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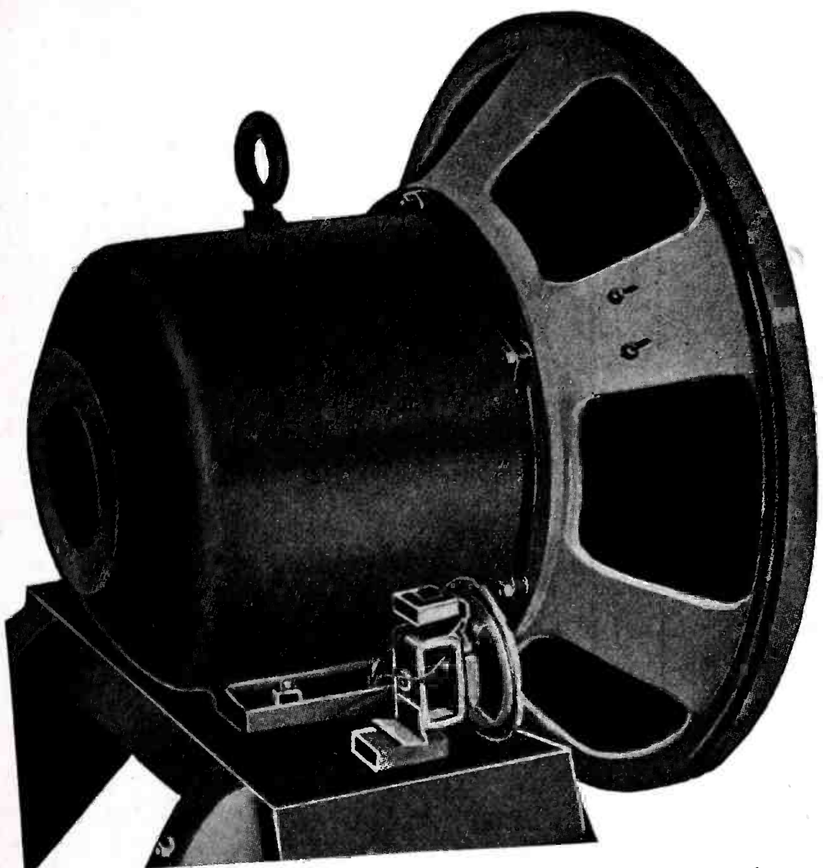

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Voice coil impedance at 400 c.p.s.	16	Field coil load	190 watts
Outside diameter	26¾"	Weight of speaker	455 lbs.
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VOLUME 20
NUMBER 1

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

Shown on the front cover of this issue is a number of new ultra-high-frequency tubes used in the Western Electric altimeter. This tube generates 5 watts at 750 mc.

• Editorial Comment •

THE Broadcast Engineering Conference for 1940 will be held February 12-23, inclusive, at the Ohio State University, Columbus, Ohio. This year the gathering will serve also as an engineering convention for the National Association of Broadcasters.

Dr. W. L. Everitt has arranged an excellent program for the technical meetings as well as a number of special entertainment features. Complete details of the program, including data on fees, registration, and living accommodations, will be found on page 7 of this issue. Final registration date has been set as February 1.

Of exceptional interest at the meeting will be the symposium devoted to frequency modulation. Introduced by Prof. E. H. Armstrong, of Columbia University, the subject of frequency modulation will be discussed by such authorities as I. R. Weir, H. P. Thomas and R. F. Shea, all of the General Electric Company, and Paul A. deMars, Technical Director of the Yankee Network. These f-m discussions will be of interest to *police* and *airways* engineers as well as to the *broadcast* group.

The Broadcast Engineering Conferences have been a distinct success ever since they were first started in February, 1938. The growing popularity of these meetings is due to the very timely subjects presented by recognized leaders in the particular fields . . . as well as to roundtable discussions of the various topics. In all, much good is gained from these sessions.

IN this issue we are presenting an article entitled "Expectations in Radio" in which we attempt a preview of 1940 based upon some of the general trends in the radio industry. This presentation is of necessity incomplete, since volumes could be written on the subject. However, we hope that in some measure it will help point the way to coming developments.

We should also like to call attention to the article by E. N. Dingley on "An Omnidirectional Radio Beacon." As Mr. Dingley points out recent developments in f-m transmitters suggest that such equipment can be used to advantage in designing a radio beacon. We believe our readers will find this article of considerable interest.

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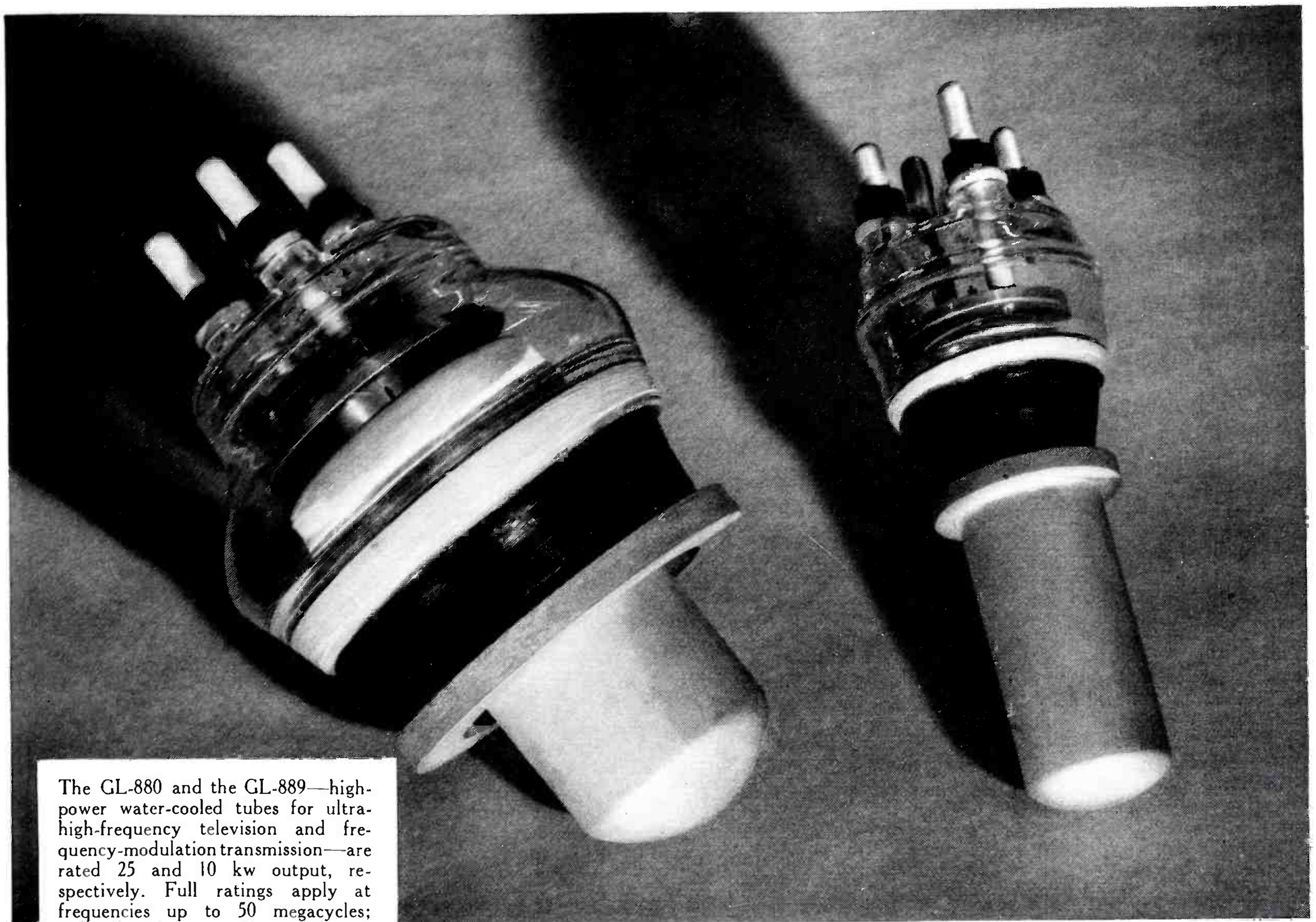

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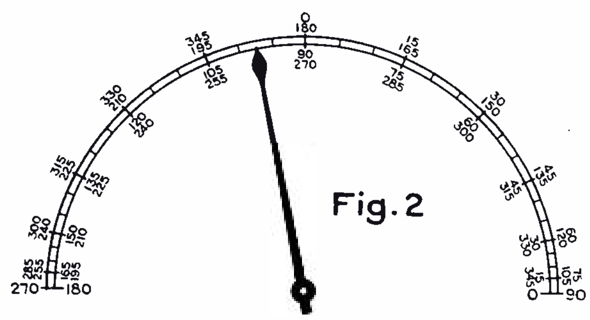


Fig. 2

A True Omnidirectional Radio Beacon

By **EDWARD NELSON DINGLEY, Jr.**
Bureau of Engineering
Navy Department

An omnidirectional radio beacon may be defined as a radio transmitting equipment capable of radiating equal amounts of signal power simultaneously and continuously in all azimuthal directions in such a manner that the signal radiated on any one azimuth has a characteristic distinguishing it from the signal radiated on all other azimuths.

Recent developments in the design and use of frequency-modulated transmitters suggested that such equipment could be used to advantage in designing a radio beacon having the characteristics defined above.

As shown in Fig. 1, a frequency-modulated transmitter 4 is connected to energize the vertical radiator 1 and to simultaneously energize either the vertical radiator 2 through the transmission line 5 or the vertical radiator 3 through the transmission line 6. Either radiator 2 or radiator 3 is energized simultaneously with antenna 1 at time intervals determined by an automatic switch.

Radiator 2 is erected due west of radiator 1 and radiator 3 is erected due south of radiator 1.

Fig. 3-a represents the manner in which the frequency of the transmitter is increased linearly by the amount Q in the time t and then decreased linearly by the same amount in the same time. This frequency modulation is continuous at the rate of 1/2t cycles per second.

In Fig. 1 let t_x seconds equal the time required for a wave to travel from the transmitter to the radiator 2 by way of the transmission line 5. Let the same time t_x seconds equal the time required for a wave to travel from the transmitter 4 to the radiator 3 by way of the transmission line 6. Let t_c seconds equal the time required for a wave to travel from the radiator 1 to either radiator 2 or 3 by way of space radiation.

In Fig. 1, assume that there is a radio receiver of conventional type capable of receiving amplitude-modulated waves, located at some distance due west of radiator 1. The time required for a wave generated by the transmitter to reach the receiver by way of radiator 1 is $t_c + k$ seconds and the time required for the same wave to reach the receiver by way of radiator 2 is $t_x + k$ seconds where k is the time required for a space wave to travel from antenna 2 to the receiver. The difference in transit time for the two waves will then be $t_x - t_c$ seconds and the instantaneous difference in frequency f_d between the two waves will be $\frac{Q(t_x - t_c)}{t}$ cycles per second as shown in Fig. 3-b.

In Fig. 1, assume that the receiver is located some distance due east of radiator 1. The time required for a wave generated by the transmitter to reach the receiver by way of radiator 2 is $t_x + t_c + k$ seconds and the time required for the same wave to reach the receiver by way of radiator 1 is k seconds where k is the time required for a space wave to travel from antenna 1 to the receiver. The difference in transit time for the two waves will then be $t_x + t_c$ seconds and the difference in frequency F_d between the two waves at any instant will be $Q\frac{(t_x + t_c)}{t}$ cycles per second.

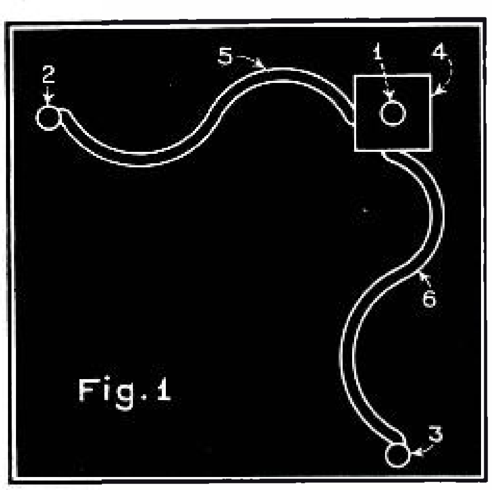


Fig. 1

In general the instantaneous difference in frequency between the two received waves, during the major portion of each cycle of modulation, will be

$$f_d = Q\frac{(t_x + t_c \sin Z)}{t} \quad \ldots\ldots\ldots\ldots (1)$$

where Z is the bearing of the receiver from the beacon with respect to true North.

The radio receiver consists of a conventional type capable of receiving amplitude-modulated signals. The receiver should be designed to amplify with reasonably constant gain, radio-frequency signals which vary in frequency by the amount Q and to attenuate as sharply as possible interfering signals outside of this range. This is not an unusual requirement because in practice the frequency variation Q is a small percentage of the unmodulated carrier frequency.

When the radio-frequency band-pass characteristic of the receiver is such as to pass the frequency band Q without appreciable variations in signal magnitude, the audio demodulator (final detector) of the receiver takes no cognizance of the fact that the two received waves are varying in frequency but the fact that these two waves differ in frequency by a constant amount causes the audio demodulator to produce in its output circuit an audio frequency equal to the difference in frequency between these two waves.

The output of this receiver is therefore an audio signal having a frequency which is a function of the true azimuth of the receiver from the transmitter in accordance with equation (1).

This audio output is then connected to operate a direct-reading frequency indicator of any one of the several types well known to the art and the scale of the frequency-indicating instrument is calibrated in terms of true bearing from the beacon rather than in terms of cycles per second.

One type of frequency meter which is capable of indicating audio frequencies with an accuracy of one-half of one percent even though the input voltage varies over a range of 5 to 300 volts is described by F. V. Hunt in the February, 1935, issue of the *Review of Scientific Instruments*, page 43. This instrument has the further advantage of indicating only the frequency of the strongest audio-frequency signal present should there be two such signals present as the result of receiving the direct waves plus waves reflected from some material object or from the ionosphere. In this case, the direct waves will produce the strongest audio signal and the correct true bearing will be indicated.

When the East-West radiators of the beacon are energized, a given deflection of the azimuth indicator indicates not one discrete bearing from the beacon but, on the contrary, indicates two conjugate bearings either one of which may be the correct bearing. In consequence the outer scale of the azimuth indicator, Fig. 2, consists of two conjugate scales.

In order that the receiving operator may know which of these two conjugate bearings is the correct one, a time-operated automatic switch is utilized at the transmitter to transfer energy alternately between radiators 2 and 3 at, say, 30 second intervals.

Utilizing radiators 1 and 3 instead of radiators 1 and 2 has the effect of shifting the radiation pattern counter-clockwise through an angle of 90 degrees. At any given receiving point, this results in causing the bearing indicator to read 90° more than the true bearing. To obviate the necessity of solving a problem in mental arithmetic after each shift of the radiation pattern, a second or inner scale is added to the instrument scale plate. Each point on this inner scale also represents two conjugate bearings.

The use of two sets of transmitting radiators and two azimuth scales at the receiver makes it necessary to indicate to the receiving operator, whether the inner azimuth scales or the outer azimuth scales should be read at any particular moment. This is accomplished by causing the modulating frequency of the transmitter to increase by about 10 per cent for the duration of about one-half second every five seconds when transmitting on the East-West antennas. This causes the pointer of the azimuth indicator to increase its deflection by about 10 per cent in short pulses between indications of the correct bearing. These short incremental pulses indicate that the outer scales of the azimuth indicator should be observed. When transmitting on the North-South antennas, the modulating frequency is decreased by about 10 per cent in a similar pulsating manner and the resulting decremental pulses of the azimuth indicator indicate that the inner scale should be observed. Of the two possible bearings indicated on the outer scales and the two possible bearings indicated on the inner scales, two will be identical and represent the true bearing without ambiguity.

At intervals of say 2 minutes, the call-letters of the beacon are transmitted using amplitude modulation on the center radiator only. The identification signal is terminated by a 5 second dash using an amplitude modulating frequency of the correct value to produce half-scale deflection of all receiver azimuth indicators regardless of their bearing from the beacon. This signal is used to verify the calibration of all azimuth indicators.

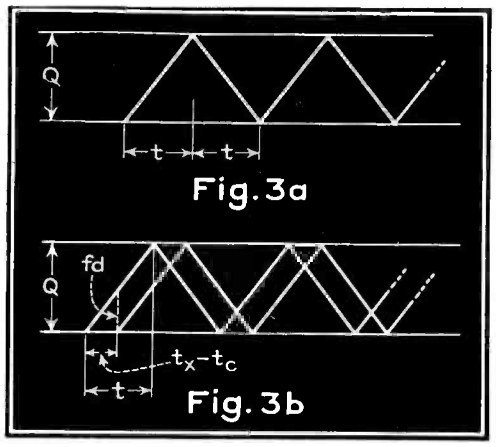


Fig. 3a

Fig. 3b

It is of interest to note that any bearing lying in the compressed area of the outer azimuth scales, Fig. 2, is also repeated in the expanded portion of the inner azimuth scales.

In order for the frequency indicator to operate satisfactorily, there must be generated at least one complete cycle of the audio frequency f_d during each time interval t. (Fig. 3-b.)

Let the minimum value of equation (1) be represented by f_d. From equation (1), the number of cycles of the minimum frequency f_d occurring in the time interval t is:

$$f_d\,(t) = Q\,(t_x - t_c) \qquad (2)$$

As above stated, $Q\,(t_x - t_c)$ must be not less than unity or:

$$1 = Q\,(t_x - t_c) \qquad (3)$$

or

$$1 = \frac{Q\,(D_x - D_c)}{3_x 10^8} \qquad (4)$$

where D_x = length in meters of transmission line 5,
where D_c = distance in meters between radiators 1 and 2,
where 3_x10^8 = velocity of wave propagation in meters per second.

Let the maximum value of equation (1) be represented by F_d. Then, from equation (1),

$$F_d = \frac{Q\,(t_x + t_c)}{t} \qquad (5)$$

In order that the range of variation of the difference frequency may be sufficient to permit of easy measurement, let the maximum of difference frequency equal twice the minimum value or:

$$F_d = 2f_d \qquad (6)$$

or

$$\frac{Q\,(t_x + t_c)}{t} = \frac{2Q\,(t_x - t_c)}{t} \qquad (7)$$

or

$$t_x = 3t_c \qquad (8)$$

or

$$\frac{D_x}{3_x10^8} = \frac{3\,D_c}{3_x10^8} \qquad (9)$$

Substituting (9) in (4)

$$1 = \frac{2QD_c}{3_x10^8} \qquad (10)$$

In equation (10) it is desirable to make both the terms Q and D_c as small as possible. A good compromise is obtained by making:

$$Q = 10^6 \text{ cycles} \qquad (11)$$

and

$$D_c = 150 \text{ meters or } t_c = \frac{150}{3_x10^8} \text{ seconds} \qquad (12)$$

Substituting equation (12) in equations (8) and (9) there is obtained:

$$D_x = 450 \text{ meters} \qquad (13)$$

and

$$t_x = \frac{450}{3_x10^8} \text{ seconds} \qquad (14)$$

and substituting equations (12) and (14) in equations (2) and (5) there is obtained:

$$f_d = \frac{10^6\,(450 - 150)}{3_x10^8 t} = \frac{1}{t} \qquad (15)$$

and

$$F_d = \frac{10^6\,(450 + 150)}{3_x10^8 t} = \frac{2}{t} \qquad (16)$$

or

$$f_d = 2F_m \qquad (17)$$

and

$$F_d = 4F_m \qquad (18)$$

where F_m is the frequency of modulation of the carrier.

Equations (17) and (18) indicate that F_m may be selected to obtain any desired value of f_d or F_d, as for example,

(*Continued on page* 35)

Program of the

Broadcast Engineering Conference

• BROADCAST • POLICE • AVIATION

THE Broadcast Engineering Conference of 1940 will be held during the period of February 12 to 23. In addition to its usual activities, the Conference will, this year, serve also as an engineering convention for the National Association of Broadcasters. The engineering representatives of the National Association of Broadcasters, Mr. Lynne C. Smeby and Mr. R. M. Wilmotte, have cooperated in submitting topics of current and timely value to broadcast engineers and have helped in the organization of the meetings and sessions.

As in previous years, lecturers and discussion leaders have been selected from organizations actively engaged in the solution of the problems and in the newest developments in the field of broadcast engineering. It is believed that the program on frequency modulation introduced by Professor E. H. Armstrong will be of very timely interest to members of the Conference.

Mr. A. D. Ring of the Federal Communications Commission will again lead a general discussion and question box, with Mr. R. M. Wilmotte of the National Association of Broadcasters acting as Chairman. Topics of general interest will be discussed, and anyone who wishes to suggest topics is urged to submit them to the Director of the Conference.

• We should like to call the attention of the police and aviation engineers to the sessions devoted to frequency modulation. It is felt that these discussions will be of interest to them as well as to the broadcast engineers.—Editor.

An unusual feature of the 1940 Conference will be an inspection by special train to Station WHAS, Louisville, Kentucky. Entertainment en route and in Louisville, and transportation will be provided as an additional privilege of registration for the Conference.

Correspondence regarding the Conference and suggestions as to discussion topics should be addressed to the Director of the Conference, Dr. W. L. Everitt, The Ohio State University, Columbus, Ohio.

