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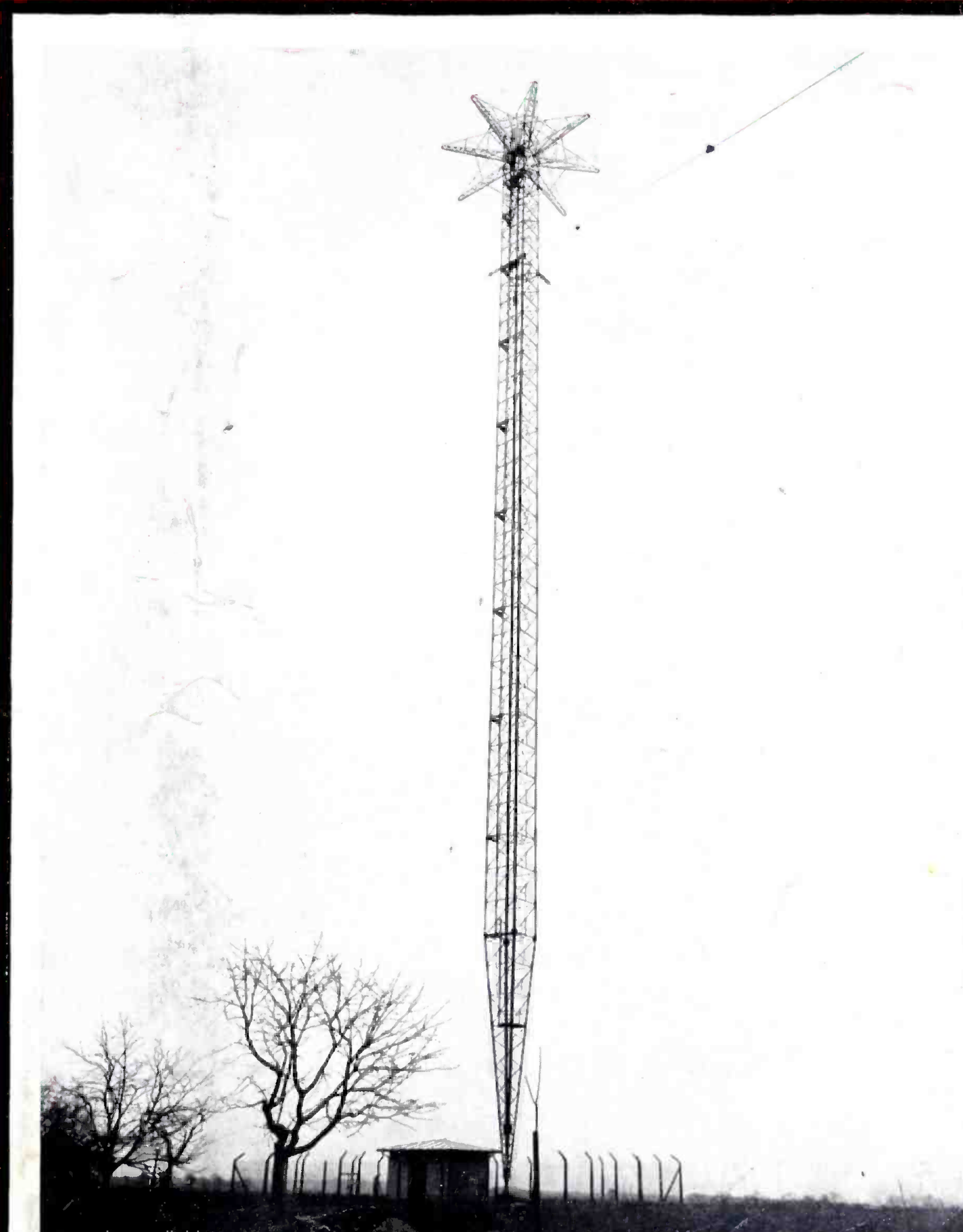
THE BROADCAST ENGINEER

MAY 1938



COMMUNICATIONS

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RAY D. RETTENMEYER • Editors • W. W. WALTZ

CONTENTS FOR MAY

Cover Illustration: The 415-foot "basket-type" vertical radiator of the 100-kw medium-wave broadcast station at Melnik, Czechoslovakia. The special top construction makes possible a considerable saving in antenna height. (See page 20.) Installation was made by English subsidiary of International Telephone & Telegraph Corp., Standard Telephones & Cables, Ltd., in cooperation with Government engineers.

VOLUME 18 NUMBER 5

BRYAN S. DAVIS
President

JAMES A. WALKER
Secretary

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

SANFORD R. COWAN
Manager

PAUL S. WEIL
Advertising Manager

A. GOEBEL
Circulation Manager

Chicago Office—608 S. Dearborn St.
Telephone: Wabash 1903.

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

Entered as second class matter October 1, 1937, 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.

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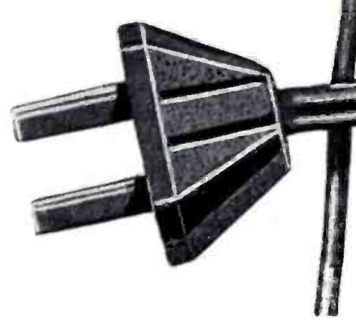

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WITH THE EDITORS

FCC HEARINGS

IN VIEW of the petitions of several broadcast stations, the Federal Communications Commission has decided to postpone indefinitely the hearing on the applications for a permanent increase in power to 500 kilowatts and to postpone until June 6, 1938, the hearing originally scheduled for the sixteenth of this month on Rule 117. Further, since an entire draft of new regulations for standard broadcast stations has just been completed, the Commission has decided to broaden the scope of the June 6 hearing to include all of the new regulations.

The Commission has indicated that this action is intended to conserve expense and time on the part of those interested in the question of high power as well as to facilitate progress in the industry as a whole. Since practically all stations are interested in the 500-kw problem as well as the new regulations, and since many questions of economic character are involved, the FCC felt that unnecessary effort on the part of all concerned could be avoided by this procedure.

While the draft regulations, according to the Commission, are designed to facilitate constructive progress in the art of broadcasting and are intended to permit the application of the latest technical advances, the Commission considers these draft regulations tentative and subject to change as a result of the June 6 hearing.

It is interesting to note that the applications of WLW, for renewal of special experimental authority to operate on 500 kw, and WHO, for a special experimental permit to operate on 500 kw, will be heard immediately after the close of the hearings on rules and regulations.

While the problems to be considered at these hearings are far from being simple in nature, it is to be hoped that the results will not be such as to retard engineering progress for a questionable economic gain.

NAB PROGRESS

REORGANIZATION seems to have put new life into the National Association of Broadcasters. Membership has reached an all time high of 434 stations, 340 of which have already qualified under the new dues schedule.

With assurance of support, the NAB Board of Directors have made three appointments to the permanent headquarters staff, and have formulated definite plans for the Association's activities during the next few months.

Search for a permanent head of the organization is progressing and the Executive Committee will continue its investigation of candidates and report to the Board at an early date.

In the meantime, the Association is making plans to represent the broadcasting industry at the June 6 hearings of the FCC, as well as at the hearings on the Celler and Chavez-McAdoo bills.

IRE CONVENTION

PLANS are progressing rapidly for the annual convention of the Institute of Radio Engineers which is to be held at the Hotel Pennsylvania, New York City, on June 16, 17 and 18. While the final program has not yet been released, the technical sessions are expected to be outstanding. Registration at the convention is expected to reach an all time high, and all members as well as non members have been invited to attend. Further details will appear in the next issue.

SECRECY IN POLICE COMMUNICATIONS

AS WE HAVE often pointed out there is nothing to prevent a criminal at large from tracing the activity of a police force by listening to the police radio broadcasts. It would seem that the efficiency of police departments might well be improved if more privacy were maintained.

"Scrambled speech" has been employed for certain types of marine radio telephone services for a number of years. While the circuits used for this service are probably too costly and complicated for police use, some simple system of phase inversion might be employed.

In any case, we believe that the manufacturers of police radio equipment might well give consideration to the matter.


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COMMUNICATIONS

FOR MAY, 1938

HOME NEWSPAPERS BY RADIO

By **FRED C. EHLERT**

FINCH TELECOMMUNICATIONS LABS., INC.

RADIO FACSIMILE transmission, singled out by the President's National Resources Committee as one of thirteen inventions which carry vast potentialities for economic, social and cultural change, recently assumed general importance as a new form of wide-scale radio newspaper service for the home.

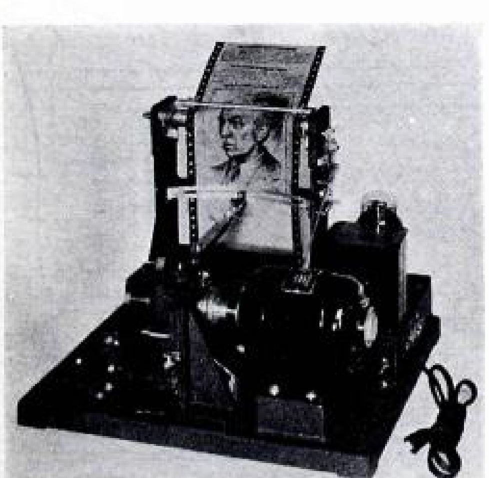
Many broadcasters already have inaugurated an experimental facsimile service to homes in their service areas. Regular broadcasting frequencies are employed using full power between midnight and 6 A. M. Stations which have been licensed by the FCC for facsimile transmissions include WSM, Nashville, KSTP, St. Paul, WHO, Des Moines, WGN, Chicago, WOR, Newark, WGH, Newport News, WLW and WSAI, Cincinnati, WWJ, Detroit, WCLE and WHK, Cleveland. In addition, many other stations have applied to the FCC for similar facsimile broadcast permits.

These developments give national significance to rapidly-forming background events which by many are believed to mark the beginning of a vital new form of public service, comparable to sound broadcasting in its broad social aspects. Simultaneous national distribution of short news bulletins and photographs, received in homes in concise, printed form, becomes a possibility of the near future. New employment opportunities for writers, artists, photographers and advertisers, as well as for radio technicians are predicted since broadcast facsimile copy may include along with straight printed matter, photographs, illustrated advertisements, comic strips and other condensed features formerly restricted to newspapers which radio facsimile will, because of space and time limitations, serve only to supplement.

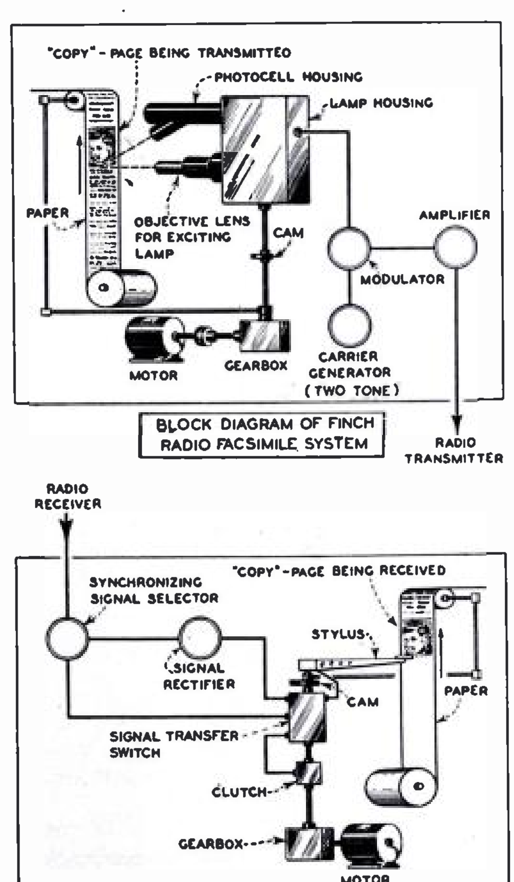
One of the reasons for the sudden opening of the "home" facsimile field is the recent development by Finch Telecommunications Laboratories, Inc., of a simplified automatic facsimile system invented by W. G. H. Finch, President of the laboratory, who in 1935 resigned a post as Assistant Chief Engineer of the FCC to complete his facsimile devices on which he has worked for many years.

The Finch system now used by the stations previously mentioned employs compact "home" receiving equipment which is attached to any ordinary broadcast receiver. Thus connected, the user tunes in a broadcasting station equipped with a facsimile transmitter. Thereafter, control signals transmitted by the broadcasting station automatically effect unattended continuous printing of photographs, news bulletins and other copy on paper 4 inches or two newspaper columns wide. Plans for the ex-

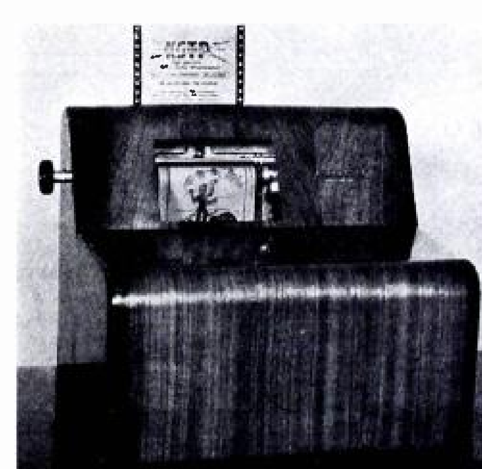
The home facsimile receiver with cover removed.

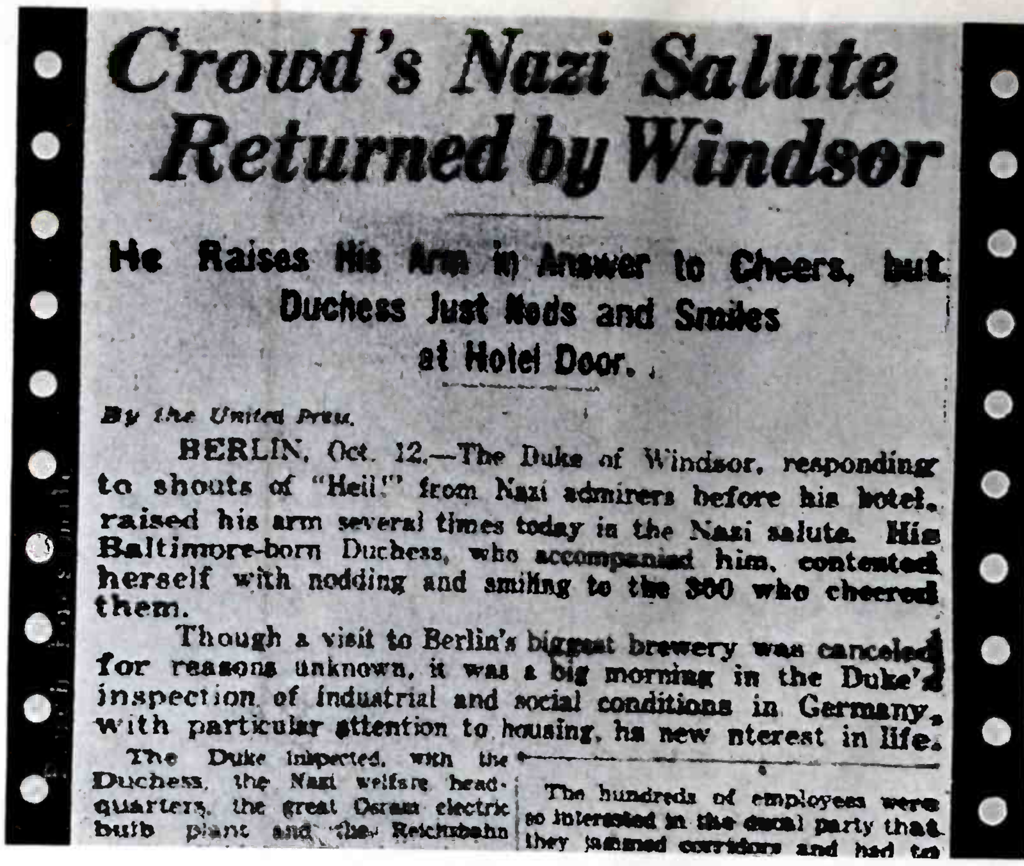


Block diagram of the Finch radio facsimile system.



Front view of the home facsimile receiver.





Crowd's Nazi Salute Returned by Windsor

He Raises His Arm in Answer to Cheers, but Duchess Just Nods and Smiles at Hotel Door.

By the United Press.

BERLIN, Oct. 12.—The Duke of Windsor, responding to shouts of "Heil!" from Nazi admirers before his hotel, raised his arm several times today in the Nazi salute. His Baltimore-born Duchess, who accompanied him, contented herself with nodding and smiling to the 300 who cheered them.

Though a visit to Berlin's biggest brewery was canceled for reasons unknown, it was a big morning in the Duke's inspection of industrial and social conditions in Germany, with particular attention to housing, his new interest in life.

The Duke inspected, with the Duchess, the Nazi welfare headquarters, the great Osram electric bulb plant and the Reichsbahn

The hundreds of employees were so interested in the ducal party that they jammed corridors and had to

A news item received in the living room over an ordinary radio receiver.

perimental period, which will be of a "proving ground nature," call for the installation of trial receivers in selected homes within the service area of the stations at the broadcasters expense. Transmissions during the initial period will be made during the early morning hours when the average radio receiver otherwise is not employed. Automatic time clocks turn the radio on and off at specified intervals. The result as anticipated is a tabloid form of a radio newspaper ready at breakfast.

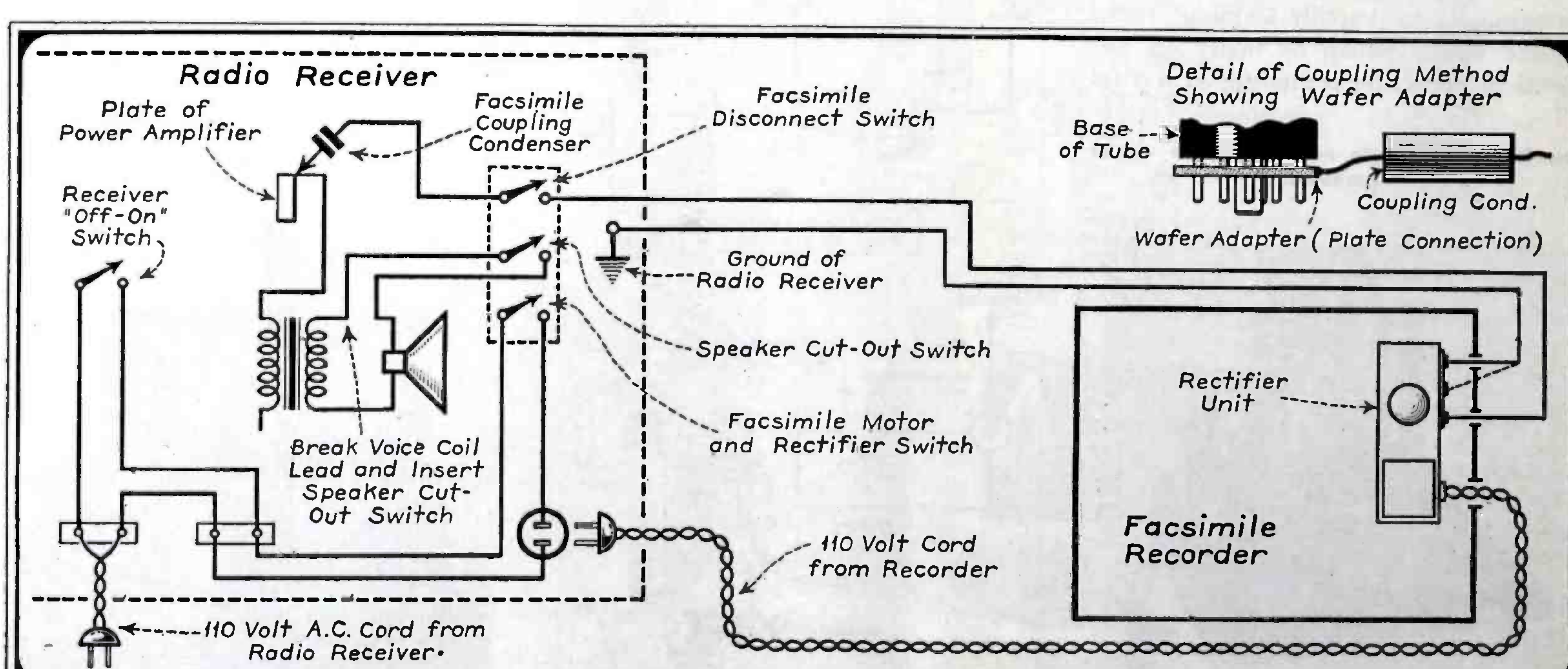
Radio facsimile transmission as a communications medium is not new. It has been used commercially for years sending news pictures and other copy across the Atlantic. Lately, with the tremendous demand for speedy distribution of news photos, press syndicates have installed nation-wide networks of wire facsimile apparatus which daily flash important news pictures between principal cities. However, facsimile apparatus used in such applications has been relatively expensive and complicated, often requiring the services of trained engineers or other technical personnel in their operation.

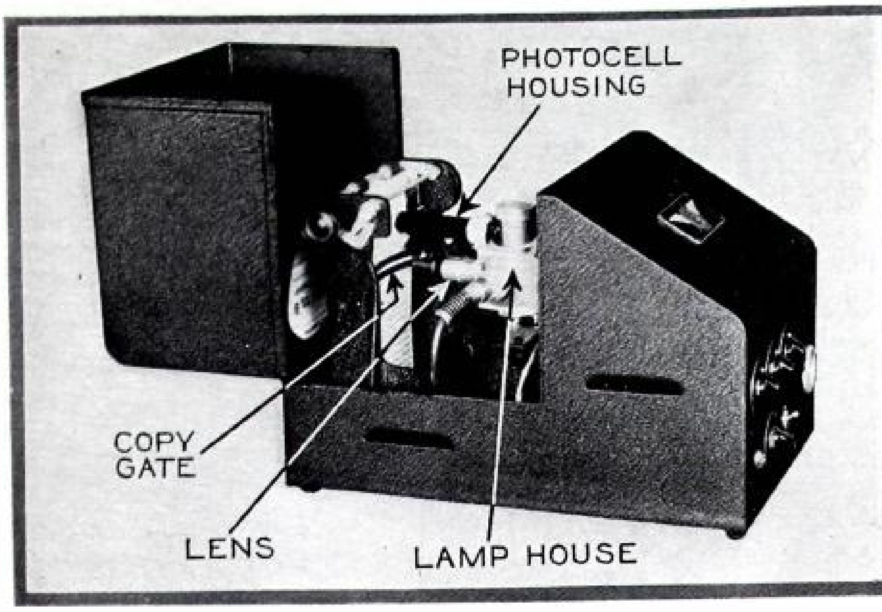
In the Finch radio facsimile system both major problems of synchronization and automatic electrical recording have been solved in what is believed to be a practical way. Synchronization is effected by two simple control units. One is a tiny electro-magnetic governor attached to the motor that drives the home recording machine in such a manner that it holds its speed as a substantially constant value. The other is a sensitive electro-magnetic clutch. This is operated by what is termed a "selective synchronizing pulse"—a low-tone radio control signal of extremely short duration which is sent over the air and starts the recording machine at exactly the right time. This pulse also keeps the receiving machine in exact step with the transmitter throughout the printing period and stops the machine when the station goes off the air. The required broadcasting frequency band necessary to transmit facsimile signals is 5,000 cycles maximum.

The facsimile transmitter now employed by the broadcasters in their experimental service employs a scanning machine in which copy to be sent over the air is inserted in what is termed the "copy head."

This holds and advances the copy in front of the "scanning head," consisting of a small electric bulb, lens system and photocell. Light from the bulb is focused, as a small spot, on the surface of the paper carrying the copy and the reflected light is picked up by the light-sensitive photocell. The scanning head is moved from side to side by an electric motor so that the spot of light traces a series of parallel paths across the copy which is moved upwards through a distance equal to the diameter of the light spot at the end of each scanning stroke. In this manner, the entire surface of the paper is scanned, line by line, one hundred lines to the inch, the black, halftone and white areas reflecting to the photocell. Varying amounts of light ranging from minimum to maximum.

Diagram of connections between radio receiver and facsimile recorder.





Showing location of parts in "Copy Head."

With closed cover scanner is noiseless in operation.

These variations in reflected light effect a change in the amount of electric current flowing through the photocell which in turn controls the loudness of a high pitched whistle-like tone. The tone, called the "facsimile carrier" with its rising and falling sound characteristics, is then applied to ordinary broadcast amplifiers. These deliver it to the radio transmitter in the same manner in which sound broadcast signals are handled. No adjustments are necessary to attain maximum definition other than the optical line-up, bias and carrier-tone adjustment. Any conventional receiver tuned to the frequency of the transmitter will then pick up the signal.

However, in order for the broadcaster to utilize these signals he must have a recording machine to convert them back into their visible equivalents on paper.

The Finch "home" facsimile recorder is used for this purpose. It is self-synchronizing, an important advantage, which means that a recorder may be located in one state and the transmitter in another: meaning that the system does not have to depend upon the local power lines for synchronization. Recorders are made available for a-c or d-c operation, or for battery supply for farm use.

The automatic recording machine in many ways is similar to the scanning instrument. What is termed a "receiving copy head" holds the dry processed electro-sensitive recording paper which is fed as a continuous strip two newspaper columns wide from a roll carried in the lower part of the machine. A recording stylus .010 inch in diameter is then moved by a small electric motor from side to side across the surface of the paper, forming marks on the paper corresponding in position and quality to the elements of the copy at the transmitter. When the incoming signal is loudest the line traced is darkest, when it is weakest no trace is formed. At the end of each of these recording strokes the paper is moved up by an amount equal to that of the width of each line element. By means of extremely short low-tone signal impulses sent out by the transmitter just before the start of each recording stroke and by the use of a small motor turning at a predetermined speed the recording stylus moves across the paper in step with the scanning head of the transmitter, recording copy in its proper position. In this manner the recorded copy is built up line by line to appear as a duplicate of the original. One hundred lines will build an inch of type, or at the operating speed of the present machine a two column newspaper at the rate of five feet per hour. Increasing use of the machine will lead to requisite refinements. It is not impractical to hope for a newspaper of five columns in the near future. This is the tabloid size and the most efficient reading organ the newspaper profession has produced.

The actual home recording machine consumes about 100 watts and contains its own rectifier unit. It can be made to sell under $50.00 in mass production and is small enough to be housed as a complete unit in a small cabinet approximately a foot square. It may be connected without auxiliary amplifying equipment to the output circuit of any broadcast receiver having a power rating of four watts or more. A switch in the loudspeaker circuit is then em-

(*Continued on page 35*)

News item with photograph as received in the living room.

DAILY NEWS, WEDNESDAY, APRI

World's Finest Emerald

Purchase of a 65-karat emerald, the finest gem of it kind, by the socially prominent Mrs. T. Wallace Orr of Bermuda, was revealed yesterday in New York. The stone, valued at $250,000, formerly belonged to

-RADIO EXPORT STATISTICS-

Compiled by RMA

CALENDAR YEAR 1937

Month	Total	Receiving Sets		Receiving Tubes		Components	Loud Speakers		Other Accessories	Transmitting Apparatus
	Value	No.	Value	No.	Value	Value	No.	Value	Value	Value
JAN.	$ 2,584,207	59,457	$ 1,584,538	653,520	$ 280,597	$ 461,983	26,001	$ 58,600	$ 60,792	$ 137,697
FEB.	2,375,752	54,502	1,321,112	869,964	368,589	456,918	24,960	53,288	45,053	130,792
MAR.	2,608,360	50,955	1,306,115	1,002,800	417,836	548,921	37,929	75,641	53,017	206,830
APR.	3,097,706	60,393	1,532,255	1,056,446	442,847	701,238	41,871	84,780	91,494	245,092
MAY	2,538,104	38,241	984,058	777,472	319,299	718,968	45,711	91,068	92,943	331,768
JUNE	2,564,405	58,659	1,148,629	820,329	345,135	668,883	49,018	107,442	217,023	77,293
6 Mos.	$ 15,768,534	322,207	7,876,707	5,180,531	2,174,303	3,556,911	225,490	470,819	560,322	1,129,472
JULY	2,624,569	45,768	1,171,681	796,624	339,193	686,510	53,640	94,812	102,032	230,341
AUG.	2,688,898	50,973	1,224,945	760,877	333,239	648,405	38,965	74,070	96,344	311,895
SEPT.	2,833,895	56,735	1,502,753	765,200	328,143	599,237	31,596	67,258	141,000	195,504
OCT.	3,258,982	63,046	1,651,664	977,733	395,523	753,068	42,535	94,266	58,975	305,486
NOV.	2,696,018	64,297	1,569,812	597,939	245,374	555,527	17,201	41,672	50,654	232,979
DEC.	2,486,521	49,002	1,361,081	603,510	246,449	522,010	18,374	45,001	35,249	276,731
6 Mos.	$ 16,588,883	329,821	8,481,936	4,501,883	1,887,921	3,764,757	202,311	417,079	484,254	1,552,936
12 Mos.	$ 32,357,417	652,028	16,358,643	9,682,414	4,062,224	7,321,668	427,801	887,898	1,044,576	2,682,408

CALENDAR YEAR 1936

Month	Total	Receiving Sets		Receiving Tubes		Components	Loud Speakers		Other Accessories	Transmitting Apparatus
	Value	No.	Value	No.	Value	Value	No.	Value	Value	Value
JAN.	$ 2,039,522	46,951	$ 1,243,672	491,354	$ 227,822	$ 280,027	12,382	$ 29,801	$ 35,037	$ 223,163
FEB.	1,828,844	45,383	1,145,272	535,780	225,738	271,841	15,244	28,631	39,556	117,806
MAR	2,229,717	58,595	1,330,100	928,827	382,930	363,035	17,705	35,050	40,163	78,439
APR.	2,104,065	46,046	1,221,688	648,955	277,425	401,976	20,907	45,127	37,201	120,648
MAY	2,191,353	45,071	1,073,249	639,876	268,260	596,202	31,809	63,134	48,698	141,810
JUNE	2,006,336	39,460	863,221	647,596	277,037	522,116	40,378	83,983	43,689	216,290
6 Mos.	$ 12,399,837	281,506	6,877,202	3,892,388	1,659,212	2,435,197	138,425	285,726	244,344	898,156
JULY	2,048,610	35,877	870,342	785,573	317,852	516,049	43,049	93,771	50,430	200,166
AUG.	2,307,953	48,963	1,154,621	746,684	305,841	543,921	36,501	84,490	52,824	166,256
SEPT.	2,720,336	60,949	1,549,838	809,933	336,867	547,604	40,886	79,003	48,036	158,988
OCT.	3,246,129	74,905	1,987,503	868,480	366,888	650,537	35,875	69,829	52,140	119,232
NOV.	2,587,819	63,299	1,605,800	655,682	251,595	519,368	22,637	44,230	48,164	118,662
DEC.	2,973,567	76,869	2,003,915	632,493	273,482	447,052	22,524	49,139	44,412	155,567
6 Mos.	$ 15,884,414	360,862	9,172,019	4,498,845	1,852,525	3,224,531	201,472	420,462	296,006	918,871
12 Mos.	$ 28,284,251	642,368	$ 16,049,221	8,391,233	$ 3,511,737	$ 5,659,728	339,897	$ 706,188	$ 540,350	$ 1,817,027

GENERAL PURPOSE AUDIO AMPLIFIER

By **ALBERT PREISMAN**

RCA INSTITUTES, INC.

