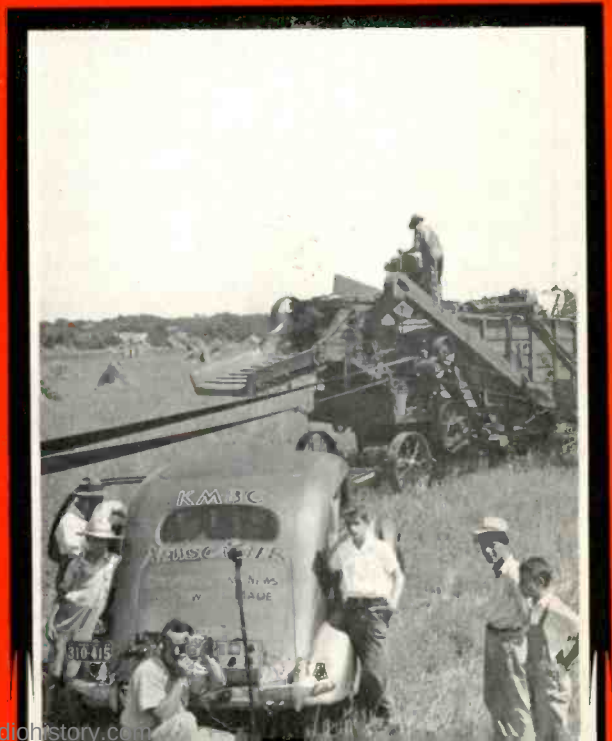
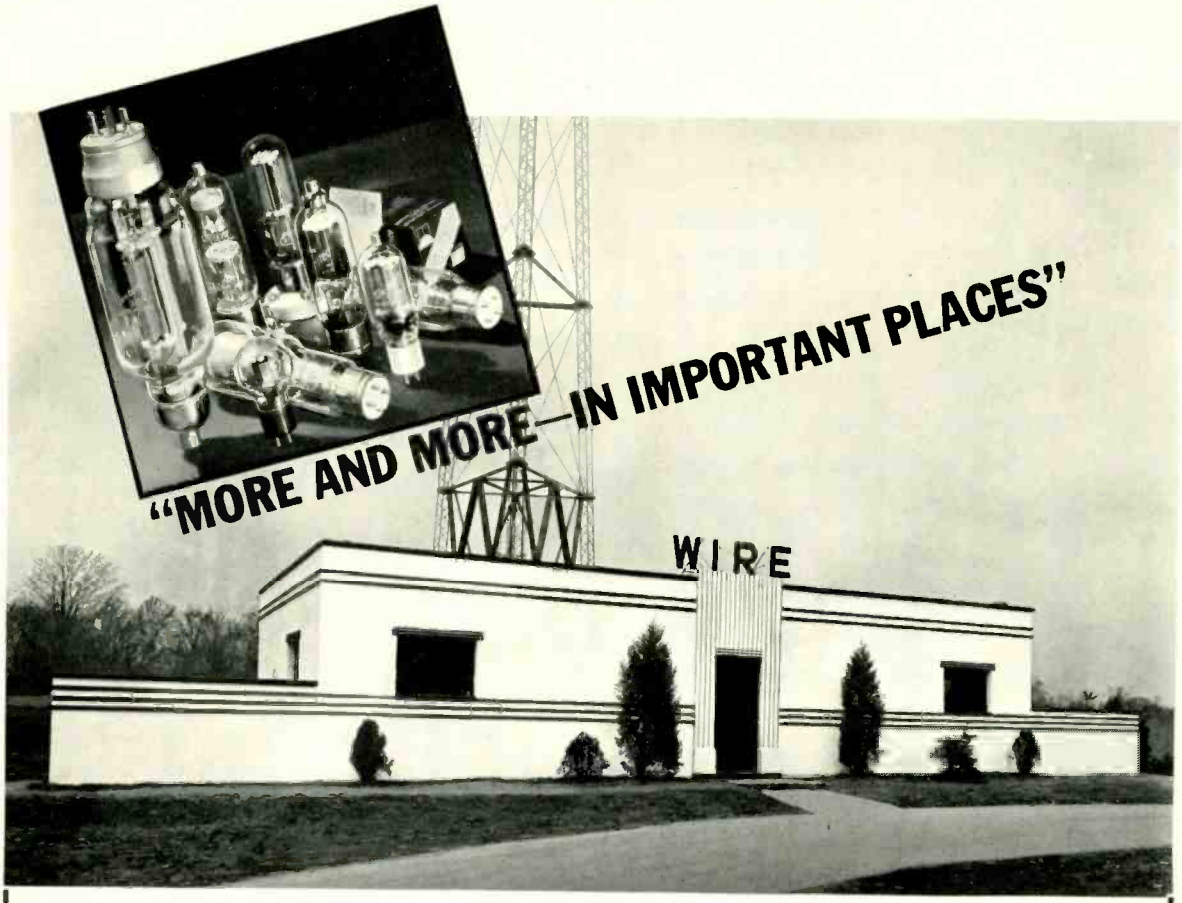
COMMUNICATION & BROADCAST ENGINEERING

AUGUST 1937





MODERN STATION

This modern mid-west station is fast making an enviable name for itself among national radio advertisers. A basic station of the Red Network, it is on the air with 5,000 watts.

Since 1935, WIRE has been using **United Transmitting Tubes**—another instance of the fast-growing recognition of these tubes by radio centers of importance. Every day adds new significance to the United slogan—"More And More —In Important Places."

Write to Dept. C for complete new technical manual.

UNITED ELECTRONICS COMPANY

Manufacturers of United Transmitting Tubes

42 SPRING STREET CABLE: UNELCO NEWARK, NEW JERSEY

COMMUNICATION & BROADCAST ENGINEERING

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RAY D. RETTENMEYER
Editor

F. WALEN
Associate Editor

VOLUME 4 | AUGUST, 1937 | NUMBER 8

Broadcast Transmission
●
Recording
●
Sound Projection
●
Television
●
Facsimile
●
Aeronautical Radio
●
Police Radio
●
Marine Radio
●
Carrier Transmission
●
Beam Transmission
●
Radio Telegraphy
●
Radio Telephony

CONTENTS

Cover Illustration: KMBC feeding the Columbia Network from a wheat field in Johnson County, Kansas. This remote setup, which was used in connection with a program on the bumper wheat crop in that part of the country, required lines approximately one-half mile in length.

Published Monthly by the
BRYAN DAVIS PUBLISHING CO., INC.
19 East 47th Street
New York City
New York Telephone: PLaza 3-0483

BRYAN S. DAVIS
President

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Chicago Office—608 S. Dearborn St.—C. O. Stimpson, Mgr.
Telephone: Wabash 1903.

Wellington, New Zealand—Te Aro Book Depot.
Melbourne, Australia—McGill's Agency.

Entered as second class matter October 17, 1934, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada, $3.00 in foreign countries. Single copies: twenty-five cents in United States and Canada, thirty-five cents in foreign countries.

EDITORIAL

GUGLIELMO MARCONI

THE DEATH of Guglielmo Marconi at his home in Rome, Italy, was received with the deepest regret. Marconi, the father of radio telegraphy, was the best known and one of the most liked men in the history of radio. Although his presence will be greatly missed, his work will not die.

LIBRARIES OF RECORDINGS

DURING THE LAST FEW YEARS sound recording has made rapid strides, not only in technical improvements, but also in acceptance by broadcast stations. A number of our radio stations are now making their own recordings for use on the air and some are starting libraries of sound recordings.

We think the latter idea has considerable merit, especially for the smaller stations, who might well build up libraries of various local events. Such records would prove of considerable interest in later years, and undoubtedly a few of them would be of a great deal of value. Recording trucks could also be built and used to cover certain type of events that could not be readily broadcast due to their location, nature, or because of interference with program schedules.

BROADCAST PROGRAMS

RADIO BROADCAST PROGRAMS have recently been the object of many adverse comments. One of the most recent criticisms was that voiced by Arthur Pryor, Jr., radio executive of Batten, Barton, Durstine and Osborn at the closing session of this year's convention of the National Association of Broadcasters. According to Mr. Pryor, "the most important task of station owners is to develop better program directors who have the ability to improve the type of programs being presented." We agree that radio station owners are giving much too little consideration to program quality in their effort to increase the volume of sales, and that something should be done about it.

FAN MAIL LISTS

JAMES W. BALDWIN, managing director of the National Association of Broadcasters, recently issued a warning to NAB members which we believe is well worth repeating here. Mr. Baldwin's statement follows:

"Members are urged not to sell or rent letters received from radio fans. The uses which might be made of the addresses in fan mail are too many and too unethical. The results can be injurious to radio broadcasting. Once released the broadcaster cannot control the use made of such lists but he must be prepared nevertheless to accept his share of the responsibility for the uses made of his mail. . . . We must not allow this type of business in radio broadcasting."

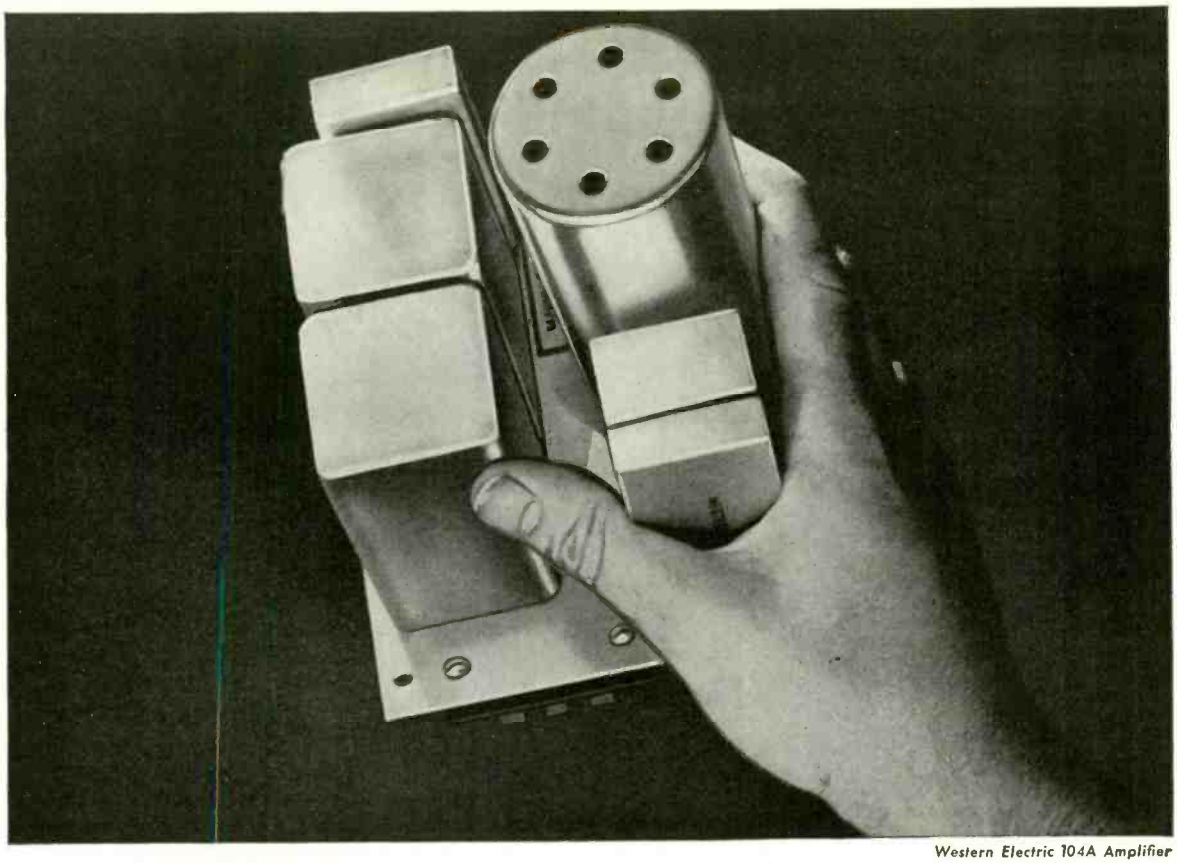
"SCIENTIFIC" FLIGHTS

THE DISAPPEARANCE of Amelia Earhart and Fred Noonan somewhere in the Pacific, although unfortunate, has at least called attention to the fact that flights of this type should only be carried out by organizations who are properly equipped for it. We further believe that flights made for personal glory under the guise of "scientific" expeditions should not be permitted.

NEW RADIO-TELEPHONE SERVICE

RADIO-TELEPHONE service between Juneau, Alaska, and Seattle, Washington, has recently been inaugurated. The installation was made by the Signal Corps of the United States Army in cooperation with the American Telephone and Telegraph Company. It is interesting to note that Alaska is the last of this country's major territories to be brought within voice range of the mainland.

Research brings prestige; prestige brings confidence; confidence brings business. . . . Sir Hugo Hirst.



Western Electric 104A Amplifier
measures 5¼" x 4⅞" x 6¾"

Here's your PRE-AMPLIFIER!

New 104A brings you

1. Premixing amplification
2. Gain of approximately 29 db
3. High Quality at Low Cost

Western Electric's new 104A Amplifier is a single stage, fixed gain unit primarily designed for use in studio amplifier channels as a premixing or low level amplifier to improve the signal to noise ratio. It may also be applied to existing studio channels using equipment such as the 701A Speech Input Bay when high level mixing is desired.

The outstanding features are: extremely compact and economical to operate—gain of approximately 29 db—frequency response flat within 1 db from 30 to 10,000 cycles—30 or 250 ohm input—30 or 500 ohm output. Three of these amplifiers may be mounted on Western Electric 998 type mounting plate which occupies only 5¼" space on standard relay rack or in equipment cabinet. For full details: Graybar Electric Company, Graybar Building, New York, N. Y.

Distributed by GraybaR

Western Electric

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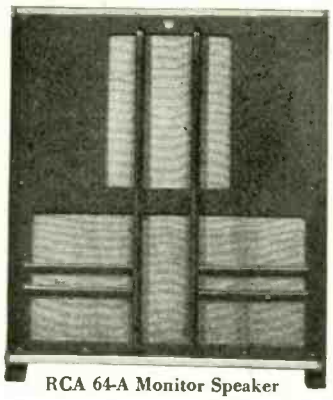
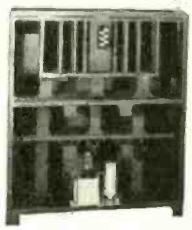
RADIO TELEPHONE BROADCASTING EQUIPMENT

New RCA Monitor Speaker offers you *Wide Frequency Response without Cabinet Resonance!*

64-A Speaker Ideal for Broadcasting Station Use



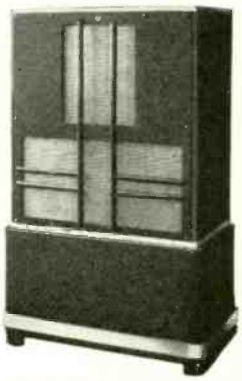
RCA 64-A Monitor Speaker



Rear view with back removed showing acoustic filter chambers. Type 79-A field supply is extra and is shown mounted in place.

Here's the ideal speaker for use in broadcast stations! It's the RCA 64-A monitoring loudspeaker. Mounted in a medium-sized, attractively finished cabinet it offers true high fidelity reproduction—the result of its special design. This apparatus is excellently suited for installation in executive offices, control booths, reception rooms, audition studios, or wherever you wish to provide the finest sound reproduction.

The 64-A is *more* than simply a loudspeaker in a box. The speaker itself is a special double-voice coil mechanism designed for equal reproduction of high and low frequencies. By constructing each portion of the cone driving mechanism for its respective part of frequency band, more uniform response is obtained over a greater frequency range than in the single-voice coil speaker. Built in the cabinet is a series of acoustic chambers of increasing size leading to an opening behind a grille at the bottom of the cabinet. The large effective baffle area assures good low frequency reproduction. The back of the speaker is completely sealed, which makes the frequency response independent of location in the room.



64-A Speaker mounted on base cabinet, which is extra and required only for amplifier housing.

NOTE THESE LOW PRICES

Type 64-A cabinet and speaker mechanism, complete	$65.00
Type 79-A field supply	$17.50
Base cabinet	$20.00

Write to address nearest you for full details

SPECIFICATIONS OF 64-A MONITORING LOUDSPEAKER

Input Impedance, 15 ohms... *Maximum Power Input*, 10 watts... *Field Coil*, 2 models of speakers available, M-I-4466, operating from 110 volt d.c. amp. supply, and the M-I-4467, from a 56 volt d.c. supply. The RCA 94-B or 94-C amplifiers will supply field for two 64-A speakers, 56 volts each... *Frequency Response*, 60 to 12,000 cycles... *Finish*, black with opalescent gray trim... *Size*, 33 5/16" high, 28 1/2" wide, 16 3/8" deep... Dimensions of *Separate Base Cabinet*, 16" high, 29 1/4" wide, 17 1/4" deep (to be ordered extra)... *Field Supply Unit*, type 79-A to operate from 110-120 volts a.c. (to be ordered extra).

RCA

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COMMUNICATION & BROADCAST ENGINEERING

FOR AUGUST, 1937

Day Propagation at Medium Frequencies

BY

RAYMOND M. BELL
Department of Physics
PENNSYLVANIA STATE COLLEGE

AND

PAUL S. LeVAN
Engineer
WHP

INTRODUCTION

SINCE SOMMERFELD'S first paper[1], investigators have been interested in the propagation of radio waves. The Sommerfeld theory has been modified by Rolf[2] and van der Pol[3]. A number of recent papers[4] have made contributions from both theoretical and experimental standpoints. It is well established that for the medium frequencies the ground (or direct) wave is predominant during the day up to a certain distance. The sky (or indirect) wave, a reflection from the Heaviside layer, is dominant for the greater distances, especially at night. It is much more variable than the ground wave.