Time	9 A.M. to 11 A.M.	11 A.M. to 1 P.M.	2:30 P.M. to 4:30 P.M.
Monday Feb. 19	Transcription Recording and Reproduction R. A. Lynn National Broadcasting Co.	The W2XBS Television Service of N.B.C. Raymond F. Guy Robert Morris National Broadcasting Co.	Some Engineering Aspects of International Broadcasting Raymond F. Guy National Broadcasting Co.
Tuesday Feb. 20			Television Measurements Compared with Broadcast Station Measurements—T. L. Gottier RCA Manufacturing Co.
Wednesday Feb. 21		General Discussion and Question Box A. D. Ring—F.C.C. R. M. Wilmotte	Audio-Frequency Testing by Means of Square Waves L. B. Arguimbau General Radio Co.
Thursday Feb. 22	CBS Broadcasts from Europe A. B. Chamberlain Columbia Broadcasting Co.		
Friday Feb. 23		Foreign Relations in Broadcasting Gerald C. Gross Federal Communication Comm.	The Lawyer and the Engineer A. W. Scharfeld

Thursday, February 22—6:30 p.m.—Banquet, Fort Hayes Hotel

Time	9 A.M. to 11 A.M.	11 A.M. to 1 P.M.	2:30 P.M. to 4:30 P.M.
Monday Feb. 12	Broadcast Station Measurements H. J. Schrader RCA Manufacturing Co.	Frequency Modulation E. H. Armstrong Columbia University	Microphones R. N. Marshall Bell Telephone Laboratories, Inc.
Tuesday Feb. 13	Ultra-High Frequency Propagation H. O. Peterson RCA Communications		
Wednesday Feb. 14	Studies of Noise J. H. DeWitt Radio Station WSM	Yankee Network Experience with Frequency Modulation Paul deMars Yankee Network	
Thursday Feb. 15		General Electric Experience with Frequency Modulation H. P. Thomas I. R. Weir General Electric Co.	
Friday Feb. 16	Round Table on Receivers D. D. Israel—Emerson Radio Wm. F. Cotter—Stromberg-Carlson Co. Chairman—R. M. Wilmotte		
Saturday Feb. 17		Frequency Modulation Receivers R. F. Shea General Electric Co.	

SPECIAL FEATURES

Thursday, February 15—6:30 p.m.—Dinner, Fort Hayes Hotel
Saturday, February 17—Basketball Game—Ohio State vs. University of Wisconsin
Sunday, February 18—Inspection Trip to Station WHAS, Louisville, Ky.

Fee

The fee for the Conference is twenty ($20) dollars, payable at the time of registration. For those who wish to attend one week only, the fee is twelve ($12) dollars. Fees include the cost of the banquet, the dinner, and the inspection trip to WHAS scheduled in the program.

Registration

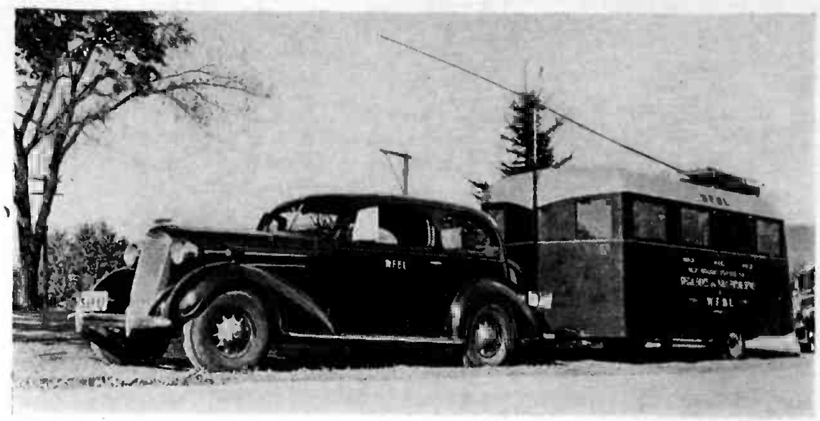
Registration should be sent in advance and not later than February 1. A registration blank should be filled out and mailed with remittance. Registration will be completed at the Fort Hayes Hotel after arrival in Columbus.

(*Continued on page* 32)

VERSATILE VERTICAL

By Don Langham

• WFBL •



THIS is written on behalf of the vertical antenna as applied to special event broadcasting at WFBL. In one form or another the vertical has taken the greater share of honors in this type of transmission.

"Buggy whip" antenna have run the gamut from airplane to pack transmitter with creditable performances. The main reason for this popularity has been that the self-supporting radiator requires but one anchorage point. A related advantage is, of course, that the space required is all in the vertical plane thereby lessening the problem of obstacle clearance.

But to get to the point, this article is devoted to the application of the vertical antenna to a mobile unit such as the Covered Wagon trailer of WFBL.

Until recently our special event crew had been installing horizontal systems either of the antenna-counterpoise or doublet types. In the case of the doublet, which was cut to a half wavelength, coupling was quite simple, using twisted pair feeders. This is an excellent system at intermediate frequencies but requires much clear space in a horizontal plane plus two anchorage points.

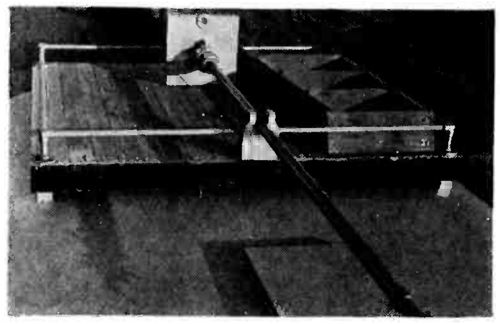
The same conditions apply to an antenna-counterpoise system which in addition requires a coupling-loading device so that various lengths of wire can be used.

Results obtained were very good, but while casting around for methods of improving and speeding up antennae installations, the vertical type was dicussed and voted to be given a trial.

Consequently a 35-foot telescopic antenna was installed atop the trailer. A small 5′ x 5′ platform was built on the rear end of the roof to allow room for operations. As an additional strengthening factor the anchorage bars for this platform ran down through the trailer walls to the chassis.

The antenna base insulator was mounted on a hinged sub-base about 12″ square so that when not in use, the collapsed length of 7 feet would lie in a clamping socket along the trailer top. When it is desired to operate under mobile conditions, the antenna can be lifted about a foot from this position and extended to 15 or 18 feet. It is supported then by a pole and insulator at the front end of the trailer.

Above: Illustrating the operation of the antenna under mobile conditions. Below: Note how antenna lies along trailer top when not in use.



Upon arrival at a fixed point for a broadcast, the antenna is raised and bolted into place by means of only one large bolt and wing nut since the hinges already hold one side of the base. With the aid of a small stepladder which is easily carried on the platform when traveling, the sections are extended and fastened in place with set screws. The lead-in is permanent, being flexible enough to allow raising and lowering of the collapsed antenna. The complete operation requires only about 7 or 8 minutes.

Showing the 35-foot telescopic antenna in operation at a fixed location. The lead-in is permanent, being sufficiently flexible to allow raising and lowering antenna.

For a complete picture of the set-up, a few items more should be mentioned. In particular, this antenna works against a counterpoise-ground screen installed underneath the trailer floor. This has proved to be a very handy and unobtrusive system, but if the trailer is not so equipped, a ground, ground wire or counterpoise can be used although more time is required in making a set-up.

Since our antenna is only 35 feet long and the operating frequencies from approximately 2.8 to 1.6 mc/s, obviously we must use a loading network. This is in our case a pi-net which does the job very nicely.

Other convenient fixtures are a small ladder up the back of the trailer to the platform, three feed-through insulators in the walls and plenty of ground connections so that the transmitter and receiver chassis, etc., may be grounded.

Tests made to determine the efficiency of the vertical compared to full half-wave antennae showed that signal strengths up to about 25 miles were essentially the same. The vertical showed slightly less tendency toward selective fading.

In favor of the doublet let us say that operation with it proved simplest and easiest to adjust with an absolute lack of any r-f troubles. However, when properly tuned and with good grounds all around, the vertical system is also perfectly stable and free from r-f difficulties.

In discussing its advantages let us also remember that when starting out on any short-wave job it is extremely comforting to know exactly what you will use for an antenna system, especially if it's one of those frequent last-minute notice affairs. No worrying about the possibilities for hanging a "sky wire" or encroaching on property other than that required for the mobile unit to park on. Simply drive up—and set up. Since its installation this radiator has been used on every WFBL trailer re-broadcast with great success.

Expectations In Radio

A preview of 1940 based on general trends in the radio industry

By RAY D. RETTENMEYER

Editor

THE radio industry has just concluded one of its most successful years with over 9,000,000 radio receivers sold, with network billings up from 10 to 30% and substantial business increases in nearly every phase of the art. Too, the past year saw the establishment of television service, frequency modulation and commercial sponsorship of international broadcast programs . . . to mention a few of the outstanding events.

The primary purpose of this article is to call attention to some of the existing trends and in a measure to attempt to point the way towards developments in radio during the year. However, in view of the rapidly changing international situation, predictions of things to come must be made with reservations, i.e., "subject to change without notice."

The outlook for the industry during 1940 is encouraging. With ever increasing interest in affairs abroad and with a presidential election taking place, radio receiver sales and network billings should show substantial increases. The European situation should result in an increase of exports of short-wave receivers and other radio apparatus, as well as place our international broadcasting on a paying basis. But let us consider the various fields separately.

Broadcasting

Since its inconspicuous beginning some 20 years ago, radio broadcasting has come a long way . . . from 1 station to over 760, with approximately 47,000,000 receivers in the hands of the American public.

Network billings for 1939 showed increases ranging from 10 to 30% over 1938. One authority[1] has given the gross billing figures as follows: NBC (blue and red chains), $45,244,354; CBS $34,539,665; MBS, $3,329,782 . . . a total of $83,113,801. Increasing interest in news from abroad, a national election and an expected advance in general business conditions should all contribute towards making 1940 an even better year.

In transmitter design there is a definite trend towards improved appearance and better mechanical layout to permit easier servicing. Continued improvement in fidelity, circuit design, components and efficiency can be expected. This is especially true of efficiency, as high-efficiency amplifiers have been making their appearance since Doherty first described his development[2]. New modulation schemes will undoubtedly make their appearance in 1940.

Today vertical antennas have become practically universal as far as commercial broadcast stations are concerned. Some work has been done with short radiators equipped with ground screens[3] with promising results. Shunt-fed antennas have been used rather widely and from all reports have proved quite satisfactory. Both developments will probably be used more widely. Further, with more and more broadcast stations being licensed there is likely to be increased use of directional antenna systems. For the most part these will be two or more vertical radiators fed in the proper phase relationship.

With the increasing use of u-h-f for television, international broadcasting, frequency modulation and radio-relay stations, the tower manufacturers are likely to be kept busy, for in an increasing number of instances the u-h-f antennas will be erected on top of towers, since there are only a limited number of tall buildings.

The new volume indicator[4] introduced early last year will most probably become a standard unit. Microphones may also come into the spotlight during 1940. Good results have been obtained with the "machine-gun" mike[5] and a number of other developments are believed to be in the offing.

Line equalization by means of predistortion has found some use[6] and might receive more attention. It is claimed that this system of line equalization permits the use of long but inexpensive non-loaded cable circuits, reduces the power handling requirements of the studio amplifier and simplifies the monitoring and control functions at the speech-input equipment.

Television

Considerable activity is expected in television during this year. Reasons

TELEVISION BROADCAST STATIONS*

(as of January 1, 1940)

Licensee and Location	Call Letters	Frequency (kc)	Power Visual	Power Aural	Emission
Columbia Broadcasting System, Inc., New York, N. Y.	W2XAB	42000-56000, 60000-86000	7½kw	7½kw	A3, A5
Allen B. Du Mont Laboratories, Inc. (area of New York, N. Y.)	W10XKT	156000-162000	50w	50w	A3, A5 (C. P. only)
Allen B. Du Mont Laboratories, Inc., Passaic, N. J.	W2XVT	42000-56000	50w	50w	A3, A5, Special
First National Television, Inc., Kansas City, Mo.	W9XAL	42000-56000, 60000-86000	300w	150w	A3, A5
General Electric Co., Bridgeport, Conn.	W1XA	60000-86000	10kw	3kw	A3, A5 (C. P. only)
General Electric Co., Albany, N. Y.	W2XB	60000-86000	10kw	3kw	A3, A5 (C. P. only)
General Electric Co., Schenectady, N. Y.	W2XH	288000-294000	40w		A5
General Television Corporation, Boston, Mass.	W1XG	42000-56000, 60000-86000	500w		A5
Don Lee Broadcasting System, Los Angeles, Calif. C. P.-T-Hollywood, Calif.	W6XAO	42000-56000, 60000-86000 C. P., 44000-50000 kc.	1kw	150w	A3, A5
Don Lee Broadcasting System (area of Los Angeles, Calif.)	W6XDU	321000-327000	6.5w		A5
National Broadcasting Co., Inc., New York, N. Y.	W2XBS	42000-56000, 60000-86000	12kw	15kw	A3, A5
National Broadcasting Co., Inc., Portable (Camden, New Jersey and New York, N. Y.)	W2XBT	92000 and 175000-180000	400w	100w	A1, A2, A3, A5
Philco Radio and Television Corp., Philadelphia, Pa.	W3XE	42000-56000, 60000-86000	10kw	10kw	A3, A5
Philco Radio and Television Corp., Philadelphia, Pa.	W3XP	204000-210000	15w		A5
Purdue University, West Lafayette, Ind.	W9XG	2000-2100	1½kw		A5
Radio Pictures, Inc., Long Island City, N. Y.	W2XDR	42000-56000, 60000-86000	1kw	500w	A3, A5
RCA Mfg. Co., Inc., Portable (Camden, N. J.)	W3XAD	321000-327000	500w	500w	A3, A5
RCA Mfg. Co., Inc., Camden, N. J.	W3XEP	42000-56000, 60000-86000	30kw	30kw	A3, A5
State University of Iowa, Iowa City, Iowa	W9XK	2000-2100	100w		A5
State University of Iowa, Iowa City, Iowa	W9XUI	42000-56000, 60000-86000	100w		A5
Zenith Radio Corporation, Chicago, Ill.	W9XZV	42000-56000, 60000-86000	1kw	1kw	A3, A5

* COURTESY, NATIONAL ASSOCIATION OF BROADCASTERS.

[1] *Broadcasting*, p. 84, Jan. 15, 1940.

[2] "A New Power Amplifier of High Efficiency," by W. H. Doherty, p. 7, May, 1936, *Communication & Broadcast Engineering*; "A High Efficiency Modulating System," by A. W. Vance, p. 506, August, 1939, *Proc. IRE*.

[3] "A Short Radiator With Ground Screen," by C. E. Schuler, p. 16, May, 1938, COMMUNICATIONS.

[4] "A Standard VI and Reference Level," by H. A. Affel, H. A. Chinn & R. M. Morris, p. 7, April, 1939, COMMUNICATIONS.

[5] "Line Microphones," by H. F. Olson, p. 438, July, 1939, *Proc. IRE*.

[6] "Line Equalization by Predistortion," Walter J. Creamer, p. 22, Jan., 1939, *Proc. IRE*.

advanced for this condition are based, in the main, upon increased quantity and improved quality of programs, and a probable reduction in receiver list prices. Before discussing programs and television receiver prices, let us quickly review the situation.

It has been estimated that approximately 2,000 television receivers were sold to the public during 1939. At an average list price of $350 this represents a business of $700,000. While not all that was anticipated it still represents a fair sum for the first year of a new industry.

Though lightly stressed, an important point has been the familiarization of a great many people with television. In addition to the programs broadcast by the stations on both coasts, large crowds attended demonstrations at the World's Fairs, at their radio dealers, in department stores, theatres, etc.—at least one traveling demonstration equipment was in use a good deal of the time, while several broadcast stations had similar television equipment in operation. It is encouraging to note that in most instances the viewing public was agreeably surprised with the results. This type of educational work will expand considerably during 1940.

A well received action was the recent adoption by the FCC of their Television Committee's recommendation which permits television broadcasters to accept sufficient commercial programs to cover operating costs. This is undoubtedly a step in the right direction, since the expense of program production is one of the television broadcaster's paramount charges. Clarification of this ruling was the subject of an FCC hearing held on January 15.

As we mentioned previously, programs are likely to increase in number and improve in quality during 1940. In the first place, New York City will shortly have a second station on the air with a regular program schedule; it is also anticipated that several other stations will be licensed before the end of the year. In addition to the FCC ruling concerning commercial programs, the experience gained in programming is already having its effect on the types of material televised. In this respect there is a trend towards more diversified material, with increased emphasis being placed upon spot news, sport events, etc., and less upon drama and movies.

During this year television transmitters will be simplified, improved and cheapened. Portable equipment, housed in carrying cases, has been put on the market.[7] These units (operating in vicinity of 325 mc) permit good quality transmission and are used for relaying programs to the main transmitter. Since they are cheaper than the usual mobile units, they are suitable for the smaller stations where they may be used in the studio as well as for pickups.

New individual passenger radio receivers have been installed on TWA's big twin-motored planes flying between New York and the Pacific Coast. Individual receivers are connected to a central receiver in the rear of the plane operated by the hostess. At left, Hostess Francis Ice explains to Virginia McNabb how the pad-like receiver can be adjusted. Insert shows master receiver with cover removed.

Television studio equipment is becoming more nearly standardized.[8] Lighting methods[9] and pickup technique[10] also fall into this category, although more data on lighting will shortly be made available. Concerning the transmission of films, both 35-mm and 16-mm varieties will be widely used this year, the latter for the first time.

In receivers there is a trend towards larger picture tubes. Estimates as to desirable picture size for home reception range from 12-inch diameter tubes to screens 8 or 10 feet wide. It is believed, however, that ultimately good pictures ranging from 18 to 24 inches in width will be considered satisfactory for the average living room.

Increase in receiver picture size can be accomplished by producing larger tubes or by means of projected images from very small tubes. Both methods are the object of experimental work. The advantages and disadvantages of each system are too well known to warrant discussion here.

Attempts are also being made to shorten picture tubes. Shorter tubes mean greater flexibility in cabinet design as well as mechanical layout. However, the amount a tube can be shortened without producing distortion is limited by the width of the deflection angle.

Good high-quality sound programs are now being transmitted on television stations at times when no picture is on the air. Hence, it would not be surprising if some of the new receivers were equipped with a switch to cut out the picture circuits and thus permit the reception of sound programs at reduced receiver power.

Considerable experimental work is being done on television pickup[11] and receiver picture tubes, and new types may be announced during the year. Other probable developments for 1940 include demonstration of large screen television, and television relay stations using frequencies in the vicinity of 500 mc. Further, receiver prices are likely to be reduced during 1940. Merchandising experiments along these lines have indicated large quantity sales for television receivers when sold at lower prices.

Frequency Modulation

Another subject of considerable importance is frequency modulation. During the past year several stations were built and construction permits granted for a number of others.[12] In addition,

[7]See "Television Economics," Part XII, by Dr. Alfred N. Goldsmith, this issue see also "RCA Television Field Pickup Equipment," by T. A. Smith, p. 290, Jan., 1940, *RCA Review*.

[8]"New U-H-F Transmitters," p. 10, Dec., 1939, COMMUNICATIONS.

[9]"Television Lighting," Part I, by W. C. Eddy, p. 17, May, 1939, COMMUNICATIONS.

[10]"Miniature Staging," by W. C. Eddy, p. 22, April, 1939, COMMUNICATIONS.

[11]"Television Pickup Tubes Using Low-Velocity Electron-Beam Scanning," by Albert Rose & Harley Iams, p. 547, Sept., 1939, *Proc. IRE*.

[12]"Frequency Modulation," by Charles H. Yocum, p. 5, Nov., 1939, COMMUNICATIONS.

several commercial models of both transmitters[13] and receivers[14] were placed on the market.

Field tests[15] on this system of modulation have shown that at least three distinct advantages can be obtained through its use—high quality, static reduction and service area extension at ultra-high-frequencies. While f-m has had but little effect on radio business, it is expected to gain momentum rapidly during 1940. A number of new models of f-m receivers as well as combination a-m/f-m units will be introduced this year—it is also possible that special converters will be produced to permit the use of the audio portion of present a-m receivers. Also, by the end of 1940 it is likely that 250, 1000, 3000, 10,000 and 50,000 watt f-m transmitters will be on the market.

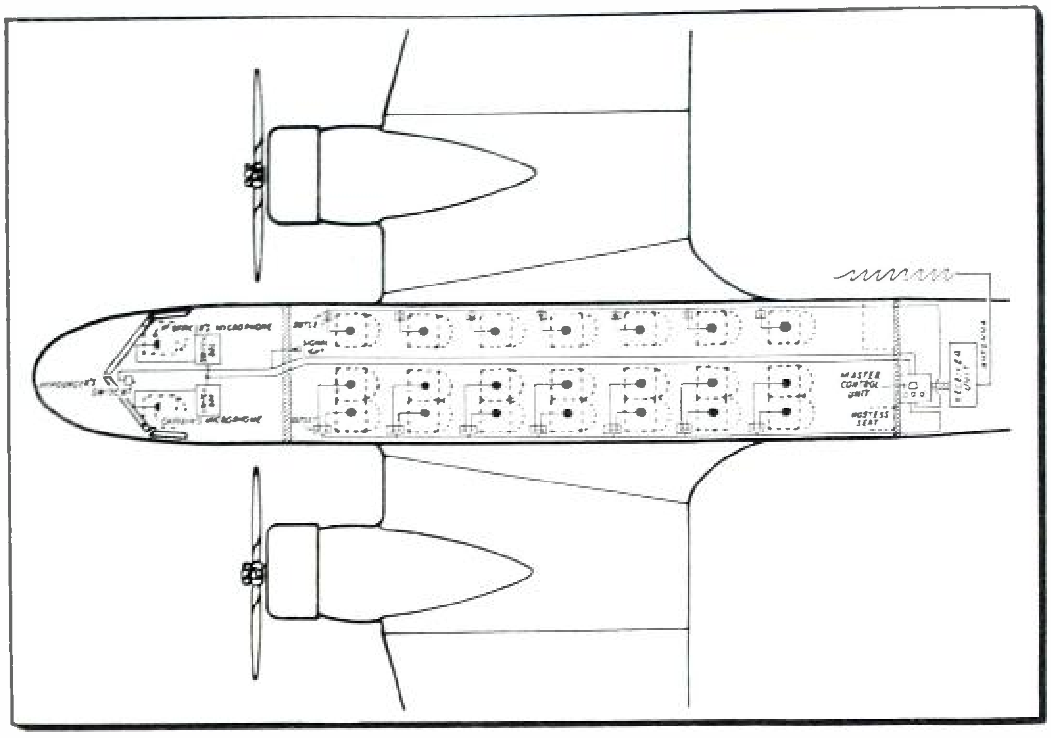
Frequency modulation may also play an important part in aeronautical and police radio. Experiments are being conducted in this direction and undoubtedly more will be heard as to these applications later in the year.

