MAY, 1935

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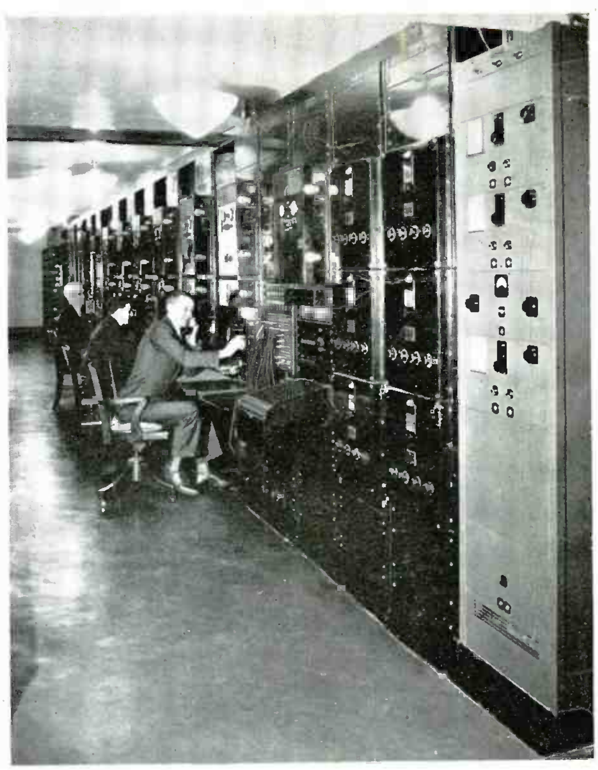

VOL. XV NO. 5

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DEPARTMENTS

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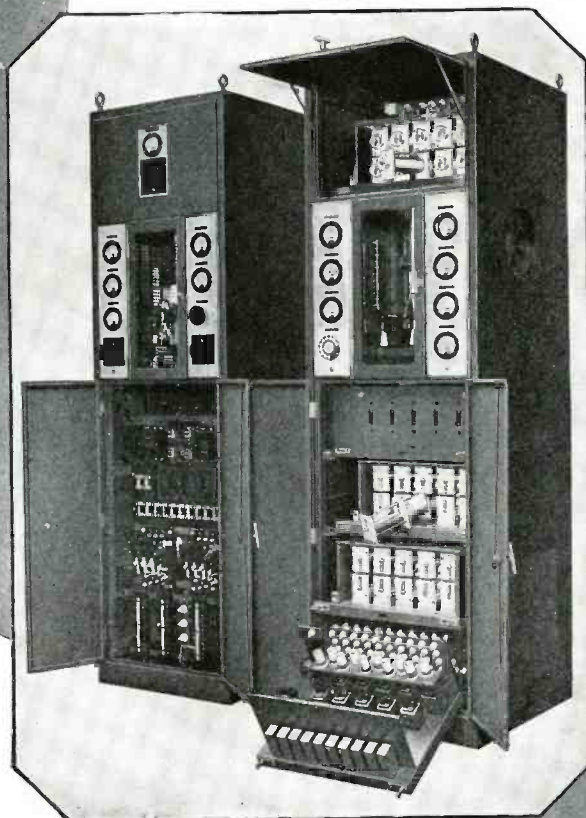

EDITORIAL

TELEVISION — II

THE STATEMENT ON TELEVISION, by David Sarnoff, President, Radio Corporation of America, made at the annual meeting of RCA stockholders, should be of particular significance to everyone in the radio field. The statement is significant because the action to be taken by the Radio Corporation will serve as a definite security against premature establishment of television services, and against exploitation.

Portions of Mr. Sarnoff's statement will bear quoting. The italics are ours:

"Our laboratory efforts have been guided by the principle that the commercial application of such a service could be achieved only through a system of high-definition television which would make the images of objects transmitted clearly recognizable to observers. The results obtained by RCA in laboratory experiments go beyond the standards accepted for the inauguration of experimental television service in Europe. We believe we are further advanced scientifically in this field than any other country in the world.

"In the sense that the laboratory has supplied us with the basic means of lifting the curtain of space from scenes and activities at a distance, it may be said that television is here. But as a system of sight transmission and reception, comparable in coverage and service to the present nation-wide system of sound broadcasting, *television is not here, nor around the corner*. The all-important step that must now be taken is to bring the research results of the scientists and engineers out of the laboratory and into the field.

"Because of the technical and commercial problems which the art faces, this system must be built in *progressive and evolutionary stages*.

"Considering these factors and the progress already made . . . the management has formulated and adopted the following three-point plan:

"1. Establish the first modern television transmitting station in the United States, incorporating the highest standards of the art. This station will be located in a suitable center of population. . . .

"2. Manufacture a limited number of television receiving sets. These will be placed at strategic points of observation in order that the RCA television system may be tested, modified and improved under actual service conditions.

"3. Develop an experimental program service with the necessary studio technique to determine the most acceptable form of television programs.

"Through this three-point plan of field demonstration we shall seek to determine from the practical experience thus obtained, the technical and program requirements of a regular television service for the home.

"It will take from *twelve to fifteen months* to build and erect the experimental television transmitter, to manufacture the observation receivers and to commence the transmission of test programs.

"Our research and technical progress may be judged by the fact that upon a laboratory basis *we have produced a 343-line picture*. . . . These advances enable the reception, over limited distances, of relatively clear images whose size has been increased without loss of definition.

"Important as it is from the standpoint of public policy to develop a system of television . . . *premature standardization would freeze the art*. It would prevent the free play of technical development and retard the day when television could become a member in full standing of the radio family. Clearly, the first stage of television is field demonstration by which the basis may be set for technical standards."

One of the problems to be faced is "the fact that if the new art of television is to make the required technical progress, there will be *rapid obsolescence of both television transmitters and television receivers*."

And thus is the future of television at least temporarily safeguarded. Mr. Sarnoff has definitely set a mark on the technicalities and the standards of service which must be met. Anything short of this mark will be doomed to failure.

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RADIO ENGINEERING

FOR MAY, 1935

RECEIVER BAND-WIDTH AND BACKGROUND NOISE

By C. B. AIKEN and G. C. PORTER
BELL TELEPHONE LABORATORIES

THE INTEREST IN high-fidelity broadcasting has called forth many comments on the problems associated with the radio transmission and reception of a wide band of frequencies. These discussions have pointed out that an increase in the background noise is inevitable when the width of the frequency band selected by the receiver is enlarged, but there does not seem to have been any quantitative realization of the seriousness of this effect. It might be casually supposed that, if the received band is doubled, the apparent noise level would increase about 3 db, since the noise energy brought in should be doubled. However, it is by no means simply a matter of energy, as the high-frequency components of noise may be very much more troublesome, from the standpoint of the listener, than the low-frequency components; and, hence, when we double the band-width, the noise level may seem to increase by a large amount. An experimental study has been made of this important effect, and it has been found that conditions are worse than had been expected. The results of this study are given in the present paper.

EXPERIMENTAL SET-UP

Fig. 1 shows a block schematic of the experimental set-up which was employed. This arrangement included a radio-receiving system the band-width of which could be adjusted by low-pass filters located in the audio-frequency output. A modulated signal was supplied to the input of the receiver, together with an adjustable amount of high-frequency noise. The noise was derived from a train of broad-band radio-frequency amplifiers connected in cascade, and was due to thermal agitation in the input circuits of the first amplifier. Noise of this type is uniformly distributed over the received band and is quite similar in character to the more or less steady "hissing" and "frying" noises which are heard in broadcast receivers. It was believed to be more generally satisfactory for a test of this kind than any other type of noise which might have been used.

OVERALL CHARACTERISTICS

The overall characteristics of the receiving system are shown in Fig. 2. These include the radio receiver, the audio amplifiers and the low-pass filters. The transmission characteristic of the transmitter was very nearly flat over the frequency range employed and was,

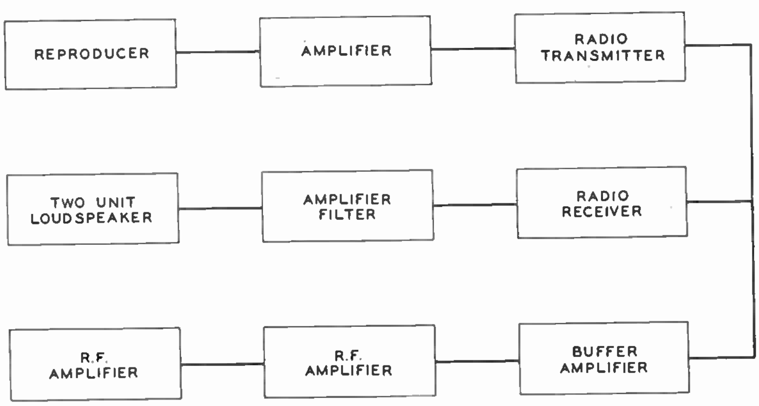


Fig. 1. Block schematic of circuits used in the study of background noise.

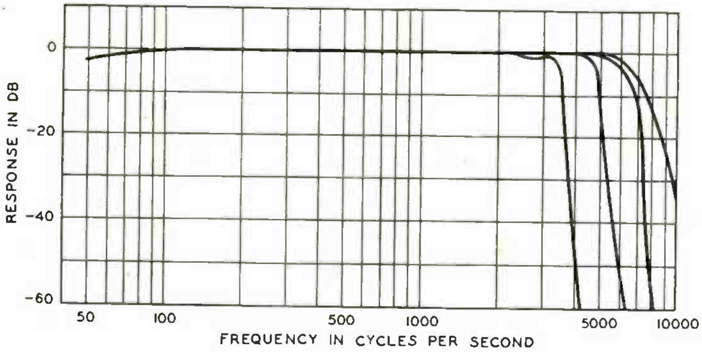


Fig. 2. Overall fidelity characteristics of receiving systems and low-pass filters.

in fact, better than that of the phonograph record from which the program was derived. The upper curve on the right shows the characteristics obtained at "full band," that is, without any of the low-pass filters cut in; while the other three curves are those obtained when one or the other of the three low-pass filters is in circuit. The cut-off frequencies of the filters may be taken as 3500, 5000 and 7000 cycles, while on the same basis the cut-off of the full band may be taken as 7500 cycles.

Two loudspeakers, the Western Electric 595B and 596A, were used. The first is a dynamic unit for the lower frequencies and the second a small horn for the higher frequencies. These were fed through appropriate filters and the two together were capable of reproducing frequencies from 60 to 10,000 cycles per second.

THE OBSERVERS

In order that reliable averages might be obtained, twenty observers were used in making listening tests. This group comprised sixteen men and four women, none of whom had any obvious defects in hearing. Audiograms were taken of twelve members of this group and it was found, as might be expected of adults chosen at random, that some had deficient sensitivity at high frequencies.

In order to give an idea of the auditory characteristics of the twelve measured observers Table I has been compiled. The figures represent the number of observers having a given hearing loss or gain, in the best ear, at each frequency. Data are given only for the best ear of each observer since it is inevitably the one used in making judgments.

FIRST TEST

As the first test there was determined the setting of the attenuator, in the noise-supply circuit, at which the thermal noise could just be detected by the observer above a very faint background noise which was present in the system. The absolute values of the attenuator readings have no significance, but it is the difference between the readings for various band-widths that is of interest. The observer was placed in every case about 12 feet from the loudspeaker. The audio-amplifier gain was 6 db above that used in the next test, which is described below.

The results of this first test are indicated in Table II. It will be observed that when a 3500-cycle band was employed the noise had to be 5 db louder, on the average, than when a 7000-cycle band was employed. This figure is only 2 db greater than that which would be predicated on a straight energy ratio basis.

The effect of changing the band-width from 3500 cycles to 7000 cycles can be calculated, using the data on the "average" ear and assuming that the noise energy per cycle is uniform at all frequencies. The result of such a calculation shows that the threshold of audibility should be changed by about 3 db.* The identity of this figure with that obtained from considerations of energy alone could not, of course, have been predicated. In fact, were the band to be doubled in another part of the range, i.e., changed from, say, 1000 cycles to 2000 cycles, a figure different from 3 db would result from theoretical calculations.

The difference between the experimentally determined value and the theoretical value which appears in the present case may be due to either or both of two causes. It will be noted from Table I that those observers whose ears were measured possessed considerably less sensitivity, on the average, at 4096 cycles than at 8192 cycles. This fact would be expected to make the frequencies in the neighborhood of 7000 cycles seem abnormally important to them. Since these people represent a fairly typical adult group, this result is of some importance.

The second factor which may contribute to the 5-db figure is that a certain amount of street noise was audible through the closed windows of the room in which the observations were made. This noise undoubtedly exercised the same type of masking effect as did the musical program used in the remaining tests.

SECOND TEST

The next test involved the determination of the minimum audible noise level in the presence of a musical program. Adjustments were made so that the loudest passage of the program gave a volume level, as measured at the amplifier output, of + 14 db (referred to 6 milliwatts). A musical selection of practically constant level was employed in order that conditions might be as uniform as possible. Had a record containing considerable level variations been used, the observer would have made his determinations during the softest passages and the results obtained would, therefore, have been similar to those shown in Table II.

The results of this test are shown in Table III. It is seen that the dependence of the apparent noise background upon band-width is here very much greater than in Table II. Reducing the band-width from full range to 7 kc caused a change of 1 db in spite of the slight difference between the two right-hand curves of Fig. 2. A change from full range to 5-kc cutoff caused a change of 4 db, and from full range to 3.5 kc resulted in the surprisingly large change of 18 db in threshold noise level. It is evident that the lower frequency com-

*This has been pointed out by Mr. J. C. Steinberg.

TABLE I

Frequency → DB	*64*	*128*	*256*	*512*	*1024*	*2048*	*4096*	*8192*
+15						1		1
+10	1	4		1	3	4		
+ 5	9	5	7	6	5	2	3	2
0	2	3	4	4	3	3	3	4
— 5			1	1		1		1
—10					1	1	2	1
—15							1	2
—20							1	1
—25								
—30							2	

TABLE II

Observer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average	Change from Full Band
Full Band	60	58	72	66	58	62	60	62	70	72	66	68	64	64	64	64	70	64	72	72	64.9	
7000	60	60	70	68	56	62	60	60	70	72	64	70	64	64	62	66	70	66	72	60	64.8	.1
5000	58	54	64	68	54	60	58	58	68	70	62	66	62	60	62	64	68	64	70	56	62.3	2.6
3500	50	52	60	60	52	58	54	56	66	68	62	64	60	60	62	62	62	62	70	54	59.8	5.1

TABLE III

Observer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average	Change from Full Band
Full Band	54	52	66	62	54	56	58	60	58	64	64	56	60	60	58	64	60	60	60	52	58.9	
7000	52	52	64	64	52	56	58	58	58	64	64	54	58	60	58	60	60	60	58	50	58	.9
5000	50	36	62	64	48	54	54	58	56	62	60	52	56	56	54	58	56	54	58	46	55.2	3.7
3500	32	26	44	46	40	42	42	40	40	48	42	44	44	44	40	44	40	40	48	34	41.1	17.8

TABLE IV

Observer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average	Change from Full Band
Full Band	20	20	20	20	20	20	20	20	20	20	20	20	26	20	20	20	20	20	20	20	20	
7000	16	15	18.5	16	16	18	18	18	18	18	17	19	18.5	18	18	18	18	18	19	17	17.6	2.4
5000	15	12	18.5	14	15	17	16	17	17	16	16	17	18	17	16	18	18	19	19	16	16.5	3.5
3500	12	12	17	12	14	16	12	16	15	14	15	14	15	16	18	16	16	15	18	15	14.9	5.1

TABLE V

Observer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average	Change from Full Band
Full Band	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
7000	14	15	18	14	14	18	17	16	17.5	16	17	18	17	17	14	16	18	18	19	18	16.5	3.5
5000	12	13	17	12	12	16	14	15	13	16	16	18	13	15	14	16	16	16	19	17	15	5.0
3500	8	10	16	10	11	8	11	14	11	15	11	11	12	13	14	14	13	12	18	10	12.2	12.8

ponents of noise are masked, to quite an appreciable extent, by the music, while the masking effect on the higher frequencies is very much less pronounced.