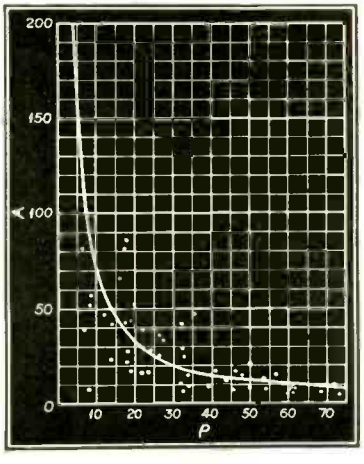
This paper is chiefly concerned with the day propagation of the medium frequencies—550 to 1500 kc/s. Measurements have been taken at noon at intervals of approximately two weeks for a period of six months. Readings of sixty stations have been obtained under similar receiving conditions. While the antenna efficiency of transmitters varies, and the ground conductivity of different sections also varies, it is felt that the average results obtained from so many stations over a period of six months throw new light on the propagation of these frequencies.

EXPERIMENTAL

Readings of field strength were taken about three miles west of Harrisburg, Pennsylvania, at a point where receiving conditions seemed favorable. Intensities were recorded between noon and 1 p.m. EST (1700-1800 GMT) on sixteen different days between January 1 and July 1, 1936—at approximately equal intervals. This six months period was chosen to give the average of both winter and summer conditions. All readings were taken about noon when the sky wave is a minimum for the medium frequencies.

The readings were made on a vacuum-tube voltmeter which read the input to the second detector of a ten-tube commercial receiver. Care was taken to eliminate any directive effects due to antennas. Receiving conditions were kept practically constant, factors such as fluctuations in line voltage, aging of tubes, and time of operation of receiver were taken into consideration. The meter was calibrated in millivolts per meter. By use of a standard oscillator uniform input for the entire frequency range was obtained. On one day readings were taken hourly throughout the day. Averages differed little from the noon readings. The readings are accurate to within 5 percent.

FIG. 1. OBSERVED ATTENUATION (A) PLOTTED AGAINST P. THE SOLID LINE REPRESENTS THE THEORETICAL EXPRESSION OF VAN DER POL.



Sixty stations within a range of 620 miles (1000 km) have been found with average field strengths between 1 and 0.01 mv/m (excluding locals). An average conductivity of 4×10^{-14} emu and an average dielectric constant of 13 esu are assumed for the section covered. These estimates are based on the results of previous investigators. The assumption of a uniform conductivity would not be justified were it not for the fact that the variation in efficiency of the transmitting antennas more than compensates for the variation in conductivity. The attenuation to the northwest is probably greater than the average, while that to the southeast is probably less. It is well known that a great difference in efficiency exists between stations of the same licensed power. In making the measurements two stations the same distance away in the same direction with nearly the same frequency

[1] A. Sommerfield. "Uber die Ausbreitung der Wellen in der drahtlosen Telegraphie," *Annalen der Physik*, 4th. series, Vol. 28, No. 4, pp. 665-736, March (1909).
[2] B. Rolf, "Graphs to Prof. Sommerfeld's Attenuation Formula for Radio Waves," *Proc. IRE*, Vol. 18, No. 3, pp. 391-402, March (1930).
[3] B. van der Pol, *C.C.I.R. Document No. 70*. March 31, 1931, prepared by the International Broadcasting Union.
[4] P. P. Eckersley, "Calculation of the Service Area of Broadcast Stations," *Proc. IRE*, Vol. 18, No. 7, pp. 1160-1193, July (1930).
T. L. Eckersley, "Direct-Ray Broadcast Transmission," *Proc. IRE*, Vol. 20, No. 10, pp. 1555-1579, October (1932).
A. D. Ring, "Empirical Standards for Broadcast Allocation," *Proc. IRE*, Vol. 20, No. 4, pp. 611-625, April (1932).
S. S. Kirby and K. A. Norton, "Field Strength Measurements at Frequencies from 285 to 5400 kilocycles per second," *Proc. IRE*, Vol. 20, No. 5, pp. 841-862, May (1932).
R. C. Higgy and E. D. Shipley, "Ground-Wave Radio Transmission," *Proc. IRE*, Vol. 24, No. 3, pp. 483-486, March (1936).

have been found to have the same field strength, although the licensed powers differ by a ratio of 20 to 1.

The data obtained are given in Table 1. An average of the field strengths should give the field obtained from January to July for the average transmitter in the northeastern United States over the average terrain. Sky-wave measurements are included for the more distant stations.

In the sixth column are listed the observed values of field strength averaged for the six-month period. In column seven are given the values of the average deviation of a single value from the average. The next column gives the values of ρ, as defined in equation (3). Columns nine and ten list the observed and calculated values of the attenuation, defined in equation (1). The calculated values are obtained by the use of equation (4) (in the calculated values in the table all distances are in miles). In the column of calculated values of attenuation, the various letters designate the following:

- a value uncertain due to interference from another station
- b location of transmitter changed during six-month period
- c value uncertain due to time sharing with another station
- d power changed during six-month period
- e reading not obtained due to local, but greater than 0.01 mv/m.

ANALYSIS OF DATA

The data have been analyzed from both quantitative and qualitative viewpoints. The generally accepted equation for field strength is:

$$E = (KAP^{\frac{1}{2}})/D \quad \ldots\ldots\ldots\ldots (1)$$

- E field strength in millivolts per meter
- P power output in kilowatts
- D distance in miles
- A attenuation
- K a constant equal to 187, if D is in miles (equal to 300, if distance is in km).

A is a function of the frequency and distance for a constant conductivity and represents the attenuation due to the conductivity of the earth. For short distances it is unity and for great distances it is inversely proportional to the distance. The dielectric constant is generally neglected for frequencies less than 3000 kc/s. Assuming that K is 187 means that the field of a one-kilowatt transmitter at one mile is 187 mv/m. This represents an antenna efficiency of 50 percent and applies generally to quarter-wave antennas.

Previous investigators have been interested in determining the value of A. It has been found generally that A is a function of ρ where:

$$\rho = (\pi d)/(2\sigma\lambda^2 C) \quad \ldots\ldots\ldots\ldots (2)$$

- d distance in cm
- σ ground conductivity in emu
- λ wavelength in cm
- C velocity of light in cm/sec.

For a σ of 4×10^{-14} emu:

$$\rho = 0.234\ Df^2 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

- D distance in miles
- f frequency in megacycles per second

(if the distance is in km the constant is 0.145).

In Fig. 1 the observed values of A are plotted against ρ. The function which seems to give the best average value is the van der Pol approximation in which:

$$A \doteq (2 + 0.3\rho)/(2 + \rho + 0.6\rho^2) \ldots (4)$$

This is the solid line in the figure. The agreement is fair considering that a constant ground conductivity and a constant antenna efficiency have been assumed.

From the qualitative side the data show several results. In the table is listed the average deviation (a.d.) in decibels of a single value from the average for each station. This simply indicates the variation in signal during the six months. Of the thirteen stations which have an average deviation of 3.5 db or more, all are over 280 miles away but one. This exception is a station with a directional antenna at right angles to the receiving point. Although it is less than 150 miles away, the sky wave seems to be almost as strong as the weak ground wave. This would account for the wide variation. It is also found that every one of the stations over 280 miles distant has an a.d. of 3.5 db or more. This clearly shows the presence of a sky wave which varies greatly from one day to another. It predominates in the winter months for distances greater than about 280 miles (450 km). It is found that the greater the distance the greater the a.d. Low values of a.d. are found for stations of high field strength and for stations of high frequency. The latter indicates absence of sky waves at noon in the higher frequencies measured.

A study of the data shows that about half of the stations remained practically constant in value from January to July, while the other half decreased in strength. This decrease was found to be proportional to the distance; i.e., the greater the distance the greater the decline in field strength from winter to summer. For the lower frequencies the drop is approximately 15 db for 600 miles, 10 db for 400 miles, and 5 db for 200 miles. The data show a decline in the region of 600 kc/s for all stations over approximately 80 miles distant; for 800 kc/s this was 150 miles, for 1000 kc/s 180 miles, and for 1200 kc/s 200 miles. No stations over 150 miles away have been measured in the region of 1400 kc/s, so that no decline is found in this region. Not only is the decrease proportional to the distance, but the limiting distance seems to increase with frequency. This may indicate the presence in the winter months of sky waves to a small degree for distances as low as 80 miles for the lower frequencies, or it may represent a decline in ground wave due to some unknown cause.

A check has been made of the stations over 280 miles away—those with strong sky waves—to find any relation to barometric pressures. No definite results have been obtained, except that during the first three months, when sky waves were strongest, stronger signals were recorded when the pressure was relatively high at the receiving end. This was especially true for signals from the southwest. It is difficult to say whether this has any meaning.

The results reveal certain stations which deviate considerably from the average. Much could be written on them. Efficiency, directivity, and type of antenna, as well as the attenuation due to the nature of the intervening terrain, are important factors. To take examples, one station with a value far above the average was found to have a path over water for a considerable portion of the way. This would mean low attenuation and stronger signals. Another station with a very low value of field strength was found to have a shadow in the direction of the receiver due to the location of the antenna.

A study of the data obtained from field-strength measurements at noon of sixty stations over a period of six months shows an approximate agreement with van der Pol's ground-wave approximation to the Sommerfeld theory. Qualitatively, the presence of a strong sky wave in winter is shown for stations over 280 miles away. A decrease in field strength is found to be related to the frequency and distance of the transmitter.

•

NEW WGY STUDIOS

EXCAVATION for the spacious, elaborately-equipped new studio building of Station WGY, Schenectady, N. Y., outlet of the NBC-Red Network, was begun recently, with the expectation that one of the oldest broadcasting stations in the country will be operating in one of the most up-to-date plants by late December. The building is a part of NBC's recently announced plans for expansion and improvement in key cities of the Blue and Red Networks.

-TABLE 1-

Freq.	Power Output	Distance 200mi	Distance 320km	Dir.	Field Strength	Ave. Dev.	ρ	Attenuation Obs.	Attenuation Calc.	
550kc/s	1kw			nnw	.022mv/m	3.0db	14.2	.023	.045	a
560	1	95	155	e	.075	1.5	6.9	.039	.110	
600	1	70	115	s	.220	2.0	5.9	.081	.130	
610	1	95	155	e	.015	2.5	8.3	.008	.082	
620	.25	135	215	w	.033	3.0	12.1	.047	.055	
630	.5	95	155	s	.081	2.0	8.8	.057	.080	
650	50	610	980	wsw	.011	6.0	60.0	.005	.009	
660	50	180	290	ene	.160	2.0	18.2	.022	.034	
670	50	580	930	wnw	.017	6.0	61.0	.008	.009	
680	5	320	510	ssw	.012	3.5	34.5	.009	.017	
690	10	290	470	nnw	.021	3.5	32.3	.010	.018	
700	500	390	630	w	.081	3.5	45.0	.008	.012	
710	50	150	240	ene	.760	1.0	17.7	.086	.035	
720	50	590	950	wnw	.022	6.5	72.0	.009	.007	
740	50	600	970	sw	.013	5.5	77.0	.006	.007	
750	50	350	560	wnw	.063	5.0	46.0	.017	.012	
760	50	130	210	ene	.830	1.0	17.6	.081	.036	
770	50	580	930	wnw	.017	5.5	80.0	.008	.007	
780	1	235	380	s	.038	1.5	33.5	.047	.017	
790	50	235	380	nne	.086	2.0	34.2	.015	.017	
800	.25	105	170	sw	.059	2.0	15.7	.066	.041	
810	1	160	260	ene	.031	1.0	24.5	.026	.024	b
820	50	480	770	wsw	.012	6.0	76.0	.005	.007	
830	1	53	85	e	.700	1.0	8.6	.200	.082	
840	5	270	430	nnw	.019	2.5	44.3	.012	.012	
850	1	155	250	n	.043	2.0	26.2	.036	.023	
860	50	145	235	ene	.350	1.0	25.0	.039	.023	
880	.5	100	160	nne	.036	2.5	18.1	.028	.034	c
890	.5	175	280	wsw	.019	2.0	32.5	.024	.018	
900	.5	66	105	s	.380	1.0	12.5	.190	.053	
920	.5	95	155	e	.059	3.0	18.9	.042	.033	
940	.5	155	250	ene	.036	2.0	32.1	.041	.018	
950	1	95	155	s	.100	2.5	20.0	.052	.031	
980	50	145	235	w	.056	3.5	32.6	.006	.018	
990	50	320	510	ne	.018	5.0	73.0	.005	.007	
1010	5	165	265	ene	.023	2.5	39.5	.009	.014	
1020	10	90	145	e	.260	1.0	22.0	.039	.027	
1040	50	240	390	ne	.025	2.5	61.0	.005	.009	
1060	10	66	105	s	.380	2.0	17.3	.041	.036	
1070	50	255	410	wnw	.029	2.5	68.5	.006	.008	
1080	50	410	660	ssw	.011	3.5	113.0	.004	.005	
1100	5	145	235	ese	.049	1.5	41.0	.017	.014	
1110	5	190	310	s	.014	2.5	54.5	.007	.010	
1120	.5	80	130	ese	.027	2.0	23.7	.017	.025	
1130	1	155	250	ene	.018	1.5	47.6	.014	.012	
1150	50	195	315	n	.038	2.5	60.0	.006	.009	
1160	5	195	315	w	.017	1.5	61.5	.008	.009	
1170	50	85	135	e	.520	1.5	27.3	.033	.021	
1180	1	155	250	ene	.025	2.0	50.0	.020	.011	
1200	.25	95	155	ene	.029	2.0	32.0	.029	.018	
1210	.1	42	68	n	.059	1.5	14.3	.041	.045	a
1220	5	155	250	w	.031	1.5	54.0	.011	.010	
1250	2.5	155	250	ene	.027	2.5	57.0	.014	.010	
1270	.5	70	115	s	.046	1.5	26.5	.024	.022	
1290	2.5	155	250	w	.019	1.5	60.5	.009	.009	d
1310	.1	55	89	e	.019	2.5	22.1	.017	.027	a
1320	1	22	35	se	.440	1.5	8.9	.052	.079	
1440	.5	76	120	ene	---	---	37.0	---	.016	e
1460	10	100	160	s	.049	1.5	50.0	.008	.011	
1500	.25	37	60	ese	.046	2.0	19.5	.018	.031	

NEW AIRCRAFT RADIO RECEIVERS

By STANLEY J. GUSTOF

RCA AVIATION RADIO ENGINEER

WITH THE increasing popularity of the small aeroplanes and the restrictions placed by the Bureau of Air Commerce, a need has arisen for a small, compact and easily installed aircraft radio receiver to meet the requirements of the pilots for the reception of weather reports as broadcast by the Airways Radio Stations of the Bureau of Air Commerce and for traffic control instructions as issued by various airports. The receivers described here are also adapted for use as an efficient auxiliary receiver supplementing the primary receiver already installed in larger planes. This feature permits the pilot to receive simultaneously the radio beam with the primary receiver and receive airport traffic control or weather with the auxiliary receiver.

In designing the models AVR 10 and AVR 10A aircraft radio receivers, reliability and weight considerations were among the important features given this class of equipment. As the useful load of a small plane is naturally not very great it will be realized the importance of making any equipment for these planes as light as possible. The weight of these receivers complete with headphones, power-supply unit and the necessary interconnecting cable is only 8½ lbs.

The model AVR 10 receiver has been designed for operation from a 12-volt battery and draws a total current of 0.7 amperes while the model AVR 10A operates from a 6-volt direct-current source and draws 1.4 amperes. The tuning range is from 200 to 400 kc (beacon-weather, traffic control band).

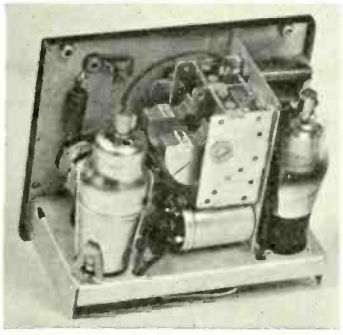


FIG. 2. THE TWO-TUBE RECEIVER UNIT.

FIG. 3. THE POWER-SUPPLY UNIT.

This equipment consists of a receiver unit and a power-supply unit as well as all necessary tubes, headphones and cables (Fig. 1). The receiver is a two-tube unit (Fig. 2) utilizing the recently developed 6F7 vacuum tube giving the equivalent performance of a four-tube radio receiver. One tube is used as a tuned-radio-frequency amplifier, also as a tuned detector, and the other tube is used as two stages of audio-frequency amplification having an output of 35 milliwatts at 600 ohms impedance.

The power-supply unit (Fig. 3) consists of a synchronous vibrator-rectifier, power transformer and its associated filter unit.

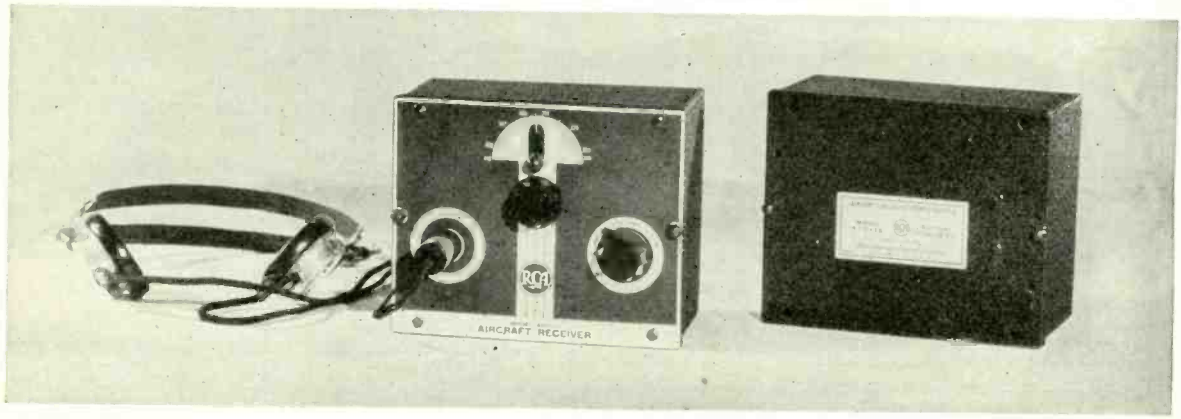
The receiver and power-supply units are housed in identical cabinets having the following dimensions: height 5½", width 6½", and depth of 3½".

Aircraft radio installations are subject to certain limiting factors, such as type of plane, instrument panel arrangement, etc. There are a few basic factors that are applicable to practically all installations.