It is interesting to note that the FCC has allocated the following amateur bands for television and radiotelephone frequency-modulation transmission[16]: 112,000—116,000 kc, 224,000—230,000 kc, and 400,000—401,000 kc. Special authorization has also been secured for a 1000-watt station, operating on 42.18 mc, to gather comparative data using a-m and f-m for both aural and facsimile programs.

The FCC has recently given notice of an informal engineering hearing (Feb. 28) to determine the status of aural broadcasting on frequencies above 25,000 kc. At this meeting an attempt will be made to determine: whether this broadcast service should be of a regular or experimental nature; the relative merits of frequency modulation (wide-band and narrow-band) and amplitude modulation; frequency allocations for f-m and a-m stations; the possible future effects on the 550-1,600 kc band; and the existing patent situation.

Pending the outcome of this gathering, the Commission will grant applications for permission to carry out fundamental research which show satisfactory promise of being able to contribute substantially towards the development of aural broadcasting, and applications filed by existing licensees to experiment with aural broadcasting on frequencies above 25,000 kc, provided the request to operate additional stations involves a program of experimentation directly related to the existing station. About 20 applications are pending action by the commission for new stations desiring to use f-m. There are now 34 a-m stations and 20 f-m stations authorized by the FCC.

It is interesting to note that various groups concerned with frequency-modulation broadcasting have recently formed an organization known as FM Broadcasters, Inc. This organization will present technical data and group recommendations at the February hearing.



Block diagram of new TWA passenger radio installation.

Receivers

Reliable figures[17] place the 1939 receiver sales between 9 and 10 million—an exceptionally good year. Twenty percent of the year's sales are attributed to each of the first two quarters, 25% to the third and 35% to the last quarter. This follows the general division of sales of previous years.

Statistics show that the average receiver offered contained 6.6 tubes and had a list price of about $56, that 31% of all models had self-contained loops, that 35% had push buttons and that 47% possessed only one band.

There are no actual figures available which show how the receivers sold during 1939 increased the listening public. However, the accompanying charts do present long-time trends in the receiver industry. It should be noted that they indicate a growing market for secondary receivers.

It has been calculated[18] that in each years, since 1935, about 75% of the listening public replaced receivers bought 7 years previously. Considering the extent of improvements in receivers it would seem that this is a long period. Concentration on new features and higher priced models, especially on phonograph combinations, should help break down this resistance on the part of the purchaser. The trend seems to be in this direction.

A recent series of articles, [19, 20, 21] discussed the circuit features of the 1939-40 lines. Since then additional material has been available. In all, data on some 650 different receiver models, introduced by the manufacturers between April and December 15, 1939, was studied for the survey presented here. These receivers are referred to as 1939-40 models.

The large majority of sets offered in the past contained 5 or 6 tubes. The percentage of 5-tube models, however, has been steadily increasing. For the 1939-40 season, about 42% of all models offered have 5 tubes, approximately 20% have 6 and 10% have 7 tubes. In the 1938-39 models 38% were 5-tube sets, 18% were 6-tube and 11% were 7-tube models. In former years, sets with as many as 25 tubes were offered; the maximum number of tubes in any one 1939-40 receiver is 18.

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[13] "New U-H-F Transmitters," p. 10, Dec., 1939, COMMUNICATIONS; "Frequency Modulated Transmitters," p. 20, Nov., 1939, *Electronics*.

[14] "Frequency Modulation Receiver," p. 388, August, 1939, *Service*; "Frequency Modulation Receiver," p. 476, Oct., 1939, *Service*; "F-M Receivers," p. 518, Nov., 1939, *Service*; "A Noise-Free Radio Receiver," by G. W. Flyer & J. A. Worcester, Jr., p. 307, July, 1939, *G-E Review*.

[15] "Field Tests of Frequency—and Amplitude-Modulation with Ultrahigh-frequency Waves," by I. R. Weir, Parts I, II, p. 188, May, 1939, and p. 270, June, 1939, *General Electric Review*.

[16] In this connection the following articles covering amateur equipments should be of interest: "Wide-Band Frequency Modulation in Amateur Communication," by George Grammer & Byron Goodman, p. 11, Jan., 1940, *QST*; "Receiver Circuits for Frequency Modulation," by Geo. W. Brooks, and "Experimental Frequency Modulation Transmitter," by E. Seiler, p. 64 and p. 75, respectively, Jan., 1940, *Radio*.

[17] From a paper, "A review of the Broadcast Receiver Field for 1939," by Dudley E. Foster, delivered before the *IRE* on January 3, 1940.

[18] "Basic Economic Trends in the Radio Industry," by Julius Weinberger, p. 704, Nov., 1939, *Proc. IRE*.

[19] "Battery Portables," by Henry Howard, p. 230, May, 1939, *Service*.

[20] "Loop Antennae," by Mark and Edward M. Glaser, p. 375, Aug., 1939, *Service*.

[21] "Receiver Trends for 1940," by Henry Howard, p. 419, Sept., and p. 472, Oct., 1939, *Service*.

In the new models, there is also a definite trend towards simplicity. Motor tuning has been abandoned in all but a few higher priced units, as has a-f-c, amplified a-v-c and noise suppression. This trend is further evidenced by the gradual move towards fewer tuning bands. Almost 50% of the models now offered have but a single band as compared with 35% so designed last season. Approximately 2% of the receivers offered for 1939-40 possessed more than 3 bands; there were over 8% among the 1938-39 presentations.

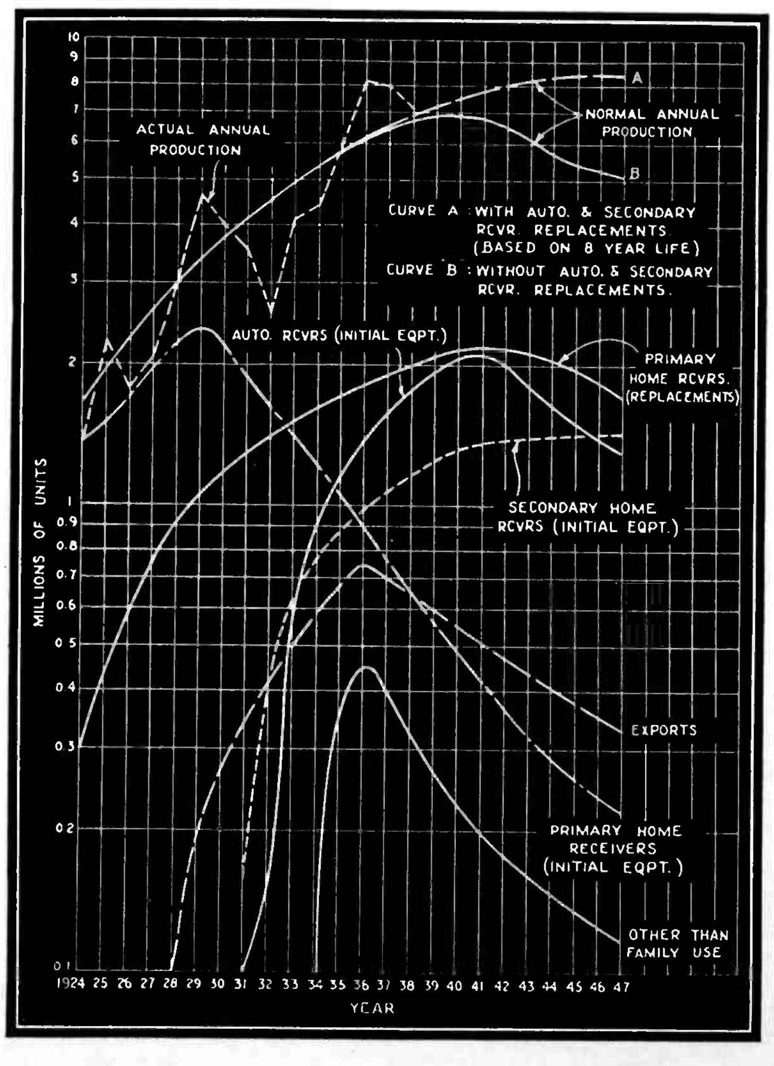
It appears that home recording will be added as a major feature in many 1940-41 consoles. We can also expect more models providing for f-m and a-m reception. Pre-set tuning may also make its appearance on the short-wave bands.

Concerning battery-operated portables, there are approximately 50 varieties, ranging from 3.5 to 35 lbs (12 lbs average), all with self-contained loop. About 20% of these are capable of both line and battery operation. With the announcement of the new miniature tubes[22] we look forward to an increased number of even smaller battery portables.

The growing tendency toward combining a-c/d-c with battery operation of small portables has been bolstered by the introduction of several 117-volt tubes, namely the 117Z6GT and the 117L7GT. The former is a rectifier designed to operate directly from the power lines and supply both A and B power for the receiver when it is plugged into the power lines. The 117L7GT is a combination half-wave rectifier and power output tube. The rectifier section supplies both A and B power, while the power output section is substituted in the output stage during line operation for improved performance.

Relative to speakers, it is interesting to note that the use of p-m's has been gradually increasing. In the 1939-40 lines over 35% of the models feature this type of speaker. The introduction of the battery-operated portable undoubtedly explains this situation, and we can expect even greater use of these units.

For the past few years there has been considerable improvement in condensers, followed, naturally, by price reductions. One manufacturer has a new line of wax-molded tubular condensers which reduce moisture absorbtion, while another has introduced a 600-volt tubular using a treated cellulose derivative dielectric. Several firms are specializing in fabricated plate types of electrolytrics, others are featuring etched foil units. In general, all types of condensers have less leakage, higher voltage breakdown, less equivalent resistance, improved power factor, better by-pass action and a longer expected life.



Curves showing the past and anticipated future normal annual production of radio receivers for various types of demand. Actual data: 1924-1937, predicted data: 1938-1947. Top curves show normal annual production. (These curves are from a paper by Julius Weinberger, "Basic Economic Trends in the Radio Industry," Proc. IRE, p. 704, Nov., 1939.)

Wire-wound resistors have new ceramic coatings which render them entirely waterproof. One producer marks the coating with a unique spot which changes color when the resistor is subjected to an overload. Several other manufacturers are using fiberglass as insulation. Carbon composition resistors are also improved, being smaller with better insulation.

Communications Receivers

The communications receiver field has been marked by noteworthy technical advances during each recent year. 1939 has been no exception, witnessing in addition the progress of a new trend toward lower price levels and greater values. This comes partly as the result of increased sales that permit the economies of large-scale production, and partly through design and production innovations which permit many heretofore deluxe features to be incorporated in receivers of modest price.

It is probable that temperature compensation and more accurate maintenance of frequency calibration will be two objectives of the manufacturers during 1940. This year will probably see a marked interest in ultra-high-frequencies, with a resulting demand for communications equipment with bands to 2½ meters.

Tubes

Since January 1939 over 140 new tube types have been announced.[22, 23] However, for the new year one large producer of sets and tubes has announced the intention of standardizing on 36 types. A survey of the tube manufacturers indicates that they would welcome standardization, although there may be some disagreement as to just which types should be "preferred". If the original list of 36 were to be enlarged slightly, and some compromises made, there is every reason to believe that standardization could soon be accomplished.

The 1.4-volt tube series has given the set engineer the basis for the self-contained battery portables discussed earlier in this article. Miniature tubes, recently announced, should find application in small portables and in other equipment where extremely small size is of paramount importance.

An important technical development, relating to tubes, during the year, was the announcement of a new basis for tube ratings.[22, 24] In the past, receiver designers used the published absolute maximum ratings as design maximum values. In cases where the power source voltage varied greatly from the original design value, the possibility

[22] "Tubes," by John H. Potts, p. 7, Jan., 1940, *Service*.

[23] "Tubes," by D. Bee, p. 62. Feb., 1939, *Service*. Also, "New Tubes," p. 133, March, 1939, *Service*.
[24] RCA Application Note 105.

existed that the tubes would be subjected to overload and consequent loss of efficiency. The new ratings have been chosen to allow for such variation in power source voltages.

Unit sales of tubes for 1939 were close to 100 million, acording to reliable estimates.[17] These are based on actual sales (65 million) for the first three quarters of the year and an estimate of approximately 35 million for the last quarter.

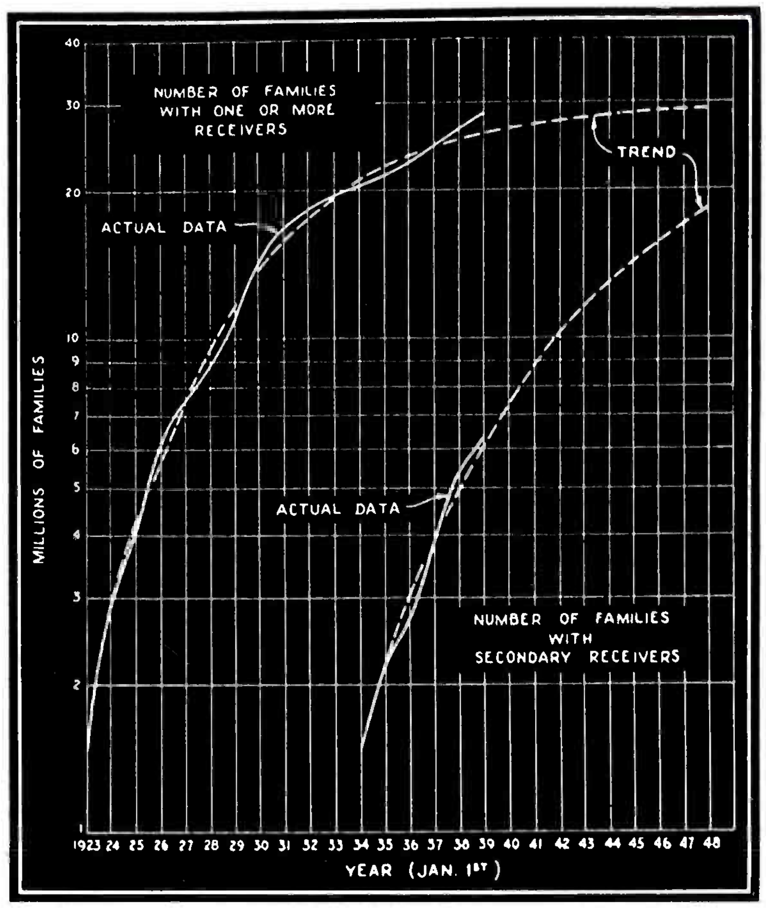
Facsimile

While facsimile has not reached a definite point of conclusion and for the time being seems likely to continue on an experimental basis, it may come into more prominence as the year progresses. Despite promising field tests, laboratory work is still being directed towards higher definition, increased speed and better synchronization.

The possibilities of using facsimile for home newspaper printing, police, aircraft, military and marine applications have often been mentioned in this publication. It is gratifying to note that experiments are being conducted along all these lines—as well as with f-m transmission.

It is quite possible that improved systems will shortly make their appearance in this country. Considerable work has been done abroad on wet electrolytic systems with favorable results.

Commercial wire facsimile will probably expand during the year. Circuits between New York City and Buffalo, and New York City and Chicago, have been in operation for some time, while



Curves showing the growth of sound broadcast receivers in the home. Note that actual data is shown by full lines, while the trends are given by the dashed lines. Upper curves show number of families with one or more receivers, bottom curves the number of families with secondary sets. (From paper "Basic Economic Trends in the Radio Industry," Julius Weinberger, p. 704, Nov., 1939, Proc. IRE.)

automatic telegraphic facsimile apparatus, for transmission of messages from hotels, etc., to the central office, was put into operation during 1939.[25] Excellent results are obtainable and both systems are meeting with good success.

We note with interest that the frequencies 1715 to 2000 kc, 56,000 to 60,000 kc, 112,000 to 116,000 kc, 224,000 to 230,000 kc and 400,000 to 401,000 kc have been set aside for amateur facsimile experimenters.

Aeronautical Radio

Much of the activity in this field during 1940 will be devoted to blind-landing systems. Considerable interest is being evidenced in the C.A.A.-I.T.&T.[26] as well as the C.A.A.-M.I.T. "3 spot" system.[27] The former equipment has been installed at the Indianapolis airport and plans call for its extension to 10 airports during 1940. The latter method, proposed by Metcalf and developed under the direction of Prof. Bowles, uses 40-cm waves with directional antennas in the form of electromagnetic horns; a klystron generator is used as the source of power. Another blind-landing system not to be overlooked is the one introduced by E. N. Dingley some time ago.[28] A feature of this system is a straight-line glide path—it does not require the use of radio frequencies.

The possibility of using f-m for aircraft radio work is also being given consideraiton.* While f-m seems to offer some interesting possibilities, its use will depend to a large extent upon the result of experiments now under way.

The new aircraft transmitters and receivers appear with multi-channel provision—generally for 10 spot frequencies. They feature quick change-over from one frequency to another as well as quick change for A-1, A-2 and A-3 emission.

While there is a tendency towards more compact and lighter unit design in aeronautical radio equipment, there is also a trend towards more and better equipment. The overall power-supply requirements are therefore increasing. In fact, some of the new Douglas D.C.4 transports have 15-kw, 800-cycle power plants.

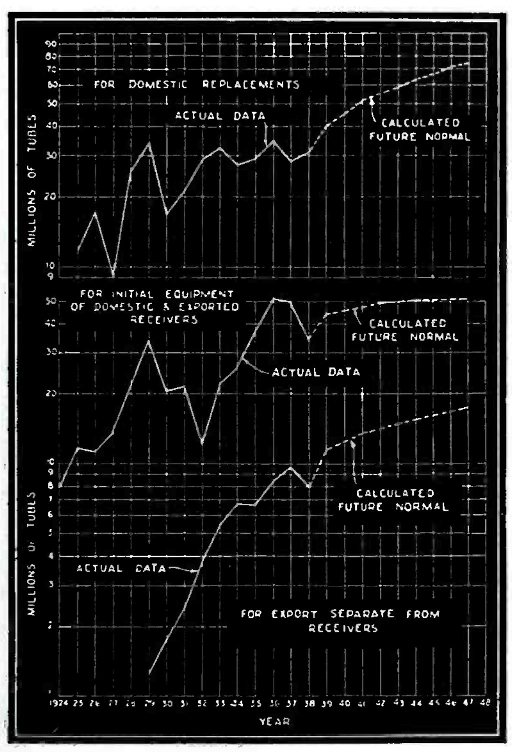
Broadcast programs are now being provided in 22 TWA planes. The same equipment permits the pilot to cut-in his speech direct to the passengers to give flight bulletins, etc. This service will undoubtedly expand in 1940.

Increased use will be found for automatic radio compasses,[29] terrain clearance indicators,[30] as well as many types of remote indicating systems. Remote indicators, using synchronous motors, are becoming more popular.

Marine Radio

As would be expected, there was a

(*Continued on page* 29)



Annual production of receiving tubes for initial equipment, replacements and exports. (From "Basic Economic Trends in the Radio Industry," Julius Weinberger, p. 704, Nov., 1939, Proc. IRE.)

[25]"The Automatic Telegraph," G. W. Janson, p. 12, April, 1939, COMMUNICATIONS.
[26]"Instrument Landing System," p. 9, Nov., 1939, COMMUNICATIONS.
[27]"The Sectoral Electromagnetic Horn," by W. L. Barrow & F. D. Lewis, p. 41, Jan., 1939, *Proc. IRE;* "40 Centimeter Waves for Aviation," p. 12, Nov., 1939, *Electronics.*
[28]"An Instrument Landing System," by E. N. Dingley, Jr., p. 7, June, 1938, COMMUNICATIONS.

[29]"An Automatic Direction Finder," p. 10, Oct., 1938, COMMUNICATIONS.
[30]"A Terrain Clearance Indicator," by Lloyd Espenschied & R. C. Newhouse, p. 222, Jan., 1939, *Bell System Technical Journal.*
*See "A True Omnidirectional Radio Beacon," by E. N. Dingley, p. 5, this issue.

Applications of the

VOLTAGE DOUBLER RECTIFIER

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THE double-diode voltage-doubler rectifier is widely used in the power supplies of radio receivers and of amplifiers, but is used to a very limited extent in other electronic applications. A 6H6 twin diode tube connected as a voltage-doubler detector operates successfully at radio frequencies and presents certain inherent advantages not offered by the usual half-wave or full-wave detector circuits.

Fig. 1-A is the basic diagram of the half-wave rectifier detector. If R is large as compared to the diode resistance, and if C has a low reactance at the frequency of the applied voltage, E_{ac}, the d-c voltage developed across R is practically equal to the peak value of the applied voltage.

Fig. 1-B shows the conventional voltage-doubler rectifier circuit in which the series-connected condensers C_1 and C_2 are charged in succession on alternate half cycles of the applied voltage E_{ac}. For light loads, or a high load resistance, the d-c voltage developed across R is very nearly twice the peak a-c input voltage. The lowest ripple frequency present in the output is twice the input frequency.

