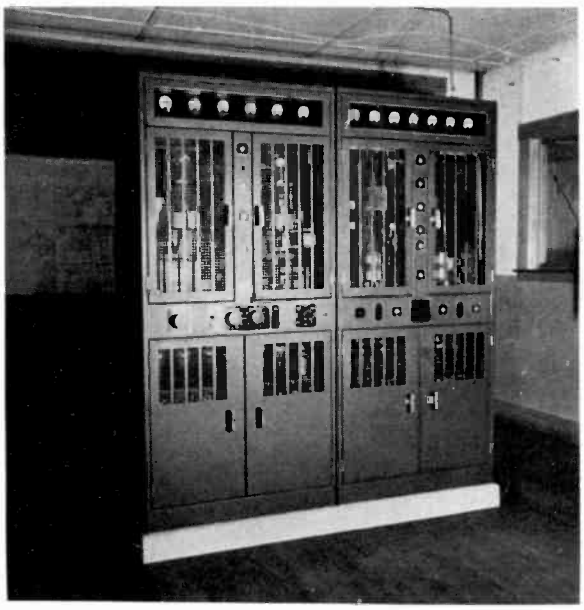


MAIN AMPLIFIER WITH HIGH-IMPEDANCE INPUT DESIGNED FOR SOURCE IMPEDANCE = Rg

FIG. 14 EXAMPLE OF SPECIAL DESIGN - 4-CHANNEL MIXER USING VARIABLE "T" CONTROLS MINIMUM LOSS = 6 DB



WHDH Boston



WHDH's Western Electric 1000 watt transmitter. Oscillator modulator unit at left and power amplifier unit at right. At top: Transmitting station on the Lynn marshes at Saugus, Massachusetts — a perfect setting for an antenna site.

Ideal Transmitter Location Boosts WHDH Signal

Station WHDH is "The Voice from Home" to thousands of New England fishermen. Working off the great fishing banks for weeks at a time, radio entertainment helps to while away their lonely existence, and the special broadcasts of market information, aimed to help them unload their catch on a rising market, means a greater profit to every man on the fishing boats.

WHDH is an outgrowth of Station WEPS, a 100 watter established in Gloucester in 1926 for service to fishermen and fisheries. Although WEPS operated satisfactorily and carried on its broadcasting for some time with the 100 watts of power, this was found to be inadequate for the type of service needed, and in 1928 the station was licensed by the Federal Radio Commission to increase its power to 1,000 watts, and a new set of call letters, WHDH, was assigned. A new Western Electric 1,000 watt, 6B transmitter was then installed at the old location at Gloucester. Four years later, in order to cover more completely the Boston area in which the studios were located, the transmitter was moved to a new location on the salt marshes at Saugus, Massachusetts.

In 1936, due to the fact that so many improvements had been made in broadcast transmitters, both in efficiency and quality of transmission, WHDH purchased a new Western Electric 304B high fidelity transmitter which was installed at Saugus and put on the air in April of 1936. This was the first Western Electric high fidelity transmitter with air-cooled vacuum tubes to be installed in the Boston area. Because the marsh location in Saugus is quite isolated from a good supply of fresh water, the air-cooled system is of great advantage. The transmitter is operating in a very satisfactory manner, and because of its high efficiency, its 100 per cent modulation characteristics and its high fidelity, it is serving fishermen and listeners of New England in the best possible manner.

WOR Buys Nine 22A Remote Pick-Ups

Station WOR, Newark, N. J., has recently received delivery of six additional Western Electric 22A Speech Input Equipments. This makes a total of nine of these portable pick-ups in WOR's Remote Department. The additional equipment was found necessary to provide adequate service for the increasing number of remote programs.

WOR now handles over 300 remote broadcasts a month for both its own transmission and the distribution of the network programs of the Mutual Broadcasting System.

Mixing Circuits for Speech Input Equipment

(*Continued from Page 18*)

when series or shunt resistances are inserted in a transmission path. But deviations of R_s and R_r from R_g and R_1 are not only undesirable but unnecessary; this is obvious if we consider the fixed artificial line or "pad" commonly used between equal impedances when it is desired to introduce loss without upsetting the impedance match. Figure 3A shows the familiar "T" pad which is the simplest form for such a device. The desired condition where $R_s = R_r = R_g = R_1$ obtains when the values of R_a and R_b satisfy the following relation:

$$R_a^2 + 2 R_a R_b = R_g^2 = R_1^2$$

The ratio of R_a to R_b is of course varied as required to obtain the desired loss. Pads of other forms may be used, such as the "π" and "bridged-T" shown in Figures 3B and 3C; but theoretically any resistance network can be reduced to a "T" form which is exactly equivalent.

Returning now to the simplified mixing circuits of Figure 2 we see that in no case is the condition necessary for matched input and output impedances obtained; in fact, one or more arms of the desired "T" form are absent in every case. This explains the failure of these circuits to give the desired terminal impedances, and suggests the modifications necessary.

Figure 4A shows the parallel mixer with a resistance added in series with each source and with the load; and Figure 5A shows the equivalent circuit in which it is apparent that the interior network has the required "T" form, and that the desired terminal impedances are obtained. For a four-channel mixer each series resistance should have a value, r, equal to 3R/5, or for the general case of n channels, $R(n-1)/(n+1)$, where $R = R_g = R_1$. The insertion loss is 12 db for four channels, or $20 \log_{10} n$ for n channels.

An analogous modification of the series circuit is shown in Figure 4B, and its simplified equivalent in Figure 5B. Here the compensating resistances are in parallel with the source and load resistances and have a value $r = 5R/3$ for four channels, or $R(n+1)/(n-1)$ for n channels. The loss is again 12 db for four channels and $20 \log_{10} n$ db for n channels.

The series-parallel and parallel-series circuits of Figures 1C and 1D are identical except for the connection at "x." Insertion of a resistance R at this point makes either circuit the same as Figures 4C and 5C, in which r and R_1 are conjugate arms of a balanced Wheatstone's bridge. Varying r will therefore not affect the power received by R_1 from any of the four sources, nor the output impedance R_r, but will affect the input impedance value R_s. When r is infinite we have the circuit of Figure 1C, and when it is the zero that of Figure 1D; in the first case $R_s = 5R_g/3$, and in the second case $R_s = 3R_g/5$. If however, r is made equal to R_g, R_s will also assume this value. While this type of circuit can thus be made to have optimum input and output impedances it is obviously not suitable for other than four channels.