THE GENERAL-PURPOSE high-quality audio amplifier described in the following article should prove of interest to the audio engineer. It is the aim of this article not only to describe the constructional details, but to go into design considerations as well. The general specifications are given below.

GENERAL SPECIFICATIONS

The power output is twenty-four watts, and is furnished by two 6L6 tubes operating in push-pull (Class AB1). The gain of the amplifier is over 100 db when an input transformer is employed, or about 80 db when the input grids are connected through 250-ohm resistors to ground (500 ohms balanced input impedance). A pair of 6L7 tubes furnish volume expansion, and the amplifier is push-pull resistance-capacity coupled throughout, to reduce the expense and yet insure flatness of frequency response. The latter can be made flat within 1 db from 30 to 15,000 cycles, depending upon the quality of the input and output transformers, or upon the latter alone, if the former is omitted and the 500-ohm resistance input used instead.

TABLE I

STAGE	TUBE	PLATE CURRENT PER TUBE (Ma.)	SCREEN VOLTAGE	BIAS
1	6F5	0.30	–	-1.7 V.
2	6L7	0.4 (No Expansion)	90 V.	-8.0 V.
3	6C5	3.9	–	-8.0 V.
4	6L6	43.0	300 V.	-28.0 V.

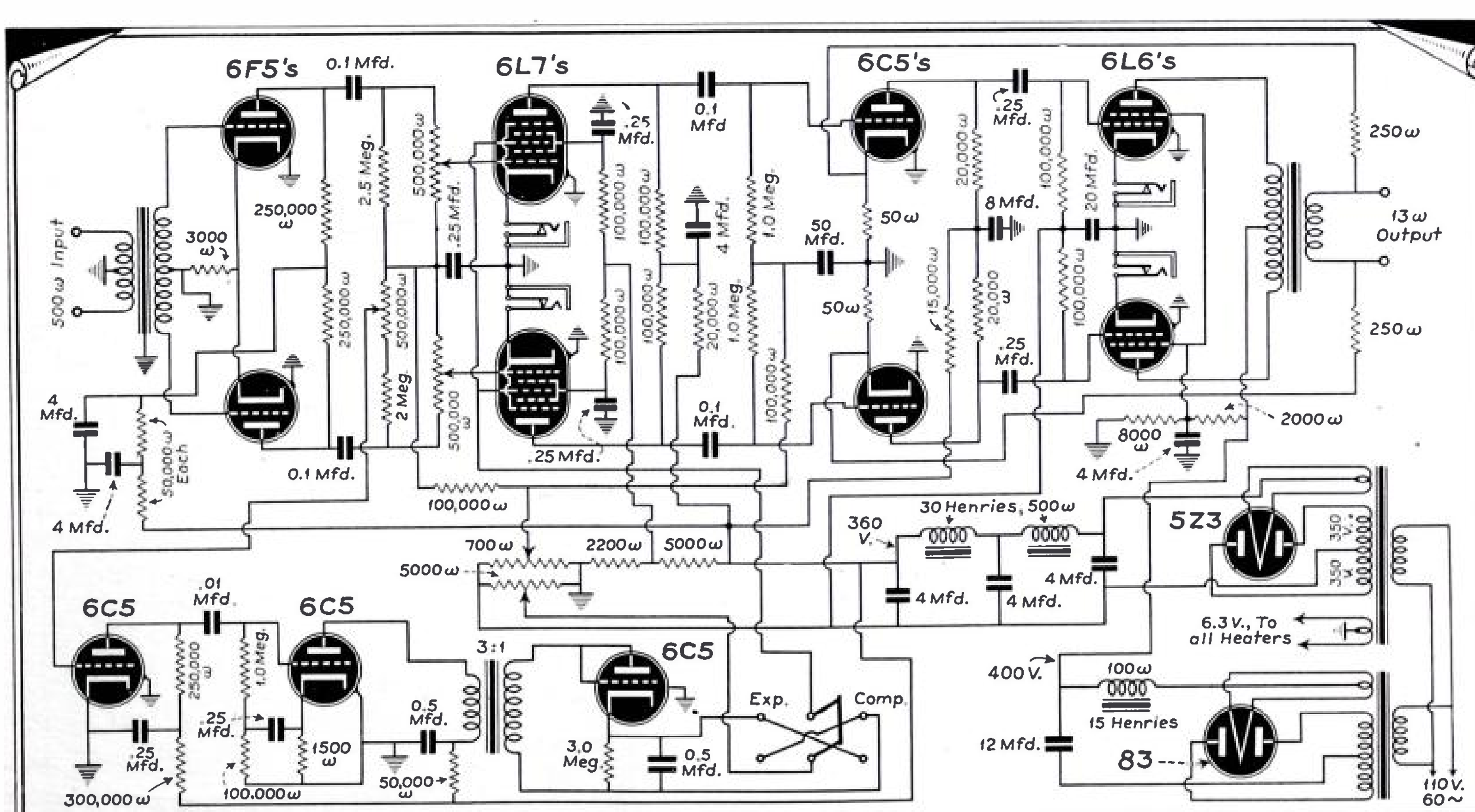
The volume expansion can be adjusted to as high a value as 30 db expansion for a 30 db change in input signal level, and provision can be made for controlling the "release" time of the expander circuit. Moreover, if it be desired to operate the amplifier as a fixed-gain unit the expander circuit can be shut off, and the gain of the 6L7 stage adjusted manually to give the amplifier any fixed gain desired.

Another feature is the use of inverse feedback for the last two stages. This is of the voltage type, and results in a low output impedance even though high-impedance 6L6 tubes are employed, as well as reduction in harmonic distortion and improvement of frequency response.

GENERAL ANALYSIS OF CIRCUIT

The design of such a high-gain amplifier involves the danger of regenerative feedback and oscillation. To obviate this as much as possible, two separate power supplies were employed: a 360-volt for the first three (voltage-amplifier) stages, and a 400-volt for the last (6L6) stage. Since the plate current of the latter varies appreciably with the signal level, and is, moreover, large in value, it was felt that the twenty-five to twenty-eight volts bias for the latter be best obtained from the voltage drop across a portion of the bleeder of the 360-volt supply, since this feeds substantially Class A stages. If the bias were taken off a bleeder in the 400-volt supply, it would either vary too much with signal level, or else would entail too great a bleeder current to steady it, and thus run up the

Fig. 1. Schematic diagram of the audio amplifier.



cost of the 400-volt supply. The 6L6 screen grids, however, are operated from a bleeder in the latter supply, since the bleeder current can be kept within reasonable limits and yet appreciably exceed the screen current and thus prevent the variations in the latter, with variations in signal level, from affecting the screen-grid voltage.

The power supplies are mounted on a separate chassis to prevent generation of 60-cycle hum by flux linkage between the power transformers and amplifiers input transformer. Even so, the latter should be thoroughly shielded with a heavy iron and copper case, and should be preferably of a hum-bucking construction. This is important because the input transformer may pick up hum not only from the power-supply transformer, but from any other a-c source, particularly a phonograph motor located near it.

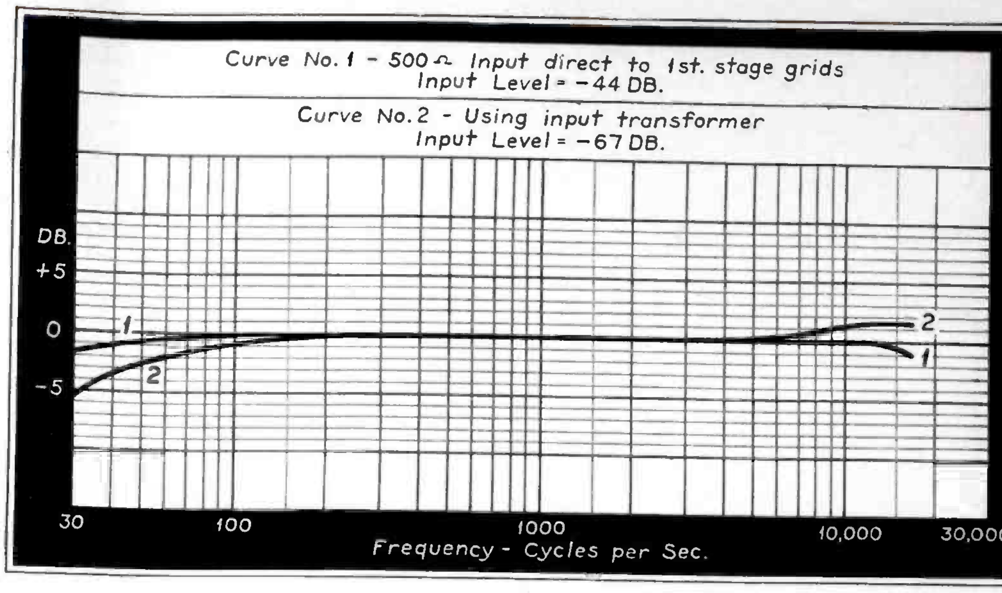


Fig. 4. Frequency response—output at 1,000 cycles = + 33.3 db.

The next problem is that of the volume-expander stage. The first question is as to whether it is to be of the single-side or balanced type of stage. In a previous article[1] the author pointed out that two variable-mu tubes having parabolic characteristics, when operated in push-pull, were capable of giving distortionless amplification, and at the same time volume expansion. (This implies that the two tubes remain balanced for all values of expander grid bias.) While the 6L7 tube has hardly a parabolic characteristic, for small amplitudes of grid swing its dynamic characteristic may be regarded as such, and hence should give no appreciable distortion when in balanced operation with another such tube. Indeed, even in single-side operation it is practically distortionless for small grid swings, which implies that even a linear characteristic is a fairly close approximation. However, it was felt that balanced operation was preferable here as insuring low distortion, and was therefore adopted for this amplifier.

The next question was as to which stage should furnish the expansion. The preceding analysis indicated that it should be a low-level stage. However, if the expansion occurred in the first stage, then the side amplifier, which rectifies a portion of the signal and uses the resulting d-c output to vary the bias of the expander grids, should bridge off ahead of this first stage, or at the very input terminals. This would necessitate a high gain in the side amplifier in order to obtain the requisite rectified d-c. In order to avoid this, a practical compromise was made, and the 6L7 tubes placed in the second stage. Thus the first stage acts not only as an amplifier for the normal amplifier, but also, simultaneously, for the side amplifier as well. Nevertheless, the signal level is still sufficiently low in the second stage to insure distortionless amplification when variable-mu tubes are used at that point.

Since the second and fourth stages are push-pull, it was advisable to make the third stage push-pull, too, and then it appeared reasonable to extend this type of operation to the first stage as well, and use resistance coupling throughout, except, of course, for the inevitable output transformer.

It must be borne in mind that resistance-coupled push-pull operation is not exactly the same as transformer-coupled push-pull in that in the former case the two sides of the circuit are not coupled to each other through the mutual inductance of the primary of a push-pull transformer. The two sides, therefore, behave exactly as if they were two separate single-side amplifiers as far as the plate load impedances are concerned. Nevertheless, if the tubes are similar, cancellation of even-order modulation products is obtained just as in the case of the more usual transformer-coupled type of balanced operation.

ANALYSIS OF FIRST STAGE

We can now proceed to an analysis of the individual stages, starting with the first one. A high gain is of value here, since it permits a lower gain in the side amplifier. Examination of the various tubes available indicated that the 6F5 was probably as well suited as any. It is a high-mu triode capable of a voltage gain of sixty-four when an a-c plate load of 156,000 ohms is employed. Referring to Fig. 1, it will be noted that the a-c plate load per tube is 250,000, 500,000 and 2,500,000 ohms in parallel or 156,000 ohms. The main volume control is after the side amplifier so that adjustment of the output level does not affect the amount of expansion. The latter is controlled by the separate one-half megohm potentiometer, in series with two megohms, and this is balanced with a fixed 2½-megohm resistor on the other side of the circuit.

The question of bias was solved by the use of a 3000-ohm self-bias resistor. It is not necessary to by-pass it since the signal level is so low. Otherwise, if it were not by-passed, there would be some production of odd-order modulation products by the interaction of appreciable second-order components in the bias mid-branch impedance with the non-linear characteristics of the plate circuits.

While push-pull circuits would appear to be more free from feedback due to the impedance of the "B" supply source, and hence less apt to "motor-

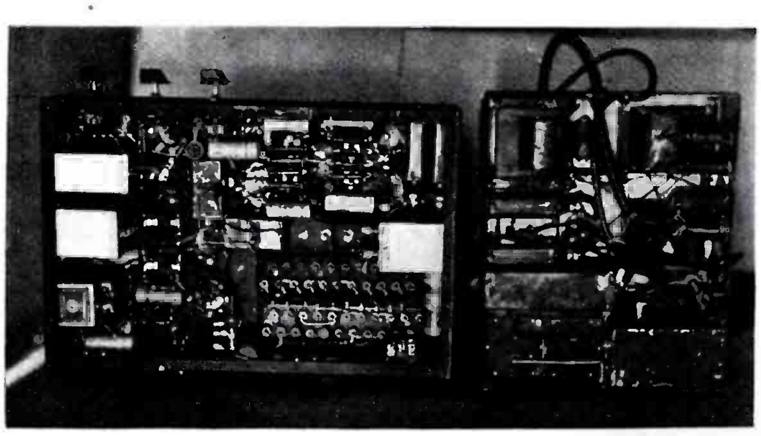


Fig. 3. Showing the layout of parts in the amplifier. Resistors and condensers are mounted below respective tube sockets with values easily readable.

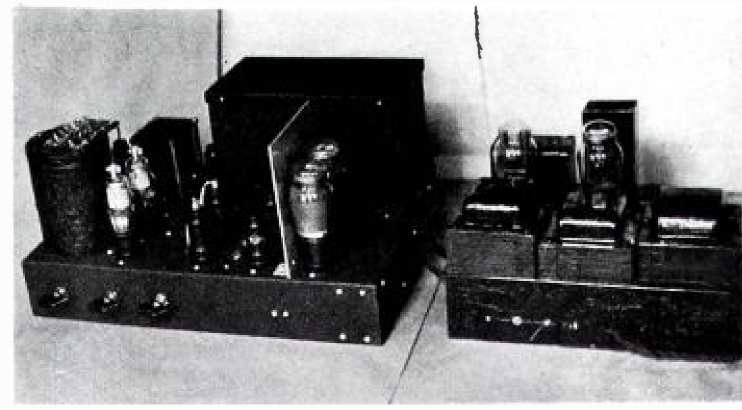
[1] "Balanced Amplifiers", Part III, *Communication and Broadcast Engineering*, September, 1936, A. Preisman.

boat" it will be found that actually this is not the case. The reason is that the two tubes of a stage may oscillate in parallel, due to mid-branch impedances. The mid-branch impedances in this case function as load resistors, and the normal load resistors as merely two additional load impedances acting in parallel. The feedback may then occur through the common "B" supply internal impedance as in the case of single-side amplifiers. The self-bias resistors, if not by-passed, may act degeneratively and prevent this oscillation, but if by-passed to obviate the generation of odd-order modulation products, may permit oscillation to occur.

Another effect is obtained if the two tubes in a stage are not identical in characteristics. In this case the stronger tube sets up a signal voltage across the mid-branch impedance which is in phase opposition to the voltage developed across the plate load resistor of the other tube. This tends to increase the unbalance between the two tubes, and should therefore be avoided.

To do so, it is necessary either to reduce mid-branch impedances to a minimum, use a common de-coupling circuit for each stage, or de-couple the two tubes of each stage from one another. While the latter is the most complete method, the second was found to be sufficient to insure stability. The first stage required a two-stage r-c filter, which is represented by the two 50,000-ohm resistors and the two 4-mfd condensers. In order to keep the size of the condensers within reasonable limits, the resistors were made of fairly high value, which in turn meant a "B" supply voltage of 360 volts. This, however, is not an uneconomical design when it is considered that the current drain is moderate, and it is to be noted that the use of 6F5 tubes, which draw only 0.3 milliampere apiece, permits the use of such high de-coupling resistors without requiring an excessively high "B" supply voltage.

Fig. 2. Showing physical layout of amplifier. The chassis at the left is of a standard size, 12 inches by 17 inches by 3 inches deep. The power pack, right, is mounted on a 10-inch by 12-inch by 3-inch chassis.



ANALYSIS OF SECOND STAGE

The 6L7 tubes in the second stage are combination oscillator and mixer tubes for superheterodyne reception, adopted here for volume-expansion purposes. The control grid is set at about —8 volts, and grid No. 3 operates as an expander grid. With zero signal its bias for 30 db expansion is about —7.7 volts. At full signal level the bias is about —2.1 volts. As a result the mutual conductance changes from a very low value to about 110 micromhos, at which value the gain of the stage is about 10. (This is for a screen-grid voltage of about 100 volts.) Thus, at low signal levels, this stage de-amplifies the signal in order that the 30 db expansion be attained. One noteworthy feature of these tubes is that the control-grid bias never changes, and is more than ample for any signal level encountered, so that overloading cannot occur due to these grids being driven positive, whereas if the expansion were accomplished by decreasing the bias on these grids, there might be such overloading at full volume, since the signal input would be relatively high (about 0.2 volt) peak, and the bias might be less than this.

Another point to note is the use of separate de-coupling R-C filters for the two screen grids. It was found that the signal crossed over at this point in the circuit from one side to the other. This was discovered by feeding a signal into one 6F5 grid and detecting signal on the third stage 6C5 grid on the opposite half of the amplifier. The above de-coupling circuits remedied this defect. In line with this it is to be noted that the plate circuits are de-coupled as a unit from the "B" supply by a 20,000-ohm resistor and a 4-mfd condenser.

ANALYSIS OF THIRD STAGE

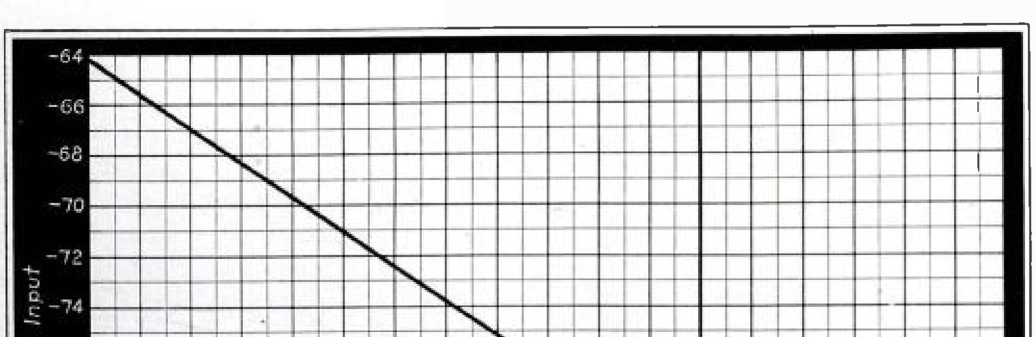
The third stage design is fairly straightforward, but was, nevertheless, complicated by the fact that it was a high-level stage, and that the grid resistors for the following 6L6 grids could not exceed 100,000 ohms each (tube manufacturer's restriction for 6L6 fixed-bias operation). In order that the a-c load line does not depart too far from the d-c load line, and thus on the negative half cycle of grid swing carry the operation into the curved region of the tube's characteristic, it was decided to use a relatively low plate load resistor. At the same time the latter must not be too low compared to the plate resistance of the tube (6C5) or the gain will be too low, and, in addition, entail a greater grid swing for maximum power output from the following 6L6 tubes. The value chosen for the plate load resistor was 20,000 ohms, which is twice the plate resistance of the tube and yet one-fifth of the grid resistance. This gives an a-c load line of 16,700 ohms, and a stage gain of 9.5 approximately. In addition to the plate load resistor of 20,000 ohms there is a de-coupling resistance of 15,000 ohms and a de-coupling condenser of 8 mfd.

ANALYSIS OF FOURTH STAGE

The 6L6 power tubes operate into a plate-to-plate resistance of 4400 ohms (Class AB1). The output transformer has a step-down ratio of 18.5:1 so that the secondary load impedance is 13 ohms. It was desired to employ inverse feedback of the voltage type to make the apparent tube impedance appear as low as that of a triode stage. Introduction of feedback into a resistance-coupled amplifier, however, is not so

(Continued on page 26)

Fig. 5. Output vs. input. Expansion adjusted for 30 db at 24 watts ouptput at 1,000 cycles.



MEASURING THE RECORDING SYSTEM
with Limited Equipment

By A. W. NIEMANN
SOUND APPARATUS COMPANY

THE TECHNIQUE of measuring the characteristics of a recording system is simple in large laboratories where unlimited equipment is available. For the average amateur and many professional recording engineers it is quite a different matter. Even in large educational institutions no elaborate apparatus is available for making such measurements. It is the purpose of this paper to describe procedures for checking the recording equipment with relatively simple measuring apparatus. In fact there is only one essential without which little or no such measurements can be made; that is, an oscillator or other source of steady reasonably pure sine-wave voltage of audio frequency.

The characteristics of the recording system which will be discussed include:

(1) Impedance measurements—matching

(2) Frequency characteristic

(3) Peak load capacity

(4) Non-linear distortion

(5) The maximum permissible amplitude.

While the accuracy of the measurements described here will not approach that of good bridge measurements the measurements are accurate enough for purposes of impedance matching and checking apparatus for trouble.

IMPEDANCE MEASUREMENT

Most recorders have impedances that are reactive and vary with frequency. The only exception is a moving coil or dynamic recorder. The impedance of such a recorder is principally a resistance and a fair measurement of its impedance can be made by measuring its direct-current resistance. A sufficiently accurate measurement may be obtained by applying the voltage of a single dry cell through a suitable milliammeter and measuring the current which flows. The ratio of applied voltage to resulting current is the recorder impedance. Such a recorder should be operated by an amplifier whose output impedance is approximately equal to the recorder resistance. In this measurement care should be taken to keep the current through the coil low enough to prevent damage. A sensitive milliammeter and a low voltage should therefore be used.

The greater number of recording heads on the market are of the electromagnetic type and have an impedance which is principally inductive and increases with frequency. Since the impedance varies with frequency it cannot be matched to the amplifier output impedance at all frequencies. Manufacturers usually design the recorder to give the specified frequency characteristic when driven by an amplifier having a given output resistance. If used with an amplifier having some other resistance, the frequency characteristic of the recorder will be changed. If impedance of the amplifier is lower than the specified value, the low frequencies will be accentuated; if the impedance used is higher than that for which the recorder is designed, the highs will be increased at the expense of the lows. Bad mismatches will not only cause serious changes in the frequency characteristic but might also require an amplifier much more powerful than would be necessary if the impedances are properly matched. It should be mentioned in passing that very few non-professional recording engineers know accurately what the output impedances of their amplifiers are. The confusion in this respect is increased somewhat by the practice of recommending that vacuum tubes be worked into a load of twice the tube resistance instead of matching the load to the tube resistance. This results in somewhat higher power output with a given tube distortion, but doesn't help the recording engineer whose recorder should be matched for proper response. Since it is important that the amplifier impedance as well as the recorder impedance be known if the proper results are to be obtained, a check on this impedance should also be made.

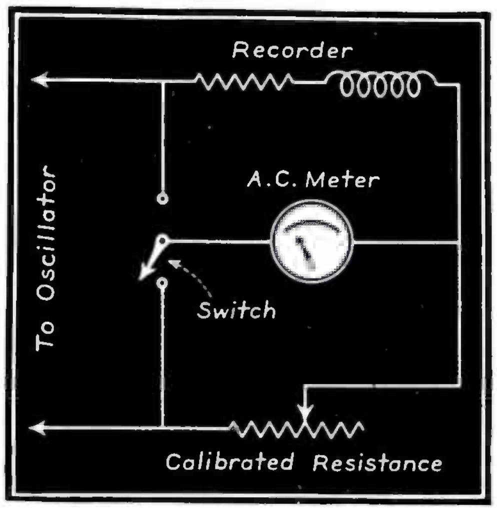


Fig. 1. Circuit used for measuring the recording system.

A practice has grown up of specifying inductive recorder impedances at a particular frequency and designing them so that if they are matched at this frequency the best recording characteristic will result. It is, however, desirable to measure the recorder impedance at this frequency and a few other frequencies as well. At high frequencies the impedance should be approximately proportional to frequency, doubling itself for every octave the frequency is increased. At the low end the impedance should decrease, but not proportional to frequency. It should flatten out to a constant value equal to the resistance of the winding at very low frequencies.

The equipment required to make a sufficiently good measurement of the recorder impedance includes: (a) a calibrated audio-frequency source (oscillator), (b) an a-c voltmeter, copper-oxide with one or two volts full-scale deflection will do, (c) a calibrated variable resistance, (d) a single-pole double-throw switch.

If no calibrated resistance box is available a substitute may be constructed from an ordinary wire-wound rheostat. Any suitably divided dial can be placed on the rheostat shaft and a plot of its resistance versus dial setting can be made with one or more dry cells of known voltage and a d-c milliammeter. By means of this curve the resistance for any setting at any audio frequency may be determined and the rheostat will serve as a calibrated resistance. An ohmmeter or wheatstone bridge is better for calibrating the rheostat if such apparatus is available. If a calibrated resistance box is available this, of course, is not necessary.

The measuring circuit used is shown in Fig. 1. The measurements are made as follows:

The oscillator is set at a suitable frequency, and the switch is first thrown so that the voltmeter measures the voltage drop across the recorder. The oscillator output is then adjusted so that a convenient reading is obtained, for example, mid-scale deflection. The switch should then be thrown to the other position. In this position it reads the drop across the rheostat. The rheostat should be adjusted until the meter reads the same as it did with the switch in the first position. The switch should be thrown back and forth until it is certain that the rheostat is adjusted so that the two readings of the meter are the same. The calibration of the rheostat dial settings will show the rheostat resistance which has the same value as the recorder impedance. This measurement should be repeated at a few chosen frequencies in the audio range and a curve of impedance versus frequency drawn. This method gives the magnitude of the impedance, that is,

$$Z = \sqrt{R^2 \omega^2 L^2}$$

where R is the effective resistance, L the inductance, and ω is $2\pi f$, and f the frequency used in making the measurement. The inductance can be measured by using a frequency high enough that ωL is large compared to R. In this case the magnitude of the impedance is ωL, and a division by $2\pi f$ will give L.

While it is desirable that the voltmeter used in this measurement be of sufficiently high resistance to draw only a small amount of current, the measurement will not be in error if the meter does draw appreciable current as the switch in effect exchanges the relative positions of the two impedances in the circuit and equal voltage readings denote equal impedances.