Fig. 1-C shows another voltage-doubler rectifier circuit in which C_1 is charged to E_{ac} peak during the half cycle that diode No. 1 conducts current, and then C_1 in series with the line charges condenser C_2 to twice E_{ac} peak on the next half cycle, when diode No. 2 conducts current. From the power supply standpoint, this circuit presents two disadvantages:

(1) Condenser C_2 must have a voltage rating of twice the peak a-c input voltage.

(2) The lowest ripple frequency present in the output is the same as the input frequency, therefore, filtering is more difficult than in the conventional voltage-doubler circuit.

In Fig. 2 are shown performance curves for a 6H6 employed as a half-wave rectifier and as a voltage doubler obtained at a frequency of 60 cycles with C_1 and C_2 equal to two microfarads and load resistance as indicated. These values are the 60-cycle equivalents of the values ordinarily employed with diode detectors at broadcast frequencies. The curves check well at a frequency of one megacycle. At high frequencies the cathode-to-cathode capacity which is shunted across one of the diodes in both circuits becomes objectionable.

A 6H6 used as a voltage-doubler detector develops approximately twice the audio-frequency voltage and d-c voltage as compared to the conventional half-wave detector for a given modulated input voltage. The detection efficiency, the ratio of the output d-c voltage to the peak a-c input voltage is from 160% to 190% in practical circuits. Fig. 2 shows that the voltage-doubler detector is quite linear for large input voltages.

It is seen that the voltage-doubler detector provides a high bias voltage for automatic volume control, volume expander, volume compressor and similar circuits. As the two voltage doublers deliver approximately the same output voltage when equivalent RC values are employed, the choice of either voltage doubler for use as a detector depends largely on the circuit arrangement desired.

The diode voltage doublers are particularly convenient for use in vacuum-tube voltmeters in which application they are sensitive full-wave peak voltmeters. With condensers C_1 and C_2 equal to from 0.01 mfd to 0.05 mfd and R equal to from 2 megohms to 10 megohms, or higher, the voltage developed across R is independent of frequency over a wide frequency range, and is directly proportional to the input voltage. If the voltmeter is to be used at low frequencies, the condensers should be at least one microfarad.

The voltage developed across R is equal to the sum of the positive and the negative peaks of the input voltage. Therefore, the voltmeter is not subject to turnover, which is the change in reading of a vacuum-tube voltmeter when its input terminals are reversed, if the voltage measured contains even harmonics in such phase position that the positive and the negative half cycles have different peak values.

A decided advantage in the use of either voltage doubler in a voltmeter for a-c measurements is that the condensers break the d-c path in the input circuit so that the instrument will read only the a-c component of the input voltage, should it contain a d-c component. Doubler No. 2 possesses an advantage over doubler No. 1 in that there is a common input and output terminal, which permits the use of a common

(*Continued on page* 35)

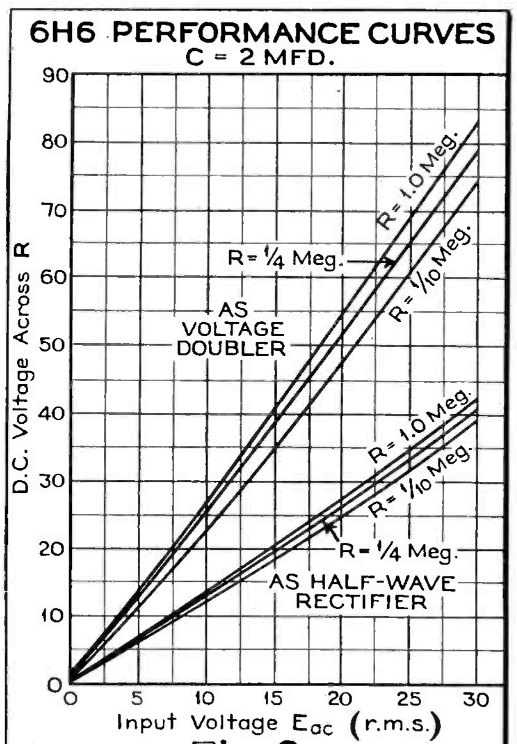


Fig. 2

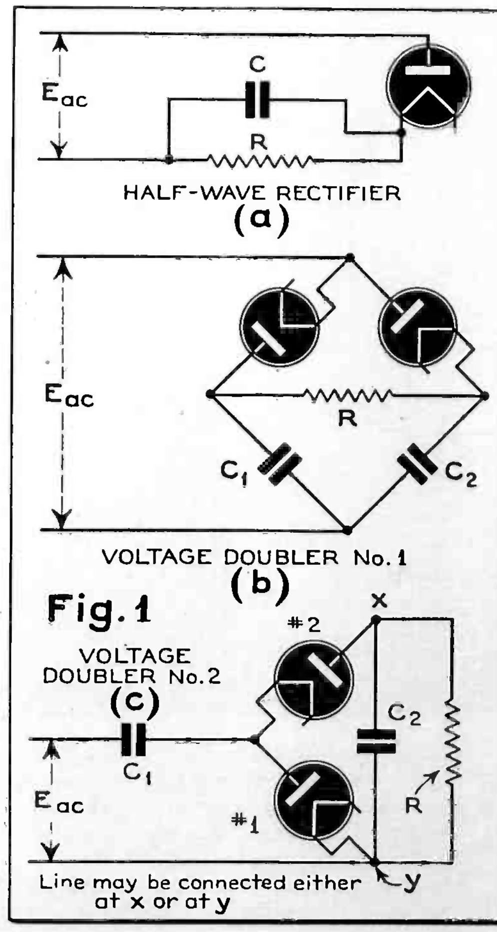


Fig. 1

Some unusual features of

OUR TELEVISION SYSTEM

By ALBERT PREISMAN
RCA Institutes, Inc.

I. Foreword

A NEW art brings forth a host of new problems, and these in turn new methods of solution, which, incidently are often applicable to the older, established arts. Television is no exception to this rule, and it is the purpose of this paper to discuss some of the unusual problems peculiar to it, and the unique methods employed to solve them.

II. Odd Line Interlacing

The first problem concerns the method of converting the variations in brightness of a two-dimensional continuum into a variation in current or voltage with respect to time through the process of scanning. The number of pictures or frames scanned per second (frame frequency) must be a submultiple of the a-c line frequency in order that unavoidable hum patterns remain stationary. Present RMA standards for a 60-cycle power frequency are thirty frames per second.

If the picture were scanned line after line in sequence, and at this low frame frequency, objectionable flicker would result, particularly at the high illumination level of the kinescope. On the other hand, were the frame frequency to be increased to sixty per second, the band width would be doubled. Hence an ingenious process known as interlaced scanning is employed. First the odd lines are scanned in sequence, and then the even lines, so that each group

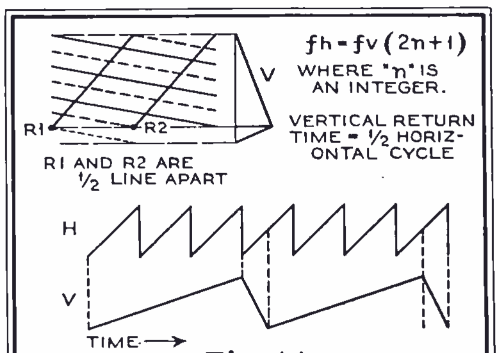
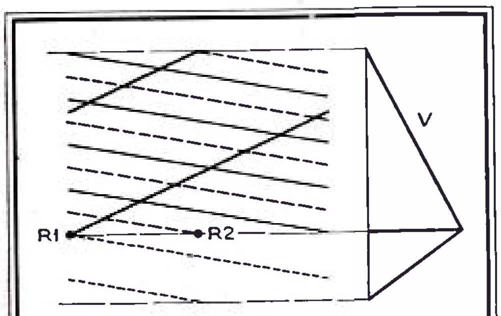


Fig. 1A

is scanned in 1/60 of a second, and yet one complete picture requires 1/30 of a second. Thus, two half pictures, interlaced with respect to one another, are presented in rapid succession to the eye, and to the observer the apparent flicker frequency is sixty per second, and practically unnoticeable, while the band width remains that for 30 frames per second.

The vertical scanning frequency (called the field frequency), is thus 60 (saw-tooth) cycles per second. Ordinarily the amplitude would have to alternate in magnitude in order that the beam return from a previous, say, even line scan, to the first line of an odd line scan, then proceed in sequence over the remaining odd lines, return from the last odd line back to the second line to begin an even line scan, and so on. This would mean that all vertical deflection saw-tooth amplifiers, including those in the receivers, would have to generate a 60-cycle saw-tooth wave on which was superimposed a 30-cycle saw-tooth wave in order to have the above variation in amplitude of alternate cycles.



VERTICAL RETURN TIME = 1½ HORIZONTAL CYCLES.
R1 AND R2 ARE ½ HORIZONTAL LINE APART
Fig. 1B

To avoid this complication and resultant expense, especially in the receivers, odd line scanning was devised. If the horizontal scanning frequency, f_h, is related to the vertical scanning or field frequency, f_v, by the relationship

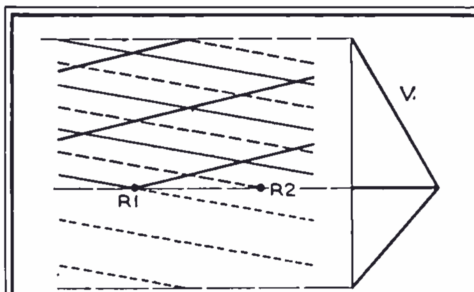
$$f_h = (n + \tfrac{1}{2})\, f_v \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where n is any integer, then two-to-one interlacing, as described above, can be obtained with a *constant amplitude* vertical saw-tooth wave. Since for two-to-one interlacing, f_v is twice the frame frequency, f_f, we have

$$f_h = 2(n + \tfrac{1}{2}) f_f = (2n + 1) f_f \quad \ldots (2)$$

and since (2n+1) is obviously an odd number, this process of interlacing is often called odd line interlacing. Present RMA standards call for a value of n equal to 220, or (2n+1) equal to 441, which is evidently the number of lines or horizontal scanning strips into which a picture is resolved.

In Fig. 1-A we have an illustration of how this frequency relationship produces interlacing. A vertical return time equal to ½ horizontal cycle is



VERTICAL RETURN ANY FRACTION OF HORIZONTAL PERIOD, AND STARTING AT ANY POINT OF HORIZONTAL PERIOD.
R1 AND R2 ARE ½ LINE APART.
Fig. 1C

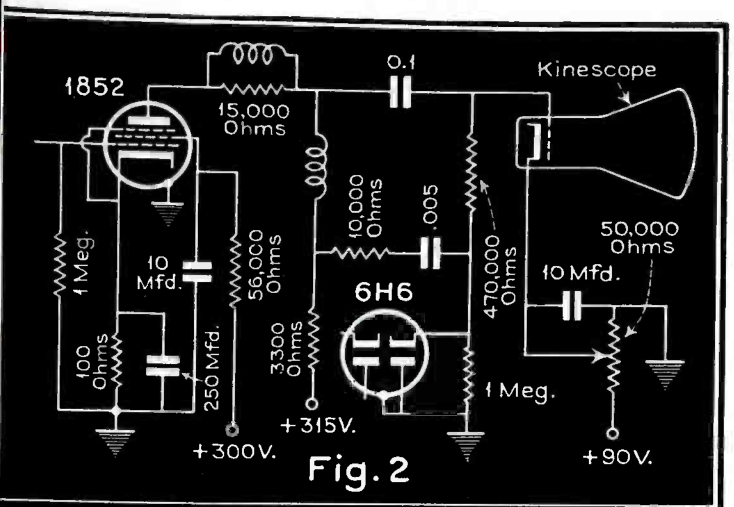


Fig. 2

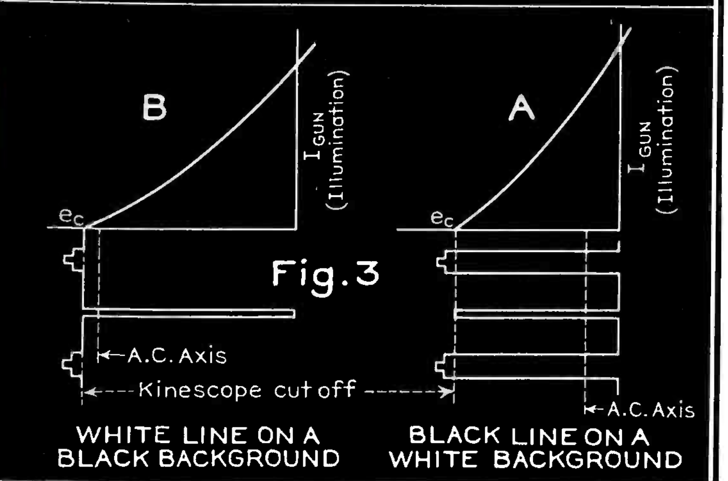


Fig. 3

WHITE LINE ON A BLACK BACKGROUND — BLACK LINE ON A WHITE BACKGROUND

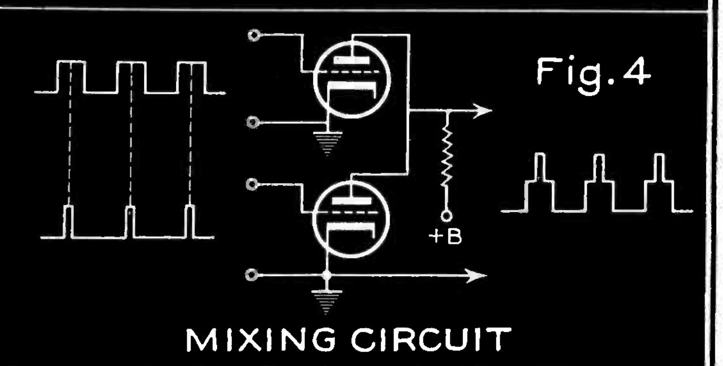


Fig. 4

MIXING CIRCUIT

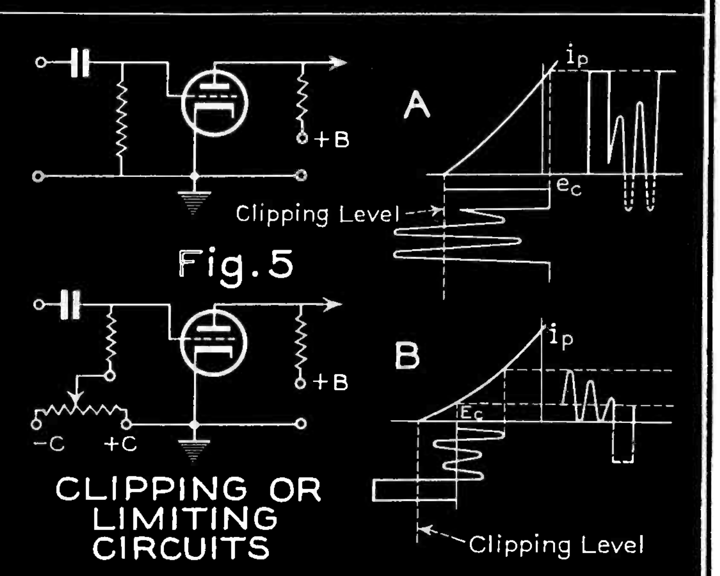


Fig. 5

CLIPPING OR LIMITING CIRCUITS

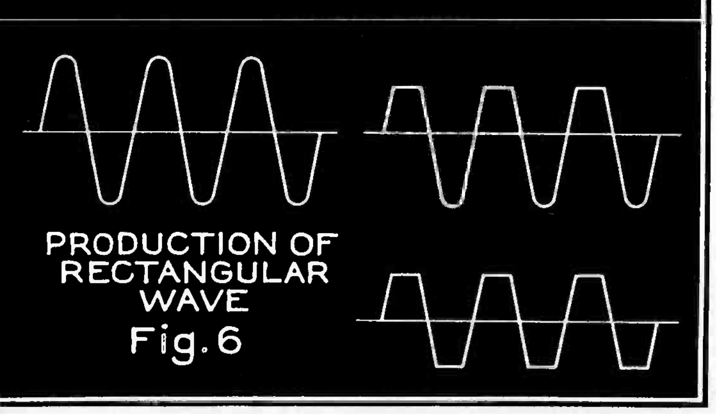

PRODUCTION OF RECTANGULAR WAVE

Fig. 6

assumed, and in all cases we shall assume zero horizontal return time. Due to the simultaneous vertical and horizontal deflection, the actual path of the beam is slightly slanting to the horizontal, and after the first field scan, the beam returns to the top, and as will be noted, half a line away from the upper left-hand side of the picture. Thus the second field scan starts half-way across, and completes the remaining half of that line scan parallel to the others, so that on the horizontal return stroke it is half-way between the first and third lines of the first field scans. As a consequence, the second field scan consists of the even lines, between the odd lines of the first field scan, and interlacing is thus accomplished.

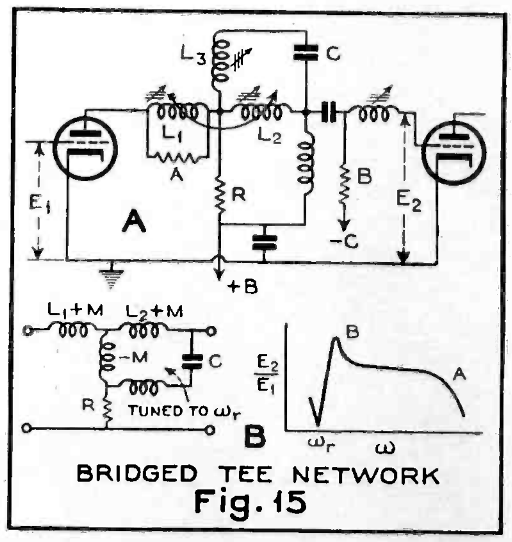
In actual practice, from 8 to 10 per cent of a vertical period is devoted to return time, so that 8 to 10 per cent of the 220½ horizontal lines are sloped in the opposite direction and would cause an interfering pattern on the screen. By injecting a negative voltage impulse, called the blanking pedestal, on the kinescope gun control grid, the electron beam is biased off at that time, and so the return traces do not show. The important point is that the return time and the somewhat longer blanking out time do not affect the interlacing, which depends solely upon the frequency relationship. Incidentally the kinescope vertical blanking time should equal or preferably exceed the iconoscope vertical blanking time in order that only the useful horizontal traces show, and the only effect of blanking is to decrease (in the case of the iconoscope) the number of horizontal strips into which the picture is resolved, and in the case of the kinescope, the amount of picture that is shown.

In Figs. 1-B and 1-C, two other amounts of return time are shown. A simple way to analyze the behavior of the beam is to draw all the horizontal lines in the forward direction, and then bend back those that occur during vertical return. By sloping the latter properly, the last half line can be made to reach the top of the picture at a point directly above its original position, and thus the path of the beam is determined.

It is thus evident that if the frequency relationship is maintained interlacing will occur regardless of the return time employed in the receiver, provided constant amplitude of vertical deflection is maintained. As mentioned previously, constancy of amplitude is easier to obtain than precise variation in the amplitude.

III. Insertion of Average Brightness

In audio work we are interested solely in the alternating motions of the acoustic device and medium, and in the alternating currents and voltages representing these motions. In television, the a-c component of the current or voltage represents but one feature of the television picture: the variation in its brightness from point to point. In addition to this, however, we must furnish information to the kinescope as to the average brightness of the scene, and this may be defined as the total amount of light from the scene divided by the projected area of the latter. For a given scene, the average brightness will be proportional to the total reflected light. The average brightness is therefore such a value that it is the average between the brighter and darker portions of the scene, and as such may be regarded as the d-c component of the light while the variations may be regarded as the a-c component. As a datum value, we have zero light, corresponding to black, and the height of the average brightness above this datum value represents the height of the a-c axis of the light variations above zero. The corresponding video signal should therefore have its a-c axis above zero current or voltage, as the case may be, so that this height represents electrically the average brightness. This would mean that the video amplifiers would have to amplify this d-c component corresponding to average brightness, and since d-c amplifiers are inherently unstable, an ingenious method is employed whereby the blanking pedestal conveys this information to the kinescope control grid. Thus a strictly a-c wave contains information concerning the d-c component of the



BRIDGED TEE NETWORK
Fig. 15

light. (Strictly speaking, the above is true only for a "still" scene illuminated with a steady source of light. Also, the d-c component is really an a-c component of very low frequency.)

Another matter closely related to average brightness is that of the range of contrast in brightness of the elements of the scene, represented electrically by the peak-to-peak value of the video wave. This not only depends upon the scene content, but also upon the illumination level. In photography we generally compensate for variations in the latter by adjustment of the exposure time and lens opening. A similar process to lens stop occurs in the human eye, although the iris of the eye adjusts itself rather slowly. In television compensation is most conveniently made by adjusting the electrical gain (contrast control) of the video amplifier. In this way the relatively limited contrast range of the system can be made to handle the enormous contrast range encountered in nature, and the main loss in fidelity

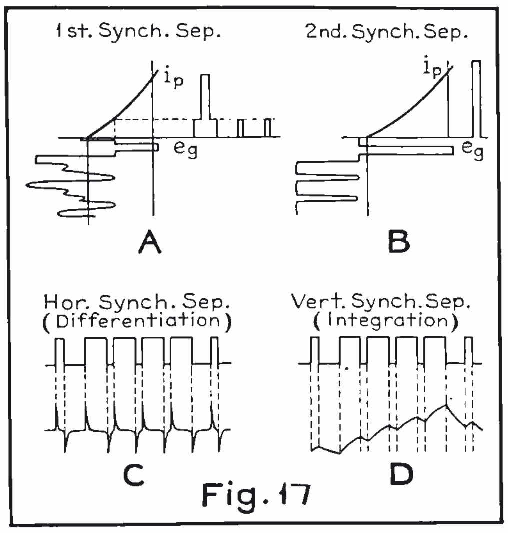


Fig. 17

is that of lack of blinking or temporary blindness on the part of the observer as the scene changes suddenly from an indoor to an outdoor scene, or vice versa, respectively. This loss is, if anything, a desirable one.