THIRD TEST

In order to show the effect of the magnitude of the noise itself, runs were made with the same music volume as before, but with a much higher noise level, nearly 40 db higher, in fact. The observer was allowed to listen to the noise at full band-width, with the music playing, for a few minutes and then the band was reduced and the noise level changed until the observer stated that the effect was just as unpleasant as before. Following this, the initial full-band conditions were restored for a moment and then the band-width was changed to 5 kc. Finally, a change from full band to 3.5 kc was made. The results are shown in Table IV.

This test is inherently more difficult than the two which preceded it, since it is rather hard for the listener to say just when two different conditions are equally obnoxious. However, it is felt that the average values obtained from 20 people are of considerable interest. With the strong noise level the dependence upon band-width is very much less marked than when the noise level is weak. In fact, the results are quite similar to those obtained in the determination of the minimum detectable noise in the absence of a program.

FOURTH TEST

As a fourth step, observations were made with the same initial noise level as in the case of the third test, but with the program level 6 db higher. Both noise and signal were then quite loud, but there was a greater spread between the two than before. The results, which are indicated in Table V. are intermediate between those of Tables III and IV, and show that changing from full band to 3.5 kc requires a change in noise level of 13 db to produce an equal degree of annoyance in the two cases.

CONCLUSIONS

From the results of this investigation, it is evident that background noise is sometimes a serious drawback in wide-band broadcasting. The effect of such noise varies widely from one set of conditions to another, but the following facts have been established.

If the noise level is extremely high, the damaging effect, from the standpoint of signal-to-noise ratio, of increasing the band-width from 3500 to 7500 kc is only slightly more serious than might be expected from energy considerations alone, and is, in fact, about 5 db. Of course it must be realized that when such high noise levels are encountered the great majority of set users would consider the reception to be intolerably bad.

If the noise level is low, as it should certainly be whenever an effort is made to employ high-fidelity reception, the dependence of the signal-to-noise ratio upon band-width is very much greater. In the extreme case a change from 3.5 to 7.5 kc will produce as much as 18 db change in the threshold audibility level of the noise.

In many cases the judgment of noise will be made at moments when the program level is well down and then the masking effect of the program will be less pronounced. Furthermore, the improvement in the quality of the program will, in some cases, at least, help to offset the unpleasantness of the increased background. There are many such uncertain factors, but it is undoubtedly safe to say that in doubling the received band-width we require an increase in field strength for satisfactory reception that is well over 3 db, and may even be of the order of 8 to 10 db.

TRANSMITTER POWER

This means a good deal in terms of transmitter power. If the public comes to enjoy high-fidelity programs even in the presence of considerable noise background, then perhaps existing powers will have to be increased by only a few db. On the other hand, if there develops a demand for high-fidelity broadcasting essentially free from extraneous disturbances, then a very considerable increase in broadcasting power is indicated.

One remedy that naturally suggests itself is predistortion of the radiated signal. If the higher modulating frequencies are considerably exaggerated at the transmitter, and if compensation for this distortion is made at the receiver, a very marked reduction in the high-frequency noise will result. However, the general utility of this procedure may well be doubted, for if we exaggerate frequencies in the range from 5000 to 7000 cycles, then, with the present frequency separation between channels, we greatly increase the interference in the adjacent channels. Should all of the broadcast stations in the country employ such a system, night-time interference on all channels would be very greatly increased, perhaps intolerably so. This being the case, it would seem that an increase in transmitter power must accompany the general utilization of high-fidelity broadcasting, if the noise-free service areas now existing are to be maintained.

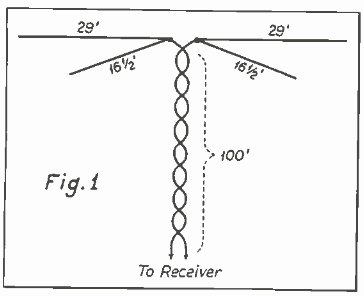
ANTENNA

By ARTHUR G. MANKE
Engineer
GENERAL HOUSEHOLD UTILITIES CORP.

● SYSTEM FOR ALL-WAVE RECEIVERS, PROVIDING MAXIMUM PERFORMANCE IN LOW- AND HIGH-FREQUENCY BANDS

THE USE OF THE doublet-type antenna has recently become very popular on all-wave receivers. The reason for this becomes evident when a short-wave signal-to-noise ratio test is conducted in which the doublet is compared with the usual single-wire antenna in a location having a rather high noise level.

Whereas a doublet of the type shown in Fig. 1 is a very desirable antenna for the higher frequency bands, it is a very short antenna for the lowest frequency band, especially when used as a doublet for reception in all bands. This difficulty should preferably be corrected—at least to the extent that it is economically feasible—in the band switch of the receiver, so as to utilize in the most efficient manner the entire length of wire used in the doublet antenna. A method of switching the doublet antenna which improves its overall effectiveness is described in the following paragraphs.



Typical double-doublet, with twisted-pair line, for all-wave reception.

DOUBLET EFFICIENCY

A four-band receiver is capable of covering a frequency range of .140 to 18.0 megacycles, or possibly the four ranges may be used to cover the frequency range of .54 to 25 megacycles. In either case the short doublet-type antenna, which makes an efficient and desirable antenna for the highest frequency range, may, in many locations, be sufficiently inadequate as an antenna as to cause a noticeable increase in the hiss level of the receiver when receiving signals on the lowest frequency band. Also, when the antenna circuit is arranged as shown in Fig. 2, which is common practice on the majority of receivers today, the primary of the antenna coil is shunted by an appreciable capacity existing between the twisted pair of lead-in wires. This capacity is in the order of 5000 mmfd for the usual one hundred feet of twisted pair commonly used to connect the doublet to the receiver. Although this 5000 mmfd does not act like a concentrated capacity, it is sufficient when shunted across the usual high-impedance primary of the lowest frequency band, to result in a further decrease in input signal at the grid of the first tube, thereby necessitating additional amplification in the receiver, when operating on the lowest frequency band.

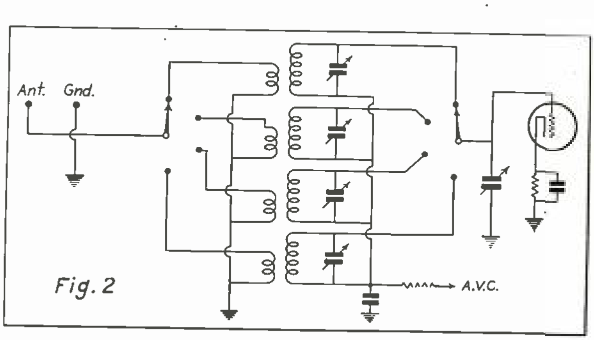
There is another effect which contributes to reduction of input at the grid of the first tube when the doublet is used as shown in Fig. 2. This is the detuning effect of the high capacity doublet. In production the receiver is aligned on the lowest frequency band with the standard dummy antenna of 200 mmfd, which approximates the capacity of an average single-wire antenna. When the doublet is used as shown in Fig. 2, the antenna coil does not track as perfectly as it would when used with an antenna having a capacity close to 200 mmfd. The extent of the mis-alignment due to the high-capacity doublet is of course largely dependent upon the design of the antenna coil.

CHANGING EFFECTIVE LENGTH

The conditions mentioned can be appreciably improved if the doublet is used as a single-wire antenna, thereby adding the twisted portion to the effective length of the aerial for the lowest frequency band. That is, the antenna circuit is changed so that both sides of the doublet act as individual wires connected to the high side of the antenna coil primary. Due to the resonant impedance of the twisted pair, many of the commercial doublet antenna kits provide one hundred feet of twisted pair, and in cases where this length is added to that of the horizontal portion of the doublet, there is a very appreciable increase in the effective length of the antenna when it is changed from a doublet to a single-wire type by the switching mechanism in the band switch.

The necessity of an aerial which is longer than the ordinary doublet for receiving signals on the lowest frequency band can easily be demonstrated in any location where the noise level is not too high. When a relatively weak station is tuned in using a short antenna, the receiver noise is usually noticeable in the background. This is because the receiver is operating near its maximum sensitivity and under this

Typical antenna band-switching circuit as used in all-wave receivers.



SWITCHING

condition, receiver noise is evident unless the particular receiver is very poor in sensitivity or has a very limited high-frequency response. Now if the length of the aerial is increased appreciably, and all portions of the aerial are exposed to the signal, then the longer aerial will produce a larger signal across the input terminals of the receiver and thereby reduce the sensitivity required to produce a given audio output.

THE SWITCHING SYSTEM

A simple and inexpensive method of utilizing the doublet to the fullest extent on the high-frequency bands and then switching it to act as a single-wire antenna on the lowest frequency band, is shown in the schematic of Fig. 3. The switch is shown in position No. 1, which is the highest frequency band. The four terminals, "J," "A," "D" and "GRD" are arranged in a convenient manner on a terminal strip. A jumper connection is provided and is placed from "J" to "A" when a doublet is used. The doublet is connected to terminals "D" and "A" and the ground wire to the terminal marked "GRD." There are, of course, many different ways of accomplishing the same doublet connections, and since this method is as economical as any other switching system the writer has used, it will be described in detail.

An inspection of the diagram shown in Fig. 3 will reveal how both sides of the doublet are connected directly to each primary for switch positions 1, 2 and 3. However, for switch position No. 4, both sides of the doublet are connected to the high-potential side of the antenna-coil primary, thereby converting the doublet into an effective single-wire antenna of a length equal to the lead-in plus the horizontal portion. This is accomplished when wiper lug "D" makes contact with switch contact 4'. This switch contact is always connected to terminal "J" of the terminal board and for the case where the doublet is used the "J" terminal is connected to "A" by means of the jumper.

It is important to note that the doublet is provided with a leakage path to ground for static charges on each of the high-frequency bands. This leakage path occurs through the lower frequency primary to ground, yet neither side of the doublet is at ground potential for high-frequency currents.

RESONANT FREQUENCIES

When the switch is in position 2, 3, or 4, there are higher frequency primaries connected to the antenna or doublet. This, however, does not cause any interference, since the secondary and its associated trimmer of any of the higher frequency coils cannot tune to an operating frequency which falls in the lower frequency band. The reason for this is readily explained by considering the total minimum capacity of the tuning condenser plus the additional capacity of the switch and wiring. When these capacities are removed from the higher frequency secondary by the process of changing bands, this secondary with its associated trimmer will be resonant to a frequency considerably higher than that of the adjacent lower frequency coil with tuning condenser at minimum, unless an unusually large overlap in range occurs between the two bands.

There is another possible interference consideration due to the presence of the unused primaries of higher frequency coils, and this is the natural period of these coils. However, with coils of good design, the natural period of any primary is higher in frequency than the band over which it is used and therefore this possibility of absorption interference is also eliminated. The capacity of any of these higher frequency primary coils to ground is small, so there is no appreciable loss of signal due to the capacity to ground of the unused coils.

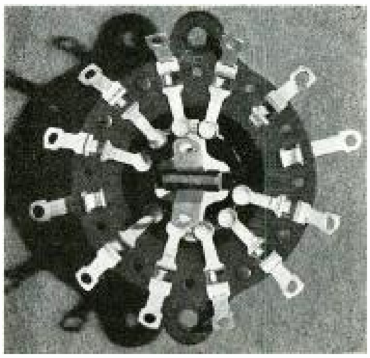


Fig. 4. Illustration of the switch, modified for use in the circuit shown in Fig. 3.

JUMPER CONNECTIONS

In some installations where the lead-in passes through a location having an exceptionally high noise level, it is sometimes desirable to retain the doublet connection for all bands. Where this is preferable, it is readily accomplished by changing the jumper connection at the terminal board.

For the case of a single-wire antenna, the jumper connection at the terminal board is from "D" to "GRD." By tracing the diagram of Fig. 3 for this jumper connection, it is seen that the antenna and ground connections are made directly to the terminals of the particular coil in use.

THE SWITCH

The above described switching of doublet or single-wire antenna can be accomplished with practically no additional cost over that of the conventional switch. A popular switch, with the proper modification, is shown in Fig. 4. The lower contacts are used for the primaries and the upper contacts are used for the secondaries. The wiper arm, marked "D" in Fig. 3, is the lug riveted to the movable center portion of the switch and precedes the regular contact. In the top half this same lug is provided and is equally useful. In this case, it follows the regular contact and is used to short the adjacent lower frequency secondary.

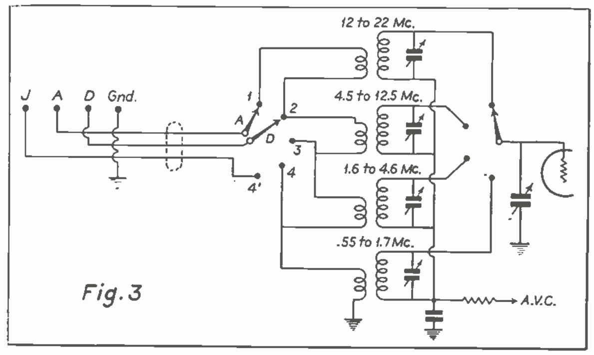


Fig. 3

The switching system described in the accompanying article.

Compact Class B P-A Unit

By HUBERT L. SHORTT

Chief Engineer

WHOLESALE RADIO SERVICE CO., INC.

THERE IS A SPECIFIC demand in the public-address field for a 100-watt amplifier, for use at ball parks, college stadia, airports and other places where sound intelligence must be conveyed to large crowds and where a high local noise level prevails. However, the sound specialists who sell, install or rent such amplifiers do not want to spend more than $100 for the amplifier unit proper.

Just how and why this arbitrary scale of a dollar per watt came to be established no one knows, but if the large number of letters received by the writer's organization is any indication, it certainly does exist.

When prospective customers with money to spend want something, a manufacturer's sales manager makes quick representations to his engineers. When the assignment was handed to the writer, he made a detailed study of various amplifier arrangements, spent several weary months on experimental designs and finally emerged from the laboratory with a 100-watt amplifier that seems to fill the requirements. As it involves a few unusual features, a description of it may be of interest.