In each of the above cases a load impedance R_1 equal to the source impedance R_g has been assumed. In a recent article* Mr. M. Rettinger has described a form of circuit wherein a lower insertion loss is obtained by giving R_1 a different value determined by the number of mixing channels. Figure 6A shows a parallel mixing circuit of this type in which a resistance, r, inserted in series with each source, has a value equal to $3R_g/4$ for a four-channel mixer, or $R_g(n-1)/n$ for the general case of n channels. The load resistance, R_1, equals $7R_g/16$ for four channels, or $R_g(2n-1)/n^2$ for n channels. The insertion loss is 8.4 db for four channels, or $10 \log_{10}(2n-1)$ db for n channels. The equivalent circuit of Figure 7A shows the network inserted between any source and the load as an unsymmetrical "T" having only one series arm; this is the familiar "matching pad" often used to join circuits of unequal impedance when it is desired to match both source and load with minimum insertion loss. Figure 7C shows a pad of this type in which $R_s = R_g$ and $R_r = R_1$ when the values of R_a and R_b satisfy the relations:

$$R_a^2 = R_g^2 - R_g R_1$$
$$\text{and } R_b^2 = R_g R_1^2/(R_g - R_1)$$

Examination of Figure 7A shows that the values of resistance in the inserted network satisfy these relations, and this circuit therefore provides "matched" input and output impedances.

The corresponding series circuit is shown in Figure 6B and its simplified equivalent in Figure 7B. The insertion loss is the same as for the parallel circuit for the same number of channels, but the shunt resistance r has a value $4R_g/3$ for four channels, or $R_g n/(n-1)$ for n channels, while the load impedance is $16R_g/7$ for four channels or $R_g n^2/(2n-1)$ for n channels.

Since either of these circuits requires a load impedance different from the source impedance, and since the load impedance required in any given case depends on the number of channels, these circuits lack the flexibility inherent in the type shown in Figure 4A; this disadvantage may well outweigh the advantage of lower insertion loss which these circuits possess. This matter is discussed further under "General Designs."

The fixed mixing circuits described above are the basic ones, but many variations involv-

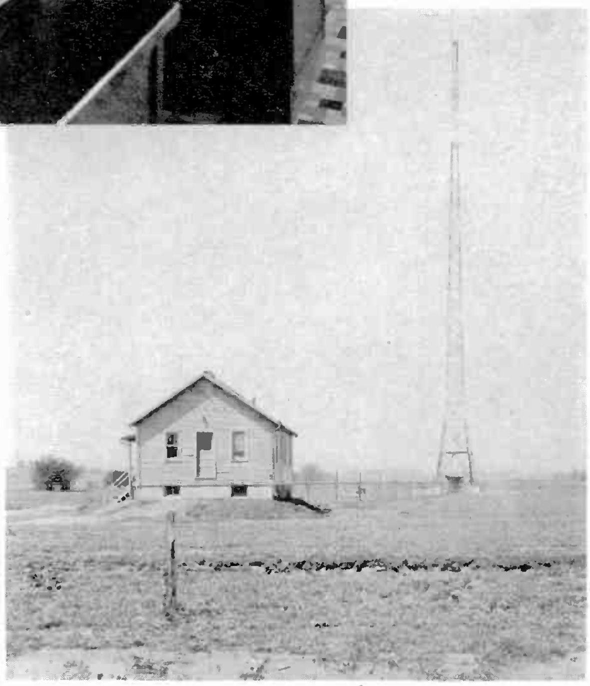
(*Continued on Page 23*)

* "Microphone Mixers"—S. M. P. E. Journal, June 1937.

KFJB

Marshalltown, Iowa

E. N. Peak,
President



Wayne Peak,
Chief Engineer

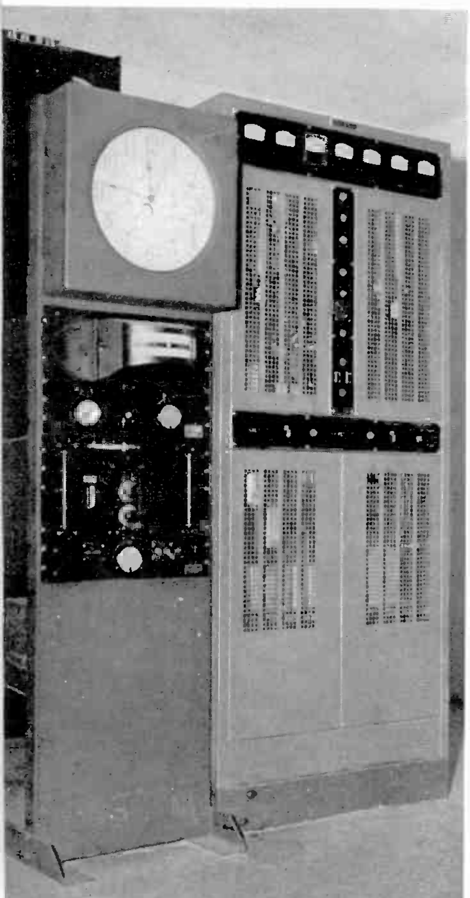
A. E. Mickel,
Station Manager

Lee Blodgett,
Operator

Maurice Reutter,
Chief Operator

"Central Iowa's Own Station" is another in the long list of stations using Western Electric's 23A transmitter. The transmitter and its companion piece the 23A speech input equipment are shown in the above photograph.