While the circuit is set up to measure the recorder impedance a satisfactory measure of the recording amplifier impedance can be made. The tubes of the recording amplifier should be heated and the proper plate voltages for operation applied. The input terminals of the recording amplifier should be short circuited. This does not affect the output impedance in any way and insures against any stray voltages being picked up on the input grid and, consequently against any such voltage being amplified and delivered to the output terminals. After this precaution is taken, place the output terminals of the recording amplifier where the recorder impedance is shown in Fig. 1. Next short circuit the terminals leading to the oscillator. If there is no reading on the meter the circuit is ready for measurement. If a substantial reading is obtained when the oscillator output is short circuited the proper precautions against stray voltages being picked up by the amplifier have not been taken, or there is an undue amount of hum or other noises in the amplifier. When the circuit is ready the measurement is made exactly as in the recorder measurement. The amplifier impedance should approximately be the same at all frequencies in the audio range, however, instead of varying widely with frequency as the recorder impedance does and measurement at one or two frequencies should be sufficient.

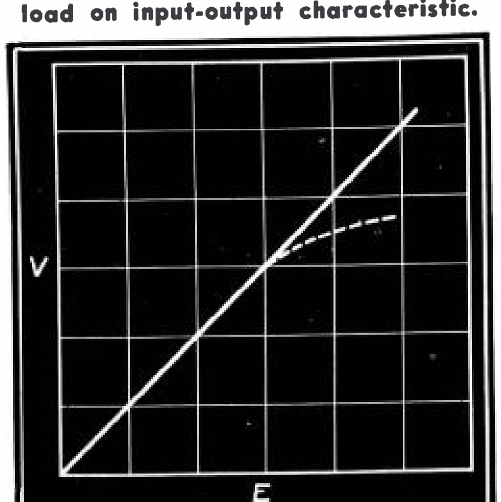
Fig. 2. The frequency characteristic may be measured by means of a light band.

FREQUENCY CHARACTERISTIC

The fidelity of a recording is limited principally by the frequency characteristic of the recording system. At least this is true except in very wide-range systems where surface noise and needle-tracking problems become the limiting factors. The statement is especially true in most direct-playback recording systems where only a limited amount of money can be spent for equipment. The method of measuring the frequency characteristic to be described below will give the overall response of the amplifier and recorder. This is really the important measurement and should show a reasonably flat response over the range of interest if good recordings are desired.

It has been shown by Meyer[1] and others that a phonograph record, which has been cut by a stylus moving at a variable velocity and frequency will reflect a certain kind of light in a manner which permits a measurement of its frequency characteristic to be made with calipers, or an ordinary ruler. Consider first a record cut at constant velocity. If parallel rays of light are allowed to strike this record coming from behind the observer, the record can be held so that the reflected light will cause a bright band to appear on the record. This band will be of constant width all along the radius of the record. If the velocity of the stylus varies as the record is cut the width of this band of light will vary and the width where the band crosses any groove will be proportional to the velocity of the stylus when the groove was cut. It should be kept in mind that the width of this light band does not vary if the frequency is changed unless the change of frequency is accompanied by a change of stylus-point velocity. This principle is the basis of the measurement of the frequency characteristic. Fig. 2 shows the light band and displays the frequency characteristic of a high-quality direct-playback recorder.

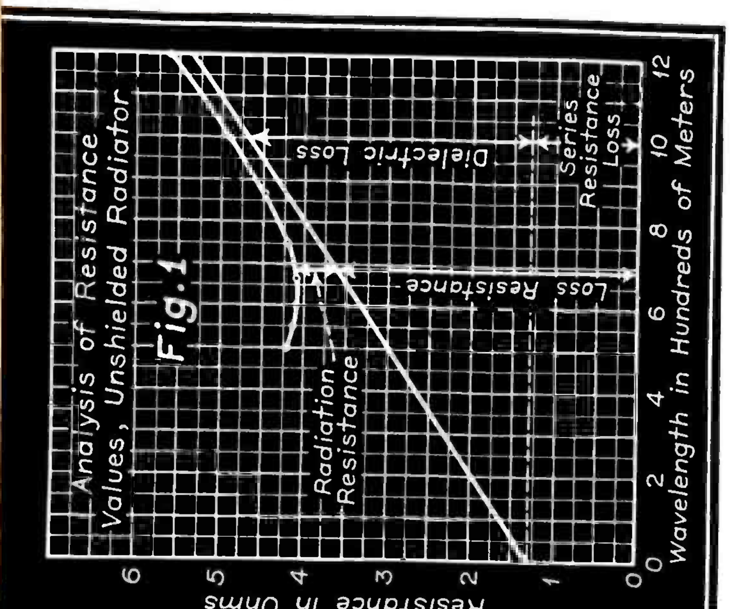
Fig. 3. Showing the effect of overload on input-output characteristic.

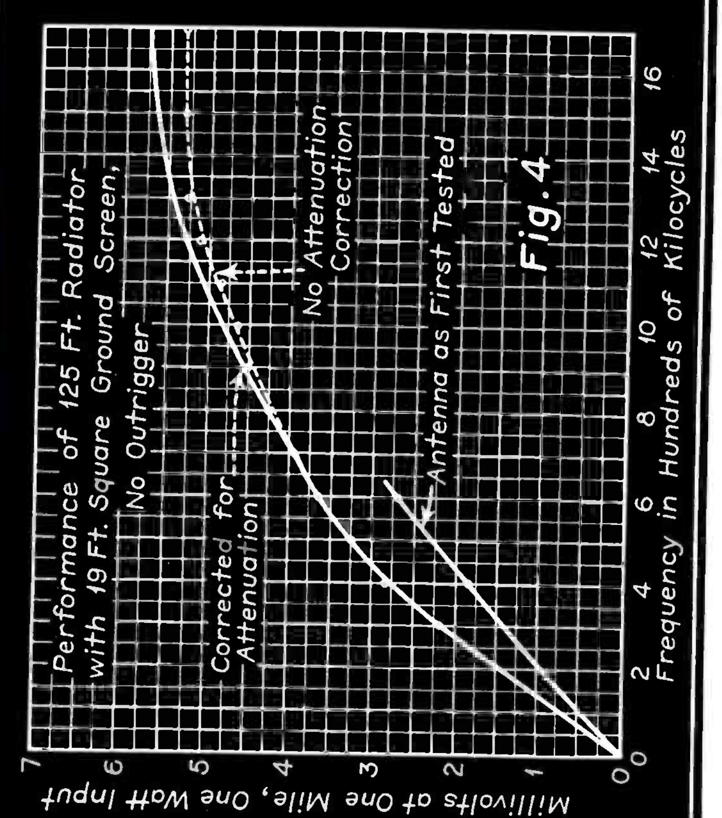


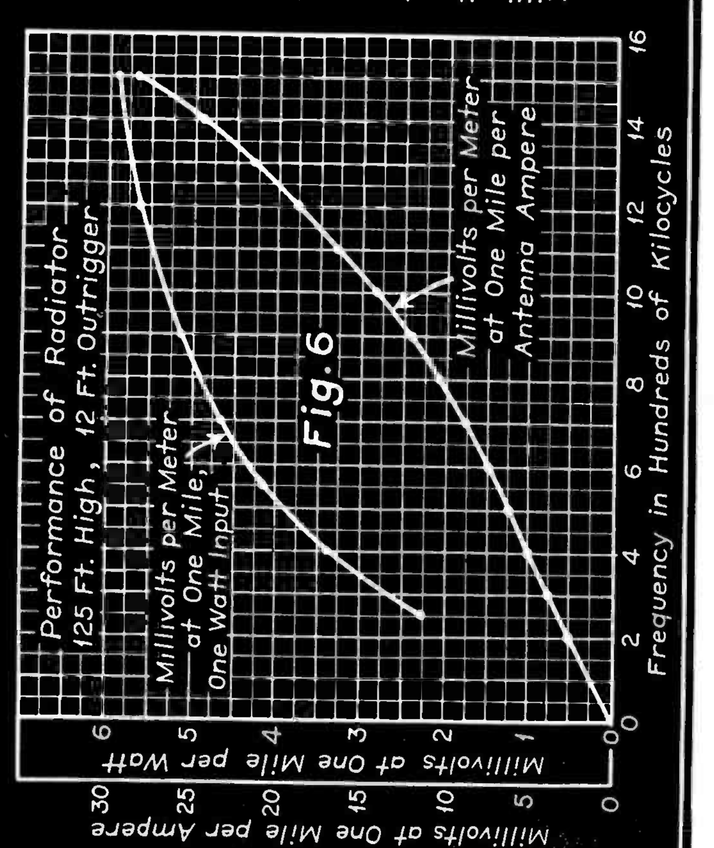
The equipment needed in addition to the recording system to be measured is an oscillator and a calipers. The most convenient form of oscillator is a beat-frequency or heterodyne oscillator whose output voltage is constant with frequency. If such an oscillator is available its output should be connected to the input of the recording amplifier through a suitable volume control so that the first stages of the recording amplifier are not overloaded. When this is done the level of the output of the recording amplifier can be set by its own volume control. A blank record should then be placed on the turntable and the level set for recording. As the record is cut the tuning dial of the oscillator is slowly turned so as to sweep through the frequency range of interest. The record when held in a beam of parallel light rays will then show a light band the width of which varies as the frequency characteristic of the amplifier and recorder. As shown in the photograph, if the system is flat the width of the light band will be constant and no oscillator calibration will be needed. If, however, the characteristic shows a bad peak or other undesirable variations it is necessary to determine the frequencies at which these variations occur. One way to get a complete frequency calibration is to repeat the recording and interrupt by means of a key the recording current from the oscillator at predetermined frequencies on the dial. If these interruptions are long

(*Continued on page* 36)

[1]Buchmann U. Meyer: "Eine neue optische Mebmethode fur Grammophon-platten," ENT, 1930, Heft 4.







A SHORT RADIATOR

By CHARLES E. SCHULER

Manager—Electrical Department

IN ORDER to study the effectiveness of short antennae for both radio beacon and broadcast service, a 125-foot tower was erected and equipped with a ground system such as used by the Department of Commerce on the Airways Range Beacon Stations. This ground system consists of eight radial wires 85 feet long buried approximately 18 inches and connected at their inner ends to a ground ring about 10 feet in diameter surrounding the tower foundation. The outer ends of the radials were connected to 6-foot ground rods. A small ground screen 9 feet square was also installed and connected to the ground system along its boundary. The conductivity of the ground in the vicinity of the antenna is very close to 10^{13} E.S.U. In view of the present broadcast practice, this ground system might be said to be very inadequate, but the results of these tests will show that when the proper precautions are taken a large number of radials are quite unnecessary. For example, the increase in antenna resistance resulting from the elimination of four of the eight radials was only .3 ohm and was entirely independent of frequency.

The first tests performed on the tower were in the frequency range 250 to 600 kc. The tower equipment consisted of only the 9-foot square screen and the eight radials. No outrigger was used. The antenna resistance was measured and plotted against wavelength as shown in Fig. 1. The field strength at a constant current of one ampere and at a distance of one mile was measured. The field strength at constant current is shown in Fig. 3 and this curve, as a result of later tests, has been drawn for frequencies up to 1700 kc. The field strength per watt input initially obtained is given in Fig. 4. The performance of the radiator under these conditions is far from satisfactory. The loss resistance as obtained by subtracting the radiation resistance from the total resistance is quite high, as a glance at Fig. 1 will show. At a frequency of 300 kc it appears as though the dielectric loss resistance was in neighborhood of 3.4 ohms and series loss resistance 1.3 ohms.

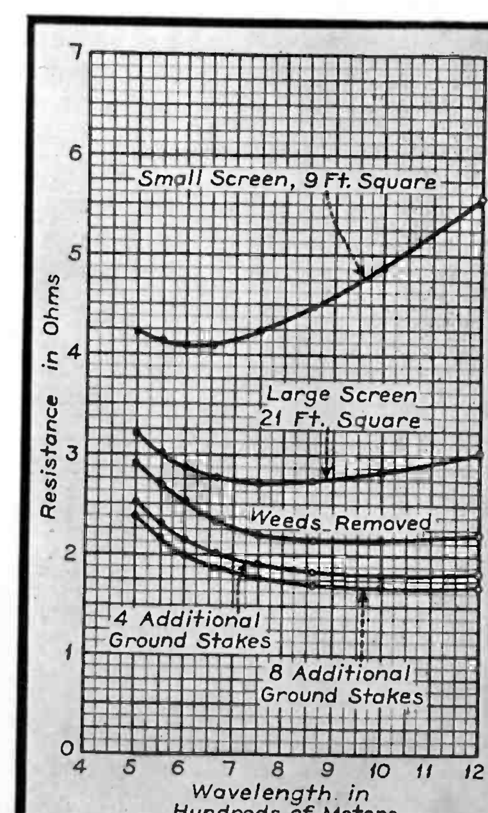
According to our ideas of the usefulness of the screen, it should be possible to reduce the magnitude of the dielectric loss resistance by suitably designing a screen to be placed at the base of the antenna. Fig. 2 shows the results obtained by increasing the size of the screen, removing some high weeds that existed at and beyond the boundaries of the screen and the improvement of the ground connection that was provided by additional ground stakes driven at edges of 19-foot square screen.

It will be noted that the reduction of loss resistance caused by the removal of weeds growing through the screen is of importance. From Fig. 2 and on a wavelength of 1,200 meters, the loss resistance was reduced by .76 ohm.

A practical method to utilize this behavior is to provide a layer of crushed rock or concrete; in fact, anything which will suppress the growth of vegetation underneath the screen. A screen buried under the surface is ineffective.

The mere presence of the screen would seem to be the largest single fac-

Fig. 2. Performance of radiator, reduction of loss resistance.



WITH GROUND SCREEN

INTERNATIONAL DERRICK
& EQUIPMENT COMPANY

tor affecting the reduction of the loss resistance. It is noticed in Fig. 2 the lowest frequency at which measurements were made was 600 kc. In order to investigate the performance of the tower at frequencies throughout the broadcast band, the resistance measurements were extended to frequencies up to 1500 kc. The field strength per ampere in the antenna was also determined at a number of points in the frequency range 250 to 1500 kc. The resistance is shown in Fig. 5. The field strength per ampere and the field strength per watt input at one mile for the tower equipped with screen are given Fig. 4.

To summarize the results of Fig. 4, it is seen that the field strength per watt input at a distance of one mile at a frequency of 500 kc is 3.45 millivolts per meter. As the frequency is increased, the performance and efficiency of the antenna improve until at a frequency of 1500 kc, the antenna provides a field strength of 5.65 millivolts per meter at one mile. The value of the field strength at a distance of one mile per watt antenna input can be derived as follows:

At any frequency, the field strength at a distance of one mile per ampere antenna current is read from Fig. 3, and the antenna resistance at the same frequency determined from Fig. 5. The power input to the antenna to produce this field is simply the antenna current squared times the value of the resistance. Inasmuch as the antenna current is maintained at one ampere, the power input is numerically equal to the antenna resistance in ohms. To correct the field strength figures to one watt input, it is then necessary to divide the field strength per ampere by the square root of the resistance in ohms. In this way, the field strength at one mile per watt antenna input is easily determined.

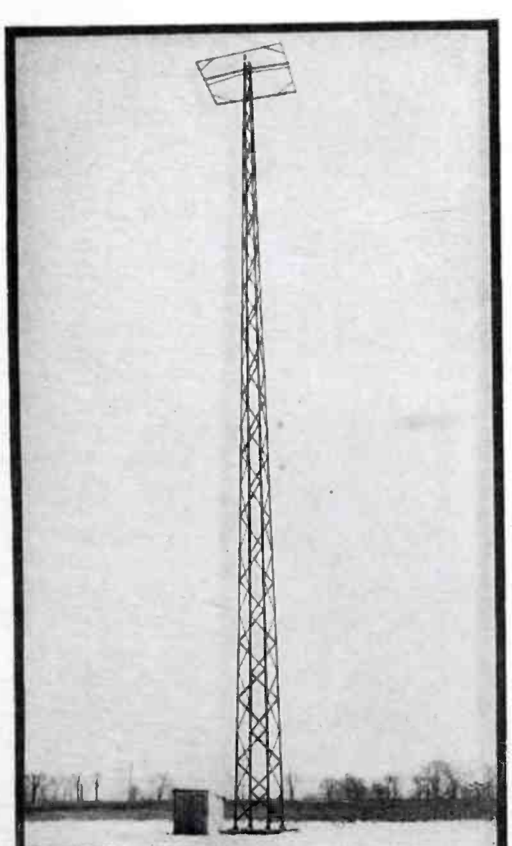
The antenna performance as shown in Fig. 4 was not deemed entirely satisfactory and it was decided to equip the antenna with a convenient size outrigger. This outrigger was a 12-foot square structural framework placed at the top of the tower. After the installation of the outrigger, the field strength per ampere was again determined and the antenna resistance measured. The results of these tests are shown in Fig. 5 and Fig. 6. The antenna performance at constant power input of one watt was again calculated as before and this is also shown in Fig. 6. The improvement in antenna performance is quite gratifying, the field strength value at 550 kc being 4.15 millivolts per meter at one mile, and at 1500 kc. 5.9 millivolts per meter at one mile. The intermediate values are proportionally higher throughout the frequency range.

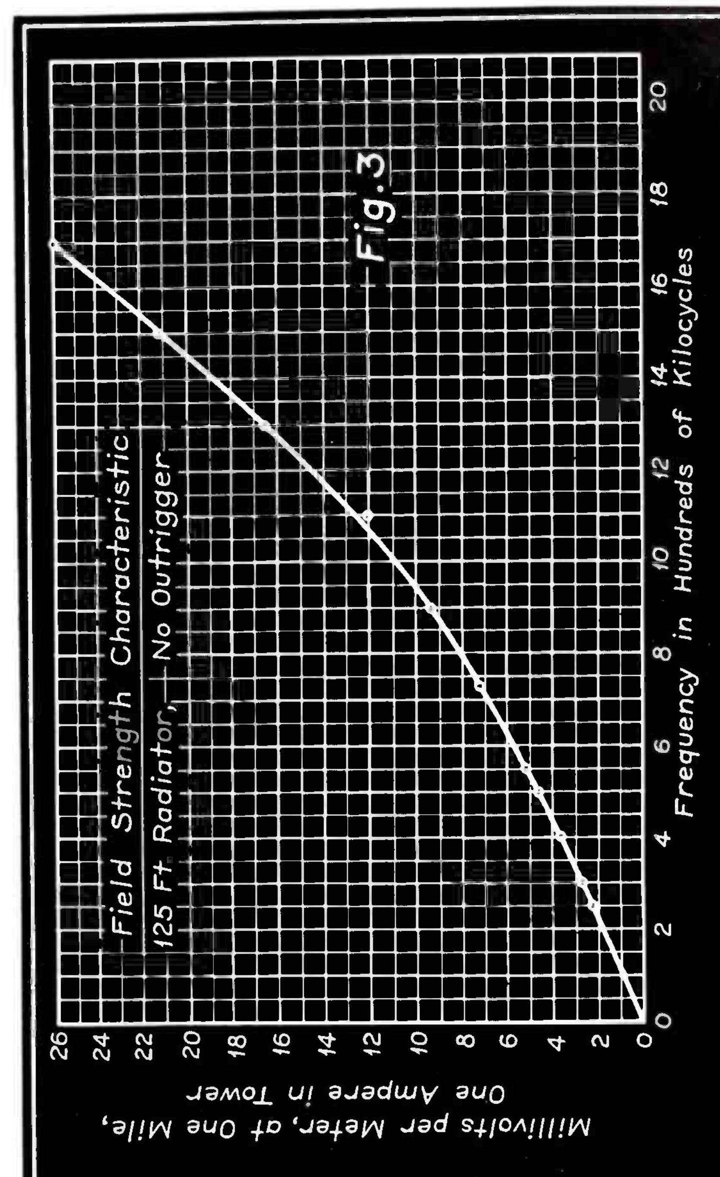
The foregoing tests show that this 125-foot tower, equipped with ground screen and outrigger, provides a field strength in excess of the minimum requirements of the Commission for the following classes of stations and in the following frequency ranges:

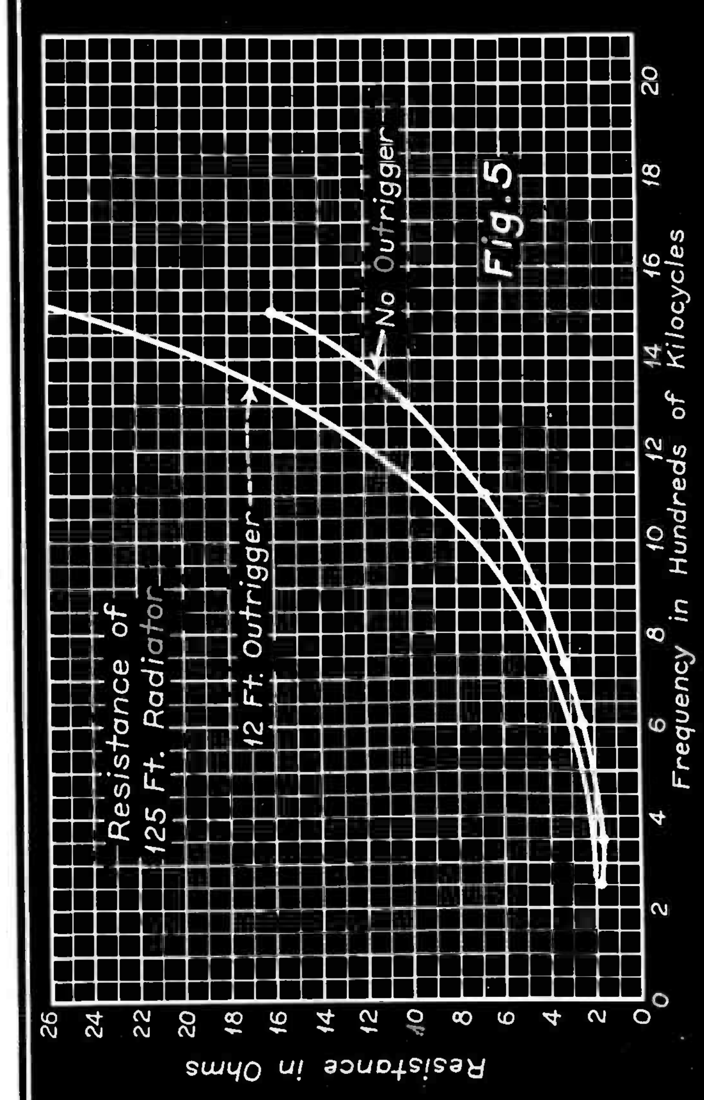
1—Local stations 550 to 1500 kc.
2—Regional stations 750 to 1500 kc.
3—High-power regional stations (5 to 10 kilowatts) 1150 to 1500 kc.

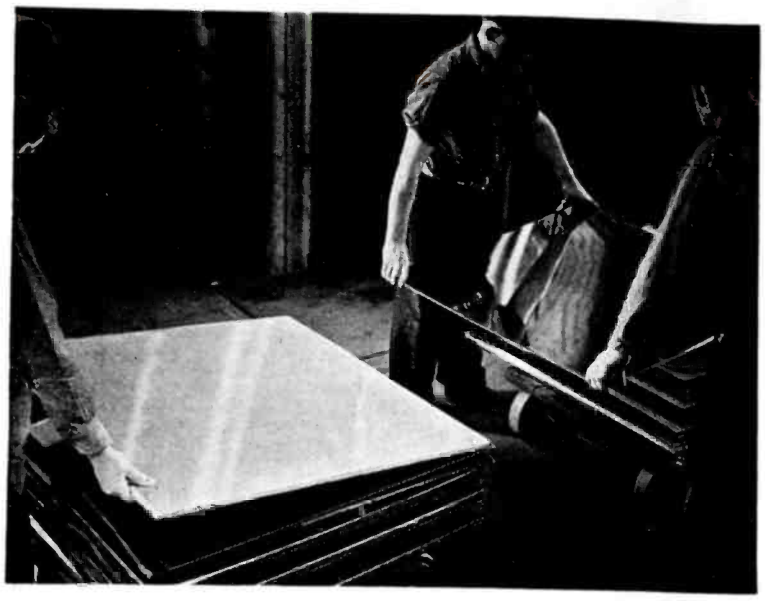
In addition, the economy of these radiators should result in their being highly satisfactory in directive arrays.

The one hundred and twenty-five foot experimental antenna.









(3) After drying, the processed material is cut and stacked between metal plates.

THE MANUFACTURE OF

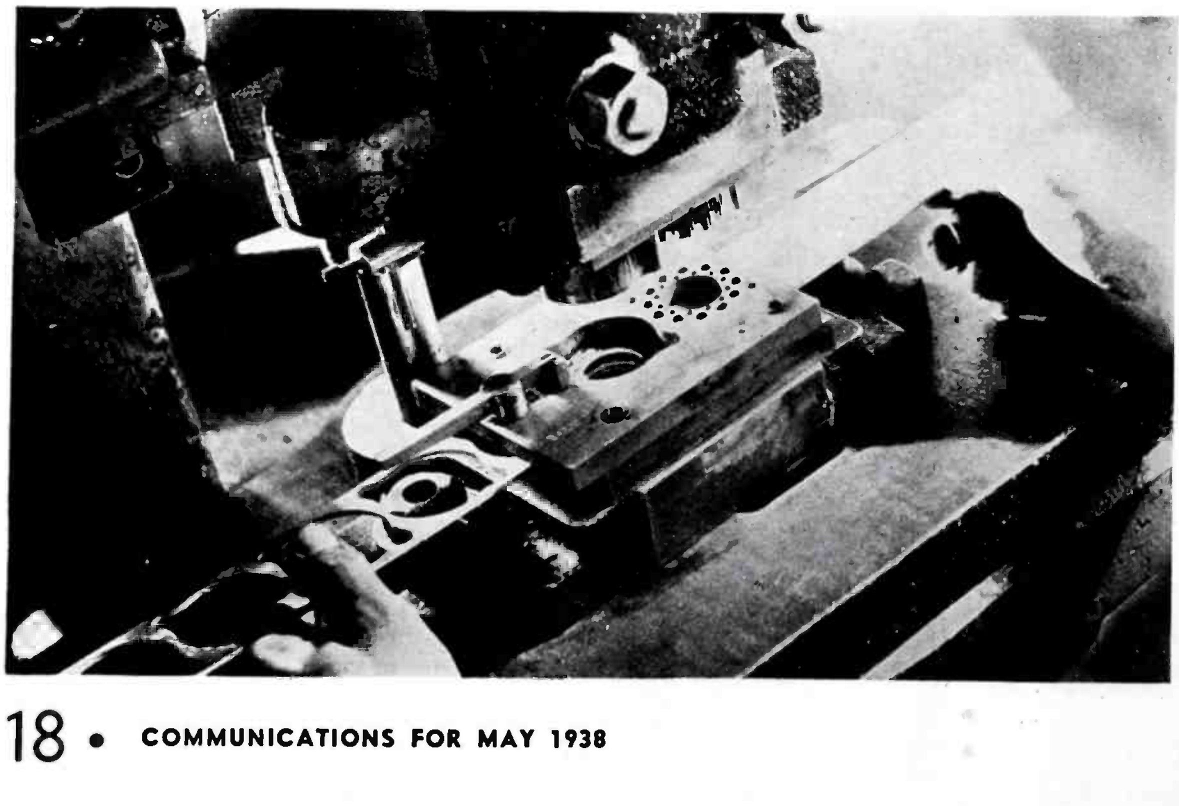
The engineer specifying laminated plastics for insulating purposes is apt to take for granted the fact that this type of material offers him a dependable dielectric without giving much thought as to why the material is a good insulator. He is interested primarily, and rightly so, in what the particular material will do for him rather than why it will do it. If he had the time, he might try to find out why it is a good insulator and how it is possible to produce such a product.

On this and the following page are illustrated various steps in the manufacture of laminated plastics, the extensive use of which is due in large measure to the care and precaution taken in the production of these materials. Each successive step in the processing of laminated material is scientifically controlled to produce a product with uniform physical properties.

It is the resinoid that imparts to the laminated product its dielectric characteristics. Generally speaking, an increase in the resinoid content results in a product of improved dielectric strength. However, no single property such as dielectric strength or surface resistivity is responsible for the use of Bakelite as an insulator. Its service in the field results rather from the combination of high frequency and mechanical strength, heat and water resistance, combined with the chemical inertness that makes these qualities permanent.

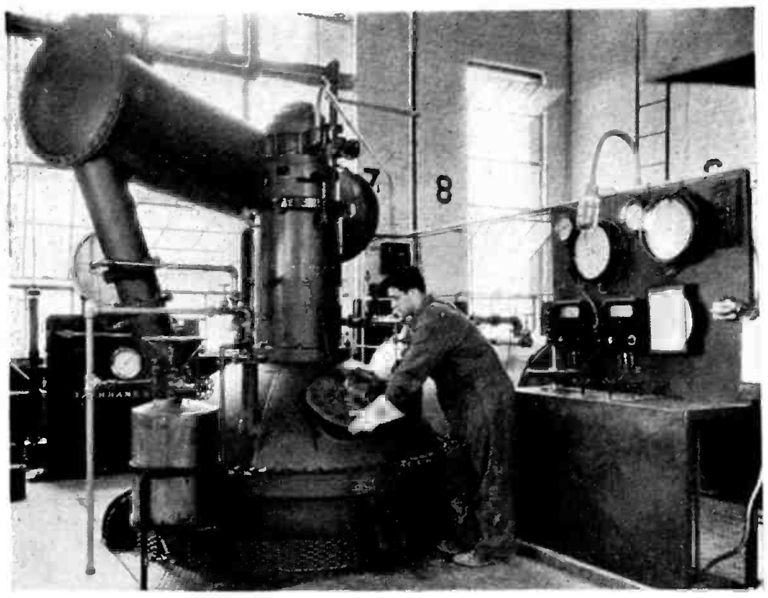
Photo courtesy Synthane Corp.

