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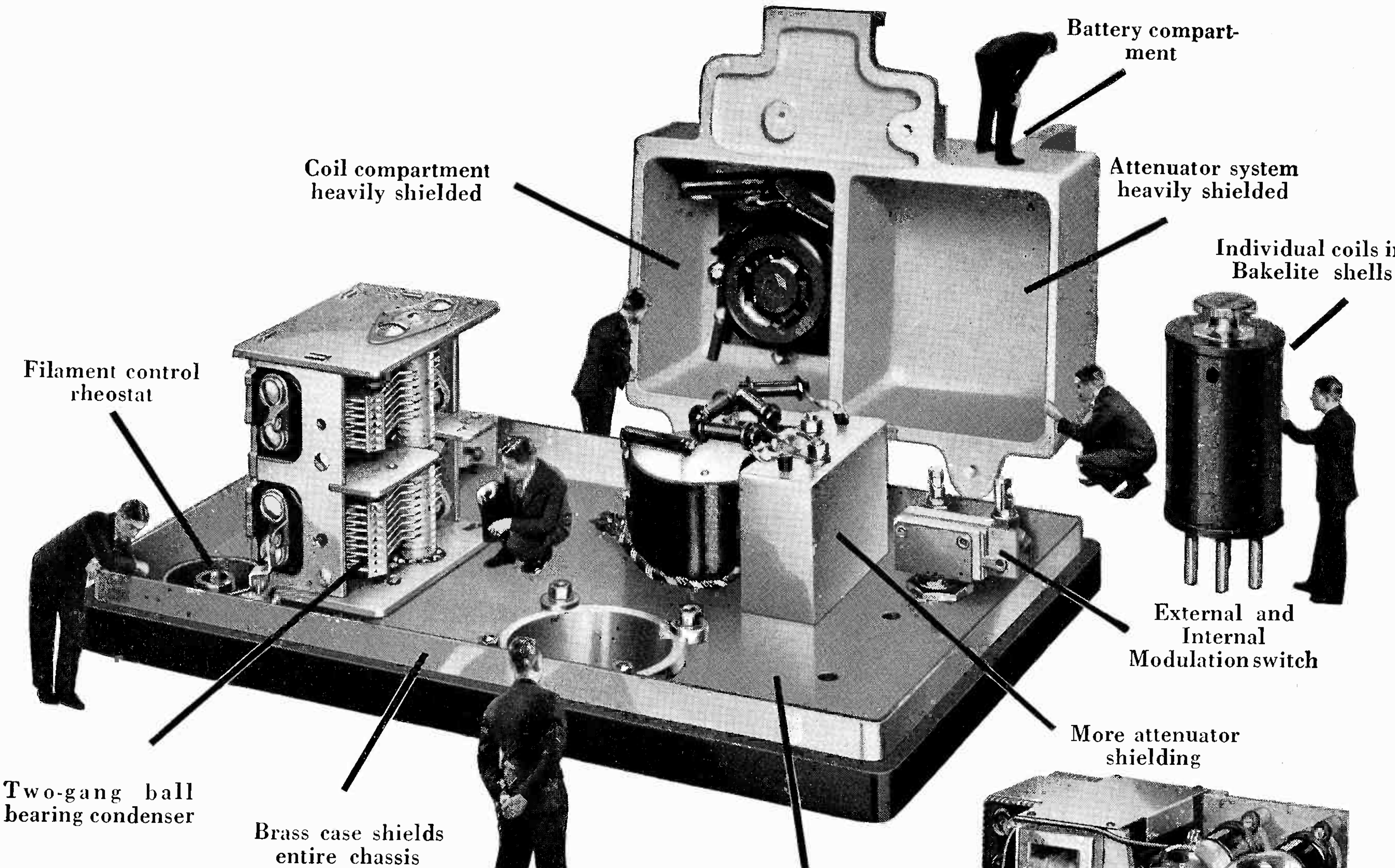
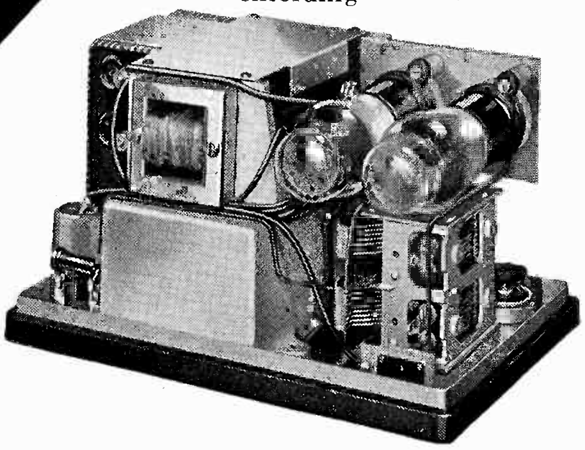
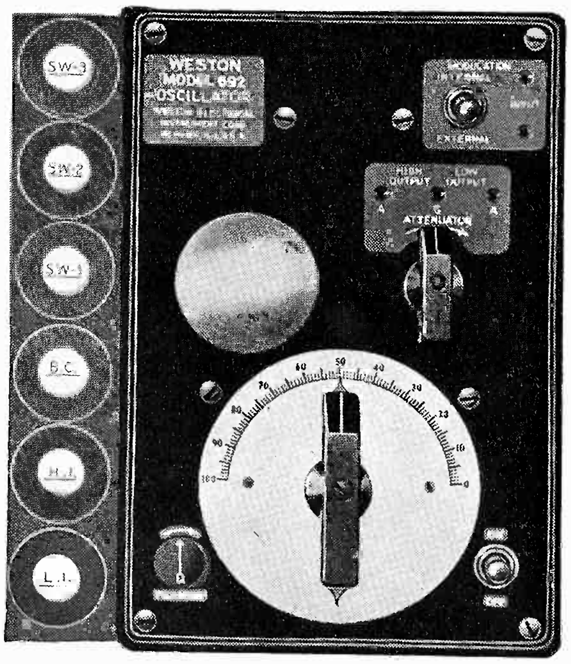




View showing chassis assembled and wired, without enclosing brass case



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ELECTRONICS, June, 1935. Vol. 8, No. 6. Published monthly, price 35c. a copy. Subscription rates—United States, $3.00 a year. Canada, including duty, $3.50 a year. All other countries, $4.00 a year or 16 shillings. Entered as second class matter, April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C.

Printed by The Schweinler Press, N. Y.

NEW YORK:
McGRAW-HILL
PUBLISHING
COMPANY, INC.

electronics

June 1935

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The radio engineer and business

THE radio industry was brought into existence by the accomplishments of the engineer. Radio could not go on without the engineer. He and his works are the very heart of radio's present—and future.

Yet the radio engineer today plays only a secondary role in the direction of the great industrial operations he has created. Laymen without radio knowledge are usually the ones who man the high positions—leaving the engineer only the role of consultant whose ideas are accepted grudgingly and even with irritation. Few engineers are found on the lists of executives; companies have vice-presidents of this or that, but "vice-presidents of engineering" are mostly missing.

ENGINEERS in other fields have better standings. In chemical and mechanical engineering, engineers are more often principals—owners, presidents, executives of their businesses. In the electrical industry engineers are taking increased responsibility for management and leadership of great organizations. But in radio, most technical of engineering enterprises, the engineer has allowed himself to be subjugated.

By his own knowledge who but the radio engineer is best qualified to see the broad outlines of radio's present problems and future development? He has made his mistake in not regarding himself as a business man as well as technician, and seeing his productions clear through to the buyer.

RADIO needs more radio men at the helm. Radio will be a better business when radio engineers become more business-minded and take their rightful posts at the top!

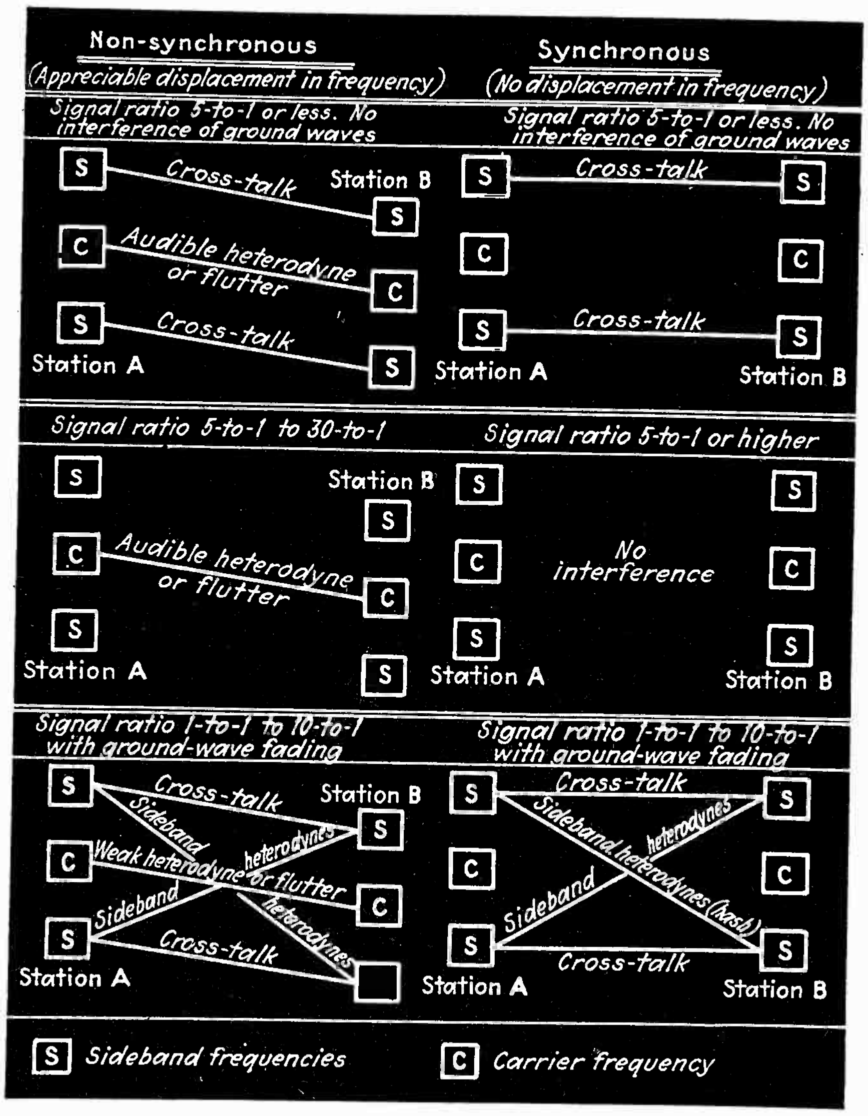
THE PRESENT-DAY STATUS OF

Three systems now operating successfully point way to expansion of broadcast facilities

EVER since broadcasting became a major industry it has been clear that the demand for wavelength assignments far exceeds the supply. This fact has been the cause of many gray hairs in the Federal Commission in Washington, who have strived to grant requests for more broadcast-station facilities without destroying clear channels or adding to the interference on shared channels.

The situation has been aggravated by the great political pressure exerted to secure higher station powers and frequency assignments for new stations. Sooner or later it will be no longer possible to avoid increasing interference when a new station goes on the air. This saturation point is not far away, but the demand for additional facilities by commercial, fraternal and educational interests is unabated.

One of the most immediately practical means of opening up new channels for broadcasting without increasing interference lies in the synchronizing of transmitters. Synchronizing, which means simply maintaining the carrier waves of two or more transmitters on the same frequency, within the narrow limits of about one-tenth of a cycle, will not cure all kinds of interference, but it will lessen the interference between stations on shared channels, and it will permit more stations to share the same



A symbolic comparison of types of interference experienced under synchronous and non-synchronous operation of broadcast stations

channel. Comparisons between the types of interference experienced with synchronous and non-synchronous transmission are given in the diagram to the left. It will be noted that under conditions which are practically realizable, no interference whatever occurs between synchronized stations.

Effects of synchronizing on reception

When two stations share the same channel simultaneously, a variety of effects may be noticed at the receiver, depending upon the relative location of receiver and transmitters, and upon the difference between the carrier frequencies of the two stations. If the difference between carriers corresponds to an audible frequency, *i.e.,* 20 cycles or more, a heterodyne note of that frequency will be heard in the receiver, even though the ratio of signal strengths received from the two transmitters may be as high as 20 to 1 or higher. Under the regulations of the FCC, it is possible to obtain beat notes as high as 100 cycles per second between stations operating on the same channel, since each is allowed to deviate from its assigned frequency by 50 cycles. Actually, very few audible beat notes arise, since frequency deviations of more than 10 cycles are rare. But even though there is no audible beat note, an inaudible beat usually exists which may give rise to an audible annoying "flutter effect," often noticed on shared channels at night. This flutter arises from the interaction between the inaudible beat note and the noise components received by or generated in the receiver. Finally, even though heterodyning or flutter may not be present, if the signal strengths received are nearly the same, say one-to-one or two-to-one, cross-talk will occur, since both programs will be detected by the receiver.

If the carrier frequencies are precisely the same, *i.e.,* exactly synchronized, no audible or inaudible beat note can occur, and no fluttering appears. Exact synchronism is an ideal which can be approached but never attained, because of the "elastic" quality of even the best frequency control, so the error which can be tolerated must be decided. Most systems of synchronizing used today will maintain the two transmitters in synchronism to within 0.1 cycle, or 36 electrical degrees. This is considered to be the highest allowable deviation for successful synchronous operation; one system, it is claimed, maintains control within one or two electrical degrees.

Since heterodyning and beat notes are eliminated by synchronous operation, trouble arises only when the signals received from two synchronized stations are of approximately the same strength, *i.e.,* ratios from a one-to-one to 10-to-1. When the signals are approximately equal cross-talk is the absolute limitation; it can be cured only by the use of the same program on both stations. Even if the same program is used, still another difficulty arises due to wave-interference between the ground waves of the two stations. When the carriers of the two stations arrive out of phase, they tend to cancel out, while the sideband frequencies, being of different wave-

BROADCAST SYNCHRONIZING

Improved reception conditions and wider service areas possible. A review of methods used

length, do not. With the carrier much reduced, beating between the sidebands occurs, and the result is a very disagreeable type of distortion.

There are secondary effects of minor importance, but cross-talk and side-band "hash" are the most important technical difficulties which arise between synchronized stations. These difficulties have the practical effect of limiting the separation of the stations to not less than 200 miles. The limiting distance depends to a certain extent upon the power of the stations involved and upon the type of radiation system used in each case, upon the attenuation constant of the surrounding territory, and the population distribution. Under ordinary conditions, two 1,000-watt stations should be separated by at least 200 miles, when sending the same program. Otherwise sideband "hash" will occur within the primary service area of both stations. Between 100-watt stations, the distance may be reduced to 100 miles.

In addition to the requirement of synchronism within 0.1 cycle, it is necessary to synchronize the program circuits when both stations use the same program, as is usually the case. The delay introduced by wire lines averages about 7 milliseconds per 100 miles, so that if the program lines of the two stations differ in length by several hundred miles, a considerable lag may be introduced. In the regions where signals from both stations are received, the resulting echo is quite distinct.