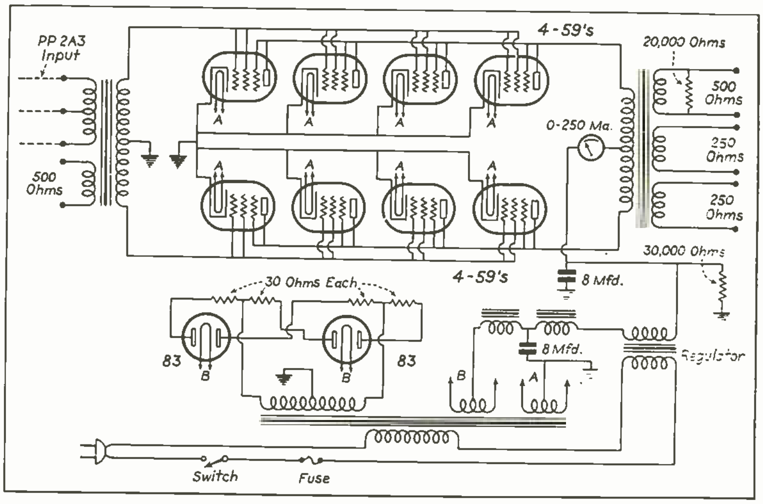


Fig. 2. Circuit of the 100-watt amplifier and power supply.

CLASS B FAVORED

For all-around effectiveness at high audio levels, the Class B method of amplification was found to be best. Engineers who wince at the mention of Class B must not let the disastrous results of early Class B attempts blind them to the true possibilities of tube operation in the positive quadrant. We know now that we did not always, in the past, satisfy the requisites of Class B; namely, an extremely low resistance, well-regulated plate supply, a driving source of correct power and impedance, and proper input and output transformers.

Class B components simply cost more than ordinary parts, and there is no escaping the fact. Roughly, a satisfactory input transformer for low-power Class A Prime costs about 40 cents; a corresponding transformer for Class B about $1.25. Class B has a poor reputation in some quarters merely because many engineers and manufacturers of sound equipment have refused to acknowledge this price differential and have attempted to use inadequate units for high-power amplifiers.

Fortunately, the ratio of the cost of Class B components to power output is not a linear function, the cost per watt decreasing as the power output increases. Even so, 100-watt amplifying transformers for Class B cost plenty, but no compromise with quality can be tolerated at this point.

TRANSFORMER CONSIDERATIONS

Two important considerations in regard to the output transformer must be observed—its insertion loss and its leakage reactance. An insertion loss of 2 db, which is considered acceptable in lower power amplifiers, is not acceptable at a 100-watt level, as this means we would have to deliver 158 watts into the primary in order to get 100 watts into a 500-ohm line. About the lowest insertion loss we can expect is 1 db, which means a loss of only 25 watts.

The leakage reactance must be kept very low to prevent dynatron oscillation from occurring in the plate circuit. This is a distressingly common trouble in Class B amplifiers and is altogether overlooked by many design engineers.

Some idea of the size of the output

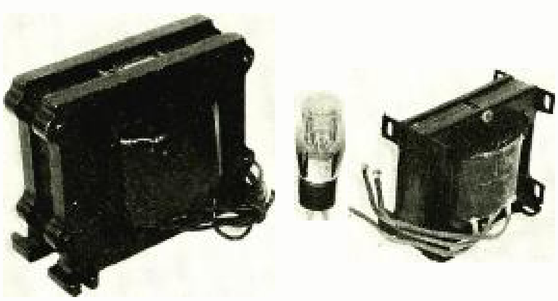


Fig. 1. The 100-watt output transformer, left, compared with a type 30 tube and with a "mis-rated" 100-watt transformer, right.

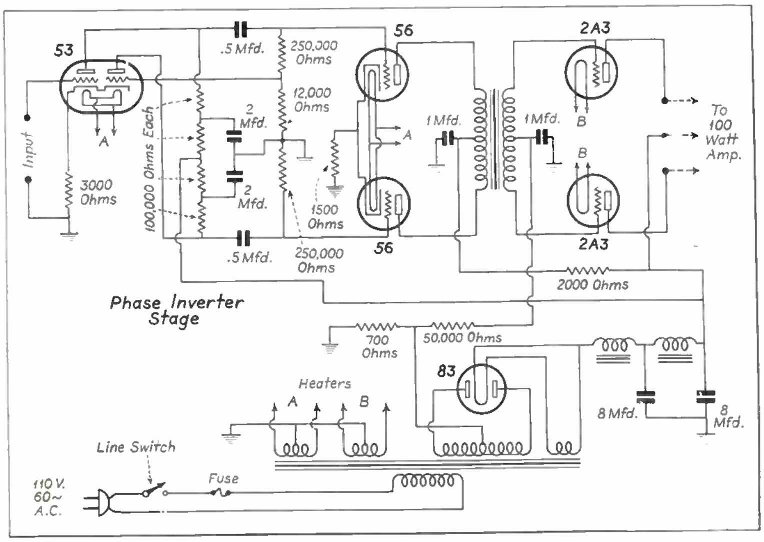


Fig. 3. Circuit of the driver amplifier and power supply.

transformer finally developed for the desired 100-watt amplifier may be obtained from the illustration of Fig. 1, which includes a type 30 tube for size comparison. On the right is a so-called "100-watt" output transformer used in a much mis-rated 100-watt amplifier. The writer would consider this satisfactory for about 25 watts, but not more. The real 100-watt transformer, on the left, measures 7¼ by 5½ by 5 inches and weighs something like 20 pounds!

TRANSFORMER AND CHOKE RESISTANCE

Since no saving in cost could be effected in the critical transformers without impairing both the level and the quality of the output, the situation as regards the power supply and the tubes was considered next. Since the plate current in Class B amplifiers swings over a large range, the resistance of the power transformer windings and of the filter chokes must be very low; otherwise, the IR drop causes the plate voltage to drop, and in turn creates a high order of distortion. It isn't practicable merely to use low resistance, low inductance chokes; the filtering action is then inadequate and the hum level is high, so nothing has been gained.

VOLTAGE REGULATION

Examination of the schematic diagram of Fig. 2 will reveal the nature of the highly successful means of stabilizing the output voltage to the unprecedented value of 95 percent regulation. On the same core with one of the filter chokes is wound a separate reactor, which is connected in series with the primary of a special power transformer. As the plate current requirements of the Class B tubes increase, the rising current through the choke increases the core saturation, thus lowering the reactance of the supplementary coil. This lowered reactance, in turn, boosts the emf across the primary, which gives more output in the secondary to the filter system. Some pretty delicate calculating was done on the respective values of the filter, reactor and trans-

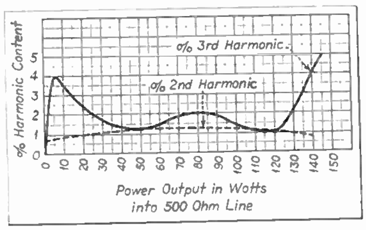


Fig. 4. Harmonic content at various levels into 500-ohm line of the 100-watt amplifier and 12-watt driver.

former windings, and in actual operation the automatic control works perfectly.

TYPE 59 TUBES USED

Since the cost of the tubes for a 100-watt audio amplifier may readily be a healthy portion of the total, the possibility of using ordinary receiving type tubes was investigated. Transmitting type tubes of suitable power rating naturally suggested themselves first, but their cost is high and they require high plate voltages, with attendant filter troubles. A push-pull parallel arrangement using eight type 59's, which are quite low in cost, was found to be altogether satisfactory. The tubes need no grid bias and there is no mess with separate bias rectifiers or batteries. The whole 100-watt amplifier, in spite of its imposing output, is exceedingly simple and is absolutely free of "bugs."

THE DRIVER

The diagram of Fig. 3 shows the recommended driver, a 12-watt unit using two 2A3's in the output. The low plate impedance of these tubes makes them ideally suited for the purpose. Harmonic content and frequency response curves are given in Fig. 4. The technical characteristics of the system may be stated as follows:

Peak output ....180 watts
Maximum output into plate load ....125 watts
Maximum output into 500-ohm line ....100 watts
Harmonic content, 100-watt unit only ....3 percent
Harmonic content, 100-watt unit plus recommended 12-watt driver ....5 percent
Gain of 100-watt unit only...14.3 db
Gain of 100-watt amplifier plus recommended driver... 95 db
Hum level of whole system —50 db below max. output
Power consumption of whole system ....460 watts.

The complete 100-watt amplifier, illustrated in Fig. 5, is designed for either rack or cabinet mounting. It measures only 19 by 12 by 10 inches overall, but its weight is 122 lbs, which gives some idea of the amount of iron in it.

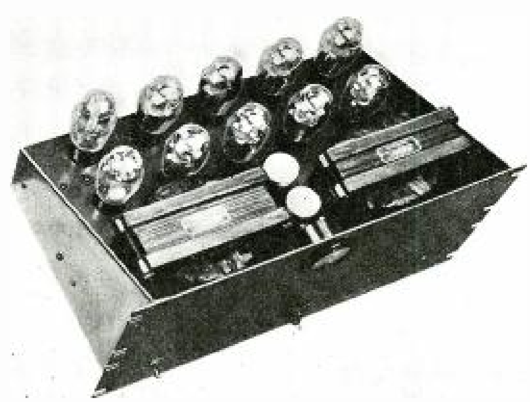


Fig. 5. The Lafayette 100-watt audio amplifier and power unit for rack mounting.

Radio Advances in Germany*

By C. T. ZAWADZKI
VICE-CONSUL, BERLIN, GERMANY

ALTHOUGH NO startling changes were introduced at the last German Radio Show, the new German receivers are superior to those of the previous season in that they possess better and higher selectivity as well as extreme ease of manipulation. Additional progress is represented by several universal sets. An increase in long-range sensitivity was also attained through the use of new tubes, the iron-cored coil, and new insulating materials.

VACUUM TUBES

Numerous sets working on the superheterodyne principle came on the market in Germany during 1933. Various difficulties were met with, however, in trying to have the generation of the oscillator frequency and intermediate frequency remain uninfluenced by fading compensation. These difficulties are said to have been overcome by the introduction of new tubes in which the generation of oscillator frequency, and the mixing of the incoming high frequency, was totally independent of fading compensation. This was accomplished through the octode and the new fading-mixing hexode. Inasmuch as fading compensation depends upon the method of rectification used, a practical solution was reached by the use of the so-called binode tube. It has been found, however, that it is preferable not to combine the rectifying elements in one glass bulb with an audio-frequency amplifier tube, as is done in the binode, but instead to have a separate rectifier. The result has been the so-called duo-diode, a rectifier tube containing two anodes but only one common cathode. A further gap in the series of dc tubes existed in the lack of a power tube of 2 to 3 watts output. This want has been filled by the development of a new output-pentode tube. In view of the great interest manifested by foreign countries in the automobile receiver, all new tubes have also been designed for filament voltages of 6.3 and 13 volts.

In the way of new tubes, an ac octode, fading-mixing hexodes for direct and for alternating current, the new duo-diode for direct and alternating current, and a new dc output pentode have been brought out for the German market. In addition, there are tubes with several systems united under a single glass bulb and designed for dc or ac use, for instance: A universal screen-grid detector tube combined with output pentode for one-circuit receivers; a universal screen-grid detector tube with diode and output pentode for two-circuit receivers with reflex connection; a universal tube with mixer, oscillator, and intermediate-frequency amplifier tube for superheterodynes; and a universal tube with high-frequency pentode, screen-grid detector tube, and output pentode for two-circuit straight sets.

Among the universal tubes, the following are manufactured exclusively for sale abroad: High-frequency pentodes, a duo-diode, an octode, two types of output pentodes, and two half-wave rectifiers.

These new tubes impart to the new sets markedly stable working qualities, especially when fading compensation is desired at the same time, particularly in superheterodynes. Some of the new tubes possess additional desirable features, such as high internal resistance causing only a feeble damping of the oscillating circuits, thus resulting in better selectivity.

The selectivity and long-range sensitivity of the receivers have been further raised, however, by the employment of totally new insulating materials, and of the iron-cored coil.

IRON-CORED COILS

This is a small coil with an iron core. While the air filling the inner space of air-cored coils has a permeability of 1, it is about 8 for the iron core of the new coil.

The iron-cored coil is as a rule used only for the broadcast-wave range. With long waves, its advantage over a good air-cored coil is not great enough to justify its higher cost. With short waves, on the other hand, the losses in the iron core become so large as to offset the saving of losses in the winding and screening.

The core material consists of finely divided inter-insulated soft-iron particles. The core is made either by applying a coating of iron paste to a paper ribbon and rolling the paper up into a spool, or by molding the mass under high pressure. In the latter case, the correct pressure must be very accurately maintained, for if it is too low then the individual iron particles are not spaced close enough to obtain the required high degree of permeability, while if the pressure is too high, the thin insulating skin of the particles is liable to become injured, with resulting increased losses. An advantage of the iron-cored coil is that it is indifferent to changes in atmospheric humidity, temperature, and direct-current loading, as well as to the frequency of the impressed oscillating current.

INSULATING MATERIALS

The air-cored coil would not have been used by the Germans in the long-wave band this year if it had not been possible to find new insulating materials, distinguished by very low losses, for the coil bodies and the wire insulation. The materials available today for coil bodies, i.e., "Trolitul," "Amenit," and "Ultra-Calan," have very low-loss factors; the loss factor of the Hescho product "Ultra-Calan" is but one-fourth of that of "Calan," which was the best insulating material last year, and but one-fifteenth of that of vulcanite. As far as wire insulation is concerned, a material far superior to silk, wool and varnish is said to have been found in a special hard paper.

It may be mentioned that all tube sockets in Germany will probably soon be made from the new ceramic materials. As a matter of fact, a large proportion of the tube sockets now used in German radio receivers already consist of them.

CONDENSER INSULATION

These new materials are now also used for insulation in variable condensers, while entirely new materials have been evolved for the dielectrics, namely "Condensa C" and "Kerafar." These new materials combine a very low-loss factor with a dielectric constant as high as 80. What this means can best be grasped by a comparison with mica, which has a dielectric constant of but 8

*Provided by Andrew W. Cruse, Chief, Electrical Division, U. S. Department of Commerce.

DETAILED REVIEW OF RECEIVER TRENDS IN GERMANY, TOGETHER WITH DATA ON ENGINEERING DESIGN AND NEW MATERIALS AND COMPONENTS BEING PUT TO USE IN HOME RECEIVERS.

to 10. Even this, however, is not the most important gain, which is rather to be found in the extraordinarily high mechanical strength of "Condensa" and "Kerafar." This latter fact is reflected by the great simplification of assembly and increased dependability of operation of the condensers. These new dielectrics are principally used in block condensers, the silver covering being fused on the small plates, which are then bedded in trays, usually of "Ultra-Calan." Variable condensers with fixed dielectric elements made from the new materials, however, are also in use.

The importance of the new condensers in modern German radio-receiver construction is particularly marked in superheterodynes and in straight receivers with band-pass filters.

SHORT-WAVE RECEPTION

The new German insulating and dielectric materials have greatly improved short-wave reception and it has been possible to obtain excellent short-wave reception, even with the new one-circuit sets, something which was quite impossible even last year. In the superheterodynes, short-wave reception has also been bettered by the new tubes. The quality of short-wave reception has in general been raised in all German sets this year, although they are still behind standard American all-wave sets in this respect.

TONE CONTROL

Almost all of the new German radio receivers have been improved as far as the ease of handling is concerned. As an example, tone control of different types has been embodied in two-tube, one-circuit sets, frequently by the use of the differential condenser for this purpose. The radio listener is no longer compelled to use the reflex circuit for regulating the sound volume, which he can leave set at the receiver's sufficiently selective point. A further gain achieved is the possibility of obtaining low volume even with very strong input—something impossible in German sets during the past years.