(4) A number of the sheets, depending on size desired in finished product, are placed in a hydraulic press, where, under action of approximately 350°F heat and from 2,000 to 8,000 lbs./sq. in. pressure, the resinoid-impregnated layers become a hard homogeneous sheet.

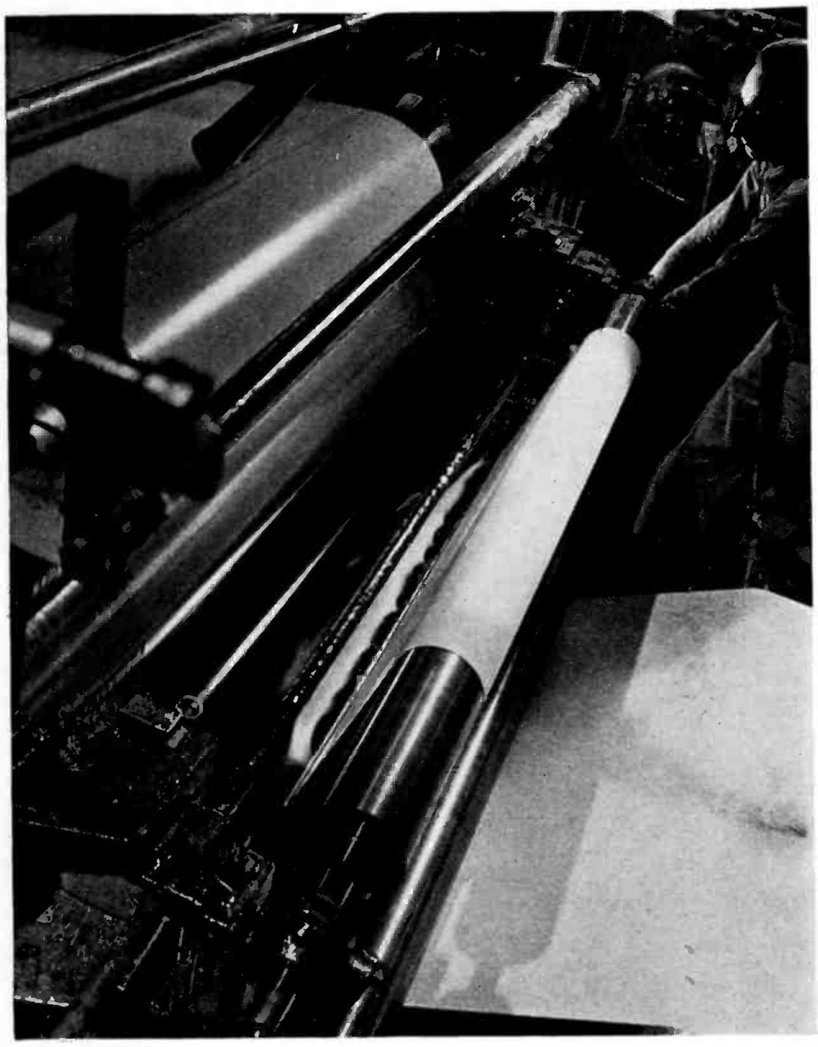


(5) Laminated products may be fabricated with ordinary machine tools, sawed, drilled, planed, milled, punched and polished.

LAMINATED PLASTICS



(1) The production of the resinoid is scientifically controlled to insure uniformity.

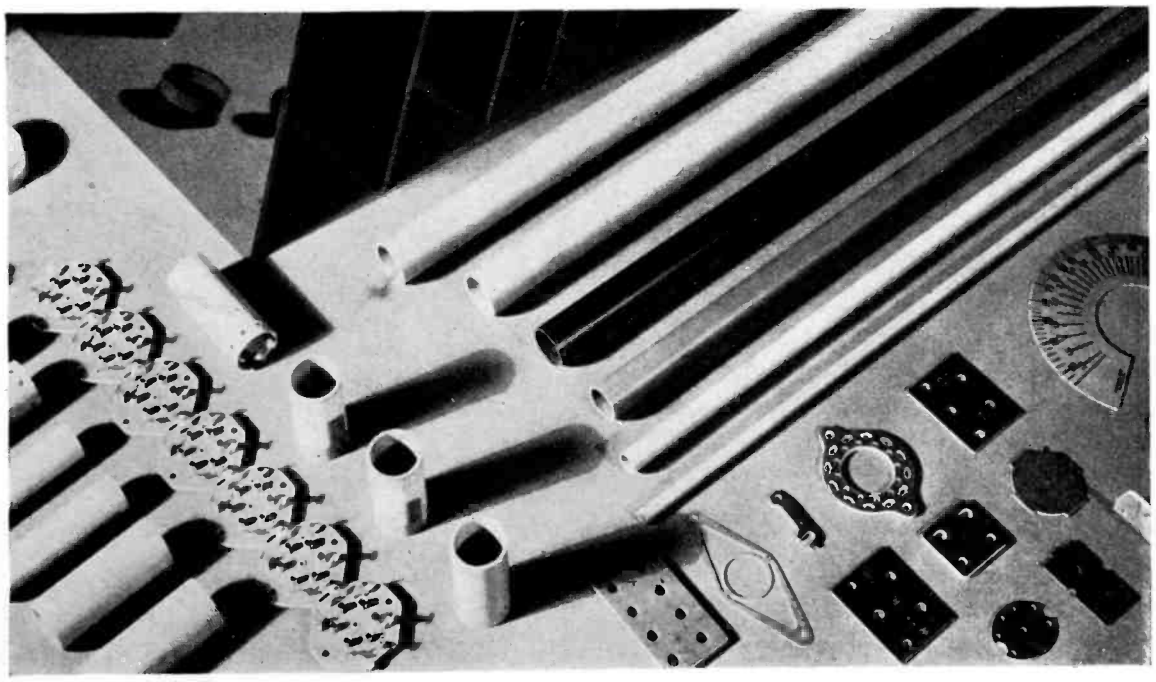


(2) The resinoid is dissolved in solvents to provide a varnish for impregnating paper or fabrics, which form the filler or base of laminated products. By means of rollers, the sheet of fabric passes continuously through a resinoid varnish bath for impregnation.

In the manufacture of laminated plastics, the initial resinoid is dissolved in solvents to provide a varnish. The varnish is then used to impregnate the laminated sheet, which is either paper or cloth. Impregnation is accomplished on special machines. By means of rollers the sheet passes continuously through a dip tank or other device by which the varnish is applied in a uniform coating. The varnish-laden sheet passes from the dipping operation to a dryer where the solvent is evaporated. After being freed of solvent, the processed web is cut into sheets of convenient size. A number of these sheets, depending upon the size desired in the finished product, are then superimposed and placed in a hydraulic press. Under the action of heat and pressure, a hard, rigid plate is produced. The mass of resinoid-impregnated layers has been transformed into an infusible and insoluble sheet which will not delaminate. cannot be resoftened by heat and is non-hygroscopic.

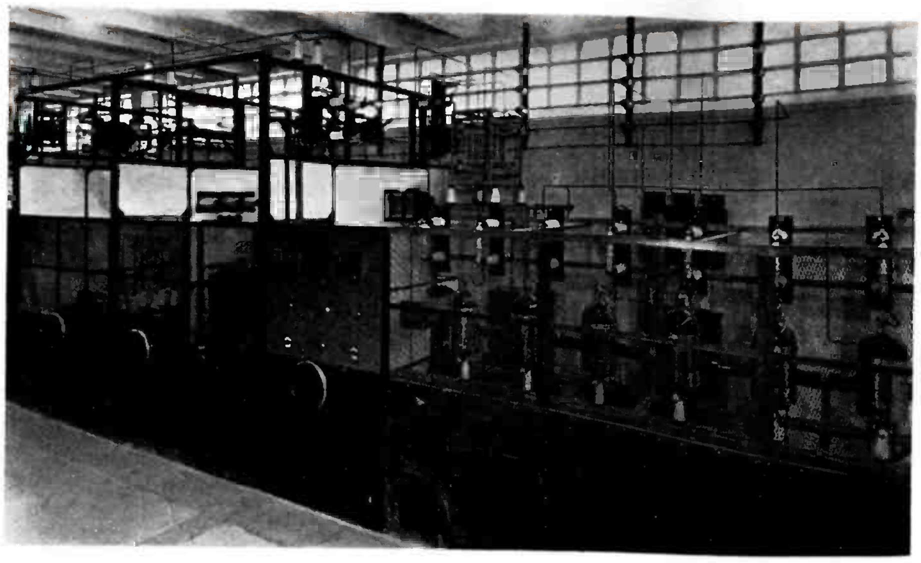
There are many different types and grades of laminated products which are specially designed to meet specific requirements. Certain grades have greater dielectric strength than others and these types have been standardized.

The illustrations on this and the opposite page are used through courtesy of the *Bakelite Corporation.*

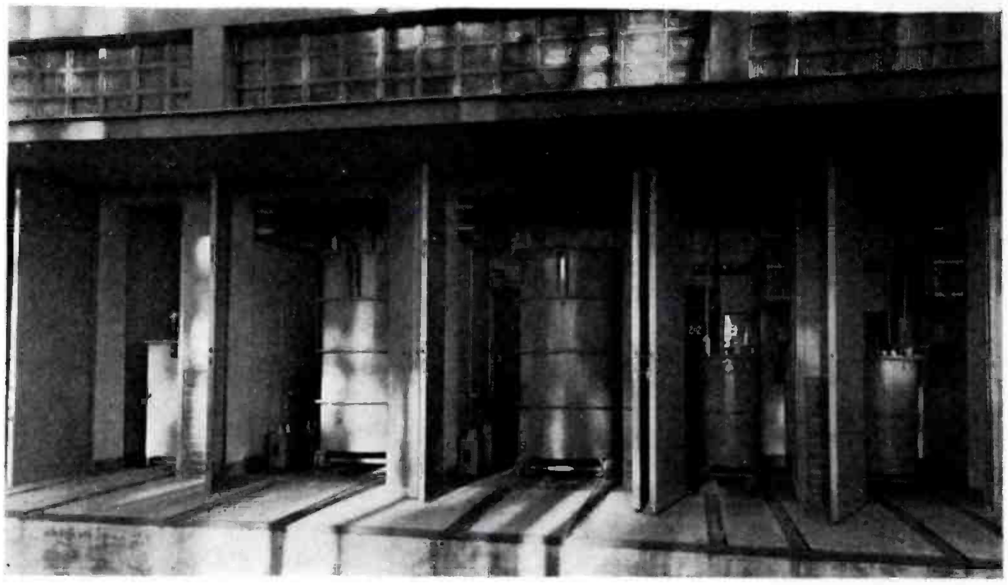


(6) Group of laminated radio insulation parts. In radio, Bakelite laminated is used extensively as insulating material.

MELNIK'S 100-KW BROADCASTER

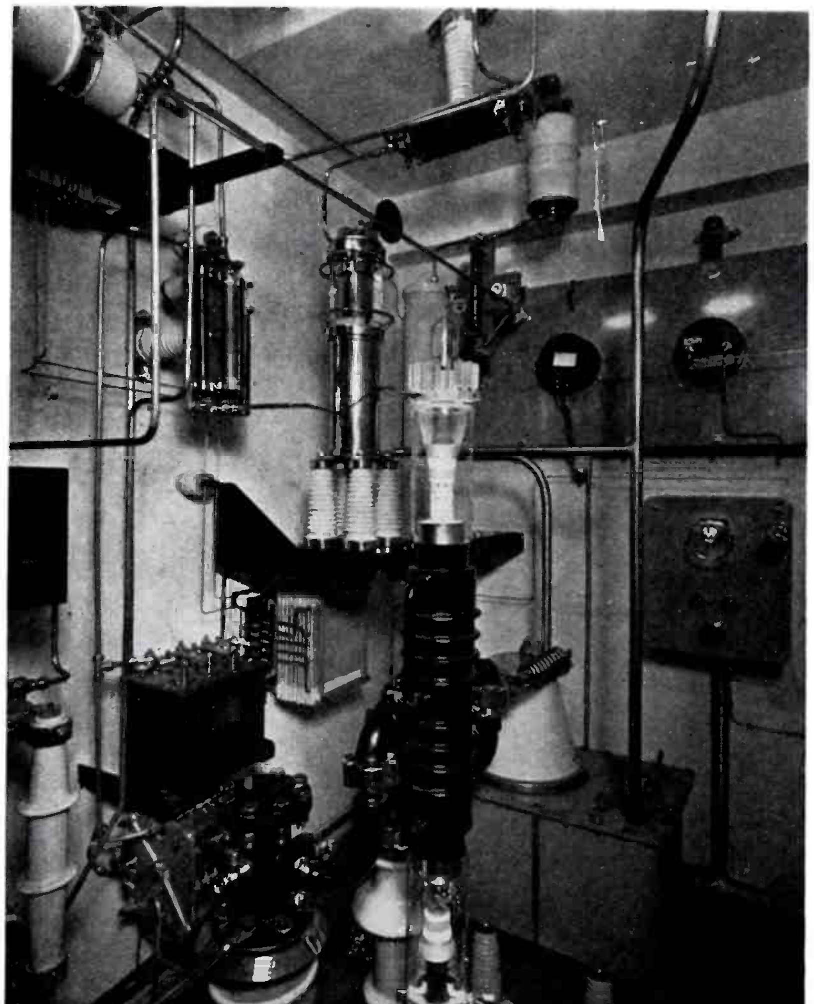


H.C.M.V. rectifier, showing oil circuit breaker cubicle, H.T. transformer cubicle and rectifier cubicle. This 100-kw, 1113-kc station was designed and manufactured by the English subsidiary of the International Telephone and Telegraph Corp., Standard Telephones and Cables, Ltd., and installed in cooperation with the Government engineers of Czechoslovakia.



View of audio-frequency transformer and reactor cubicles, showing one of the five reactors, the two modulation transformers, and the two interstage transformers. Among the unique features of this transmitter is the provision for cutting in quickly the complete reserve equipment. This is done by employing cubicle construction and by placing the reserve equipment on tracks so that it can be moved into place quickly.

Final high-frequency amplifier tube cubicle. Six such cubicles are installed, four working and two in reserve, the tubes working in a parallel push-pull circuit.



Kolben steel tank mercury-arc rectifier, showing H.T. transformer cubicle and rectifier cubicles.

STANDARD SPEECH-INPUT UNITS

for Broadcast Studios

By JOHN P. TAYLOR

IN THE FIRST of this series of articles on broadcast speech-input equipment[1] the more important features of units of this type were discussed in a general way. Since performance is the first requisite of such equipment the emphasis was naturally placed on that point. Nor can the importance of a high order of performance be underestimated. However, having once decided on his requirements as to performance, the station engineer may well wish to carry his analysis somewhat further—and, in all likelihood, to incorporate in his specifications additional requirements bearing on such factors as appearance, mechanical design, construction, physical layout of units, accessibility of components and the like. In any event—and regardless of whether or not included in the preliminary consideration—such an analysis is correctly the second step in the selection of the units which go to make up a speech-input installation.

At the outset this "number two" consideration must necessarily recognize a major difficulty—i. e., the impossibility of reaching definite all-inclusive conclusions. In the "number one" considerations—that is, of performance—it was indicated that fairly hard and fast standards could be laid down, leaving relatively little room for difference of opinion. But when it comes to these somewhat less important, but still not to be overlooked physical aspects of this equipment, the situation is quite different—for here there is plenty of leeway for personal choice. In the early days of broadcasting—in fact, up to just a few years ago—speech-input constructions were pretty much alike, and finishes were invariably "soft black" (albeit the blacks had an almost unbelievable lack of match). Today, a glance at the speech-input field reveals several distinct types of construction—with any number of minor variations—and finishes anywhere from black or grey to the latest pastels. In so far as the latter are concerned (assuming that the finish is durable and not too-given to fingerprinting) there is little basis for scientific choice—you simply like a particular finish or you don't. In regard to construction, each type has advantages and disadvantages—with the balance probably favoring the more expensive types, but with the final choice still depending much on personal preference.

[1]John P. Taylor, "Selecting Speech-Input Units," COMMUNICATIONS, April, 1938.

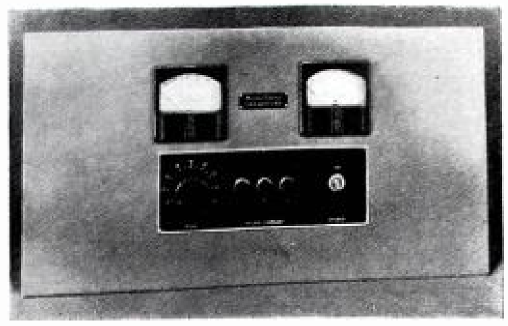


Fig. 1-A. The Type 105-A studio amplifier with built-in VI meter.

One way of approaching an analysis of these various types of speech-input construction is by a brief review of typical units of the several most popular lines. Obviously it is impossible to include all of the hundreds of equipments offered in this field—or even those of every one of the numerous manufacturers. However, the units offered by the five or six largest manufacturers make up an overwhelming proportion of the equipment sold in this field, and hence are sufficient for illustration. It should hardly be necessary to add that the equipments illustrated are in each case the newest line of the manufacturer—in most instances units of older lines are, of course, still available for stations wishing to make additions to existing installations.

Fig. 1-B. The 94-C monitoring amplifier.

Fig. 2. Type 104-A preamplifier, a small plug-in type unit which may be mounted in a variety of ways.

WESTERN ELECTRIC

Western Electric rack-type speech-input units for broadcast station use comprise four amplifier units and a complete line of auxiliary panels, together with a special limiting amplifier designed to accomplish compression of audio peaks. Each unit is complete in itself, and each of the amplifiers includes a built-in power supply (except that the preamplifier obtains plate voltage from the main amplifier). Thus, external power connections are required only where a telephone panel or relays are employed. The "studio" amplifier (also sometimes referred to as the "main" or "program" amplifier) of this line is shown in Fig. 1. The panel of this and the other units is provided with a "soft-grey" finish, with the front-of-the-panel controls grouped on an etched panel finished in black and silver. Square-type illuminated meters are used. More or less the same appearance is followed throughout the other units, so that the assemblies provide essentially symmetrical appearance. The mechanical arrangement of these units makes use of a "recessed panel" construction. The major components, such as tubes, condensers, transformers and the like, are mounted on a vertically placed sub-panel—with the terminals and wiring between the sub-panel and the main front panel. Access to the latter is therefore from the front—that is, by removing the "face mat" or front panel. Access to tubes is from the rear of the equipment.

As noted above the Western Electric line includes four rack type amplifiers—that is, studio, line, monitoring and program types. In the most recent arrangements the preamplifiers used are of small single-stage, fixed-gain units. One of these is illustrated in Fig. 2. As will be seen, this is a small chassis-mounted unit which may be utilized in a number of different ways. In a typical assembly three or four of these—that is, those associated with a single speech channel—are mounted on the back of a single rack panel. A plug-in arrangement allows easy substitution of a spare unit in case of failure.

RCA

RCA speech-input units for broadcast stations make up what amounts to two complete lines. The first of these—the "deluxe" line—features the so-called "network-type" construction and design (i. e., utmost emphasis on quality and reliability). The second, the "economy" line, is the most recent recognition of the fact that small stations oftentimes require equipment different from that of their larger brothers. While the performance and fidelity of the units of this "economy" line is indicated as substantially equal to that of the larger equipments, the emphasis has been placed on obtaining this at a minimum of expense.

The appearance and construction of the deluxe-type units is indicated by the several views of the Type 40-D amplifier, Fig. 3, which is the "studio" or "main" amplifier of this line. In appearance these units—styled by John Vassos—are modern to a degree. The finish of the panels is optionally grey or black, with chromium-plated trim. A notable part of the latter are the fin-like louvers which are provided in each of the amplifier panels (in order to obtain front ventilation where enclosed cabinet-type racks are used). Looking at the rear view it will be seen that all of the main components are mounted on a horizontal subpanel, which is hinged at the rear. This allows the whole assembly to be swung backward through 180 degrees, thereby providing access to terminals and wiring on the bottom of the chassis. Similarly, front access to tubes is provided through the medium of front doors. The whole arrangement probably represents the maximum in accessibility achieved to date. Other features of this line include nickel-plated components and chassis, push-button metering, and streamlined meters and control knobs. In addition to the studio type amplifier shown, there is a three-channel preamplifier, a line amplifier, monitoring amplifier, a limiting amplifier, a complete line of auxiliary panels, and a special series of test panels which include a low-distortion audio oscillator, a distortion-measuring equipment, and a special attenuator panel.

The RCA "eçonomy" line is unique among high-fidelity broadcast units in that each of the equipments is furnished mounted on a subpanel base—with the desired type of panel mounting to be ordered separately. The program amplifier is illustrated in Fig. 4—the unit being shown alone, as nominally furnished, and also with a special panel and shelf assembly which allows it to be conveniently mounted on a rack. When the latter arrangement is used, front access to tubes is provided by the hinged door in the panel, while access to wiring is possible by lifting the unit from the shelf on which it sits. Still another type of panel mounting for use with these "economy" units consists of a plain panel on which the assembly may be mounted in a vertical position—that is, with the bottom of the base up against the back of the panel. Units of this line include, in addition to the monitoring amplifier shown, a studio amplifier, an isolation or line amplifier, and a small preamplifier. Two of the isolation amplifiers, or six of the preamplifiers, may be mounted on a single panel and shelf assembly of the type shown in Fig. 4. These two-units are also used on occasion, with the deluxe-type units. In general the auxiliary panels of the "economy" and "deluxe" lines are interchangeable.

COLLINS

The newest line of Collins speech-input equipment constitutes a series of conveniently - laid - out units having many of the features of the equipments described previously. The Type 7-S amplifier—which is the main amplifier of this line—is shown in Fig. 5. The panels of these units are nominally finished in black crystaline but are available in color on special order. Square type meters, finger grip controls and push-button metering are front-of-the-panel features. The construction of the main units of this line is illustrated by the exploded view of the amplifier. Here again, the tubes and other main components are mounted on a vertical sub-panel. In this case, however, these components are toward the front of the unit, while the terminals and wiring are

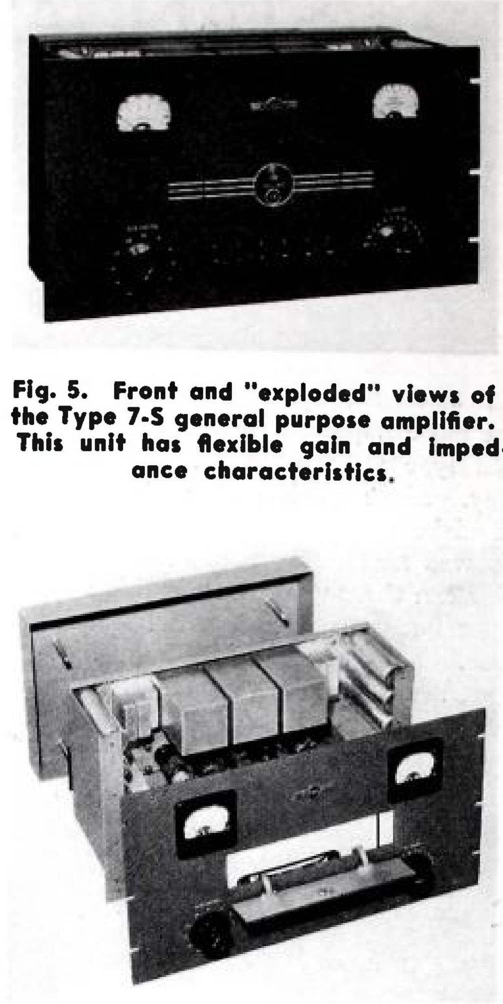


Fig. 5. Front and "exploded" views of the Type 7-S general purpose amplifier. This unit has flexible gain and impedance characteristics.

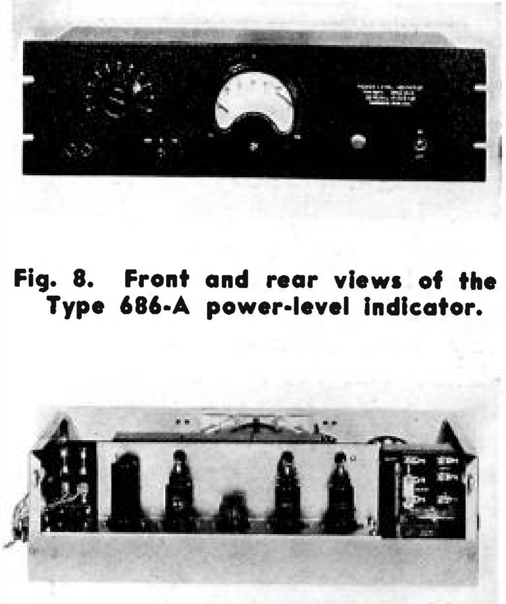


Fig. 8. Front and rear views of the Type 686-A power-level indicator.

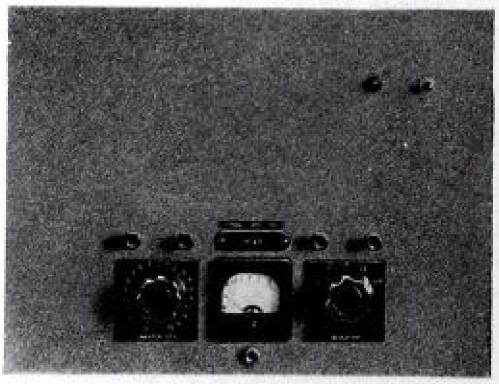
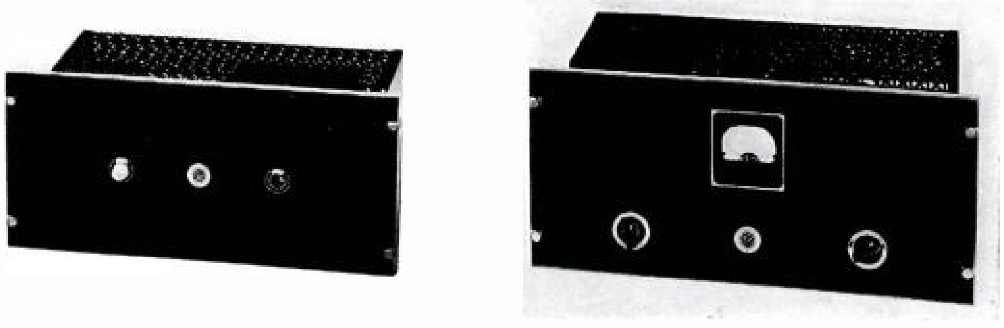
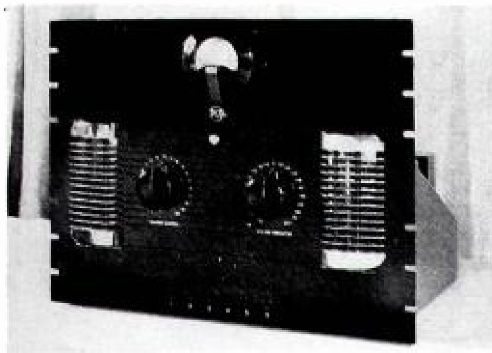


Fig. 6. The Type 106-C program amplifier. This unit has a built-in VI meter and also includes a special amplifier switching arrangement.

Fig. 7. The Type 7-A amplifier and associated Type 8-A power supply.





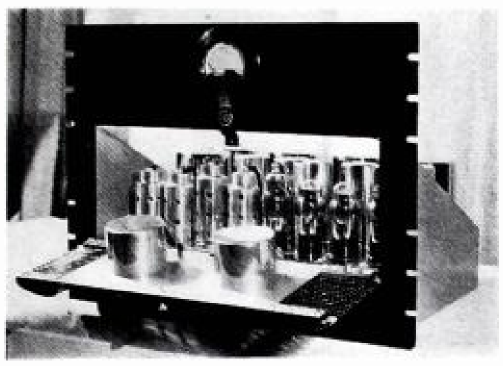
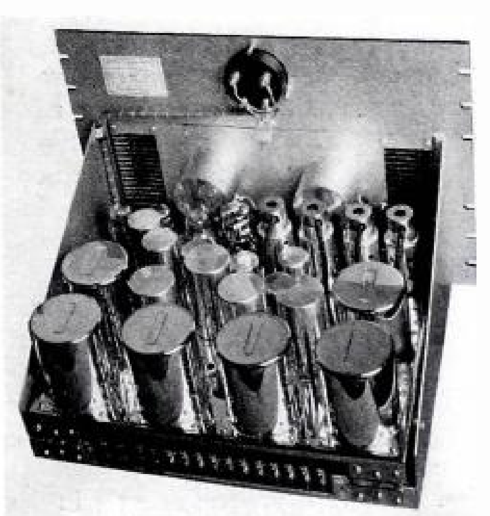


Fig. 3. Several views of the Type 40-D studio amplifier, which includes a built-in floating VI meter. In this type of construction components and tubes are mounted on a hinged subpanel, as may be seen in the bottom view.