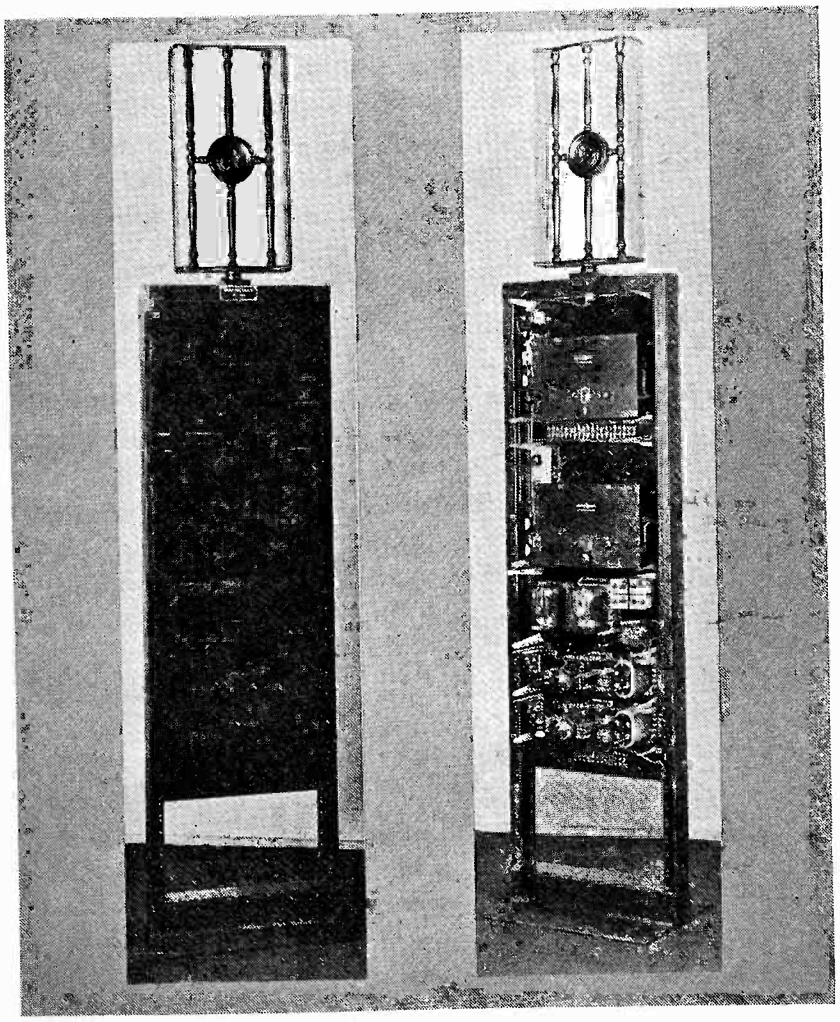
The use of wire lines to carry the synchronizing frequency between the stations introduces several important factors which determine the type of apparatus used. First, the reference frequency must be of audible or at most barely super-audible frequency, otherwise it is impossible to send sufficient energy over the distances required. In the second place, the lines are subject to casual phase shifts and amplitude changes which give an "elastic" quality to the control exercised by the line. In other words, although the average frequency may be maintained with great accuracy, the frequency at any instant may depart from the average by amounts sufficient to throw the two stations temporarily out of synchronism. Various schemes have been devised to overcome these line variations, or at least to lessen their effect on the control. The methods used are well illustrated by the following descriptions of apparatus used by synchronized stations now operating.

WBZ-WBZA in Boston and Springfield, Massachusetts

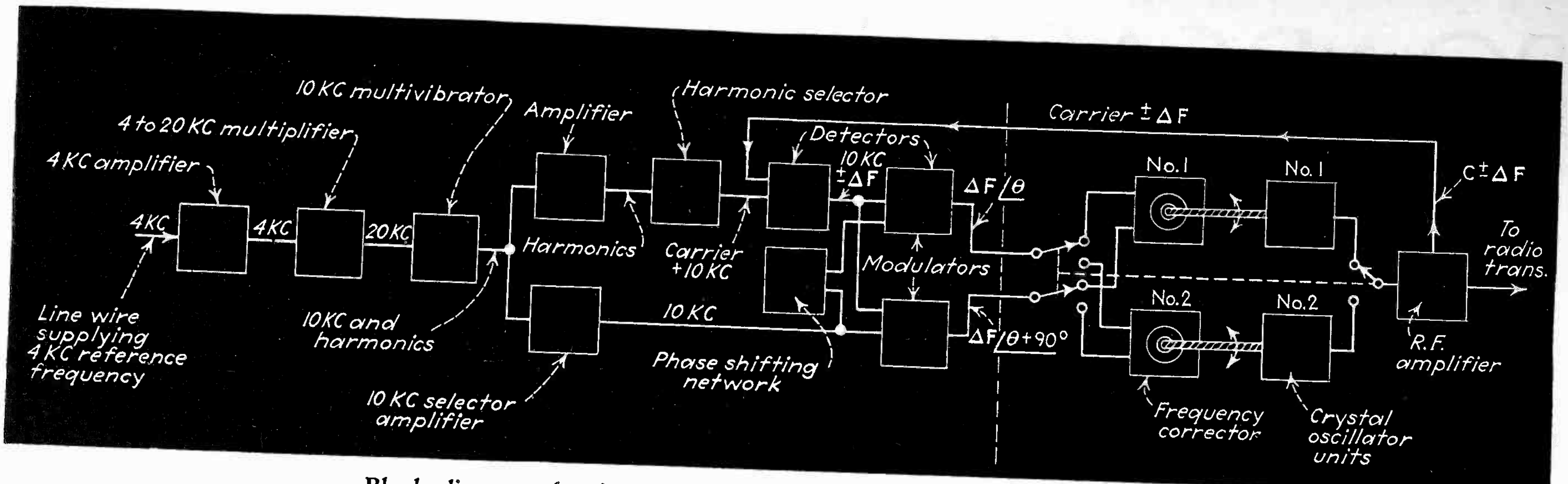
Westinghouse Stations WBZ, 50,000 watts, located at Millis, Mass., and WBZA, 1,000 watts, at Springfield, are operated synchronously, using apparatus developed and installed by the Radio Division of the company. The carrier frequency of the stations, 990 kc., is generated by a stable crystal oscillator at the Springfield station. This frequency is then divided by stable multivibrators 72 times, giving a reference frequency of 13.75 kc., which is then fed through balanced line amplifiers to a program circuit leading to the transmitter at Millis. This program circuit, a single open-wire pair, carries the regular inter-station program, in addition to the reference frequency. Low-pass audio filters having a cut-off at 10 kc are installed at both ends of the line to separate the program from the 13.75 kc reference frequency. The frequency of 13.75 kc is sufficiently low to be transmitted with sufficient level over the short (70-mile) connecting line and still high enough to be well out of the program range.

At the Millis station, the reference frequency from the line is received in a balancing network, amplified through a saturated amplifier whose output is substantially independent of changes of amplitude in the input circuit, and multiplied back to 990 kc. The output of the final multiplier, after passing through a two-stage crystal filter and a buffer, is used directly as the excitation frequency of the transmitter at Millis. Since adverse weather may cause line failure resulting in the loss of the 13.75 kc reference frequency, an automatic relay system is provided to control an emergency crystal oscillator, maintained at normal operating conditions at all times, thus always assuring the proper operating frequency for the transmitter.

This system, the pioneer synchronous installation in this country, has been in continuous commercial operation since 1926. There are several contributing factors which make it possible to synchronize two stations sepa-



Front and rear views of receiver used midway between WHO and WOC, for determining the degree of synchronism between those stations. Manual control was used in this installation



Block diagram showing synchronizing apparatus used at WBBM-KFAB

rated by such a short distance (65 miles air line). Most important is the extremely high attenuation of the territory surrounding both stations. The rocky, dry soil has the effect of producing relatively compact areas of high signal strength. Secondly, the areas in which the signals from the two stations are of comparable intensity are narrow, well-defined, and located in very sparsely populated regions. A directional antenna, used at the Millis transmitter reduces the signal level in these zones. The interference pattern is apparently stationary, showing that the degree of synchronism is very high.

WJZ-WBAL at Bound Brook and Baltimore

WJZ's 50,000-watt transmitter at Bound Brook, N. J., operating on 760 kc. provides a synchronizing signal for WBAL, 2,500 watts, at Baltimore, 150 miles distant from Bound Brook. The stations are synchronized during the night time transmissions only; during the day, WBAL operates on a channel (shared with KTHS in Hot Springs, Ark.) of 1,060 kc with 10,000 watts power. The equipment used for synchronizing is the result of several years of development under the direction of C. W. Horn, Director of Research and Development of the National Broadcasting Company, which company installed the equipment.

In the primary service area of both stations, no interference from either station is experienced by the other. "Hash" areas are known to exist between the two stations, but these have been made to fall in unpopulated regions, and have been localized sufficiently so that the distortion may be overcome by the use of a long antenna (such as a capacity connection to the telephone lines). The use of a directional antenna at WBAL, proper proportioning of power between the stations, and very exact synchronizing have been necessary to secure the present high degree of satisfactory service. No complaints of poor reception which can be traced to the synchronous operation have been received.

According to Mr. Horn, one of the important problems in this installation was maintaining synchronism to within three or four electrical degrees, so that the pattern of the distortion areas would remain stationary. This high degree of precision cannot be maintained by wire lines, except as the line variations are averaged over a long period. It is necessary, therefore, to provide a very stable frequency source at each transmitter whose frequency could be compared with the average frequency received from the line, but which would not follow the instantaneous variations in the line. Such a "fly-wheel" effect is produced in this case by the use of a highly accurate temperature-controlled tuning fork. The reference frequency, 4,000 cycles per second, is supplied by the master frequency source of the Bell System, the Marrison clock in New York, which maintains an accuracy of nearly 1 part in 100,000,000. This frequency is used to control both WJZ and WBAL.

The 4,000-cycle signal is received from the line, amplified through a saturated amplifier and buffer stages, and applied directly through an electromagnetic drive to the tuning fork. The tuning fork tends to maintain a very accurate frequency of 4,000 cycles of its own accord, but if it deviates from that value, the control from the line pulls it back. The vibration of the fork induces a voltage in a second coil, which, when amplified and multiplied, provides any frequency from 1,500 to 550 kc. The 760-kc frequency is picked off and used as the excitation frequency for the transmitter. The inertia of the tuning fork system prevents incidental variations in the line from exercising any control, but allows the average frequency whose accuracy is extremely high, to maintain control.

This system, while highly satisfactory, is not the final form of synchronizing developed by NBC. The problem is still being studied by this organization, and refined methods of obtaining even closer approaches to absolute synchronism are now in process of development.

WBBM-KFAB, Chicago and Lincoln, Nebraska

WBBM operates on a frequency of 770 kc, with 25,000 watts power; KFAB, synchronized with WBBM, operates with 5,000 watts power, at a distance of 480 miles from the WBBM transmitter. These stations have been operating synchronously since January, 1934. The equipment used is the standard Western Electric Synchronization System, developed by the Bell Telephone Laboratories.

The system used, shown in the accompanying illustration, operates as follows: The standard Bell System 4,000-cycle signal is received over the wire line, and is amplified at 4,000 cycles. A 5-times multiplier increases this frequency to 20 kc, the output of which is fed to a multivibrator which provides 10 kc. and all the harmonics required for any broadcast frequency up to 1,500 kc. (the 150th harmonic). These harmonics are then led to a circuit which amplifies them and selects the one which is 10 kc. higher than the desired carrier (in this case, the case of WBBM-KFAB, this is 770 plus 10, or 780 kc.). A portion of the carrier output of the transmitter is mixed with this 780 kc. in a detector whose output therefore consists of 10 kc. plus or minus whatever frequency deviation is present in the carrier of the station. By another path the 10 kc. fundamental of the multivibrator is amplified and applied, through a 90-deg. phase-shifting network, to a detector where it is mixed with the 10 kc. ± Δf. The result is Δf/θ, the deviation from the correct frequency with an arbitrary phase angle. In a separate circuit the 10-kc. multivibrator output is combined with the 10-kc. ± Δf, but without the phase shift. The result is Δf/θ + 90° with the same arbitrary phase angle, but advanced 90 degrees.

These two outputs, Δf/θ and Δf/θ + 90° are fed to a two-phase synchronous motor which is connected mechanically to the trimmer condenser in the crystal control circuit of the transmitter. When a frequency deviation appears, the voltages acting on the motor cause it to turn in the proper direction to correct the deviation. The time-lag involved is appreciable, but small enough to give practically continuous correction. Duplicate frequency correctors and crystals are provided.

According to reports of the engineering staffs of these stations, the system has operated with complete success since its installation. It has been found that if the carriers of the two stations were synchronized to within 0.5 cycle, no adverse effects could be noticed by trained observers using modern receivers, even when the signals were at their extreme low fading level.

SOME POSSIBILITIES OF SYNCHRONIZING

What a new broadcast reallocation might show

THE present broadcasting structure was set up in November, 1928. Since that time, nearly seven years ago, a number of new factors, new requirements, and new advances in the art, have come into the broadcasting picture. Among these are:

- Chain-broadcasting nation-wide service.
- High-fidelity receivers (50-7,500 cycles).
- Demands by Canada, Mexico and Cuba for additional channels.
- Directive antennas for broadcast stations.
- Demands by educational groups for additional stations.
- High advertising rates obtainable for local broadcasts.
- Demand for additional regional and local stations.
- Synchronizing improvements.

With all of these new requirements and new possibilities in mind in 1935, what kind of a broadcast allocation could be made today, utilizing the advances in broadcast technique, and providing improved and increased service for the listening public?

Synchronizing has now reached a degree of successful operation, in isolated cases, which leads its proponents to offer it as a means of greatly increasing the radio facilities on the present broadcast band.

Synchronizing, they point out, could be used in two ways to relieve the existing pressure on the broadcast channels. First, under synchronized operation a number of chain transmitters carrying the same program, could be operated on one or more channels, freeing channels for other uses. Second, by synchronizing the carrier frequencies of stations sharing regional and local channels, such stations, though carrying different programs, could be operated at geographical separations much less than at present; permitting many more stations to share the same channel.

Synchronized chain programs

Applying these two principles to a new allocation—"starting fresh"—let us see what results might be obtained.

First, in the matter of operating chain programs on a synchronized basis:

In place of a single network program now heard on 20 or more channels, a whole network (80 to 100 stations, or more) might be put on two or three synchronized channels, adjacent to each other—insuring good coverage with a clear signal at all points. While between stations on the same channel there might be "hash areas," yet by using several channels, and by staggering stations, any areas of interference distortion between stations on the same channel would be well covered with good service by the stations on the adjoining channels.

Thus, a given network program might be listed as operating on, say, "750 kc."—that is, within a channel or two of 750 kc., depending on the locality. Thus, "750 kc." would be the designation for this network program for the entire country; which would be an advantage. At the same time, for the listener no more effort would be required for tuning into the channel carrying the "best signal" than "centering" present sets which are rarely calibrated exactly—and which require some "hunting around" to get the best reception. The listener would merely tune in this region until he found the best tone quality.