In Fig. 4 a typical installation is shown. Due to the small size of the re-

(*Continued on page* 19)

FIG. 1. SHOWING THE RECEIVER, POWER-SUPPLY UNIT AND HEADPHONES.



MIXER CIRCUITS

PART II*

By ALBERT PREISMAN

Head of The Department of Audio-Frequency Engineering

RCA INSTITUTES, INC.

VI. INSERTION LOSS OF MIXER

Although a mixer enables several generators to feed one load and match the impedances of all, it exacts as a tribute for this service a certain amount of loss of signal, which is called the insertion loss of the mixer. Thus, in a series arrangement, the signal of any one generator is not only bypassed in part by the resistor R shunting its terminals but, in addition, that portion of the signal which gets to the load has to traverse all the other generators' impedances in series, and this tends to cut down the magnitude of the latter portion. In a parallel-mixer arrangement not only does the signal have to pass through the additional series resistors R, but after having done so is in part bypassed by the other generators connected in parallel with the load. It is evident therefore, that the fraction of the signal which gets to the load is less, the greater the number of stations. We now seek a quantitative expression for this insertion loss.

Consider first the series type of mixer. Let us denote the generator current by I_G. This would normally flow into a matched load of impedance Z_1. The total impedance into which it here flows is also Z_1 but part of the latter is R and the remainder is a shunting impedance consisting of the $(N-1)$ other generators in series with Z_2, the load. Let us denote the fraction of I_G [illegible]ows through R as I_R and the remaining fraction which flows through the load, etc., as I_L. We have then that

$$I_L = I_G - I_R \quad \ldots\ldots (7)$$

*Part I of this article appeared on page 9, June, 1937, COMMUNICATION AND BROADCAST ENGINEERING.—*Editor.*

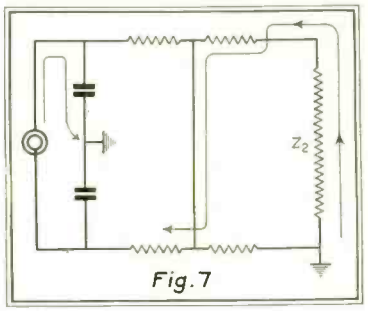


Fig. 7

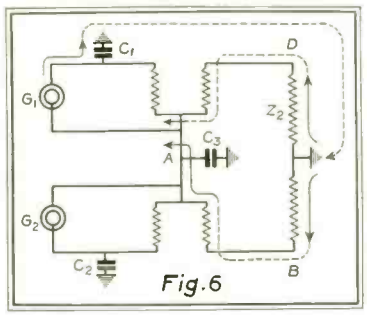


Fig. 6

$$I_R = I_G \frac{Z_1}{R} = I_G \left(\frac{N-1}{N} \right) \quad \ldots\ldots (8)$$

Hence, by equations (7) and (8)

$$I_L = I_G \left(\frac{1}{N} \right) \quad \ldots\ldots (9)$$

The power into the load Z_2 is

$$P_o = I_L^2 Z_2 = I_G^2 \left(\frac{Z_1}{2N-1} \right) \quad \ldots\ldots (10)$$

since

$$Z_2 = Z_1 \left(\frac{N^2}{2N-1} \right) \quad \ldots\ldots (3)$$

If the load impedance were Z_1, the power into it would be

$$P_o' = I_G^2 Z_1 \quad \ldots\ldots (11)$$

The insertion loss is therefore numerically equal to

$$\text{db (loss)} = 10 \log \frac{P_o'}{P_o}$$

$$= 10 \log (2N-1) \quad \ldots\ldots (12)$$

Equation (12) gives the loss of a series mixer, and it is noted that the loss of a mixer designed according to equations (3) or (4) depends solely upon the number of stations and is independent of their impedance or of that of the load.

We now formulate the loss of a parallel type of mixer. As before, we denote the generator current by I_G. Part of this current flows through the $(N-1)$ combinations of generator and compensating resistors in series, a total of $(R + Z_1) / (N-1)$. We denote this current by I_R. The remaining portion of I_G (call it I_L) flows through the parallel impedance Z_2. The above mentioned parallel impedances when added to the compensating resistance R of the generator under consideration gives a total impedance of Z_1. Hence the parallel group itself has an impedance of $Z_1 - R$. We may now write:

$$I_L = I_G \frac{Z_2}{Z_1 - R} = I_G \frac{N}{2N-1} \quad \ldots\ldots (13)$$

since

$$R = Z_1 \frac{N-1}{N}$$

$$Z_2 = Z_1 \frac{2N-1}{N^2} \quad \ldots\ldots (5)$$

The power into Z_2 is

$$P_o = I_L^2 Z_2 = I_G^2 Z_1 \frac{1}{2N-1} \quad \ldots\ldots (14)$$

The power that would be obtained if a load Z_1 were directly connected to the generator Z_1 would, as previously, be

$$P_o' = I_G^2 Z_1 \quad \ldots\ldots (15)$$

Hence, the insertion loss of the parallel mixer is

$$\text{db (loss)} = 10 \log \frac{P_o'}{P_o}$$

$$= 10 \log (2N-1) \quad \ldots\ldots (16)$$

It is to be noted that this equation is identical with equation (12) for the series mixer. In the case of a series-parallel or parallel-series mixer, let N_S denote the number of stations in series and N_P denote the number of stations in parallel, then by combining equations

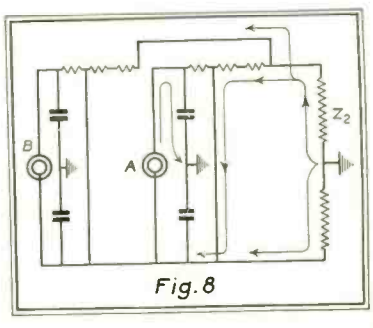


Fig. 8

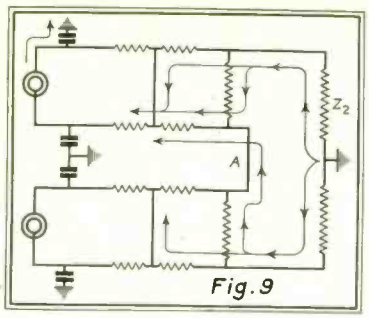


Fig. 9

(12) and (16) we have the total loss for either of the latter type of mixers, the expressions

$$\text{db (loss)} = 10 \log (2N_P - 1)(2N_S - 1) = 10 \log (2N_P - 1) + 10 \log (2N_S - 1) \quad \ldots\ldots\ldots\ldots (17)$$

Returning to our previous illustrative example of a four-position mixer, we note by equation (12) or (16) that the loss for an all-series or all-parallel mixer would be 8.5 db. For a series-parallel or parallel-series mixer the loss (by equation (17)) would be 9.5 db. While this would indicate the superiority of the former types of mixer, other considerations, such as cost of T-pads versus H-pads and freedom from cross talk, generally more than balance this slight difference of one db loss.

VII. ELIMINATION OF CROSS TALK

Often it is found that when the fader volume control is turned down to zero, signal can be obtained from the connected generator in the load. Since the volume control was turned down to prevent this, it obviously presents an undesirable condition and is known as cross talk. It is generally more pronounced for the higher frequencies than for the lower frequencies, and may be due to either of the following two conditions: (1) feed through capacitive coupling from the unwanted source into the load, and (2) feed by inductive coupling between the unwanted source and another generator or the load itself. The first type more easily occurs when the source impedance is high since in this case, for a given db level of the source, the voltage output is relatively high and the current flow relatively small. This type of coupling is probably the most important in mixer circuits and will be discussed here at some length. The second type of coupling is more pronounced if the source impedance is low and the current relatively large, while the voltage is relatively low for a given db level. This type of coupling is usually very small in effect, and hence seldom troublesome. The difference between the two types of coupling can best be realized by considering what takes place if the leads coming from the source are disconnected from the mixer. If the leads are not shorted upon themselves we can have current flow only through the capacities of these leads to ground. The resulting capacitive current flow is too small to cause any inductive coupling with neighboring source leads, but the current itself can enter the mixer and flow through the load and thus cause cross talk. On the other hand, if the leads, after being disconnected from the mixer, are shorted and grounded, any capacities to ground are shorted out but the resultant current flow from the generator in its shorted circuit may be relatively large and cause inductive pickup in neighboring circuits, such as leads coming to the other fader positions. The amount of this pickup depends upon the amount of run in which the source leads are in proximity to one another. Since the leads generally come from different microphones located at appreciable distances from one another, and run in common conduits usually for short distances, inductive coupling should generally not prove serious. Moreover, the use of twisted pairs, which corresponds to transpositions in telephone lines, tends to reduce this still farther.

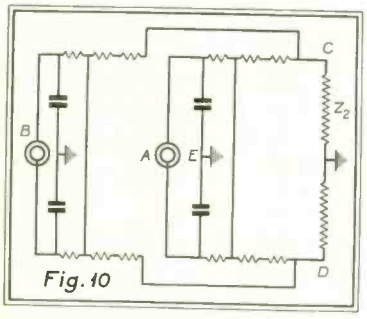


Fig. 10

Returning now to electrostatic coupling, consider a two-position series mixer. As shown in Fig. 6, the two generators are represented by G_1 and G_2, and assume first that their common connection (a) is not grounded. As shown in the figure, the fader T-pads have been set for infinite attenuation in either case. The capacities of the generator leads to ground (shield) are represented by C_1, C_2 and C_3. The load resistance Z_2 is grounded at its center tap. Consider generator G_1. Current flows in its circuit and through the resistor X_1 of its T-pad. A shunt current flows as shown by the arrow, through capacity C_1 to ground. From ground it may return to the generator through C_2, C_3 and the ground on Z_2. The first two returns contribute nothing to the cross talk, but the third return through the center of Z_2 may. However, as shown in the diagram, the current divides equally through the two halves of Z_2 to meet again at point A and thence back to G_1. The equal flow of these two currents in opposite directions cancel out each other's effects in Z_2, and hence produce no net cross talk. We note that if point A were directly grounded, the capacitance Z_3 would be shorted out and no cross-talk currents whatsoever would flow in Z_2. Hence, a two-position series mixer constructed as above, would be free from cross talk due to electrostatic coupling.

If the T-pad for generator G_1, for instance, were reversed so that the series resistors such as X_1 of the pad were on the opposite side of generator G_1's circuit, then the impedance to the two current flows through Z_2 would be unequal and, in particular, the current up through Z_2 would be greater than the current down through Z_2, or there would be a resulting cross talk. Sometimes a mixer is designed and the ground connected to point B or D. In this case point A cannot also be grounded since part of the T-pad of generator G_2 would be shorted out. Consequently there will be some cross talk current entering Z_2 through the grounded end and it will flow in its entirety through Z_2. The remedy is, of course, obvious in such a case, and it also indicates that for this two-position series mixer the output must be grounded at the center tap or else at A, i.e., balanced to ground.

It is to be noted that the cross talk will be more pronounced at the higher frequencies since the capacitive currents are greater. In the diagram the volume controls were purposely shown set at infinite attenuation in order to demonstrate the possibility of unwanted signal in the load. Such capacitive feed can, of course, also occur when the pads are not set at infinity, and while its effects may not be noticed then as cross talk, it can affect the frequency response by causing more highs to appear across the load Z_2.

In Fig. 7 is shown the possibility of cross-talk current from a generator connected through a balanced or H-pad to a load Z_2 grounded at one end (unbalanced to ground). The cross-talk current is shown by the arrows. This is an interesting possibility not only in the case of a parallel mixer employing fader H-pads and feeding an unbalanced input transformer, but also in the case of a single generator feeding an unbalanced input transformer through an H-pad. Obviously, either a T-pad should be used if the generator can be unbalanced to ground or else a balanced input transformer should be employed. While all this may appear obvious on paper, the author has found many cases of audio test setups and installations where this rule was not followed. The result was a pronounced rise in the fre-

quency response under normal operation, and the presence of cross talk when the volume control was turned down to zero.

Similarly, in Fig. 8 is shown a two-position parallel mixer connected to a load balanced to ground where unbalanced T-pads are employed for the fader positions. The cross-talk current from one generator (A) down through Z_2 from the center tap is greater than the cross-talk current through the upper half of Z_2. However, the more stations, such as B, that are connected across Z_2, the less will be the difference in cross-talk currents.

In Fig. 9 is shown a two-position series mixer whose load Z_2 is balanced to ground. H-pads are used in the fader positions. In this case, the cross-talk current through the upper half of Z_2 from the grounded center tap will exceed that flowing in the lower half of Z_2. If point A is grounded, instead, then some cross-talk current will flow down through G_8, its pad, and up through all of Z_2.

Fig. 10 shows a parallel mixer balanced to ground and employing H-pads for the fader controls. In this case points C and D of Z_2 are at the same potential as point E. Hence, no currents will flow through Z_2. This type of mixer is also free from cross talk. Since a two-position series mixer has an output which is balanced to ground, it may readily be connected in parallel with another two-position series mixer balanced to ground, giving rise to a series-parallel combination which is also free from cross talk. It is for this reason that the four-position series-parallel or parallel-series mixer was recommended earlier in this article. While a four-position parallel mixer balanced to ground will also be free from cross talk and have approximately one db less insertion loss, nevertheless, it requires H-pad fader volume controls and is therefore more expensive and probably noisier than the aforementioned type.

Fig. 11 shows a two-position parallel mixer unbalanced to ground and employing T-pads. Any capacitive currents from either generator to ground flow directly back to the generator without passing through the load Z_2. Hence this type of mixer is free from cross talk. Consequently, the output of such a two-position or (multi-position) mixer may be combined in series with a similar group to form a parallel-series mixer which will be free from cross talk.

Finally, in Fig. 12 is shown a nine-position series mixer. The central position is shown using an H-pad fader volume control. The remaining positions employ T-pads. The capacities of the various leads to ground are shown. The top station will exhibit cross talk when the volume control is set for infinite attenuation, since the impedance to cross-talk currents entering at A up through Z_2 and back to the top generator is less than the impedance down through Z_2 from A and through the eight other generators back to the top one again. If the pad for the top generator, however, is set for some other value than infinite attenuation, it may happen that the impedance up through Z_2 and through this pad is as great as down through the lower half of Z_2 and thence up through the remaining eight stations. For this particular attenuation, the top generator will show no cross talk. For very low attenuation of this pad, the impedance conditions may be reversed and more cross-talk current may flow through the lower half of Z_2 than through the upper half, although in addition, of course, there is the normal signal flowing from the top generator into Z_2. Hence, we may conclude that generators farther and farther away from the central one will show more and more cross talk, and at other values of attenuation, the frequency response of these generators may tend to vary. For this reason it is preferable to use but two stations in series and combine such pairs in parallel or else combine the stations in two parallel groups and then the two groups in series.

While this discussion of cross talk is admittedly qualitative in nature, it is sufficient for the practical elimination of most of such difficulties arising in practice. In addition, when the source and its leads are disconnected from a fader position it is desirable that the leads be shorted to one another and this connection grounded.

VIII. USES OF A MIXER

A mixer may be used to enable several generators simultaneously to feed one load, or one generator at a time may be "faded in" by means of its station volume control, then "faded out" and another source "faded in." Another use for a mixer is to superimpose the signal of one generator (such as that coming from the announcer's microphone in a broadcast program) upon the normal signals coming through the mixer from other generators such as the normal broadcast program. In this case the broadcast program may be cut down while the announcer fader volume control is simultaneously turned up. A mixer can also be used in recording of sound film, for instance, so that upon the second film there is recorded not only the output of the original film but in addition, orchestral music, which is to serve as a background in the final composite recording. Furthermore, one position of the mixer may be assigned to sound effects which are produced at the

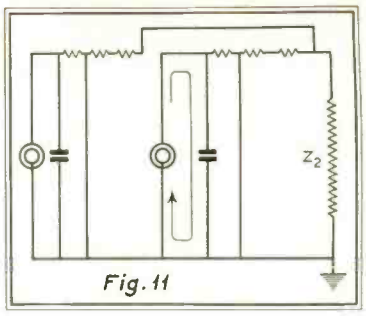


Fig. 11

proper time while the microphones connected to the other positions are picking up the normal dialogue.

Finally, a remote or "nemo" program which in itself is the output of a portable mixer located at the remote point of pickup, may be routed through one of the positions of a studio mixer while to another fader position is connected a microphone into which studio announcements may be made.

Normally, where several sources are operating simultaneously into a mixer, the fader volume controls are set at the beginning of the program (as determined by a previous rehearsal) so as to obtain the best balance in volume between the several sources. An example of this was cited previously in this article in the case of a theatre sound-reenforcing system. Thereafter the master gain control is used for monitoring the program so as to keep the volume range of the output within the limits prescribed by the load, such as the recording medium, or in broadcast work, the transmitter tubes. It may be required, however, to change the fader position volume control settings at certain times during the course of the pick-up depending upon the nature of the program.

IX. DEFECTS IN MIXER CIRCUITS

While there are many different forms of mixer circuits possible, it will be found that the majority of mixers in actual use are of the forms described in this article. As such, they are very satisfactory and reliable in operation. It has been claimed that in the case of a series mixer, should an open circuit de-

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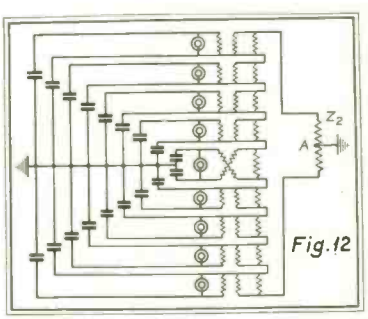


Fig. 12

SOME

By R. S. NASLUND

T AND Pi PAD

KDAL

TABLES

FROM TIME TO TIME these pages have promulgated information[1,2] and graphs[3] pertinent to the design of resistive attenuating networks, or vernacularly "pads."

While an understanding of such formulas and fundamental filter theory from standard texts is imperative to the designer, it is the writer's contention that tables giving resistance values in ohms for impedance ratios and attenuation ranges of pads most commonly used in broadcast practice is of interest. The following tables were compiled with a slide-rule and constants from a classic paper on the subject[4], and have an accuracy comparable with commercial resistors commonly used for this purpose. The accuracy, however, is not sufficient for laboratory equipment, and the reader is referred to McElroy's paper for five and six-place tables of constants to be employed in designing such attenuators.