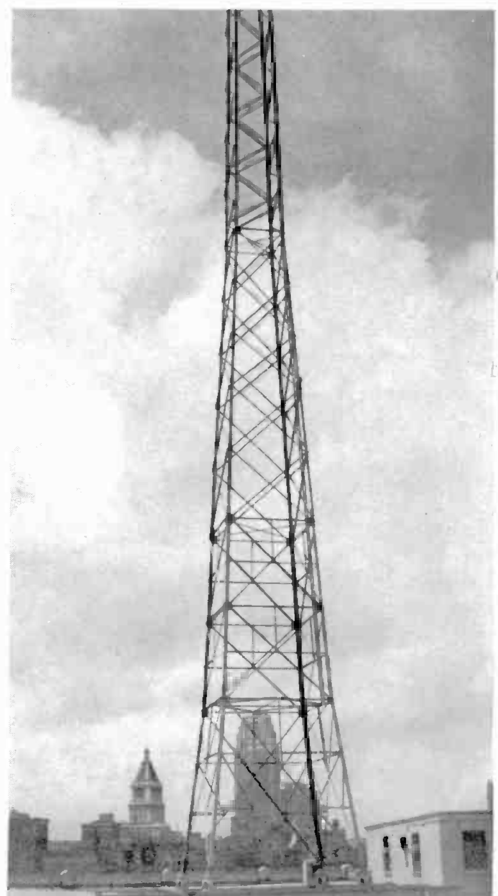
KFJB's 215-foot vertical radiator is connected to the transmitter by the concentric transmission line clearly visible in the photograph at right.



WCPO

Cincinnati, Ohio

Owned and operated by the Cincinnati Post, of the Scripps-Howard newspaper chain.



Engineer tuning the 702A oscillator. Left: The Western Electric 23A transmitter. Right: WCPO's vertical radiator, with Cincinnati's skyline in the background.

(*Continued from Page 21*)
ing parts of these are possible; one of these variations will be discussed under "Special Designs."

Variable Mixing Circuits

The variable control feature required in practical mixing circuits can be incorporated in any of the fixed mixing circuits described above, simply by inserting a suitable potentiometer or other control between each source and the remainder of the circuit. A similar control can also be inserted in the common output, if desired, to serve as a master gain control.

The type of controls used determines whether the minimum insertion loss and the terminal impedances will be the same for the complete circuit as for the basic fixed mixing circuit.

Let us therefore consider, first, the various types of control potentiometers available; and second, the application of these types to practical mixing circuits. The type whose operation is easiest to analyze and which least affects the properties of the overall circuit is the most complicated in construction; while the types which are simpler and cheaper to build, and which have therefore been more widely used, in general complicate the theoretical design of the circuit through the introduction of additional variable factors. In the order of their simplicity of application the principal types of control are (1) the variable "T" network, (2) the ladder network, (3) the compensated potentiometer and (4) the simple potentiometer; types (2) and (3), are, moreover, fundamentally interchangeable as will be shown in the following discussion.

Variable 'T" Network

The fixed "T" network is a basic form which, by the choice of proper values for its three arms, may be made equivalent to any resistance network however complicated. A variable "T" network in which all three arms vary in resistance independently when the knob is rotated is therefore the general prototype of which all other types are special cases, and the consideration of this type control is thus discussed first.

A fixed "T" network can be so designed that its terminal impedances equal the impedances of the source and load between which it works; and that by varying the values of its series and shunt arms it can be given any desired attenuation value down to a minimum which, when source and load impedances are equal, is zero. Figure 8A shows a variable "T" network in which all three arms are varied to provide control of its insertion loss; the practical construction of a control using this circuit requires three resistances and three contact points for each step in the control range. By using the form shown in Figure 8B an equivalent control using only two contact points per step but requiring the same number of resistances may be constructed. The form shown in Figure 8C is a "bridged-T," equivalent in all respects to the others, which requires only two sets of points and two sets of resistances, plus two fixed resistances; this form is therefore used in commercial "T"-type mixing controls.

If the basic mixing circuit is one which, like Figures 4A, 4B, 4C, 6A and 6B provides terminal impedances to match the sources and the load, the insertion of properly designed variable "T" controls results in a complete variable mixer whose terminal impedances will be constant regardless of control settings. Figure 8D shows the simplified equivalent circuit of such a mixer in which two "T" networks are seen between the source and load; the first is the variable control network associated with that source, while the other is the fixed network representing the other sources and their controls. If another control of the same type is used in the common output circuit this would be represented by a third "T" in tandem with the others. Since the attenuation in the control networks can be reduced to zero the minimum insertion loss of such a mixer, with or without the master gain control, would be fixed by the design of the basic circuit.

Ladder-Type Mixing Control

The basic circuit of the ladder-type mixing control, shown in Figure 9A, may be viewed as a series of "T" networks connected in tandem and terminated with a resistance R. In the simplest case, R and the characteristic impedance of the "T" networks are made equal to R_g. An equivalent circuit is shown in Figure 9B, where the two "T" networks are varied simultaneously so that the sum of their losses is constant; the left network of this circuit controls the attenuation between source and load, while the right network terminated in R is effectively a resistance equal to R in parallel with the load. A simpler equivalent is therefore that shown in Figure 9C.

Since the output of the "T" network is already terminated by R, the input impedance R_s will equal R_g regardless of the attenuation setting provided R_1 is infinitely high; but if R_1 equals R_g, R_s will vary from $R_g/2$ with zero attenuation to a value approaching R_g when the attentuation is very large. The output impedance R_r will be constant at $R_g/2$ regardless of the loss setting of the "T" network. If the source and load are interchanged, so that the input is to the sliding contact, these impedance considerations are in general reversed; the input impedance is then constant if the load resistance has the proper value, while the output impedance varies with attenuation setting unless the source impedance is infinitely high.

Many variations of the basic ladder circuit are used, the object usually being to simplify construction or to fit the control to a specific type of circuit. The circuit shown in Figure 9D is that of a typical commercial design, while Figure 9E is its approximate equivalent. Regardless of modifications, however, the ladder design has inherent limitations arising from the presence of the extra shunt arm in its equivalent circuit. Aside from its use in series circuits where the load impedance can be made very high, substitution of this type for the "T"-type in any given design will result in (1) an increase in the minimum mixer loss of at least 3 db, (2) widely varying input impedance or (3) a considerable degree of interaction between channel controls.

In spite of its inherent disadvantages, however, the ladder-type control is now in very general use, chiefly because of its lower cost and smaller bulk.

Compensated Potentiometer

The compensated potentiometer, of which a typical circuit is shown in Figure 10, was evolved as an improvement over the simple potentiometer described below. It consists of a potentiometer in which a separate resistance is inserted between each contact point and the potentiometer winding in order to "build out" the impedance seen at the sliding contact to a constant value.