In addition to the three synchronized channels for network, one clear-channel super-power station (500 to 2,000 kw.), carrying the same network program, might be provided for covering rural districts over a wide territory. Under such a plan, a network of 90 or more stations covering the principal cities and trading centers of the United States, would be handled by three or four channels.

Chain executives have long lamented the fact that they have not had their own local broadcasting outlets. Instead, they have had to enter into trading agreements with independent stations which are free to "take or refuse" nationally sponsored programs, depending on whether the time can be sold locally at a more advantageous price. In place, then, of the present unsatisfactory arrangement—by adopting synchronizing, a more

USING SYNCHRONIZING:—

the present broadcast band (550 to 1600 kc.) might be rearranged to provide

- High-fidelity (20-kc.) channels
- Chain programs on three or four adjoining channels, (each chain program at an established dial position wherever heard)
- Facilities for five or more nation-wide chains
- Super-power clear channels for rural coverage
- Chain stations delivering chain programs exclusively
- Additional regional and local stations for profitable local operation
- Additional stations for educational, fraternal and religious groups

practical chain set-up could be conceived, whereby each broadcast chain would wholly *own* all its local outlet stations, and these stations would then become purely chain-program outlets, broadcasting the network programs from 6 a.m. till after midnight, daily. Such chain outlet stations could be grouped on three wavelengths, the spacings and power being so chosen that any areas of interference on one channel would be covered by the same program on an adjoining channel.

Providing 20-kc "high-fidelity" channels

Since the future high-fidelity radio receivers will demand that for best service the broadcast channels be considerably wider than the 10-kc channels set down in the original allocation of 1928, advantage should be taken of the new allocation to secure, say, 20-kc channels for high-fidelity service, as indicated in the accompanying tabulation. And since undoubtedly additional chains will soon have to be provided for, it might be timely to arrange that all these chain channels be 20 kc in width.

In the accompanying allocation table, provisions have therefore been set down for five chains. Three of them have four 20-kc channels (the fourth channel being for a single exclusive super-high-power transmitter, broadcasting that same chain program). Two other chains are also provided for with three 20-kc channels, but omitting the associated high-power, clear channel.

In addition, it might be well to provide at least seven super-power, clear channels, for independent stations of 500 to 2,000 kw, these channels also to be each 20 kc wide, or twice the present channel width.

So far we have used up 50 of our present 10-kc channels, out of the 106 in the broadcast band (550 kc to 1,600 kc), so that we still have 56 channels to assign for other purposes.

Suppose we allot 40 of these channels to regional use, for 1,000-watt stations. Applying the separation distances which should be satisfactory for synchronized service, at least 12 stations per channel could be taken care of. This assumes that with synchronized carriers, stations can be operated at separations corresponding to those for unsynchronized stations of one-fifth the same power, as authorized in the separation tables of the FCC. The 40 regional channels would therefore provide space for 480 stations if synchronized. For these regional stations, as for the locals, only 10-kc channels are provided.

On the local channels, 100-watt stations when synchronized can be located at such intervals that 100 or more can be handled per channel. In this way 600 local stations of 100 watts or under could be operated on the six local channels—probably enough to meet any demand that will arise for local 100-watters for some years to come.

The "exclusive channel" needs of Canada, Mexico and Cuba are still to be taken care of—but these countries could be adequately served with high-power broadcasting by, say, ten channels. Moreover, by synchronizing these channels would be available on both borders—ten in Canada, and also ten in the South (when they would be divided between Mexico and Cuba), and should be reserved for high-power broadcasting in those countries. The 40 "regional" channels and the six "local" channels already mentioned would also be available for use in Canada, Mexico and Cuba with the same separations as obtained in the United States. It has always seemed an absurdity that in the "gentleman's agreement" with Canada, any channels were set aside as "shared Canadian wavelengths," when in fact the whole band of United States regional and local channels might be just as freely used "above the border" as below, providing similar separations were maintained. Of course, most of the Canadian cities desiring regional stations are very close to the United States border, and this to some extent limits the freedom of placing regional stations in the United States. But with the shorter separations needed with a synchronized set-up, stations on both sides might be brought in much closer to the border.

Would provide for 1527 stations

An allocation based on the use of synchronizing, as above outlined, would occupy the 106 present channels

[*Please turn to page 183*]

A Broadcast Allocation Contemplating Synchronizing, High Fidelity and High Power

Class of service	Number of new channels	Present 10 kc. channels occupied	Number of stations provided for
Chain A*	4 20-kc. channels	8	90
Chain B	4 20-kc. channels	8	90
Chain C	4 20-kc. channels	8	100
Chain D	3 20-kc. channels	6	80
Chain E	3 20-kc. channels	6	80
Clear-channel super-power stations 500 kw. to 2000 kw.	7 20-kc. channels	14	7
Regional 1 kw.	40 10-kc. channels	40	480
Local (100 watts)	6 10-kc. channels	6	600
Exclusive channels to Canada, Mexico and Cuba	10 10-kc. channels	10	
Total		106	1527 stations

* Chains A, B and C would each use three synchronized multi-station channels and one clear channel for a super-power station,—all four channels carrying the same chain program.

Play-back recording methods for broadcasting

By W. E. SCHRAGE
230 West 97th Street
New York, N. Y.

THE problem of efficient sound recording in radio studios has been a very serious one since broadcasting began. The usual method of recording speech and music on a wax record, as used in this country and abroad, is not entirely satisfactory. The so-called lateral wax cut, for example, cannot be used to record and reproduce audio frequencies above 4000 cycles without great expense, if reproduction direct from the wax cut is desired.

A comparatively better method of sound recording is given by the vertical recording method, often referred to as "hill and dale recording." It reproduces directly frequencies up to 5000-6000 cycles. This method, mainly developed in this country, has apparently not been used in European broadcast stations—at least not for direct playing from the wax.

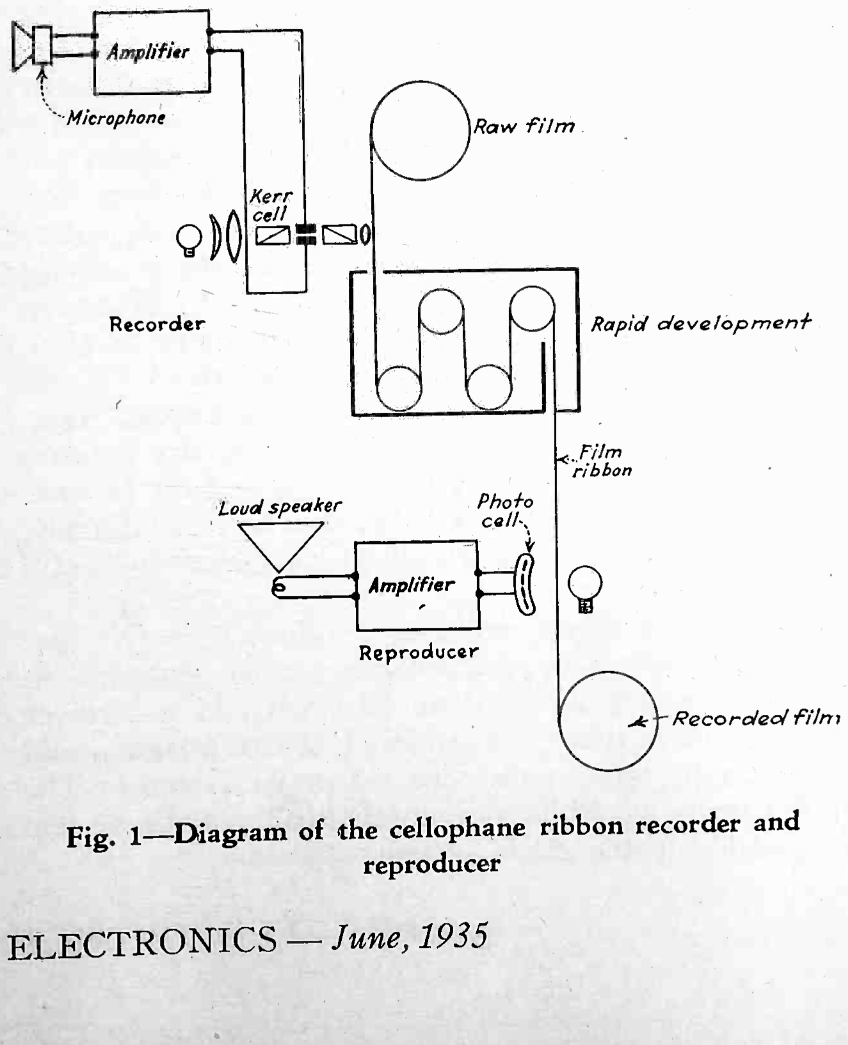


Fig. 1—Diagram of the cellophane ribbon recorder and reproducer

Much attention has been paid in England and Germany during the last years to the so-called steel-wire and steel-ribbon recording method invented by Poulsen in the year 1900. According to the current variations, similar strong or weak magnetic impressions are recorded on the steel wire. These magnetic recordings are retransformed into electrical impulses by means of an electromagnetic pickup.

The German company "Echophon Ltd.," Berlin, has sold during the last 10 years many steel-wire recorders for use in offices for recording of dictation, etc. However, for use in broadcasting stations the steel wire cannot be recommended.

New method uses cellophane strip

Another interesting method of sound recording has recently been tried in Germany. It is an application of the well-known sound track used in sound recording for "talkies." In the new method a small cellophane or celluloid ribbon only 0.1 inch wide contains the photographically recorded sound. All frequencies between 60 and 9000 can be recorded with fluctuations not exceeding 5 decibels over the full range. The speed of the ribbon is only 90 feet per minute, about 1/20 of the speed necessary for steel wires. The quality of the reproduction is far superior to the quality obtainable by means of steel wire.

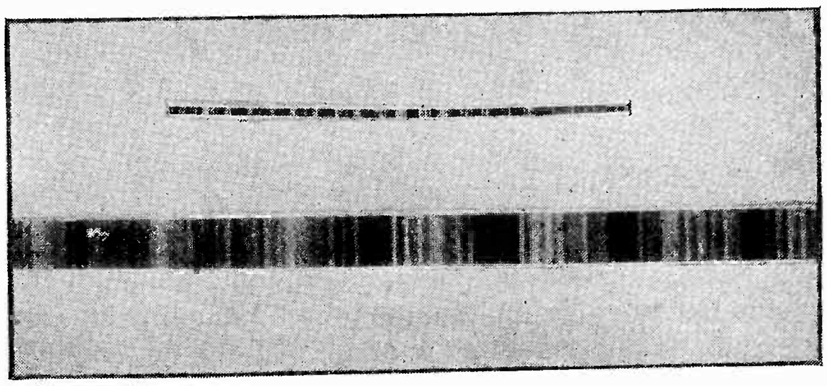


Fig. 2—Actual size and enlarged view of the cellophane strip

As shown in Fig. 1, the sound is recorded upon the film ribbon by means of a Kerr cell as light valve. This valve records the sound in the so-called variable intensity manner. Through rapid development methods the development process can be shortened to about 15-25 minutes without destroying much of the quality. If rapid development is used the negative film will be used for the reproduction. If three hours time are available a first-class positive print can be made. There are also experiments to utilize the so-called "Umkehrfilm" (inverse film) for reproduction. This kind of recording method makes it possible to obtain dark-black sound scripts direct upon the negative ribbon without special printing, etc.

Very interesting experiments in this line have been made recently in Austria. Instead of the celluloid or cellophane ribbon, photographic paper has been used. While the recording process is similar to that described above, (light valve), the pickup uses the reflection method, as often applied for picture telegraphy. The Austrian method is, according to reliable reports, about 70 per cent cheaper than the German one. However, the response curve of this kind of recording covers only the frequency range from 60-6000 cycles.

A variable selectivity superheterodyne

"XPS" applied to medium-priced receivers of higher fidelity

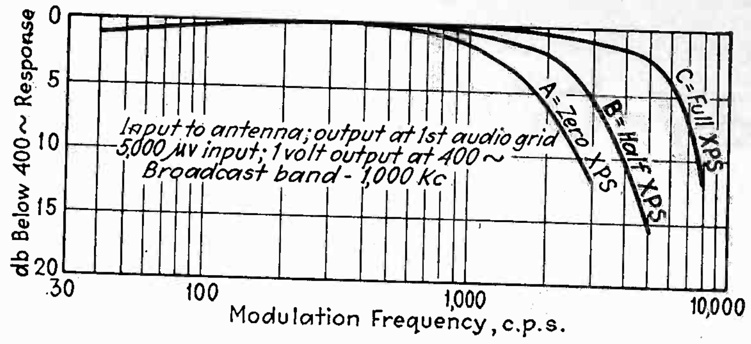


Fig. 2—Electrical fidelity of high frequency circuits, range 2

THERE is unquestionably a growing demand by the listening public for a broadcast receiver capable of reproducing speech and music with a degree of fidelity closely approximating the actual production in the studio. The technical conditions surrounding the existing broadcast structure are such that receiver design up to the present time has been governed by an attempt to secure selectivity at the expense of fidelity of reproduction.

An attack on this problem was undertaken in the Hazeltine Laboratories some time ago, and the first results of this work were described in the series of papers which were delivered at the Philadelphia I.R.E. convention a year ago. Since that time the Laboratories have undertaken further development work with the idea of applying these developments to radio receivers in the lower priced brackets so that the usable advantages of higher fidelity could be made available to a wider range of listeners.

The system described in this article eliminates the compromise between selectivity and tonal fidelity which has been necessary in practically all receivers produced to date. It restores to the user a control over those two conditions in such a way that he can use either maximum selectivity, maximum fidelity, or any compromise between the two which best meets the existing condition for the station that he desires to listen to. With the arrangement provided, he can secure a greater degree of selectivity than is possible with radio receivers of the fixed selectivity type; or he can secure greater fidelity wherever local conditions permit.

In this system a single control member serves the dual purpose of adjusting the selectivity of the receiver and altering tone quality. A system of this character has several practical advantages, some of which may be enumerated as follows:

(1) Assume that the listener prefers a tone rich in the lower frequencies. By adjustment of the selectivity control the higher audio frequencies are attenuated and the selectivity of the receiver is sharpened, thus excluding stations which might ordinarily cause interference.

(2) Assume the listener is located close to a powerful transmitting station and has experienced difficulty in receiving one or more desired stations through the adjacent station. By adjustment of the selectivity control the selectivity of the receiver may be improved over that of fixed selectivity sets, thus reducing or eliminating interference.

(3) Assume the listener prefers high quality, that is, an audio response rich in both high and low frequencies. By adjustment of the selectivity control the selectivity of the receiver is broadened, thus permitting the higher frequency sidebands to be passed through the selective circuits with resulting improvement of tone quality.