Inspection of the tables will reveal that the resistors attain absurd values for high and low attenuation. Shifting from one family of pads to the other will often bring the resistors into reasonable and readily obtainable values, while for high attenuation the difficulty can be circumvented by placing two pads in series, the total attenuation desired being the sum of the losses in each individual pad. At least one source of information is available on the construction of special resistors[5].

"H" and "O" pads, derived from fundamental "T" and "π" networks respectively, have resistance ratios shown in Fig. 1.

The reader is referred to the bibliography for information on the minimum loss and losses due to impedance mismatch since this article is primarily concerned with the tables and their use.

Correction of inadvertent errors in the tables is solicited.

[1] "The Design of Pads," by L. W. Barnett, COMMUNICATION AND BROADCAST ENGINEERING, pp. 12-14, Vol. 2, No. 2, February, 1935.
[2] "Design of Resistance Pads," by C. F. Nordica, COMMUNICATION AND BROADCAST ENGINEERING, pp. 12-14, Vol. 3, No. 11, November, 1936.
[3] Chart showing "Attenuation of Resistance Pad vs. Ratio of Termination to Input Resistance." COMMUNICATION AND BROADCAST ENGINEERING, p. 26, Vol. 3, No. 10, October, 1936.
[4] "Designing Resistive Attenuating Networks." McElroy. *Proceedings of the Institute of Radio Engineers*, p. 213, Vol. 23, No. 3, March, 1935.
[5] "Measurements in Radio Engineering," by F. E. Terman, pp. 88-105, McGraw-Hill Book Company.

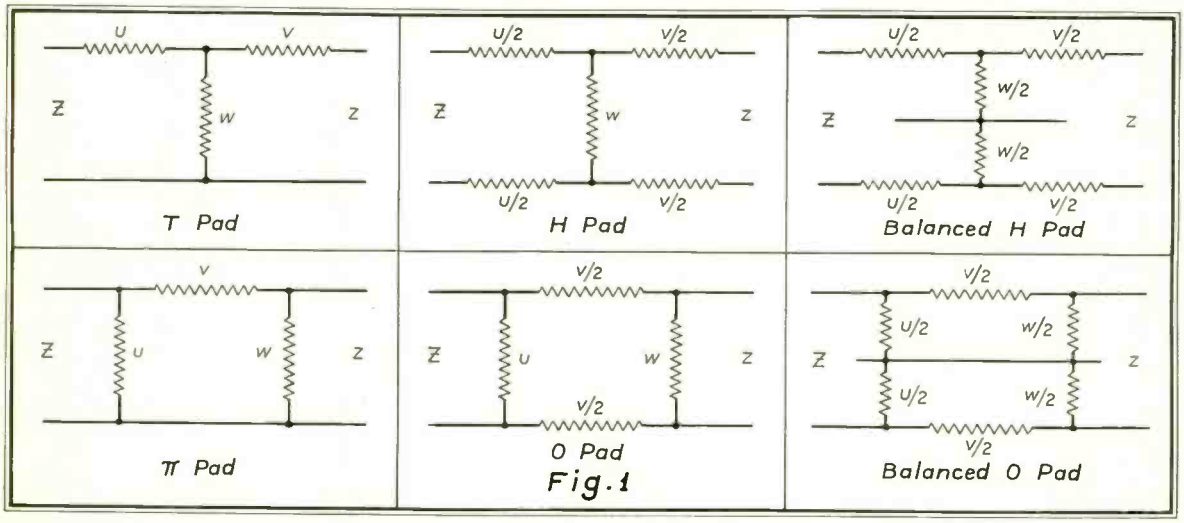
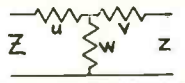


Fig. 1

Z = 500Ω z = 500Ω

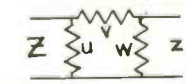
LOSS db.	u	w	v	u	v	w
1	28.9	4334.	28.9	8690.	57.5	8690.
2	57.3	2152.	57.3	4360.	116.	4360.
3	85.5	1419.	85.5	2920.	176.	2920.
4	113.	1048.	113.	2210.	238.	2210.
5	140.	822.	140.	1785.	304.	1785.
6	166.	669.	166.	1500.	372.	1500.
7	191.	558.	191.	1310.	448.	1310.
8	215.	473.	215.	1160.	528.	1160.
9	238.	406.	238.	1050.	613.	1050.
10	260.	351.	260.	962.	713.	962.
11	280.	306.	280.	890.	815.	890.
12	300.	268.	300.	835.	930.	835.
13	317.	236.	317.	785.	1060.	785.
14	333.	208.	333.	749.	1220.	749.
15	356.	184.	356.	715.	1360.	715.
16	363.	163.	363.	688.	1538.	688.
17	376.	144.	376.	664.	1733.	664.
18	388.	128.	388.	644.	1952.	644.
19	399.	114.	399.	626.	2200.	626.
20	408.	101.	408.	612.	2475.	612.
22	426.	80.	426.	586.	3125.	586.
24	443.	63.	443.	567.	3940.	567.
26	450.	50.	450.	552.	4980.	552.
28	462.	40.	462.	540.	6280.	540.
30	469.	32.	469.	530.	7900.	530.
32	475.	25.	475.	525.	9940.	525.
34	480.	20.	480.	520.	12,500.	520.
36	484.	16.	484.	515.	15,780.	515.
38	487.	13.	487.	512.5	19,850.	512.5
40	490.	10.	490.	510.0	25,000.	510.0
42	492.	8.	492.	508.0	31,400.	508.0
44	493.	6.3	493.	506.0	39,800.	506.0
46	495.	5.0	495.	505.0	49,800.	505.0
48	496.	3.9	496.	504.0	63,100.	504.0
50	497.	3.1	497.	503.0	79,200.	503.0
55	498.	1.7	498.	502.0	142,000.	502.0
60	498.	1.0	498.	501.0	250,000.	501.0
65	499.	0.56	499.			
70	499.	0.31	499.			

Z = 500Ω z = 250Ω



LOSS db.	u	w	v	u	v	w
8	353.	335.	9.0	750.	374.	373.
9	357.	288.	34.0	697.	436.	350.
10	364.	248.	58.	688.	505.	345.
11	369.	217.	76.	674.	578.	338.
12	377.	190.	94.	660.	660.	331.
13	386.	167.	109.	639.	750.	320.
14	394.	147.	124.	632.	852.	317.
15	403.	130.	136.	620.	964.	311.
16	411.	115.	148.	608.	1,090.	305.
17	418.	102.	158.	597.	1,228.	299.
18	426.	90.	168.	587.	1,384.	294.
19	433.	80.	176.	578.	1,559.	289.
20	438.	72.	183.	570.	1,752.	285.
22	449.	57.	196.	555.	2,217.	278.
24	458.	45.	206.	545.	2,790.	273.
26	467.	36.	215.	535.	3,520.	268.
28	474.	28.	222.	528.	4,430.	264.
30	479.6	22.4	227.6	522.	5,580.	261.
32	482.2	17.8	232.2	518.	7,040.	259.
34	486.9	14.1	235.9	514.	8,850.	257.
36	488.8	11.2	238.8	512.	11,170.	256.
38	491.1	8.9	241.1	509.	13,140.	254.
40	492.9	7.1	242.9	507.	17,700.	254.5
42	494.4	5.6	244.4	506.	22,280.	253.
44	495.5	4.5	245.5	505.	28,060.	252.5
46	496.5	3.5	246.5	504.	35,300.	252.
48	497.2	2.8	247.2	502.5	44,400.	251.5
50	497.8	2.2	247.8	502.	56,000.	251.
55	498.7	1.3	248.7	501.5	99,500.	251.
60	499.3	0.7	249.3	501.	177,000.	250.5

Z = 500Ω z = 200Ω

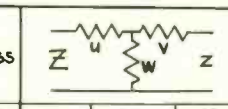


LOSS db.	u	w	v	u	v	w
8				783.	334.	267.
9	388.	266.	2.0	765.	389.	256.
10	390.	222.	22.0	742.	451.	255.
11	392.	194.	41.0	720.	516.	253.
12	397.	170.	57.0	698.	589.	250.
13	404.	149.	72.	678.	670.	247.
14	411.	131.	85.	662.	760.	244.
15	417.	116.	97.	645.	860.	240.
16	423.	103.	107.	629.	973.	236.
17	431.	91.	117.	615.	1,096.	233.
18	436.	81.	125.	602.	1,235.	230.
19	441.	72.	133.	591.	1,390.	226.
20	446.	64.	140.	581.	1,566.	224.
22	455.	51.	151.	565.	1,978.	219.
24	464.	40.	162.	550.	2,470.	215.
26	471.	32.	169.	541.	3,145.	213.
28	477.	25.	176.	531.	3,960.	210.
30	479.	20.	180.	524.	4,980.	208.
32	484.	16.	184.	520.	6,280.	206.5
34	487.4	12.6	187.4	517.	7,910.	205.
36	490.	10.	190.	512.	9,960.	204.
38	492.	8.	192.	510.	12,550.	203.
40	493.4	6.6	193.4	508.	16,730.	202.5
42	495.	5.	195.	506.	19,900.	202.
44	496.	4.	196.	505.	25,500.	201.5
46	496.8	3.2	196.8	504.	31,500.	201.5
48	497.5	2.5	197.5	502.5	39,650.	201.
50	498.	2.	198.	502.	50,000.	200.8
55	498.9	1.1	198.9	501.5	88,800.	200.6
60	499.4	0.6	199.4	501.	158,000.	200.5
65	499.7	0.3	199.7			
70	499.8	0.2	199.8			

Z = 500Ω z = 50Ω

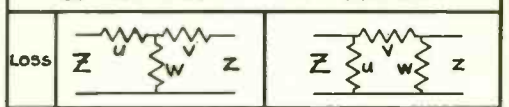
LOSS db.	u	w	v	u	v	w
16	474.	51.	0.5	930.	486.	52.7
17	474.5	45.5	6.5	850.	548.	52.6
18	475.8	40.2	11.4	789.	617.	52.5
19	476.	36.	15.2	750.	737.	52.4
20	478.	32.	19.	714.	782.	52.3
22	481.	25.	25.6	664.	990.	52.
24	484.	20.	30.4	620.	1,247.	51.7
26	487.	16.	34.3	591.	1,573.	51.4
28	489.5	12.5	37.7	570.	1,983.	51.1
30	491.	10.	40.1	554.	2,495.	50.9
32	492.	8.	42.	543.	3,140.	50.7
34	493.7	6.3	43.7	533.	3,950.	50.6
36	495.	5.	45.	526.	4,980.	50.4
38	496.	4.	46.	520.	6,270.	50.35
40	496.8	3.2	46.8	517.	7,890.	50.3
42	497.5	2.5	47.5	513.	9,920.	50.25
44	498.	2.	48.	510.	12,530.	50.2
46	498.4	1.6	48.4	508.	15,780.	50.2
48	498.7	1.3	48.7	506.	19,840.	50.15
50	499.	1.	49.	505.	25,000.	50.1
55	499.4	0.6	49.4	503.	44,400.	50.1
60	499.7	0.3	49.7	502.	78,000.	50.05

Z = 250Ω z = 250Ω



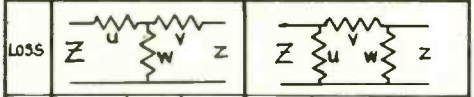
LOSS db.	u	w	v	u	v	w
1	14.4	2165.	14.4	4,350.	28.8	4,350.
2	28.6	1075.	28.6	2,180.	58.0	2,180.
3	42.8	709.	42.8	1,461.	88.	1,461.
4	56.6	520.	56.6	1,104.	119.	1,104.
5	70.	411.	70.	892.	152.	892.
6	83.	334.	83.	750.	187.	750.
7	96.	279.	96.	653.	224.	653.
8	108.	236.	108.	581.	264.	581.
9	119.	205.	119.	525.	308.	525.
10	130.	176.	130.	481.	357.	481.
11	140.	153.	140.	446.	408.	446.
12	150.	134.	150.	418.	466.	418.
13	159.	116.	159.	394.	530.	394.
14	167.	104.	167.	374.	602.	374.
15	175.	92.	175.	358.	680.	358.
16	182.	81.	182.	344.	770.	344.
17	188.	72.	188.	332.	866.	332.
18	194.	64.	194.	322.	976.	322.
19	200.	57.	200.	313.	1,100.	313.
20	204.	50.5	204.	306.	1,238.	306.
22	213.	40.	213.	293.	1,564.	293.
24	220.	31.5	220.	284.	1,971.	284.
26	226.	25.	226.	276.	2,488.	276.
28	231.	20.	231.	271.	3,135.	271.
30	234.	16.	234.	266.	3,945.	266.
32	238.	12.	238.	263.	4,970.	263.
34	240.	10.	240.	260.	6,250.	260.
36	242.	8.	242.	258.	7,880.	258.
38	244.	6.	244.	256.	9,920.	256.
40	245.	5.	245.	255.	12,500.	255.
42	246.	4.	246.	254.	15,650.	254.
44	247.	3.	247.	253.	19,800.	253.
46	248.	2.5	248.	252.	24,950.	252.
48	248.	2.	248.	252.	31,200.	252.
50	248.	1.5	248.	251.	39,500.	251.
55	249.	0.9	249.	251.	70,300.	251.
60	250.	0.5	250.	250.	125,000.	250.
65	250.	0.28	250.	250.	222,000.	250.
70	250.	0.15	250.	250.	395,000.	250.

Z = 250Ω z = 200Ω



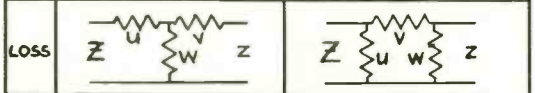
LOSS db.	u	w	v	u	v	w
6	120.	298.	36.			
7	125.	249.	46.			
8	133.	211.	64.			
9	141.	181.	77.			
10	149.	157.	87.			
11	156.	137.	97.			
12	164.	120.	107.			
13	171.	105.	116.	297.	473.	292.
14	177.	93.	123.	294.	573.	281.
15	184.	82.	131.	291.	607.	272.
16	191.	72.	138.	288.	685.	263.
17	196.	64.	144.	285.	774.	255.
18	201.	57.	149.	281.	871.	249.
19	205.	51.	154.	278.	981.	242.
20	210.	45.	159.	276.	1,104.	238.
22	217.	36.	166.	271.	1,396.	230.
24	224.	28.	174.	267.	1,760.	224.
26	228.6	22.4	178.6	263.	2,220.	220.
28	233.	18.	183.	261.	2,800.	215.
30	236.	14.	186.	259.	3,520.	212.
32	238.7	11.3	188.7	257.	4,430.	209.
34	241.1	8.9	191.1	256.	5,575.	207.
36	242.9	7.1	192.9	254.5	7,035.	206.
38	244.4	5.6	194.4	253.5	8,850.	204.5
40	245.5	4.5	195.5	253.	11,140.	203.5
42	246.5	3.5	196.5	252.	14,030.	203.
44	247.2	2.8	197.2	251.5	17,700.	202.
46	247.8	2.2	197.8	251.	22,250.	201.7
48	248.2	1.8	198.2	251.	28,000.	201.5
50	248.6	1.4	198.6	251.	35,250.	201.2
55	249.2	0.8	199.2	250.5	62,700.	201.
60	249.6	0.4	199.6	250.5	111,500.	200.4

Z = 250Ω z = 50Ω



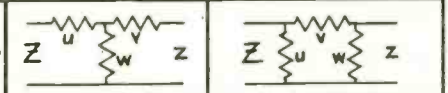
LOSS db.	u	w	v	u	v	w
13	223.	53.	2.0	433.	238.	55.7
14	224.5	46.5	7.5	404.	269.	55.5
15	225.	41.	12.	383.	305.	55.4
16	226.6	36.4	16.1	363.	344.	55.1
17	227.7	32.3	19.7	348.	391.	54.7
18	229.4	28.6	23.	336.	437.	54.4
19	230.6	25.4	25.9	324.	493.	54.2
20	232.4	22.6	28.4	315.	555.	53.8
22	235.	18.	33.6	300.	701.	53.1
24	238.	14.	37.4	288.	884.	52.6
26	240.7	11.3	39.	288.	1,130.	52.1
28	242.	9.	40.8	274.	1,405.	51.7
30	242.9	7.1	43.1	266.	1,768.	51.4
32	244.4	5.6	44.5	265.	2,226.	51.1
34	245.5	4.5	45.5	261.	2,820.	50.8
36	246.4	3.6	46.4	259.	3,530.	50.7
38	247.2	2.8	47.2	258.	4,440.	50.6
40	247.8	2.2	47.8	256.	5,590.	50.4
42	248.2	1.8	48.2	255.	7,050.	50.3
44	248.6	1.4	48.6	254.	8,870.	50.25
46	248.9	1.1	48.9	253.	11,170.	50.25
48	249.1	0.9	49.1	252.5	14,050.	50.2
50	249.3	0.7	49.3	252.	17,700.	50.15
55	249.6	0.4	49.6	251.	31,150.	50.1
60	249.8	0.2	49.8	250.5	56,000.	50.