The compensated potentiometer has the same equivalent circuit as the ladder-type, and the two are therefore generally interchangeable. Because it requires fewer resistances and a smaller number of separate values the ladder-type is cheaper to construct, and has therefore largely replaced the compensated type except for special cases where the latter design is better adapted for structural reasons. Being equivalent to the ladder-type, the compensated potentiometer has the same inherent limitations.

Simple Potentiometer

The simple potentiometer shown in Figure 11 always gives a variable impedance seen from the slider side, while the other terminal impedance is variable except when the source of load connected to the slider is a high impedance. This type is therefore of little use in conventional mixing circuits. Its most familiar use is in amplifier circuits where its slider is the output feeding the grid circuit of a vacuum tube; here the input impedance is substantially constant, and variations in output impedance do not matter.

Another instance of its use is in the Western Electric 23A Speech Input Equipment where simple potentiometers are used inverted, i.e. with input to the slider, in a special parallel mixing circuit. Here the load impedance for each control is the combination of the three other channel controls in parallel; the input impedance varies widely, but is always small compared to the internal plate resistance of the pentode-type vacuum tube which is the source, while by virtue of the high source impedance no serious variations in output impedance results.

Mixing Control Noise

The noise introduced into a mixing circuit by the operation of its sliding contacts is distinct from the thermal noise previously discussed. Its principal causes are (1) thermoelectric voltage generated by the contact of dissimilar contact metals, (2) dirt or products of corrosion on the contacts, which cause undue variation in contact resistance, and probably (3) some obscure property inherent in the crystalline structure of the contact metals themselves.

Contact noise trouble is much less prevalent in mixers used with pre-mixing amplifiers, due to the smaller amount of amplification following the mixer; recent improvements in potentiometer design have, moreover, made possible the construction of mixing controls whose contact noise is of the same order as the thermal noise in the resistances. With properly designed controls of modern type the elimination of troublesome contact noise is largely a matter of keeping the contact surfaces cleaned and lubricated.

In this connection the ladder-type potentiometer when used with the slider toward the source, has a unique advantage over other types in that any noise which may be generated by the contacts is attenuated by the loss in the control. When the attenuation setting is increased the contact noise is therefore decreased along with the program.

General Designs

In studio equipments using pre-mixing amplifiers it is possible to make the mixer source and load impedances equal; and furthermore flexibility of the system is enhanced by adhering to a standard impedance wherever possible.

For this type of application the mixer arrangement shown in Figure 12A is perhaps the most suitable; it combines the desirable properties of constant terminal impedances, freedom from leakage and interlocking, and adaptability to systems of any number of channels without change of amplifier impedances. For use with an amplifier having an unterminated input circuit this circuit can be modified slightly as shown in Figure 12B.

The arrangement of Figure 13 offers the advantage of lower mixer loss and this saving becomes substantial with a large number of channels. Its compensating disadvantage lies in the need for an impedance-matching repeating coil, or else a special input impedance for the main amplifier and master gain control; and the impedance required in these devices moreover varies with the number of mixing channels. A repeating coil for use in this circuit must be of high-grade design in order to meet present-day frequency-response standards, and must moreover be effectively shielded against hum pick-up from nearby power equipment because of the low signal power level at this point in the system. While this arrangement may be modified in a manner similar to that indicated in Figure 12B for use with a main amplifier having an unterminated input circuit, the use of repeating coils directly adjacent to the input circuits of such amplifiers is undesirable; the frequency response of this system within the normal audio-frequency range of 30 to 10,000 cycles may be seriously affected by the repeating coil even if the latter has a flat response to considerably higher frequencies when measured alone due to the absence of a fixed resistance termination for the repeating coil.

Because of the relatively high cost of variable "T"-type controls it may in some cases be necessary to substitute ladder-type controls for the "T"-type in the circuits of Figures 12A, 12B or 13. When this is done the circuit design is no longer straightforward, but involves compromise between insertion loss, interaction of controls and inconstancy of terminal impedances. For this reason the final design of multi-channel mixers using ladder-type controls must be determined by trial and measurement with the particular sources and amplifiers to be used. In general the insertion loss of the mixer will be at least 3 db higher than with "T"-type controls, and will usually be somewhat greater depending on the impedance variations and control interaction which can be tolerated.

If the main amplifier has an unterminated input a series mixing circuit, using ladder-type controls with the moving contact toward the output, can be designed to give practically constant input and output impedances and freedom from interaction; however, the difficulty with leakage inherent in multi-channel series mixers limits the usefulness of this circuit.

Special Designs

As a rule the engineer who undertakes the design of a mixing circuit does not have a free hand in the choice of other system components, but is restricted to such standard amplifiers, repeating coils and other parts as may be available. The typical mixing circuit is therefore usually not an ideal design, but rather the best compromise that can be achieved within the limitations imposed by economic considerations, the electrical properties of other system parts and the relative importance of various factors in the performance of the overall system.

Figure 14 is included to illustrate a special design which might be chosen for a 4-channel mixer when low insertion loss is the primary design requirement. If low cost, the use of some particular type of control, adaptability to an unusual system design, or the meeting of some special operating requirement is the controlling factor, then another special design can usually be determined to fit the individual case. However, any such specialized design has limitations such as impossibility of future expansion and possible difficulty in future amplifier substitution.

It is hoped that the fundamental circuit principles outlined above will assist in promoting a better general understanding of mixing circuits, their properties, capabilities and limitations.

James E. Tarr

When Major Edwin Armstrong disclosed his super regenerative receiving circuit a young farm lad at Castle Hill, Maine, read about it—drew all the money he had from the bank—cashed a precious five dollar gold piece to swell the capital and invested this, his worldly wealth, in radio gadgets.

James E. Tarr

It's a long road from hoeing potatoes on an isolated Maine farm to developing speech input equipment at Bell Telephone Laboratories, but that is the road Jim Tarr has traveled since his first radio venture. In 1921, at the age of 17, he entered the University of Maine. Twice during his college days he had to return to Castle Hill to help on the farm. These interruptions dragged out his course in electrical engineering to six instead of the customary four years.

During his training he heard college men talk of the Laboratories on West Street and he determined that some day he would become a member of that famous organization. After receiving his B.S. degree in 1927, Tarr took the introductory training course offered by the New York Telephone Company. He was dissatisfied. The field of radio, not telephony, was the field he wanted to explore. There was no deterring him. He kept at his boss until he was granted a transfer to Bell Telephone Laboratories.