TUNING SCALES

Although the American airplane dial has not made its appearance in German radio sets, great improvements have been made in the tuning scales, particularly in the way of clearer arrangement. The station names are arranged either alphabetically, as in the A.B.C. scale, or by countries, as in the land scale, or else by nations. In this connection, an interesting feature has been introduced by a certain manufacturer whereby only the stations of the sought country are heard upon rotating the scale. Another improvement, from the German viewpoint, is a synchronous scale which only shows the station names, while the wavelengths appear on a separate scale. A further novelty is the cine-scale, in which the name of the station is projected in large and clearly legible letters on a ground-glass screen by a small projector built into the receiver. An interesting aid in turning the tuning scale has been created in the shape of the flywheel (gyroscopic) scale. In this device, the scale shaft is connected with a flywheel, to which it only is necessary to impart a light impetus to cause it to continue turning the scale and save the tiresome operation of rotating the scale by hand.

ONE-CIRCUIT SETS

Among the one-circuit sets, the People's Set (Volksempfaenger) occupies a prominent position. Interest in this set, costing about $31, has been very pronounced, so that the eighth and ninth hundred thousand are now to be built. This model is available in three basic types, one for ac, one for dc, and one for battery operation with anode-current saving connection. Its performance, however, cannot be compared with that of the average American "midget" set.

Most of the German one-circuit sets have a built-in blocking circuit, some of them even for a range of wavelengths extending from 200 to 2,000 meters. A few of the one-circuit sets are equipped with iron-cored coils. The "Aero-pilot" by Ehrich & Graetz has a loudspeaker of fivefold efficiency giving large and undistorted sound output. Almost all new one-circuit sets are, moreover, provided with a very strong output tube of 9 watts anode dissipation.

A remarkable specimen of one-circuit receivers is the Lumophon "Markgraf," which must be classified as a two-tube, two-circuit receiver of the reflex type except that the input circuit cannot be tuned, with the result that one variable condenser is eliminated. In consequence, the selectivity and long-range sensitivity are lower than with the corresponding two-circuit set, although the receiver is superior in that respect to the usual one-circuit sets. The connection employed also offers the possibility of calibrating the set, without the calibration being affected by an altered antenna coupling.

TWO-CIRCUIT SETS

The German two-tube sets are of the reflex type, inasmuch as the first tube is used twice. The first tube is either a high-frequency pentode or a hexode, but some sets have a duo-diode in addition.

If there is no duo-diode tube, the high-frequency input from the antenna is taken to the first tube via a tuning circuit; the amplified high frequency then passes to a second tuning circuit and thence returns to the first tube to be rectified, the rectified audio-voltage being conducted to the output tube. Where a duo-diode is provided, the amplified high frequency passes from the second tuning circuit into the duo-diode, in which it is rectified. The audio-frequency voltage thus obtained is returned to the first tube and thence passes to the output tube. Both connections have equal selectivity and long-range sensitivity; the system containing the duo-diode may, however, be more severely loaded, so that there is always a very clear reception even from a very powerful broadcast station.

Two German sets deserve special mention since they depart from the customary, namely, the "Rienzi" by Nora and the "Trixor" by Koerting. Both sets have so-called electron coupling which is characterized by readily lending itself to giving especially good selectivity. In the Nora set, the regeneration is not manually controlled, so that the handling of the set is simple all the way through. In the Koerting set, the regeneration is adjusted manually, but this is easily done because the regeneration does not affect the wave setting or adjustment of the tuning scale for a station, as is the case with most other methods of connection.

FOUR-TUBE, THREE-CIRCUIT SETS

The new German four-tube, three-circuit sets have the same selectivity as last year's three-tube superheterodynes, but possess higher long-range sensitivity. They are mostly equipped with waveband filters, as is also the case with some one-tube, two-circuit sets. The good selectivity is due to the presence of these filters.

SUPERHETERODYNES

The number of German superheterodynes shows an extraordinary increase this year. A wholly new creation is the three-tube reflex super, in which the tubes are also repeatedly utilized. Here, also, sets with and without duo-diodes are on the market. The three-tube reflex super works partly with the new fading-mixing hexode tube, or with the new octode as a mixing tube. Either tube gives practically the same performance. German receivers equipped with the duo-diode are, however, somewhat superior to those without duo-diode because of the better fading compensation obtainable with them.

Most of the three-tube superheterodynes are also arranged for short-wave reception. In all of these sets, special measures, consisting in particular in built-in absorption wave traps and in correct choice of the intermediate-frequency, take care of suppressing the generation of whistling sounds in rotating the tuning knob. Short-wave reception with the new three-tube superheterodynes is regarded as ideal by German radio engineers.

The German four-tube superhets represent peak products of the domestic radio industry. All of them contain a high-grade arrangement for eliminating fading and for suppressing noise in turning the tuning scale from one station to the next. This device is known in Germany by the designation of "crack killer." Visual tuning adjustment is provided in many of these receivers, whereby the station can be accurately set by eye when it would not always be possible to do so by ear. Most of these sets are also equipped for short-wave reception.

A feature of interest in the "Ideal 4W9" is that it has two band filters, each consisting of three single circuits. This arrangement gives markedly good reproduction of high and low notes, coupled with excellent selectivity. In addition, there is provided a device for broadening the band width of the filter when strong stations are being received without interference from feeble stations, so that the high notes get through particularly well and reproduction becomes very natural. The same arrangement is found in the Stassfurt five-tube "Imperial 64" super, which is considered by many to be the best German radio set.

FIVE-TUBE SUPERHETERODYNES

These superheterodynes are all equipped with visual tuning adjustment and many other valuable features. Among them, the "Imperial 64," besides having the above-mentioned band-broadening device, is conspicuous by the provision of two loudspeakers incorporated in the cabinet and specially constructed, respectively, for high and low notes, with consequent perfect reproduction of high as well as low notes.

BATTERY AND SPECIAL SETS

Battery sets are built by Brandt, Nora, and Orwin. Brandt has brought out a one-circuit set with short-wave reception. The Nora firm produces, among others, a four-tube, two-circuit set of entirely modern design with a connection which makes spare use of the anode battery. Orwin builds a two-circuit set with iron-cored coils and an anode-current economizing Class B amplifier.

Among special receivers are several Telefunken products. One of these is the "Kamerad," a high-grade special superheterodyne for collective reception. Two others are a special superheterodyne for short-wave reception, and the new car-receiver, which is a four-tube superheterodyne with rectifier for generating the anode voltage from the starter battery.

LOUDSPEAKERS

In the loudspeaker field, several items are worthy of notice. Koerting has brought out the "Maximus Minor," a moving-coil loudspeaker of sixfold efficiency and a capacity of 12 watts. Telefunken, Grassmann, and Lenzola make loudspeakers with non-deflecting conical diaphragm, which does not give off octave tones with large sound volume. In permanent-magnet moving-coil loudspeakers the German radio industry now makes use of the excellent Oerstit iron, which results in higher loading and better efficiency. A wholly new loudspeaker for speech transmission over great distances has been brought out by Eugen Beyer. This is a horn-type instrument in which an emergent stream of compressed air is modulated by a tube in accordance with the rhythm of speech. This design has the advantage of rendering the tones uniformly audible, laterally of the loudspeaker as well as perpendicularly to it.

AMPLIFIERS

In the amplifier field there are several new Class B amplifiers for up to 20 watts by Telefunken and a new dc push-pull output stage of 4.5 or 9 watts output by Koerting, which is remarkable for ease of handling and consumes only 75 watts. The same firm manufactures, in addition to its remaining large line of amplifiers, a new and inexpensive three-stage amplifier designed for universal use.

TENTH ANNUAL IRE CONVENTION

THE TENTH ANNUAL CONVENTION of the Institute of Radio Engineers will be held at the Hotel Statler in Detroit on the first, second and third of July.

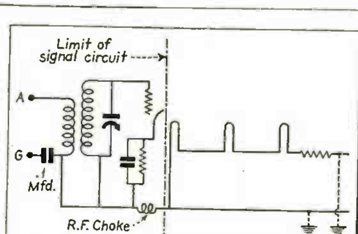
This year a booth show rather than a room show will be held. It was decided to do this because of the large number of requests for that type of exhibition. Booths will be assigned in the order in which contracts are received.

An exceptionally interesting series of technical papers are anticipated at this convention.

LINE NOISES IN UNIVERSALS

IN THE DESIGN of the small ac-dc receivers, engineers often miss a point in regard to the elimination of line noises.

Practically all sets of this type use no direct ground connection; thus the capacity or direct ground through the line places the noise voltage in series with the signal voltage.



This point may not be so evident when universal receivers are operated in localities where large signal voltages are available, but in localities having low signal voltages and/or high noise levels, the situation becomes serious.

Tests indicate that about 75 percent of the noise induced in a universal-type receiver may be eliminated by the introduction of a suitable r-f choke in series with the signal input circuit and the supply circuit, as shown in the accompanying diagram.

E. G. Montoux.

RADIO LICENSES IN NEW ZEALAND

THE POST AND TELEGRAPH Department of New Zealand has announced that a total of 147,427 paid radio receiving licenses have been issued up to Dec. 31, 1934. This is a great advance over the figures of a year ago, at which time only 112,284 paid licenses had been issued, according to March 25, 1935, *Electrical Foreign Trade Notes.* The distribution of these licenses was 44,980 in the Auckland district, 55,316 in and about Wellington, 27,010 in Canterbury, and 20,121 in Otago. The grand total of all licenses at the end of 1934 was 149,798, as against 114,535 a year ago. (*W. W. Hoffman, Vice-Consul, Wellington.*)

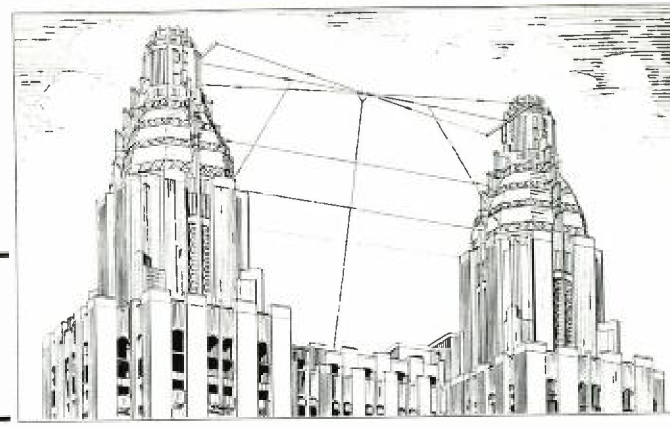


FIG. 1. THE TRIPLE-DOUBLET ALL-WAVE ANTENNA SYSTEM AS INSTALLED BETWEEN THE TOWERS OF THE WALDORF, 660 FEET ABOVE STREET LEVEL. THE THREE BOTTOM WIRES SERVE PRIVATE RECEIVING SETS AND THE BROADCAST BAND FOR THE WALDORF'S PROGRAM DISTRIBUTION SYSTEM.

TRIPLE-DOUBLET
For All-Wave Reception

WITH THE ADDITION of new short-wave receiving equipment to the radio system already in use, what is probably the world's largest all-wave radio-receiving system was put into operation this month at the Waldorf-Astoria Hotel, New York City.

The radio system operated by the hotel since its opening, covers the ordinary broadcast band of 550 to 1500 kilocycles.* This system makes available to the 2000 private rooms, banquet halls, ballrooms, and the like, a continuous selection of six programs composed of radio broadcasts, recordings, and public affairs taking place within the building. To this service the new Western Electric installation has added the entertainment to be derived from the 2200- to 25,000-kc bands.

* See page 7, January, 1932, PROJECTION ENGINEERING; page 187, February, 1932, BELL LABORATORIES RECORD; and page 22, April, 1932, PROJECTION ENGINEERING.

THE ANTENNA SYSTEM

The hotel's complete antenna system is shown in Fig. 1. The antenna installation for the short-wave equipment, which has been designed by the Bell Telephone Laboratories, consists of the three upper strands of wire strung between the two towers and the vertical, twisted-pair lead-in. It will be noticed that two of the strands are crossed in the form of a large "X" while the third aerial represents to a certain degree an inverted "U." This has resulted in three doublets of different lengths and therefore different points of resonance; namely, 3000, 6000 and 12,000 kc. Odd multiples of these frequencies, such as, 9000, 15,000, 18,000, and 21,000 kc, also represent points of high pickup efficiency. Further, by means of special design, the twisted-pair lead-in has been made to act as a fourth antenna. An interesting chart indicating how this antenna system covers the short-wave band is shown in Fig. 2.

The three bottom strands shown in Fig. 1, are the antennas for the original system. The lowest two serve private receiving sets in the tower suites, and the one above is used for the program distribution system.

In the design of this short-wave antenna installation it was found that wires strung between the two towers of the Waldorf would actually be broadside to the points where the majority of short-wave stations are located. Fig. 3 shows a gnomonic projection of the world giving the true direction of all points on the globe with respect to this system. It will be noticed that the antenna, indicated by the three crossed lines, is oriented so as to be as nearly broadside as possible to the principal continents.

The vertical, twisted-pair lead-in wire

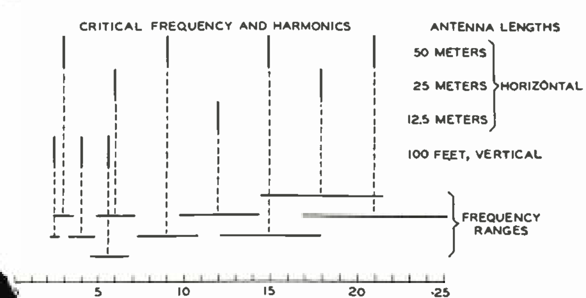


FIG. 2. CHART INDICATING HOW THE DOUBLET ANTENNA SYSTEM COVERS THE SHORT-WAVE BAND. THIS CHART ALSO INDICATES THE EFFECTIVENESS OF THE 100-FOOT VERTICAL LEAD-IN IN THE 2.21- TO 6-MEGACYCLE BAND.

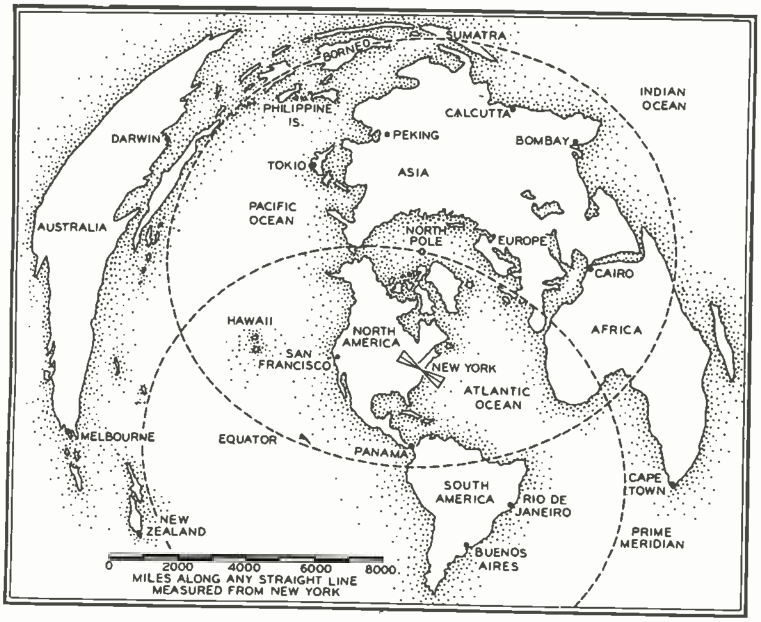


FIG. 3. A GNOMONIC PROJECTION OF THE WORLD GIVING THE TRUE DIRECTION OF ALL POINTS OF THE GLOBE WITH RESPECT TO THE WALDORF'S ANTENNA SYSTEM. THE ANTENNA, INDICATED BY THE THREE CROSSED LINES, IS ORIENTED SO AS TO BE AS NEARLY BROADSIDE AS POSSIBLE TO THE PRINCIPAL CONTINENTS.

is coupled through transformers to a 600-foot transmission line, the latter being terminated at the receiver in the radio room on the sixth floor. The short-wave receiver is housed in a cabinet about seven feet high. This unit is the one to the extreme right in the illustration on the front cover of this issue. This receiver contains three r-f amplifiers, covering the following bands: 2200 to 6000 kc; 6000 to 13,000 kc; and 12,000 to 25,000 kc.