Z = 200Ω z = 200Ω



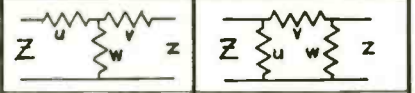
LOSS db.	u	w	v	u	v	w
1	11.5	1736.	11.5	3460.	23.	3480.
2	22.9	861.	22.9	1745.	46.5	1745.
3	34.2	567.	34.2	1170.	70.5	1170.
4	45.3	419.	45.3	883.	95.4	883.
5	56.	329.	56.	714.	122.	714.
6	66.5	268.	66.5	602.	149.	602.
7	76.5	223.	76.5	523.	179.	523.
8	86.	189.	86.	465.	211.	465.
9	95.	162.	95.	420.	246.	420.
10	104.	140.	104.	385.	286.	385.
11	112.	122.	112.	357.	327.	357.
12	120.	107.	120.	334.	373.	334.
13	127.	94.	127.	315.	424.	315.
14	133.	83.	133.	300.	481.	300.
15	140.	73.	140.	287.	545.	287.
16	145.	65.	145.	275.	615.	275.
17	150.	58.	150.	266.	694.	266.
18	155.	51.	155.	258.	782.	258.
19	160.	45.5	160.	251.	880.	251.
20	164.	40.5	164.	244.	990.	244.
22	171.	32.	171.	234.	1,251.	234.
24	176.	25.	176.	227.	1,579.	227.
26	181.	20.	181.	221.	1,990.	221.
28	185.	16.	185.	216.	2,508.	216.
30	188.	12.5	188.	213.	3,159.	213.
32	190.	10.	190.	210.	3,979.	210.
34	192.	8.	192.	208.	5,010.	208.
36	194.	6.3	194.	206.	6,308.	206.
38	195.	5.	195.	205.	7,942.	205.
40	196.	4.	196.	204.	9,999.	204.
42	197.	3.2	197.	203.	12,588.	203.
44	197.	2.5	197.	202.	15,849.	202.
46	198.	2.	198.	202.	19,953.	202.
48	198.	1.6	198.	201.	25,119.	201.
50	198.	1.3	198.	200.	31,623.	200.
55	199.	0.7	199.	200.	56,234.	200.
60	200.	0.4	200.	200.	100,000.	200.
65	200.	0.22	200.	200.	177,830.	200.
70	200.	0.13	200.	200.	316,230.	200.

Z = 50Ω z = 50Ω



LOSS db.	u	w	v	u	v	w
1	2.9	433.	2.9	869.	5.2	869.
2	5.7	215.	5.7	436.	12.	436.
3	8.6	142.	8.6	292.	18.	292.
4	11.3	104.	11.3	221.	24.	221.
5	14.	82.	14.	179.	30.	179.
6	17.	67.	17.	150.	37.	150.
7	19.	56.	19.	131.	45.	131.
8	22.	47.	22.	116.	53.	116.
9	24.	41.	24.	105.	61.	105.
10	26.	35.	26.	96.	71.	96.
11	28.	31.	28.	89.	82.	89.
12	30.	27.	30.	84.	93.	84.
13	32.	24.	32.	79.	106.	79.
14	33.	21.	33.	76.	122.	76.
15	36.	18.	36.	72.	136.	72.
16	36.	16.	36.	69.	154.	69.
17	38.	14.	38.	66.	173.	66.
18	39.	13.	39.	64.	195.	64.
19	40.	11.	40.	63.	220.	63.
20	41.	10.	41.	61.	248.	61.
22	43.	8.	43.	59.	313.	59.
24	44.	6.3	44.	57.	394.	57.
26	45.	5.	45.	55.	498.	55.
28	46.	4.	46.	54.	628.	54.
30	47.	3.2	47.	53.	790.	53.
32	48.	2.5	48.	53.	994.	53.
34	48.	2.	48.	52.	1,250.	52.
36	48.	1.6	48.	52.	1,578.	52.
38	49.	1.3	49.	51.	1,985.	51.
40	49.	1.	49.	51.	2,500.	51.
42	49.2	0.8	49.2	50.8	3,140.	50.8
44	49.3	0.63	49.3	50.6	3,980.	50.6
46	49.5	0.5	49.5	50.5	4,980.	50.5
48	49.6	0.39	49.6	50.4	6,310.	50.4
50	49.7	0.31	49.7	50.3	7,920.	50.3
55				50.2	14,200.	50.2
60				50.1	25,000.	50.1

Z = 200Ω z = 50Ω



LOSS db.	u	w	v	u	v	w
12	173.4	53.6	4.1			
13	174.	47.	8.3	316.	222.	59.3
14	174.5	41.5	13.5	300.	240.	57.1
15	176.3	36.7	16.6	286.	272.	56.7
16	177.5	32.5	20.	276.	308.	56.3
17	179.2	28.8	23.2	266.	347.	55.7
18	180.4	25.6	26.	258.	391.	55.3
19	182.3	22.7	28.6	250.	440.	54.8
20	183.8	20.2	30.8	244.	495.	54.4
22	186.	16.	33.4	234.	626.	53.6
24	189.3	12.7	37.7	228.	790.	53.2
26	191.	10.	39.7	222.	995.	52.4
28	193.	8.	42.2	216.	1,254.	51.9
30	193.7	6.3	43.8	213.	1,580.	51.6
32	195.	5.	45.	210.	1,990.	51.2
34	196.	4.	46.	208.	2,550.	50.9
36	196.8	3.2	46.8	207.	3,150.	50.8
38	197.5	2.5	47.5	205.	3,970.	50.7
40	198.	2.	48.	204.	4,990.	50.4
42	198.4	1.6	48.4	203.	6,290.	50.3
44	198.7	1.3	48.7	202.4	7,930.	50.2
46	199.	1.	49.	202.	9,960.	50.2
48	199.2	0.8	49.2	201.6	12,520.	50.2
50	199.4	0.6	49.4	201.4	15,820.	50.1
55	199.6	0.4	49.6	200.8	28,100.	50.1
60	199.8	0.2	49.8	200.2	50,000.	50.1

BOOK REVIEWS

COMMUNICATION ENGINEERING, by W. L. Everitt, published by the McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York City, second edition, 727 pages, price $5.00.

Communication Engineering has been written principally as a text book. It covers its subject matter in a critical manner, presenting the principles and fundamental laws together with a thorough discussion based on experimental evidence.

This edition contains a considerable amount of new material, while the chapters on "Medium- and High-Frequency Measurements" and "Complex Quantities" have been omitted; material of this nature is readily available in other texts. Special attention has been given to the effect of non-linear distortion in r-f and a-f amplifiers. Also, the order of certain chapters has been slightly rearranged, notably the chapters on modulation and detection which now precede those on amplifiers.

Communication Engineering is to be recommended as both a text and reference book.

SERVICING WITH SET ANALYZERS, by H. G. McEntee, published by Radcraft Publications, Inc., 99 Hudson St., New York City, 63 pages, price $0.50.

This book has been written principally for the service man, and covers the fundamental theory and application of modern set analyzers and associated apparatus. It contains chapters on the fundamental analyzer principles, trouble shooting with set analyzers, and associated testing equipment. The chapter on "Commercial Testing Equipment" gives data on nearly all the available testing equipments. A chart of the RMA socket numbering system is also included.

TELEVISION TECHNICAL TERMS AND DEFINITIONS, by E. J. G. Lewis. Published by Pitman Publishing Co., New York. 95 pages plus space for additional notes, price $1.75.

This book suffers from the same defects that handicap those from any foreign source which attempt to define technical terms. For the Englishman it is probably excellent, but we find too many inconsistencies and omissions to make it of any value to the engineer on this side of the Atlantic. Furthermore, many terms which properly are already part of an engineer's equipment, occupy space which otherwise might better have been devoted to more specific details of actual television terminology. Incidentally, the RMA will be interested to know how completely its recommendations have been ignored in the preparation of this work.

DIELECTRIC PHENOMENA IN HIGH VOLTAGE CABLES, by D. M. Robinson, published by Instruments Publishing Co., 1117 Wolfendale St., Pittsburgh, Pa., 173 pages, price $5.00.

This is Volume III of a series of monographs on electrical engineering prepared under the editorship of H. P. Young. This particular volume contains a foreword by P. V. Hunter, past president of the Institute of Electrical Engineers.

This book presents chapters on the technique of testing and examining cables and on cable failure by the tracking mechanism as well as by thermal instability. Sections are also devoted to d-c and a-c phenomena, mixed breakdowns and the problems of tracking, the formation and significance of voids, dielectric loss, barrier action, surface stress and cable design. Of considerable value are the short bibliographies which are included at the end of each chapter.

Dielectric Phenomena in High Voltage Cables is intended mainly for use by engineers dealing with electrical power problems, but it should prove of some interest to the radio engineers. It is to be recommended.

TELEVISION OPTICS, by L. M. Myers. Published by Pitman Publishing Co., New York. 338 pages, price $8.50.

The optics of television systems, both past and present, are presented in great detail in this book which should prove of interest to all who are or may be engaged in this coming art.

Commencing with a long chapter on the theory of image formation, the book proceeds to studies of photometry, the Kerr effect, and mechanical scanning systems. To this point it might be called historical.

The last chapter, which fills nearly one hundred pages, is devoted to electron scanning. Such details as time bases, electrostatic lenses, etc., are discussed in sufficient detail (sufficient for the present, at least) to give the reader considerably more information than may be obtained from the more popular descriptions which have appeared from time to time. Mathematical expressions are used generously, but this need not deter anyone from this book; acquaintance with algebra, trigonometry and elementary calculus is all that is required. Several nomograms for the determination of various Kerr cell phenomena are included.

ELECTRONIC TELEVISION, by G. H. Eckhardt, published by The Goodheart-Willcox Company, Inc., 2009 South Michigan Avenue, Chicago, Illinois, 162 pages, price $2.50.

With the emergence of electronic television from the laboratory into the field, the author felt that there was a need for a book that would be understandable to "readers other than highly trained engineers." Hence, *Electronic Television* is an easily readable book, devoted mainly to the fundamentals of television as practiced in this country by RCA and Farnsworth.

This book is divided into three parts. Part I is devoted to the pickup and transmission of electronic pictures, while the second part is concerned with the reception of television pictures. The last section contains material on the "by-products" of electronic television, such as, electronic multipliers, infra-red fog-penetration cameras, etc.

TELEVISION—A GUIDE FOR THE AMATEUR, by Sidney A. Moseley and Herbert McKay, published by the Oxford University Press, New York, Inc., 114 Fifth Avenue, New York City, 144 pages.

This book, according to its English authors, was written to make the principles of television intelligible to the general reader. As a result, it has been written in a general, non-mathematical manner and will be of little value to the engineer. It begins with a discussion of how a picture is scanned, and follows this by describing mechanical and electronic scanning. The electron-image camera is the next subject considered. Elements of reception, modulation, cathode-ray tubes, cathode-ray tube receivers, and the like, also receive space.

RESONANT-CIRCUIT AND REACTANCE CHART

THE CHART on the reverse side of this page has numerous uses in the solution of resonant circuits, the determination of reactances, and other computations. A very wide range of values is covered in a convenient form.

Consider first only the three columns for inductance, capacitance and frequency; neglect the reactance column. Now, knowing any two of these three quantities, the third may be found. This is accomplished by passing a straight line through the two known quantities and observing where this line cuts the vertical column for the unknown quantity. For example, the dashed line on the chart shows that an inductance of 300 microhenries (use only the figures in the individual rectangles for this example) and a capacitance of 150 micromicrofarads will be in resonance at a frequency of 750 kilocycles.

In this chart, three sets of numbers are given for each column. One of these sets is in individual rectangles, another is in circles, while the third is without a designation. In using, choose one of these sets according to the order of magnitude of interest in the particular computation, and neglect the other sets of numbers; i.e., do not use together numbers from different sets.

The reactance column gives the reactance at the particular frequency of both the inductance and the capacitance. The fact that it gives both reactances results from the equality of inductive and capacitive reactance at resonance . . . a well-known principle. The reactance column may be used to obtain the reactance of any inductance at any frequency, it may also be used to obtain the reactance of any capacitance at any frequency.

A general statement of the scope of the chart may now be made. Four quantities are involved, and given any two of these the other two can be found immediately. This permits the quick solution of problems of numerous types; for example, an inductance of 3 microhenries is of interest, and a reactance value of 140 ohms, the question being the frequency at which the inductance will have this reactance. The dashed line on the chart, using the plain figures, shows the answer to be 7500 kilocycles.

Note. The capacitance values increase downward on the chart, but the other scales upward. To avoid errors in reading points, therefore, it is well to note always the numbered graduations above and below the point.

Celluloid Reading Lines. A convenient reading line may be made by ruling a line on the under side of a transparent strip of celluloid and filling the line with black ink.

Additional Ranges. Using colored pencils or ink, additional ranges may be added (see Table I).

Parallel-Resonant Resistance. The value of the parallel-resonant resistance of an efficient tuned circuit is QX, where Q is the well-known ratio of reactance to total series resistance, and X is the reactance of either element given by the reactance column of this chart. For example, for the figures in circles the dashed line in the chart shows a reactance of 140 ohms, from which, if the Q were known to be 100, the parallel-resonant resistance would be 14,000 ohms.

Formulas. In case greater accuracy is desired, the formulas in Table II may be used. These are arranged ready for the substitution of values in convenient units. The fundamental forms are also given.

•

SHIELDED-LOOP ANTENNA

A NEW and simple type of shielded loop which can be rotated for direction finding service is being introduced in the aviation field by the Western Electric Company. Because of its shielded construction, it is instrumental in reducing the disturbances in radio reception caused by rain, snow and sleet static.

The new loop equipment is compact, light and sturdy in construction, can be installed with ease in any desired location aboard the ship, and, while designed primarily for use with the Western Electric 14 and 20 type receivers, it is also applicable to other types.

The aural null direction finder enables the taking of radio bearings by rotating the loop. Rotation is accomplished by a compact control unit equipped with a 264-to-1 gear ratio and connected to the loop through a flexible shaft. The position of the loop is indicated at the control unit by a needle on a scale, permitting extremely accurate loop adjustment.

TABLE I

General Frequency Range	Inductance Range	Reactance Range	Capacitance Range	Frequency Range
Low Audio	7 h to 3 mh	100,000 to 1 ohm	0.001 μfd to 5000 μfd	2000 cycles to 40 cycles
High Audio	100 mh to 300 μh	100,000 to 1 ohm	100 μμfd to 500 μfd	20,000 cycles to 400 cycles
Wire Carrier	30 mh to 30 μh	100,000 to 1 ohm	10 μμfd to 50 μfd	200 kc to 4 kc
Low Hyper-Frequencies	0.7 μh to 0.0003 μh	10,000 to 0.4 ohm	0.01 μμfd to 50,000 μμfd	2000 Mc to 40 Mc

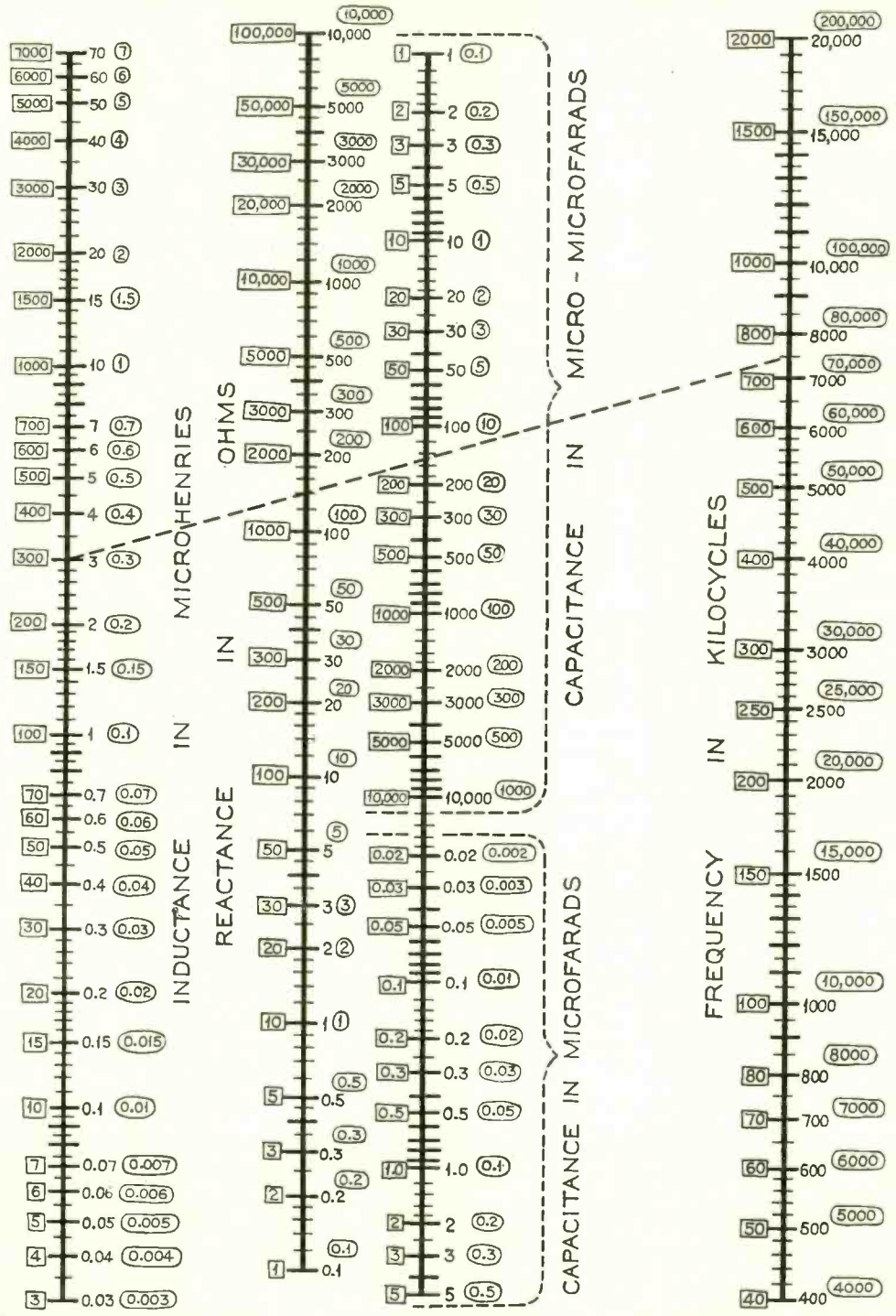
μ = micro (10^{-6}) m = milli (10^{-3}) M = mega (10^{6})

TABLE II

Range	Units	Natural Frequency	LC Product	Inductive Reactance	Capacitive Reactance
Medium Radio Frequencies	μh, μμfd, kc and ohms	$f_0 = \frac{159,155}{\sqrt{LC}}$	$LC = \frac{25,330}{f_0^2}$	$X_L = 0.006283fL$	$X_C = \frac{1.5915 \times 10^8}{fC}$
High Radio Frequencies	μh, μμfd, Mc and ohms	$f_0 = \frac{159.15}{\sqrt{LC}}$	$LC = \frac{25,330}{f_0^2}$	$X_L = 6.283fL$	$X_C = \frac{159,150}{fC}$
Low Frequencies	h, μfd, cycles and ohms	$f_0 = \frac{159.15}{\sqrt{LC}}$	$LC = \frac{25,330}{f_0^2}$	$X_L = 6.283fL$	$X_C = \frac{159,150}{fC}$
Fundamental Forms	h, fd, cycles and ohms	$f_0 = \frac{\left(\frac{1}{2\pi}\right)}{\sqrt{LC}}$	$LC = \frac{\left(\frac{1}{2\pi}\right)^2}{f_0^2}$	$X_L = 2\pi fL$	$X_C = \frac{\left(\frac{1}{2\pi}\right)}{fC}$

RESONANT-CIRCUIT AND REACTANCE NOMOGRAM

SOLVES NUMEROUS PROBLEMS INVOLVING WIDE RANGES OF VALUES. SEE DIRECTIONS BELOW.