Starting in the Systems Development department, Tarr continued in his attempts to get into the radio division. One day in 1928 his boss went to the head of the Radio Development Department and said, "I have a young chap who is determined to get into radio and he just won't be happy until we put him there—how about it?" Thus it was that, in 1928, Tarr settled down with a smile of contentment to work with the speech input equipment group.

His specialty is systems engineering, the design of complete installations around amplifiers and other basic units which involves the juggling of gains, losses, noise-levels and impedances, and the development of control circuits for mixing and output switching.

It is also Tarr's job to hobnob with radio engineers and to plan and revise speech input equipment to suit the particular needs of various broadcasting stations throughout the country. Among recent station installations he has had a hand in are those at WWJ, Detroit; WEEI, Boston, and KNX, Hollywood, which will go into operation in the near future. He is the author of the article "Mixing Circuits" which appears in this issue of *Pick-Ups*.

POLICE

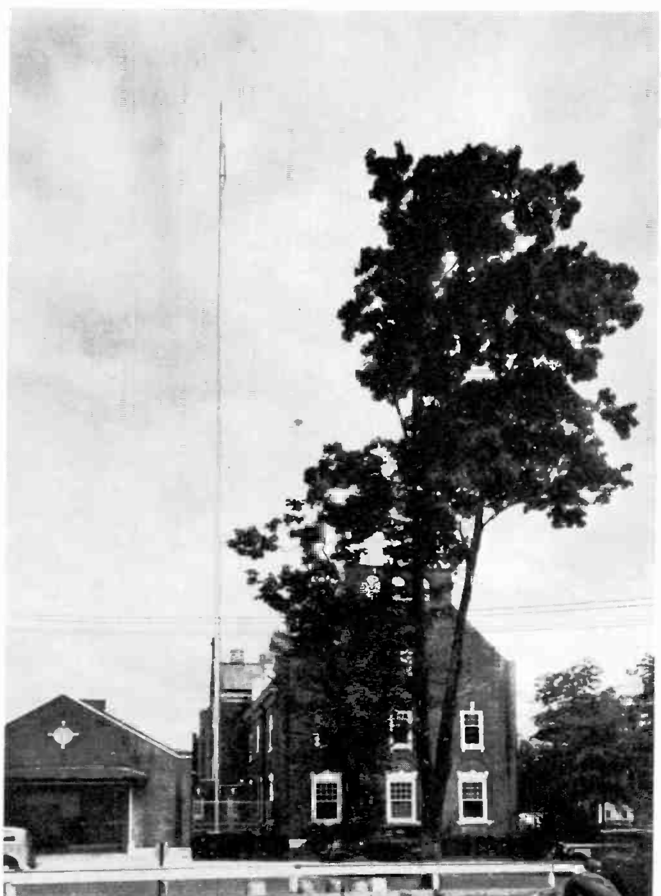
MT. VERNON, NEW YORK

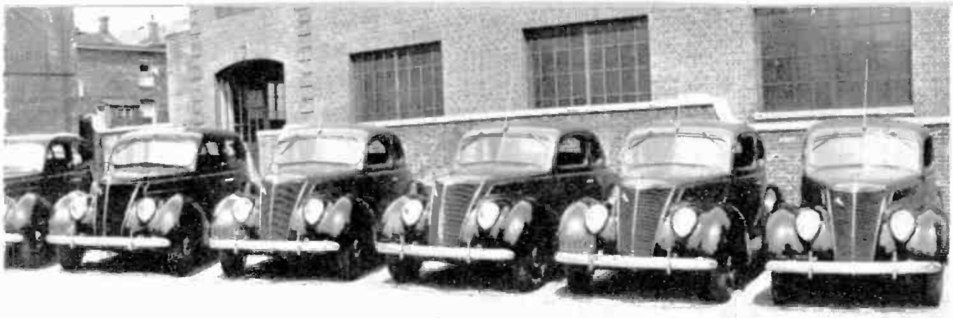
Since installing new Western Electric ultra-high frequency police radio equipment, Mount Vernon's police department is rendering faster and more comprehensive protection to the city's 65,000 inhabitants without increasing operating expenses and with no change in number of operating personnel.

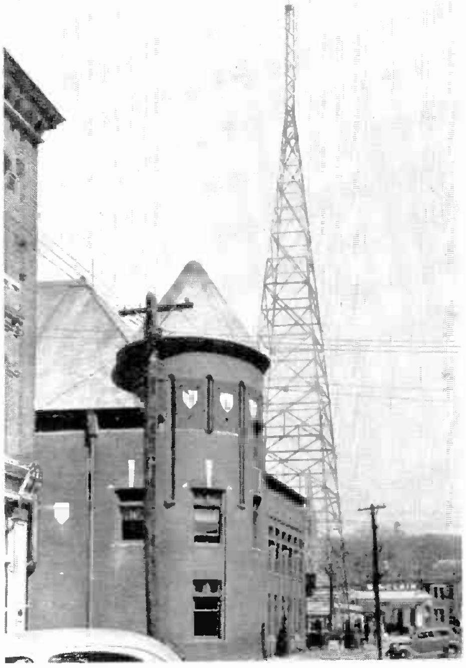
Eighteen of Mount Vernon's 21 radio equipped cars form an impressive line-up in panel at top. Left: Sergeant Henry, of the Radio Bureau, calls the mobile fleet into action from headquarters, through the medium of the 16B 50 watt transmitter at left. An 89A Speech Input Amplifier stands on desk.

Below: A radio patrolman takes a few minutes off to have a receiver set checked. This repair station, next door to headquarters, is used exclusively for police equipment. Spare receiver sets are held in readiness for quick replacement.

The self-supporting half-wave antenna atop a steel mast (lower left), tops the highest point in Mount Vernon. The clear, strong signal gives complete coverage of the city.