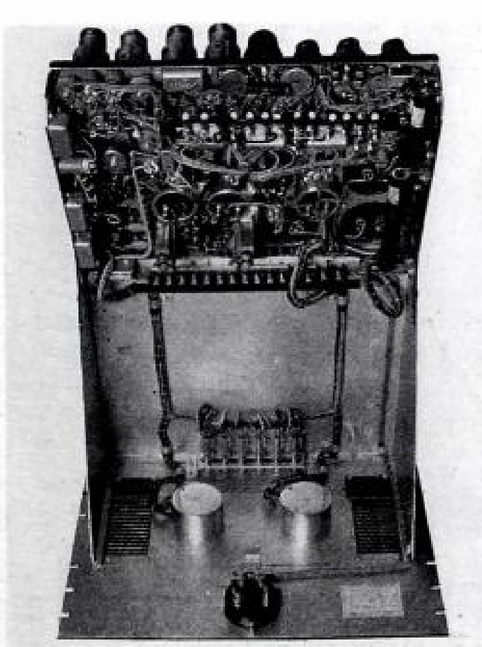


Fig. 4. The 82-A monitoring amplifier (left) as normally furnished, and (right) mounted in a Type 36-A panel shelf.

toward the rear. In operation the latter are protected by a rear dust cover which is held in place by aircraft-type fasteners. Small hinged doors in the front panel of the unit provide immediate access to tubes.

The 7-S amplifier shown has unusually flexible characteristics as to input and output impedance and gain, thereby allowing it to be used interchangeably for various applications and reducing the number of different types of units which are used. In addition to this unit the Collins line includes a preamplifier of somewhat similar type construction—that is, it is a single panel-mounted unit—a bridging amplifier of the chassis type, which may be mounted directly in the speaker cabinet or on the back of a plain rack panel, and an extensive line of auxiliary panels, including a rather unusual speaker switching panel.

GATES

Gates speech-input equipment for broadcast station use comprises a series of panel-type units which in arrangement and layout follow the larger-type equipments described previously. The Type 106-C amplifier, which is the main-amplifier unit of this line, is shown in Fig. 6. The finish of this panel, and of the other units of this line, is grey-ripple enamel with escutcheon-plates, meters and knobs of contrasting black. The tubes and other main components of these equipments are mounted on vertical subpanels which are attached to the back of the front panel. Thus access to all tubes is from the rear—while wiring is reached by removing the subpanel. An unusual feature of the program amplifier illustrated above is an output switching system which is so arranged that when two amplifiers are used in a studio circuit, the second amplifier can be cut-in simply by operation of the key on the panel—thereby eliminating the necessity for patching in the emergency unit as would otherwise be required. The second amplifier, in this case, may be used for auditioning or recording in the interim—all of the necessary switching being accomplished without use of patch cords. Push-button metering, and a built-in volume indicator are other features of this amplifier. In addition to this unit the Gates line includes a preamplifier—of the single panel-mounting type—a monitoring amplifier, auxiliary panels, and a rather unusual equalizer panel which provides for either low-end or high-end compensation.

UTC

In addition to a very extensive line of high-quality components for broadcast and other uses, the United Transformer Corp. offers a number of assembled rack-type units particularly adapted for broadcast station use. The studio-monitoring amplifier of this line is shown in Fig. 7. An etched panel, with trim extending all the way around the outer edge and around the meters and other controls, is used on this panel as well as the several other units of this line. In the case of both this amplifier and the preamplifier, the power supply is built in a separate panel-mounted unit of equivalent dimensions and appearance. Tubes and other components are mounted on subpanel bases which are fixed to the front panel in either horizontal or vertical fashion. Access to tubes is from the rear. In each case the subpanel assemblies are provided with metal shields for mechanical protection. The Type 7A-8A amplifier which is illustrated can be used with either of several combinations of tubes in the output stage. Thus it may be effectively utilized as either a studio amplifier or a monitoring amplifier. In addition to this unit this line includes a preamplifier—of the single panel-mounting type—and several types of attenuator, equalizer and filter panels.

GENERAL RADIO

Although specializing in test and measuring equipment rather than in the broadcast field, the General Radio Company offers several rack-type units suitable for broadcast use. The Type 686-A power-level indicator is a good illustration. This unit, shown in Fig. 8, is mounted on a black crackle-finished panel designed for standard rack mounting. The rear construction of this unit

(Continued on page 39)

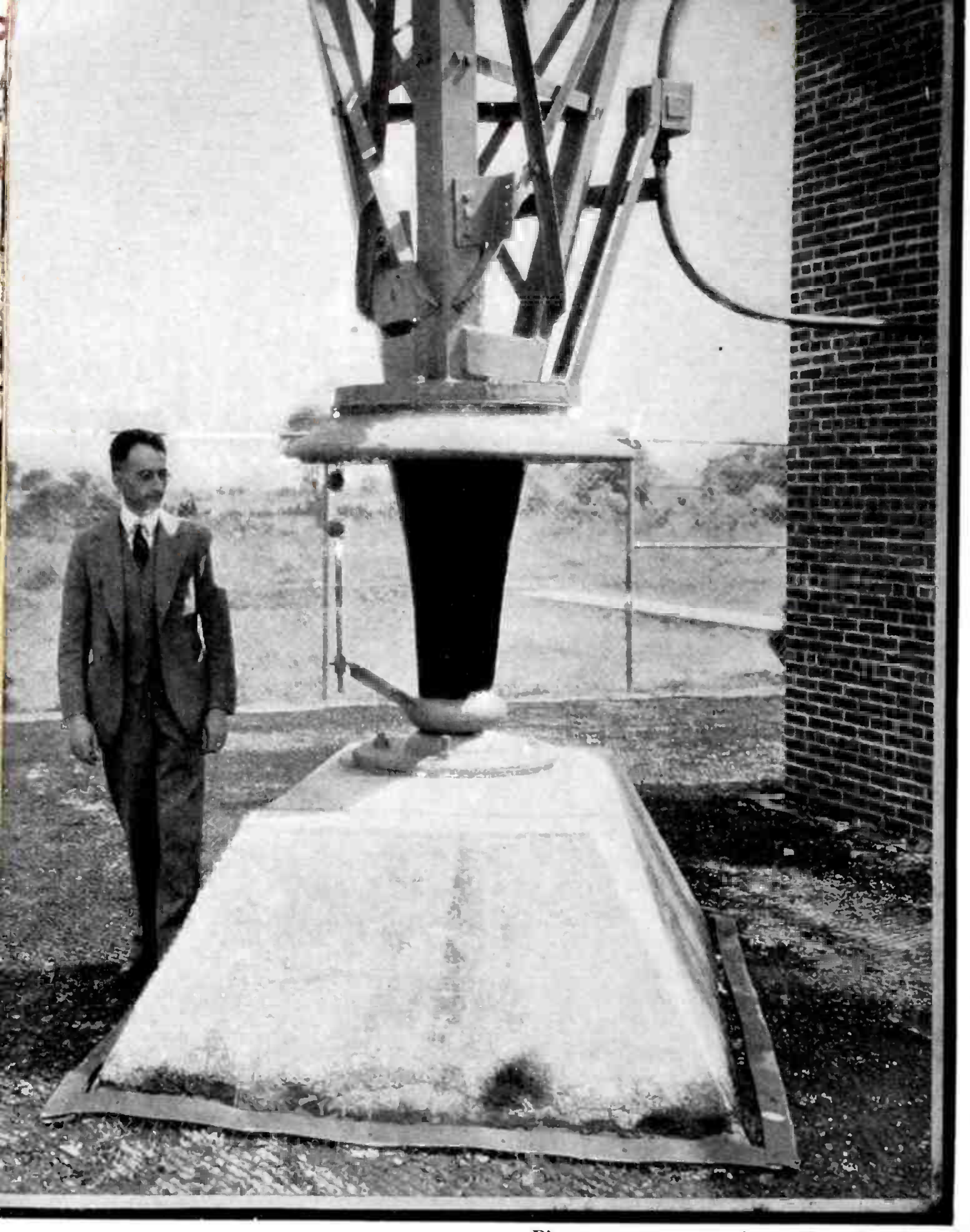


Photo courtesy National Broadcasting Co.

Showing the base of WJZ's vertical radiator with ground screen installation for minimizing dielectric hysteresis losses.

REDUCING DIELECTRIC

at vertical

By SCOTT HELT

THE RADIATION EFFICIENCY of a vertical antenna, operating in the broadcast portion of the frequency spectrum, is best expressed by the equation

$$E_R = \frac{R_R}{R_R + R_L}$$

where

E_R = radiation efficiency
R_R = radiation resistance
R_L = loss resistance.

It is seen, therefore, that the efficiency of a given radiator is an inverse function of the loss resistance involved. In an earlier paper, in which the writer described conventional methods for determining the resistance of broadcast antennas[1], these losses were discussed more or less in detail. It suffices to say that the total radio-frequency resistance of a broadcast-antenna system comprises a number of resistive components, only one of which may be considered useful, i.e., radiation resistance. The other resistive components comprise loss resistance which only serve to dissipate energy to no purpose. Losses due to the ohmic resistance of the tower, dielectric absorption, eddy-current flow, and dielectric hysteresis are all important from the standpoint of radiation efficiency. It will be the purpose of this paper to discuss the latter loss, about which there has been little useful information in the literature, and to discuss present methods for minimizing it.

It is well known that every antenna has a certain amount of capacitance to ground, the conducting surface of the antenna comprising one plate of the theoretical condenser, the earth the other, and a gaseous dielectric (air) intervening, the dielectric constant of which is unity. When potential is applied between the tower and buried ground radials, energy is stored up electrostatically. The resulting forces in the dielectric are in evidence because of an attraction which exists between the two plates of the theoretical condenser, and dielectric and magnetic fields are both present. The power can be said to be a function of the product of the two fields, and the angle existing between them. Because of the dielectric field existing between the tower and the plane of the buried ground wires, any given point in the intervening dielectric assumes a definite potential. The energy stored in the dielectric field is

$$\frac{e^2 C}{2}$$

e = voltage
C = a constant of the circuit called capacity or permittance.

It is seen that the energy stored in the dielectric field is a direct function of the voltage. The emf per unit length of the dielectric circuit is the voltage gradient through equi-potential planes, which at any given point in the dielectric assume circles of definite potential. This is similar to the magnetomotive force in the magnetic circuit, and the flux density at any given point in the field is proportionate to the volts per centimeter at the point, and to the permittivity of the dielectric medium.

For perfectly homogeneous dielectric such as the gaseous dielectric (air) which exists between the tower and ground system, the capacitance or relative capacitance must be substantially constant. This is not true for the nonhomogeneous material which lies between the plane of the buried ground radial wires and the surface of the earth. Of course, the buried ground system at the base of the radiator, which is in effect one plate of the theoretical condenser, is usually placed six to eight inches below the mean surface of the earth for protection against mechanical injury, resulting in a dielectric constant which is something more than unity. The dielectric constant of the six to eight inches of soil between the buried wires and the actual plane surface of the earth is greater than that of the air (unity), and depends upon the nature of the soil at the radiator site. The constant is different for various geographical locations, and a set of typical conditions are given below, as taken from *The Engineering Handbook of the National Association of Broadcasters*:

Nature	*Dielectric Constant*
Sea water	81
Pastoral low hills, (typical of Dallas area)	20
Pastoral, low hills (typical of Ohio area)	14
Flat country, marshy, densely wooded, typical of Louisiana, near Mississippi	12

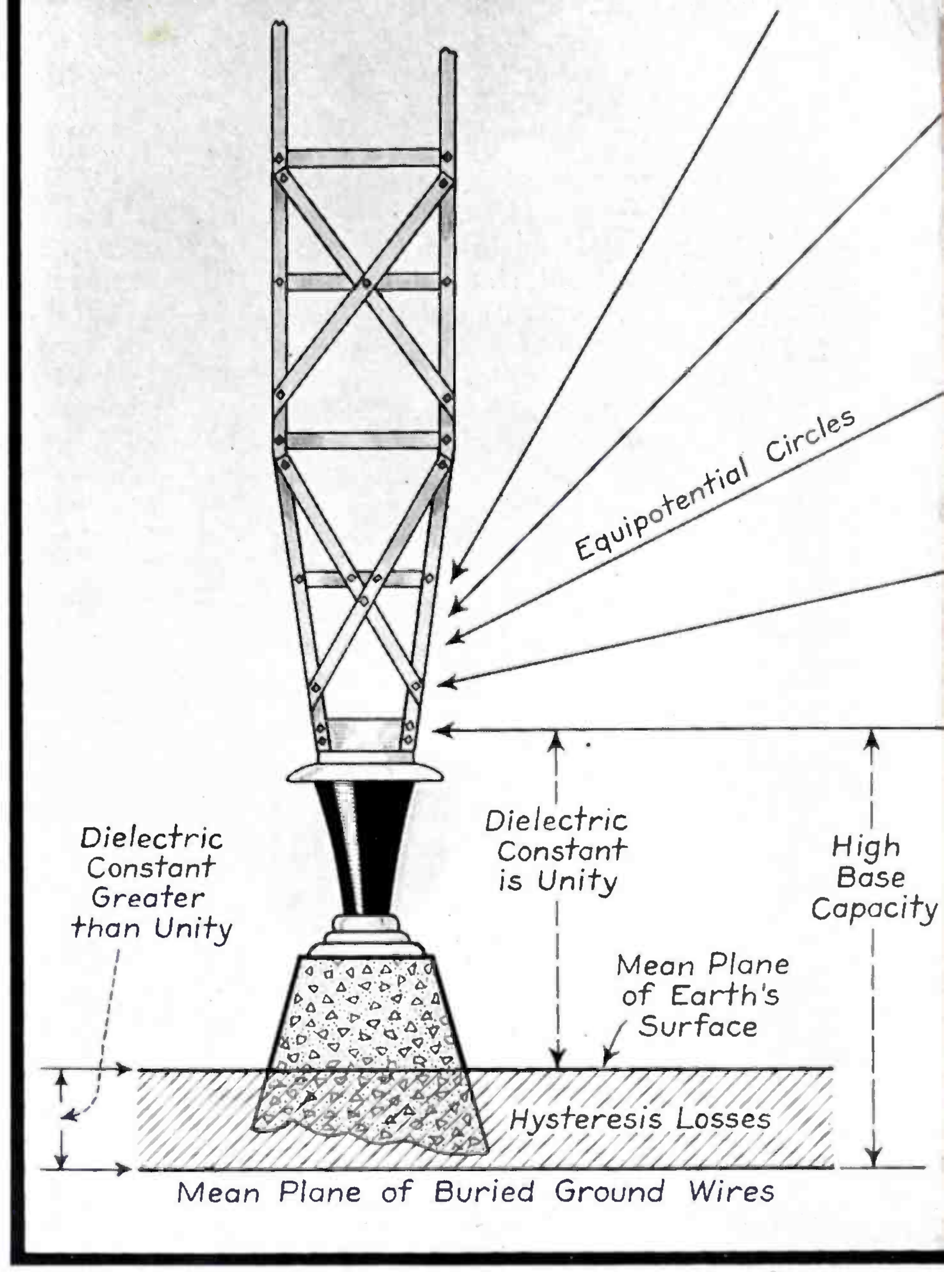
[1]"Measuring Resistance of Broadcast Antennas," by Scott Helt, *Electronics*, Vol. 7, No. 2, February, 1934.

HYSTERESIS LOSSES*

radiators

RADIO STATION WIS

Pastoral, medium hills, and forestation, typical of Maryland, Pennsylvania, New York, exclusive of sea coasts and mountainous country	13
Pastoral, medium hills and forestation, heavy clay soil, typical of central Virginia	13
Rocky soil, steep hills, typical of New England	14
Sandy, dry flat, typical of coastal country	10
City, industrial areas, average attenuation	5
City, industrial areas, maximum attenuation	3



An antenna has a certain amount of capacitance to ground, the earth and conducting surface of antenna acting as plates.

In dielectrics which are not strictly homogeneous, the effect of the residual potential, as the dielectric is charged and discharged with time and frequency, is to cause the flux to lag behind the voltage. This is especially true where the voltage variation is rapid as in the case of radio frequencies. The effect is said to be analogous to damping, and a hysteresis loop results. The loop means loss, and the loss increases with increasing voltage, temperature, frequency, moisture content of the soil, and impurities in the soil. Principally, the losses at the vertical radiator are a function of the base voltage of the tower, the nature of the soil existing between the buried wires and the earth's surface, and the operating frequency. In considering the equivalent of a vertical radiator having such losses, it is customary to consider the radiator as a perfect condenser with a resistor in series, the value of the resistor representing the losses. Since the voltage drop across this resistance represents a power loss, which in turn is a waste of useful energy, it is of course of importance that the value of R be kept at the minimum, if high antenna efficiency is to be realized.

The current and voltage distribution in a vertical radiator is such that the phase difference is essentially 90 degrees. Thus, the current anti-node and voltage node are present at the base of a quarter-wave radiator, while exactly the opposite condition obtains at the base of a half-wave vertical radiator. Thus, the voltage to ground at the base of the half-wave radiator is approximately at maximum, and is nearly minimum for a quarter-wave radiator. Since the dielectric-hysteresis loss is, in part, a function of the base voltage, it is clear that for a given set of operating conditions, these losses are at maximum for a half-wave radiator, and are at a minimum for a quarter-wave tower. Since the use of the half-wave tower means an increase in intensity of approximately 3 db over the quarter-wave tower, it is economical to use the half-wave tower even though the base losses are greater, for means are known by which the hysteresis losses may be minimized.

The loss may be greatly reduced by the placing of a ground screen at the base of the vertical radiator. A typical installation is shown in the accompanying photograph. In this case the screen is fifty feet square and lies on a surface of stone and tar designed to prevent the growth of plants and weeds. It is connected through busses to the tuning equipment at the center, and the buried ground radials are connected to the extremeties of the screen. The ground screen usually consists of closely woven galvanized-iron wire-screening, such as poultry fencing, having 0.5- to 1.0-inch mesh. It is easily seen how such a system raises one plate of the theoretical condenser above the surface of the earth, and the dielectric constant is then unity, resulting in greatly improved radiation efficiency.

One method of minimizing base losses is to mount the base insulators twenty feet of more above the plane surface of the earth, the steel below the insulators simply providing base columns for the tower. At one station, the base insulators have been thus mounted, and the structure of the tower below the base insulators made of wood which has a low dielectric constant. This reduces the lumped capacity to earth, and the losses reduce proportionately. The more tapered the base can be made, the narrower the base, and the higher it can be elevated above the earth, the less the losses will be. Single insulator base mounting is preferred.

Also, if hysteresis losses are to be kept at the minimum, it is well in the first consideration, that the radiator be placed well away from the building which houses the transmitting equipment. If the radiator is placed on top the plant, as has been done in some instances, or in close proximity to the building, and if the building is constructed of material having a high dielectric constant, hysteresis losses will be present in the structure as well as in the earth below the tower. It is under-

*Ms. accepted Sept. 1937.

stood, however, that throughout this discussion the radiator is of such electrical height as to present high base voltage. And if the base voltage is high, the tower should be placed well out in the open, energy being supplied to it, preferably, by means of a buried coaxial transmission line. Otherwise, the building must also be shielded, theoretically, if the hysteresis losses are to be kept at a low value.

In closing, it might be well added that there is no particular advantage in burying the radial ground wires deeper than six to eight inches below the mean surface of the earth. Theoretically, if the ground wires were sufficiently conductive, and could be placed on top of the earth when close to the tower base, this would be the ideal method of construction, but since some protection against mechanical injury must be afforded six to eight inches is recommended. And a ground screen must be used at the base of the tower where high base voltage is encountered, if high radiation efficiency is secured.

So far as is known, the only quantitive measurements ever made which tend to show the improvement obtained through use of the ground screen are those shown by Raymond F. Guy, Radio Facilities Engineer of the National Broadcasting Company.

[2] *R.C.A. Review*, Vol. 1, No. 4, April, 1937, Pages 57 and 58.

GENERAL PURPOSE AUDIO AMPLIFIER

(*Continued from page* 13)

simple, since all signal voltages in all the stages are voltages to ground; i.e., it is difficult to introduce the feedback voltage in series with the normal voltage appearing in that stage. If the feedback is, say, from the plate of each 6L6 tube through a resistance (and blocking condenser) to its grid, it will be found that the feedback voltage is of such phase as to draw the signal current of the preceding tube through the feedback resistors instead of that current flowing through the preceding tube's load resistance. The latter therefore sees its source as one of very high impedance, or else the source (preceding tube) sees the load as of very low resistance. In either case the gain of the preceding stage is very low. If the feedback voltage is introduced into a resistance between ground and the 100,000-ohm 6L6 grid resistance, then it will be found that a very small fraction of this voltage appears on the grid of the 6L6 tube because the 100,000-ohm resistance, and the 200,000-ohm resistance in parallel with the 6C5 plate resistance form a voltage divider such that little of the feedback voltage gets to the grid of the 6L6 tube.

The solution is indicated in Fig. 1. Two 50-ohm resistors are inserted between the two 6C5 cathodes and ground. Feedback is from the secondary of the output transformer through two 250-ohm resistors to the above 50-ohm resistors, and the feedback voltages appear between the respective 6C5 cathodes and ground. Thus these voltages are introduced into the grid circuits of the 6C5 tubes without their interfering with the normal flow of the signal currents in the various stages. There is also some degeneration thus introduced directly into the third stage, but this is small compared to that from the following stage. Furthermore, it must be remembered that the two 50-ohm resistors introduce some additional d-c bias over and above that furnished by the fixed-bias source.

A disadvantage of this method is that the secondary of the output transformer and the connected loudspeaker load is positive to ground by the small bias voltage developed in the 50-ohm resistors in the third stage, but there are two advantages to this method:

(1) Feedback from the secondary compensates for all variations in the frequency response of the output transformer, in particular, that due to leakage reactance at the higher frequencies, whereas feedback from the primary compensates only for the effect of a reduced primary open-circuit reactance at the low end of the spectrum.

(2) Feedback from the primary would require two large 400-volt blocking condensers, which are both bulky and expensive.

The percentage feedback can be calculated on the basis of a step-down ratio in the output transformer of 18.5:1, and a gain in the 6C5 stage of 9.5 (approximately), determined graphically. The percentage feedback will be

$$\frac{50 \times 9.5}{18.5\ (250 + 50)} = 8.56\%$$

This will give an apparent plate resistance of

$$\frac{2 \times 22500}{1 + (.0856)\ (135)} = 3600 \text{ ohms.}$$

The measured value was found to be 4790 ohms, which may be due to the fact that the bias was closer to —28 volts than to —25 volts.

ANALYSIS OF SIDE AMPLIFIER

The side amplifier contains two 6C5 tubes for voltage amplification, and the second tube feeds a third 6C5 tube connected as a diode rectifier through a step-down transformer of about 3:1. The rectifier thus looks back into an apparent source impedance of about

$$\frac{10000}{(3)^2} = 1111 \text{ ohms.}$$

The internal resistance of the rectifier tube in the conducting direction is but a few thousand ohms, hence the 0.5-mfd condenser shunting the three-megohm resistor charges up very rapidly on a positive impulse on the rectifier plate, such as a sudden increase in signal, or even the appropriate half cycle of the signal itself. This produces a positive voltage in the expander grid circuit, which voltage counteracts the normal negative bias obtained from the 5000-ohm potentiometer, and thus increases the mutual conductance of the 6L7 tubes and hence the gain of the circuit.

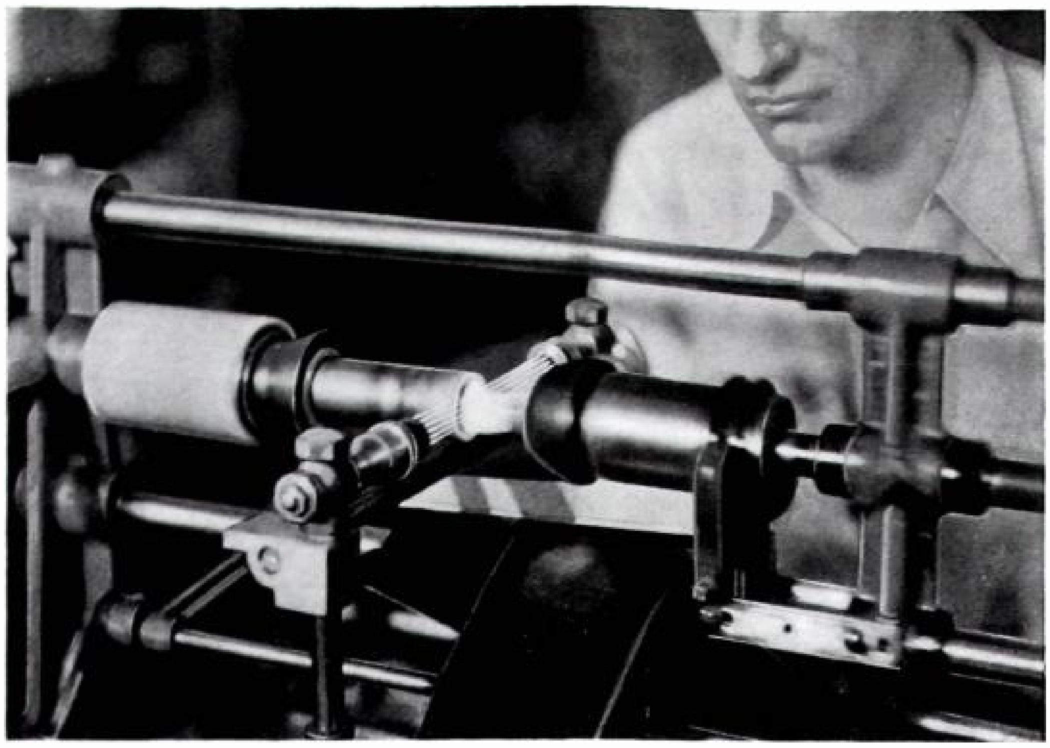
On the other half cycle of the signal, or upon a decrease in the level of the latter, the 0.5-mfd condenser can discharge through the three-megohm resistor only, and hence expander bias and gain of the 6L7 tubes decreases slowly (the time constant is 1½ seconds). This produces a fast "attack" time to catch momentary crescendos in the music, yet gives a slow "release" time to prevent the expander circuit from producing a modulation of the lower audio frequencies. If it is desired to vary the "release" time, the three-megohm resistor can be made variable. The action of the rectifier circuit is identical with that employing a condenser input filter.

ADJUSTMENTS OF AMPLIFIER

The only adjustment required is that of the expander circuit. The expander grid bias is reduced to about 2½ volts by adjusting the 5000-ohm potentiometer. This causes the amplifier to have maximum gain. The ½-megohm control is turned down to zero, while the main volume control is turned up to maximum. Then sufficient input signal

(*Continued on page* 30)

Fusing the glass window to the shell of the cathode-ray tube, RCA-913. The operation is performed on a precision lathe. A section of the glass is placed in the lathe and moved up against the metal alloy edge of the shell.



Under intense flames, the temperature of the glass is raised to a yellow, plastic mass. When withdrawn, it leaves an air-tight bubble of glass (screen window) over the shell opening. Photo courtesy RCA Manufacturing Co., Inc.

BOOK REVIEWS

RADIO OPERATORS' MANUAL, Radio Department, General Electric Company, Schenectady, N. Y., second edition, 181 *pages, price* $1.00.

This book is a rewritten edition of the previous *Police Radio Operator's Manual.* The scope of the present manual has been expanded to include not only broadcast transmitters and police radiotelephone and radiotelegraph systems, but also radio systems for land and marine fire departments, transit and electric power companies, and conservation departments.

It is published to assist those who wish to qualify for commercial radiotelephone and radiotelegraph operator licenses, to assist prospective station licensees in obtaining Federal authorizations and to present general information on radio syestems in various fields of applications.

The book describes radio systems in use; outlines the organization and function of the Federal Communications Commission; lists questions and answers relevant to Federal examinations; and includes sections on maintenance, definitions, study references, radiotelegraph code, and "Q" abbreviations.

GRAPHIC ROUTES TO GREATER PROFITS, by John W. Esterline, published by The Esterline-Angus Company, Indianapolis, Indiana, 320 *pages,* 450 *illustrations, price* $3.00.

This is a book on the use of graphic instruments in increasing the productive capacity and efficiency of industry. It is a volume of case history rather than opinion, covering some 250 cases, and giving the procedure followed, graphic charts obtained and solution reached in each case.

The introductory section comprises 30 pages, and is divided into three chapters, entitled "The High Cost of Inefficiency," "What Graphical Representation Means" and "Classification of Industrial Problems." The remainder of the book is in five divisions: "The Problems of Machines," "The Problems of Power," "The Problems of Processes," "The Problems of Men" and "Research and Special Problems." The case studies throughout the 19 chapters are numbered and cross-indexed.

This book is presented in an interesting manner. It should be of value to executives and engineers.

PHOTOELEMENTS AND THEIR APPLICATIONS, by Dr. Bruno Lange, Consulting Engineer, Berlin-Dahlem, translated by Ancel St. John, Ph.d., published by Reinhold Publishing Corporation, 330 *West* 42 *Street, New York City,* 297 *pages, price* $5.50.