DIRECTIONS. DETERMINES NATURAL FREQUENCY, RESONANT INDUCTANCE, RESONANT CAPACITANCE, AND REACTANCE OF THE INDUCTANCE AND THE CAPACITANCE.

A STRAIGHT LINE THROUGH ANY TWO KNOWN QUANTITIES GIVES THE REMAINING TWO UNKNOWN QUANTITIES. USE ONE OF THE SETS OF SCALES (FIGURES IN RECTANGLES, PLAIN, OR IN CIRCLES) DEPENDING ON ORDER OF MAGNITUDE, AND NEGLECT OTHER SCALES.

SEE REVERSE SIDE FOR FURTHER INFORMATION.

AIRCRAFT RADIO RECEIVER

(*Continued from page* 8)

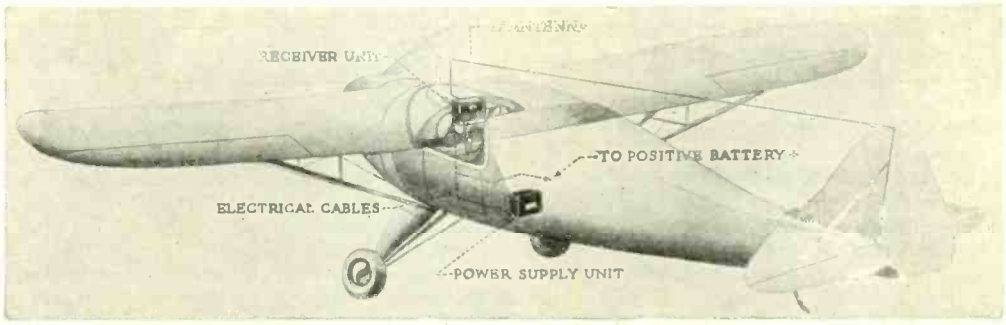


FIG. 4. A TYPICAL INSTALLATION OF THE AVR 10 RECEIVER.

ceiver unit it may be mounted on the instrument panel.

Thorough shielding of the engine ignition system is necessary to obtain the maximum performance from any aircraft receiver. This shield consists of a network of shielded ignition wires, shielded spark plugs, shielded magnetos or distributors, shielded ignition switch and shielded primary wiring, specially designed to eliminate the radio interference caused by the ignition system of the engine. Radio-ignition shielding kits are manufactured by many accessory suppliers and are available for practically all types of aircraft engines.

Although it is not necessary in the majority of cases, careful shielding of all low-tension wiring is advisable in order to insure the greatest range and satisfaction from the equipment. This can best be done by utilizing shielded electric cable in all electrical wiring of the plane, with the shield on the cable frequently grounded to the plane's structure.

The cables on the models AVR 10 and AVR 10A aircraft radio receivers are furnished complete with shielding. Leads are brought out from the shield on these cables for easy grounding to the plane's structure.

The preferred method of installing the receiver unit in place is to remove the front panel from the receiver and use it as a template to drill the instrument board, after which the receiver unit may be mounted in the rear of the instrument board with the receiver front panel and control knobs mounted on the front.

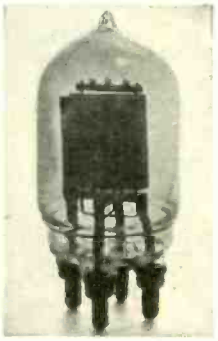
In Fig. 4 the antenna arrangement is shown. It has been found that this type of antenna gives very good signal strength with this type of receiver when used for airway weather and traffic control and is quite effective even when the plane is on the ground.

HIGH-FREQUENCY TUBE

ESPECIALLY DESIGNED for use in ultra-high-frequency or short-wave service, a new oscillator and amplifier tube has been announced by the Westinghouse Electric and Manufacturing Company. Some of the main fields of application in which this tube will be used, due to its unique characteristics, are for therapy, radio, and other high-frequency purposes.

In therapy work, in particular, it will permit higher power output to be obtained at the shorter wavelengths. It can be used equally well in ultra-high-frequency radio transmitters, wherever a three-element radio-frequency amplifying tube of its characteristics is required.

The usual types of tube construction have been modified in this tube by supporting the grid, filament and plate electrodes directly from short heavy rods.



THE WL-461.

These support rods in turn terminate in short sturdy thimbles which may be used to connect directly with the external circuits.

Other decided advantages are the low interelectrode capacity of the tube which results from the new mounting and the high conductivity of the large and short support rods. Tantalum is utilized for the anode material in this tube. This tube has a plate dissipation of 160 watts and is capable of delivering 400 watts of useful power up to 50 megacycles.

The simplification of the internal supporting structure has also made it possible to reduce the size of the tube to the point where only a minimum amount of space need be reserved for it. Designated as the WL-461, this tube has the following ratings: maximum d-c plate voltage, 2000 volts; maximum a-c plate voltage, 2500 volts; and maximum plate current, 250 ma. The filament voltage is 5 volts and the filament current is 11½ amperes.

TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

AIRWAY MODERNIZATION PROGRAM

A PROGRAM of airway modernization which eventually will involve the expenditure of more than $7,000,000 has been undertaken by the Bureau of Air Commerce.

Projects to be initiated immediately are designed primarily to augment the existing system by modernization and improvement and by provision of new facilities to fill in gaps where aids to navigation are needed.

1. Modernization of existing full-power stations—

(*a*) Combining existing broadcast and range stations and improving with Adcock antennas.

(*b*) At existing vertical radiator radio range stations adding fifth tower and other equipment to provide for simultaneous voice transmission.

(*c*) Provide and install special radio equipment for conversion of existing stations to simultaneous transmission.

2. Purchase and installation of engine generators for emergency power supply at existing radio stations.

3. Installation of remote receiving antennas at existing stations.

4. Installation of ultra-high-frequency radio location markers for cone of silence and traffic control.

5. Conversion of existing nondirectional radio markers to directional or ultra-high-frequency type.

6. Installation of additional radio stations on existing airways to fill in gaps in the present system.

7. Installation of equipment to permit remote control shift between day and night frequency.

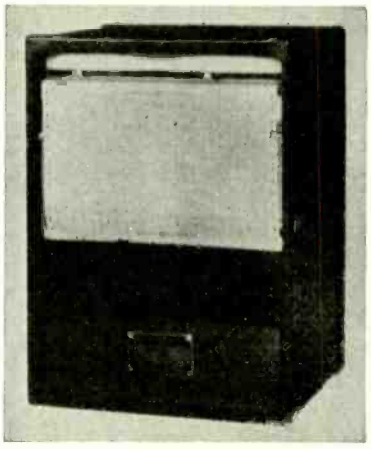
8. Miscellaneous airways lighting relocation plus a small amount of additional airways lighting.

DOUBLE PHOTOELECTRIC RECORDER

A PHOTOELECTRIC INSTRUMENT which will record simultaneously on one chart, two electrical quantities as low as one microampere, full scale, and representing a power consumption of but 0.000000001 watt from the measured circuit, has been announced by the General Electric Company.

The double photoelectric recorder can be applied wherever simultaneous readings are desired. This recorder is the outgrowth of the original photoelectric recorder which has become familiar to electrical and mechanical engineers, physicists, and others, including physicians, and scientific crime-detection specialists.

With the original photoelectric recorder, many applications to the measurements and recording of electrical and mechanical quantities have been made. The only requirement is that the measuring element needed in the recorder must be capable of rotating a small galvanometer mirror. By means of an optic and photoelectric system, and power circuit, the measuring element causes the recording element to follow its movement.



THE DOUBLE PHOTOELECTRIC RECORDER.

TRANSMITTER FOR AIR LINE BROADCAST

A NEW TYPE of short-wave transmitter, built specially for broadcast-band use, has been completed by engineers of United Air Lines and successfully used on a series of programs over the Red Network of the National Broadcasting Company. For the first time in radio history, this "publicity" transmitter was used during the month of May on an educational series to familiarize listeners with the wonders of the western national parks.

From an altitude of 10,000 to 12,000 feet an NBC crew described the countless features of Rocky Mountain National Park, Zion and Bryce Canyon National Park, Yosemite National Park, Ranier National Park and Yellowstone National Park. A special twelve-ton Douglas Mainliner transport of United Air Lines was withdrawn from its regular coast-to-coast schedules on Sunday to present this series. The transmitter has a range of 1,000 miles and the pickup point for all five broadcasts was at a point near San Francisco. It was relayed to San Francisco and sent over a coast-to-coast hook-up from there.

The overall dimension of the transmitter unit is 19″x19″x50″ and weighs 170 pounds. The unit consists of a receiver, microphone amplifier, switching panel, transmitter tuning meters, antenna reel panel and power plug panel. All units are mounted on standard relay-rack panels and are enclosed in shield cans in addition to the shielding provided by the side panels of the frame.

The receiver is a specially designed superheterodyne, covering a frequency range from 500 kc to 32 mc. This is used to monitor the broadcasts by listening to one of the stations carrying the program or as a cue receiver by tuning one of the various high-frequency stations used for this purpose.

Antenna and power lead filters are included to permit reception while the transmitter is operating. The speech amplifier has a gain of 90 db and is generally used with inductor mikes. Three input positions are provided with necessary faders—level indicator and master gain control. The frequency response is essentially flat from 30 to 10,000 cycles which is a wider range than can generally be used in airplanes.

A low-pass filter is included and this can be cut in and out at will by a switch on the panel. With the filter in the circuit frequencies below 150 cycles are attenuated. Thus, the tendency of these frequencies to garble the transmissions is eliminated. Enough engine noise is passed by this filter to provide realism to the program, yet not enough to interfere with intelligibility.

Both the receiver and the speech amplifier chassis are shock mounted from the main front panel to eliminate any

possibility of microphonic disturbances. In addition to this, the entire upper section floats on shocks which separate it from the lower section.

The transmitter is a Bendix S-150 modified for the special frequencies and audio requirements of broadcast work. It can be pretuned to a maximum of eight frequencies, six of which are used in this installation—12862.5, 8655, 6425, 4797.5, 3492.5 and 2790. Changing frequency is merely a matter of setting the frequency-change switch at the desired point and reeling the trailing wire out to a quarter wave of the desired frequency.

The r-f circuits are as follows: "A" cut crystal, 807 oscillator, 807 doubler, 803 output. Modulation is through an 801 driving a pair of 830-B Class B, which modulates the screen and plate of the 803. The entire unit is very compact, measuring 11½"x14"x15" and weighing 45 pounds.

THE "DELTA-T" PAD

HIGH-FIDELITY and impedance mismatch are two factors that cannot exist together in public-address equipment. They are like the mythical immovable object and irresistible force. Either one or the other, but not both, can exist in the same piece of sound apparatus.

There are three fundamental attenuator networks that will maintain constant impedance in either direction through a pad. These are the π pad, the T pad, and the bridged-T pad.

Fig. 1 illustrates the circuits. As indicated in Fig. 1, three variable-resistor branches are required to attenuate the signal, meanwhile maintaining constant line impedance, in the π and T pads. Only two variable branches are required in the bridged-T pads. Constant impedance with variable attenuation is accomplished by choosing the correct resistance values and tapers for X and Y,

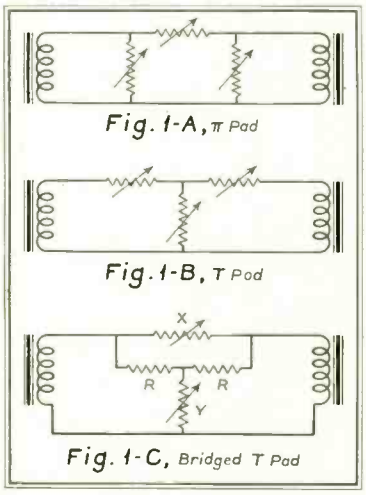


Fig. 1-A, π Pad

Fig. 1-B, T Pad

Fig. 1-C, Bridged T Pad

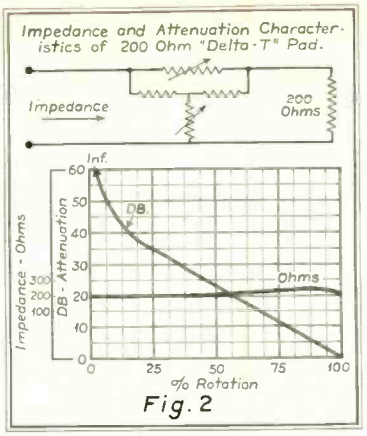


Fig. 2

the variable-resistance legs. R indicates two fixed resistors of equal value that complete the network.

The bridged-T pad is known as the "Delta-T" pad. The name is derived from the combination of a delta and a T network to make up the complete circuit.

Preliminary tests show that the "Delta-T" pad operates in accord with the basic theory. Fig. 2 shows how attenuation and impedance vary with rotation. Notice that the attenuation curve approaches a straight line from 5 percent to 100 percent rotation. At 0 percent rotation the attenuation is infinite. The impedance is constant throughout the first 50 percent of rotation with a slight rise between 50 percent and 90 percent rotation. The test was made on 5 controls with nominal impedance of 200 ohms.

Fig. 3 shows the connections to control terminals that agree with the circuit in Fig. 1-C. The control may be used as an attenuator in a single line, or individual generating sources may be connected to the "in" lines of several controls and the "out" sides of the controls can then be wired in series to form a series mixer circuit. Fig. 4 schematically illustrates a typical four-source mixer of this type. Four 50-ohm "Delta-T" pads are used as mixer controls. A 200-ohm pad is used as the main attenuator at the amplifier input.

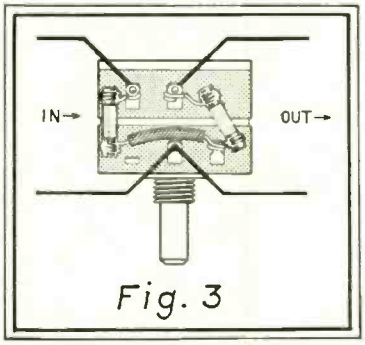


Fig. 3

Many similar circuits could be illustrated, but all will be variations of the one shown.

Wm. H. Fritz,
Centralab.

MIXER CIRCUITS

(*Continued from page* 11)

velop in any fader position, the entire mixer will be rendered inoperative, i.e., no signal will obtain from any of the other fader positions. However, if such a mixer is constructed according to the principles laid down in this article, specifically if compensating resistances R are used, it would appear to be but a remote possibility that in any one station the generator leads, the T-pad and resistance R should simultaneously develop open circuits. It is true, however, that if the connecting link between fader positions should open that the entire fader will be inoperative. The possibility of such complete failure, however, depends in large measure upon the actual manner in which the various units are wired to one another.

Noisy volume controls can be avoided by the choice of units of good design and careful construction and by the proper maintenance of such units, with special reference to keeping the contacts clean and smooth. The elimination of cross talk has been dealt with in a previous section and should not appear after the equipment has been in operation for some time if all the joints and ground connections have been properly and carefully soldered.

The design of several types of practical mixers has been explained including such matters as proper impedance matching and calculation of insertion loss. Causes of cross talk have been discussed and the proper types of circuits, units and points of grounding explained. Finally, a brief discussion has been given of possible troubles and modes of operation of this device.

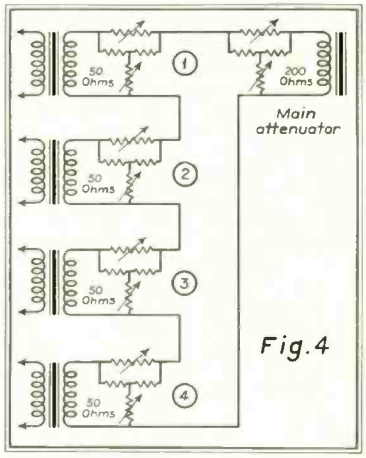


Fig. 4

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGonigle, President, RCA Building, 30 Rockefeller Plaza, New York, N. Y.

WIRELESS VETERAN NO. 1

WE RECORD with deep regret the passing of our late beloved Member, Wireless Veteran No. 1, Guglielmo Marconi.

On the day of his death, David Sarnoff, Life Member of our Association and President of the Radio Corporation of America, over a world-wide NBC network, eulogized Marconi:

"We have suffered the loss of a great inventive genius—one whose name will live forever in the pages of history.

"The genius of Marconi was a gift, not to the people of one nation but of all nations. His scientific achievements, like the radio waves themselves, transcended international boundaries. They benefit all men everywhere, regardless of the man-made barriers of language, creed and politics.

"It was my great privilege to have known Guglielmo Marconi for more than thirty years, ever since I was a boy. He was always a source of inspiration to me; always a kind teacher and a loyal, helpful friend. It is impossible to put into words my deep sense of personal loss. I can only express my gratitude that my life should have been enriched by this friendship."

On the evening of the day of Marconi's death the coast-to-coast network of the Mutual Broadcasting System with a program "Memorial to Marconi" originating in the studios of WOR in New York, paid tribute to the memory of this great man. —Our President, William J. McGonigle, participating in the broadcast, said:

"Six years ago, on December 12th, 1931, the President of the Veteran Wireless Operators Association spoke over this station in conjunction with the world-wide broadcast commemorating the thirtieth anniversary of the conquest of the Atlantic through the medium of wireless communication by Marconi. We were then privileged to present Senatore Marconi with a Special Gold Medal of our Association. Tonight, I am here to inscribe his name on the Perpetual Roll of Honor of our Association and to pay our last respects to our late beloved member, Guglielmo Marconi, Wireless Veteran No. 1.