If we assume that most scenes have some black and some white in them, then the above procedure will result in the peak-to-peak value of the video wave being maintained constant. While in some cases this rule is modified for esthetic reasons, or to compensate for poor motion picture film, etc., and while the final criterion is the result observed by the monitor engineer on the monitoring kinescope, neverthless we may assume that in general the peak-to-peak value of the video wave is maintained fairly constant. If now the blanking pedestal is adjusted to exceed the blackest peak of the signal by a small amount, and then the bias of the kinescope grid caused to decrease from the cut-off value (zero gun current) by an amount proportional to the distance of the top of the blanking pedestal from the a-c axis, then the average brightness of the fluorescent screen will correspond to that of the televised scene.

The method of accomplishing this is shown in Fig. 2. The output stage and kinescope gun cathode and control grid are shown, together with the circuit for restoring the d-c component. The latter consists of a diode, a 1-megohm load resistor, and a 0.005-mfd condenser, forming in part, a negative peak voltmeter, connected to the 3300-ohm output tube's plate load resistor. While for the type of plate load shown, the highest video frequencies do not appear across this resistor, a sufficient number of them do appear to enable a reasonably good blanking pedestal voltage to be developed at this point. At the same time, the d-c restoring circuit does not introduce too much capacity in the video stage, and thus reduce its gain.

The action of the restorer is due to the fact that during the negative half cycle, the 0.005-mfd condenser can charge up through a low resistance composed approximately of the diode internal resistance and the 3300-ohm plate load resistor, while on the positive half cycle, it must discharge through the 1-megohm resistor. Thus this condenser charges up to the negative peak voltage, but hardly discharges at all during the positive half cycle, so that on the next negative cycle it re-charges just about at the peak voltage. As a consequence, the potential developed across the 1-megohm resistor is composed of d-c of a value equal to the negative peak of the video wave, and of such polarity that the top-end of the resistor is positive, plus as much of the video wave as appears across the 3300-ohm plate resistor. The latter is essentially filtered out of the gun control grid circuit by the action of the 470,000-ohm grid resistor and 0.1-mfd blocking condenser, which combination, however, acts oppositely to the complete a-c video signal coming directly from the output tube. The control grid is thus driven positive to ground by the blanking pedestal, and since the kinescope cathode is already positively biased with respect to ground, the negative potential of the control grid with respect to cathode is decreased from a pre-set cut-off value to a value corresponding to the average brightness of the scene.

The action can now be followed with respect to two sample scenes. One shall consist of a black line on a white back-ground, Fig. 3-A, and the other of a white line on a black background. In either case one line scan is shown, and for Fig. 3-A the impulse is due to the black line, and for 3-B it is of opposite polarity, and due to the white line. In either case the blanking pedestal just exceeds the blackest part of the signal, and its length with respect to the a-c axis therefore varies. It will be observed how the d-c restorer changes the bias of the kinescope control grid, and thus the average brightness. It will be further observed that black corresponds to cut-off and white to an amount of grid swing towards the positive limited by the "blooming" of the kinescope screen. The synchronizing impulse shown extending from the

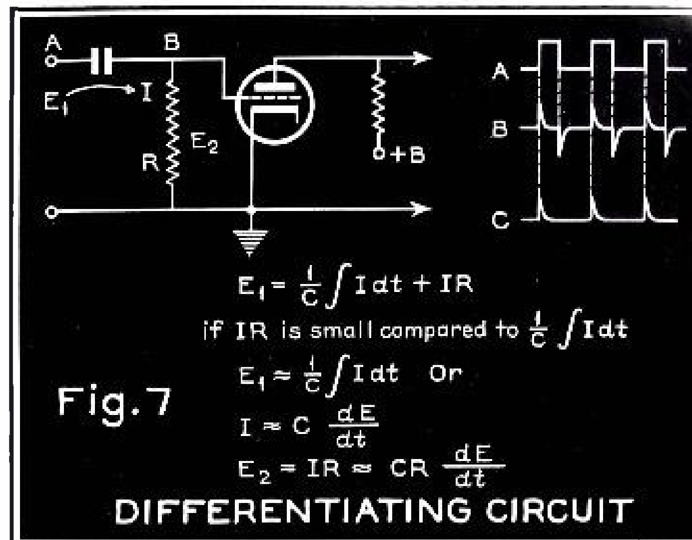


Fig. 7
DIFFERENTIATING CIRCUIT

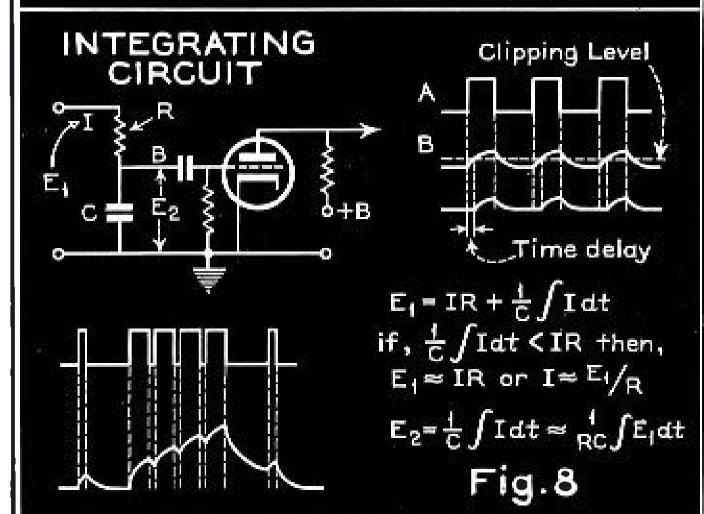


Fig. 8

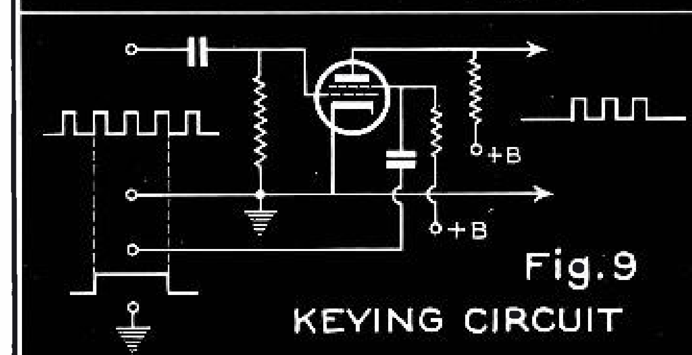


Fig. 9
KEYING CIRCUIT

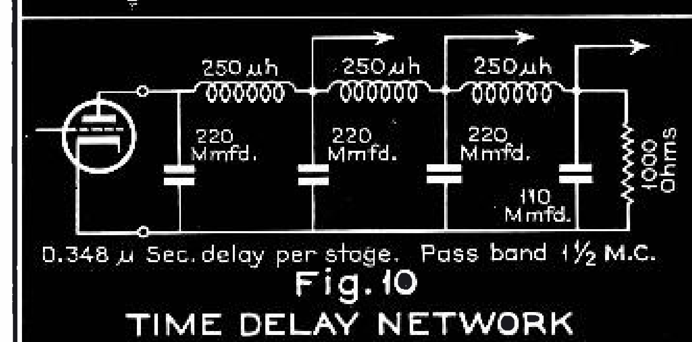


Fig. 10
TIME DELAY NETWORK

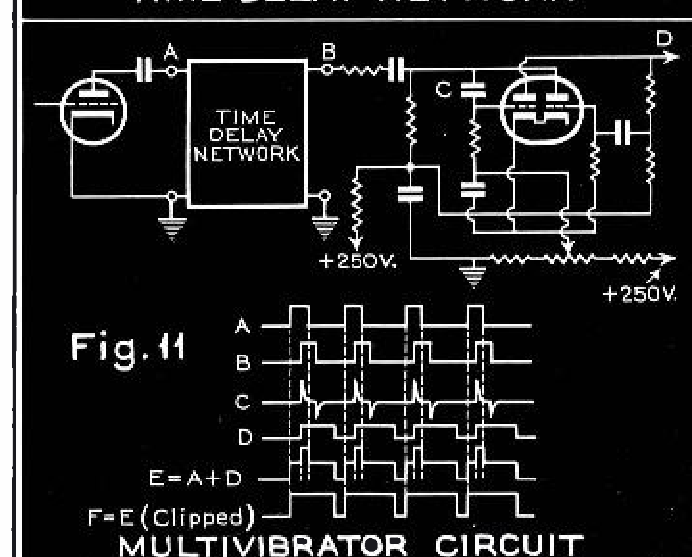


Fig. 11
MULTIVIBRATOR CIRCUIT

pedestal is in the "infra-black" region of the signal swing.

IV. Shaping Circuits

One striking difference between an audio and video signal is that the former consists entirely of the microphone output, while the latter consists only in part of the iconoscope output, and in part of a combination of artificially produced signals such as shading, blanking, and synchronizing impulses. These latter signals are produced mainly by a device known as the Synchronizing Generator, and the circuits employed are known as Shaping Circuits.

The operation of these shaping circuits is based essentially on seven principles. The first of these is Electronic Mixing, and is shown in Fig. 4. Two tubes have separate input (grid) circuits, but a common output circuit. The two different signals impressed upon the two grids superimpose in the output circuit to give the composite wave shown.

The second of these principles is "Clipping," or Amplitude Limiting, and two common forms are shown in Figs. 5-A and B. Examination of Fig. 5-A reveals that it has features common to the d-c restorer circuit of Fig. 2, except that here the control grid and cathode of the tube act as the diode element, so that the a-c signal component is not filtered out. Thus the latter appears in the grid circuit, together with a d-c bias voltage established by the grid current, and equal approximately to the maximum positive peak of the wave. If the signal is sufficiently great, and the plate voltage is sufficiently low, then a pre-determined portion of the signal will be beyond plate current cut-off, and hence will be "clipped-off" in the output plate circuit, as shown in the accompanying dynamic characteristic. This simple type of circuit is well suited for a definite, unvarying signal that is to be clipped at a fixed level.

Where the signal has to be clipped at different levels, the circuit of Fig. 5-B is preferred. Here the signal is kept below a level that would drive the grid positive, and an external bias is applied to move the a-c axis of the wave to or from cut-off, as shown in the accompanying dynamic characteristic. This circuit is particularly suited to clipping the blanking pedestal to set the black level in the video wave.

By means of clipping and amplifying circuits, rectangular waves may be produced from sine waves, as shown in Fig. 6. By a sufficient number of clipping and interspersed amplifying operations, the sinusoid may be converted into a rectangular wave having as steep a wave-front as desired. If the clipping operation in alternate stages is done at different levels, then an asymmetrical rectangular wave, such as those shown in Fig. 4, may be produced.

The next principle is that of Differentiation, illustrated in Fig. 7. The mathematical derivation is obvious, and indicates that the grid voltage E_2 (across R) is approximately the derivative of the applied voltage E_1. The latter wave is shown by wave A, and E_2 by wave B. Due to the finite time constant RC, E_2 is not exactly the derivative of E_1, since such a wave would consist of a series of alternate positive and negative unit pulses of infinite amplitude and infinitesimal time duration. The important thing to note is that pulse E_2 starts exactly in time with E_1, but is narrower. If, in addition, clipping occurs in the plate circuit, then all that will appear in the output is a series of pulses (wave C) timed exactly with E_1, but of shorter duration. Differentiating circuits are therefore of value in narrowing rectangular impulses without delaying them.

The fourth principle is that of Integration, as illustrated in Fig. 8. A similar R-C circuit is employed, but now the output voltage E_2 is taken off the condenser. As explained in the figure, E_2 is proportional to the integral of E_1, and would be a saw-tooth wave if the time constant were sufficiently high. Once again wave A represents E_1, and wave B represents E_2. If the latter is clipped in the plate circuit so that only that portion above the broken-line appears, then wave C is obtained. This can then be squared-up by clipping, but it will be noted that a time delay has been obtained by the integrating process. If instead of clipping as shown, the upper portion of the integrated wave is rejected, a broader pulse wave than E_1 can be obtained after clipping to square the accepted portion.

Integrating circuits are useful to separate the vertical synchronizing signal from the horizontal synchronizing signal, as shown in the lower portion of the figure. The closely spaced impulses represent the vertical synchronizing signal; the narrow pulses, one on either side, two of the many horizontal synchronizing impulses. After integration, the former may be separated from the latter on an amplitude basis.

The fifth principle is that of Keying, as shown in Fig. 9. The pentode tube is normally biased to cut-off by the use of a low screen grid voltage. The broad impulse injected into this circuit brings the tube into operation, and permits those impulses applied to the control grid during this time to appear in the output circuit. If the screen grid be operated at a high potential, and the polarity of the impulse applied to it be reversed, "keying out" of the narrower impulses can be accomplished. Keying can also be obtained by first mixing the two sets of impulses, and then injecting them together in one grid circuit. It may also be accomplished by the use of a variable mu tube. In a sense, it is a form of clipping.

It is possible to delay an impulse without distorting it appreciably by the use of a series of low-pass filter sections, as shown in Fig. 10. Different time delays may be obtained by tapping off various sections. A typical set of circuit constants for a network employing this principle is shown in Fig. 10.

Finally there is the method, shown

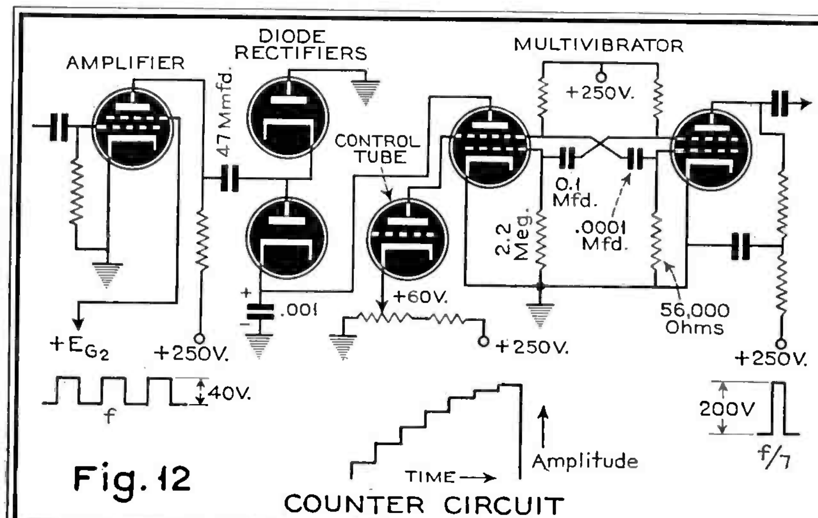


Fig. 12 COUNTER CIRCUIT

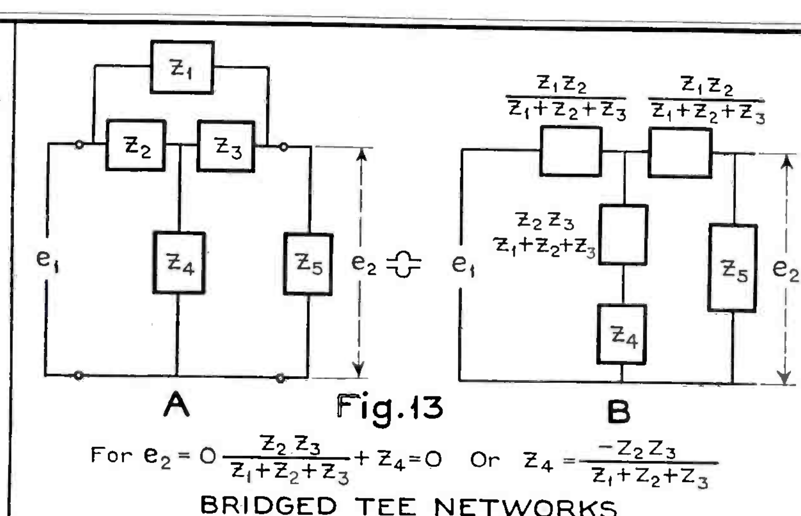
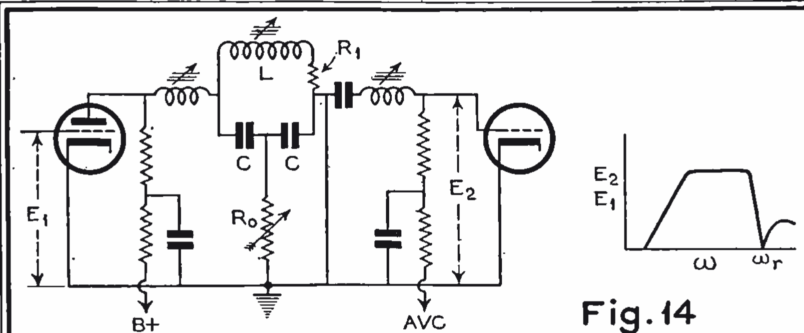


Fig. 13

For $e_2 = 0 \quad \frac{Z_2Z_3}{Z_1+Z_2+Z_3} + Z_4 = 0$ Or $Z_4 = \frac{-Z_2Z_3}{Z_1+Z_2+Z_3}$

BRIDGED TEE NETWORKS

in Fig. 11, which employs a multivibrator for the production of a wide impulse from an initial narrow impulse. Many of the previous principles are also employed as well. As may be noted from the figure, the original impulse, A, is delayed, B, and then differentiated, C, in order to form a narrow impulse to trip the multivibrator. (The latter has been adequately treated in other articles.) By proper adjustment of the time constants of the multivibrator, a broad impulse, D, can be obtained. This is then mixed with the original impulse, A, and wave E obtained. Wave E has the same leading edge as A, or is in exact timing with it. Finally, by clipping E, wave F is obtained, and this is a wave whose leading edge is that of A, but broader in width.



$$Z_4 = \frac{-\left(\frac{1}{j\omega C}\right)^2}{R_1 + j\omega L + \frac{2}{j\omega C}} = \frac{\frac{1}{\omega C}}{\omega C R_1 + j(\omega^2 LC - 2)} \text{ if } \frac{LC}{2} = \frac{1}{\omega_r^2} \text{ then}$$

$$Z_4 = \frac{1/\omega C}{\omega C R_1 + j2\left(\frac{\omega^2}{\omega_r^2} - 1\right)} \text{ For } \omega = \omega_r,\ Z_4 = \frac{1}{\omega^2 C^2 R_1} \text{ (a pure resistance)}$$

Fig. 14

BRIDGED TEE NETWORK

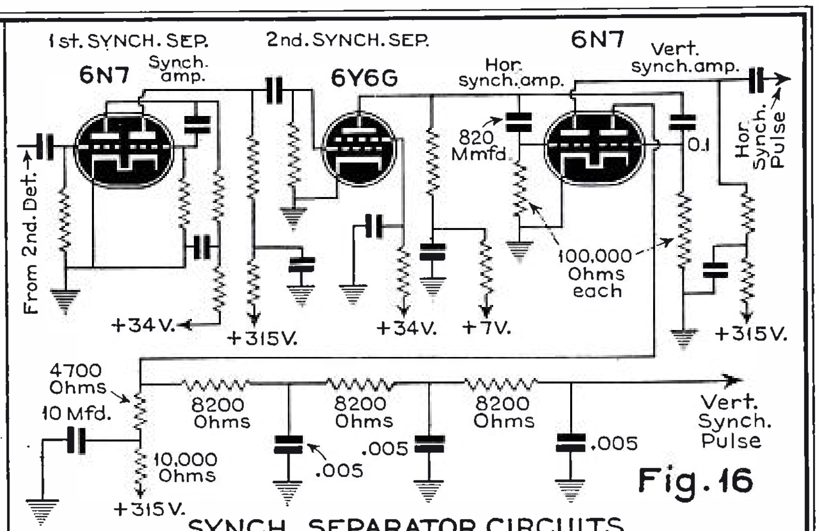


Fig. 16

SYNCH. SEPARATOR CIRCUITS

V. Counter Circuit

It has been shown that for odd line interlacing, the horizontal scanning frequency f_h, cannot be an integer multiple of the vertical scanning frequency f_v. However, 2 f_h will be an integer multiple of f_v (for 2:1 interlacing) and hence if one is chosen, and by some process of multiplication or de-multiplication the other obtained, and then f_h produced from $2f_h$ by de-multiplication, the two scanning frequencies will be obtained. If f_v is multiplied up to $2f_h$, then difficulty will be experienced in filtering out unavoidable side bands close to $2f_h$, such as $2f_h \pm f_v$. It appears simpler to start with an oscillator whose free-running frequency is about $2f_h$, and amenable to frequency control, and then de-multiply this frequency down to f_v, as well as to f_h. While multivibrator circuits are suitable for this purpose, the following Counter Circuit is possibly even better in that it is less susceptible to line voltage and tube variations. In passing, it is well to note that the de-multiplication is done in several steps, or circuits, each step being usually less than 10:1.

The circuit is shown in Fig. 12. Proceeding from left to right we note first an amplifier tube which amplifies a series of rectangular impulses (negative polarity). The latter swing the grid from beyond plate current cut-off to the positive grid region, so that the output (of positive polarity) is substantially independent of minor variations in the amplitude of the input wave. This output is fed to the 47-mmfd and 0.001-mfd condensers in series through the lower diode, and charge up the two condensers in inverse proportion to their capacitances. After the first (positive) pulse has passed, the next half of the cycle (of negative polarity) discharges the 47-mmfd condenser through the upper diode to ground, but the 0.001-mfd condenser retains its charge. The following positive half cycle charges the two condensers, the next negative half cycle discharges the 47-mmfd condenser. Due to the first charge remaining in the 0.001-mfd condenser after the first cycle, the net voltage applied to the two condensers during the first half of the second cycle is less, so that the second increment of charge received by the 0.001-mfd condenser is less than the first increment, but still of a sizable amount.