In general, the receiving units are similar in design to those used at the Bell System stations at Netcong, New Jersey, the link in telephone service between North and South America, and at Miami in telephone service with the Caribbean countries. They are also used in ship-to-shore telephone service.

One of the most interesting features of these receiving units, other than their high degree of selectivity, is the incorporation of a switch to alter the width of the audio band. This switch may be set to admit a wide audio band for good reception conditions, and it can also be used to narrow down the band when noise or other interference makes a wide band undesirable.

QUOTA RESTRICTIONS IN GREECE

RECEIVING SETS ARE duitiable in Greece under paragraph d of import tariff classification 134, entitled "Electrical Instruments and Appliances," which also includes electrical measuring instruments, storage batteries, and all kinds of electrical household appliances. When the import quota system was inaugurated in May, 1932, the quota for class 134 as a whole was fixed at about 65 percent of actual 1931 imports. However, in view of the great variety of products included under the general heading of electrical appliances and instruments, the effect of the import quota restrictions was not felt severely in the radio trade.

In the latter part of July last, the Greek Ministry of National Economy announced its intention of breaking up the quotas for tariff class 134 into two separate classifications, one comprising radio receiving sets and other radio products, and the second including all the other electrical appliances and instruments covered by the original classifications.

This new policy aroused importers of American radio sets, most of whom had either imported no radios between 1929 and 1931, or were doing a very small volume of business owing to the undeveloped state of the Greek radio market at that time. Protests were filed with the Government and the matter was under consideration for 3 months. Late in September the Ministry of National Economy announced that 30,000 kilograms would be deducted from the total half-yearly quota for class 134 and distributed among radio importers to be used exclusively for the importation of radio products. The allocation of quotas was to be made on the basis of 65 percent of average 1929-31 radio imports as established by customs certificates. Any remainder left over was to be distributed among phonograph and piano importers who may care to use a portion of their quota allotments for radio imports.

From the point of view of American radio dealers, this was a very unsatisfactory solution because American radio shipments to Greece during the basic period of 1929-31 were comparatively small. Efforts are being made by importers to have this decision modified. (*Electrical Division, Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.*)

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NEWSREELS ADOPT UNIFORM RECORDING STANDARD

THE FIVE NEWSREEL COMPANIES, Fox Movietone News, Hearst-Metrotone, Paramount News, Pathe News, Inc., and Universal Pictures Corporation, have announced an important change in recording practice which will result in better and more uniform sound quality in the newsreel release prints.

At present, each newsreel company records its sound without regard to the others, the tendency being to record sound at too high a volume or loudness level.

This difference in volume level in the various newsreels, and particularly the tendency to record the newsreels too loud, has made it necessary for theatre projectionists to reduce the volume of newsreels when they appear on the screen. The quality of newsreel sound has likewise suffered through the distortions introduced by the loud recording.

Following a series of meetings, the newsreel companies have now agreed to reduce the volume level of newsreels to a uniform standard, approximately the same as that commonly used in the making of feature pictures. The adoption of this standard will do several things of importance to theatres. It will materially improve newsreel sound quality by removing the present distortion. It will make unnecessary fader changes on the part of projectionists while running the show, and it will bring to audiences better sound quality at an appropriate loudness.

Beginning with the first run releases of March 4, 1935, all newsreel companies will start using the new standard, and continuing for several weeks film cans will be suitably labelled warning projectionists of the reduction in loudness.

This move is considered as a great forward step in newsreel sound quality and theatres are expected readily to accustom themselves to the improve sound with benefit to all concerned.

AC-Type Electrolytic Capacitors

By PAUL MacKNIGHT DEELEY
Chief Engineer, Electrolytic Division
CORNELL-DUBILIER CORP.

THE PRECAUTION about connecting ordinary electrolytic condensers properly according to their polarity markings has been emphasized so much that many radio men seem to forget the existence of ac-type electrolytics. Indeed, it is not unusual to encounter otherwise well-informed technicians who never heard of condensers of this nature. As ac-type electrolytics find many applications in fields related to radio, a brief review of their construction and characteristics should be of general interest.

CHARACTERISTICS

The alternating-current type of electrolytic capacitor differs from the direct-current type in that it is non-polarized. It consists essentially of two electrodes, both anodically formed and immersed in a suitable electrolyte. In such a capacitor each anode functions alternately as such when it is positive in relation to the electrolyte and likewise each anode which at the moment is negative functions merely to make contact with the electrolyte.

Because of questions of economy, size and high power factor, the wet-type electrolytic capacitor is not readily adaptable for ac service. For this reason we will limit our discussion to the dry-type of construction.

The electrolyte best suited for use in the ac-type capacitor must possess the characteristics of low temperature coefficient and low specific resistivity. This is apparent when consideration is given the fact that the measure of merit of efficiency of a capacitor operated on alternating current is power factor. Obviously, the higher the equivalent series resistance of an electrolytic capacitor, the greater will be the power factor. In a capacitor a high-power factor represents a power loss, which manifests itself in the generation of heat. In an electrolytic unit this heat raises the temperature of the electrolyte; if the latter does not possess a low temperature coefficient, a double power loss will take place.

If, by virtue of its physical shape and construction and its electrical characteristics, an electrolytic capacitor cannot radiate the generated heat rapidly enough to prevent a temperature rise above a low equilibrium value, then an accelerated cycle of self-destruction sets in.

POWER-FACTOR LOSS

The question of power-factor loss against heat radiation governs the usefulness of ac-type electrolytics. In other words, an electrolytic capacitor will not function continuously on alternating current in most applications due to its high power-factor losses unless the generated heat is radiated at such a rate that no further increase in power factor takes place. Unfortunately, at the present state of development of the art, ac electrolytics are limited in application to intermittent service.

FUNCTIONAL POINTS

The anodic film constitutes an asymmetric dielectric in that it can retain

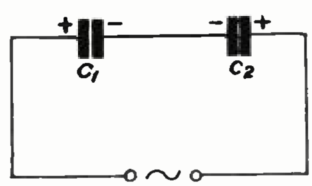


Fig. 1. Electrical equivalent of alternating-current type electrolytic condenser.

positive charges only on the side in contact with the metal of the anode. A single anode immersed in the electrolyte constitutes an asymmetric cell. Compared with an ordinary mica or paper dielectric capacitor, the anode and the electrolyte correspond to the two conducting surfaces and the anodic film to the dielectric.

When two anodically formed electrodes are immersed in the electrolyte a series-connected opposed arrangement of two asymmetric cells results. This is the equivalent of two ordinary mica or paper dielectric capacitors connected in series, but the distribution of electrostatic charges internally is quite different from that obtained in the mica or paper dielectric capacitors due to the asymmetric properties of the anodic film.

The potentials across the two anodic films of an electrolytic capacitor are thus in opposition to each other, whereas in the case of two series-connected mica or paper dielectric capacitors the potentials across the individual dielectric act in series.

The capacitor action of two series-opposed asymmetric cells results from the energy changes accompanying the variations in distribution of the constant charge held by the unit. Such an arrangement will not allow direct current to pass, but alternating current will pass, producing a leading current in the circuit network in which it is incorporated.

Upon connecting an electrolytic capacitor consisting of two series-opposed asymmetric cells in an alternating-current voltage source, current flows until the impressed voltage on the cell terminals has reached its maximum. One electrode of the cell then has a maximum voltage applied to it and therefore has its maximum charge. As the potential decreases from its maximum value, the electrode which was positive begins to discharge into the circuit network and the charge which it held accumulates on the other electrode, thus making the other electrode positive.

For any subsequent voltage variation, the total coulomb charge remains constant for any given maximum applied voltage variation, the total coulomb charge remains constant for any given maximum applied voltage, whereas in an ordinary mica or paper dielectric capacitor the charge varies with the applied voltage.

The constant electrostatic charge existing in the cells sets up a uniform potential difference between the electrolyte and any point outside the cell in the external network, which is neutral with respect to the alternating-current voltage.

The electrolyte is, therefore, always negative with respect to the neutral alternating-current voltage reference point. The arithmetical sum of the voltage across the two anodic films is constant and equals the maximum voltage impressed on the capacitor terminals.

The algebraic sum of the instantaneous values equals the instantaneous value of the impressed voltage. The potential difference existing between the electrolyte and either anode is the resultant of a uniform voltage equal to one-half of the maximum instantaneous value of the voltage impressed on the cell, and an alternating-current voltage equal to one-half of the effective value of the voltage impressed on the cell. This is a pulsating, uni-directional pressure. Each anodic film is therefore subjected to an alternating component equal to one-half the pressure impressed on the capacitor and each anodic film is subjected to the maximum pressure impressed on the cell, instead of one-half as is the case with two ordinary mica or paper dielectric capacitors connected in series.

As has been mentioned above, when the charge on one electrode is at maximum the charge on the other is zero. The energy stored at the maximum voltage is

$$W_1 = \frac{QE\,(max)}{2}.$$

where Q is the charge in coulombs and E(max) is the maximum voltage.

At the moment the applied voltage becomes zero, each anodic film holds one-half the charge at one-half the voltage and the stored energy then becomes equal to

$$W_2 = \frac{QE\,(max)}{4}.$$

The energy variation is therefore one-half the total energy stored in the capacitor when the maximum voltage is impressed on its terminals.

COMPARISONS

From this it is seen that whereas an electrolytic capacitor, consisting of two series-opposed asymmetric cells, stores and gives up only one-half of its total charge, an ordinary mica or paper dielectric capacitor stores and gives up its total charge. In other words, in the alternating-current electrolytic capacitor one anodic film charges while the other discharges, while in the ordinary mica or paper dielectric capacitor both electrodes charge and discharge together.

In alternating-current electrolytic capacitors the two anodic-filmed electrodes should be of the same electrostatic capacity. If the electrodes are not of the same electrostatic capacity, the charge stored in the capacitor is independent of the capacity of the smaller electrode and is determined solely by the maximum charge capable of being stored by the larger electrode. If one of the electrodes has a negligible capacity the unit no longer reacts in an alternating-current network as an ordinary capacitor, since it is able to receive a charge but is unable to return it. Also in such a cell, the potential difference between the smaller electrode and the electrolyte has (at least theoretically) a maximum value of twice the maximum voltage applied to the cell terminals.

ELECTRICAL EQUIVALENT

The electrical equivalent of an alternating current or non-polarized electrolytic capacitor is that of two polarized direct-current electrolytic capacitors connected in series but in reverse order, as illustrated in Fig. 1.

In such a connection the total effective capacity is approximately equal to:

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}.$$

From this relation it is readily observed that in a non-polarized capacitor the total anode area, for a given voltage of formation, must be approximately four times as great for the same capacity in a direct-current polarized capacitor, or, in other words, the area of each foil in an alternating-current type capacitor must be twice as great as the area of each foil in a direct-current type for a given capacity and voltage of formation.

RATINGS

Alternating-current types of capacitors are rated according to operating voltages (ac root-mean-square) and the voltage of formation of the anode film must be made to conform to the peak value of the root-mean-square rating. This peak value is equal to:

$$\text{ac voltage (rms)} \times \sqrt{2}$$

In addition to this factor, consideration must be given to the normal ranges of voltage variation encountered in commercial sources of alternating current. In other words, the anodic formation voltage should match the peak voltage of the highest alternating-current voltage which may be applied to the capacitor.

In the calculation of anode areas for given voltages and capacities it is convenient to consider one foil as the anode and the other as the cathode. In this manner double the anode area as indicated in tables for anode areas for direct-current capacitors can be used.

Experience has shown that the cold application electrolyte is best suited to use in alternating-current capacitors.

DESIGN

Windings are made in the same manner as for medium and high-voltage direct-current capacitors, with the exception that instead of baking the unassembled windings, they are connected direct to rated alternating-current voltage and allowed to heat to indicated temperatures. After this heating process they are removed from the circuit and immediately pressed into desired shape: that is, unless they are to be round sections. In the measurement of temperatures of the windings a thermometer is placed into the center of each winding.

This method of heating on alternating current serves also the purpose of aging the capacitors to desired leakage currents.

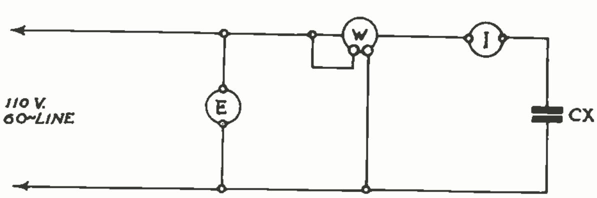
Finished capacitors may be further aged on direct current by applying direct current equal to the formation voltage first in one direction and then the other. This may be done with a manually-operated or motor-driven commutator which allows the voltage direction to be reversed at approximately five-minute intervals.

TESTING

In the testing of alternating-current type capacitors the direct-current leakage is usually disregarded and only capacity and power-factor measurements are made.

Both power-factor and capacity measurements are made with the aid of a voltmeter, ammeter and wattmeter as indicated in the circuit diagram of Fig. 2.

Care should be exercised in the selection of the wattmeter for such measurements because of the high current which must pass through the wattmeter in proportion to the relatively low wattage reading.



E = VOLTMETER
I = AMMETER
W = WATTMETER

$$\text{POWER FACTOR} = \frac{W}{EI}$$

$$\text{RESISTANCE} = \frac{W}{I^2}$$

$$\text{CAPACITY IN MICROFARADS} = \frac{10^6}{2\pi f\sqrt{\left(\frac{E}{I}\right)^2 - \left(\frac{W}{I^2}\right)^2}}$$

Fig. 2. Approved method of measurement for ac electrolytic condensers.

BOOK REVIEW

PHOTOELECTRIC CELL APPLICATIONS, *by R. C. Walker and T. M. C. Lance, published by Sir Isaac Pitman and Sons, Ltd., London, England (U. S. Representative, Pitman Publishing Corp., 2 West 45th Street, New York City), second edition, 245 pages, cloth covers, price* $2.50.

To attempt to cover in any detail all of the varied applications of photoelectric cells in a 245-page book would, to say the least, mean the undertaking of an exceptionally difficult task. Logically, the authors of *Photoelectric Cell Applications* originally set forth as their objective the description of a few typical examples of the many practical applications of this device. However, since the first edition of this book appeared in 1933, there have been such numerous extensions in the industrial uses of photocells that the appearance of a second and more up-to-date edition was required in 1935.

Feeling that the physics of light sensitive devices has been competently covered elsewhere, only a brief review of the theory of photoelectricity has been included . . . this in the first chapter which covers some twenty pages. The historical background, modern theory of atomic structure, the vacuum cell, gas-filled cells, cathode construction, cells sensitive to ultra-violet radiation, dark current, time lag, and rectifier cells are the subjects covered in Chapter I.