The original work of Dr. Bruno Lange was published in Germany, this English translation having been performed by Ancel St. John. The book is intended primarily for the layman, thinking of the possible use of photoelectric devices for his own purposes, as well as the engineer who is interested in new uses and devices.

In addition to the usual description of the basic photoelectric phenomena and of the historical development of the photoelements, various theories concerning the semi-conductor photoeffect are given. The physical properties of semi-conductor photocells are also given in the first part of the book.

The second section of the book is devoted mainly to applications. Included is data on construction and performance of the photoelements, photoelectric illumination meters, exposure meters for photographic purposes, special photometric apparatus, long-distance transmission of quantities, amplifying equipment, photoelectric switching and signal devices, and other uses in the various fields of activity.

Rather lengthy bibliographies enhance the value of this book, although, as might be expected, most of the references are to foreign publications and books.

HOW TO PASS RADIO LICENSE EXAMINATIONS, by Charles E. Drew, published by John Wiley & Sons, Inc., 440 *Fourth Avenue, New York City,* 201 *pages, price* $2.00.

This is a revised edition of Mr. Drew's already well-known book designed to serve as a question and answer guide for those preparing to take government examinations for radio operator licenses.

The first eight pages of this book have been devoted to the rules governing the issuance of radio operator licenses, as well as a special table list-

(Continued on page 30)

TOLERANCES ON CERAMICS

By FRANK J. STEVENS

Engineering Vice-President

AMERICAN LAVA CORPORATION

YOU HAVE often noticed that manufacturers of ceramics have called your attention to broader-than-specified tolerances and this has, undoubtedly, brought the questions to your mind—"Why?"—"Can't we get the same accuracy of parts in ceramics that are obtainable in other molded parts?"—"Is it because the maker of ceramics is not as progressive as the plastics competitor?"

This last question should be answered first. The ceramic manufacturer is keenly aware that his limitations for mechanical accuracy and surface appearance are a handicap when the application does not demand the resistance to heat, to cold flow or other needed characteristics found in a ceramic product. Therefore, he strives the harder to overcome the natural obstacles to the attainment of mechanical perfection.

Because a specified tolerance may be needed for ease of assembly or to facilitate fitting together of parts, a review of the factors controlling the making of ceramic parts will lead to a better understanding.

In ceramics, hardened at high temperatures, you need tolerances to provide for:

(1) Mechanical inaccuracies of the dies.

(2) Shrinkage in kilning.

(3) Chemical and/or physical variations in raw materials.

(4) Mechanical inaccuracies in commercial machining operations.

(5) Tool or die wear.

(6) Variations in shrinkage due to variations in kiln temperatures caused by:

(a) Personal factor in reading instruments.

(b) Imperfections in instruments.

(c) Weather changes—humidity and temperature.

(d) Changing loads in kiln.

(e) Change in viscosity of fuel oil or heat units in gas.

(7) Warping during firing—such as out-of-round.

It is true that both plastic and ceramic industries have the same problem of accurately-made dies. In plastics the die produces the finished part with few, if any, subsequent deforming operations and no subsequent high temperature vitrifying process. In ceramics the die-forming operation is frequently followed by mechanical machining operations and also by the chemical reactions of kilning with the inherent problems of shrinkage of 12% to 15% and occasionally as much as 30%. This high shrinkage in linear dimensions is influenced by exceedingly slight variations in raw materials, pressures of forming, kiln temperatures, time in the hot zone and even kiln gas conditions. And a shrinkage constant varies as between length and thickness.

In making the dies for production runs, the dimensions of the specified part must be converted to the die size, making due allowance for shrinkage. Assuming this to be 12%, an inch dimension becomes 1.120 inches. The completed die drawings are turned over to the die maker to follow. Of economic necessity, the work must be fast, and he must have tolerances within which to work. These tolerances provide for inaccuracies in equipment, tools, and the human element. Every metal worker knows that there is not one one-quarter inch drill in a thousand which will drill a one-quarter inch hole within .001". To make it closer to dimension, the hole must be drilled smaller and reamed or lapped to size, thereby increasing the cost rapidly as tolerances decrease.

In dies for pressing many irregular shapes are encountered, making it necessary to complete the dies by hand methods of filing, scraping or grinding. So, if we assume the computations for shrinkage have been exact, we will still have the minimum variations of the finished article due to inaccuracies of die making and, later on, to those changes in size due to die wear.

The very characteristics of extreme strength and hardness for which ceramic parts are valued are natural corollaries of their highly abrasive qualities which cause the dimensional changes in dies when in use.

Then, too, there must be allowance for some wear provided in tools or dies, even though the most abrasion-resisting steel may be used. In an extrusion die, the diameter increases with use; in a press die use decreases the diameter of pins where, on the contrary, the holes within the parts of the die gradually wear larger; therefore, there must be some tolerance provision made for wear.

After either pressing or extruding, frequently the part must be milled, tapped, drilled, threaded or otherwise machined to fit in with the customer's drawing and, whether you are machining ceramics or metal, again you do not in mass production reach exact dimensions to a millionth of an inch. You must have some allowance for the natural variations that occur either to the looseness in the machine, to the spring of the tools, to the wearing of the tools, and for variations in the original setting of these tools to dimensions.

The ceramist also has variations due to slight variations, chemically or in particle size, in the raw materials themselves. There must be some allowance for that. Fortunately, he is able to mix a great many bags of raw material together and, in that way, keep the variations from one batch to another at a minimum. But, nevertheless, there must be some allowance to take care of those variations.

Last, and more important, there must be an allowance for variations in firing temperatures because the slightest variations in firing temperatures produce variations in the size of the piece. Remember that in the kiln itself conditions change continually. The internal condition of the kiln is affected by the change in the barometer outdoors and also by the change in the temperature outdoors. Temperatures are likewise changed by slight variations in pressure and temperature of the heating medium of oil or gas. As the pressure drops, temperatures go down. Colder fuel likewise lowers temperatures. Then, there is the physical difficulty of reading the temperature exactly. By "exactly" we mean within one or two degrees at 2500 degrees Fahrenheit. First of all, the instruments are not that accurate, nor does it appear that they can be made more accurately at the present time. Then, there is the variation in the human element of reading a particular temperature on these instruments. Con-

(*Continued on page* 38)

A STUDIO INPUT EQUIPMENT

By HARRY PARO
WHOLESALE RADIO SERVICE CO.

A STATE of flux and change must be regarded as the normal condition of a studio's control equipment. The input arrangements should be such that they can grow somewhat in the manner of, say, a sectional bookcase, without sacrifice of appearance, efficiency or sound quality, and without requiring retirement of existing equipment. Provisions should exist for the addition at any time of mixing, preamplifier or equalizing units, at a minimum cost for installation or wiring, and with no unsightly crowding of apparatus or outstanding contrasts in panel design.

With these requirements in mind a series of new Lafayette high-quality studio control panels, including preamplifiers, mixers, equalizers, monitor panel, power supply and 10-watt output stage, have been designed.

Modern tone quality was the first requirement to be given consideration. The individual units are designed to be added to existing facilities or to be combined into a complete, modern control rack with numerous possibilities of future growth. Compactness has been carried to a degree consistent with good sound results, and in consequence even a small room that may house a number of the complete racks will present a neat, uncrowded appearance. Vertical red stripes running through the gray

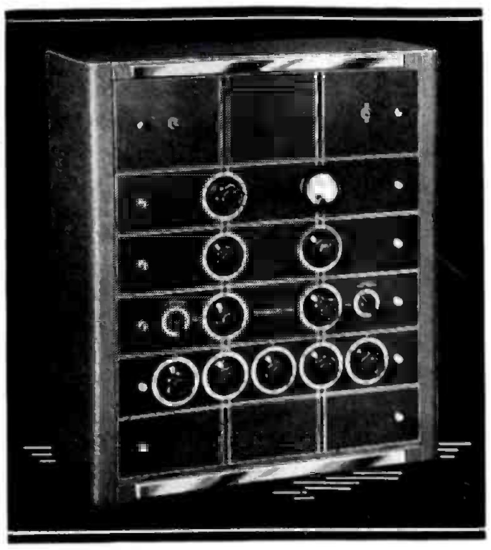


Fig. 2. A complete rack assembly of the studio input equipment.

panels make the last panel added to the rack look as if it had been present from the beginning as an integral part of the original installation. Future apparatus, as developed, will follow the same panel design.

The preamplifiers are available in two models, for low or high impedance sound sources. They are cushion-mounted, and non-microphonic. The input transformer of the low-impedance model is triple-shielded as insurance against magnetic pickup. That amplifier is flat within plus or minus ½ db from 50 to 10,000 cycles; the high-impedance model, 5-megohm input, is similarly flat down to 30 cycles. Gain of either model is 35 db.

The matched 5-channel electronic mixer, with 37 db gain, is flat within plus or minus 0.8 db from 40 to 10,000 cycles, with maximum output at zero level.

The matched, two-section equalizer panel affords independent control of the high and low frequencies. The minimum insertion loss is 2 db while the maximum is 53 db.

The power amplifier is of 10 watts output, .006 watt maximum input, using reverse feedback to keep harmonic content to 2½% at 10 watts. The hum level at 10 watts is –63 db. Flexibility in practical use is promoted by the range of power amplifier output impedances available: 1.2, 2, 2.5, 5, 7.5, 10, 15, 20, 30, 50, 125, 250, 333 and 500 ohms.

Fig. 1 shows the flexibility provided in the circuit, in that three output positions are provided, a simple switch changing over from auditorium speaker to 78 rpm recording, and in third position to 33⅓ rpm recording. The switch shown associated with the output jacks is ganged to the switch drawn just left of the coupling condensers between the

(*Continued on page* 35)

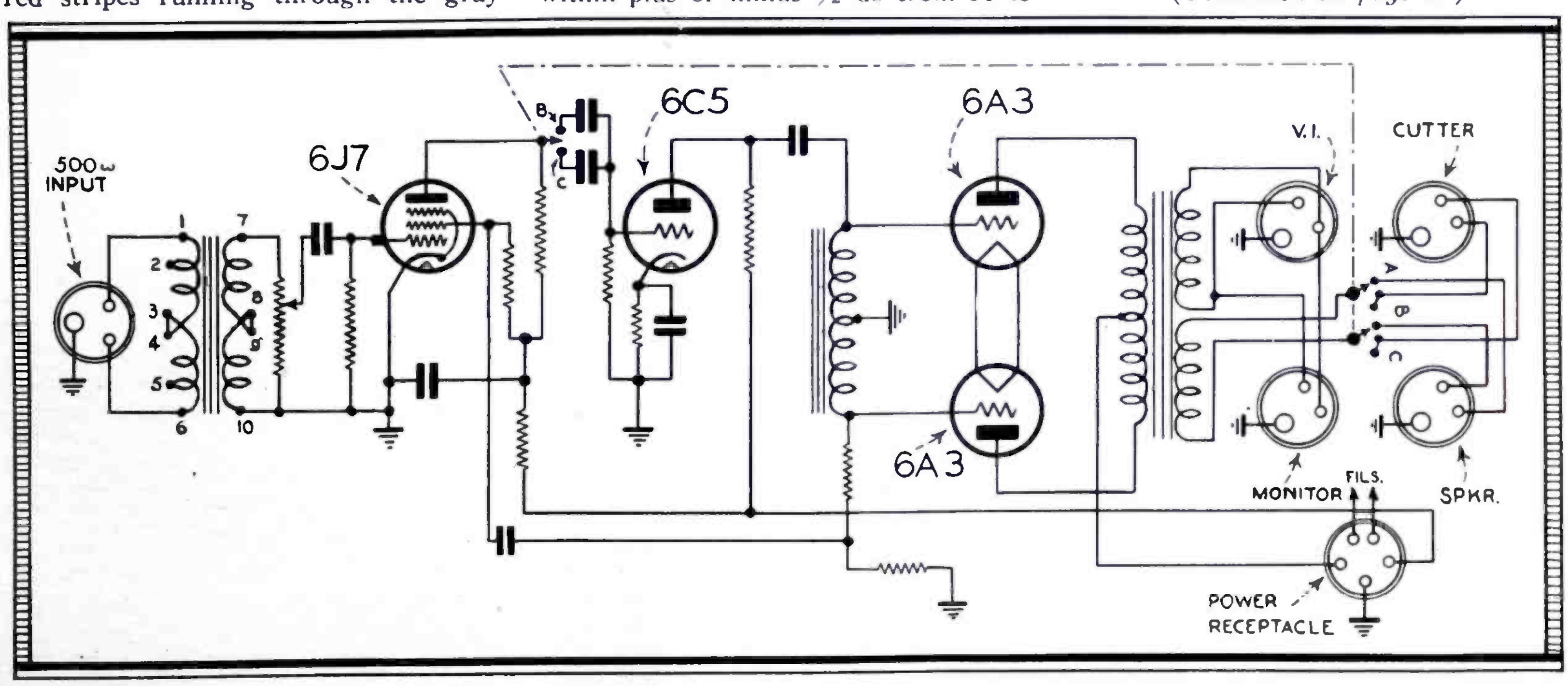


Fig. 1. Schematic diagram of the power amplifier.

BOOK REVIEWS

(*Continued from page 27*)

ing the districts, territory within each district, and address of inspector in charge.

Chapter II covers radiotelegraph transmitter apparatus, installations, communication receivers, care and maintenance of storage batteries, power-supply apparatus, radiocommunication laws and regulations (radiotelegraph—commercial marine services).

Chapter III, "Radiotelephone Subjects," is given over to broadcast transmitter and receiver diagrams, radiotelephone transmitters, receivers, power-supply apparatus, and laws and regulations covering first and second-class licenses. Abbreviations used in radio communications, and a chapter devoted to radiotelegraph and broadcast transmitter legends concludes the book.

GENERAL PURPOSE AUDIO AMPLIFIER

(*Continued from page 26*)

(say at 1000 cycles) is fed into the amplifier to give maximum undistorted output (about 24 volts), and this input signal is maintained constant during the remainder of this test. The expander bias is now made more negative until the output level drops by an amount desired for expansion, say 30 db. The ½-megohm expander volume control is now turned up until the output is restored to its original value. The amplifier has thus been adjusted to the desired amount of expansion.

In making this adjustment, it may be found that the two 6L7 tubes do not expand equally. This can be detected by observing the amplitude of the signal on each 6C5 or 6L6 grid with an oscilloscope. By trying various 6L7 tubes, a pair will be found that match up at full expansion, and this is satisfactory since unbalance will produce appreciable distortion only at high signal levels.

Care should also be taken in balancing up the tubes of the other stages, particularly the final stage, but in general these tubes run sufficiently uniform to occasion no particular difficulty in this respect. Furthermore, the power-supply voltages should be adhered to in order to obtain best results, and Table I is appended to give the various plate currents and screen voltages for the main amplifier.

PHYSICAL LAYOUT

The physical layout is best described by Figs. 2 and 3. In Fig. 2 we note, proceeding from left to right, the well shielded input transformer, the 6F5 tubes, the 6L7 tubes, the 6C5 tubes, and the 6L6 tubes. The output transformer is in a shielded case behind the latter. The side circuit starts with a 6C5 tube between the first and second stages, and to the rear of these. Behind the 6C5 tube is another (the second stage of the side amplifier), and to the left of it is the step-down transformer, while to the left of it, and behind the input transformer, is the 6C5 tube functioning as a rectifier. The chassis is of a standard size, 12 inches by 17 inches by 3 inches deep. On the front side of the chassis, proceeding from left to right, are the expander bias control, the expander volume control, and the main volume control. On top of the chassis are mounted four jacks of the closed circuit type, for checking the total current (plate and screen) of each 6L7 and each 6L6 tube. The first two serve as a quick check of the expansion of the 6L7 tubes by indicating the corresponding increase in plate current, and the latter two as a quick service check of the condition of the 6L6 tubes. Input and output terminals are on the rear side of the chassis.

The power pack (to the right) is mounted on a 10-inch by 12-inch by 3-inch deep chassis, and requires no special discussion. An eight conductor shielded cable connects it to the amplifier chassis, at which end it is terminated in a female plug, which fits a recessed male plug in the amplifier chassis.

In Fig. 3 we note the layout of parts within the chassis. All carbon resistor and small condensers are strapped across terminal strips below the respective tube sockets, or between such a terminal and a socket terminal. The resistors and condensers are so mounted that their values are easily read when the amplifier is turned over. Larger values of condensers are of the Pyranol type so as to be compact, although electrolytic condensers can also be used. They are so mounted as not to cover the resistances and smaller capacities, in order to facilitate servicing of the unit, and the reading of the various plate, screen and bias voltages. Heavier current-carrying resistors are of the wire-wound type, and mounted vertically on large bolts in the power pack.

ELECTRICAL CHARACTERISTICS

The gain, amount of expansion, power output, etc., have been given above. The frequency response (without expansion) is shown in Fig. 4 with and without an input transformer. It is evident that any variations from flatness are due to the particular input transformer, and to a lesser extent, the output transformer employed. The characteristics of the amplifier itself are more than satisfactory for the most exacting service.

In Fig. 5 is shown the manner in which the output varies with input at 1000 cycles when expansion is employed, and indicates that the expansion is linear down to 18 db below the maximum input. For input levels below this the relationship was not readily measurable, but indications are that the expansion is linear in this region, too, although curvature of the rectifier characteristics may enter in.

When using the side amplifier as a contractor—as in recording—a lesser bias on the 6L7 expander grids will be required, as well as a smaller amount of gain in the side amplifier, otherwise the contraction will be so great that a greater input level will result in an actual lesser output level.

CONCLUSION

In conclusion it may be stated that this article has described the design and construction of a high-gain, high-fidelity 24-watt amplifier adapted for volume expansion or contraction, and suitable for a wide variety of purposes, such as that of recording and reproduction of phonograph discs, public-address work, and general experimental work in audio.

The writer wishes at this point to acknowledge the kind co-operation of Mr. John Munro, of WNEW, and a former student of RCA Institutes, Inc. He was responsible for the mechanical layout of parts, the construction and final testing of the amplifier.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President | RCA Building, 30 Rockefeller Plaza, New York, N. Y. | H. H. PARKER, Secretary

TITANIC MEMORIAL

A TITANIC MEMORIAL PROGRAM, originating in the studios of station WOR and the Mutual network, was presented on April 15, 1938, under the auspices of our Association:

Announcer: "Twenty-six years ago today occurred the greatest marine disaster of all time—the foundering of the world's newest and largest ship of the day, the luxury liner *Titanic,* which struck an iceberg in the North Atlantic Ocean and sank with great loss of life. To commemorate this event, the Special Features Division of the Mutual network presents a special Memorial program under the auspices of the Veteran Wireless Operators Association. The commentator on this program will be William J. McGonigle, President of this international association of wirelessmen. Mr. McGonigle."

Mr. McGonigle: "We dedicate this broadcast to the memory of Jack Phillips, heroic Chief Wireless Officer of the ill-fated *Titanic.*

"Our Chaplain, a former wireless officer in the American merchant marine, the Reverend Dr. Walter P. Doty, will lead us in prayer."

Reverend Doty eulogized the heroism of Jack Phillips and that of other wirelessmen and prayed for the safety of all engaged on ships traveling the seven seas.

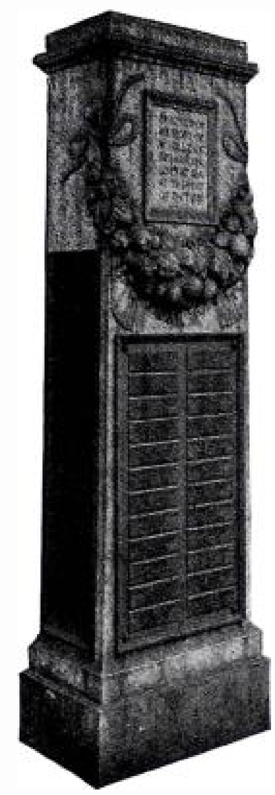
Mr. McGonigle: "The man who has the unique distinction of having first sent SOS as a signal of distress and of receiving the second SOS distress signal is Theodore D. Haubner. Mr. Haubner is present in the studio and will now address you. Mr. Haubner."

Mr. Haubner traced, briefly, the history of "CQD" and "SOS" as distress signals and told of the occasion which necessitated his first use of SOS while wireless officer aboard the *S. S. Arapahoe* off Cape Hatteras; because of this experience, and his receiving of the second SOS signal later in 1909, he stated his belief that: "The record of wirelessmen during trouble at sea proves that neither the mental processes nor the emotions of wirelessmen at such times, concerns self preservation for themselves."

Mr. Haubner continued: "The memory of Jack Phillips, Chief Wireless Officer of the ill-fated *Titanic,* needs no tribute from me. He gave all on April 15, 1912—his life—that others might live. His heroic sacrifice fulfilled the finest traditions of the merchant marine in time of distress, added lustre to prior heroic rescues effected through the instrument of wireless and set a new standard which some wirelessmen have since equalled—but none can ever exceed."

Our President then narrated the story of the *Titanic's* first, and only, trip relating in part: "At the time of the collision, the Chief Wireless Officer, John George Phillips, was on duty in the wireless room, shortly to be relieved by Harold Bride his assistant. That same day Phillips had spent over six hours repairing the wireless equipment and but for his ability and perseverance in effecting a successful repair perhaps no one would have survived the disaster.

"Phillips was preparing to retire for some much needed rest having been relieved by Bride—neither of them suspecting anything very serious though the ship had stopped—when Captain Smith came to the wireless cabin and requested that they stand by for a possible distress call. Back to the bridge for a brief period to determine the exact condition of his vessel. Captain Smith returned within ten minutes



The VWOA Monument.

of his first visit to the wireless cabin with the order 'Send out the call for assistance.' Phillips immediately sent a series of distress calls on full power using both CQD and SOS followed by the *Titanic's* call letters MGY, her position and details of her condition."

Mr. McGonigle continued his narration with: "Phillips remained at his post keeping approaching ships informed. Bride acted as messenger between the wireless cabin and the Captain. With remarkable discipline under the circumstances the job of abandoning ship was begun under the direct supervision of Captain Smith. Women and children first, the aged before youth—officers and men at their posts until the end."

And concluded with: "That 712 persons were saved from this greatest of marine disasters is a splendid tribute to the courage and ability of Chief Wireless Officer Jack Phillips. The wirelessmen of the world salute your memory, Jack Phillips."

Our president in introducing the Coast Guard representative said in part: "The splendid record established by the United States Coast Guard in the Ice Patrol is indeed a monument to the efficiency of Coast Guard personnel. It is a matter of record that not a single life has been lost due to collision with ice in the North Atlantic since this Patrol was first begun in 1913. Through the courtesy and cooperation of Commander J. S. Baylis, Chief of Staff of the New York Division of the United States Coast Guard, we present Lieut. D. F. de Otte, Communications Officer of the New York Division, who will now address you."

Excerpts from Lieut. de Otte's address follow: "The United States Coast Guard is indeed glad to have this opportunity to acknowledge the splendid achievements of radiomen, both at sea and ashore. . . . The SOS or NCU must be transmitted regardless of the difficulties or the dangers involved. The dangers take the lives of many of these men, and the Coast Guard is only too glad to join at this broadcast in paying tribute to them. . . . Several speakers have referred to the loss of Jack Phillips, Chief Wireless Officer on the *Titanic.* His death brought sorrow to many, but, perhaps it was not in vain, for it focussed the attention of the world on the value of radio, and it may be said to have been the real start of the present system of marine communication which is marked by a spirit of mutual helpfulness and by a history of personal courage of the men at the key, whose motto may well be said to be, 'Duty first, safety last'."

Lieut. de Otte concluded his remarks with the reading of the message received from the Coast Guard cutter *Tahoe* on Ice Patrol telling of the Memorial services held that day by them in the vicinity of an iceberg in commemoration of the loss of the *Titanic.*

Mr. McGonigle then introduced Mr. George H. Clark, President of the Wireless Operators Monument Fund and Executive Secretary of the Marconi Memorial Fund, who said in part: "A monument was dedicated in 1915 at Battery Park, New York City, to the memory of all wirelessmen who had given their lives that others might live. Each year the Veteran Wireless Operators Association pays tribute to the memory of its departed co-workers in an appropriate service. Today at 12:30 Noon our Memorial services will be held at the Monument."

Mr. Clark closed: "The Veteran Wireless Operators Association is now sponsoring a memorial to commemorate its departed leader, the late Guglielmo Marconi. Should this be in material form, it is probable that the present Monument will be incorporated in this new and larger edifice that thereby the memory of

(*Continued on page 43*)

OVER THE TAPE . . .

NEWS OF THE COMMUNICATIONS FIELD

DRIVER-HARRIS RESUMES OPERATION

Difficulties between the Driver-Harris Company of Harrison, N. J., and the C.I.O., resulting in the closing down of the plant for three weeks, were settled on April 5th. The plant has reopened and resumed operations in all departments. The production of alloy castings and alloy wire is again on a normal basis, and immediate deliveries of wire are being made from stock carried at Harrison, Chicago, Cleveland and San Francisco.

UTAH STOCKHOLDERS MEETING

At the annual meeting of the stockholders of Utah Radio Products Company, eight of the nine Directors in office during the preceding year were re-elected. Mr. Robert M. Felsenthal was elected a Director to bring the Board to the full number.

At the meeting of Directors, immediately following the stockholders' meeting, the following officers were re-elected: G. Hamilton Beasley, President; John A. Snyder, First Vice-President; E. L. Barrett, Vice-President in charge of Development and Engineering Research; W. Dumke, Vice-President in charge of Production; and H. S. Neyman, Secretary-Treasurer.

"FREQUENCY CONTROL WITH QUARTZ CRYSTALS"

This booklet was written to acquaint the engineer and amateur with the theory and practice of quartz crystal frequency control. The information is basically theoretical so that quartz crystals can be applied to any type of oscillator circuit. To partially offset the cost of publication, these booklets are sold through regular Bliley distributors at 10c per copy. Where there are no conveniently located distributors they may be obtained directly from the Bliley Electric Company, Union Station Bldg., Erie, Pa.

NEW OFFICES FOR STANCOR

Standard Transformer Corporation have announced the removal of their general office and factory. The new address is 1500 N. Halsted Street, Chicago.

PRICES ON PYRANOL CAPACITORS

A price reduction of as much as 42 percent on Pyranol capacitors for radios has been effected by the General Electric Company. Production economies coupled with increased demand for the units have made possible the lowered prices according to the company announcement. A complete listing of all reductions in the line is contained in the bulletin GEA-2021A just published by the company.

TECH BULLETIN

A bulletin covering new developments in instrument type tap switches is announced by Tech Laboratories, 7 Lincoln Street, Jersey City, N. J. The new line of switches covers both r-f and low-frequency applications. Write for bulletin 381.

WESTON EMPLOYEES MARK ORGANIZATION'S 50TH YEAR

More than 1,000 employees of the Weston Electrical Instrument Corporation were present at a Golden Anniversary Dinner held in Newark on April 7th as a testimonial to Edward F. Weston, President of the organization. At the dinner, Mr. Weston was presented with a framed portrait of his father, the late Dr. Edward Weston, based on the same photographic negative as the accompanying illustration. The dinner was arranged and the gift presented by the employees of the organization. Mr. William Stevens, oldest Weston employee and an associate of Dr. Weston since 1877, served as toastmaster.

The late Dr. Edward Weston, founded the Weston Electrical Instrument Company (now Corp.) at Newark, N. J., in the Spring of 1888, just a half-century ago. Dr. Weston was a pioneer in many fields of early electrical developments, including the construction of dynamos, electro-plating and arc-lighting. At the opening of the

The late Dr. Edward Weston.

Brooklyn Bridge in 1883, the system of Weston arc-lighting with which it was then equipped attracted international attention. Later Dr. Weston's work on carbon filaments contributed an essential element to the practical success of the incandescent lamp.

The Weston Electrical Instrument Company was an outgrowth of Dr. Weston's private laboratory, where he conducted research to answer the need of scientists and engineers for a convenient and precise means to measure the electrical quantities then coming into general application.

Dr. Weston continued active in the affairs of the organization until 1925, when he was succeeded as President by his son, Edward Faraday Weston. Dr. Weston died on April 20, 1936.

"ELECTROLYTIC CAPACITORS IN FILTER DESIGN"

The article on "Electrolytic Capacitors in Filter Design," by Paul MacKnight Deeley, which appeared in the April issue of COMMUNICATIONS, has provoked quite a bit of comment. For those interested, Mr. Deeley is Chief Engineer of the Electrolytic Division of the Cornell Dubilier Electric Corporation of South Plainfield, N. J.

POTTS RECEIVES APPOINTMENT

The announcement has just been made by Floyd W. Bell, President of Bell Sound Systems, Inc., 61 E. Goodale Street, Columbus, Ohio, of the appointment of R. E. Potts as Sales Manager. Mr. Potts fills a newly-created position, sales having been previously directed by Mr. Bell. Potts comes to his new position from Parkersburg, W. Va., where he was associated with the Ideal Corrugated Box Company for the past three years. Prior to that, he was in business organization work in Columbus. He is a graduate of Ohio State University and active in various fraternal groups.