For illustrative purposes the variable selectivity system has been included in a 7-tube receiver designed to operate over three frequncy ranges, namely the European broadcast band (150 to 350 kc.), the U. S. broadcast band (540 to 1600 kc), and the skipband (6 to 18 Mc). Obviously any frequency range may be employed, but it was felt desirable to incorporate a European long-wave range for the reason that high selectivity appears to be of great importance in Europe, principally because of the closer spacing between stations, and additionally, because of the peculiar geographical location of powerful stations.

Although the design includes 7 tubes, it is felt that substantially superior performance can be procured in designs incorporating 8, 9 or 10 tubes. If a receiver employing more tubes is considered, the re-design would not materially affect either the r-f or i-f systems. The improvements would be incorporated in the audio system and possibly in the AVC system.

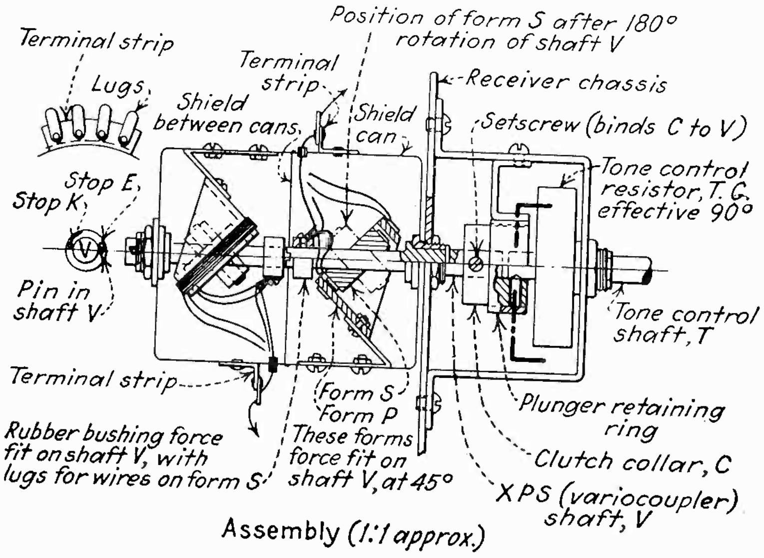


Fig. 1—Details of the XPS variocoupler and selectivity control Rotor coils=40 turns 7/40 s.s. litz, layer-wound on hard rubber form 5/8" i.d. x 3/16" long. L=29.6 μh in can at 1,000~. Stator coils=30 turns same wire on form 7/8" i.d. x 3/16". L=29 μh

The type of selectivity control employed in this receiver utilizes variable mutual inductance in two of the i-f transformers to adjust the reception bandwidth, such as successfully incorporated in high fidelity receivers of the XPS type. Such control gives consistent, symmetrical expansion; the top of the response curve is flat, the width depending upon the setting of the expansion control, with the sides of the curve as steep as the efficiency of the circuit permits, the center of the curve being maintained at a fixed frequency during expansion.

There are many types of systems which will expand the selectivity. Some of these expand in such a way that the shape of the selectivity curve is round with varying slope. This type tends to decrease the selectivity markedly, but does not give a flat response. Others expand from the narrow position to the expanded position in such a way that the extreme selectivity curves are substantially the same as those of the system described herein. For intermediate decrease of expansion, however, there are apt to be irregularities in the curve caused by either a peak or a dip at some frequency in the audio spectrum for an intermediate setting. There are other types of systems which shift the frequency to the center of the curve during expansion. The system using the variable mutual inductance is one of the simplest arrangements meeting the requirements of flat top steep sides, consistent expansion, and fixed center frequency of resonance.

The expanded curve of the two transformers with variable coupling is double peaked. The valley between these peaks is filled by the shape of the selectivity curve of the 3rd fixed coupled i-f transformer. For the best approximation to the perfectly flat-top curve the power factor of each circuit in the fixed tuned transformer should be twice the power factor of the 2nd variable coupled transformer and the coupling in the 3rd transformer should be relatively small; that is, of the order of one-half optimum coupling. This condition is approached reasonably well in the set.

The mutual variation is obtained by means of small vario-couplers mounted in separate cans, the windings of which are connected in series with those of fixed mutual inductance i-f transformers similar to the usual i-f transformer. About 5% of the self-inductance is in the vario-coupler. Rotation of 180 degrees changes the frequency at which the overall electrical fidelity is 6 db below the 400 cycles response from 2000 to 6500. Although other methods of varying the mutual inductance between

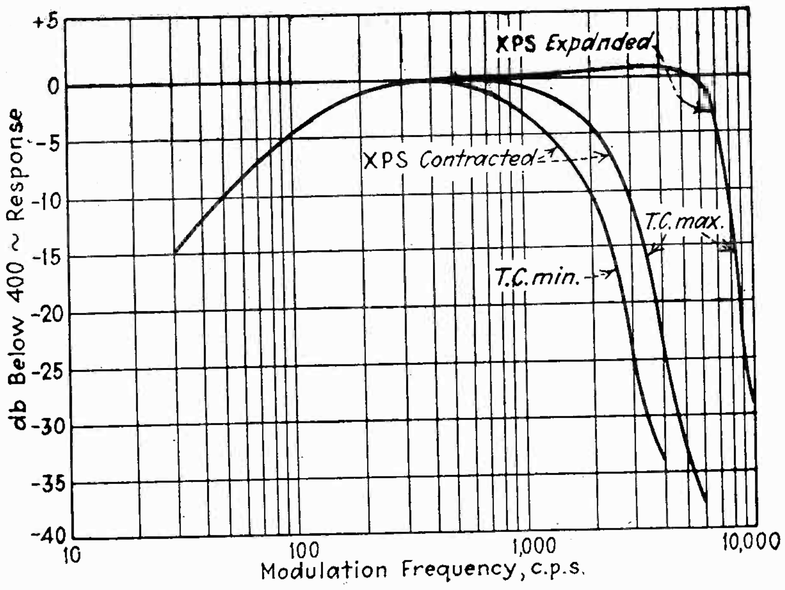


Fig. 4—Overall electrical fidelity; 8,000 ohm load; 5,000 μv input, 50 volt output; 1,000 kc; 30% modulation

the windings can be employed, the present design is believed to be both simple and economical.

Combined tone and selectivity control

Since it was felt desirable to have a setting of the selectivity control available which would make the acoustic characteristic approximately equal to that of the usual set with the tone control set for minimum, a tone control was mounted on the vario-coupler shaft in such a way that the first 90 deg. of the 270 deg. total rotation changes the tone control in the audio system from minimum to maximum high note response. The remaining 180 deg. of the rotation controls the expansion of the i-f selectivity.

The set uses a conventional audio system (75 amplifier and 42 output pentode) and an eight-inch speaker of the usual type. Such a speaker has a relatively high acoustic output between 1500 and 4000 cycles which sounds quite objectionable when the electrical characteristic is flat to 6500 cycles. A corrector circuit is included which levels off this rise in the acoustic characteristic. The response of the system at 10,000 cycles was sufficiently great so that the beat between carriers on adjacent channels was objectionable. A 10 kc filter is included in the voice coil circuit to eliminate this whistle. The design of the corrector circuit and the 10 kc filter circuit must of course be changed if the type of speaker is changed. To prevent limiting of the expansion characteristic of the receiver, as determined by the i-f circuits, the r-f circuits for No. 2 range have been broadened somewhat by appropriate loading so as to pass approximately ±6 kc with little amplitude reduction regardless of the selected frequency while preserving good off-frequency discrimination and substantially constant gain throughout the tuning range. Full expansion is available on the broadcast and shortwave bands only, since the selectivity of the antenna and r-f transformers limited the expansion in the European range.

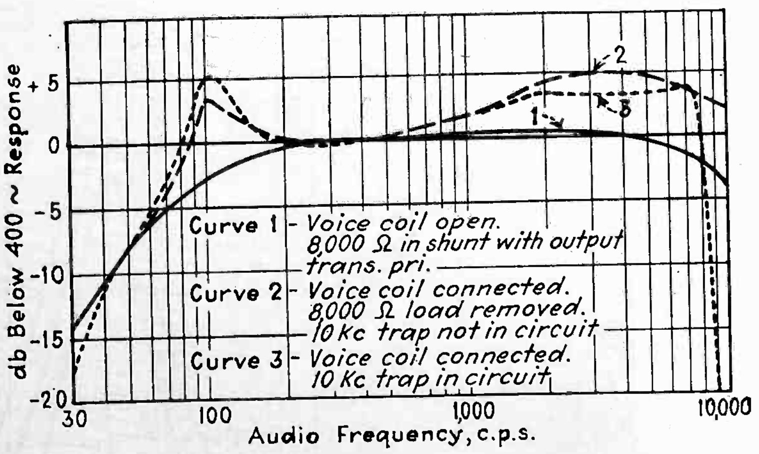


Fig. 3—Audio fidelity. Tone control set for maximum highs; speaker corrector not in circuit; output 100 volts at 400 cps., input to first a-f grid

Circuit details

The circuit from the antenna to the 6A7 plate is similar to circuits in general use. A 10 ohm resistance is connected in series with the secondary resonant circuit of the antenna and r-f transformers on range 2 to accomplish the broadening as explained above. The 50,000 ohm resistor in shunt with range 2 r-f primary has some broadening effect and makes the amplification more uniform.

The AVC is conventional. The first three tubes are controlled. The d-c diode resistor is 100,000 ohms instead of the usual 500,000 ohms to broaden the selectivity of the last i-f transformer. For this load the selectivity of the circuit with fixed coupling is broad enough to level off the overall selectivity in the expanded position.

Figure 5 shows the characteristics of the 1st i-f transformer. The second transformer has approximately the same characteristic. Half rotation of XPS vario-coupler control corresponds to approximately optimum coupling. The overall i-f resonance curves in Fig. 5 show how the characteristic of the fixed coupled transformer corrects the dips in the two variable coupled transformers at maximum expansion. Figure 5 shows that the maximum variation of gain caused by the variation of coupling is approximately 7 db. The AVC compensates for this variation so that it is not noticeable in listening to a station. Figure 5 shows the antenna and r-f transformer characteristics on range 2. The curves show that the bandwidth is practically uniform over the range. Figure 2 shows the electrical fidelity measured from the antenna to the 75 tube grid on range 2. The curves show that the XPS varies the sideband admission, measured at half 400 cycle output voltage, from 2000 to 6600 cycles. The intermediate curve shows the consistency of the expansion.

On range 1 the selectivity of the antenna and r-f transformers limits the XPS action. Instead of an expansion of nearly two octaves the expansion is limited to about half an octave.

Figure 3 shows the electrical fidelity of the audio amplifier. Comparison of curve 1 with the curves in Fig. 2 shows that the speaker output transformer has caused material reduction in low-frequency response. If the set is to be used in a cabinet having adequate baffle area it will be desirable to use a more expensive speaker and transformer to improve the low-frequency response.

Figure 6 shows the acoustic characteristics with the speaker corrector in the circuit. The speaker was mounted in a cabinet 18 inches high, 16 inches wide, and 9 inches from front to back.

The first two i-f transformers are made of single section winding of 570 μh each. The circuits have a Q of approximately 100. This combination gives adequate contraction and gain. The transformers are adjusted so that the coupling varies from approximately $\frac{1}{3}$ optimum coupling to 3 times optimum coupling.

The vario-couplers specified in Fig. 1 provide a fairly simple and inexpensive means for varying the coupling. The arrangement eliminates the necessity for moving the entire i-f coils. The vario-couplers are connected in the low potential side of the circuit. They are symmetrically placed in the shields.

Effect of tone control

The tone control has most of the change in resistance in the first 90 deg. of its travel. Consequently there is no effect on the fidelity even though the tone control is in circuit during movement of the XPS control. The clutch mechanism engages the vario-coupler shaft whenever the knob is turned beyond the 90 deg. position. This mechanical detail is included to show one method of accomplishing this result. It can be arranged to act smoothly so that the user does not know when the XPS mechanism starts to turn.

An alternative arrangement consists in employing separate tone and fidelity controls, one controlling the

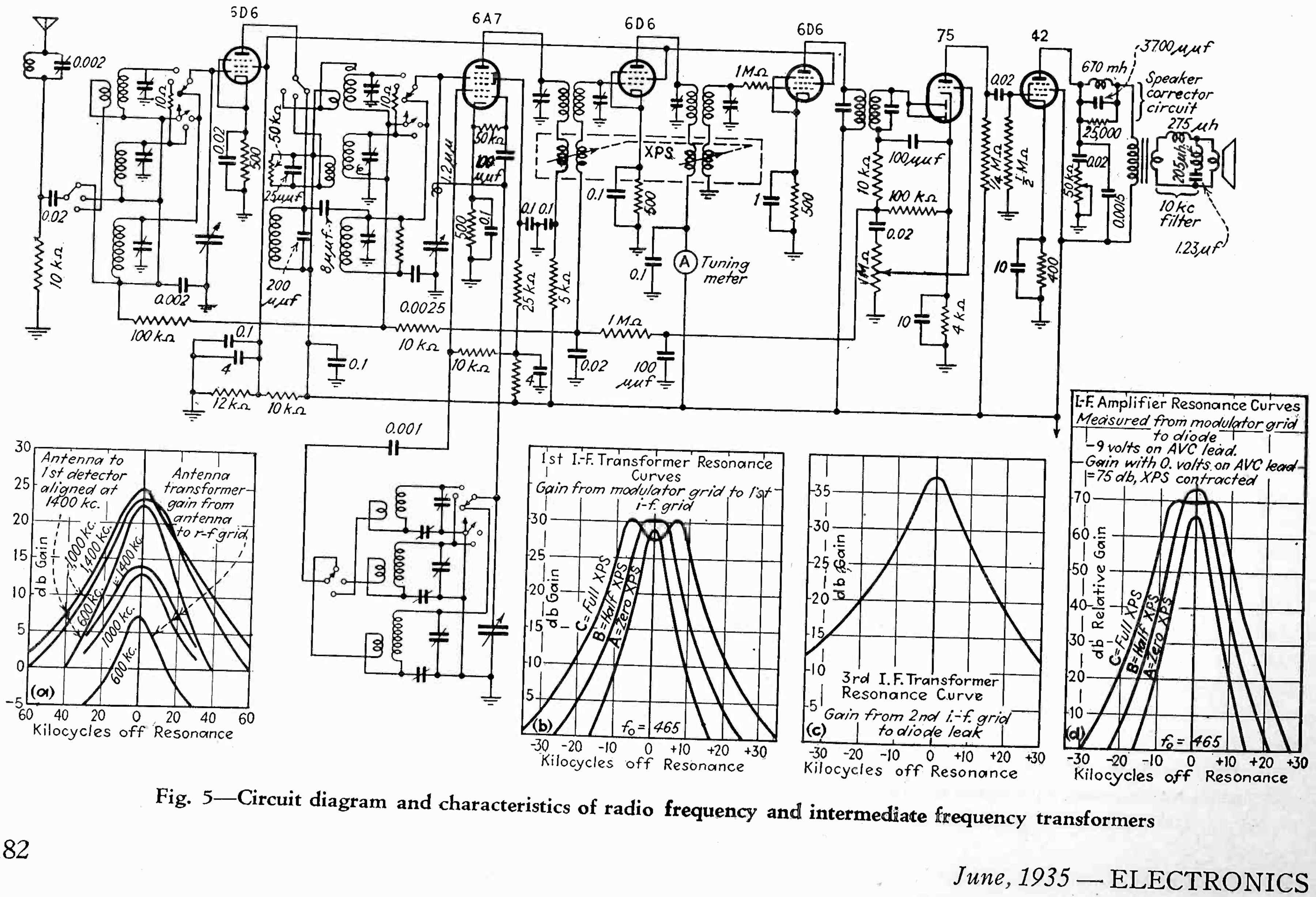


Fig. 5—Circuit diagram and characteristics of radio frequency and intermediate frequency transformers

audio fidelity (tone control), the other controlling the selectivity. This arrangement permits the user to set the XPS knob in the broad position and turn the tone control down to reduce high frequency noises in tuning. This gives broad, easy tuning for local reception.