Chapter II is concerned with the methods of use of photoelectric cells, including galvanometer circuits, thermionic valves, the grid-glow tube, electrometer triode, gas-filled relay, time-delay circuits, and the like; while counting, timing, and mechanical handling devices are dealt with in the following chapter. Alarms, indicators and safety devices have been devoted some 24 pages. Advertising, Sound Reproduction and Phototelegraphy are the titles of Chapters V, VI and VII, respectively. The subject of Television has also been given an entire chapter.

Chapter IX is devoted to scientific instruments. The use of the photocell in conjunction with recording microphotometers, density meters, photometry, lamps and color temperature, ultra-violet-ray measurements, and color-matching instruments are discussed.

The final chapter is given over entirely to additional circuits of various kinds, devices for increasing sensitivity, and the like.

An added item of value is the reference list given, with but one exception, at the end of each chapter and at the end of the book. Such a list is of considerable value in a book of this nature.

All in all, *Photoelectric Cell Applications* is to be recommended for those interested in the uses of light sensitive devices.

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ELECTRIC CIRCUITS AND WAVE FILTERS, by A. T. Starr, published by Sir Isaac Pitman and Sons, Ltd., London, England (U. S. Representative, Pitman Publishing Corporation, 2 West 45th Street, New York, N. Y.), first edition, 375 pages, cloth covers, price $6.00.

The importance of the study of electric circuits and network theory can hardly be stressed too much. Direct applications are to be found in nearly all branches of the electrical industry. In writing *Electric Circuits and Wave Filters* the author felt that he should start from first principles and lead, without any omissions of theory, to a complete survey of the subject. From all appearances, Mr. Starr has succeeded quite well in carrying out his original intentions.

This book begins with the customary list of notations and abbreviations, after which follows Chapter I on "Mathematical Processes." This chapter begins with the well-remembered quadratic equation $ax^2 + bx + c = 0$ and its solution. Next comes the solution of simultaneous equations by use of determinants, which, in turn, is followed by progressions and binomial series, algebraic notation, exponential and logarithmic functions, trigonometric functions, real hyperbolic functions, complex numbers, the relation between hyperbolic and trigonometric functions, and linear differential equations, . . . all in order. Since this material is covered in 24 pages, the condensed nature of this book will be quite apparent to the reader.

Chapter II has been devoted to the fundamental principles of alternating-current theory. In this chapter some 5½ pages have been devoted to electrostatics; about 4 pages to self, direct and mutual capacity; 1 page to continuous currents, 3 pages to magnetism, 2 pages to the vector potential, 1½ pages to electromagnetism, 2 pages to the vector potential due to steady currents, 1 page to electromagnetic induction, 9 pages to the algebraic and vectorial methods of solution in alternating current, etc.

"Theory of Electric Circuits" is the title of Chapter III which covers impedance and admittance, Kirchhoff's laws and Maxwell's circulating currents, coupled circuits, the general ladder network, reciprocal theorem, compensation theorem, Thevenin's theorem, star-mesh transformation, theorem on the general three-terminal network, mechanical and acoustic analogies, electro-acoustics, piezo-electricity, negative resistance, the continuous line, etc.

Chapter IV covers the design of resistances, coils and condensers, while Chapters V and VI are devoted to two-terminal impedances and four-terminal networks, respectively. Chapter VII is given over to the subject of wave filters. Low-pass, high-pass and band-pass filters are considered in the following three chapters.

"Calculation and Measurement of Performance" is the title of Chapter XI, while Chapter XII, the last one, treats the subject of transients in networks.

Five Appendices are given at the end of the book. The first three are summaries of low-pass, high-pass and band-pass filters. The fourth appendix is "A Nomogram for the Band-Pass Filter," while the last one covers the development of the lattice-type filter.

The advanced student, the engineer engaged in the design of electrical units, or any electrical engineer with a fairly good background of mathematics will find *Electric Circuits and Wave Filters* an excellent reference book.

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THEORIE ET PRACTIQUE DES LAMPES DE T. S. F., by A. Kiriloff, 116 pages, 6¼ x 10 inches, 146 diagrams. Paper covers. Printed in French. Publisher: Etienne Chiron, Paris.

Starting with the Edison Effect and ending with pentodes, this book of 116 pages is a popularly written treatise on radio vacuum tubes intended for practical experimenters and amateurs. It includes numerous diagrams showing the applications of various European types.

Rather poorly printed on coarse paper, this book probably will be of interest in the United States only to engineering students and recent college graduates who might like to exercise their classical classroom French on something practical. The technical terms are very much like ours, and the diagrams and sketches indicate the meaning of terms and words not found in the usual French-English dictionary.

Design .. Notes And

FREQUENCY MODULATION

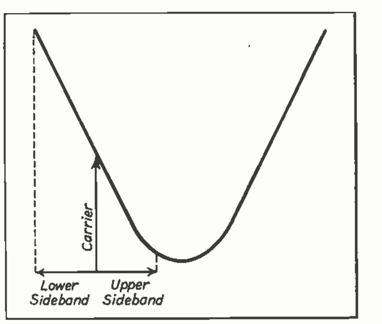
AT FIRST GLANCE it would appear that phase modulation or frequency modulation should result in a signal-bearing wave requiring a very narrow band. Thus the phase of a carrier wave could be varied through π radians and the carrier-frequency change would never need be greater than one-half cycle. Likewise it might appear that a frequency-modulated wave, in which the total change in frequency was only 100 cycles, would only require a 100-cycle band in the ether. This delusion has tempted many veteran experimenters but results have always been as elusive as the fabled pot of gold at the end of the rainbow. This does not mean that phase or frequency modulation is of no importance. On the contrary it would appear that it can be employed to advantage as will appear later, but not to obtain narrower bandwidths.

Modulation can, of course, be accomplished by operating on any of the three parameters of a wave, namely amplitude, phase or frequency. All three types of modulation have been thoroughly analyzed by such investigators as J. R. Carson, Balth van der Pol, Hans Roder, J. G. Chaffee, and others.

The generalized expression for an alternating current is

$$I = A \cos(\omega t + \theta).$$

This current may be modulated by a process (called amplitude modulation) in which the signal controls the amplitude (A) of the carrier wave, while the carrier remains constant in phase and frequency. It is assumed that the amplitude of the carrier is at all times proportional to the instantaneous amplitude of the signal wave. In phase modulation the phase of the carrier is at all times proportional to the instantaneous amplitude of the signal wave, while the amplitude and frequency of the carrier remain constant. In frequency modulation the instantaneous amplitude of the signal wave is employed to vary the apparent frequency of the carrier wave, the amplitude and phase of which remain constant.



The expression for an amplitude-modulated wave consisting of a carrier modulated by a single tone is well known. It may be arrived at by substituting the variable signal-wave expression for that of the peak amplitude of the carrier. Let the signal wave be

$$K A \cos p t.$$

Then the amplitude-modulated wave will be

$$I = A(1 + K \cos p t) \cos \omega t = A \cos \omega t + \frac{AK}{2} \cos(\omega + p) t + \frac{AK}{2} \cos(\omega - p) t \quad (1)$$

in which K is the so-called percentage modulation, the first term of the expression to the right of the equality sign the carrier, and the second and third terms the upper and lower sidebands respectively. It is at once obvious from (1) that the instantaneous amplitude of the carrier wave varies between a peak of $(1 + K)$ and a minimum of $(1 - K)$ during modulation. Evidently this is equivalent to a carrier having a constant amplitude and two additional frequencies symmetrically disposed on either side of the carrier at a frequency interval corresponding to the sum and difference of the signal and carrier frequencies.

The expression for a phase-modulated wave may be derived in a similar manner. Starting with the general expression for a carrier current

$$I = A \cos(\omega t + \theta)$$

and operating on the phase angle (θ) with a single frequency signal results in

$$I = A \cos[\omega t + \theta_1 (1 + K \cos p t)] \quad (2)$$

which reduces to

$$I = A \cos(\omega t + \theta_1) \cos(K \theta_1 \cos p t) - A \sin(\omega t + \theta_1) \sin(K \theta_1 \cos p t).$$

Expanding the sine and cosine terms in accordance with their respective power series

$$\sin \phi = \phi - \frac{\phi^3}{|3} + \frac{\phi^5}{|5} - \frac{\phi^7}{|7} + \ldots$$

$$\cos \phi = 1 - \frac{\phi^2}{|2} + \frac{\phi^4}{|4} - \frac{\phi^6}{|6} + \ldots$$

gives

$$I = A \cos(\omega t + \theta_1) - A K \theta_1 \sin(\omega t + \theta_1) \cos p t - \frac{A K^2 \theta_1^2}{2} \cos(\omega t + \theta_1) \cos^2 p t + \frac{A K^3 \theta_1^3}{6} \sin(\omega t + \theta_1) \cos^3 p t + \ldots$$

A term by term comparison with (1) shows that the wave resulting from phase modulation contains a carrier $[A \cos(\omega t + \theta_1)]$ of constant amplitude, frequency, and phase; two first order sidebands $[A K \theta_1 \sin(\omega t + \theta_1) \cos p t]$ essentially identical to those of expression (1); together with higher order sidebands consisting of the carrier modulated by harmonics of the signal frequency. It is interesting, however, to note one peculiar difference in expressions (1) and (2), that is, the first and other odd order sidebands are displaced $\frac{\pi}{2}$ radians from their position in an amplitude-modulated wave. Thus is (2) the carrier is a cosine term and the odd order sidebands are sine cosine products which, upon expansion, reduce to sines of sum and difference frequencies.

It will be recalled that:

$$\sin(p t + \frac{\pi}{2}) = \cos p t$$

and

$$\cos^2 p t = \tfrac{1}{2} \cos 2 p t + \tfrac{1}{2}$$
$$\cos^3 p t = \tfrac{1}{4} \cos 3 p t + \tfrac{3}{4} \cos p t$$
$$\sin^2 p t = \tfrac{1}{2} - \tfrac{1}{2} \cos 2 p t$$
$$\sin^3 p t = \tfrac{3}{4} \sin p t - \tfrac{1}{4} \sin 3 p t.$$

Of course this wave applied to an ordinary detector would result in no signal until the phase of the carrier was shifted and then the output would increase as the phase of the carrier was varied to a maximum at $\frac{\pi}{2}$ radians from its normal position as shown in expression (2).

The equation for a frequency-modulated wave can be derived as was that for phase modulation by substituting for the frequency term. It is

$$I = A \sin(\omega t + M \sin p t). \quad (3)$$

By the same process as that just outlined for the case of phase modulation, it can be expanded into

$$I = A [I_0 M \sin \omega t + I_1 M \{\sin(\omega + p) t - \sin(\omega - p) t\} + I_2 M \{\sin(\omega - 2p) t - \sin(\omega + 2p) t\} + \ldots].$$

In this particular case the I's are Bessel functions of the first kind and of the order indicated by the subscript. M is the variation of frequency of the carrier from the unmodulated mean value, divided by the modulating (signal) frequency. The quantity M is usually referred to as the modulation index and may be compared to percentage modulation in the equation for an amplitude-modulated signal. Of course the modulation index can be and usually is greater than unity for the peaks of the modulating signal. Like the phase-modulated wave, frequency-modulated waves consist of several sets of sidebands. It is here assumed that the amplitude of the radiated wave is constant

Comment . . Production

and that its frequency is varied in accordance with the instaneaneous amplitude of the modulating or signal frequency. If the modulation index is less than unity, then the amplitude of the first set of sidebands will be approximately proportional to this index, while the amplitude of the higher order sidebands will be negligible. When the modulation index exceeds unity the higher order sidebands become of more importance, in that they carry more energy, while the carrier amplitude drops rapidly. Under this condition there will be sideband components of appreciable magnitude extending on either side of the carrier up to the extreme limits between which the carrier frequency is varied. As the modulation index becomes greater, less and less energy is carried by the carrier and first set of sidebands (i.e., those nearest the carrier in frequency) and more and more by the higher order sidebands.

From the above discussion, it is apparent that the bandwidth transmitted with a frequency-modulated signal is at least of the same order as that of an amplitude-modulated signal and may be much greater. This fact coupled with the difficulty of receiving such signals has largely prevented the use of frequency modulation in the past. It is evident that before detection the frequency-modulated signal must be reconverted to an amplitude-modulated signal. In general this is done by the use of an equalizer network in which the attenuation is directly proportional to frequency. In the simplest case the side of the resonance curve of a tuned circuit might be used. That is, the circuit is detuned so that the carrier falls to one side of the band instead of in the center. This is shown in the accompanying illustration, from which it is evident that the pass band of the tuned circuit is not used for signal transmission. If this is to be done without distortion, it is obvious that some additional equalization may be required. Moreover the amplitude of the side band components depends upon the signal frequency so that the modulation index is inversely proportional to the signal or modulating frequency. Thus, if the amplitude of the modulation frequency is kept constant while the frequency is varied, the modulation index and hence the amplitude of the intelligence-bearing sidebands will decrease as the signal frequency is increased. This may of course introduce distortion. At any rate it is evident that frequency modulation is most readily applicable at a single wavelength rather than over wide bands.

In the foregoing an attempt has been made to show something of the differences involved between frequency and amplitude modulation as well as some of the difficulties involved in the use of the former. It is obvious that frequency and phase modulation involve an almost completely new technique and that some of our conceptions of modulation as well as some of the customary axioms must be changed or discarded. This does not of course mean that frequency modulation has no place in the present scheme of things. On the other hand it appears that it offers numerous advantages at very short wavelengths and may come into general use when the proper equipment for its transmission and reception is available. All of which brings us to that time-tested axiom of communication which may be stated[1]: The total amount of information which may be transmitted over a system which is limited to a restricted frequency range is proportional to the product of the frequency range which it transmits by the time which it is available for transmission.

Recently Major E. H. Armstrong has suggested that inasmuch as the elimination of frequency modulation at ultra-short wavelengths is very difficult to accomplish, it might be better to employ it exclusively, instead of amplitude modulation. As a matter of fact frequency modulation is generally admitted to be easier of accomplishment at wavelengths in the centimeter range than amplitude modulation. In addition, Major Armstrong has worked out ways and means of accomplishing this and has announced that experiments conducted between the Empire State Building in New York City and other stations in New Jersey and Long Island have proven that the theoretical advantages of such a system may be realized in practice.

It is present practice in radio systems to use as narrow a bandwidth as possible, consistent with the degree of fidelity required, to reduce interference both from static and from thermal and tube noises to the lowest possible value in the receiver output. It has been shown that the noise due to thermal agitation and shot effect has a constant distribution with frequency. That is, a given bandwidth at any frequency admits a given amount of noise. This is, of course, not true of static which disappears at very high frequencies.

According to Major Armstrong, thermal noise and shot effect consists of variations not only in amplitude but also in frequency, so that they would appear in the output of a receiver intended for reception of frequency-modulated signals as well as those intended for the reception of amplitude-modulated signals. However, he finds that by employing a greater swing in the frequency of the carrier than that caused by the above mentioned disturbances the signal-to-noise ratio can be greatly improved. It would seem that this might be carried to almost any desired degree with the penalty, of course, of a wider transmitted frequency band. It should be borne in mind that when the carrier swing exceeds the frequency band of the modulating signal (i.e., the modulation index is greater than unity) that the higher order sidebands begin to assume importance. This, of course, calls for a wider received band, but since it overrides set noise this is of no consequence at frequences at which there is no static.