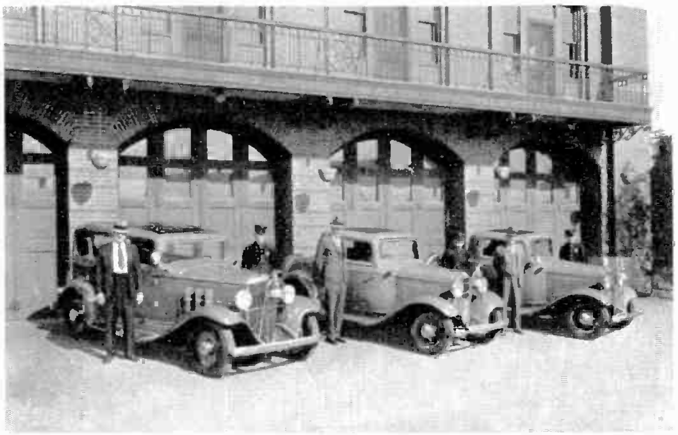
RADIO

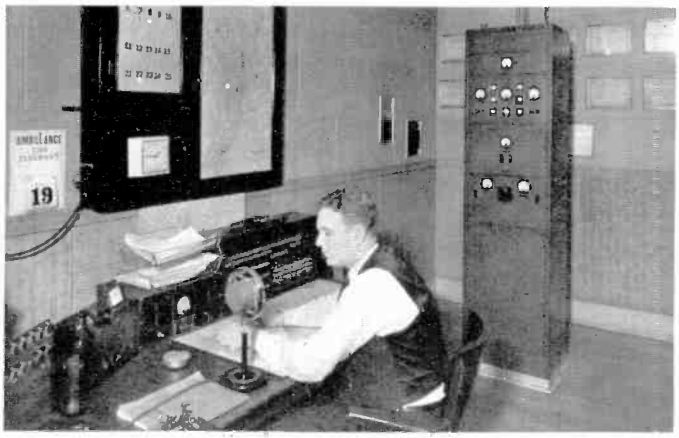
ST. JOSEPH, MISSOURI

The first Western Electric two-way ultra-high police radio system west of the Mississippi and one of the most complete installations in the country serves St. Joseph's 82,000 citizens. The 185-foot tower (upper right), topped with eight feet of tubing lifts the antenna ten feet above the surrounding hills.

Three cars (right), used by the fire department are also equipped for two-way radio communication. Police headquarters radio room (lower right), with 16B transmitter in background and an 89A Speech Input Amplifier (center of desk).

Below: One of the three antennas for the remote 19A receivers which pick up the signals from the mobile fleet. These are located at extremely high vantage points about the city. Panel at bottom shows radio cars lined up before police headquarters.





Is Radio Developing Public's Appetite for "Better Music"?

(*Continued from Page 5*)

being done to further the appreciation of good music among students." KWK has mapped out a series of weekly one hour programs in which all the high, public, parochial and private schools in St. Louis and St. Louis County will participate.

KFRU, WJAS (Pittsburgh), WENR-WMAQ, KRE put the problem of the classics' future right up to listeners by saying that they will increase better type musical programs when public appreciation and demand warrants.

Speaking for Columbia as chief consultant on music, Deems Taylor promises a staggering lot of serious music for 1937-1938. "Symphonic music will pour out through the seasons of the Philharmonic Symphony Society of New York, the Cincinnati orchestra, the Los Angeles, Philadelphia and Detroit Symphony orchestras—all this in addition to chamber music, string quartets, the American School of the Air series, vocal and piano recitals."

Since the survey definitely points to an increase in the quantity of serious music about to go on the air what about the quality of such broadcasts and the manner of presentation? Listeners can always switch to the lighter favorites if the classics grow boring. That's the fly in the broadcaster's ointment. How can he catch it? *Pick-Ups* wanted to know and asked:

Have you any suggestions as to how broadcasters can improve the presentation of programs devoted to better music?

Sterling Harkins, program manager of KWK, suggests closer cooperation among educational and musical authorities and musicians' unions to attain three objectives. "First," explains Mr. Harkins, "persuade educational authorities to devote more time to instruction with a view to broadcasting. Second—show musical leaders that commercial sponsorship of better music has a definite value; is not unethical; would assist materially in increasing the number of such broadcasts. Third—show musicians' unions that wholehearted cooperation in broadcasting of good music is decidedly to their advantage as it increases the demand for such music which in turn leads to a greater demand for their services."

Jack Joy, program director of KHJ, comes out flatly with, "Take classical music out of the 'Holy of Holiest' cubicle, humanize the older composers instead of deifying them. In other words the 'stiff shirt' should be taken out of the classics."

KEHE (Los Angeles) advises broadcasters to go after classes of sponsors who have the desire and ability to back such broadcasts.

"Radio is the greatest force in the world for making the public better-music conscious," says Alfred Wallenstein, general musical director of WOR—Mutual.

KJBS (San Francisco) stresses simplicity in preparation, regularity in presentation and endless variety with a minimum of requests answered.

As a 100 watter, working in competition with three larger and richer stations WOL has discovered that electrical transcription produces finer programs than can be produced through live talent available to them. KRMC (Jamestown, N. D.) suggests a special transcription service for small stations.

KDYL hops to the opposite side of the fence and contends that greater appreciation of better music will come when more local stations broadcast classical programs by local musicians.

KSFO believes that a larger cross-section of the public can be reached by feeding it less of the heavy, more of the lighter classics.

"Advertise the classics in advance," writes WINS.

"Good commercial copy will help," adds WFOY.

WOKO, WQAM, KMOX (St. Louis), WWJ (Detroit), KOMA, WJAS (Pittsburgh), WENR-WMAQ, KSAC (Manhattan, Kans.) agree that commentaries, short explanations of the musical composition being played and interesting highlights on the composer's life help listeners to better understand and appreciate the programs. David R. Young, program director of KGB also votes for short explanations and adds, "Classical music broadcasts can be improved by continual repetition of many fine selections now only rarely heard."

WCAE and WCCO (Minneapolis)

are all for slipping the classics into a variety program. J. F. Murray of WCAE points to Bing Crosby's method of presenting concert and opera stars along with his lighter entertainment. "Most people who do not like symphonic music," explains Hayle C. Cavanor, program manager of WCCO, "do not like it because they do not understand it. The public cannot be made to appreciate such music overnight. Education must come gradually."

KOMO-KJR disagree with the above statement—think variety or drama is disconcerting.