EASTERN TRIP FOR LASURE

Harry A. Lasure, manufacturer's agent, with general offices in Los Angeles, California, is leaving for annual trip East about June 1. During the parts show in Chicago, Mr. Lasure will be at the Stevens Hotel.

SOUND CATALOG

Transformer Corporation of America, through the Clarion Institute of Sound Engineers, have just released their new 1938-1939 catalog of Clarion "Unified" sound Systems and associated accessories.

The complete new line, ranging in size from the 5 to 8 watt system to the 70 to 98 watt system, and including portable systems ranging from 5 to 8 watts to 40 to 54 watts, is fully described and illustrated in this catalog. In addition to the sound systems, a complete line of Clarion microphones, speakers and other accessories as well as two new types of inter-communicating systems is also included.

Copies of the new catalog may be obtained from the Clarion Institute of Sound Engineers, 69 Wooster Street, New York City.

DUMONT MOVES

The removal of its manufacturing plant, offices and laboratories from Upper Montclair to its own factory building at 2 Main Avenue, Passaic, New Jersey, is announced by Allen B. DuMont Labs., Inc. The two-story-and-basement brick and concrete building, with its large plot of ground, providing adequate room for future plant expansion, was purchased some time ago. During the past several months a force of workmen have been making extensive alterations and improvements.

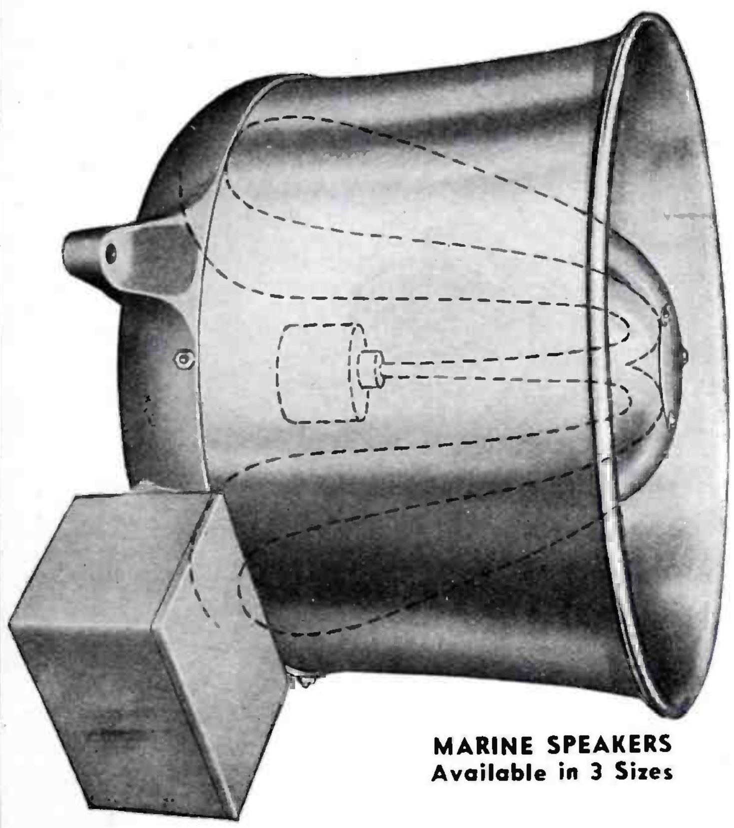
NEW HOME FOR CREI

For some time the Capitol Radio Engineering Institute have felt the need for additional space for school and office facilities. As a result they have purchased a building at 3224 Sixteenth St., N. W., Washington, D. C., and the remodeling work is already under way. The new building is expected to be ready for occupancy by the latter part of June. Due to the amount of work required in moving and reinstalling laboratory and shop equipment, CREI has cancelled the summer class for this year.

(Continued on page 41)

"nice work if you can get it"

Contracts to install sound equipment in ball parks, churches, auditoria, aboard ships, etc. are very desirable and profitable. Practically every successful bidder for these high class types of sound installation specify the use of Racon Loud Speakers and Driving Units. ★



MARINE SPEAKERS
Available in 3 Sizes

Bull Marine Speaker, 60 watts; Regular Marine Speaker, 10 watts; Midget Marine Speaker, 5 watts.

The only outside speaker approved by the Department of Commerce for ship use.

Sensitive enough to use as a microphone.

PERMANENT MAGNET UNITS

The Bull PM unit has a 25-lb. Alnico magnet ring and a special patented phase cancellation device. Handles 60 watts continuously. Weighs 50 lbs. Smaller size PM and electro dynamic speaker units available.

360° RADIAL HORNS

Projects sound accurately and with even intensity over a 360 degree radius. This horn is equivalent to a circular bank of 12 six-foot trumpets. Weatherproof and indoor models available in 2-unit and 4-unit styles.

★ Racon Horns and Units are preferable, especially for use in important sound installations. 1—Because Racon is synonomous with perfection in quality reproduction. 2—There is a Racon Speaker, Baffle and Driving Unit for every purpose. 3—Because there are built-in and *patented* engineering features in Racon products that no other speaker producer can simulate or copy. 4—Racon engineers lick those tricky problems which so often face sound equipment purchasers.

The latest RACON Catalog C5 contains complete technical data and describes all RACON Horns, Loud Speaker Units, Baffles, etc. Send for your free copy today!

Racon Electic Company, Inc.

224 Fourth Ave. **New York, N. Y.**

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATIONS FIELD

RECORDING MACHINE

The recording machine shown in the accompanying illustration has just made its appearance on the market. One of the features of this machine is automatic switching to eliminate the manual operation of recording and reproducing switches. Further, the amplifier is said to have a dual characteristic; i. e., one for recording and one for reproducing, the change being accomplished automatically. A special belt-driven motor is said to permit recordings to be made without wows or flutter, while a special mounting further is stated to reduce hum below annoyance level. The speaker is built into the cover and may be used at any distance from the recorder. The whole machine is built into a carrying case 15" x 15" x 10". The weight is approximately 35 pounds.

Literature is available from *Sound Apparatus Company*, 150 W. 46 Street, New York City.—COMMUNICATIONS.

COLD-CATHODE TUBE

A new cold-cathode, glow-discharge tube designated as Gas-Triode RCA-0A4-G, has recently been announced by RCA to radio equipment manufacturers.

The 0A4-G is intended primarily for service as a relay tube and is designed especially for use in an electrical system for the remote tuning and control of line-operated radio receivers. It can be actuated by r-f impulses generated under the control of the user and transmitted over the power line that supplies the radio receiver. Only a small amount of electrical energy is required to actuate the 0A4-G. Being of the cold-cathode type, it does not consume power when the receiver is not in use. A remote-control system using the 0A4-G provides a simple method for eliminating special cables and gives the user a large choice of control positions.

The remote-control capabilities of the 0A4-G can be utilized by the ingenious experimenter in numerous ways.

Additional information on the 0A4-G is available from the *RCA Radiotron Division, RCA Manufacturing Co., Inc.*, Harrison, N. J.—COMMUNICATIONS.

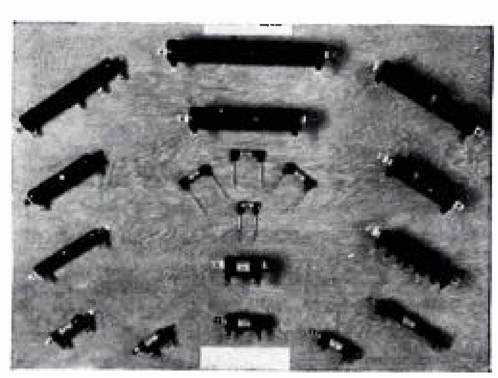
MOLDING COMPOUND

A new molding compound is announced by General Plastics to be known as 2274. This material was developed to meet the problem of molding parts with especially large inserts which are subject to extremes of temperature. While this new 2274 compound is comparable with standard compounds, the final set is said to be slightly more flexible. Therefore it is stated that cracking is avoided in the finished piece which might occur with expansion and contraction of the metal inserts. 2274 is especially adaptable with terminal studs, brush holders, etc.

Complete information may be secured from *General Plastics, Inc.*, N. Tonawanda, N. Y.—COMMUNICATIONS.

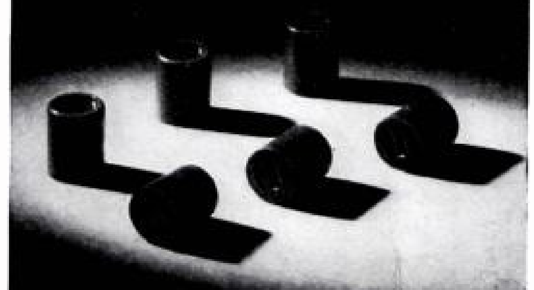
Sound Apparatus recording machine.

RCA cold-cathode tube.



Lectrohm resistors.

Erie knobs for push-button tuners.



ANTENNA AMMETER

Victor J. Andrew has announced a new type of remote-reading antenna ammeter for use in broadcast stations.

It is designed for a maximum of safety from failures due to lightning. Rugged construction and the use of a shielded current transformer with a vacuum-tube rectifier is said to insure reliability and accuracy. Other features are a linear scale, a reading which does not vary with modulation of the transmitter, and an accuracy not affected by as much as fifty ohms resistance in the pair of wires to the remote-indicating meter. These meters are accepted by the Federal Communications Commission. Various models are available with full-scale ranges from 1 to 80 amperes.

For further information write to *Victor J. Andrew*, 7221 South Francisco Ave., Chicago, Illinois.—COMMUNICATIONS.

WIRE-WOUND RESISTORS

The resistors illustrated are representative of a complete line of wire-wound vitreous enameled Lectrohm resistors which range in size from 5 watts to 200 watts. Standard ratings for these resistors are based on a power dissipation as set up under Radio Manufacturers' Association standards.

Graduations in tube sizes are available from the smallest 5-watt unit measuring 5/16" in diameter and 1" in length to the largest 200-watt unit measuring 1⅛" in diameter and 12" in length.

These resistors are wire space wound on low-loss ceramic cores with resistance wire having a low temperature coefficient. Tolerances can be held to a plus or minus 1% if necessary; commercial limits, plus or minus 5%.

These units can be obtained in either fixed, tapped or adjustable types with terminals of either flexible pig-tail or soldering lug. Brackets can be supplied if specified.

Manufacturers having special requirements on units other than standard sizes and values can obtain samples for test purpose by forwarding their specifications to *Lectrohm, Inc.*, 5133 W. 25th Place, Cicero, Illinois.—COMMUNICATIONS.

KNOBS FOR PUSH-BUTTON TUNERS

The Plastics Division of Erie Resistor Corporation announces that it is in a position to furnish molded plastic knobs for radios equipped with push-button tuning mechanisms. These knobs, molded in a stock die, are approximately ½" in length and ⅜" in diameter and will fit all standard push-button tuning devices. They can be finished in any desired color and are molded by the injection process.

Samples and quotations may be obtained by writing *Erie Resistor Corporation*, Erie, Pa.—COMMUNICATIONS.

(*Continued on page* 44)

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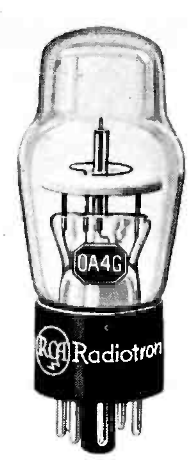
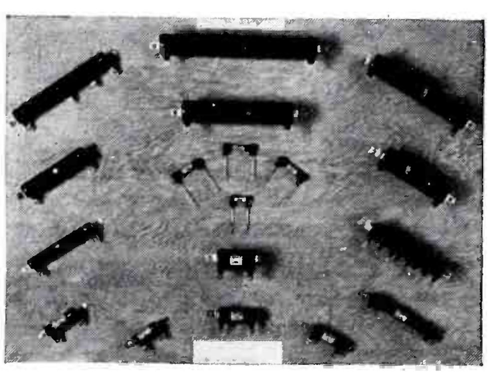
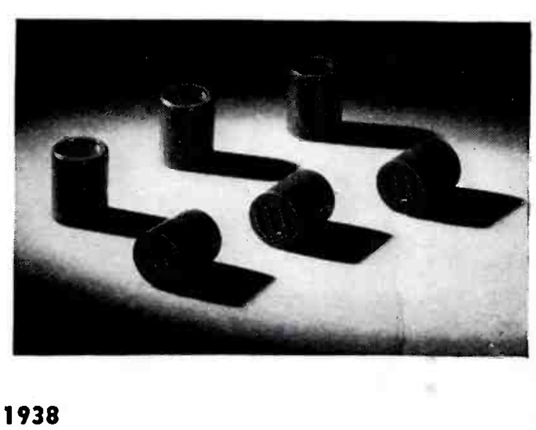




Lectrohm resistors.

Erie knobs for push-button tuners.



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(*Continued on page* 44)

NEWSPAPERS BY RADIO

(*Continued from page* 9)

ployed to cut the speaker off during the recording of facsimile broadcasts. The broadcasting stations from which facsimile signals are sent is tuned in with a receiver as would be the case if regular sound programs were to be received. The facsimile recorder is switched on and the volume control of the receiver is turned to the point where the copy has the desired contrast. The actual recording operation is wholly automatic and requires no attention.

There are no adjustments on the recorder to obtain maximum definition other than the initial adjustment of framing and stylus pressure. Furthermore, there is no servicing of deterioration other than routine lubrication and replacement of stylus after many months of use. Paper costs about 15 cents per week. 200 feet on a roll.

The machine holds a roll of dry processed recording paper which is automatically fed as long as facsimile signals are received. Each roll holds enough paper (200 feet) to provide for a week's recording operations without reloading. Recording paper in a number of different color combinations has been developed, but it is believed that stock on which the facsimile copy appears as black or in half tones on either a white or orange background will be most popular.

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STUDIO EQUIPMENT

(*Continued from page* 29)

first and second stages, automatically introducing a pre-determined low-frequency attenuation when the output switch is thrown over to the low speed cutting head.

The monitor panel affords direct-level readings between +5 and +45 db, using a 2-inch meter of modern design, with high speed return damping and moderate speed advance.

The power-supply unit incorporates three stages of filtering, with a total of 72 microfarads capacitance. It will furnish all needed power to the 10-watt amplifier, 12 preamplifiers and 10 mixing channels, simultaneously, or may be used with other combinations of the equipment, as with 20 mixing channels and 6 preamplifiers; additional power units can be added at any time to meet still more elaborate needs.

A complete, compact rack assembly of these units, allowing for future expansion, is shown in Fig. 2. Each unit is individually shielded, each is matched in appearance to all the others.

RECORDING SYSTEM

(*Continued from page* 15)

enough in duration so that about two grooves are cut with no motion of the stylus they will be easily counted on the record and a comparison with a list of the frequencies at which the interruptions were made will give a good frequency calibration of the curve on the record.

The reader should be reminded at this point that the conventional recorder has a region at low frequencies which is cut at constant amplitude instead of constant velocity. In this region the velocity is proportional to frequency and the light band should increase in width instead of remaining constant. The inner portion of the record in the photograph has the low-frequency end of the scale cut on it and shows the typical recorder characteristic plainly.

If no beat-frequency oscillator is available but some source of fixed frequencies is, a measurement can be made by recording a few grooves at each frequency and measuring the width of the resulting light band. In this case it is necessary to make a voltage measurement at each frequency to be sure that the voltage on the input of the amplifier is the same at each measurement.

A constant-frequency record could be used as such a source, but if used a measurement of the voltage put out by the pickup at each frequency should be made at the time the test record is cut.

If it is desired to measure the overall characteristic of the recording and reproducing system at the same time, a suitably cut heterodyne-frequency record can be played through the reproducing system into the recording amplifier and the resulting light band measured. This is limited, however, to systems which have separate recording and reproducing amplifiers.

Another important feature of a recording system is the maximum stylus-point velocity which may be used before the system begins to show appreciable overload. The overload may come from two possible sources. The amplifier might overload or the recorder might overload due to the magnetic saturation in the armature or other parts of the magnetic circuit. It is desirable to cut direct-playback records at a high level in order to get the best possible signal-to-noise ratio. The writer referred to previously showed that the velocity of the stylus is given in terms of the light band width by the formula

$$V = \frac{W \pi N}{60}$$

where W is the band width measured in centimeters, N the number of revolutions of the turntable per minute and V the velocity of the stylus in centimeters per second. If there is no overload in the system the output velocity should be doubled when the input voltage to the amplifier is doubled. That is, if we plot output velocity against input voltage the result should be a straight line as shown in Fig. 3, if no overload is present when the input voltage is high enough to overload either the amplifier or the recorder. The input-output characteristic will deviate from the straight line as shown in the dotted curve of Fig. 3. Since it is seen from the formula that the velocity is proportional to light band width the result of plotting the band width versus input voltage should also be a straight line if no overload is present. The method of making the overload measurement is therefore as follows: set the oscillator at some frequency, say 250 cycles, and adjust the voltage on the input amplifier so that the light band is increased in width slightly over the width shown by a blank groove. Measure the voltage and band width and plot a point of the line as in Fig. 3. Then double the voltage, measure the band width and plot the results as the next point. This should be continued until the maximum desired stylus velocity is reached. A smooth curve is then drawn through the plotted points. If this curve coincides with a straight line through the first points plotted the system will handle the desired level without overload. The frequency of 250 cycles was chosen for two reasons. First, it is the point where the velocity curve on most standard recorders begins to fall off due to the amplitude characteristic used for low frequencies, and second, it is in the range of maximum energy for speech and orchestral music and therefore at a point likely to be overloaded. It is not, however, the point at which the magnetic circuit is most likely to overload. The flux density in the armature is greatest for constant voltage at the lowest frequency. Therefore if it is desired to record at high level an orchestra having a predominance of low notes this measurement should be repeated at about 50 cycles. This second measurement will serve to determine whether the overload, if any, is in the amplifier or recorder. If overload appears in the low-frequency measurement at a voltage level where no overload was shown for 250 cycles it can be concluded that the overload is in the magnetic circuit and not in the amplifier.

When the input level is raised to a point where the input-output characteristic deviates from a straight line the system begins to introduce non-linear distortion. The observation of the deviation from linearity of this characteristic is not an accurate way to measure the level of the distortion products, but is, however, a good way to determine whether they are present. A sufficiently good criterion is that on a carefully measured and plotted characteristic any visible deviation from linearity will be accompanied by audible distortion products. It is also sufficient to be assured that the maximum level recorded is on the linear part of this characteristic since if this is the case no serious distortion will be present.

MAXIMUM PERMISSIBLE AMPLITUDE

It is customary to cut all frequencies below 250 or 300 cycles at constant amplitude instead of constant velocity. The maximum permissible amplitude on any record is an amplitude equal to one-half the groove spacing. If amplitudes greater than this value are cut there is danger in cutting over into the next groove. In making the measurements described above it is necessary to go only up to this amplitude. Consider the case of a record spaced at 100 grooves per inch. The maximum permissible amplitude is .005 inch or .0125 cm. This corresponds to a velocity of about 20 centimeters per second at 250 cycles. From the formula we can compute the light band width corresponding to this velocity for any turntable speed. This formula can be written

$$W = \frac{60V}{\pi N}$$

and for speed of 78 rpm we get

$$W = \frac{60 \times 20}{78\pi} = 4.9 \text{ cm} = 1.9 \text{ inches.}$$

Thus it can be seen that for a pitch of 100 grooves per inch and a 78-rpm turntable the measurements described in the preceding paragraph need to be extended only to the point where the light band is approximately 1.9 inches wide.

This gives also a very good way of determining the proper recording level for any system. These values should be regarded as upper limits and recording levels should be kept considerably lower. Most recorders are designed to work at amplitudes of about .007 centimeter from 50 to 250 cycles per second and at constant velocity of about 10 cm per second above this frequency. The volume-indicator setting which gives a light band width corresponding to an amplitude somewhat less than half the groove spacing should be marked on the dial. During recording the needle should not be allowed to swing very far past this mark if the recording monitor wishes to be sure that no groove is cut over into the adjacent groove.

TOLERANCES ON CERAMICS

(*Continued from page 28*)

sequently, we must expect that, for one reason or another, the temperature in the kiln will change or, at least, the temperature which is read as being in the kiln will change slightly.

Likewise, the way the material is loaded from one tunnel kiln car to another influences final temperature. For instance, if you have a very thin wall tube, the load on one car is light. That may be followed by another car which is made up of slats and in that car the load will be very heavy. The first car absorbs a small amount of heat and the next car absorbs a large amount of heat and, when those cars reach the cooling end of the kiln, one gives up a small amount and the other gives up a large amount to preheat the gases going towards the burners.

Even such slight temperature changes produce shrinkage changes. On some ceramic bodies a 1.000″ dimension changes .0005″ with each change of one degree Centigrade. Other bodies will change somewhat less, but in any case the fact must be recognized in the final size.

You may wonder why a variation of a few degrees makes so much difference in the shrinkage. Stop and consider that practically all of the shrinkage of 10% or 13%, or whatever it may be, on the pieces takes place in a range of about twenty or thirty degrees near the end of the firing cycle. When the material first enters the kiln, the heat gradually expands the piece a small amount; then, there is practically no change taking place in the piece except that the chemically combined water and organic matter within the material burns out up to 1000 degrees Centigrade. At that point, the minerals begin to change. From this point in the cycle the material gradually decreases in size over quite a period of time. At the end, however, it is followed by a very rapid change in dimensions over a small range of temperature and then that is followed by a slighter change in size as the temperature is increased from that point on.

The reactions in ceramic material in firing are influenced by the fineness of grinding, the intimacy of the mix, by initial forming pressures and by very slight changes in the amount of the fluxing material.

Another variation almost beyond control in firing tubes, particularly thin wall tubes, is the difficulty of keeping them round in firing, because the support for the tube may not permit it to draw inward in all directions equally as it shrinks. Most ceramic materials are soft and plastic at the high temperatures and will stretch instead of drawing in over some slight obstacle. Thick wall tubes have greater strength at such a time and will stay round in shrinking where thin wall tubes will not. That is why they are cheaper in spite of containing more material.

Thin ceramic parts frequently follow the contour of their supports and are bent in firing. In designing for their use it becomes necessary to allow for camber or provide for grinding straight after firing. Because of the difficulty of grinding a material which possesses almost the hardness of the grinding medium, it is usually more economical initially to provide in the design for an allowance for camber of the fired ceramic parts.

From the above you can readily understand why too close tolerances are expensive.

Isn't it, therefore, important that the design engineer give very careful consideration to the tolerances actually required? Often their determination is most casual. The designer, recalling that he can get screw machine products or plastics or mica with no subsequent change in size, jots down the first figures that come to mind—possibly ±.002″—where he can conceivably be far more generous. He forgets the ceramic engineers' problems completely and specifies in an offhand way the ±.002″. You seldom see tolerances of ±.004″ because it seems natural to specify ±.002″, ± .005″ or ± .010″, although the needs of the job may require ± .004″ instead of ± .002″ or ± .013″ instead of ± .010″. As a result, he makes the ceramic part become unnecessarily costly or, perhaps, impossible.

In good design practice it is desirable, therefore, to secure the ceramic part first before completing the final dies for stampings which must fit it. Usually the design permits slight changes in such parts without compromising the ultimate application of the device.

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SPEECH-INPUT UNITS

(*Continued from page* 23)

illustrates still another variation. Tubes and components are mounted on a horizontal subpanel, as in some of the previously-mentioned equipments, but the tubes are arranged along the rear of this subpanel shelf, so that they may be very easily reached from the rear. The large size (5″) dual-speed meter is illuminated with two small lamps and is marked so as to be easy to read under any condi-

(*Continued on page* 41)

SPEECH-INPUT UNITS

(*Continued from page* 39)

tions. The meter action is of the high-speed type, with provision of a suitable damping circuit which tends to "stop" the needle at maximum swing, and to retard the return in such manner as to make possible observations of peak amplitude while at the same time eliminating the fatigue which would result from trying to follow the motion of a high-speed meter not provided with damping. In addition to this power-level indicator, the General Radio line includes a rectifier-type VI meter, a small adjustable attenuator, and components such as mixer and volume controls.

REMLER

Speech-input equipment offered by the Remler Company includes a complete line of amplifier and auxiliary units. The panels of the individual rack units are of dural, and are finished in aluminum-grey lacquer. An unusual feature of the arrangement of these units is the provision of a combination bridging and line amplifier. This unit—the Type AR67 amplifier—consists of a three-stage line amplifier section and a two-stage bridging amplifier section combined in a single unit; in other words, a five-stage amplifier with a 500-ohm interstage connection between the third and fourth stages from which the line output is obtained. In addition to this unit, there is a preamplifier—of the single rack-mounted type—and auxiliary panels, including a power-supply unit for the operation of the Type AR67 amplifier. Components and tubes for the amplifier units are mounted on vertical subpanels, with the tubes projecting frontward.

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OVER THE TAPE

(*Continued from page* 32)

NEW OFFICES FOR CARTER

Carter Motor Company have announced the removal of their offices and plant to 1608 Milwaukee Avenue, Chicago. Additional equipment has been installed at the new plant which will double their capacity.

DANIEL RECEIVES APPOINTMENT

W. Ralph Daniel has recently been appointed sales manager of Morner Productions Inc. For the past ten years Mr. Daniel has been with Electrolux, Inc., in various sales executive capacities and as Personnel Director. Prior to that time he was a newspaper man and public relations counsel. Mr. Daniel is a brother of the late John B. Daniel, well-known N. B. C. announcer.

Morner Productions Inc., plans to add an industrial department to its organization, contacting those industries not having radio advertising connections.

ELECTROSOUND OFFICES

ElectroSound Products, Inc., a distributing company opened offices and display rooms at 620 North Michigan Ave., Chicago, on Thursday, April 28. Mr. V. G. Geisel, Vice-President of the company, is Manager.

Initially, only Radiotone Recording Equipment will be sold, but other lines of sound equipment will be added as time goes on. Mr. Geisel, who has just returned to the Middle West after two months spent at the Radiotone factory, states that it is only recently that manufacturing facilities have been increased sufficiently to permit expansion into markets other than the Company's own Hollywood market. A new factory for Radiotone, Inc., is now under construction, and when it is finished in June it will step up production several hundred per cent.

HUDSON DIVISION ARRL CONVENTION

The Hotel Astor, Times Square, New York City, will be the scene of what will probably be the biggest and most interesting Amateur convention in Hudson Division annals. The Convention will open at Noon, Friday, June 17, and will continue through Friday and Saturday with lectures and demonstrations by prominent men in the radio field culminating in a grand ball and banquet on Saturday evening, June 18, at which time many worthwhile door prizes will be distributed. Numerous contests of varied nature will be held during the two days of the Convention which should prove interesting to all.

FREED TRANSFORMER MOVES

Freed Transformer Company have announced the removal of their offices and factory to 72 Spring Street, New York City. The telephone numbers are CAnal 6-1190 and 1191.

ISOLANTITE BULLETIN

"Isolantite Bushings" is the title of a new bulletin recently made available by Isolantite, Inc., 233 Broadway, New York City. This bulletin covers flanged bowl and cone type insulators, conical pair lead-ins, wall bushings, deck type bushings, transformer and condenser bushings, small glazed and unglazed bushings, insulating beads, washers, etc. Copies may be secured from the above organization.

NEW ADDRESS FOR RIDER

John F. Rider, publisher of servicing manuals and books, has moved from 1440 Broadway to 404 Fourth Avenue, New York City. The new offices are between 28th and 29th Street.

NEW COMPANY

Announcement has been made of the formation of Greyhound Equipment Company, specializing in radio and industrial coil windings, with offices and factory at 1720 Church Avenue, Brooklyn, N. Y. Mr. F. K. Coppel heads the organization, with Sylvan A. Wolin as representative in the metropolitan New York area on domestic and export sales.

TELETRAN CATALOG

Teletran Products Company, 2233 University Ave., St. Paul, Minnesota, have just issued a catalog covering public-address accessories and kits, intercommunicators, centralized radio, and specialized sound systems. Write to the above organization for Catalog No. 25.

BAKELITE PLASTICS BOOKLET

A new edition of the booklet "The Versatile Service of Bakelite Plastics" has just been published by Bakelite Corporation, 247 Park Avenue, New York. This 16-page booklet tells the history of modern plastics from the time of their discovery by Dr. L. H. Baekeland up to the present day, when they are being used by practically every industry in one form or another. Copies of this booklet may be had upon request.

RCA PROMOTES SHANNON

Announcement of the election of Robert Shannon, Vice-President and General Manager of the RCA Manufacturing Company, as a member of the Board of Directors, was made recently by David Sarnoff, Chairman of the Board. Mr. Shannon, who is 46 years old and a resident of Haddonfield, N. J., has been identified with radio manufacturing and administration since the earliest days of radio.

HIRTLE PRESIDENT OF BURGESS

The Burgess Battery Company has elected Mr. Dan W. Hirtle President and Dr. C. F. Burgess Chairman of the Board of Directors at its annual meeting held March 26, 1938. Prior to his association with Burgess, Mr. Hirtle was an Assistant Superintendent of the American Rolling Mills Company, Middleton, Ohio.