This process continues until the voltage has built up across the 0.001-mfd condenser in a series of steps shown to a pre-determined amount, whereupon a control tube, whose grid is coupled to this condenser, is brought from beyond cut-off into an operating condition, and trips the multivibrator following it. As shown in the figure, the cathode bias is adjusted so that this occurs every seventh cycle. The multivibrator is designed with one stage having a low time constant (0.001-mfd and 56000-ohm) and the other having a large time constant (0.1-mfd and 2.2-megohm). The control tube trips the low time constant stage, which is normally in the operating condition but cannot produce oscillations in conjunction with the high time constant stage because the latter has biased itself beyond cut-off from a previous oscillation. Once the control tube trips the multivibrator, the latter produces one cycle of operation, and becomes inoperative over the next de-multiplying period because of the high time constant stage biasing itself off once again.

However, during this one oscillation, the plate of the high time constant stage succeeds in discharging the 0.001-mfd condenser, so that the latter is brought back to its initial condition, and proceeds to charge up in seven steps once more. The output, from the plate of the low time constant stage, consists of one pulse for each seven of the incoming signal.

The de-multiplying action depends upon the constancy of capacitance values of the two condensers, and is practically independent of the plate supply voltage (for reasonable variations) since this not only changes the amplitude of the output voltage of the amplifier tube, but also the cathode bias of the control tube in the same direction, and so causes the two effects to cancel each other.

VI. Bridged T Networks

The bridged-T four-terminal network has been found to have many interesting properties, and among these is the ability to attenuate a very narrow band of frequencies independently of the generator and load terminations of the network.

It is shown in its most general form in Fig. 13-A. By means of the Delta-Y transformation first described by Kennelly,* it may be transformed into an ordinary T, as shown in Fig. 13-B. If the shunt arm of this equivalent circuit be set equal to zero at some frequency, then infinite attenuation will be obtained at that frequency regardless of the source or load impedances.

The practical embodiment of this network in a band-pass i-f stage of a tele-

(*Continued on page* 33)

*Kennelly, A. E.: "The Equivalence of Triangles and Three-pointed Stars in Conducting Networks, *Elec. World and Engineer*, Sept. 16, 1899.

Television Economics

Part XII

By
Dr. ALFRED N. GOLDSMITH
Consulting Industrial Engineer

K-4 Cable Networks

COAXIAL cables or their electrical equivalent can be used for interconnection of television stations by metallic conductors (it having been stated by communication authorities that the adaptation of ordinary telephone lines to the purpose is not commercially feasible). However, for minor distances of a few miles, spur extensions to television relay circuits may be contrived by using heavily corrected, equalized, and at least ordinarily quiet telephone lines. In fact, by introducing repeater equipment with equalization every mile or two, television signals have been satisfactorily conveyed over 4 miles of ordinary telephone lines—thus indicating the possibility of convenient and relatively inexpensive extension of main coaxial-cable or radio-relay feeders to the television transmitter.

There have recently been described various forms of u-h-f wave guides, but the use of these for syndication is in all likelihood remote since the large-scale engineering of this type of circuit is still in the early developmental stage. The relative convenience, performance, and cost of coaxial-cable operation versus wave-guide operation also remain to be determined at some future time.

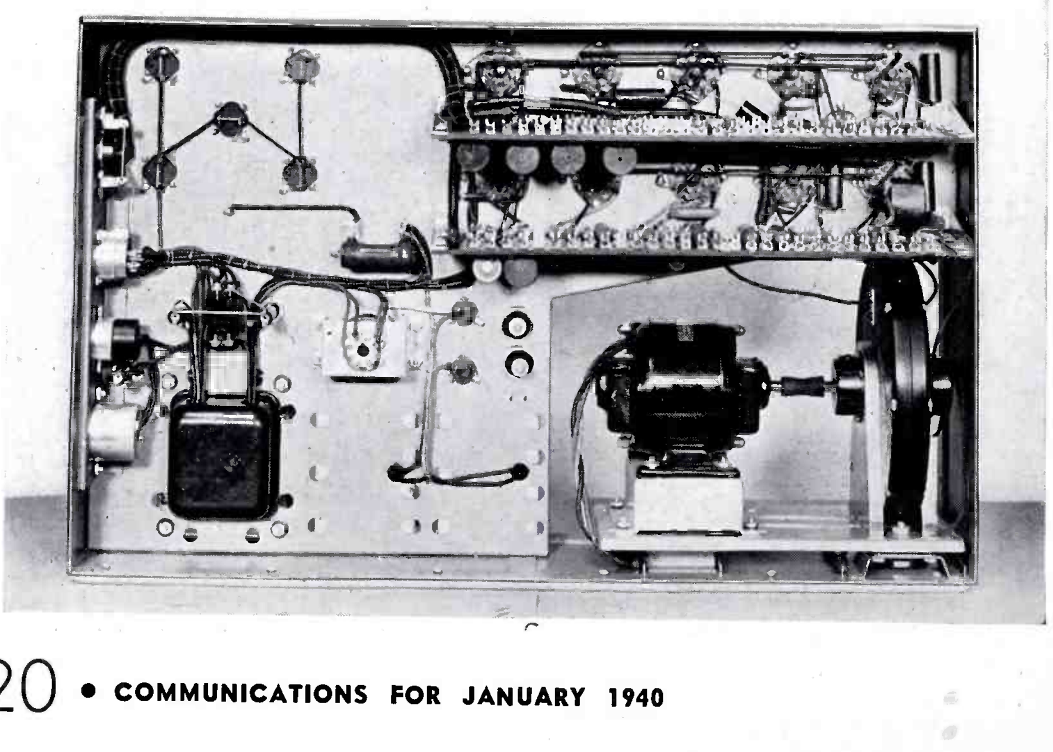
In America, a coaxial cable of limited television capabilities was run between two cities 95 miles apart. Without repeaters, this cable would have an attenuation of 200 db at 120 kc and 570 db at 1,000 kc. For 240-line television tests, the frequency band used on the cable was from 120 to 1,000 kc. In order to overcome the attenuation, repeaters were inserted every 10 miles and the line was thus equalized to about 3 db through the desired frequency range. The phase delay for the line alone was found to be 554 microseconds at 120 kc and 530 microseconds at 1,000 kc, or a change of 24 microseconds. After equalizing, the phase delay difference in the 120-1,000-kc range was plus-or-minus 0.3 microsecond. More recently, a request has been made to and granted by the Federal Communications Commission for permission to run a 195-mile coaxial cable in the Middle West in America.

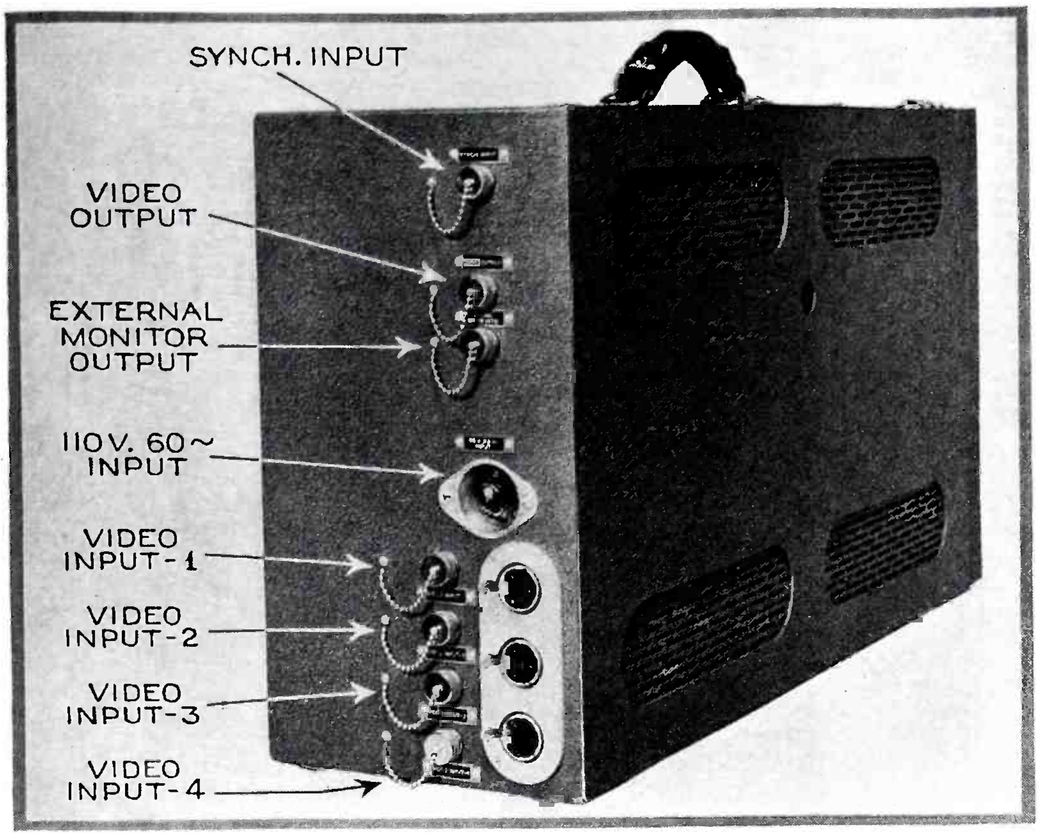
This line, from Stevens Point, Wis., to Minneapolis, Minn., a distance of 195 miles, is estimated to cost $2,000,000, or about $10,000 per mile. It will be partly ready in 1941. It consists of 4 coaxial cables in one lead sheath (one cable being used in each direction, and the other two being spares). It is to be capable of carrying a total band width of 3 mc (which may be taken to correspond approximately to a 380-line picture, and thus somewhat below RMA standards). There will be provided 480 telephone circuits; and no television use of the cable is now planned.

A European coaxial cable 375 miles long has been laid and is planned to be used in part for 441-line television transmission. This cable consists of an inner metallic conductor 5 mm in diameter and a concentric outer conductor 18 mm in diameter, lead sheathed, both conductors being suffcently heavy to carry adequate 50-cycle power supply to feed the intermediate amplifier or repeater stations. The average dielectric constant of the insulation between the two conductors, which is of course mostly air, is 1.17. It is also interesting to note that 95% of the entire current at 4 mc lies within 0.1 mm of the surface of the conductors. The cable is used for 200 carrier-current telephone circuits in the range between 100 and 700 kc, the separate amplifiers for these circuits being located every 22 miles. The total attenuation for the line is 53 db at 1.5 mc; 63 db at 2.2 mc; and 87 db at 4.2 mc. The range from 1.5-4.2 mc is to be used for the television signals, with repeater stations every 11 miles. The amplifiers for television at these stations are used for that purpose only, and are carefully designed for wide-band operation, with maximum reduction of tube noises and careful shielding against local electrical disturbances getting into the amplifier input circuits.

Up to the present, it has been found convenient occasionally to consider the "kilocycle-mile-year" as a unit for communication-channel service at a given cost. This unit involves, on the average, the transmission of 1-kc band of frequencies over a distance of 1 mile at all times throughout a year. Thus, if a telephone circuit which transmits say 5 kc for broadcasting purposes were to cost $84 per year, the kc-mile-year cost would be about $17. Inasmuch as television requires a video band of at least 2.5 mc for average quality and 4 mc for the desired superior quality, it is clear that the cost of a major network based on coaxial cable would be entirely prohibitive unless the kc-mile-year base cost were reduced to a small fraction of the present figure. One television analyst has estimated that a coaxial cable network carrying a 250-line picture to 98 major market areas, each having more than 100,000 population therein, would cost more than $100,000,000. Even this astronomical figure would permit television coverage of only about 5% of the area of the country but would include over 50% of the population and an even higher percentage of the purchasing power of the country.

An interior view of the portable pulse generator.





Rear view of master control unit. Photos on this and opposite page are of RCA portable television pickup equipment.

L. NON-BROADCASTING APPLICATIONS OF TELEVISION

Television equipment manufacturers may find a number of fields suited to television exploitation outside of the broadcasting domain. These fields include in part the following. Television two-way communication is of interest in a number of fields where objects, processes, documents, or persons at separated locations must be identified or studied. In this general connection, one-way television circuits may prove of interest in the supervision of industrial processes. A number of pieces of machinery or processes might, for example, be supervised by simple television means at a central point. In certain industries, this process may enable more effective operation and resulting economies. Thus, each of a group of motion-picture stages might be viewed by television from a central supervising point, thus keeping a check on operations and enabling the expediting of any lagging procedure, or speedy response to any emergency conditions. Anther one-way television system of interest might be applied to the control of road or tunnel traffic. Traffic often tends to pile up in "bottle necks" with resulting congestion in the surrounding areas. If such conditions can be visually observed in their early stages, it is conceivable that loudspeaker traffic control, special signals, re-routing of traffic, and the like might be effectively utilized. Another recent and interesting application of television has been educational, to wit, instruction of medical students in the details of a surgical operation sent to them by television from the operating table. Limited or distant viewing, as well as the risk of infection of the patient, may thus effectively be avoided. It is readily possible to imagine further similar applications of television in the instruction of large groups of persons through demonstrations which, in themselves, are too delicate or on too small a scale to be readily observed at a distance.

The use of television for military and naval purposes may be highly developed in due course. Observation planes, equipped with television transmitters (and either unmanned and remotely controlled, or manned) may carry views of the underlying terrain to army headquarters or to receiving stations on board ship. An elaborate technique of this sort might in effect enable the commanding officers literally to oversee the scope and progress of their military operations.

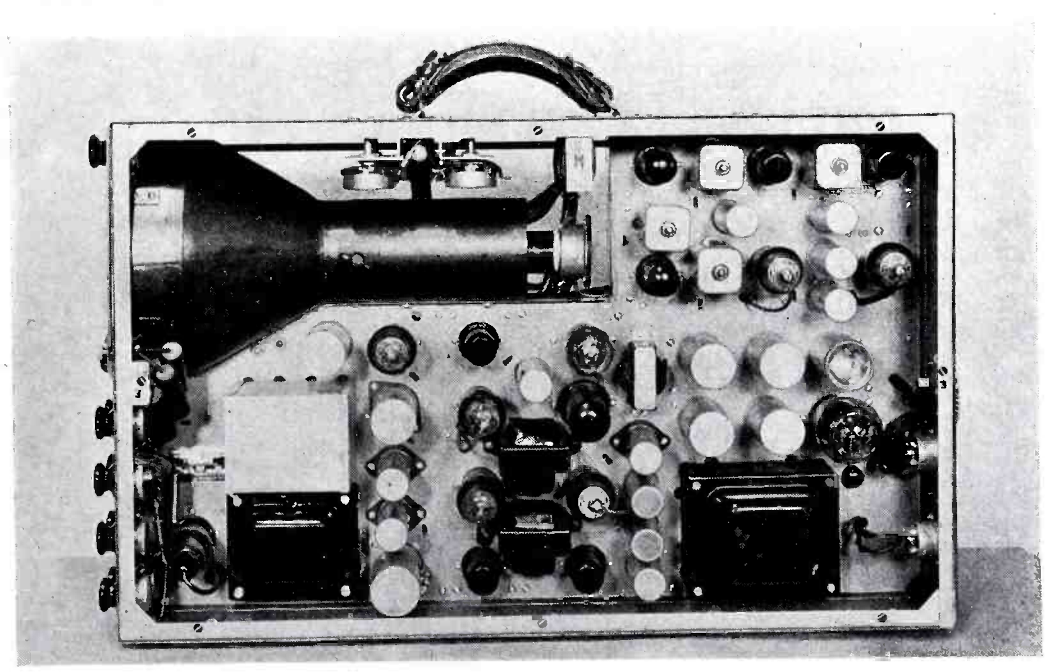
At the present time, the guidance of ships and airplanes at night or in fog is accomplished by beacon stations, by the radio compass, or by beams. Television offers the important possibility of literally permitting televisibility, that is, the observation of surrounding and distant terrain regardless of optical visibility; and thus it will in time permit the electrical viewing of surroundings under conditions when optical viewing is not possible.

As television develops, it is certain that many other non-broadcasting applications of that field will eventuate, and these will in considerable measure assist the radio industry in the development of television by encouraging reseach and by carrying a portion of the corresponding development costs.

M. DEVELOPMENT RATE OF TELEVISION BROADCASTING

It appears highly probable that television broadcasting, which offers sight as well as sound to the public, will ultimately become a widely accepted and successful field. The rate of its development and commercial acceptance will, however, depend upon many factors which cannot be here evaluated individually. These factors include the possible extension of the range of transmitting stations (either directly or by local relays) with resulting reduction in cost of delivering the program to the listener, the careful location of stations in areas of maximum population density, the expansion of the service by adding centers of population not too widely separated from each other at each stage, the reduction in cost of syndication methods, the development of a solution to the problem of providing a rural television broadcasting service, the maintenance

(*Continued on page* 35)



A side view of the portable camera control unit with cover removed.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

Spirit of the Cruise

IN his speech at the Banquet on de Forest Day at the World's Fair, Dr. Lee de Forest well expressed the spirit of our Annual Cruises. He said in part: "To-night is in my young life the *Night of Nights*, because here for the first time in my life are gathered together about me a host of old friends—men who have stood beside me at the very beginning of my work in wireless—veterans who have fought side by side in those primitive days of strange beginnings, when a wave-meter was unknown, and static and interference were licked merely by the boys' amazing ability to get "under the table," clamp the "cans" to their ears, and come up for air with the answer ready to pencil on the Aerogram blank. The full tale of the heroism of those wireless pioneers will never adequately be told."

And further along in Doc's speech: "What more can I say? This is no time or place to expatiate further upon today's marvels of broadcasting and of radio communications, nor in the revolution in the home life and the manner of thought throughout the civilized world which have transpired during these first fleeting years of their development.

"Rather is this an occasion for retrospect; to happily pause in the relentless forward march of time; to gaze back wistfully upon the olden years, golden now in the haze of memory.

"For we oldsters have tonight the well-earned right to look back, with some full measure of satisfaction, upon the long paths we have trod; to thank fate that we, as pioneers, were fortunate to have played our part in this making of the history of modern science and of our modern civilization.

"And so, to all you Fellow Veterans—my affectionate salutations—but not yet—not for twenty years—farewell!" That is the spirit upon which our Association was founded. That is the reason why year after year our Veterans return to the scene of our Cruise and renew old acquaintanceships—postponing indefinitely—farewell! (Note:—A brochure containing all the addresses of Dr. de Forest and others at the festivities on de Forest Day together with a photo of Doc and of his Scroll is being prepared. Copies will be available for the cost of printing and mailing—25 cents. They are well worth having, as Doc might well have made his fortune in literature. He writes beautifully of the early days of wireless and of the wireless pioneers.)

Cruise

The Fifteenth Anniversary of the founding of the Veteran Wireless Operators Association will be celebrated with a grand Dinner-Cruise at the Hotel Astor, Times Square, New York City, on Wednesday evening, February 21, 1940. From all indications this affair will surpass all previous cruises in attendance and in the highlights which will be featured. The committee is working strenuously to arrange an outstanding evening of good fellowship and grand entertainment. We must request purchase of tickets in advance as only then can a comprehensive and complete program be arranged. Should conditions arise at the last moment preventing attendance of anyone purchasing tickets in advance, advice to the committee will prevent a total loss of the purchase price. All those who have attended our cruises in the past know what a good time is had by all. We earnestly request early reservations so that the work of the program committee may be expedited. Tickets are $4.00 per person and include a delicious full course Astor Dinner with cocktail and dancing and entertainment until the wee' small hours. Tickets are available from any officer, director or committeeman or from headquarters at the address at the top of the page. May we have the pleasure of greeting you at the Astor on the 21st of February?

Secretary

We did not like receiving the following communication, but we realize the conditions which made it necessary. It reads: "This will confirm our telephone conversation some weeks ago wherein I stated that my resignation as Secretary of VWOA would be effective as soon as my successor was elected in 1940.

"It has been a pleasure to me to have aided in maintaining our contacts among our membership and it is only because of urgent business affairs needing all my attention that I cannot give more time and do justice to VWOA activities."

It was signed by H. H. Parker. We now pay tribute to a splendid job of co-operation in furthering the interests of our Association during the past three years by as hard working a secretary as we have ever had or may hope to have, H. H. Parker. We know that HHP will be ever willing to help in any way possible in keeping our organization an up and going fraternity of old time wirelessmen. The Secretary's job is a tedious and exacting assignment and three years of successful operation of the office is a great contribution to our progress by our retiring Secretary. May his successor do nearly so good a job and all will be well. Our sincere thanks to you, HHP, and may you continue to be elected a Director and thereby further serve VWOA. MC.

San Francisco

A long and interesting letter from Gilson Willets, San Francisco Chapter Chairman. He says in part: "Enclosed please find application of Van Carroll accompanied by his check. Please send him membership card for 1940.

"I talked with Bill Fenton of Mackay Radio today and we agreed to have our Annual Cruise here as usual. We hope to have it the same place as last year but have not yet placed our reservations. Those who wish to attend should communicate with Bill Fenton at Mackay Radio here or with me at my home address. Every effort will be made by our committee and we hope to have a cruise even more successful than last year.