Suggestions from KRE and KXRO click, in that both stations believe classical broadcasts can be improved by putting the arrangement and announcing in the hands of men who understand the music and who feel sympathetic towards that which they are presenting. Frederick Macpherson of KRE says, "Symphonies should be presented in their entirety—proper sequences of movements must be followed—compositions of masters whose works conflict should not be presented together. Our station is careful not to break programs, even those sponsored, for the sake of commercials and the commercials should always be in keeping with the type of music being played."

Ben K. Weatherwax, program director of KXRO, points a warning finger to the practice of bringing student groups before the microphone because of the formative stage of the average listener's mind. "What they hear on the radio leaves a profound impression and is apt to be a contributing factor to their musical thinking, hence it is necessary that every performer who is presented in this type of program should be of the highest calibre obtainable that the music may not lose from inartistic presentation."

Practically all stations reporting on the survey agree that a certain percentage of serious music is necessary for building a well-balanced program. WQAM claims that such broadcasts aid in increasing the cultural development of a community. Quoting Mr. Harlow of the Yankee Network, "Good music is like good company; the more one associates with it the less one enjoys poor company. As far as dance music is concerned it will never die, nor should it. We prefer to ignore jazz and swing—they are merely phases of passing emotions and will carry a new name with each succeeding generation."

Mildred I. Seaman, assistant program director of KFKU (Lawrence, Kans.) thinks the growing popularity of chamber music an encouraging sign. Writes Miss Seaman, "This was almost an unheard form of music over the air three years ago. The musical layman is becoming better informed, and consequently more appreciative of classical music which, not so long ago, was considered 'highbrow'."

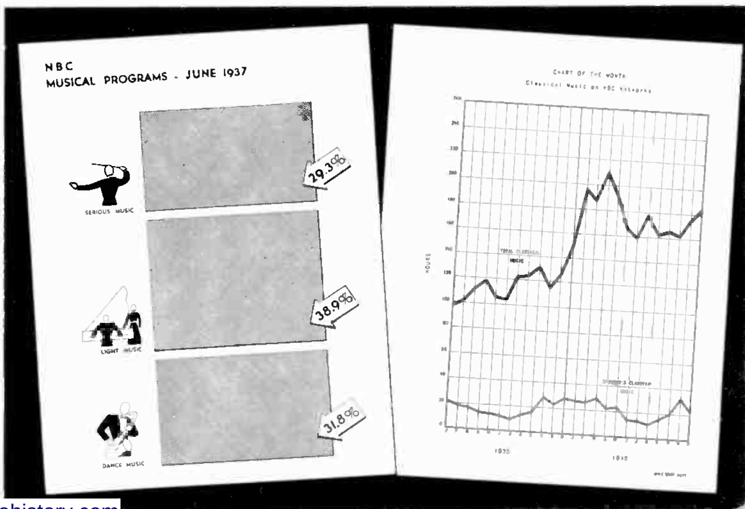
WOKO and KOIN have been battling away for some time to put more serious music on the air. Harold Smith, general manager of WOKO, writes, "From the beginning of radio the proponents of classical and semi-classical music as against a preponderance of jazz have waged a continual fight and we believe are winning out." Since 1924 it has been KOIN's objective to increase better music programs. "For many years results were discouraging," recalls C. W. Myers, president. "It seemed all the radio audience wanted was dance and jazz. Despite this we kept feeding our listeners more serious fare. Consistent endeavor, in cooperation with various music groups, has, to a large extent, reversed the preference of the audience."

After assimilating what the stations had to say concerning radio's part in America's musical advancement, *Pick-Ups* contacted the big networks and had a word with Alfred Wallenstein of WOR—Mutual, Ernest La Prade of N.B.C. and Deems Taylor of Columbia.

"Radio," contends Mr. Wallenstein, "is the greatest force in the world for making the public better-music conscious. Through this medium music never before touched upon in concert halls has gone out over the air. Even if you reach only two per cent of the listeners it is worth while." He believes that explaining music is unimportant. "Make explanations simple—give music for what it is worth," he tells you. If young people are to develop a taste for good music they must have the encouragement of parents and the foundation of a musical education at home. Then they will naturally turn to the finer music on the air. "In other words," concludes Mr. Wallenstein, "a radio broadcast of better music is like the ice cream cone after the meal."

Mr. La Prade claims that radio has instilled the desire to study music in an untold number of listeners. But what radio can do for the student is limited. It cannot teach him the technical part of music but it can give him an appreciation of its beauties and he can hear the best music ever produced and that is an essential foundation for a mu-

Chart at left shows percentages of three types of music broadcast by NBC for month of June, 1937. Other chart shows time devoted to classical music by NBC during 1935 and 1936.



sical education. According to Mr. La Prade, "Making music is the finest indoor sport in the world."

In discussing the small station's problems he suggests that musical programs be built by the best local talent possible: "Almost every community has some good musicians. If a station cannot afford to keep a good musical director on its staff it can usually afford to pay a competent musician to plan a series of worthwhile programs." His recipe for good program building is "unity and variety." "But," he cautions, "Only a genius should interpret music. Give listeners a little idea—don't go too deeply into explanations—even musicians do not always understand the more technical commentaries."

Asked if he thought the public's taste in music was improving, Mr. La Prade replied, "Why should N.B.C. go to the fabulous expense of engaging Toscanini if it did not *know* the public wanted the superlative symphonies his baton commands?"

Deems Taylor outlines Columbia's attitude toward better music broadcasts with, "We only ask for one thing—we insist that it be a good show. At Columbia we feel that nothing is really educational, unless it is also entertaining. Why shouldn't good music be interesting and absorbing? Too many people have gotten the impression that such music is a sort of pill, difficult to swallow, but awfully good for you.

"We want our artists to be enthusiastic and thrilled over their presentations. We are going to edit and revise and rewrite commentaries and announcements, until they have that lift and lilt that will cause listeners to be fascinated in advance by what is to come."

Mr. Taylor believes that radio not only has a duty to its public but to American composers as well. "It is," he tells you, "the only institution in America which is fitted at the present time to give the musician a break. With radio's resources and money, it can become the greatest patron of the living art of music ever known in the world. It reaches a very great audience and yet it eliminates the packed-in atmosphere of the concert hall. The composer can speak directly to intimate small groups, relaxed at home. The control booth also has enlarged the palette of musical effects. Solos that would be lost in the concert hall unless played on several instruments, can now be highlighted by a turn of the engineer's dial. Whole sections of the orchestra can be toned down to a distant whisper."