The coil system employed has characteristics which are sufficiently good for use in a more elaborate receiver. In such a receiver it may be desirable to use i-f tuning condensers having air dielectric instead of mica in order to reduce frequency drift with variations in temperature and humidity.

The following are suggested uses for additional tubes in case this coil system is to be used with more expensive receivers:

(1) Separate AVC amplifier and detector, such as a 6B7 operated by the signal voltage in the plate circuit of the modulator and feeding a diode through a relatively broad fixed coupling high gain i-f transformer, the output of this diode being used to supply AVC to the r-f and first detector tubes. The principal advantage of this refinement in the system is that it will reduce the noise heard on the side of a strong carrier as the set is tuned through the station. The regular AVC would then be used to control the gain in the i-f amplifier.

(2) Separate oscillator and modulator tubes used in place of the 6A7. Such a combination can be made to have less oscillator drift and a better signal to noise ratio than the 6A7 tube used in this set.

(3) Additional audio amplifier and output tubes connected in Class-A push-pull.

If these additional tubes are included it will of course be very desirable to use a speaker having better acoustic characteristics, particularly at the low frequencies, and a cabinet having adequate baffle area.

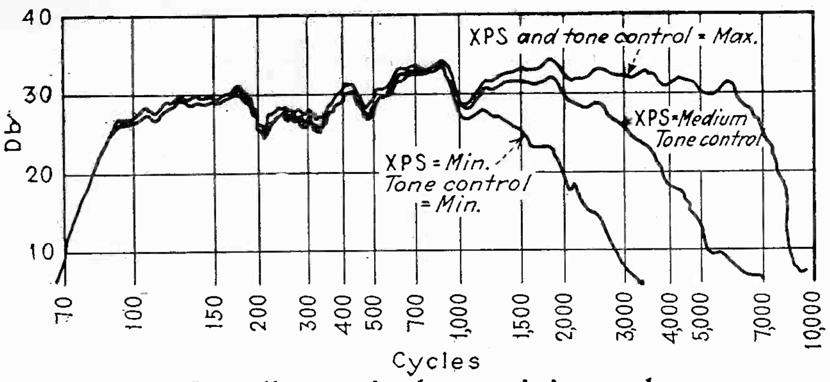


Fig. 6—Overall acoustic characteristic; speaker corrector in circuit. Microphone 1 foot in front of speaker; cabinet in corner of room. 1 watt in voice coil at 400 cps., input 5,000 μv, 1,000 kc, 30% modulation

Receiver demonstrations

A model of this receiver was demonstrated by engineers of the Hazeltine organization to members of the *Electronics* staff. The quality of the reception when the selectivity control was in the expanded position was unusually good. The value of the continuously variable control of selectivity was shown on several local stations which were subject to monkey-chatter from the adjacent channels, when the full expansion was used. A slight reduction of the bandwidth cut out this interference without noticeably affecting the quality of the desired signal.

Tuning is necessary with the expander narrowed down to minimum selectivity, since it was difficult to center the carrier in the received band with full expansion. If the carrier is slightly off center (due to improper tuning) the quality is still good with the expander wide open, but drops off when the selectivity is increased. Off-center tuning with full expansion has the effect of providing double sideband reception of the lower audio frequencies, but only single side-band reception of the higher frequencies, which introduces a 6 db lowering of the high frequency level. On-center tuning is thus essential for full fidelity; it can be accomplished aurally if the greatest selectivity is used, or visually with a tuning meter of some sort.

Synchronizing possibilities

[*Continued from page 178*]

of the broadcast band, and would provide for 1,527 stations—several hundred of them of high-fidelity quality. Even this number of stations might be considerably increased if it seemed desirable to augment the chain outlets or the number of regional or local stations. By rearranging the number of regional and local channels, additional numbers of stations of the 1,000-watt and 100-watt classes could easily be provided. Already other similar allocation proposals employing synchronizing have been drawn up to permit the simultaneous operation of 3,000 and even 6,000 stations on the present broadcast band. It is all simply a matter of selecting services to be provided.

Of course, anyone familiar with broadcasting and the Washington situation recognizes the almost insurmountable barriers to bringing about another reallocation, and the hardships it would impose on present broadcasters. The cost of a synchronizing service available throughout the country—whether by wire-line or radio—would have to be carefully investigated.

Perhaps a way to make an advance trial of such a synchronizing plan would be through some group controlling present stations on existing adjoining clear channels (or stations which could be so shifted). If three adjacent channels could be made available for the experiment, special permission from the supervising authority might be obtained for putting additional synchronized transmitter outlets on these channels in other parts of the country, and thus building up an experimental synchronized chain of the type proposed—without inflicting any widespread changes on other stations of the present set-up. Such an experiment might well show whether the art of synchronizing has yet progressed to the point where a national synchronization set-up should be considered. This partial experiment, however, would well justify itself by giving the interests carrying it out, a wide extension of broadcast service. It seems likely that it may be undertaken by some newspaper or radio group.

The political and economic difficulties that stand in the way of synchronizing are many and serious. But probably they are not insurmountable. As outlets into the ether become more and more precious, some way may be found to meet these obstacles and widen the service of the broadcast band. At any rate, the synchronizing situation offers many interesting possibilities for broadcasters, chains, radio manufacturers and applicants for broadcast facilities.

An automatic volume expander

to compensate the volume compression of broadcast or recorded programs

By W. N. WEEDEN

TO MOST of us the term "high fidelity" simply denotes a wide frequency range. There are, however, two other phases of equal or greater importance. One of these is harmonic distortion; the other is volume range. Wide frequency range in transmitters is now the rule rather than the exception. For example, the new WOR, the most recent high-power station, is down only 2 db at 9,000 cycles and down only 4 db at 10,000 from microphone to air. Its harmonic distortion is about 2.5 per cent at full modulation.

The volume range required by good music, however, has not been satisfied so well despite modern transmitters, with their low noise level and high modulation, and despite the new program networks of the Bell System. Here the range has been expanded to perhaps 40 db, compared to a former 30 db, approximately.

Symphony music calls for a range of 70 db. The best of the broadcast systems can handle only 35-40 db; wax recordings suffer from a still greater volume compression. There is room, therefore, for work of the sort to be described below. In this connection, it is interesting to note, that one of the most progressive independent stations of the country is cooperating with a large receiver manufacturer in experiments more or less along the line of those described here.

The ideal system would be an automatic volume contractor at the transmitter, replacing the present-day control operator, and having a characteristic which could be duplicated, but in an opposite sense, at the receiver. Such a system may well be part of the broadcast set-up of the future. At present it is necessary to compensate, at the receiver, the variations in level produced at the transmitter by the control operator and necessitated by reasons known to all in the art.

It is worth while to note here that Mr. A. B. Chamberlain, chief engineer of CBS, has stated that a 50-db volume range capability of a transmitter (not including lines) was excellent (*Electronics,* May, 1934). L. F. Jones (*Broadcast News,* No. 2, 1935) states that further noise reduction in the transmitter is so great that a 50-db range is about the best obtainable. Furthermore, J. V. L. Hogan, operator of the experimental high-fidelity station 2 XR, states that many letters resulting from his excellent series of tone and volume experiments indicate that listeners could easily appreciate a volume range of about 50 db. These figures are to be contrasted with our present restricted range of 35-40 db.

Until the complete volume contracting and expansion system has been worked out and put into practice at the transmitter and the receiver, it is necessary to complement the work of the control operator, cranking up the gain at the receiver at a faster rate than the volume increase at the input to the microphone and reducing the receiving amplifier gain at a rate faster than the rate at which the actual program decreases. Such a volume expander is described below. It is the result of considerable experiment by the writer for his own better enjoyment of symphony broadcasts. The system has disadvantages, of course. The control operator, for example, does not change the gain until the program begins to get near the danger point, whereas the receiver apparatus expands all signals according to their incoming level. But the overall effect on symphony programs is to be recommended by the writer.

The expander circuit

In Fig. 1, is a simplified diagram of the expander. Here the tubes are operated with a variable bias, derived from the input and proportional thereto. The 56's have a normal resistance to 10,000 ohms each, instead of working into a load of several times that value, and look into 200 to 500 ohms. Their bias is so adjusted that with no signal their plate current is nearly cut off. At that point on their I_pR_p curve, their R_p will be found to be nearly infinite, and it will be seen that the power transferred from a circuit of such high resistance to one of 500 ohms will be very small. On the other hand, as the signal applied to the E_x input increases, the bias of the controlled stage decreases, increasing the plate current of the 56's, and reducing their R_p, until at a maximum signal of 35 db above the minimum, the R_p of each 56 reaches a minimum of 7,500 ohms. The increase in gain resulting from this reduction in plate resistance amounts to approximately 35 db. Thus, a 70 db signal compressed to 35 db at the transmitter, and appearing at the output of the receiver detector also as a 35 db signal, will, after passage through the expander, reappear in the pristine form of the original—a signal with a dynamic range of 70 db.

Figure 2 is the circuit diagram of an expander designed to operate from and into a 200-500-ohm line. Transformers T_1 and T_2 should be of the best design and construction and as well balanced as possible. Transformer T_3 may be identical to T_1. However, it may be desirable to have the turns ratio of T_3 higher than that of T_1. T_4 should be of as high ratio as possible, compatible with frequency response.

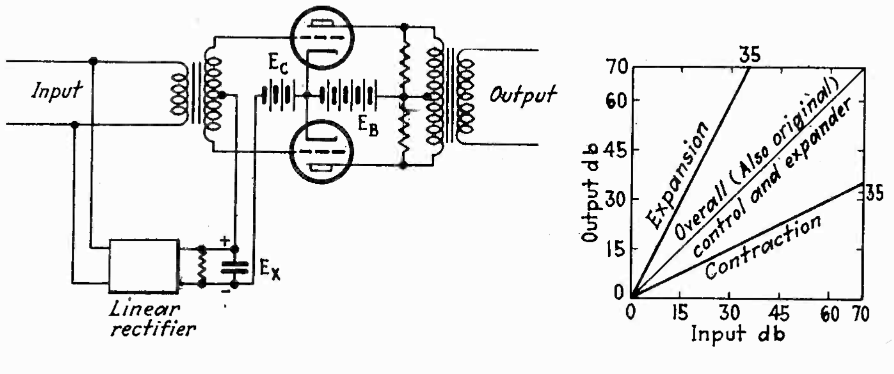


Fig. 1—Scheme of the volume expander

There are two points to which the control circuit may be connected. If connected to point 1, the expansion will remain constant, regardless of the setting of the level control A. It connected at 2, the degree of expansion will vary with the volume control A. In general, it would appear advisable to operate the expander from point 1, but if less expansion is desired at lower volume levels, then point 2 should be employed.

The volume or level control in this circuit should be of the constant impedance variety. The control B is the expansion control, and may consist of any good 250,000-500,000-ohm potentiometer. If the unit be properly constructed, 30-40 db expansion should be secured with the grid of V_3 receiving the full voltage delivered by T_3 (13-15-volts peak signal). For lesser degrees of expansion, control B may be given appropriate settings.

The 5,000-10,000-ohm control may or may not be a panel control. Its purpose is to vary the initial no-signal bias of V_1 and V_2, and may be operated so as to select the proper minimum signal for the room noise.

The V_4 control may be a high resistance volume control 2 megohms or higher—if a suitable control of such high resistance can be found. Otherwise, it would seem preferable to employ a four- or five-point switch with proper fixed resistance units. The purpose of this control is to vary the time constant of the circuit and the rapidity with which it changes the gain. Another way of expressing this is to state that the action of the "ex" should not be instantaneous, but should follow the average trend of the orchestral volume changes just as the compressor or control engineer endeavors not to vary the level too rapidly at every change in orchestral volume. This would destroy much of the effect, of course. By varying the resistance at V_4 from .25 to 5 megohms, the speed may be varied from approximately a half second to several seconds. As there is no definite value for this delay, it is deemed advisable for the listener to select the value most pleasing to himself, depending to some extent on the type of music being performed. Once a smooth performance has been secured, it is doubtful if this will be changed.

In operating this expander from the power supply used for the receiver and amplifier, precautions must be taken to prevent feedback. The difficulty is little greater than that experienced with any multi-stage amplifier having the same overall gain. The chokes, resistances and bypass condensers indicated should all be included to completely isolate the various circuits.

If a separate power supply is included in the main unit to provide fixed grid bias for the output stage, it might be advisable to obtain the initial bias for V_1 and V_2 as well as the bias for V_3, from that source instead of the common plate supply.

Tubes V_1 and V_2 should be selected so that their plate currents near cutoff are nearly equal. They should also be checked at maximum values of I_p as well. The above precaution, together with properly balanced transformers (T_1 and T_2) will insure freedom from harmonic distortion, if the signal applied to V_1 and V_2 is of the proper magnitude.