While it is not the intention to set forth here the details of the circuits which Major Armstrong has invented and proposed for use at ultra-short wavelengths the reader is referred to patent No. 1,941,069 which describes transmitting and receiving circuits capable of producing the results claimed by Major Armstrong. In general the circuits described in this patent consist of a more or less conventional transmitter in which frequency modulation is obtained in a novel and somewhat involved manner. Current limiting is provided to insure that the transmitter transmits a current of constant amplitude. Thus a frequency-modulated signal of constant amplitude results. The receiver is of the triple-detection type and feeds a balanced output or bridge circuit. Two series tuned circuits each feeding a rectifier are, in turn, connected differentially between receiver output and the headphones. One tuned circuit resonates at the lower edge of the second i-f band while the other similar tuned circuit resonates at the upper edge of the second i-f band. The circuits are so arranged that equal outputs of noise are produced by the two last detectors, the outputs of which are differentially connected, thus eliminating to a large extent set noises. This is accomplished by arranging the tuned circuits so that their impedances over the audible range on either side of the second intermediate frequency is equal. Noise currents are therefore balanced out, whereas signal currents which vary over a much wider frequency range are unbalanced. One edge of one resonance curve is used for signals of increasing amplitude and the other side is used for decreasing the amplitude.

1. *Transmission of Information*—R. V. L. Hartley—Bell System Technical Journal, Vol. VII, pg. 535-563, July, 1928.

· RMA NEWS ·

CONNECTICUT ANTI-RADIO BILL DEAD

THE BILL IN THE Connecticut Legislature to prohibit automotive radio is dead. Sufficient opposition to the bill was organized by the RMA to force withdrawal of the bill by the author at the Hartford Capitol on April 2. The hearing scheduled on the bill by the Connecticut Senate Motor Vehicles Committee was attended by about fifty representatives of radio and automotive interests but none were heard as an immediate announcement by Senator Hungerford, committee chairman, stated that the author of the bill insisted on its withdrawal and desired no comment. Appreciation of the opponents of the bill was expressed to the Committee by Bond Geddes of Washington, representing the RMA.

Among the radio and automotive representatives prepared to oppose the bill at Hartford were several manufacturers and many Connecticut and other New England distributors and dealers. The RMA was represented by Mr. Geddes and also Judge Van Allen of Buffalo, general counsel of the RMA, and there were also representatives of the Automobile Manufacturers Association and the Ford Motor interests. Francis E. Stern, Hartford radio distributor, represented the Radio Wholesalers Association.

SOUTH DAKOTA BANS SHORT-WAVE AUTO RADIOS

South Dakota is added to the few states which have enacted laws regulating "short-wave" radio sets in automobiles but without restricting or regulating public automotive radio sets covering the regular, standard broadcast band.

The new South Dakota law requires a permit for installation of a short-wave automotive set. It also authorizes a state police broadcast station at Pierre, the Capitol, and a state radio police system requiring all state and county police vehicles to be radio equipped.

"LUXURY" TAX BILL IN OKLAHOMA

RMA members are requested to have their distributors and dealers in Oklahoma use all possible influence in opposition to a bill just introduced in the Oklahoma House of Representatives which would levy a special discriminatory "luxury" tax of three percent on radio receiving sets. The RMA has already opened attack on the bill before the Revenue and Taxation Committee of the Oklahoma House.

Broadcasting and other interests are also opposing the bill because of its special discriminatory taxes on only a few articles, including charges for radio broadcasting, sporting goods, cosmetics, confections, jewelry, etc.

While the bill has just been introduced and no action yet taken, it will be vigorously opposed by the RMA. In the protest to the Oklahoma Legislative Committee, the RMA emphasized that radio was not a luxury or semi-luxury but a necessity, and that the bill would discriminate unfairly by taxing only a few articles, exempting many others competitive with radio. It is also contended that the bill is unconstitutional under Federal Court decisions prohibiting a state tax on radio receiving sets as an interference with the interstate commerce of broadcast program reception.

RADIO EMPLOYMENT INDICES

Seasonal reduction in the radio industry following the holiday season was detailed in the report of the U. S. Department of Labor, Bureau of Labor Statistics, on radio factory employment for the month ending January 15, 1935, just released.

For the monthly period ending January 15, fifty-two radio and phonograph establishments reported employment of 34,658 employees, and the January statistics do not include reports from a number of manufacturers previously reporting. This compares with fifty-six establishments reporting employment of 37,822 employees for the month ending December 15, 1934. No wage increases were reported in either month.

During the month ending January 15, 1935, per capita weekly earnings in radio factories were $18.44, a decrease of 7.5 percent compared with the average December earnings of $19.86.

Average hours worked per week during the month ending January 15, 1935, were 32.2 hours, a decrease of 8.8 percent compared to 35.2 hours in December, 1934.

Average hourly earnings of radio factory employees during the month ending January 15, 1935, were 57.5 cents compared to 56.5 cents in December, 1934, an increase of 1.2 percent.

As compared with the three-year average of 1923-25, radio employment during January was increased 91.4 percent, while January payrolls were 12.5 percent above the three-year average but 14.8 percent less than December, 1934, and 18.3 percent above those of January, 1934.

HAITIAN RADIO TARIFF MAY BE REDUCED

Provision for conditional reduction of the Haitian import tariffs on radio receiving appliances is made in the reciprocal trade agreement between the U. S. and Haiti which was signed March 28. The Haitian agreement provides for fifty percent conditional reduction in the radio tariff, from thirty percent to fifteen percent advalorum, when the Haitian budget is reduced to a certain amount. The trade agreement also provides that Haiti will not increase the rates on radio broadcast and electrical apparatus. No date has been set for conclusion of the Haitian trade agreement. It is subject to approval of the Haitian Congress and is the fourth of the reciprocal trade agreements concluded by Secretary Hull and the State Department.

RADIO STATISTICS AVAILABLE BY COUNTIES AND CITIES

New estimates of radio set ownership in counties and cities have been made by the Columbia Broadcasting System and individual state reports are available upon application to the Market Research Department of CBS at New York. The survey breaks down the state reports into county and community estimates of large and small cities and also rural districts.

CANADIAN SALES

The RMA, through the cooperation of the Canadian RMA, is advised that total radio industry sales of receiving sets in Canada during 1934 aggregated 168,833, valued at $16,771,222.04. Total ac sets amounted to 132,190, battery sets 23,408, and automobile sets 13,235.

Of the ac sets there were 34,106 sales of console dual-wave type; 29,773 of mantel standard; 25,638 of mantel dual-wave; 22,666 of console standard; 16,546 of console all-wave, and 3,388 of mantel all-wave.

In Canada January set sales totaled 7,693 valued at $931,285.52, and Canadian inventories on January 31 were 34,379 sets, with projected production from February 1 to March 31 of 30,137 sets.

PERMITS REQUIRED FOR IMPORTS TO ITALY

An Italian Government decree published February 19, according to cable advices to the U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, from the American Commercial Attache at Rome, makes all imports, including radio sets, subject to special permit. Up until March 31, 1935, customs authorities may admit a fixed percentage of the quantity of each product imported during the period from February 16 to March 31, 1935. The percentage of imports of radio sets is limited to 25 percent, the same rate applicable to motor vehicles, office machinery, and some other articles. Special quota allotments already assigned to the United States are not affected by the new decree. Exception from the import restrictions may be made where general or private exchanges for Italian products are arranged, but no further details are yet available.

1934 RADIO EXPORTS BREAK RECORDS

All records for export of radio apparatus from the U. S. were broken during 1934 with sales abroad of $24,856,898, according to the recent report of the Department of Commerce, Electrical Equipment Division. The 1934 exports were $1,723,083 above the former record exports of 1930, according to Andrew W. Cruse, Chief of the Electrical Equipment Division, and all classes of radio apparatus shared in an export increase over 1933.

Recovery in foreign markets from adverse conditions affecting American radio sales abroad in 1932 and 1933 were evidenced, according to Mr. Cruse. All-wave sets were credited with increasing the unit value of receiving sets sold abroad in 1934 to $35, as compared with $18 in 1933. Spain, United Kingdom, Mexico and Brazil were again the first ranking foreign markets for American radio.

NEWS OF THE INDUSTRY

NEW RCA VICTOR MANUFACTURING EXECUTIVES

Appointment of R. Shannon, as Manager of Manufacturing, and of N. A. Mears, as Manager of Materials Control, both reporting to the Vice-President in Charge of Manufacturing for the RCA Victor Division, was announced by Mr. G. K. Throckmorton, Executive Vice-President of the RCA Manufacturing Company.

Mr. Shannon was formerly Manager of Manufacturing at the Harrison, New Jersey, RCA Radio Tube Plant. He has been identified with lamp and tube manufacturing since 1912. Mr. Mears was formerly General Purchasing Agent for RCA Victor, and prior to that was Plant Manager for the Chicago Forging and Manufacturing Company.

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NEW ERIE RESISTOR PLANTS

The Erie Resistor Corporation has recently completed an addition to their Erie plant. Approximately 5,000 square feet of additional floor space is available through this addition. A large portion will be used for the manufacture of insulated carbon resistors, recently placed on the market by this company.

The Erie Resistor Ltd., an English subsidiary, has moved into their new factory, located at Queensbury, about seven miles from London. This building, specially designed for the manufacture of resistors and suppressors, is one of the most modern and best equipped factories in Great Britain.

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WESTINGHOUSE ELECTS NEW DIRECTOR

A. W. Robertson, Chairman of the Board of the Westinghouse Electric and Manufacturing Company, announced, at the Annual Meeting of Stockholders of the Company, held April 10, that Winthrop W. Aldrich, H. B. Rust and Samuel M. Vauclain were reelected members of the Board of Directors.

The election of John L. Hall, Senior Member of the law firm, Choate, Hall & Stewart of Boston, as a Director of the Company, was also announced.

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RADIART PERSONNEL CHANGE

The Radiart Corporation, Cleveland, Ohio, announce that Mr. James Dalgleish terminated his employment with them on April 15. Mr. Dalgleish's place has been filled by Mr. Charles S. Blank, formerly associated with the Ohio Varnish Company.

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NEW BOOK ON STAMPINGS

A new book, entitled "Modern Stampings—Their Place in Present Day Design, Manufacturing, and Selling," has just been issued by the Geuder, Paeschke and Frey Co., Milwaukee, Wis., one of the pioneers in metal stampings. This book treats fully the possibilities in stampings as a solution for the basic sales problems of beauty, quality, and price. Along with the discussion of these problems are illustrated many examples of how these problems have been solved with metal stampings. The progress made in metal stamping is also considered.

CROWE BULLETIN

Crowe Bulletin No. 55, issued by the Crowe Name Plate and Manufacturing Company, 1749 Grace Street, Chicago, Ill., covers name plates for tuning controls, remote controls, dials, grilles, metal cabinets and escutcheons for the 1935 receivers, and its fifty some pages are profusely illustrated. Incorporated in this booklet is a great deal of technical data and descriptions of the different products. For further information address the above company.

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NEW CONSOLIDATED CATALOG

The latest edition of the Consolidated Catalog is just off the press. The number of pages has been increased, and a great many new items of interest to the trade have been added.

Of particular interest to the auto-radio field is the new Meshtenna running-board antenna, the matched-impedance triangular cable antenna, new noise suppressors and other auto-radio accessories. The home

radio has in no way been slighted; for this field Consolidated has released a newly-engineered all-wave variable antenna coupler, a larger variety of insulators, window lead-in strips and other items.

Aside from this large selection of merchandise. there are a number of tables and data that will prove useful for reference. This catalog is sent free upon request and is available to those in the radio and electrical field. Address the Consolidated Wire and Associated Corporations, Peoria and Harrison Streets, Chicago.

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PORTER JOINS ACHESON COLLOIDS

Mr. Bernard H. Porter has recently joined the Technical Department of the Acheson Colloids Corporation located at 444 Madison Avenue, New York City. Mr. Porter received his B. S. at Colby College in 1932 and his Sc. M. at Brown University in 1933. While doing general field-research work, he will devote a major part of his time to electrical applications.

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ROSEN APPOINTED RCA JOBBER

Raymond Rosen and Company, prominent Philadelphia radio and refrigeration wholesale organization, has been appointed a distributor for the sale of RCA Victor centralized radio, public address, sound reenforcement and other commercial sound systems in the eastern Pennsylvania and southern New Jersey territory, according to an announcement by W. L. Rothenberger, in charge of those activities for the RCA Manufacturing Company. This pioneer radio distributing company already represents RCA Victor in the sale of "magic brain" radio and radio-phonograph instruments.

As a preliminary step in developing the potentialities of the rapidly growing commercial sound applications field, the Raymond Rosen Company has taken over the business of the L. P. Clark Company of Philadelphia, which has for many years specialized in this work and incorporated it into a newly-created Special Products Division. Paul Ziesmer has been placed at the head of the new department in charge of sales and service, and L. P. Clark will work with him as Sales Engineer.

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DUBILIER TOURS EUROPE

William Dubilier, Vice-President in Charge of Research of the Cornell-Dubilier Corporation, of New York, left during the early part of April for a two-month tour of Europe. He will visit the firm's British and continental affiliates, make first-hand observations of engineering progress in several countries and pay particular attention to television developments in Great Britain and Germany.

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RCA RADIOTRON APPOINTMENTS

C. R. King, Sales Manager for RCA Radio Tubes, announced the appointment of Paul J. Pfohl, as Sales Manager of the Chicago District, including Illinois, Wisconsin, Indiana and Kentucky, with headquarters at the RCA Radiotron Division Sales Offices at 520 N. Michigan Avenue, Chicago. Richard A. Graver, formerly Chicago District Sales Manager for RCA Radio Tubes, has been appointed Sales Manager of the Chicago Talking Machine Company, RCA Victor and RCA Radiotron wholesale distributors.

Mr. Pfohl has been identified with RCA Radiotron activities for many years, as factory representative for initial tube-equipment sales to radio manufacturers in the Chicago area, and more recently as wholesale and retail trade representative in the same territory.

Mr. Graver has been with RCA Radiotron since 1930 when it was formed as a Company. He was appointed Atlanta District Sales Manager, and later Sales Manager of the important Chicago District.

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TAYLOR APPOINTED SALES MANAGER OF KENYON

The Kenyon Transformer Company, Incorporated, 840 Barry Street, New York City, New York, recently announced the appointment of Mr. William E. Taylor to the position of General Sales Manager.

Mr. Taylor will apply his experience to the promotion of the company's complete line of transformers.

NEW PRODUCTS

DED-FUSE TATTELITE

Ded-Fuse Tattelite is the name of a tiny neon lamp and casing, designed to tell instantly when and where a fuse is blown. The lamp bulb itself is only the size of a pencil tip 1 inch long. It is a product of the Littelfuse Laboratories, 4507 Ravenswood Ave., Chicago.

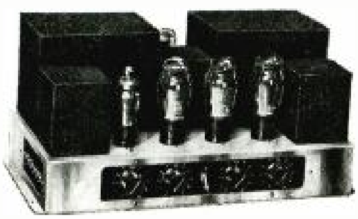
Ded-Fuse Tattelites connect directly in parallel with the fuse and draw no current until the fuse has blown. They are adapted for use on any size cartridge fuse, and even plug fuses, since they measure only 1¾ inches long overall by 5/16 inch maximum diameter and have 6-inch connecting leads. They are designed for circuits of 100 to 550 volts ac or dc and light on only .0005 ampere current. A protective resistance is built in. Other uses are indicating open circuits, switches, relays, etc.