In 1923 while critic on the old *New York World* Mr. Taylor wrote an article in which he proved that radio broadcasting couldn't last more than three years. "And now," laughs Deems Taylor, "fourteen years later I am making predictions and enthusiastic plans about the darn thing."

Since the big networks and 92 per cent of stations included in this survey show a definite increase in better-music broadcasts — since N.B.C. thinks it worthwhile to spend thousands of dollars alone for Toscanini's services and Columbia considers it good business to engage six composers to write special classical music to feed their chain—since 81 per cent of stations reporting will further increase better-music schedules, are not sponsors overlooking a good bet in not backing more programs of this nature? For despite recent strides taken by the classical muse, stations are still bearing the brunt of carrying the majority of classical broadcasts.

Do the above facts indicate that there is a greater demand for serious music than either broadcasters or sponsors realize and that it is high time conscientious effort be made to more accurately determine the musical preferences of America? If, by house-to-house canvassing, telephone inquiries and correspondence, station directors could prove that a good percentage of listeners are really listening and applauding finer music, wouldn't more merchants and manufacturers tell the world about their automobiles, cigarettes, chewing gum, tooth paste, and refrigerators via the Better Music Channels of the air?

And finally, wouldn't broadcasters be able to render a greater service to the listening public?

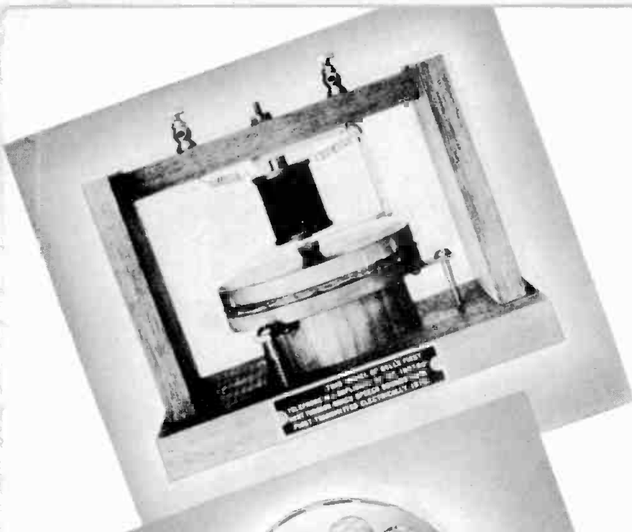
Stereophonic Sound Thrills

(*Continued from Page 12*)

to one thing—the quality of reproduction. He knew that the reproduction and reinforcement of music and voice at that time was far from a faithful reproduction of the original. He knew that his continued success in the business depended upon how nearly he could reproduce the original sounds. He decided then never to sacrifice quality for price or any other consideration. Realizing that his own equipment was not the best, he set out to find something better. He finally chose Western Electric equipment and has been using it exclusively ever since.

Langevin's fame became nation-wide when he handled all sound reproduction for the San Diego Exposition in 1935. This was the first time Wide Range reproduction had been used on a large scale and it became the talk of the fair. It was only natural that the success of this job should reach the officials of the Texas Exposition and that he should get that job last year.

Quality of reproduction is Langevin's battle-cry. By quality, he means these three things: the sound coming out of the loud speakers must be an exact copy of that going into the microphone; the volume must not be too great but sufficient for every listener to hear, without straining, every word or note of sound, clearly and distinctly, above all extraneous noise, and third, the illusion that the reproduced sound is coming from its original source must be perfect.



The Ears of the World

The history of broadcasting might well be written around the development of the microphone. It will always be the first instrument in the long chain of equipment which picks up a sound wave, transforms it into a corresponding electrical wave and eventually sends it cascading out of the mouth of a loud speaker, again as a sound wave.

Improvements in the quality of the signal have naturally followed improvements in the microphone. Thus it is that the microphone, from the inception of broadcasting, has become the symbol of the art. And because the progenitor of all microphones was invented by Alexander Graham Bell in 1875 it is perhaps fitting that a Western Electric microphone should have been adopted as the accepted symbol of broadcasting. The influence of Bell's early work can be traced from that first effort right down to Western Electric's latest—the Salt-Shaker.

The infant broadcasting industry cut its teeth on a Western Electric microphone. Everyone remembers it well—the old double button carbon bird-cage. Actually developed for public address work, it was ready and waiting for broadcasting when that art was born. It is still used today. Next came the condenser microphone affording tremendous improvement in the broadcast signal. When motion pictures acquired a voice, there, too, was the condenser microphone in universal use.

On its heels came the dynamic which went back to the fundamental principles developed by Bell. It made broadcasting more flexible; further improved the signal and, because of its dependability under all conditions, became the accepted standard for all-purpose use.

The original dynamic went through various stages of development wherein it was vastly improved, radically changed in appearance and last year was introduced to broadcasting as the "Eight Ball." Here for the first time was one microphone with two characteristics. Normally it was non-directional. No matter where sounds came from, the Eight Ball picked them up. But by taking off its hat, fastening on a directional baffle, it immediately did a Doctor Jekyll and Mr. Hyde, changing its characteristics and becoming directional. The Eight Ball won immediate acclaim and new honors for its maker.

Then recently the "Salt-Shaker" appeared, a new version of the dynamic, having approximately the same two sets of characteristics as the Eight Ball, but at a far lower price. The Salt-Shaker is repeating the success of its predecessor.

Western Electric microphones are truly the ears of the world.

1875 — The world's first microphone — model of Alexander Graham Bell's first telephone.

1921 — The double button carbon microphone — for years the symbol of broadcasting.

1928—The condenser microphone — the great increase in signal quality gave radio its first glimpse of "high fidelity."

1931 — The flexible, sturdy dynamic microphone became the standard all-purpose quality pick-up.

1936 — The "Eight Ball" — revolutionary two-characteristic microphone — the recognized instrument and symbol for "high fidelity" transmission.

1937 — The "Salt Shaker," Western Electric's latest microphone, has won instant acceptance in broadcasting and public address work.

Western Electric 23B Studio Speech Input Equipment in a studio at CBS station WABC, New York, N. Y.