A simple test to determine the proper input voltage is to insert a milliameter in the common plate circuit of V_1 and V_2, remove V_4, adjust its control for as low a value of plate current as will be used—with no signal—then raise the input until the plate current begins to kick up on the peaks, indicating plate circuit rectification. Then reduce the signal to about half that necessary to start rectification, and you may be quite certain that little distortion will occur so long as the signal is kept below the overload point. It would be advisable to insert a fixed pad in the input circuit to limit the input to V_1 and V_2 to the proper value—regardless of the setting of the level control A. Of course, it may be possible to otherwise limit the input signal, but some such method should be included. In view of the fact that the input should be

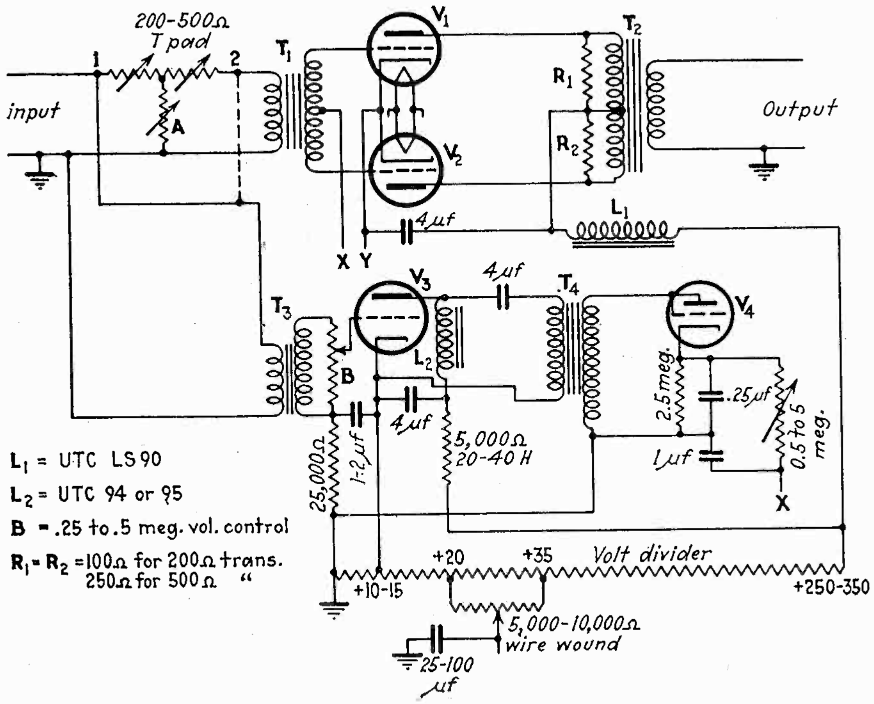


Fig. 2—Complete specifications of volume expander

kept low, there should be a voltage amplification of about 400 between the expander and the power tubes grids.

It may be wise at this point to note some of the limitations of an expander of this type. First, there are very few programs which greatly exceed the 35 db transmission range. Symphonic and operatic programs, with a few of the larger studio orchestral programs, about complete the list. Chamber music covers little more than 35 db, while most of the popular and dance music may utilize a still narrower range. The second limitation is that of maximum peak volume. With a normal room noise, to utilize a range of 70 db would require that the peaks should be 10 to 20 watts.

The use of the expander at the present time requires much regulation to compensate for the various levels and different monitoring on different programs. When the electrical compressor comes into general use, this condition will no longer hold. At present, however, it is best to remove the expander from the circuit when not listening to one of the few programs requiring the wide range.

One of the great advantages of expansion is the fact that receiver noise, low level static, and hum set up ahead of the expander will be reduced in the same ratio as the signal—so that with a weak signal which is barely audible, and which just passes through the amplifier without raising its gain appreciably—the noise will also be reduced to a point where it will cause much less annoyance than with an unexpanded signal. This same fact is particularly valuable in reducing record surface noise—which is particularly unpleasant during pianissimo passages and rests.

The use of the compressor in broadcasting should be a boon from the viewpoint of transmitter overmodulation which frequently occurs with manual monitoring—particularly if the operator does not have sufficient time to rehearse with the orchestra. Considering the difficulty of the problem, a good control man who *is* familiar with the musical score can do a very fine job, and it is doubtful if the compressor can ever replace him completely.

Dentistry and the "radio knife"

SEVERAL SUGGESTIONS have been made that the "radio knife," utilizing high frequency currents, might be used instead of the dentist's drill for removing tooth structure, clearing up cavities, etc.

In answer to an inquiry from the Editors of *Electronics,* H. J. Holmquest, consulting engineer for the General Electric X-Ray Corporation, Chicago, comments interestingly as follows: "According to my experience, high frequency currents—produced either by a vacuum-tube oscillator or by a spark-gap oscillator—cannot be used to cut bone. The most tenable theory of the cutting of tissue by high frequency currents is that such cutting results from a very rapid expansion, literally an explosion, of the moisture in tissue cells due to the concentrated heating—an effect of the high frequency current applied to the tissue by means of a needle or knife-like electrode.

"Theoretically, then, since bone is relatively dry, it should not be readily cut by high frequency currents such as are used in electro-surgery.

"It would indeed be a great boon to dentistry if the high frequency surgical knife could be used for cutting tooth structure. I fear that if one attempted very strenuously to cut such structure with a high-frequency surgical current, the electrode would become excessively hot and char the bony structure."

✦

Testing sign "cat's eyes" with photo-cells

FOR TESTING the relative efficiency of various types of highway-sign reflector buttons or "cat's eyes," the California Division of Highways has carried on an investigation of the use of the photo-electric cell.

In one end of a six-foot-long, light-tight box a photo-electric cell was mounted behind a shutter which is adjustable. A hole in the end of the box permits the light beam to enter. A support and holder for the reflector button is near the opposite end of the box, and the arrangement for holding the button is designed so that the angle between the reflecting button and the beam of light may be varied.

The source of light is provided by a balopticon equipped with special lenses and the projecting lens is placed close to the hole in the dark box. In order to concentrate the light a plate having a small, square hole in the center is placed in the slide carriage of the balopticon so that a two-inch square illuminated area is directed on the button holder at the rear end of the box.

A vacuum-tube amplifier is used to boost the current 10,000 times after it passes through the cell when it is read on a micro-ammeter. After recording the normal position of the button to the light beam as that of an angle of incidence of O degrees, the button's position is rotated from the normal in steps of five degrees with a reading recorded at each step.

Upon completing one set of readings the button is rotated ninety degrees and another set of readings at varying angles of incidence are obtained. Readings at each of the quarter points in the circumference of the button are also secured and the button is rated on the average of the readings taken in the four positions.

✦

PORTABLE RECORDER FOR JUNGLE EXPLORERS

Lincoln Thompson has developed this portable spring-driven outfit for recording on aluminum discs. It weighs less than 50 pounds. Special construction of the oil-damped cutting head permits it to record while being carried or shaken on a moving vehicle. Records can be played back at once. The A battery comprises two standard dry cells; B, seven 22½-volt blocks. B battery drain is only 15 milliamperes

Vocal warning when "too high" or "too low"

AN INTERESTING audible monitor for use in public-address work, broadcasting stations, etc., has just been developed by J. O. Kleber and C. J. Le Bel, of the American Foundation for the Blind, Sixteenth Street, near Fifth Ave., New York City. With this device the operator does not have to look at his meters to control amplification for if it gets too high a speaker automatically announces "Too high, too high," and if too low it will say "Too low," and will keep repeating until the amplification has been adjusted. The device has many other uses, such as for announcing rise and fall of temperatures, barometer pressures, wind velocity, water height in reservoirs, changes in gas or liquid in transmission lines, loss or gain in altitude in airplanes, fire indicators on ships, etc.

As shown, the device consists of a

phonograph turntable with two pick-ups side by side, and records specially made for the particular type of an-

For many indicators it is desirable to have a spoken warning, also. Pick-ups running in circular grooves call out either "too high" or "too low"

nouncements and a relay device. The slow-speed record has two continuous circular grooves, one for the "Too high" announcement and the other for "Too low," each groove having its own pick-up. When amplification is too high, a relay cuts in the pick-up running in that groove; when too low it cuts in another pick-up.

✦

Excessive power demand reduced by photo-cell

In the electricity rates quoted for industrial power by many utility companies, a special charge is made for high "demand" which requires large power-plant investment. That is, the customer obtains a very much lower average rate if his demand in kilowatts is uniform, rather than marked by excessive swings.

A "power demand controller" has been developed by Watts Electric Controls, 671 Broad Street, Newark, N. J., which employs a photo-cell to detect the swing of the demand meter beyond a fixed limit, and so gives warning, or can be arranged to cut-out some particular part of the load to hold the peaks down to the limit set.

In some instances use of this photo-electric peak detector has resulted in savings of electric-power charges amounting to 20 to 25 per cent. Depending on the form of electricity rate, savings may be made in either the "demand" or the "energy" element of the charge. In other cases, use of the photocell eliminates costly duplication of metering equipment.

✦

Photo-cell maintains slack

In paper-coating machines, the loop of paper that must be maintained between the coating rolls and the dryer section, is now being controlled by a photo-electric cell. No mechanical system of slack maintenance is possible, on account of the wet condition of the sheet. Through the agency of the photo-cell which responds to the shadow of the loop, if the slack becomes too great the dryer motor is speeded up; if the loop becomes too short, the dryer-motor speed is reduced.

✦

Fire department installs 5-meter radio

In the United States, police departments have made wide use of radio communication in cars, but the application of radio by fire departments has been limited except in connection with local police systems. That is, when a police radio system is installed, the fire chief's car is often equipped with the same apparatus as the police patrol cars, so that the fire-department head can keep in touch with police activity.

One of the first fire departments in England to be equipped with its own separate short-wave system is that of the Northwood (Middlesex) fire brigade. The new chemical engine and hose-cart owned by this town is fitted out with 5-meter receiver and transmitter. As the local fire brigade covers a wide suburban area of 20 sq. miles, this radio outfit enables headquarters to keep in continuous touch with the mobile fire-fighting apparatus.

✦

St. Clair lightship radio-controlled

When the St. Clair Lake lightship takes its station in the middle of Lake St. Clair, above Detroit, this summer, it will have the distinction of being operated by remote radio control. The ship will be anchored eight miles from shore, and will be operated by a shore crew, working both the air fog signal and radio beacon by radio. The electric light of the ship will be controlled by an automatic astronomical clock, and the boat will also have an auxiliary gas light, which operates by the sun.

Sunlight will put the light out, and darkness turn it on. The radio-controlled lightship is placed in Lake St. Clair at a point where some of the densest traffic on the Great Lakes passes. The picture shows David N. Reid, radio constructor of the Lighthouse Service, working on the apparatus by which the lightship signals will be operated.

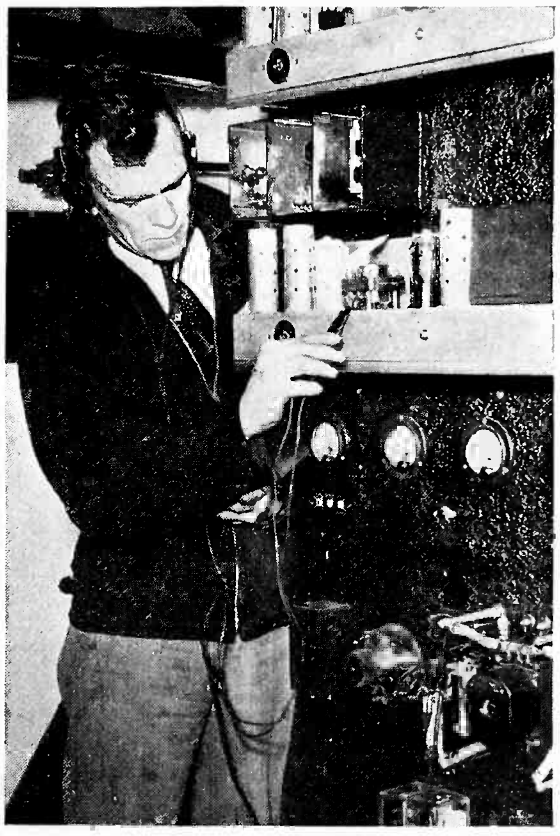
✦

Checking glass for goggles

Wilson Products, Inc., Reading, Pa., makes use of photo-cells for testing the glass employed in the goggles it manufactures. By comparing this glass with standard samples provided by the Washington Bureau of Standards, unskilled factory employees can quickly test and classify the material to be used for manufacture.

By the aid of the photo-electric meter which shows maximum and minimum values, all that the operator has to do is to be sure that the indicating instrument reads between the limits which have previously been set by an engineer, based on the graded samples supplied by the Bureau of Standards.

FOG-HORN CONTROL



This equipment will control the fog-horn and radio beacon on the Lake St. Clair lightship, from a shore station, 8 miles away

Frequency modulation advances

System on ultra-high frequencies, developed by E. H. Armstrong, discriminates against noise, increases range to 100 miles

ON Friday, April 26, Major E. H. Armstrong, famed for his work on the regenerative, super-regenerative, and superheterodyne circuits, announced in the daily press that he had developed a system of frequency-modulated radio transmission for use on the ultra-high frequencies which reduced the noise level to such an extent that the range of seven-meter signals had been extended from 25 to 100 miles. The announcement was received with great interest by radio engineers, all of whom wished to know more about how it was done than appeared in the newspaper accounts. Major Armstrong has consistently refused to go into the details of his system until he has presented a paper on the subject before the I.R.E., which will not be possible until next Fall.

The main question aroused by Major Armstrong's announcement was not how the frequency-modulated signals were transmitted and received, but how the use of frequency modulation discriminated against noise, which heretofore has been the ultimate limitation of all radio transmission. There appears to be no doubt that the system used actually does give a vastly better signal-to-noise ratio than conventional amplitude modulation methods. Several highly competent observers have witnessed demonstrations in which two receivers, one for amplitude modulation and the other for frequency modulation, were placed in operation side by side at Mr. Armstrong's laboratory at Haddonfield, N. J. (about five miles from Philadelphia). Seven-meter transmissions from the Empire State Tower in New York City were sent alternately by amplitude and frequency modulation. The amplitude modulation was buried in the noise, while the frequency modulation came through at the receiver with only barely perceptible noise background. The quality of the frequency-modulated signal is comparable in every way to that of the best amplitude modulated systems.

Amplitude vs. frequency modulation

The concept of frequency modulation, while not difficult in itself, is sufficiently unfamiliar to have caused many misconceptions. In pure frequency modulation, the amplitude of the transmitted wave is kept constant, at the maximum power output of the transmitter. The modulation of the wave is accomplished by changing its frequency, in much the same way as if a condenser microphone were used as the tuning condenser in the tank circuit in an ultra-high frequency oscillator. By speaking into such a microphone, the frequency of the output would be swept through a band of frequencies, centering about the carrier frequency (the frequency when no modulation is present). The width of the band swept through depends upon the depth of modulation; for 100 per cent modulation the maximum band-width would be used. If the modulation frequency is 1,000 cycles, the frequency of the transmitter is swept through the frequency range 1000 times per second, for 5000 cycles, 5000 times per second, and so on. It can be seen that 100 per cent modulation can occur within any desired band-width, depending upon the range of the frequency changing device (in our example, the maximum and minimum capacity of the condenser microphone).

Each frequency modulated transmitter has two distinct characteristics. One is its carrier (unmodulated) frequency. The other is the ratio of the maximum frequency displacement on each side of the carrier to the highest modulation frequency. In Armstrong's equipment this ratio is 10. Hence, since the highest modulation frequency used is 10,000 cps, the frequency displacement each side of the carrier is 100,000 cps, making a total band width of 200 kc. It will be noticed, however, that the band width does not vary with the modulation frequency, but only with the depth of modulation. If this wide band width were used in the broadcast range (550 to 1500 kc) it would constitute anywhere from 10 to 35 per cent of the carrier frequency. In the seven-meter (40 megacycle) range, however, it represents only one half of one per cent of the carrier frequency. This percentage is smaller than that consumed by broadcast stations (10 kc in 1000 kc, or 1 per cent).