"Any tribute, however great, that we might pay at this time would be small by comparison with his accomplishments. From that first day in 1895, when Marconi achieved the first successful transmission of intelligence by wireless communication, he continued daily active, improving and perfecting the new communications medium. It must have been a source of profound satisfaction to him to have lived to witness the magnificent progress of his youthful hobby to one of mankind's most useful instrumentalities—radio today.

"Marconi, the man, is no more. His spirit and achievements will live on forever as a guiding star to posterity. Scholar, soldier-statesman, scientific genius, his name will be recorded in history with other immortals who, like him, devoted their lives to the interests of humankind. A benefactor to us all, we are his debtors.

GUGLIELMO MARCONI
Photo from George Clark, RCA Historian.

"On behalf of the Veteran Wireless Operators Association I extend deepest sympathies and condolences—to the members of his family at the loss of a devoted husband and father—to our fellow men at the loss of a celebrated inventive genius."

On a nation-wide network of the National Broadcasting Company on a program titled "The Human Side of Marconi," participated in by many very prominent men in the radio field, all of whom knew Marconi in the early days of radio, George Clark, Junior Past President of our Association, spoke:

"Although Mr. Marconi was a very busy man, yet he always found time to send a long personal message of greeting to our annual gathering of old-time radio men of the VWOA and the message was always warm and real.

"In December, 1931, on the 30th Anniversary of his first wireless conquest of the Atlantic, the VWOA presented him with a special Gold Medal. He replied: 'I am deeply touched at having been conferred such a generous token of appreciation by the Veteran Wireless Operators Association, the component members of which are particularly close to me, and while once more conveying to them all my heartfelt thanks, I wish to assure you that your valuable gift and its accompanying document will be treasured amongst the most cherished rewards I have ever received.'

"There is a monument in Battery Park, New York City, overlooking the sea, which is dedicated to the memory of wireless operators who have given their lives in saving others. This monument is under the care of the Veteran Wireless Operators Association and from its fund Mr. William J. McGonigle, President of that organization today, has pledged a donation of one hundred dollars as a first subscription toward a larger, more worthy monument to Marconi. RCA has become second on this list of donors, by direction of its President, Mr. Sarnoff, a Life Member of our Association. What form this monument will take, where it will be located, remains for the future to tell, but without doubt it, too, will face the sea that Marconi loved."

A message from the late Senatore Marconi received at one of our Annual Cruises follows: "Cordial greetings to my fellow Veteran Wireless Operators assembled in New York for Annual Cruise stop every year the diversity and extent of wireless communications grows but the fine pioneering spirit of the service meets each new demand with zeal, ability and assurance of success stop long may it continue so with hearty veterans to lead the younger generation to new space triumphs stop personal regards to George Clark David Sarnoff and my many personal friends with you tonight."

The last message from Senatore Marconi received at our most recent Annual Cruise at the Hotel Great Northern in New York City on February 11th, 1937, follows: "As the original wireless veteran may I participate your reunion and wish you best luck."

MARCONI MEMORIAL

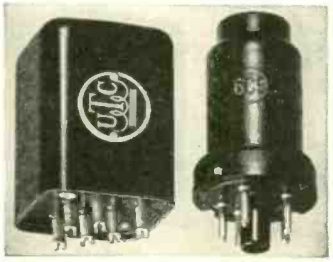
IT WAS ANNOUNCED in the press and over the radio that the Veteran Wireless Operators Association had launched a Marconi Memorial Fund, the purpose of which is the erection of a monument commemorative of the ideals and achievements of the inventor of the wireless telegraph, Guglielmo Marconi, No. 1 Veteran of our Association. The Fund was started by the contribution of $100.00 by the President, William J. McGonigle, for the Association. Mr. Sarnoff, Life Member and President of the Radio Corporation of America, was the second subscriber with a contribution of $1000.00. Mr. Alfred McCosker, President of Radio Station WOR and Chairman of the Board of the Mutual Broadcasting System, was the third contributor.

In general the Fund will be solicited from organizations engaged in the radio field; communications, manufacturing, amateurs, etc., and their employees—the people most likely to know of his outstanding accomplishments and desirous of participating, by contribution, in the erection of a "living tribute" to this truly great man.

A committee composed of outstanding men in the radio field will be appointed to pass upon a suitable design and site for the monument. Designs will be solicited

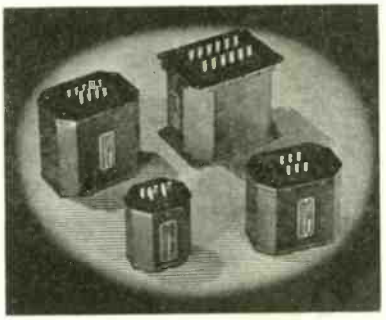
(*Continued on page* 31)

Choice of the Discriminating User*



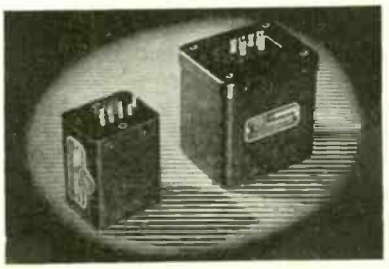
ULTRA COMPACT HIGH FIDELITY AUDIO UNITS

The UTC ultra compact audio units are extremely small and weigh only 5½ ounces. The fidelity, however, is excellent, the frequency response being uniform ±2 DB from 30 to 20,000 cycles. These units are ideal for remote pickup equipment and similar applications where both weight and size are paramount factors.



PUBLIC ADDRESS UNITS

The Public Address series of units is a popular priced line having medium fidelity. A complete line of input, output and power components is provided, suitable for every public address and amateur transmitting function. Units of this class are used extensively by commercial communications companies for service where broadcast fidelity is not essential.



UTC HIPERM ALLOY COMPONENTS

UTC Hiperm Alloy Components are similar to the Linear Standard units but of a more compact design and employ a light-weight high conductivity case so that these units can be employed for portable and compact service. They are used extensively in recording and remote pickup equipment.

UTC LINEAR STANDARD COMPONENTS

UTC Linear Standard components are ideal high fidelity units for broadcast and recording service. The frequency response is guaranteed uniform from 30 to 20,000 cycles, and the shielding and insertion loss is maintained at extremely low values. These units are unequalled for studio and speech input equipment.

HAVE YOU A COPY?

If not . . . WRITE for the NEW UTC BROADCAST BULLETIN, describing transformer, equalizer and amplifier components for every broadcast and recording application.

* UTC transformers are used by RCA, G.E., Western Electric, Westinghouse, Bendix, C.B.S., N.B.C., M.B.S., U. S. Army, Navy, Signal Corps, Coast Guard, Dept. of Commerce, Bureau of Standards, etc.

UNITED TRANSFORMER CORP.

72 SPRING STREET • NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N.Y. CABLES: "ARLAB"

OVER THE TAPE...

NEWS OF THE RADIO, RECORDING AND SOUND INDUSTRIES

RADIO OLDTIMERS CLUB

A Radio Oldtimers Club is in process of formation with the avowed intention of having two events a year in Los Angeles. One will be the annual beer binge and barbeque. The other will be a gala program of pioneer entertainers and will be on the air.

Those who have been in radio for ten to fifteen years will belong. There will be no dues. There will even be enough offices so everybody can have a title.

Prime movers and instigators are Walter Biddick, present radio station representative, and E. K. Barnes, recording engineer. Both were with KHJ in its early days of 1923-'25.

Permanent secretary, nobody else wanting the job, will be Dr. Ralph L. Power, radio counsellor, with offices in the Van Nuys Bldg., Los Angeles. He resigned from a USC professorship in 1922 to become studio manager and announcer for *The Examiner's* radio station and finished up by being radio editor for most all the other local sheets over a period of ten years before opening his own office.

NEW WHOLESALE CATALOG

The Wholesale Radio Service Co., Inc., of 100 Sixth Avenue, New York, N. Y., announces the release of their new 1938 Winter Catalog No. 69. This 180-page catalog, like its predecessors, is distributed free of charge.

Really six big catalogs contained in one, readers will find separate sections devoted to home, farm and auto radios, public-address equipment, ham equipment, replacement parts, tubes, test equipment and a line of electrical appliances.

GENERAL ELECTRIC BULLETIN

Small Pyranol capacitors for motors and other equipment are completely described in a new bulletin just issued by the General Electric Company, Schenectady. N. Y. Write to the above organization for Bulletin GEA-2027A.

DELCO-REMY BULLETIN

Delco-Remy Division, General Motors Corporation, Anderson, Indiana, have just made available a new edition of their Bulletin No. 1 G-112A. This 12-page bulletin lists the up-to-date applications of Delco-Remy Special Service Generators suitable for cars used in police communication work.

TEMCO BULLETIN

The Transmitter Equipment Manufacturing Co., Inc., 130 Cedar Street, New York City, have issued a bulletin covering their medium-power (100-350 watts) multi-frequency transmitters. Complete information is contained in the bulletin. It is available on request.

RADIO RECEPTOR EQUIPMENT FOR WNYC

Radio Receptor Co., 251 W. 19th St., New York, N. Y., has just completed antenna tuning equipment as well as an antenna coupling and phasing system for WNYC, New York's Muncipal Station. The field pattern of WNYC's new antenna has been made elliptic in shape in order to provide adequate coverage of the city. Radio Receptor Co. is now estimating on similar installations for other stations.

AEROVOX ANNIVERSARY CATALOG

The fifteenth anniversary edition of the Aerovox catalog is now ready for distribution. This 32-page book lists a large and diversified line of condensers and resistors. A new method of listing permits the finding of any required condenser in minimum time. A copy of the catalog may be had from any Aerovox jobber or by addressing Aerovox Corporation, 70 Washington St., Brooklyn, N. Y.

PRESTO BULLETIN

The Presto Recording Corporation, 139 W. 19th St., New York, N. Y., now have available literature on their new Junior portable sound recorder. This unit is suitable for recording voices or combinations of musical instruments that can be played back immediately, handling any record up to 12 inches in diameter.

WESTERN ELECTRIC BULLETINS

Three new bulletins have just been issued by the Western Electric Company describing and illustrating the latest additions to its line of equipment for broadcast stations. In the first of these bulletins the new 104A, 105A and 106A amplifiers are set forth. In the second bulletin, the new 110A program amplifier is described, while the third bulletin describes the new 23B speech-input equipment which is designed for use by stations when the operators ride channel gain by means of the main gain control.

SPRAGUE CATALOG

The new 1937 Catalog has just been issued by the Sprague Products Company, North Adams, Mass. Many pages are devoted to helpful condenser information such as a readily understandable explanation of power factor, leakage, etc. The new catalog also includes an analysis of radio-frequency, audio-frequency and filter circuits and data as to the proper condenser types to use in each circuit.

USE BULLETIN

United Sound Engineering Company, 2233 University Ave., St. Paul, Minnesota, have made available a 4-page bulletin covering their "Call-Phone" intercommunication equipment. Write for Catalog No. 108.

IDEAL BUYS BELDEN "REVOLUTION COUNTER" BUSINESS

Ideal Commutator Dresser Co., Sycamore, Illinois, has bought out the "revolution counter" business of the Belden Manufacturing Co. Hereafter, this product will be marketed and manufactured by Ideal at Sycamore, Illinois, who are fully equipped through their widespread manufacturing, engineering and sales organization to give good service to customers.

RCA BULLETINS

New literature is now available on RCA Victor instantaneous recording discs, a new and modernized meter panel (Type 15-C), and on the Type 100-G and 250-G broadcast transmitters. The 100-G transmitter is for 100-watt stations, the 250-G for 250-watt or 100/250-watt operation. These bulletins may be obtained from the RCA Manufacturing Co., Camden, N. J.

NEW SOLAR PLANT IN PRODUCTION

The Bayonne, New Jersey, plant of the Solar Manufacturing Corporation is now in active production of wet and dry electrolytic condensers. The additional production facilities thus made available will almost double the Solar electrolytic capacity.

ANACONDA BULLETIN

The Anaconda Wire and Cable Company has just issued a 20-page publication describing non-metallic sheathed cable for direct burial in the ground. In addition to complete descriptions of the types available and their uses, helpful information relating to the application, installation and other engineering data is included. This publication, entitled "Anaconda Duraseal Cable," publication No. C-27, can be secured by writing to the Anaconda Wire and Cable Company, 25 Broadway, New York, N. Y.

MAGNAVOX BULLETIN

The Magnavox Company, Fort Wayne, Indiana, have recently issued three interesting bulletins. One bulletin gives data on Magnavox wet electrolytic capacitors, a second is devoted to their Model 305 15-inch dynamic speaker, while the third gives standard specifications of the Magnavox line of dynamic speakers. The bulletins may be obtained free on request.

GENERAL RADIO BULLETIN

The General Radio Company, 30 State St., Cambridge, Mass., recently issued a very interesting and complete bulletin on "The Technique of Noise Measurement." This 18-page bulletin has been divided into four parts and contains data on equipment and standards, sound-level meters, and on making sound-level measurements. An interesting list of references is also included.

(*Continued on page* 30)

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

TRANSDUCER MIKE LINE

J. T. Kane, Sales Manager of Transducer Corporation, announced this week that the complete line of Bullet microphones has been redesigned and improved to provide higher fidelity, sensitivity and better all round performance.

The new models are: TR-5, an all purpose mike with sensitivity of 42 db high or low impedance. Available in standard black telephone bakelite. TR-6, substantially the same as TR-5 but adapted for use with exceedingly long lines. Sensitivity —40 db. available in standard black telephone bakelite. TR-7, a non-directional, vertical type. Sensitivity—40 db. available in standard black telephone bakelite. TR-8, custom built mike to satisfy any line or amplifier requirement. Sensitivity—38 db. This job may be had in black or choice of colors and in impedances of 10, 50, 200, 500, 2,500, 50,000, 500,000 ohms. TR-9, a custom built mike furnished with individual laboratory drawn curve. Sensitivity—38 db. available in black or choice of colors and any of the following impedances—10, 50, 200, 500, 2,500, 50,000, 500,000 ohms.

Complete information is available from the manufacturer; address, Radio City, N. Y.

WEDGE POWER PLANT

A portable power plant is announced by Wedge Manufacturing Co., 300 W. Adams St., Chicago. The 2-pole, d-c generator is direct connected to a 4-cycle, ⅝-hp gasoline engine. The unit is governor controlled for constant speed.

Up to 200 watts are available from either the 6-, 12- or 32-volt d-c plants.

Additional information may be obtained from the manufacturer.

VOCAGRAPH AMPLIFIERS

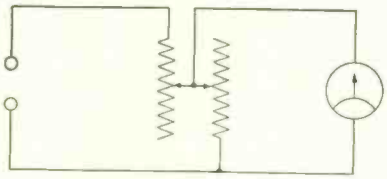
In an announcement just made to their distributors, a series thirty amplifier line has been introduced, offering Vocagraph "hushed power" features at prices which are said to equal the lowest in the industry. Complete systems and fully portable units are included at equally low prices. Descriptions and technical data are available from local parts distributors or by writing the manufacturer, Electronic Design Corporation, 164 North May Street, Chicago, Illinois.

C-D'S TYPE JR. CONDENSER

The "inside" story of one of Cornell-Dubilier's popular etched foil, dry electrolytics is revealed in the accompanying illustration. This unit, Type JR, is first dipped in wax, then encased in an inner cardboard container which is vacuum impregnated. Into the space between the inner liner carton and the condenser section is poured a special asphalt compound which surrounds and hermetically seals the condenser unit. After passing C-D's test requirements, this condenser is sealed in a silvered cardboard container and equipped with universal flanges for mounting.

OUTPUT METER

The General Radio Type 483 output meter consists of a copper-oxide voltmeter and a resistive multiplier network. It has been especially designed for use in laboratories where audio-frequency measurements are made. Full-scale deflection on the indicating instrument is 2 volts. The L-type multiplying network provides full-scale ranges of 2, 4, 10, 40, 100 and 200 volts. The instrument and its schematic wiring diagram are shown in the accompanying illustrations. Complete information may be secured from the General Radio Company, 30 State Street, Cambridge, Mass.



PERI-DYNAMIC REPRODUCERS

Jensen has just announced a line of Peri-Dynamic Reproducers available in kits; these consist of speaker and knock-down enclosure. All necessary screws, bolts, grilles, brackets, etc., are furnished for assembling. Enclosures in all cases are cut to size, drilled and all necessary parts for sembling.

There are two models, Model KM and Model KV. Model KM uses both Peri-dynamic and Bass Reflex Principles and is recommended for general uses and where reproduction of music is chiefly desired.

Model KV employs the Peri-dynamic Principle and is recommended where reproduction of speech is of paramount importance and music reproduction is secondary.

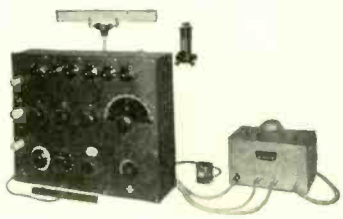
Complete information on models, prices and sizes available on request to Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.

MODIFIED SCHERING BRIDGE

For the purpose of determining the characteristics of samples of both liquid and solid dielectrics, the Leeds & Northrup Company has developed a modified form of Schering bridge. High voltage is applied only to the test sample and to the standard air capacitor. All adjustable elements being confined within a grounded shield, the operator is fully protected and accuracy is assured. The guard rings of the standard capacitor and of the sample are brought to the proper potential by merely connecting them to the grounded shield.

A method of compensation for residual capacitance is used which enables results to be calculated from simple equations. In the case of low power factors, the result is read directly. Capacitances ranging from 40 mmfd to 0.020 mfd and power factors from 0.0001 to 0.70 can be determined.

For further details, ask for Catalog E-54 (2) from Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.



IRC WIRE-WOUND RESISTOR

To meet the need for a small precision resistor in values up to 1¼ megohms, the International Resistance Co., 401 North Broad St., Philadelphia, Pa., has introduced a new precision wire-wound resistor known as Type WW-5. This is made in ranges from 500,000 ohms to 1¼ megohms.