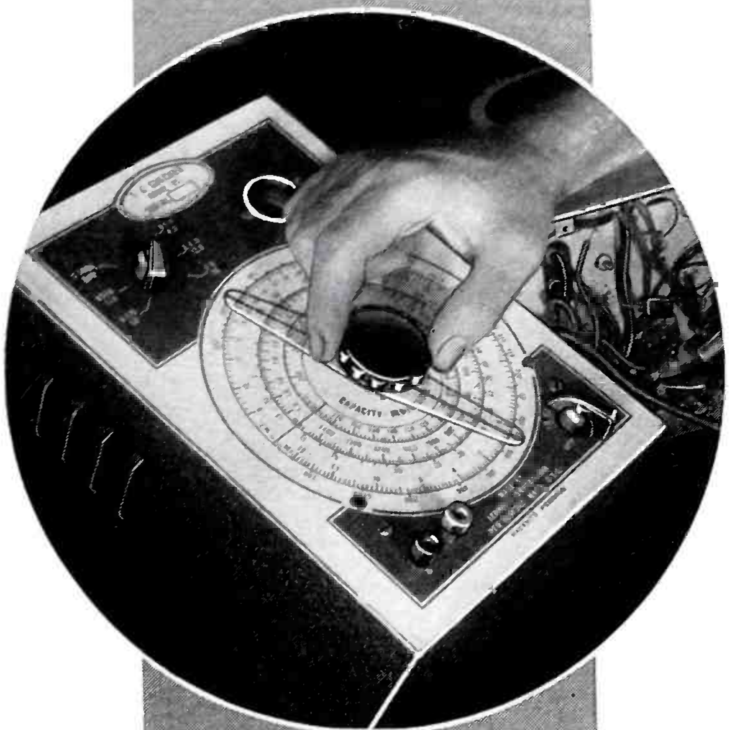
"The Marconi Memorial Scroll of Honor awarded to Henry Wiehr, America's foremost one-armed wireless operator, by our Association was presented to him by yours truly and he was most appreciative of the high honor accorded his efforts.

"We expect things to hum from now on and solicit communications from interested persons in the San Francisco area regarding our cruise on the 21st of February. A good time is assured with the whole-hearted cooperation of all concerned."

Personals

More than pleased to see J. F. J. (Jim) Maher early President of our Association at a recent meeting. Jim still retains his deep love for the Association and all it stands for. We look forward to having him with us again at the Fifteenth Anniversary at the Astor. . . . There, too, was Roscoe Kent, Sales Manager for the Finch Telecommunications Laboratories, and one of the earliest assistants of Dr. de Forest and a truly pioneer wirelessman. He is enthusiastic about our forthcoming "Big Event" and promises to round up many who have missed our affairs in recent years. With that type of cooperation we're bound to have a swell Cruise. . . . John M. Petty writes in from Valparaiso, Ind., regarding membership requirements. JMP started in commercial radio in 1923 and we gladly sent him full details. . . . Carl O. Peterson was at our most recent meeting, too, and plans to be with us on the 21st. Carl recently appeared on "Hobby Lobby" and did a grand job of describing some of his Polar masterpieces, the collection of which he has been engaged in for these many years. You know, he was with Byrd twice, in the Antarctic once before that and in the Arctic also. A true Polarite. . . . John W. Scanlin, one of the first wirelessmen in the United States Navy, sends in his dues. JWS was with us at the Cruise in '38, traveling all the way from Washington, D. C. We trust that conditions permit him to be with us again this year. . . . "Steve" Wallis, Mackay Radio Superintendent down N'Orleans way, sends in the application of Wm. T. Freeland for Associate Membership. Bill started in commercial radio with Mackay Radio in 1933. Glad to have you with us, WTF. . . . Al Koehler of Tropical Radio sends in the necessary for '40. We'll welcome the same from all who have not yet remitted. . . . Arthur F. Rehbein, who always attends our affairs when possible, remits and will be there on the 21st.

Two "musts" for your 1940 work



● With 1940 already shaping up as a banner radio year, now's the time to see just what equipment is required for the laboratory, factory, and service stations out in the field. First and foremost in any recommendations or requisitions for new equipment must come these two low-priced but mighty important items:

L-C CHECKER

This instrument does many important things, yet it costs only $29.50 net.

The most attractive thing about the L-C Checker is the way it checks condensers right in their circuits — without disconnecting or unsoldering — at operative radio frequencies. It's a real *radio* test — and a time-saver. Also checks for capacity, opens, shorts, intermittents.

The L-C Checker also checks inductances, circuits, frequencies, resonant points, etc., etc.

A tremendous help in aligning r.f. and i.f. stages; tuning traps; checking chokes; checking natural period of antennae and r.f. transmission lines, etc.

Alone, it has a score of invaluable applications. With associated equipment, it has many more functions.

It's a *must* in our 1940 equipment—especially at that price!

CAPACITY AND RESISTANCE BRIDGE

Then there's the AEROVOX bridge. It's a popular priced job, all right, at only $35.75 net. But it's a high-grade job because it utilizes a meter in place of the usual neon lamp.

This bridge is invaluable for checking capacity, power factor, leakage, insulation resistance, etc., of condensers. Also for checking resistance values.

And because it has a high-grade meter and a variable power supply, externally available, it serves a lot of functions beyond the usual bridge, such as power supply, vacuum-tube voltmeter, voltmeter, millivoltmeter, milliammeter, etc.

No lab. is complete without a bridge. This one is sufficiently accurate for most of the work in the lab., factory, service station.

Ask to See Them . . .

● Your local jobber can show you both these instruments. Try them for yourself. Ask for descriptive literature. Or if you prefer, write us direct.

AEROVOX CORPORATION
New Bedford, Mass.
Sales Offices in All Principal Cities

OVER THE TAPE . . .

NEWS OF THE COMMUNICATIONS FIELD

Peter L. Jensen

FARNSWORTH PRODUCTS

Marking the beginning of the new year for Farnsworth Television & Radio Corporation, E. A. Nicholas, President, announces the company's extensive research laboratories and special products division in Fort Wayne, Ind., have started the commercial production of a wide variety of electronic devices. Among them are the Farnsworth image-dissector tubes, multipactor tubes, telecine projectors for televising motion-picture film, television pickup cameras, photocell multiplier tubes, master timer and pulse generators and complete studio and radio transmitting equipment for both sight and sound. The company has just issued a series of engineering bulletins, describing in detail a number of its electronic products.

EDWIN W. ALLEN

Edwin W. Allen, Vice-President of General Electric since 1926, died at noon, January 1 in Johns Hopkins hospital, Baltimore. He had been under treatment two months following an operation.

ELECTROVOX ANNOUNCEMENT

The Electrovox Company, 424 Madison Ave., New York, has announced that several new refinements have been incorporated in the Walco sapphire cutter. This concern is also introducing a new hand-polished alloy steel cutting needle at low prices.

Thos. A. White

UTAH APPOINTMENT

The Utah Radio Products Co., of Chicago, have announced the association of Peter L. Jensen with the Utah organization. Mr. Jensen will assume the duties of Vice-President. The announcement was made by G. Hamilton Beasley, President of Utah.

MICROVOLTS INCREASE PRODUCTION

Microvolts, Inc., Boonton, N. J., has recently increased its production facilities so as to be able to take care of the demand for signal generators, and will be in production on its new ultra-high-frequency noise meter shortly.

LICENSE AGREEMENT

Announcement that the Radio Corporation of America has entered into new license agreements with the General Electric Company and Westinghouse Electric & Manufacturing Company was made today by officers of the three companies. The new agreement is supplemental to license agreements which have been in effect between the companies since 1932.

I. A. Mitchell (left) and S. L. Baraf

CORNELL-DUBILIER CATALOG

Catalog No. 160-T is now available from the Cornell-Dubilier Electric Corp., South Plainfield, N. J. This catalog covers the C-D line of radio transmitting capacitors. In addition to a great deal of data on the various condensers, this 32-page bulletin contains material on peak operating potentials, guides to the selection of various types of condensers, and an interesting and useful capacity-frequency-reactance chart.

JENSEN PROMOTIONS

The Jensen Radio Manufacturing Co. have recently made the following announcement concerning their personnel. W. E. Maxson becomes President and General Manager after serving the corporation for ten years as Managing Director. Hugh S. Knowles and Thos. A. White have been elected Vice-Presidents while continuing as Chief Engineer and Sales Manager, respectively. A. Leslie Oliver, after an eleven-year tenure as Vice-President, becomes Chairman of the Board of Directors. Other corporate officers remain in their capacities except for Peter L. Jensen whose resignation as President and Director was recently accepted.

G. Hamilton Beasley

CHICAGO I.R.E. ELECTION

P. C. Sandretto, Superintendent of United Air Lines radio laboratory and noted for his aeronautic radio research, was elected President of the Radio Engineers Club of Chicago at the annual election at the Merchandise Mart. Sandretto succeeds Hartman B. Cannon, Chief Engineer for Wells-Gardner & Co.

NEW COMPANY

As of the first of the year the manufacture and sale of Cinaudagraph loud speakers has been transferred to a new company known as the United Teletone Corporation. This new organization, which is managed by I. A. Mitchell and S. L. Baraf, of United Transformer Corporation, will continue to manufacture Cinaudagraph speakers at the present plant with as far as possible the complete personnel of the present organization.

IDEAL BULLETIN

The Ideal Commutator Dresser Co., 1250 Park Ave., Sycamore, Ill., have recently made available a bulletin giving data on their line of electric etchers, grinders, commutators and slip ring resurfacers, power mica undercutters, coil winding equipment, insulation testers, wire strippers, soldering tools, variable-speed transmissions, electric cleaners, motor bases, etc. Write to the above organization.

Hugh S. Knowles

"The Market Place"

Manufacturers are requested to send data on their new products for use in the communications and broadcasting field, promptly, for inclusion in "The Market Place" section.

W. E. APPOINTMENTS

W. A. Wolff, Advertising Manager since 1929 of Western Electric Company and Electrical Research Products, Inc., a subsidiary, has been appointed Information Manager of both companies, it has been announced by P. L. Thomson, Director of Public Relations. He is succeeded by H. W. Forster, Information Manager for the past ten years.

A graduate of Columbia University School of Engineering in 1905, Mr. Wolff entered Western Electric's student training course. After early assignments in the engineering, sales and manufacturing departments, he entered the advertising department as a publicity and copy writer in 1911. In 1929 he became Advertising Manager.

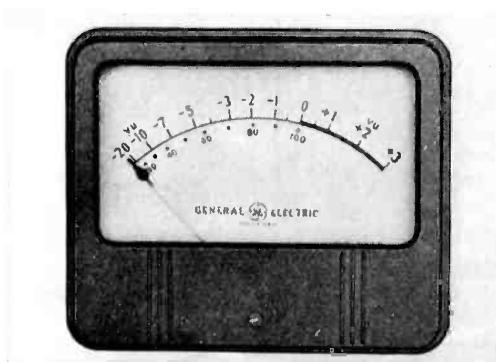
Mr. Forster upon his graduation from Columbia College in 1920 was a chemist for American Metal Company in Mexico. Subsequently he was a newspaper reporter in New York and in 1924 joined Western Electric. He later entered the public relations department as Editor of two of the Company's employee papers, *The Observer* and *The Distributor,* and as an Associate Editor of the *Western Electric News.* Since 1930 he has been Information Manager.

• • •

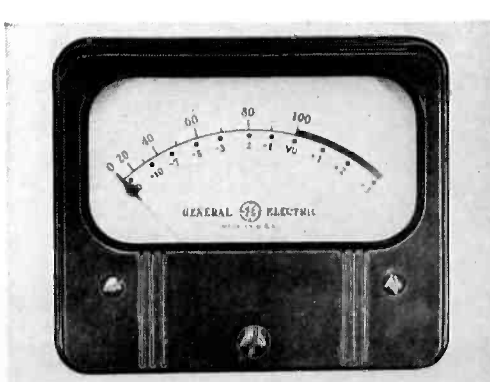
THE MARKET PLACE

VU METER

For broadcast monitoring and use with public-address systems, General Electric Co., Schenectady, N. Y., has produced a new VU volume-level indicator, Type DO-61, which meets the electric, dynamic, and mechanical specifications formulated as a result of the combined efforts of the National Broadcasting Company, Columbia Broadcasting System, and the Bell Telephone Laboratories. The VU instrument is essentially a low-range rectifier-type rms voltmeter consisting of a D'Arsonval element with an Alnico magnet in series with a stable, noncorrosive, full-wave, copper-oxide rectifier designed for performance under wide variations of frequency. The new indicators are normally calibrated for use on nonmagnetic panels, but can be calibrated for use on steel panels up to 1/16-inch thick.



G-E VU Meters. Bottom model illuminated.



You and your associates can obtain a year's subscription to COMMUNICATIONS (12 issues) for only $1.00 each by using the Group Subscription Plan.

A regular yearly subscription to COMMUNICATIONS costs $2.00 — but when four or more men sign up at one time, each one is entitled to the half-price rate. (Foreign subscribers on the "G-S-P" only pay $2.00 each).

COMMUNICATIONS
19 E. 47th St., N. Y. C.

Please enter annual subscriptions (12 issues) for each of the undersigned for which payment is enclosed at the rate of $1.00 each. (This rate applies only on 4 or more subscriptions when occupations are given.) Foreign Subscriptions are $2.00 each.

Name ....
Street ....
City-State ....
Occupation or title ....
Employed by ....
Nature of business ....
(State If Manufacturer, Broadcast Station, etc.)
Product ....

Name ....
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Occupation or title ....
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(State If Manufacturer, Broadcast Station, etc.)
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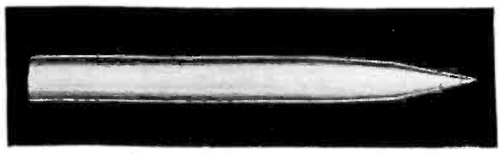
Nature of business ....
(State If Manufacturer, Broadcast Station, etc.)
Product ....

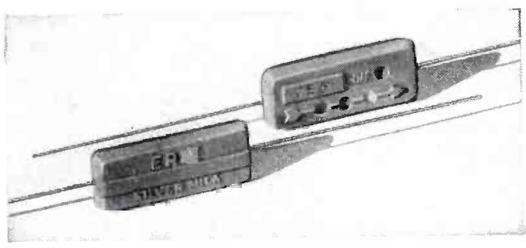
REPRODUCING NEEDLE

Permo Products Corporation, 6415 Ravenswood Ave., Chicago, offer a high fidelity, transcription type, play-back phonograph needle, which is tipped with a point of precious metals made from the group of the elements of rhodium, ruthenium, osmium and iridium. This new needle is designed for high fidelity reproduction and is for use in broadcast transcription work, recording and sound studios. Special characteristics of this needle tip provide a lubricating action which does not wear nitrate or commercially pressed records, it is said.



SILVER MICA CONDENSERS

Erie Resistor announces an addition to its line of silver-mica condensers. Known as type J the new unit measures 13/64" x 7/16" x 1-1/32". The type J unit is unusually stable over a wide range of temperature and humidity changes. Average temperature coefficient (20 to 80° C) is +.00025 mmfd/mmfd/°C. Maximum power factor at 1,000 kc is less than .04%. Erie Resistor Corporation, Erie, Pa.



AIRCRAFT RADIO-TELEPHONE

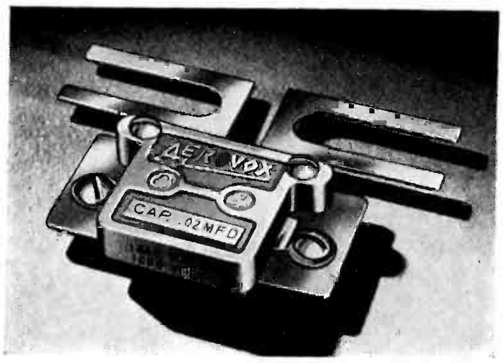
A multi-channel radio telephone for aircraft, which provides for dial-switch selection of any one of ten pre-tuned frequencies, has been announced by the Western Electric Company, 195 Broadway, New York City. The new apparatus was designed primarily for use by airlines and private planes.

DYNAMOTORS

The new, complete line of dynamotors by Eicor offers a wide range of sizes from the smallest to the largest required. These new dynamotors are for aircraft, police, marine, and amateur transmitters and receivers. Eicor also manufactures a complete line of convertors, generators, motors and alternators. For details write to Eicor, Inc., 515 S. Laflin Street, Chicago.

MICA CONDENSERS

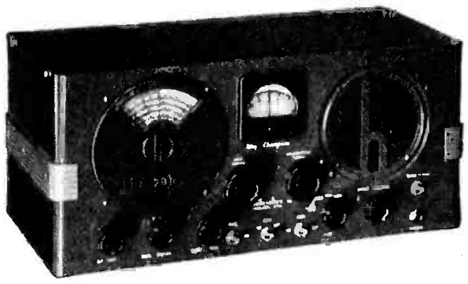
Bakelite-molded mica condensers provided with handy meter-mounting brackets, for the purpose of radio-frequency shunting of meter windings, are announced by Aerovox Corporation, New Bedford, Mass.



The heavy 3/16" thick brass brackets are mounted and connected to the popular series 1445-57 mica condensers. Long slots in the brackets permit attachment to the terminals of any of the standard panel-mounting meters.

COMMUNICATIONS RECEIVER

The Hallicrafters, 2611 Indiana Ave., Chicago, announce the improved "Sky Champion" communications receiver, Model S20-R. The tuning range is from 540 kc to 44 megacycles in four bands of 540-1770

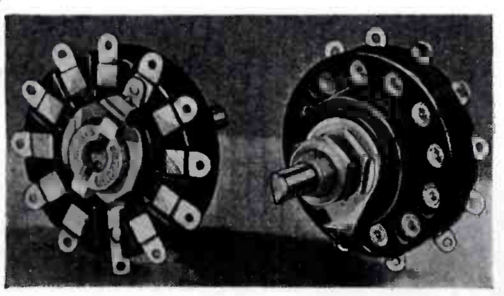


kc, 1.72-5.4 mc, 5.3-15.7 mc, and 15.2-44.0 mc. The tube line-up includes: 6SK7 tuned r-f stage, 6K8 oscillator-mixer (with special input tuned circuit which provides approximately twice normal conversion gain at frequencies above 14 mc.), two 6SK7 i-f stages, 6SQ7 detector—a-v-c—first audio, 6F6G audio power stage, 6H6 automatic noise limiter, 6J5GT beat-frequency oscillator, and 80 rectifier.

TAP SWITCH

A new addition to the Ohmite family of high current tap switches is the small size, open-type, high-current Model 111. With this new unit, 5 sizes of high current tap switches are now available, in ratings from 5 amperes—120 volts to 75 amperes—240 volts.

Model 111, like the larger Ohmite tap switches is a multi-point, load-break, non-shorting, single-pole rotary selector designed for alternating-current use. It is all-ceramic in construction, compact and well insulated. Has silver-to-silver con-



tacts which are self-cleaning and require no maintenance. Positive cam-and-roller mechanism provides "slow-break," quick-make action for alternating current. Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago.

SQUARE-WAVE GENERATOR

The Type 769-A square-wave generator can be used to determine the frequency response, particularly under transient conditions, of amplifiers and other networks. The method used is to apply square waves of appropriate frequency to the input of network under measurement and to observe the output waveform on a cathode-ray oscillograph. This square-wave generator is particularly useful for measuring the low-frequency response of television systems. The generator is actually a

device for converting a sinusoidal timing signal into a square-wave signal. Squaring is accomplished by amplifying and clipping the peaks of the signal in several successive stages.

The output voltage can be obtained either unbalanced or balanced to ground. The plate-to-plate output voltage is 150 volts balanced, 75 volts unbalanced. Minimum output voltage is 10 microvolts. Output impedance is 500 ohms balanced, 250 ohms unbalanced. The impedance is independent of frequency down to d-c.

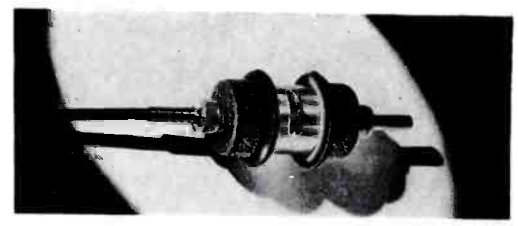
Square waves with *fundamentals* from 10 to 5000 cycles per second can be produced. The output circuit will pass frequencies between 0.1 cycle and 250,000 cycles.

The waveform is very close to a true rectangular shape. At low frequencies, the entire rise in voltage takes place in 0.001 cycle.

Dimensions are 19 x 7 inches (panel); depth behind panel, 8½ inches. The net weight is 22 pounds. General Radio Co., 30 State St., Cambridge, Mass.

CABLE-TYPE TRANSFORMER

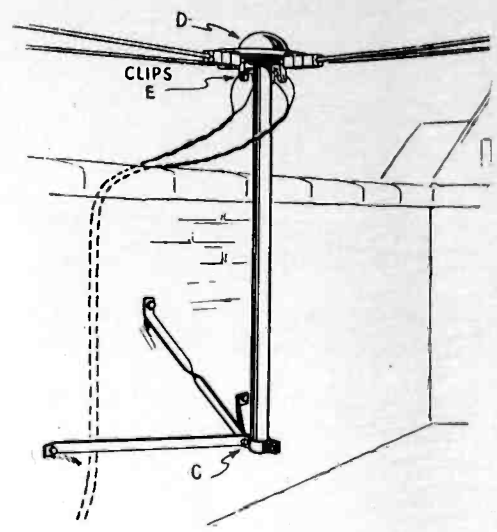
A new cable-type transformer to match 35-50 and 200-250 ohm low-impedance dynamic microphones (or lines) to high-



impedance amplifier input is now offered by Shure Brothers, 225 W. Huron St., Chicago, Ill. The A86A transformer may be located within 25 ft. of the amplifier. The compact tubular case is magnetically shielded. Cast end-covers are removable for access to the terminals. Compression fittings seal-in microphone and amplifier cables.