Reception of frequency modulated signals

A frequency-modulated transmitter makes much more efficient use of its equipment than does an amplitude modulated transmitter. The power output of a frequency modulated transmitter is constant. For a 1-kw output, only 1 kw equipment is necessary, regardless of the depth of modulation. In the amplitude modulation systems, however, where the peak power is four times the unmodulated power, 4 kw equipment (tubes and power supply) are required for a 1 kw signal.

If a pure frequency-modulated signal is received on a conventional receiver designed for operation on amplitude modulated signals, no response is obtained. It is necessary, therefore, to convert the frequency-modulated signals to amplitude-modulated signals, before they can be detected. The conversion is accomplished by a tuned radio frequency stage operating at one side of resonance. When so operated, the output of the stage is proportional to the frequency of the input. To make use of the frequency modulation on each side of the carrier, two such circuits are required, operated in push-pull. One half of the system supplies increased output as the frequency goes higher than the carrier, while the other gives an increased output as the frequency goes lower than the carrier. The combined output is an amplitude modulated wave which can be amplified and detected in the usual manner. Specially designed circuits are required to have a response linear with frequency over the wide bandwidths required; and it is supposed that Major Armstrong's development of these circuits is one of the most difficult achievements of the entire system.

Effect of band-width on noise

According to well-established theory, the radio frequency components of noise are fairly equally distributed throughout all wave lengths. Thus, the wider the band-width received, the more noise components there are present. Major Armstrong has found with his apparatus, on the contrary, that the wider the band-width received, the lower the noise level in relation to the signal received. This fact has been established beyond doubt. In fact, the wide band-width of 200 kc for full modulation was chosen because only by so doing could the noise be reduced sufficiently to permit satisfactory reception over the distances required (about 80-90 miles).

The explanation of this seeming direct contradiction of the theory is not yet forthcoming. Either the theory is not correct or else some unsuspected effect has been introduced by the use of frequency modulation. Major Armstrong, in upholding his right to explain the system in a carefully prepared paper, has not released any information on this point. Several published explanations of the noise-discrimination effect are in error, according to Mr. Armstrong. It is evident that the new system has revealed a new phenomenon; whether it resides in the physical distribution of noise components in the ultra-high frequency region, or in the method of transmission and reception, will be made clear in the forthcoming paper.

The fact of Major Armstrong's demonstrations is that noise from any source (including tube and circuit noises introduced before conversion) is greatly reduced, when a wide band is received, and that the weak underlying signal can be amplified up through the noise to a useful level.

Million-cycle co-axial cable for television?

A. T. & T. installing $580,000 system between New York to Philadelphia capable of carrying 200 telephone channels or one television picture

BY NEXT April the American Telephone & Telegraph Company plans to have completed and ready for test, its co-axial conductor cable between New York City and Philadelphia. This new cable will be capable of passing, in each direction, a band of frequencies more than a million cycles wide, and thus will be available for transmitting 200 telephone conversations simultaneously, or television pictures of great detail.

The new co-axial conductor installation will run underground most of the way, and will comprise a lead sheath $\frac{7}{8}$ in. in diameter, containing two $\frac{3}{8}$-in. co-axial conductors like that pictured on this page, one co-axial conductor for each direction of transmission. Occupying the space between co-axials and outer sheath will be some eight paper-insulated conductors for order wires and for pressure alarms in case of the failure of the pressure of the inert gas with which the cable interior will be filled.

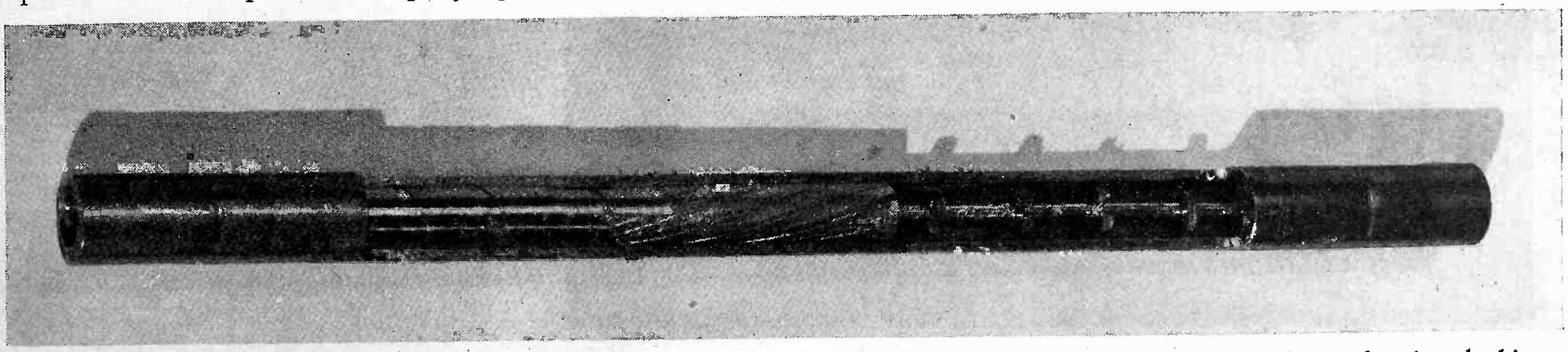
Rubber-disk insulators carry the central conductor of the co-axial, as shown in the cut-away picture herewith. The interlocked metal covering which makes up the outer shell of each co-axial is carried at ground potential—although, for purposes of sectionalization and test, the co-axial shells are separated from the lead outer sheath by several layers of paper and fabric.

Energy to operate the repeaters will be supplied over the central conductors of the co-axials. These repeaters are to be located in manholes about ten miles apart. Each repeater will be capable of amplifying the full width of frequencies required for the 200 telephone channels or the single high-definition television channel. The $\frac{3}{8}$-in. co-axial conductor is capable of passing something above one million cycles; increasing the diameter of the co-axial conductor shell permits a wider frequency band, increasing with the square of the shell diameter. Thus, a $\frac{7}{8}$-in. co-axial conductor would be able to transmit over 4,000,000 cycles.

Owing to the fact that the frequencies involved in these co-axial conductor experiments fall in the middle of the broadcast band (1,000 kc.), it was necessary to apply for the permission of the Federal Communications Commission before undertaking the actual installation.

The cost of installing such a two-way million-cycle cable is estimated at about $6,000 per mile, and the total outlay for the New York-Philadelphia job is expected to be $580,000. Studies made of the relative cost of the usual 200-pair telephone cable, as compared with the new co-axial conductor (and its necessarily elaborate terminal equipment of frequency generators and filters), show that the co-axial cable can be operated to advantage on heavily-loaded circuits even as short as 75 to 100 miles, comparable to the New York-Philadelphia line.

From the standpoint of television, this new co-axial conductor, states the A.T.& T. application, "may be used to connect together television broadcasting stations in different cities, in much the same way that telephone lines are now link stations for sound-program distribution."



A piece of co-axial conductor. Note the insulating spacers supporting the central wire. The outer shell is made up of an interlocking banding. A $\frac{3}{8}$-in. co-axial conductor like this (one-way) is capable of carrying 200 simultaneous telephone conversations, or a single television picture 1,000,000 cycles wide.

X-Rays and metal radio tubes

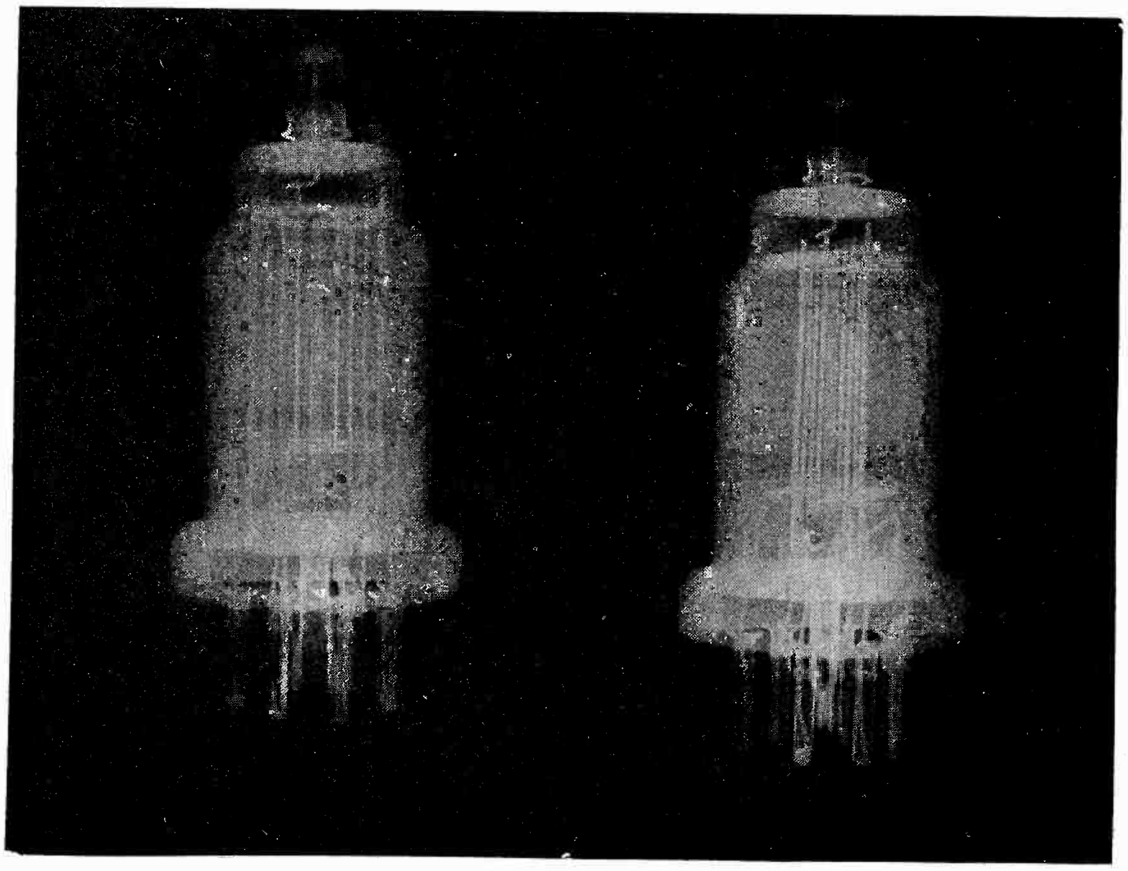
By Robert C. Woods

In the radio tube industry, as in every other manufacturing business, various forms of inspection are used to insure that the product shipped from the factory is in good condition. All radio tubes are tested in an electrical circuit for such things as faulty connections, gas, and numerous other defects.

In some instances, however, the different elements inside the tube may be slightly out of position relative to each other—a type of defect which may not register in the initial test but will cause trouble in the long run. The only method of finding this particular kind of alignment difficulty is by visual examination. This is a simple matter when the tube has an opening or a window through which the examiner can look but in the new all-metal tubes visual forms of testing are, of course, out of the question unless the sheath is cut away to disclose the insides. When the case has been cut open, however, the tube is no longer salable and must be counted as a loss. Even when a small number of the total shipment of tubes is destroyed for this purpose it is an expensive proposition. If, for example, a manufacturer is making 300,000 tubes a month, at an average cost of 15 cents each, and plans to examine for internal alignment 2% of this number, he would then be forced to discard 6,000 tubes a month; a loss of about $900. This figure does not include the bill for the time and labor involved in the sectioning and checking processes.

The only solution to this problem is the inspection of these tubes by X-rays, either by the photographic or fluoroscopic method. The X-ray will show up all the details of the internal structure of the wiring and spacing alignment in the same size and relation as they exist in the tube. The cost of fluoroscoping these tubes would only amount to about 8 or 10 cents each and would still permit the acceptable ones to be sold.

X-RAY EXAMINATION OF ALL-METAL TUBES



Photographs taken by Mr. Woods of all-metal tubes. X-ray inspection enables the manufacturer to check alignment without destroying the tube

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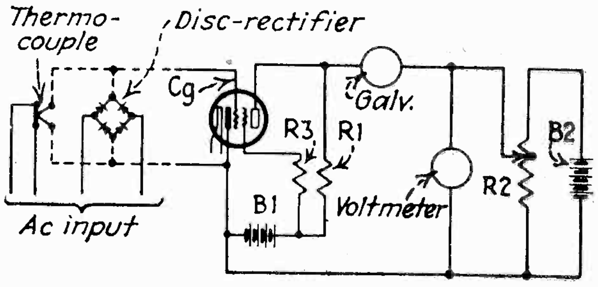
Thermocouple used in low-voltage tube voltmeter

By Charles Murray

The usual method of measuring alternating currents at low voltages with a meter, requires an instrument of low internal resistance. This materially affects the circuit under measurement, especially in radio circuits, where the supply is very limited.

The vacuum tube voltmeter shown in the figure has been devised and used quite successfully for this purpose. It has been found by adding a "no-current" voltmeter circuit, voltage variations may be read directly, after calibrating the set-up.

The thermocouple as the voltage element should have a high resistance heating element, as the voltage gen-



Circuit diagram of tube voltmeter. The resistance R_1 should be equal to the plate resistance of the tube used, which may be a 27, 24 or 57, depending on the desired voltage sensitivity. The dry-disc rectifier may be substituted for the thermocouple if desired

erated is the only required factor. The output of the thermocouple is connected in the conventional way to the control grid (*CG*) as in the figure. A non-inductive high resistance (*R1*) is connected in the plate circuit, between the plate and the positive charging voltage supply (*B1*). Also to this plate is connected a second positive charging voltage from (*B2*) thru a variable resistance (*R2*) and the galvanometer.

Any change in potential on the control grid will cause a corresponding change in the plate resistance of the tube and also a change in voltage drop across the resistance (*R1*), this will be noted by the unbalanced galvanometer reading. The second charging voltage is varied until a balance is again obtained. The difference in voltage may be noted on the voltmeter (*Vm*) in the second section.

This circuit arrangement has other possibilities. It may be used for measuring direct current voltages from a limited supply or it may be substituted for a very delicate and sensitive galvanometer in a bridge circuit, where an unbalanced condition may cause damage to the galvanometer element.

The calibration of the circuit with a thermocouple should be made by comparison with an accurate alternating current voltmeter in the usual parallel method.

One of the advantages of the circuit shown is the fact that the thermocouple (or dry-disc rectifier) may be placed in the circuit under observation, while the tube and indicating meter may be placed at a remote location. Since only d.c. flows between the thermocouple and the tube, the length of lead connecting it to the tube is not important unless appreciable grid current is drawn, and even in that case, the meter may be calibrated. If, on the other hand, the a.c. were led to the tube directly over long leads, interfering fields would undoubtedly affect the measurement, particularly if the circuit under test was operating at a radio frequency.

✦

Automatic bias generation for a-c amplifiers

By Verne V. Gunsolley
Consulting Engineer, United Sound Engineering Co., St. Paul, Minnesota.

Heretofore, the use of fixed bias on direct current amplifiers has necessitated the use of a C battery. On all self-biassed amplifiers the conversion to fixed bias operation generally entails changes too involved to justify the trouble and expense. The automatic bias generator herein described meets the need for complete electrification of direct current and AC-DC amplifiers with fixed bias and provides a simple method of converting any amplifier to fixed bias operation.