•

NEW MORLEN AMPLIFIER

A public-address amplifier with the new "power-driven" Class AB type circuit has been announced by the Morlen Electric Co., Inc., 100 Fifth Ave. This unit is shown in the accompanying illustration.

The tubes used are a 6C6 voltage amplifier, a 50, connected as a Class A driver,



which feeds a pair of push-pull 50s operating Class AB. The operating level of this amplifier can be held at 30 watts (plus 37 db) consistently, while power swings up to 45 watts will still have good quality, it is stated. The amplifier, known as the type 4A, includes a mixer-type input and dual-winding output of 500 ohms and 15 ohms tapped at 8 and 4 ohms. The weight is 65 pounds.

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Q-METER

The Boonton Radio Corporation, Boonton, N. J., are producing their new Type 100-A Q-Meter, a modern high-speed laboratory and factory instrument for the measurement of coils, condensers, resistors, and other circuit components. This instrument has been developed by engineers of the Radio Frequency Laboratories to fill the need for a completely contained instrument for measuring over a wide range of radio frequencies (50 kc to 50 mc).

Heretofore the Q of a coil has been determined by the assemblage of numerous pieces of equipment, by computations, and by repeated reference to calibration curves. The Q-Meter requires no additional apparatus for its operation. It contains a complete r-f oscillator, a measuring circuit consisting of a tuning condenser and the external coil which is being measured, a vacuum-tube voltmeter of special design which reads the voltage developed across the tuning condenser, and a means of introducing a known amount of the oscillator voltage in series in the measuring circuit.

The procedure in measuring Q consists of either adjusting the oscillator to a predetermined frequency and tuning the circuit under measurement to resonance, or conversely of tuning the circuit with a predetermined capacitance and adjusting the oscillator to resonance. At resonance the voltmeter indicates the Q of the circuit.

The outstanding characteristic of this instrument are the speed and facility with which measurements may be made due to the direct-reading frequency calibration of the oscillator, the self-contained oscillator coil system, the direct-reading calibration of the tuning condenser and of the Q voltmeter . . . and the fact that the cabinet design and location of controls on a sloping panel places the calibrated dials and controls directly under and on a plane normal to the line of vision.

There are two Q ranges on the meter, 0-250 and 0-500, while the tuning condenser range is continuously variable from 40 to 450 mmfd. The power supply operates from 100/120-volt, 60-cycle ac, with a power consumption of approximately 50 watts.

The Q-Meter is a more useful instrument than its name implies. It is a universal instrument with which the radio-frequency inductance, capacitance and resistance of coils, condensers, resistors, switches, insulating materials, etc., may be determined.

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NEW PORTABLE P-A SYSTEM

A new portable public-address and sound-reenforcement system for moderate-sized public places, compactly self-contained in a carrying-case and weighing only 28½ pounds has been introduced by the RCA Victor Commercial Sound Sales Department.

This unit is suited to the steadily growing market for an inexpensive portable sound system. It has been designed for such applications as window demonstrations in dealers' stores, counter-to-kitchen restaurant call systems, and for local fairs and carnivals. The new sound system is to be known as Model PG63-B and will be made available to radio and electrical supply dealers and service organizations through the regular RCA Victor Distributors . . . and in some cities through RCA Victor Commercial Sound Distributors as well.

Exceptional tone quality and simplicity of operation are two of the principal features which distinguish this low-cost system, according to Mr. W. L. Rothenberger, Manager of RCA Victor Commercial Sound Sales. The equipment has been designed so that actual operation is as convenient and fool-proof as that of an ordinary radio receiver, he said. It is only necessary to connect the power plug to the 110-volt, 50/60-cycle house-current supply, and plug in the microphone and speaker cables to set the system in operation. The loudspeaker, which is imbedded in the cover, may be separated from the rest of the carrying case and suspended from a hook within a 25-foot radius of the speaker cable. The microphone is of the close-talking type with 12 feet of extension cord. The complete unit measures 8½ by 16⅝ by 16 inches.

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BRUSH PIEZO-ELECTRIC HEADPHONES

The Brush Development Company, Cleveland, Ohio, have recently announced their Type A piezo-electric headphones. These are high-impedance units that are said to possess high current sensitivity and to find ready application in a wide variety of uses, being especially well adapted for monitoring work.

The piezo-electric drivers used in these Brush headphones are bimorph elements of

typical Brush assembly. Plates used in the bimorph elements are cut from Rochelle Salt crystals, in accordance with the methods developed by Brush technicians. In standard Type A headphones the two plates in the bimorph element are ⅝ inch square by 0.010 inch thick. They are cemented together in opposition and provided with silver electrodes. The unit is then water-proofed. Three corners of the bimorph element are cemented to thin rubber pads and secured in the case . . . leaving the fourth corner disengaged.

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THE TORK "TYMIT"

The Tork Clock Company, Mount Vernon, New York, have available a timing device to automatically turn on and off electrical appliances, such as, radios, lamps, refrigerators, fans, heaters, etc. This unit is equipped with two pointers which can be set for the time of day you wish some electrical appliance to start operation and the time for which you wish it to be turned off . . . and, if desired, left on those settings permanently.

These devices are available in two sizes. The No. 6 Tymit is a 600-watt plug-in type, for all domestic uses except oil burners. The No. 15 Tymit is a 1500-watt unit that may be installed for oil burner, sign, window, and indoor commercial uses. They come finished in black and chrome or walnut and chrome. Designed for operation on 115-volt, 60-cycle ac.

NEW CARBON RESISTORS

A new line of carbon resistors, obtainable in values as low as .04 ohm and in ratings from .25 watt to 10 watts, is now being manufactured by The Ohio Carbon Co., 12508 Berea Road, Lakewood, Ohio. They are known as the "Ohiohm LV" series and they conform to the same standards of load, voltage, life, overload and humidity characteristics already set by the company's regular line of Ohiohm carbon resistors of higher ohmic values. In fact, extended laboratory tests show

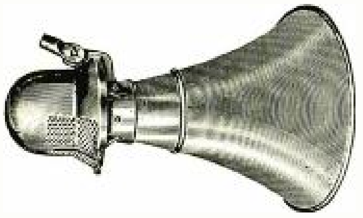
that these "LV" units will react satisfactorily under humidity conditions much more severe than those specified in the RMA tests, it is said.

Special attention has always been given to this "heat-humidity" condition because of the considerable export business done by the company, as well as in the form of completed receivers by its customers. Thus these resistors are often required to function correctly under tropical conditions where the moisture and heat are exceptionally severe.

•

"TURRET PROJECTOR"

An interesting new type of reproducer, known as the Turret Projector, has been announced by the Racon Electric Company, Inc., 52 East 19 Street, New York City. This is said to be a complete high-fidelity, high-efficiency loudspeaker. As supplied standard for public-address service, it consists of the new broad-band electro-dynamic cone speaker, which is mounted within an all-steel acoustically-damped bullet back, it is stated. This is coupled through a



heavy aluminum casting, through an especially designed all-aluminum bell section. A special mounting bracket provided with a pipe socket fitting is integral with the throat casting, and the complete assembly is balanced at the mounting bracket so that the projector can be mounted in practically any position. The complete unit is compact, durable, weatherproof, and is said to have a remarkably high efficiency in terms of audio input versus sound output. It is suited for all types of outdoor public-address service, and the single-unit construction makes it easy for public-address operators to set up on temporary installations.

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NEW HAMMARLUND I-F TRANSFORMERS

The Hammarlund Manufacturing Company, Inc., 424-438 West 33 Street, New York City, have recently announced their new variable-coupling, air-tuned, intermediate-frequency transformers. These new Hammarlund transformers are designed to permit continuous variation of the mutual inductance between primary and secondary through a wide range of values and without otherwise affecting circuit constants. The approximate range of variation is said to be from one-third critical coupling to over three times critical coupling. Continuous variation between these limits may be controlled from the receiver panel by means of suitable mechanical arrangements, or, where continuous variation is not necessary, the coupling may be adjusted to the desired value and locked at that point by means of a collar and set-screw provided for that purpose.

The transformers lend themselves to many types of mechanical actuating devices for securing continuous coupling variation by means of a panel control.

For panel control of selectivity several transformers can be mounted in line and their coupling varied simultaneously. However, widening out the transmitted band increases the depth of the notch in the center of the curve. With several transformers in cascade this notch may seriously affect tuning and fidelity. For this reason, where wide-band or high-fidelity reception is desired, it is advisable to use three transform-

ers . . . one fixed and two variable. The coupling of the fixed transformer may be adjusted to substantially level off the notch when the two variable units are close coupled. Where a wide flat top is required, and where extreme adjacent-channel selectivity is necessary, the above precautions do not apply and almost any number of transformers may be ganged together. When this is done a stop should be provided to limit the panel control so that coupling cannot increase to a point where the effect of the notch becomes objectionable.

These transformers are not available in center-tapped types. Where it is desired to couple the last transformer into a diode, Type AAT-CT transformers may be used.

Impregnated coils and low-loss air-dielectric condensers are said to result in a highly stable unit regardless of conditions of temperature or humidity. The transformers may be used with any screen-grid tubes normally used as i-f amplifiers. Both tuning adjustments are on one side of the aluminum shield.

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NEW PRESTO NEEDLES

The Presto Recording Corp., 139 West 19 Street, New York City, have just informed us that for a long time there has been considerable difficulty in obtaining steel cutting stylii for cutting celluloid discs as well as their special coated discs. These stylii were imported from Europe, but were very unsatisfactory because of the poor workmanship and the material used. At that time there was no manufacturer in the United States that could make these cutting stylii. However, these stylii are now being manufactured exclusively for Presto and under their own specifications, it is stated. These needles are now in production and deliveries are being made.

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NEWS OF THE INDUSTRY

(*Continued from page 26*)

MANUAL FOR FOREMANSHIP DEVELOPMENT

The importance of supervisory forces in the present-day industrial organization emphasizes the need for the adequate and simplified plan for the training of foremen and other supervisors, contained in the manual "Foremanship Development." The manual is based upon the experience of the Westinghouse Electric and allied companies, and that of others who have been active in supervisory training. It is intended for both group leaders and the members of conference groups.

The first part briefly presents the increasingly important place which the foreman and the supervisor hold in industrial organization. Then follows a series of practical suggestions for conference leaders, including underlying fundamentals, suggested methods, conference technique, self evaluation for leaders, a working library, etc. The final section outlines a series of 38 conferences on major problems in foremanship, including outlines for discussion on collective bargaining, foremen as managers, as leaders, labor turnover, waste, developing understudies, company policies, wages, cooperation, self analysis, and similar topics.

The price is one dollar per copy.

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STATISTICAL NUMBER OF "ELECTRICAL FOREIGN TRADE NOTES"

Realizing the desirability of statistics on the electrical industry, *Electrical Foreign Trade Notes* have issued their First Annual Statistical Number. This number contains statistics on the following: United States Electrical Exports, 1901 - 1934; United States Exports of Electrical Goods by Classes, 1913-1934; United States Imports of Electrical Apparatus by Classes and Countries of Origin, 1934; World Electricity Production by Countries, 1924-1933; World Power Consumers by Countries; Outstanding Facts for the Electric Light and Power Industry, United States, 1927-1934; Weekly Output of Electric Light and Power Industry, United States, 1928-1935; Pounds of Coal Used per KWH Generated in the United States, 1892-1933; Estimated Sales of Electrical Merchandise in the United States, 1926-1934; Estimated Saturation of Market for Electrical Appliances in the United States, Jan. 1, 1935; Average Cost of Electricity for Household Use in the United States, 1882-1934; Farm Electrification in the United States, 1923-1933; Radio-Receiving Sets and Broadcasters by Countries, 1935; Sales of Radio-Receiving Sets by States in 1934; Saturation of Market for Radio-Receiving Sets, United States, Jan. 1, 1935; Total Broadcast Advertising Volume, 1934; Radio-Set Ownership by Principal Cities of the United States; and many other statistics of interest.

The *Electrical Foreign Trade Notes* are prepared under the direction of Andrew W. Cruse, Chief of the Electrical Division, Department of Commerce, Washington, D. C. This statistical number is available for ten cents a copy.

THE average *paid* monthly circulation of Radio Engineering for the last 6 months of 1934 was 5,028. Total monthly distribution approximately 5,700. (See A. B. C. Audit figures.)

The paid circulation today is approximately 5,400 with a total distribution of well over 6,000.

THE JUNE number will have extra distribution of several hundred copies at the I. R. E. CONVENTION in DETROIT, JULY 1, 2, and 3.

Advertising Forms Open Until June 10.

INDEX TO ADVERTISERS

Communication and Broadcast Engineering

The monthly journal for engineers and executives in the fields of telephony, telegraphy, radio broadcasting and communication, aeronautical, police and marine radio, signalling, etc.

Recent Numbers of Communication and Broadcast Engineering have carried the following articles:

N. B. C.'s Studio System	by T. H. Phelan
High Fidelity Remote Pickup Equipment	by John P. Taylor
Maintaining and Measuring the Frequency of Transmitters	by V. J. Andrew, Ph.D.
Coupling the Broadcast Antenna to the Transmission Line	by Paul Rosekrans
An Efficient Remote Amplifier	by J. C. Bailey
Accounting System for Broadcast Engineers	by R. C. Powell
WOR's Directive Antenna	by J. F. Morrison
Design of Pads	by L. W. Barnett
Ultra High Frequency Police Radio	by Paul F. Godley
Concentric Transmission Line at KDYL	by John M. Baldwin
High Fidelity Broadcasting	by John J. Long, Jr.
Commercial Radio Trends	by Haraden Pratt
Continuous Aural Frequency Monitoring	by Robert C. Moody
Temporary Vertical Radiator Construction	by George Brown

Departments in each number cover New Products and Equipment, Federal C. C. Activities and Reports, "Telecommunication," Maps of Communication and Broadcast Systems, etc.

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$84.50 With RCA Tubes, Including RCA 906 Cathode Ray Tube

for . . .

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- ★ visual alignment of circuits
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- ★ detection of wave shape distortion
- ★ study of R-F Voltage wave shapes
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The RCA Frequency Modulator, price $27.50, and the RCA Test Oscillator, price $34.50, Type TMV-97-C, are auxiliary instruments for aligning radio circuits with the RCA Oscillograph. The Frequency Modulator is a combined motor-driven capacitor and a-c generator. The Test Oscillator has a range from 90 to 25,000 kc.

SPECIFICATIONS

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SWEEP CIRCUIT—Linear "saw-tooth" oscillator, adjustable from 20 to 15,000 cycles, positively synchronized with voltage under test by special circuit. Binding posts also for external synchronization.

AMPLIFIERS—Horizontal and vertical. Linear from 20 to 90,000 cycles ±10%. Amplifier gain is approximately 40.

NEW APPLICATIONS

The RCA Cathode Ray Oscillograph, the X-Ray of the engineer, can be used to interpret any phenomenon which can be represented electrically, as well as for the more common use of examining alternating current wave shapes, phase relations, or any intermittent electrical currents.

New applications of the Cathode Ray Oscillograph are being discovered constantly in the RCA Victor research laboratory. Correspondence regarding your possible use of the RCA Oscillograph is invited.

Write to RCA Parts Division, Camden, N. J., for Instruction Book RE and treatise on Oscillographs

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