TELEVISION ANTENNA

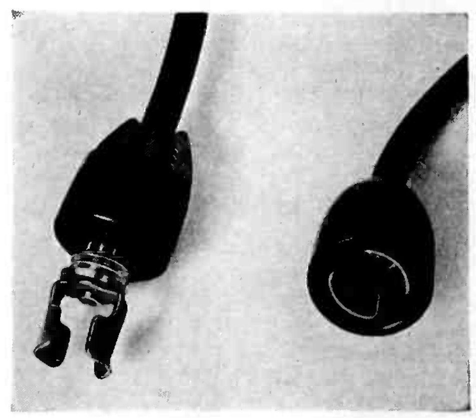
The Verti-flex television antenna consists of crossed dipoles with convenient



switching means at the receiver for choosing either dipole. In addition the switching means allows alternate halves of the dipoles to be connected together so as to receive from the 45° direction also. This means that by switching the antenna can be adjusted to within twenty-two and one-half degrees of the best receiving position . . . and hence is convenient for locations where it is desired to receive signals from more than one station. Further information may be secured from Verti-flex Division, International Seating Corp., 2138 N. Racine Ave., Chicago, Illinois.

TUBE CAP CONNECTORS

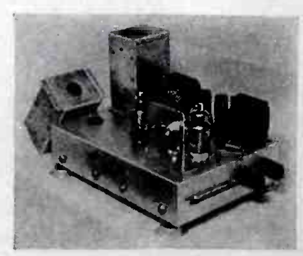
The unit illustrated, part of a complete line of insulated tube cap connectors, was made in accordance with Navy specifica-



tions. The molding can be unscrewed from the lead and contact assembly for inspection. The back of the insert crimps into the insulation on the ignition cable wire to provide strain relief and to prevent the wire from twisting relative to the clip. The construction of the cap is such that no solder is necessary. Further information may be secured from Alden Products Co., Brockton, Mass.

PORTABLE-MOBILE TRANSMITTER

Radio Transceiver Labs. announce a new amateur transmitter, Type 510. De-



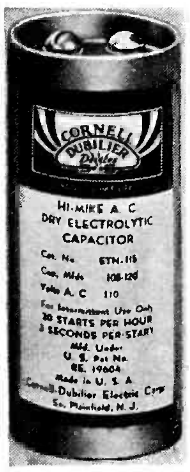
signed by Frank Jacobs, it is patterned after a police-car transmitter, crystal controlled, 12 watts, portable-mobile, with 28 and 56 mc band switching. Literature is available from the *Radio Transceiver Laboratories,* 8627 115th St., Richmond Hill, N. Y.

W.E. APPOINTMENT

Clarence G. Stoll was elected President of the Western Electric Company at a meeting of the Company's directors Tuesday, December 12, succeeding Edgar S. Bloom, who retired on December 31. Mr. Stoll has been Vice-President in charge of operations since 1928. He has spent his entire business career of 36 years with Western Electric, having risen from student apprentice to become its chief executive.

MOTOR STARTING CAPACITORS

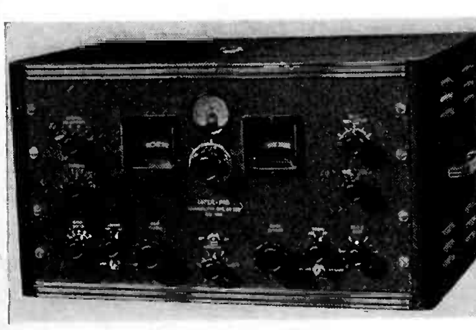
The Type ETN Cornell-Dubilier a-c electrolytic capacitors for motor starting uses are of the etched-foil type, hermetically sealed in cylindrical aluminum containers with bakelite terminal heads into which aluminum stud inserts are molded, and which also include safety vents to take care of excessive internal pressure resulting from accidental or abnormal conditions. In addition, each unit is jacketed with a specially treated cardboard sleeve of high electrical insulation qualities and moisture-proof. Other ETN types are also



available with steel end caps with inset rubber grommets through which wire leads are brought; or with these end caps and steel mounting brackets. Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

COMMUNICATIONS RECEIVER

Hammarlund announces a new and improved "Super-Pro" receiver. The new unit is available in two tuning ranges—15 to 560 meters and 7½ to 240 meters. The improvements include variable selectivity crystal filter; a new and improved noise limiter designed and adjusted to provide maximum suppression without affecting the normal performance of the receiver; and an "S" meter arrangement that permits the operator to make adjustment for receiving conditions. The tube line-up includes two 6K7's as first and second t-r-f amplifiers; 6L7 first detector; 6J7 h-f



oscillator; 6K7 first i-f amplifier; two 6SK7's as second and third i-f amplifiers; 6H6 second detector; 6N7 noise limiter; 6SJ7 beat frequency oscillator; 6SK7 a-v-c amplifier; 6H6 a-v-c and meter rectifier; 6C5 first a-f; 6F6 second a-f; and two 6F6's push-pull output audio amplifier. The power supply has two rectifiers, one type 5Z3 high voltage rectifier, and one type 80 low voltage rectifier for the C-bias supply. Hammarlund Mfg. Co., 424 W. 33 St., New York City.

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EXPECTATIONS IN RADIO

(*Continued from page* 13)

decrease in transatlantic message traffic during the latter part of 1939, although this was offset to a large extent by an increase in coastwise message traffic. This condition is likely to exist throughout 1940.

This year will see increasing use of radio telephone equipment on small pleasure craft. For the most part these will be small, compact transmitter-receiver units which will permit contact with other craft, with land telephones, and in emergency provide direct communication with the Coast Guard. Simple, foolproof operation will be featured for this type of equipment.

Direction finders are coming into more prominence. Also, some use has been made of u-h-f obstacle detectors. Experimental work will no doubt continue along the latter line. There should also be considerable Government work during this year.

Police Radio

This field is becoming better organized year by year. Much credit for this must be given to the Associated Police Communication Officers, an organization that has done some excellent work.[31] Formed in 1935, this organization is now a potent factor in keeping this field in smooth running order. According to figures recently released,[32] there are now 650 municipal radio stations, 79 state police radio stations and 67 radio telegraph network stations.

A development that will be watched with great interest is a two-way frequency-modulation short-wave system being designed by Daniel E. Noble for the Connecticut State Police. Surveys for the system were started last July and tests are now being conducted under the experimental police license W1XSP on 39.180 mc. A test f-m installation will be operated through the winter in the Hartford area to prove-out the system. Installation of 10 fixed transmitters, one for each patrol area, and 200 mobile two-way units will be made in the summer.

The possibilities of using facsimile for the transmission of various types of

[31]See "APCO Convention," p. 14, Sept., 1939, COMMUNICATIONS.
[32]"Complete Report of Frequency Allocations Committee," by R. L. Batts, p. 2, Dec., 1939, *APCO Bulletin.*

information, such as photos, maps, fingerprints, etc., have often been mentioned, as has traffic control by means of u-h-f, which would require special receiving equipment in all autos with the transmitters located at the various intersections. The use of aircraft, equipped with suitable radio apparatus, for locating and directing traffic, may be extended. This latter method of traffic control is most likely to gain prominence in the large communities. However, airplanes operating in conjunction with motor cars and motorcycles should prove a great aid for state police and seem likely to be widely used in the not too distant future.

Recording

This has been an active field for several years and should continue to expand for some time to come. The applications of recordings and recording equipment are almost too numerous to mention—certainly too numerous to discuss in any detail here. Rather we shall confine ourselves to equipments and general trends.

In both recording and reproducing equipments there have been great advancements during the past few years. Better control, refinements in technique as well as in disc materials, permit instantaneous recording of frequencies from 50 to 9000 cycles. Cutting heads as well as pickups have been simplified and improved considerably, giving better control in recording and more faithful reproduction. New devices to simplify and promote operation are being developed and it is probable that a number of such equipments will make their appearance during 1940. Predistortion, i.e., accentuation of high and low frequencies in recording and the rectification of this procedure in reproducing, is widely used.

New fields which show considerable promise for this year are home recording, and the supplying of sound for home movies by means of disc recordings. It is believed that several receiver manufacturers will introduce models which will permit the recording of programs, as well as events in the home—if prices are sufficiently low this should prove to be a very popular feature. The use of portable sound recording and reproducing equipment to add sound to 8 and 16 mm home movie cameras is also attracting considerable interest.[33]

In broadcasting there is also a trend of interest. Many programs are recorded at the time they are broadcast and the recordings put on the air over other stations at a later time. Many speeches, sporting events, etc., are also recorded and broadcast at a more convenient listening time. In all likelihood this use for recording will increase.

Public Address

Although unit sales for sets and tubes were higher in 1939 than for any previous year, this was not true of public-address equipment in general. In spite of the comparatively large amount of p-a equipment purchased for the two Fairs, sales figures were below the high mark set in 1937. This in spite of the fact that the new equipment is definitely superior, more compact and provides greater power output with less distortion. Systems have been streamlined and external appearance greatly enhanced as well.

However, we anticipate better sales during 1940 due to the national election. Another cause for optimism is the possibility of increased applications, many suggested by those at the New York World's Fair.[34] The great popularity (and low price) of the universal 6 volt-110 volt mobile units should give this trend additional impetus.

Materials

The international situation has had some effect on the supply of certain raw materials. In the main, however, there appears to be no great concern over such products, as the majority of the materials used for radio purposes are produced in this country. In some cases there have been increases in the price of imported goods, but as yet this has not been reflected in the price of receiver and transmitter components.

Plastics, an ever-expanding field, is finding more radio uses today than ever before. Not only have some very excellent plastic insulating materials been developed but their uses for knobs, dials, cabinets, etc., are ever increasing. This is especially true in radio cabinets where almost any color or color combination can be secured. With the pos-

[33]"Syncrosound System," by Ralph C. Powell, p. 12, Nov., 1939, COMMUNICATIONS.
[34]"Public Address and the New York World's Fair," by S. Gordon Taylor, p. 463, Oct., 1939, *Service*; "Radio At The Fair," by J. G. Sperling, p. 5, May, 1939, COMMUNICATIONS; The Polyphetor," by G. T. Stanton, p. 10, July, 1939, COMMUNICATIONS.

sibility of new and smaller receivers being produced, it is likely that plastic cabinets will be used for these units. One receiver manufacturer has already used a molded plastic chassis base which included sockets, trimming and padding condenser and insulated terminals. There is also a leaning towards plastic cabinets in college colors, in fraternity and sorority colors and for other specific groups.

Other interesting developments include a plastic material made from coffee beans, and a new plastic molding process using plaster of paris forms. This latter method might be used to produce samples more cheaply as well as for specific items where no large production is anticipated. It is also possible that new uses will be found for a recently developed elastic plastic.

Increasing use of the ultra-high-frequency channels will find more and more use for good insulating material of either the polystyrene or ceramic types, depending upon the specific application. With an increasing number of television stations, f-m broadcasters and other high-frequency services being placed on the air, the manufacturers of antenna insulators should be prepared for a very good year. Fiber glass insulation, announced about a year ago, is finding radio applications for insulated wire, resistor insulation, etc.

Powdered iron reduced from iron oxide has found some use as the core material in coils. This field may possibly expand, as considerable work is being done with powered metals. Magnetic alloys are also finding increasing applications in speakers. Much attention is being given to nickel, fluorescent powders, etc., in the construction of c-r tubes. In addition some of the rarer metals are employed as points on phonograph needles.

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BROADCAST CONFERENCE

(*Continued from page 7*)

Living Accommodations

The Fort Hayes Hotel has again offered special rates for the Conference. Rooms with twin beds and bath are available at $1.50 per night per person, and single rooms with bath are available at $2.50 per night. Those who wish reservations should so indicate on their registration blank.

Recreation

Members of the Conference have seemed to enjoy the gymnasium privileges extended through the courtesy of the Physical Education Department. The gymnasium and swimming pools of the University will again be available to members of the Conference. These facilities are among the best in the country including three pools, 6 handball and squash courts, badminton, basketball, volley ball, shuffle board courts and ping pong tables.

Free tickets will be available to members of the Conference who care to attend the basketball game with the University of Wisconsin on February 17.

The dinner will be held Thursday, February 15, and the banquet Thursday, February 22, both at the Fort Hayes Hotel.

Other opportunities for recreation and group discussions will be planned and announced at the time of the Conference.

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TELEVISION SYSTEM

(*Continued from page* 19)

vision receiver is shown in Fig. 14. The bridging arm is L with the same resistance, R_1, the two series arms are C and C, and if these are resonant at the rejection angular velocity, ω_r, then the shunt arm resolves itself into a pure resistance of value $1/\omega^2_r C^2 R_1$. If this be made of variable form for manual adjustment, a rejection ratio of 50,000 to 1 can be obtained in practice. Even in fixed form involving commercial tolerances, it will permit of rejection ratios of one thousand or over. The response curve for such a stage is shown in the accompanying diagram, and the sharp attenuation characteristic of this bridged T network is clearly in evidence

Another form of this network, as employed in an i-f stage, is shown in Fig. 15-A. This can be transformed into an equivalent network as shown in Fig. 15-B. The coupled inductances L_1 and L_2 can be transformed into an equivalent T with a negative mutual shunt arm, -M, and this, at any frequency will correspond to a capacitance. If the mesh composed of L_2 + M, C, I_3 and -M is tuned to the rejection angular velocity, ω_r, then L_3 and C will resonate by themselves at a higher frequency, and hence appear at the angular velocity ω_r as a capacitive reactance. The circuit therefore is of the same form as that of Fig. 14-A, and in conjunction with the proper resistive shunt arm, R, will exhibit a large attenuation ω_r. At other frequencies, however, it will react with the rest of the parameters of the stage in somewhat different manner, and with proper adjustment of all of these, a response as shown in the figure can be obtained. The two noteworthy features of this response is that the rejection frequency, at the low end of the pass band, is followed by a peak, which can be used to compensate the sloping characteristic of Fig. 14-B.

VII. Synchronizing Separator Circuits

One of the most interesting features

of the television system is the method whereby the synchronizing component of the video signal is "skimmed off" from the other components on an amplitude selecting or clipping basis, and then separated into the vertical and horizontal components by the respective processes of integration and differentiation. This is all done by relatively simple and cheap electronic and R-C circuits, and is possibly even more effective than more complicated and costly filters.

As may be noted from Fig. 16, the first "Synch Separator" tube receives the complete video signal, of negative polarity, from the second detector, and at least partially clips it in the manner described in Section III with reference to Fig. 5-A. For strong signals the clipping may be complete in the first half of this 6N7 tube, but usually only partial clipping occurs, as illustrated in Fig. 17-A. This clipping is facilitated by the use of only 34 volts on the plate. The second section of the 6N7 amplifies the clipped signal and also reverses its phase, so that it may be clipped completely in the same direction by the 6Y6-G second "Synch Separator" tube, and thus only the synchronizing signals made to appear in its output circuit. The plate voltage of this tube is even lower (7 volts). The action is shown in Fig. 17-B.

The output is fed to the two grids of another 6N7 double triode. In the left-hand grid circuit is shown a differentiating circuit, so that the grid voltage, hence plate output voltage, is of the form shown in Fig. 17-C. It will be observed that even when the broad vertical synchronizing pulse appears, the response is due solely to the steep sides of the "cut-ins" in this broad pulse. Thus horizontal synchronizing is maintained even during the period of vertical synchronizing.

The right-hand grid circuit is of orthodox character, and passes the synchronizing signal unchanged. The plate output circuit, however, contains a three-section R-C filter arrangement, which acts as a multiple integrating circuit. The output voltage across the first section alone is of the form shown in Fig. 17-D. It will be noted that the narrow horizontal synchronizing pulses have little effect on the circuit, whereas the broad vertical pulses produce a voltage of sufficient magnitude to trip the blocking oscillator in the vertical deflection amplifier.

VIII. Conclusion

A complex art, such as television, presents a great many interesting and perplexing problems to the engineer. Many still remain to be solved. Those solved will still be studied in the hope of obtaining even better and perhaps simpler solutions. It would be manifestly impossible to present all the latter problems and their solutions in a paper of this length, and so the writer has endeavored to choose those of greatest interest, and which have not been treated as thoroughly as they might in the previous literature. This may serve to explain the diversity of topics selected for this paper.

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VOLTAGE DOUBLER

(*Continued from page* 14)

ground point. For precise measurements, the small e-m-f due to the electron emission current flowing through R must be balanced out, as it approaches 0.5 to 1 volt in magnitude.

The indicating device to be used with the doubler voltmeter may consist of one of the following:

(1) A microammeter or a milliammeter in series with R.
(2) A d-c potentiometer with a galvanometer to indicate when a balance is obtained between the voltmeter output voltage and the voltage across the potentiometer terminals.
(3) A triode d-c amplifier, preferably of the degenerative type with zero balance for the meter.

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RADIO BEACON

(*Continued from page* 6)

let $F_m = 50$ cycles per second, then:
From (17) $f_d = 100$ cycles per second
From (18) $F_d = 200$ cycles per second

In Fig. 3-b it will be noted that there are periods of time near the maximum and minimum frequency limits of the frequency-modulation cycle during which one wave continues to increase in frequency after the other has started to decrease in frequency. During these periods, the difference in frequency between the two received waves is not constant nor equal to the correct value. In the case cited above, the maximum duration of these periods is

$$t_x + t_e = \frac{450 + 150}{3 \times 10^8} = 2$$

microseconds, while the period during which the difference frequency is constant is

$$t - (t_x + t_e) = \frac{1}{2\,(50)} - \frac{450 + 150}{3 \times 10^8} =$$
9998 microseconds.

The periods $t_x + t_e$ are thus shown to be so short as to have negligible effect on the operation of the frequency meter.

In the case cited, the frequency deviation Q of the carrier during modulation was taken to be 1.0 megacycle. In order that this variation of carrier frequency may transit the tuned circuits of the transmitter and receiver without variable attenuation which would produce appreciable amplitude modulation, the unmodulated carrier frequency of the transmitter should be at least 25 times the value of Q or at least 25 megacycles per second, in which case the frequency deviation is not more than ± 2 per cent of the mean carrier frequency.

The views expressed herein are those of the author and do not necessarily reflect the views of the Navy Department or of the Naval Service.

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TELEVISION ECONOMICS

(*Continued from page* 21)

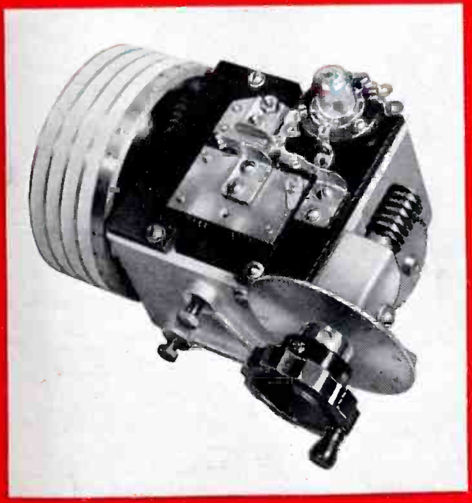
of rigid control of program costs on a basis appropriate to the new art, the avoidance of the expense of public viewing of studio operations, the training and utilization of highly skilled program producers whose product will appeal to the public, the establishment and maintenance of satisfactory relationships between television broadcasting groups and the motion-picture producers and exhibitors, the gradual reduction in cost and improvement in performance of television receivers, the development of simple and effective installation methods, the establishment of qualified servicing groups functioning speedily and on a reasonable cost basis, the education of the home audience in proper methods of placing the receiver, using it, and paying due attention to the program, the announcement of governmental policies favorable not only to the television industry but also to those whose enterprise may bring about the development of television, the continued manifestation of a courageous pioneer spirit in the radio industry and a determination on the part of that industry successfully to develop television broadcasting, and last, but not least, reasonably satisfactory economic conditions throughout the country.

Given all of the preceding favorable factors, television would doubtless become a phenomenal success and at an astonishingly rapid rate. Given a reasonable proportion of these factors, television may still be expected to reach a happy fruition.

(*To be concluded*)

Index to Advertisers

Coil assembly mounted on mycalex disc attached to switch system. Polystyrene coil insulation with unwound plug-in coil form for any additional frequency range desired; excellent electrical contact between silver-plated switch blades and contact springs.



Oscillator circuit built on Type 755-A high-frequency condenser; coil switch contacts mounted directly on condenser; 30 to 1 precision worm drive on condenser with 1500 divisions on main frequency dial; accuracy of setting better than 0.1%.

NEW Ultra-High-Frequency Signal Generator

THE development of ultra-high-frequency communication equipment for frequencies up to 300 Mc has been seriously retarded by the lack of satisfactory test equipment.

General Radio announces a new signal generator for use at frequencies between 7.5 Mc and 320 Mc. This signal generator has a number of unique mechanical and electrical features which include very compact oscillator circuit; unique rotatable coil system; new capacitive attenuator with alignment plates to present constant capacitance to the oscillator and eliminate changes in frequency with attenuator setting; very careful mechanical design and construction to obviate changes in calibration from mechanical shock.

The new signal generator features:

WIDE FREQUENCY RANGE:
in five steps from 7.5 to 320 Mc; unwound plug-in coil provided for any additional frequency range desired by user.

CONTINUOUSLY VARIABLE MODULATION:
from 0 to 60%. Internal modulation at 400 cycles ± 5%; external flat to 2 db from 200 to 20,000 cycles.

ADEQUATE OUTPUT VOLTAGE:
10 microvolts to 20 millivolts between 7.5 and 120 Mc.

COMPENSATED CAPACITIVE OUTPUT SYSTEM:
100 $\mu\mu$f capacitance with no attenuator effect on frequency; 90-ohm cable with 90-ohm termination supplied.

NEGLIGIBLE STRAY FIELD:
not noticeable with receivers of less than 10 μv sensitivity.

TYPE 804-A Ultra-High-Frequency Signal Generator...$350

● *WRITE FOR BULLETIN 524*

GENERAL RADIO COMPANY

CAMBRIDGE, MASSACHUSETTS

Branches in New York and Los Angeles