The new unit is said to be a real space saver. It is only 1¼ inches in length with

an outside diameter of ¾ inch, or about half the size of the present type, WW-2 IRC precision wire-wound units.

Like other IRC precision wire-wound resistors, the standard tolerance of the new Type WW-5 is one percent, with special tolerances as low as one-tenth of one percent available on special order. Non-inductiveness, low noise levels and impregnation against atmospheric conditions are outstanding characteristics.

ATTENTION MANUFACTURERS

Mr. G. C. Motwane, managing director of Eastern Electric & Engineering Company, Bombay, is now in the United States. Mr. Motwane is particularly interested in securing data on public-address systems, radio parts, and all kinds of sound apparatus, such as, sound-on-film recorders. He may be contacted at the Hotel Irving, 26 Gramercy Park, East 20th St., New York City.

MERCURY-VAPOR RECTIFIER

The Continental Electric Co., Geneva, Illinois, have announced their new mercury-vapor rectifier tube, which is known as Type 2-RA-15.

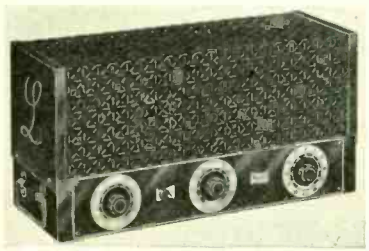
This rectifier has the following electrical characteristics: filament voltage, 2.5 volts; filament current, 16 amperes; d-c output (average), 15 amperes; d-c output (crest), 45 amperes; arc drop, 5-8 volts; pickup voltage, 8-11 volts; d-c output voltage, 60 volts max.; crest inverse voltage, 200 volts

max.; filament heating time, 2 to 3 minutes; overall length, 8½ inches; overall diameter, 3¼ inches. It is designed for low-voltage applications such as projector arcs, arc welders and the like. The manufacturer guarantees 2,000 hours' life for this tube when used within the limits shown above.

The manufacturer will gladly send complete details to interested firms.

LAFAYETTE 20-WATT AMPLIFIER

For all-around public-address requirements, Wholesale Radio Service Company, Inc., of 100 Sixth Avenue, New York City, is offering the new Lafayette Model 131-A, 20-watt amplifier. The unit features glowing red neon control dials that can be observed and set in darkened locations; reverse feedback giving only three percent harmonic distortion at the rated output, and economy of use through the inclusion of a 24-watt speaker field supply. Metal tubes, except



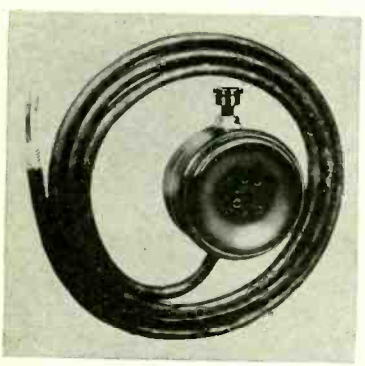
for the rectifier, are used throughout, providing a sound power of 20 watts when fed into 500 ohms. Two high-gain channels are provided for use with crystal, condenser or velocity microphones while two low-gain channels are included for carbon mikes, phono-pickups, etc. Fading and mixing controls permit flexibility of reproduction when used with orchestras, singers and phono-pickup. Photo-electric cell input can be substituted in place of these with no change in amplifier circuits.

ELECTRO-VOICE MICROPHONE

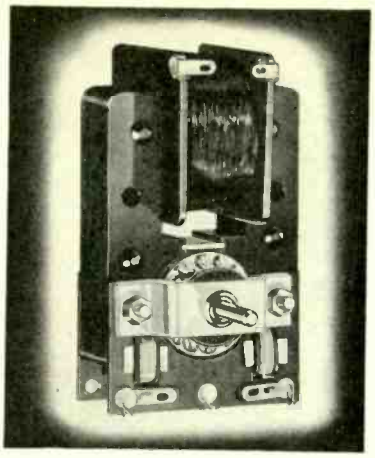
The Electro-Voice Mfg. Co., Inc., 324 E. Colfax Ave., South Bend, Ind., have announced their V-1 velocity microphone. The new unit is said to be free from r-f pickup and has shock proof cradle mounting. The output level is approximately —68 db.

AIRCRAFT MICROPHONE

Universal Microphone Co., Inglewood, Cal., has just started to produce and market a new aircraft microphone that is compact and light in weight. It is announced as 100 percent directional with extraneous noises excluded. It may be held in the hollow of either hand and a rugged push button can be operated by the thumb. There is a double contact switch, one side of which closes the circuit for microphone current and the other side operates the relay for throwing the transmittter into action. The aircraft microphone is of molded bakelite, with shielded cable, and is a single-button type.



UNIVERSAL'S AIRCRAFT MIKE



MINIATURE MOTOR

The Alliance Manufacturing Co., Alliance, Ohio, has announced a small motor for use in applications such as electrical tuning of radio receivers, etc. The full size of the motor is 1¾" x 2" x 3⅛". It is available in all a-c voltages, and for frequencies of 40, 50 and 60 cycles.

UNITED SOUND CALL-PHONE

The United Sound Engineering Co., St. Paul, Minn., has announced their Call-Phone intercommunication systems.

The illustration shows the Personal

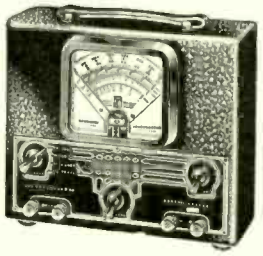
Call-Phone which is equipped with an earphone. Raising the earphone from its rest makes conversation confidential by bringing the other party's voice over the earphone instead of the loudspeaker. Other units in the system include the Standard Call-Phone, which has no earphone, the Switchboard Call-Phone for use by telephone operator in extensive installations, and the Paging Call-Phone which amplifies the call over large areas.

These units are finished in smooth black with aluminum trim. The Call-Phone is licensed under A. T. & T. and Western Electric patents.

Additional information can be obtained from the manufacturer.

CLOUGH-BRENGLE "SUPER-ANALYZER"

The Model 120 "Super-Analyzer" is a new 20,000-ohm-per-volt analyzer recently

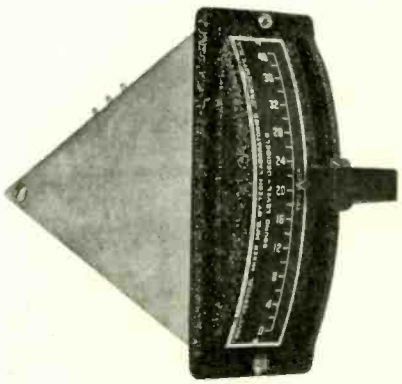


developed by the Clough-Brengle Company, 2815 West 19th St., Chicago, for measuring avc, grid bias, diode, audio, screen, and other voltages in electronic tube circuits. Functionalized switching, by means of positive-contact rotary switches, dispenses with pin jacks and binding posts, and the full open-faced etched scale permits all a-c ranges to be read on the same scale.

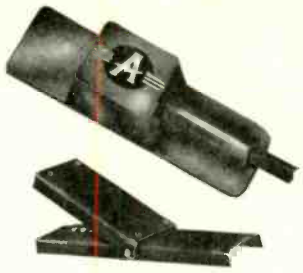
The d-c voltage ranges are 3.5, 7.0, 35, 140, 350, and 1,400 volts at 20,000 ohms-per-volt. The a-c ranges are the same with the high sensitivity of 7,000 ohms-per-volt. The ohm scales are 0-3,000, 0-30,000, 0-3 megs, and 0-30 megs. The total decibel ranges are from minus 14 to plus 61 db, using five multipliers.

"GOVE" VERTICAL MIXER

Tech Laboratories, 703 Newark Ave., Jersey City, N. J., have recently announced their Type 214 "Gove" vertical mixer. This attenuator was invented by Edward L. Gove, technical supervisor, WHK and WJAY, Cleveland, Ohio. The unit can be cleaned from the front of the panel by removing the escutcheon and it is completely shielded and dustproof. Narrow construction permits as many as seven mixers in one row on a standard 19-inch rack. Specifications are as follows: noise level, 130-140 db below zero level; range, standard units are furnished with 20 steps at 2 db; circuit, ladder or potentiometer; impedance, 30, 50, 200, 250, and 500 ohms for ladders, and 250,000 ohms for potentiometers.



THE "GOVE" VERTICAL MIXER



AMPERITE KONTAK MICROPHONE

The new Amperite Kontak microphone can be used on all vibration instruments such as guitar, violin, double bass, etc. When used with violins or other instruments having a tail piece, the microphone is merely inserted under the tail piece. With other instruments, it can be placed in position by the special adhesive tape used underneath the flaps. No tools or drilling are necessary.

The Amperite Kontak microphone is said to have a flat response from 40 to 9000 cycles. It has an output of —40 db and will operate on any amplifier having two stages of amplification or more. The foot-operated volume control increases the range and effects of the instrument.

Complete information on this unit may be secured from Amperite Corp., 561 Broadway, New York City.

MICAMOLD POWER RESISTORS

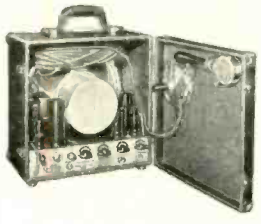
Micamold Radio Corp., 1087-1095 Flushing Ave., Brooklyn, N. Y., has recently announced a complete line of cement coated resistors in ratings from 10 watts to 100 watts. The standard line are of conventional construction and dimensions. They are listed in both the fixed and variable types with sliders and brackets. Special types can be supplied to manufacturers' specifications.

SUNCO SOUNDMASTER

The Soundmaster is a completely self-contained microphone-amplifier-loudspeaker system designed to meet the need for a light, easily set-up unit for use by public speakers, orchestra, showmen, etc. It is said to be powerful enough for audiences up to 3,000 and outdoor areas up to 25,000 square feet. Two extra inputs are provided for microphone, music pickup or phonograph. The audio power output is 12 watts.

The Soundmaster is equipped with a 12-inch, 15-watt speaker. It operates directly from 110-volt, 50 to 60-cycle lines, and converters for battery operation can be furnished.

Complete information may be secured from the Sundt Engineering Co., 4238 Lincoln Ave., Chicago.



NATIONAL UNION C-R TUBE

A two-inch cathode ray tube has been announced by the National Union Radio Corp., 570 Lexington Avenue, New York, N. Y. This tube is for use in the popular small oscillograph units and other applications where compact size combined with complete performance characteristics are factors. Complete information is available from the manufacturer.

CENTRALAB CONTROLS

Announcement has been made by Centralab, Inc., 900 East Keefe Avenue, Milwaukee, Wis., of a line of Midget replacement controls. The controls are furnished with long shafts, milled for push-on knobs; they are available in ranges from 5000 ohms to 2 megohms, and in standard tapers.

HAMMARLUND PRODUCES NEW TRANSFORMER

A new group of iron core i-f transformers are now being made by the Hammarlund Manufacturing Company, Inc., 424 West 33rd St., New York City.

These new transformers are said to provide high gain per stage together with extremely sharp selectivity. Specially developed finely powdered high permeability magnesium alloy, rust proof and non-corrosive, is used for the core. This core is claimed to afford a great increase in inductance, thus permitting a reduction in the number of winding turns and consequently greatly reducing eddy current losses. These transformers may be used with all tubes normally used in i-f amplifiers.

OVER THE TAPE

(*Continued from page 24*)

DAVEN BULLETIN

Those desiring information on the Daven ladder attenuators, Type No. LA-220, should write to The Daven Company, 158-160 Summit Street, Newark, N. J., for Bulletin No. 533. This literature contains complete information on these units and will be sent free on request.

TRANSDUCER CORP. MOVES

G. M. Giannini, president of Transducer Corp., announced from executive headquarters at 30 Rockefeller Plaza, New York City, that the Transducer factory, which had been located at 22 W. 48 St., has moved to new larger quarters at 455 W. 45 St.

In charge of activities at the new address are F. L. Lester, production engineer, and Ben Eisenberg, test and design engineer. Serving in the capacity of design consultant is Richard W. Carlisle, well known in radio engineering circles.

DU PONT BOOKLET

A booklet describing Neoprene, Du Pont's artificial rubber, has been published by that company. Copies may be obtained by writing to E. I. Du Pont de Nemours & Company, Wilmington, Del.

OGLE JOINS MALLORY

C. R. Ogle, recently Secretary and Sales Manager of the B-L Electric Manufacturing Company, has joined the sales organization of P. R. Mallory & Co., Inc., manufacturers of rectifiers, battery chargers, radio, electrical and metallurgy products.

Mr. Ogle, whose activities in the electrical field covers a period of over twenty years, will be associated with the rectifier sales activities of the Mallory Company.

ELSBERT CO. FORMED

B. J. Grigsby, president, announces the organization of Elsbert Manufacturing Co., Inc., with offices and factory at 353 West Grand Avenue, Chicago.

Mr. Grigsby organized and was president of the former Grigsby-Grunow Company. Other officers of the new company are: Raymond J. Grigsby, vice-president, O. E. Grigsby, secretary, and H. E. Kranz, chief engineer.

The company is developing and will shortly begin manufacture of a new type of slow speed high torque fractional horsepower electric motor; also, ignition devices and systems for greater efficiency in internal combustion engines, particularly with low-grade fuel.

ESTABLISHES NEW YORK OFFICE

Designers for Industry, Inc., of Cleveland, Ohio, industrial designers and product stylists have established New York quarters in International Building, Rockefeller Center, according to announcement by Chas. H. Oppenheimer. A designing staff will be maintained in the New York office which is in charge of H. C. Gooding who was transferred from the Chicago office to become business manager for the Eastern district. George E. Henry, formerly associated with the business paper field, has been appointed sales promotion manager with headquarters in the New York office.

STURDEVANT APPOINTED CONSULTANT

United States Rubber Products, Inc., 1790 Broadway, New York City, has appointed Dr. Earl G. Sturdevant as Consulting Engineer of its Electrical Wire and Cable Department.

Since 1920, when he took his doctorate at the University of Michigan, Dr. Sturdevant has been connected with many important scientific developments in the rubber field. After a two-year interval of teaching at the University of Western Ontario, he joined the technical staff of Western Electric. While there he developed a method of continuous cure for rubber-covered wire.

Dr. Sturdevant joined United States Rubber Products, Inc., in 1929, coming directly from Western Electric. His work in cooperation with the development staff at their General Laboratories in Pasaaic was outstanding. He contributed in the work of commercially applying the process of the Hopkinson and Gibbons patent for forming a rubber thread directly from latex. This process is used in making the elastic core of "Lastex," the miracle yarn used so extensively in various types of elastic fabrics.

In 1931 Dr. Sturdevant was appointed Development Manager of the Electrical Wire and Cable Department, where he contributed to the successful development of "Laytex."

AIR EXPRESS SHIPMENTS UP 35 PERCENT

Nation-wide air express shipments for May increased 35 percent over May a year ago, according to announcement by the Air Express Division of Railway Express Agency. May shipments totaled 49,383.

Outbound shipments from New York City for May showed an increase of 50 percent compared with the corresponding month in 1936. Combined outbound and inbound at New York for the month, totaling 22,237, increased 37 percent, it was said.

HYTRON CALCULATOR

The Hytron Corp., radio tube manufacturers, at Salem, Mass., announce a new and novel resistance tube price list and interchangeable calculator.

In addition to listing standard glass and metal types it has a feature enabling the determination of the equivalent interchangeable standard type number to use. This is accomplished by means of a rotating disk having two slots; in one which

appears the special type number, in the other slot appears the Hytron type number to use having the same electrical and wiring characteristics.

Copies of these calculators are available from the above organization.

VWOA NEWS

(*Continued from page 22*)

from prominent American sculptors. Mr. David Sarnoff, Life Member of our Association, has expressed his willingness to head this committee.

Contributions and communications should be mailed to the Marconi Memorial Fund, Veteran Wireless Operators Association, RCA Building, 30 Rockefeller Plaza, New York City.

NEW ZEALAND

WE REGRET the delay in including these notes on this page. They were inadvertently mislaid.

From Frank N. Davidson, Wellington, New Zealand:

"Your communication to hand and the Year Books just received. The Year Books I am distributing to the various Certificate holders throughout New Zealand and will be glad to forward one to Mr. Drummond if you can supply his present address.

"With regard to your proposal about forming a Chapter of the Association I have been thinking this over seriously, but although I am in contact with most of the operators throughout the Dominion I am so much on the move that I have little time to get an organization going.

"With the big extension of broadcasting that is going on this country at the present time, many of our oldest hands are going into that branch, as under the Government regulations so many of the staff of each station must hold 1st Class W. O. Licenses.

"Personal Notes: R. A. Patchett is now with the Friendly Road Broadcasting station, 1ZB, Auckland, and I think has been in communication with you recently. . . . John S. W. Stannage has his own radio business now and may be addressed care of the Stannage Radios, Ltd., Queen's Arcade, Auckland, N. Z. . . . Cyril McCaskey has branched out in another direction, however, having a big sheep run—ranch to you—now. But as sheep owners in this country have been receiving big checks for their wool this season I have hopes of warping him in for a sub at least. . . .

"The magazine COMMUNICATION AND BROADCAST ENGINEERING is coming to hand regularly and I note with interest the activities of the VWOA in other parts of the Pacific. Will most certainly get in touch with them if I am on a Trans-Pacific ship at any time."

PERSONALS

IN OUR PERSONALS several months back we recorded a record of service which inadvertently was recorded as being that of "Steve" Wallis. It should have read that "Steve" was responsible for signing up his personable colleague in the Mackay Company "Bill" Gillula. Glad to correct it "Bill" and welcome to our ranks. . . . Our estimable Secretary, H. H. Parker will, within the month, take unto himself a wife. More details in the next issue. . . . Glad to see V. C. Eberlin in New York again and spent a very pleasant day with him and charming Mrs. Eberlin. . . . To Mr. and Mrs. William J. McGonigle, on May 10th, 1937, a son, William John, Jr. All three doing well thank you, 73 MC.

INDEX OF ADVERTISERS

As it was in the "Twenties" . . .
As it is today . . .
As we shall diligently strive to keep it . . .

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