INSTRUMENT BROCHURE

"When You Can Measure," a 32-page brochure recently published by the General Electric Co., tells in brief the contributions of General Electric engineers and scientists to the important art of measurement. This attractive publication describes in pictures and in words the story of how instruments are designed, constructed and tested.

VWOA NEWS

(*Continued from page* 30)

Marconi's followers, as well as of himself, may be kept green in one shrine."

The broadcast was concluded with prayer by the Reverend Dr. Doty.

MONUMENT

TITANIC MEMORIAL SERVICES were held on Friday April 15, 1938, at 12:30 Noon at the Wireless Operators Monument in Battery Park, New York City, under VWOA auspices. C. S. Anderson introduced our President, who in turn introduced the other speakers. Precisely the same program as was earlier broadcast over the Mutual network was presented. The Reverend Harold H. Kelley, Superintendent of the Seamen's Church Institute, led in prayer. A Coast Guard Color Guard and bugler, furnished through the courtesy of Commander Baylis, took part and lent color to the services. The speakers who participated in the broadcast also took part in the services at the Monument. A public-address system, supplied through the courtesy of Messrs. Poppele and Content of WOR, was used. These services were attended by more of our members than possibly any other similar activity in the past. Several local newspapers carried pictures of the services on the following day.

SMOKER

AT THE SMOKER held at the Castle Garden Cafe, New York City, on Monday, April 4, 1938, a record turn-out of our members and friends enjoyed a most delicious corned beef and cabbage dinner with all the beer you could drink and corn cobs and tobacco for all. Among those present: Fred Klingenschmitt, recently returned from Florida and looking fine; Peter Podell, taking time out from his automobile agency in the Bronx; Arthur Lynch with a couple of friends, Bill Filler of Terminal Radio and Mr. Grant of Sun Radio; H. A. Steinberg, who because of his large amount of traveling doesn't always get the opportunity of attending meetings—obviously enjoying the proceedings; H. T. Hayden, Ward Leonard representative and our Membership Chairman; the inseparable Messrs. Hopfenberg and Davies, who arrived late but got their share; Arthur Rehbein, a real veteran of many years who met Davies after a lapse of nigh onto twenty years; Dick Cuthbert, a former shipmate of our prexy and a real oldtimer; Bob Frey and Joe Appel from up Westchester County way; George Clark, who claims it was one of the best affairs ever; Steve Wallis, who took a second portion of the victuals—they were that good; Carl O. Petersen with Ray Griswold, who attended his first meeting; Dick Egolf; A. Stanford of the staff of WOR; Walker of the Mackay Marine Department staff in New York; Steve Kovacs and his pal Alexander Vadas, both apparently glad they came; Charles Maps, of the New York Telco, up Bronx way; Fred Muller of Collins Radio and a former prexy; C. D. Guthrie, Radio Supervisor of the New York office of the Maritime Commission; the "Melody Boys" Jack McClosky, Teddy Jacoby and his brother and Hugh McGonigle, the prexy's brother; the President and some few others. Fred Klingenschmitt obligingly officiated at the piano, the boys removed their coats and with corn cob in one hand, a glass of better brew in the other, they proceeded to harmonize in the best "Barbershop" fashion. All in all—a fine party enjoyed by one and all.

SMALL SIZE HIGH Q COILS

Ferranti has developed a series of five new standard high Q coils which are available in compact form. These coils incorporate a special core structure which is said to result in a low leakage field, making them adaptable in filter assemblies. The field of these coils is such that they may be placed side by side. High Q coils can be furnished with any normal value of inductance over the frequency range of 50 to 10,000 cycles.

The accompanying curves indicate the value of Q which can be obtained in any one type of coil at any specific point in the frequency spectrum. The stability of these high Q coils with changes in voltage or with changes in frequency depends upon the design of the particular coil concerned, and can only be given for specific coils. By consulting following table and accompanying curves the value of Q obtainable and the size of the coil for any given frequency can readily be ascertained.

Type	Inductance Tolerance	Dimensions
1	± 2%	2⅛ x 2¾ x 2⅞"
2	± 3%	1½ x 2⅛ x 2½"
3	± 3%	2¼ x 2¾ x 3⅛"
4	± 5%	1½ x 2⅛ x 2½"
5	± 5%	1¼ x 1¼ x 1½"

Further data may be secured by writing to *Ferranti Electric, Inc.*, 30 Rockefeller Plaza, New York City.—COMMUNICATIONS.

KEN-RAD TYPE 6K8

Ken-Rad has announced a new tube known as type 6K8, a new converter tube in a metal envelope. A triode section is provided for the mixer in a superheterodyne receiver. Improved oscillator performance and frequency stability are said to make the Ken-Rad 6K8 advantageous in short-wave receivers. Since the oscillator plate can be operated at the same potential as the hexode screen, better operation is obtained in a-c, d-c receivers.

For further information write to *Ken-Rad Tube & Lamp Corporation, Inc.*, Owensboro, Kentucky.—COMMUNICATIONS.

FEEDBACK AMPLIFIER

An amplifier and power supply to be used as a program amplifier, for audition or monitor purposes, recording or public address, or as a measuring unit for laboratory, has been developed by Fairchild.

The frequency characteristic is within .3 db from 15 to 15,000 cycles with a maximum distortion of ½ of 1 percent up to 23 watts, which is the rated output, and an overall gain of 75 db.

Both units are of the same physical size behind a 7-inch panel and can be mounted on a standard relay rack.

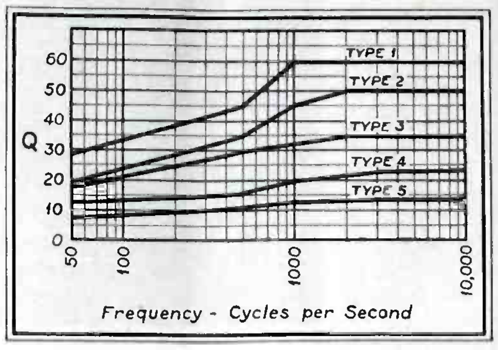
For further information write to the *Fairchild Aerial Camera Corporation*, 88-06 Van Wyck Boulevard, Jamaica, New York. —COMMUNICATIONS.

PINCOR DYNAMOTORS

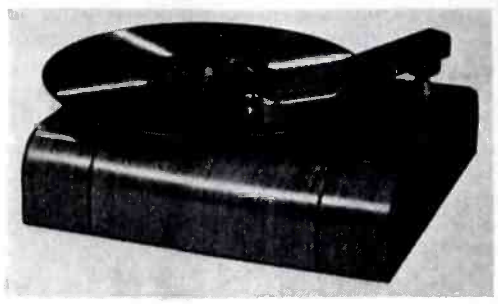
An announcement has recently been made of Pioneer's new S series Pincor Silver Band dynamotors, designed to furnish power-supply for sound systems, police and aircraft units, and mobile broadcast equipments. Data sheets on Pincor dynamotors, showing capacities, performance characteristics, etc., of representative types, including the new S series, may be obtained by writing the *Pioneer Gen-E-Motor Corporation*, Dept. R-6, 466 West Superior Street, Chicago, Illinois.—COMMUNICATIONS.

THE MARKET PLACE

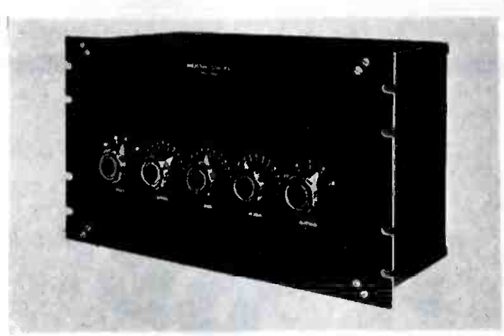
(*Continued from page 34*)



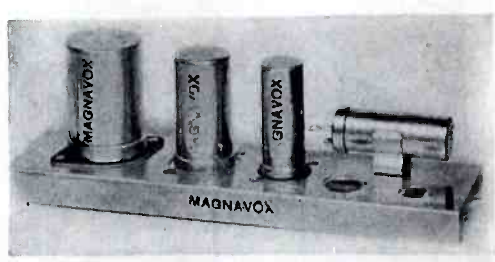
Ferranti coil curves.



RCA record player.



Amertran line equalizer panel.



Magnavox condensers.

Pioneer dynamotors.

RECORD PLAYER

A new record-player instrument for use with electrically operated radio receivers, and which is said to embody many technical improvements, has been introduced on the market by RCA Victor. The new record-player will be known as Model R-93-C. It is equipped with a new type of lightweight crystal pickup. Other structual and performance improvements on the R-93-C include true-tracking tone arm for better reproduction; a newly developed motor with bearings and supports cushioned in rubber for quiet operation; volume control and power switch in one conveniently placed control; and a special plug for easy connection to receivers.

This record player is a product of *RCA Manufacturing Co., Inc.*, Camden, N. J.—COMMUNICATIONS.

LINE EQUALIZER PANEL

Flexibility of adjustment is claimed for a new line equalizer panel, known as AmerTran Type F-188. This unit is for use in correcting the frequency characteristics of circuits for the transmission and amplification of speech and music, such as used in radio broadcasting and sound recording. It is especially intended as a general-purpose panel for equalizing lines which are not in continuous service, and consequently do not justify the installation of a fixed equalizer network.

Independent selection and equalization of high and low frequencies is feature of the equalizer. On the low side equalization at 25, 50 or 100 cycles can be controlled throughout a range of 0 to 25 db in eleven steps. The same type of control is available on the high side for frequencies of 5, 7, 8 or 10 kilocycles. There is also an 11-step, 30-db master attenuator which controls insertion loss at 800 cycles and determines the maximum available equalization. Five controls on the front panel are used for quick adjustment of the equipment.

This equalizer is a product of *American Transformer Co.*, 178 Emmet St., Newark, N. J.—COMMUNICATIONS.

ELECTROLYTIC CONDENSERS

A series of electrolytic capacitors, known as the Molanode line, has been announced by Magnavox. Simplicity in mounting, low cost and standard ratings are among the features claimed for these condensers. Literature is available from the *Magnavox Company*, Fort Wayne, Indiana.—COMMUNICATIONS.

TRANSCRIPTION NEEDLE

A new long-life needle, especially designed for reproducing laterally cut transcription recordings, has been announced by RCA Victor. It is designated as No. 1 transcription needle. It is said to play several times as long as the average transcription needle, to be so designed that it will reproduce all recorded frequencies without loss of quality, and to keep surface noise at a minimum.

To guard against possible imperfections, each needle is individually shadowgraphed twice. They are of such quality that they may be depended upon to reproduce the last part of a transcribed program with the same fidelity as the beginning, it is said. Although the new needle will reproduce several programs satisfactorily, RCA Victor recommends that it be used on two 15-minute programs for best results.

Additional information may be secured from *RCA Manufacturing Co., Inc.*, Camden, N. J.—COMMUNICATIONS.

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- And in 'Tophet (pronounced tof-fet) you are offered the sum total of the pioneer's experience, skill and good name.

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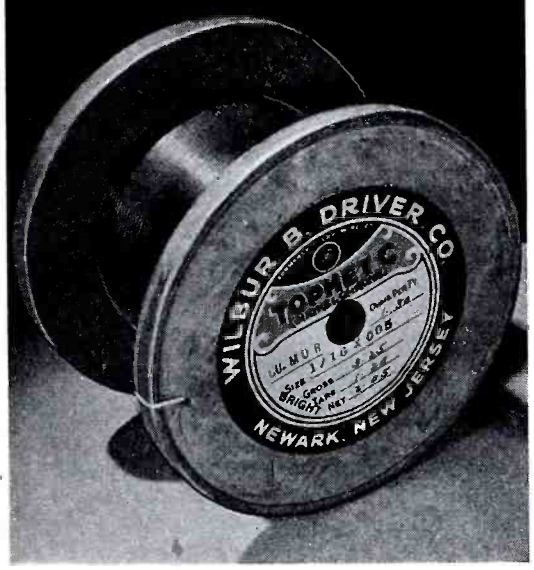
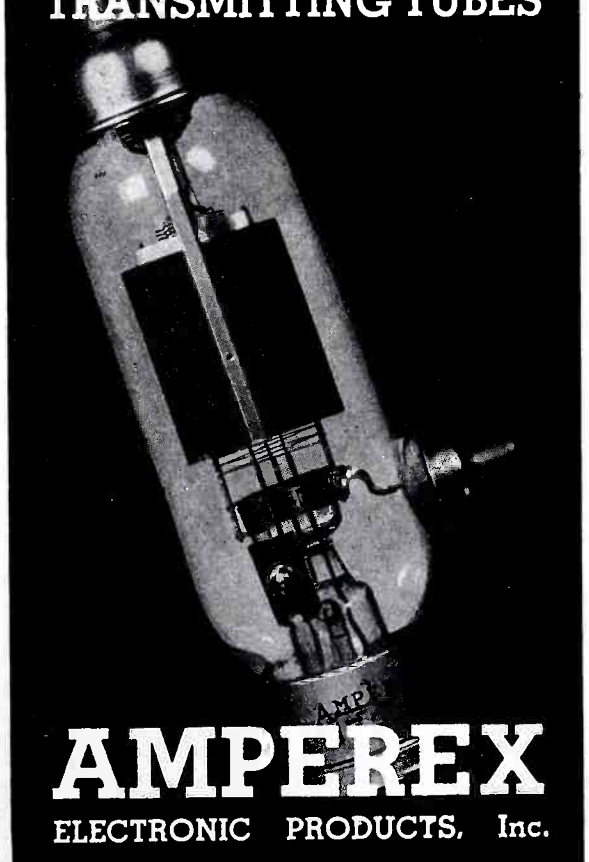


AMPEREX

CARBON ANODE TRANSMITTING TUBES



AMPEREX

ELECTRONIC PRODUCTS, Inc.

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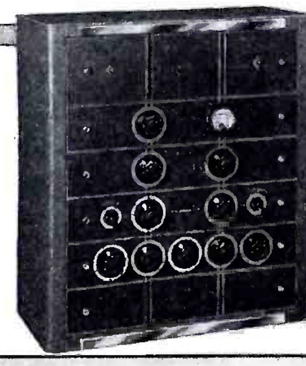
SUMMA CUM LAUDE



Highest honors go to Lafayette's new professional amplifying equipment! One look at the impressive list of features listed below tells you why. But it's when you actually *try* this matchless triumph of Lafayette styling, stamina and engineering that you get the really convincing reason for going Lafayette.

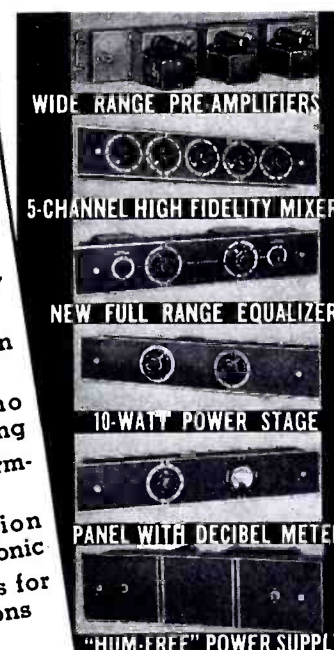
PROFESSIONAL AMPLIFYING EQUIPMENT

for every purpose

Probably the most outstanding feature of this Lafayette amplifying equipment is its amazing versatility. You can use it for an infinite number of combinations—without distorting the beauty or streamlined symmetry of the unit's design. You'll admire the perfect studio-appearance of Lafayette professional amplifying equipment. You'll like its trim compactness. Write today for descriptive literature.

FEATURES

- Beautifully designed in gray duo-tone with red trim
- All units harmonize in any arrangement
- All units completely shielded front and rear
- All inter-unit wiring by means of patch cords
- All operating controls on panel faces
- Extremely compact—no waste space—no cramping
- Highest fidelity transformers used throughout
- Pre-amplifiers cushion mounted—non-microphonic
- Equalization facilities for all frequency corrections



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AMPEREX TUBES

FCC approval has been received for the Amperex type 251A and 270A tubes, for use in the final stages of broadcast transmitters, at the following ratings:

Type 270A—350 watts for high-level modulation or plate modulation in the last radio stage; 125 watts for low-level modulation or the last radio stage operating as a linear power amplifier.

Type 251A—500 watts for high-level modulation or plate modulation in the last radio stage; 250 watts for low-level modulation or the last radio stage operating as a linear power amplifier.

These tubes are manufactured by *Amperex Electronic Products, Inc.*, 79 Washington Street, Brooklyn, N. Y.—COMMUNICATIONS.

RCA TELEVISION PARTS

In line with their policy of encouraging amateur interest in television and cooperating with experimenters in that field, RCA has made available certain additional specialized television parts for use by experimenters within radius of television transmitting stations.

With the new television parts just announced, and other standard parts already available, it is now possible for the amateur experimenter who is equipped with sufficient technical knowledge, to assemble his own Kinescope deflecting circuits for use in experimental television receivers. In its announcement, RCA emphasized that placing of these television parts on the market should not be construed in any way as an announcement by RCA of commercial television apparatus for use by the general public. The new parts, as well as two Kinescope television receiving tubes previously announced, are being made available for the convenience of radio amateurs, experimenters, laboratories and schools who have made inquiries for them.

The new parts listed for sale include a deflecting yoke, two power transformers, a vertical output reactor, a vertical oscillation transformer, a horizontal oscillation transformer, a horizontal output transformer, two power-supply capacitors, and a power-supply reactor.

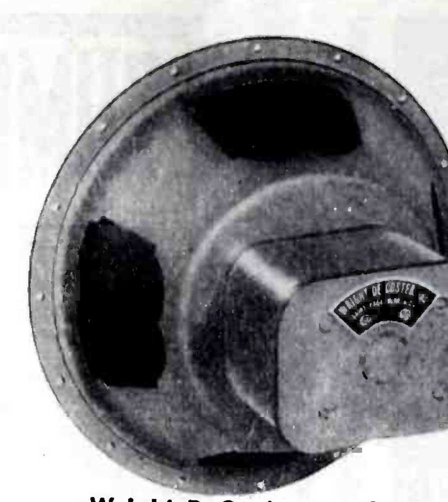
A folder describing these parts and giving wiring diagrams is available from RCA parts distributors or from the *RCA Parts Division, RCA Manufacturing Co., Inc.*, Camden, N. J.—COMMUNICATIONS.

CLIMATITE TRANSFORMERS

A process of transformer treatment which is said to enable transformers to operate continuously under severe conditions of humidity and temperature has been announced. Transformers are being sold under the trade name of Inca "Climatite" and are supplied in both power and audio types.

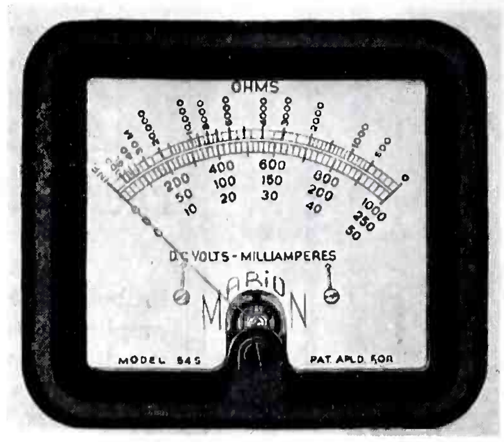
Outstanding advantages claimed for these units are that they can be built with very little increase in size, cost or weight and with little difference in appearance from the standard types used in commercial radio production. Transformers of this type are suited to export requirements where low weight, small size and minimum price are definite considerations.

Further information may be secured from the *Inca Division, Phelps Dodge Copper Products Corp.*, 2375 East 27th St., Los Angeles, Calif.—COMMUNICATIONS.



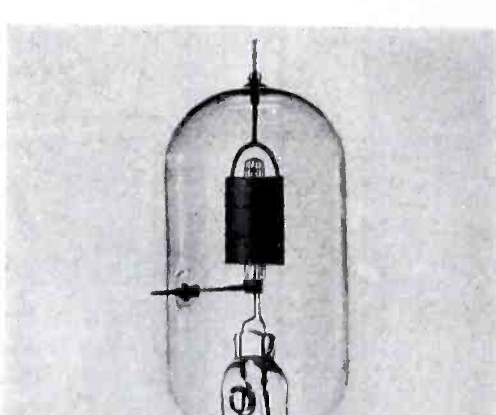
Wright DeCoster speaker.

Marion meter.



Phelps Dodge transformer.

Heintz & Kaufman tube.



NOKOIL SPEAKER

The new 12-inch Nokoil speaker shown in the accompanying illustration is said to be highly efficient. This Model N 12 HL speaker is furnished in three different types: low-frequency type, covering the range from 50 to 3500 cycles; standard type, covering from 60 to 5000 cycles; and the wide-range type, 60 to 7500 cycles. All three are capable of handling 20 watts continuously.

For further information write to *Wright De Coster, Inc.*, 2253 University Ave., St. Paul, Minnesota.—COMMUNICATIONS.

MARION METERS

Marion Electrical Instrument Co. have announced a new line of meters. All of these units feature d'Arsonval movement of 2% accuracy, large scales, ample torque to allow use in any position. Magnets are aged both naturally and artifically to insure stability. One-milliampere meter movements regularly supplied with 50-millivolt drop, but can be furnished with any millivolt drop from 50 up. The meter illustrated is the Model 54S with overall dimensions of 4⅝" x 4-3/16". Barrel diameter is 2-45/64", barrel depth 1 inch.

Literature may be secured by writing to P. W. Mack, 1270 Broadway, New York City, or from *Marion Electrical Instrument Co.*, Manchester, New Hampshire.—COMMUNICATIONS.

CATHODE-RAY TUBE SCREENS

Although the medium-persistence green cathode-ray tube pattern is generally used in standard oscillograph practice, there are other screens available where the applications vary from normal requirements.

For very rapidly changing phenomena, there is the short-persistence blue screen. For the study of transient phenomena, particularly when comparisons are desired between them, there is the long-persistence time-delay screen. On the latter the pattern traced by a single phenomenon remains on screen for as long as a minute. If desired, several phenomena may be placed on the screen and compared. Also, the screen patterns may be readily photographed because of their persistency.

Finally, there is the medium-persistence white screen, which provides for black-and-white patterns that may be more desirable than the green or the blue for certain types of work.

These types of screens are available from the *Allen B. DuMont Laboratories, Inc.*, 2 Main Avenue, Passaic, N. J.—COMMUNICATIONS.

TYPE 254 GAMMATRON

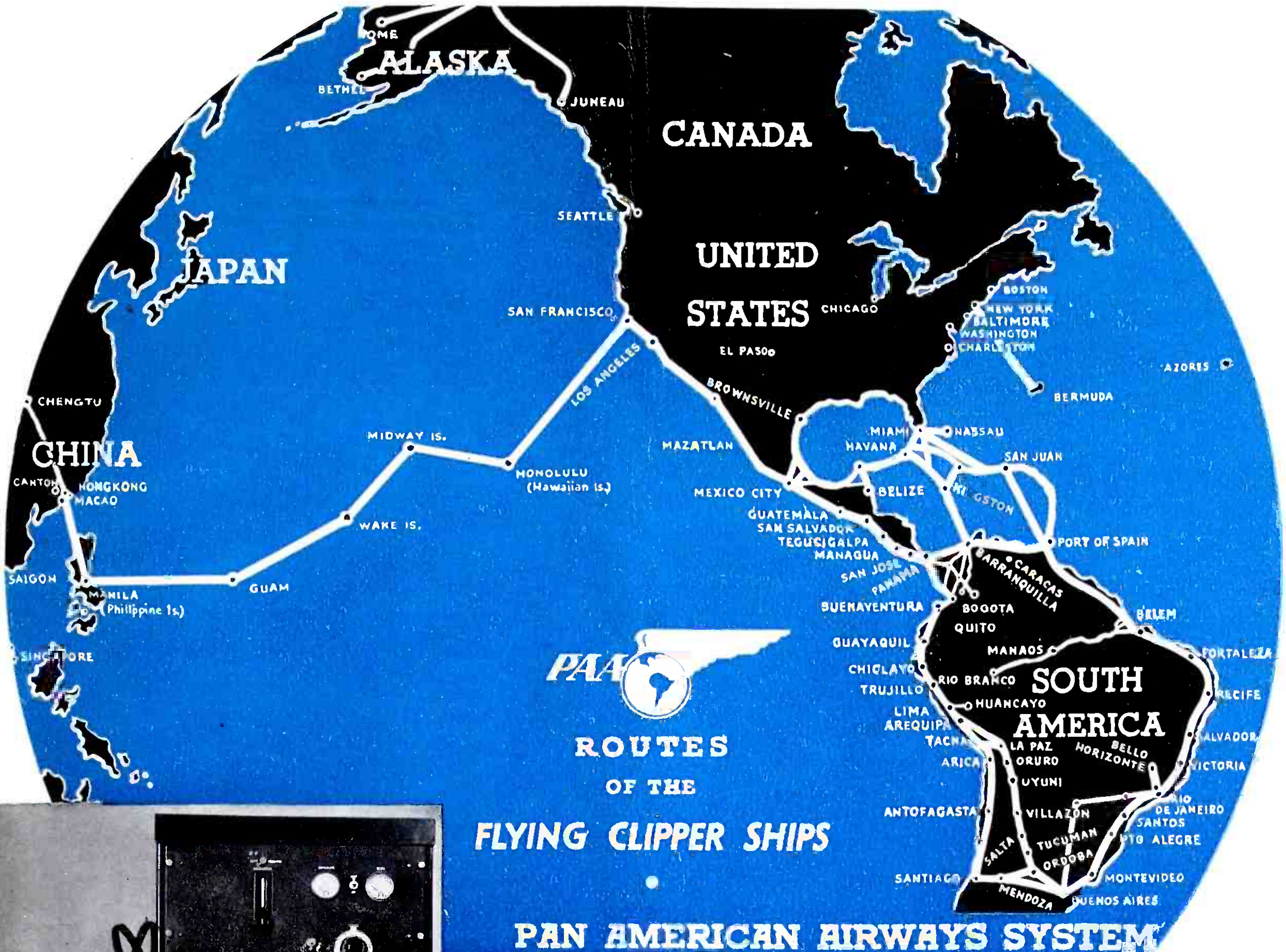
The Type 254, shown in accompanying illustration, is a triode having a plate dissipation of 100 watts. The maximum Class C power amplifier capability is 500 watts output. The Class B audio output for 2 tubes is 450 watts.

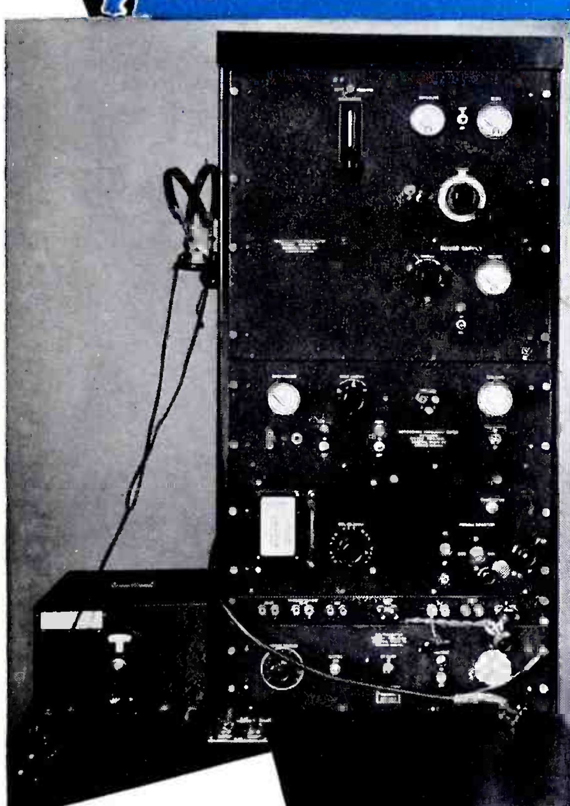
Filament voltage	5
Filament current	7.5
Normal plate dissipation	100 watts
Maximum plate current	200 ma
Maximum plate volts	3,000
Maximum grid current	40 ma

This tube has no internal insulators, uses Tantalum elements, Nonex envelopes and Tungsten supports. It is particularly designed for ultra-high-frequency operation.

Further information may be secured from **Heintz & Kaufman, Ltd.**, South San Francisco, California.—COMMUNICATIONS.

Advertising Index





THE CHOICE OF THE DISCRIMINATING

PAN AMERICAN AIRWAYS, since its foundation noted for its conservatism, its thoroughness in pioneering new air routes and its discriminating choice of personnel and equipment, has one of the most difficult problems in aircraft radio communication in the world. A far-flung labyrinth of ground stations is called upon to furnish almost instantaneous communication with the many Pan American planes in flight over the remote corners of the globe.

Behind this communication system there has to be an organization of good engineers, good technicians, good operators *and good equipment.*

In designing, manufacturing and maintaining its communication equipment, Pan American has always relied upon General Radio for laboratory and frequency measuring apparatus and parts.

Illustrated is the frequency measuring position at the Pan American International Marine Airport at Miami . . . one of several G-R Class C-10 Frequency Measuring Assemblies used by PAA.

As have many other aircraft organizations, Pan American has found that General Radio apparatus can be relied upon . . . that it is correctly engineered, correctly designed, carefully manufactured and rigidly inspected . . . that it always fills the bill.

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