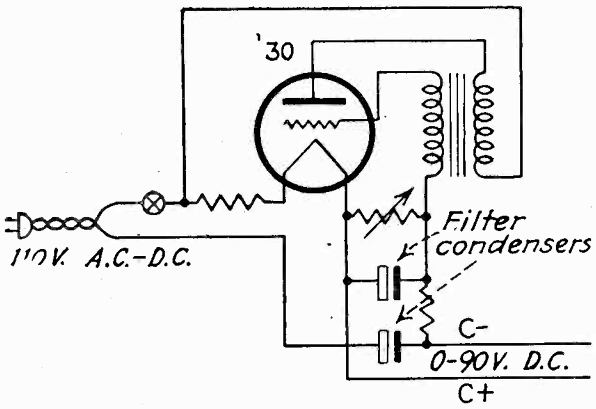
A schematic diagram of the circuit is shown. It is a simple audio oscillator with variable grid leak in the grid return. Grid rectification causes the return to go negative with respect to ground thereby supplying the bias to the power tubes. Either audio or radio frequency may be used; the latter being desirable where the construction requires the oscillator to be operated near high impedance circuits of the audio amplifier input.

A unit was built around the circuit employing a 30 type tube and supplying bias from 0 to 90 volts depending upon the setting of the grid leak resistor. The filter condensers used should have low resistance to permit the high range. For biassing pentodes the low voltage high microfarad type of electrolytic condenser may be used. Either alternating or direct current may be applied to the oscillator plate as the grid output is filtered.

This principle is working successfully in a 12 watt "AC-DC" audio amplifier. The oscillation frequency is about 105 cycles; the self capacity of the audio transformer being used for tuning to simplify the installation. A 76 tube is the oscillator.

In superheterodynes, part of the regular oscillator output may be applied to one of the unused diodes of the second detector and the output applied as bias to the final stage. This is recommended only in the low priced field where some variation in fixed bias with change in tuning frequency is permissible. In other low cost designs a dual purpose tube may be employed and the extra unit utilized as a bias generator.

The automatic feature of the generator lies in its ability to supply a higher bias with grid overload. The grid leak performs this function by sending the grids more negative and the filter circuit prevents the additional bias from fluctuating so rapidly as to cause noticeable distortion from this cause. For this same reason the generator may be used in higher power design for class C power amplifiers. It is only necessary to select an oscillator tube that will supply the power loss in the grid leak at the rated bias voltage, after selecting the leak to bias the grid properly for full excitation.



C-bias generation circuit

By use of multipurpose tubes interesting variations of this principle may be worked out to produce bias voltages higher than those impressed upon the oscillator.

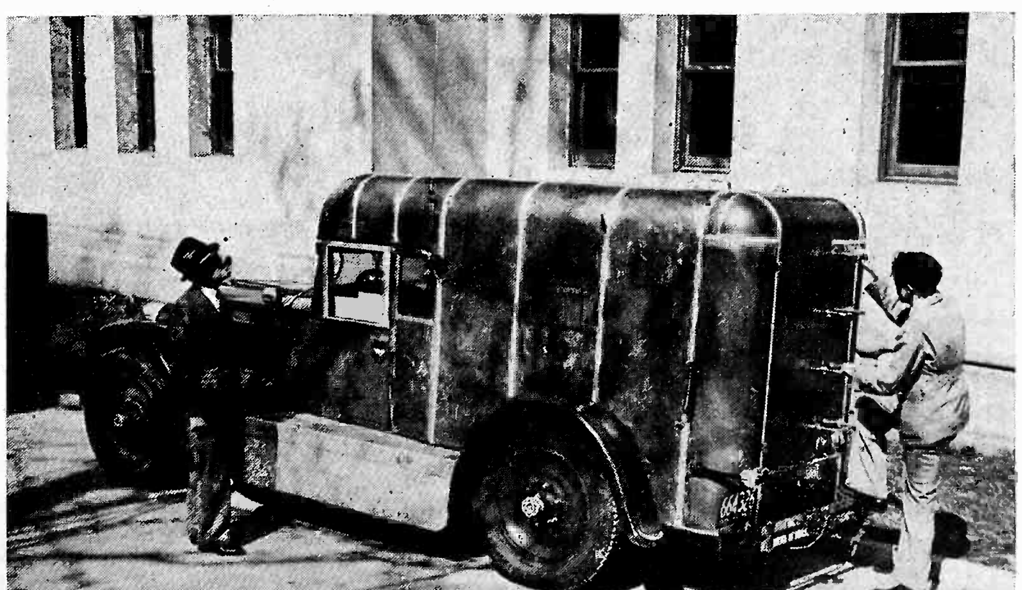
Suggestions concerning FCC high fidelity standards

The tentative standards formulated by the Engineering Department of the Federal Communication Commission for use in considering high fidelity transmitting stations, which were published on page 127 of the April issue of *Electronics,* have been circularized to members of the Radio Manufacturers Association for their comments. In answer to a request for suggestions concerning these standards several members of the Joint R.M.A., N.A.B. and I.R.E. Committee have given their comments as follows:

Mr. A. F. Van Dyck of the RCA License Laboratory has suggested that the higher harmonics are more objectionable in audio distortion than the lower harmonics, and that some recognition of this fact should be made in the high fidelity standards. The requirement of hum background on high fidelity transmission (40 db. below the full output) was considered to be too high a value, according to Mr. Van Dyck. Since a good high fidelity receiver should have its hum level 60 db. below full output it is suggested that the transmitter should have a requirement at least as good as this.

Mr. E. K. Cohan of the Columbia Broadcasting System has also offered several suggestions. He believes that two separate filters (one cutting off at 5,500 cycles and the other at 8,500 cycles) are not necessary nor desirable. It is Mr. Cohan's opinion that a single filter with a sharp cut-off at 8,500 cycles is sufficient.

TRAVELING RADIO LABORATORY



Radio echoes and other studies are made in this truck of measuring equipment built by scientists of Cruft Laboratory, Harvard University

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

ORESTES H. CALDWELL, *Editor*

KEITH HENNEY, *Managing Editor*
DONALD FINK

Vol. VIII —JUNE 1935— Number 6

A Federal police radio net

A NATION-WIDE Federal police radio system is the next step in the Government's relentless warfare on crime. Studies are now being made for a police "net" of twenty or thirty radio transmitters covering the whole country on special frequencies, and tying up with local police radio systems so that an alarm broadcast from Washington will quickly reach the attention of police officials and police cars everywhere.

A feature of this new Federal system will be facsimile apparatus for the transmission of finger prints to and from headquarters, so that identification may be aided by direct visual examination of the finger prints themselves.

Such a Federal police radio net will be of the utmost value in speeding up criminal hunts, with the aid of present invaluable state and city police radio systems.

Defenders of the Faith

TO Dr. C. B. Jolliffe, chief engineer of the Federal Communications Commission, and his engineering associates, the radio industry owes a debt of gratitude for the unswerving adherence to radio principles and sound radio practice which have characterized the engineering advice given the Commission.

The chief engineering officer of the Commission is continually "on the spot," for he must insist on enforcing theoretical "intangibles" in the face of strong political demands. Only a friendly personality and winning smile, cloaking firm determination, could stand up so many years under the hot and eroding blast that continually beats on the chief engineer of the FCC.

All radio operations of manufacturers, designers, operators, broadcasters, and industry and trade depend upon a courageous stand for radio principles at Washington. In this vigilant defense Dr. Jolliffe has such estimable lieutenants as E. K. Jett, A. D. Ring, W. H. G. Finch, G. C. Gross, W. D. Terrell, Arthur Batchellor, and their loyal staffs.

Most people are "ear-minded"

THE Harvard tests showing the "ear-mindedness" of most people, as contrasted with their "eye-mindedness," means much not only for radio, but also for the many other electronic applications of sound and sound communication. The Harvard professors, Drs. Allport, Cantril and Carver, found that "facts" are much *better understood* when *heard* than when seen on a printed page. Narrative and abstract material share the same characteristic. Numbers, simple words, sentences, prose passages, humorous comments, all have greater appeal and "register" more deeply when presented *aurally*, than visually.

These findings support the evidence presented by the public's rapid acceptance of radio listening in little more than a decade. Millions who had previously depended for information on the spoken word and the printed page, found the new sound medium a "natural," and far more acceptable than reading. Even after generations of reading habits, these people quickly reverted to the ear-channel of reception. Eye-minded creatures (like editors and proof-readers) seem to be exceptions, fortunately. The vast majority of humankind is ear-minded, and reached most readily by such aural mechanisms as radio, public address, the talking book, phonograph recordings, and other manifestations of the vibrant diaphragm.

Simple licenses for transceivers

AT this time some interest is being created in the sale and use of transceivers for two-way communication over short distances. But the enthusiasts who would like to take up this new sport are likely to have their enthusiasm considerably dampened by reports that the Federal Communications Commission has enlisted the amateurs as "vigilantes" to track down unauthorized emissions.

Certainly transceivers should be licensed, so that the authorities may keep track of them. But with the prospect of a wide service being rendered by these transceivers in the future, could not some license plan be worked out, as simple as the issuing of automobile driver's licenses? With transceiver frequencies fixed, and powers low, the danger of doing serious harm is slight. But a great new service to the average user may be nipped in the bud, if the policeman's club is waved and "cracked down" on often unwitting offenders. Instead the FCC should find a way to license and encourage laymen who want to take advantage of this new use for radio.

Recent progress in sound pictures

ADDRESSING the Society of Motion Picture Engineers at Hollywood, Cal., May 25, Max C. Batsel, chief engineer for the RCA-Photophone group, listed recent important developments leading toward the elimination of distortion and the bringing of sound pictures nearer the ideal of realism and tone fidelity, as follows:

1. The development of film moving mechanisms that are free from objectionable variations of speed, notably the magnetically-driven drum in the recorder, and the "rotary stabilizer" in the reproducer. Elimination of flutter caused by film-gate construction, and ripples produced by the sprocket holes.

2. Improvement of the recorder optical system so that it is capable of satisfactorily recording a frequency range from 40 up to 10,000 cycles.

3. Improvement of amplifiers through the development of new types of vacuum tubes, improved transformers and resistors.

4. New laboratory devices for analysis of causes of distortion so that they might be eliminated.

5. New types of microphones. These are of the velocity type, and have a smoother response over a wider frequency range than previous types, and fulfill the requirement for a directional microphone having characteristics independent of frequency.

Thinking is an electrical process

ELECTRONIC amplifiers now reveal that the brain also is the seat of teeming electrical currents which flow back and forth in the mysterious process called thinking. Already electronic amplifiers, in the form of the cardiograph, have shown that electrical flashes accompany each movement of any muscle. The heart muscles generate an emf of a millivolt or so, and this can be graphically recorded, revealing to the experienced diagnostician every detail of the heart's action.

This new research is digging deeper and deeper into human physiology and its nervous and mental machinery. With the human body itself now recognized as being but a "bundle of electrons," it is not surprising that the electronic amplifier is proving the master tool of this new assault on the mystery of life.

Industrial plants conduct classes in electron tubes

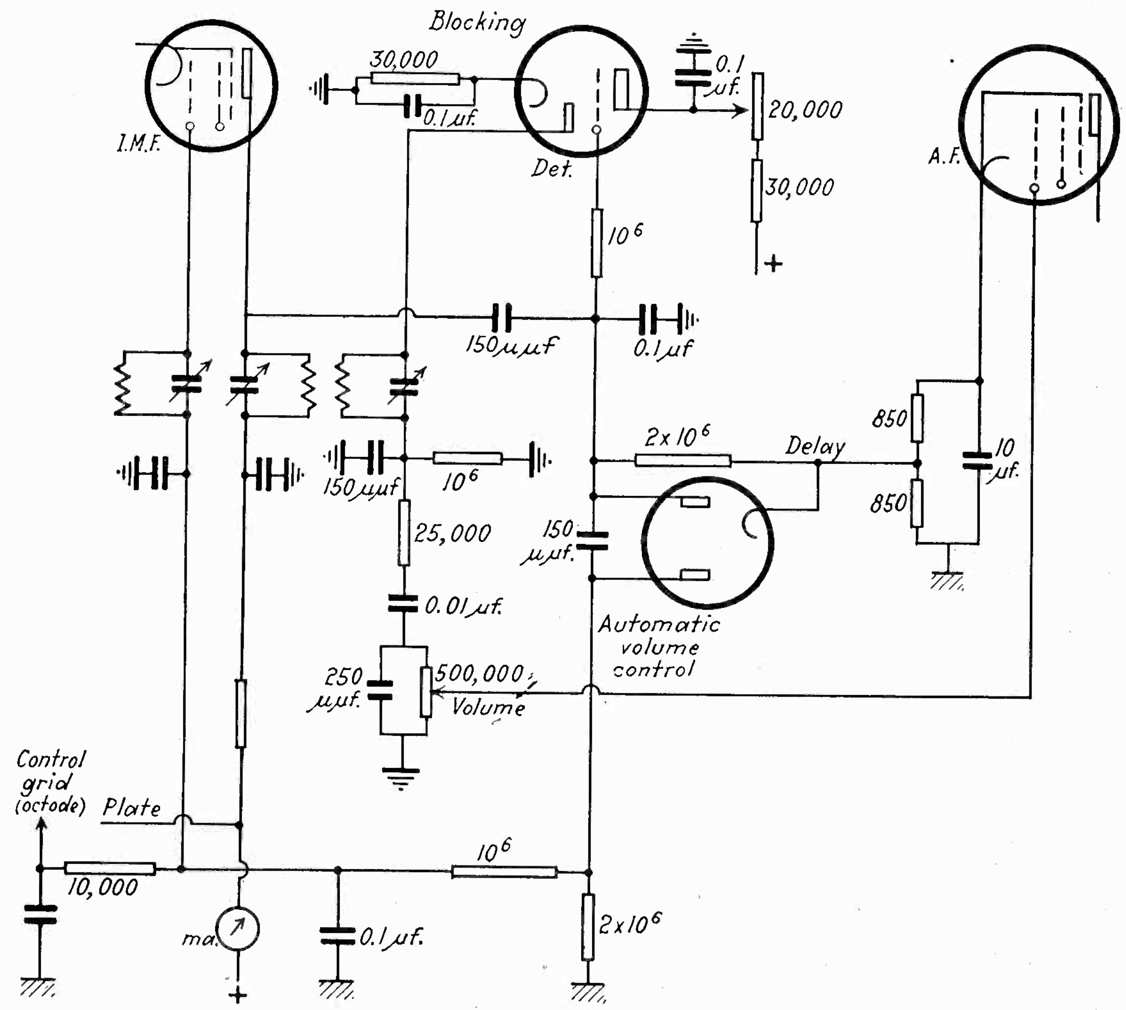
THE training of better plant electricians is one of the hurdles that still stands in the way of the more general adoption and successful operation of industrial electronic tubes. The average practical electrical man in industry knows plain wiring circuits, motors, and electro-magnetic devices, but he often stands puzzled in the presence of a glowing globe of glass. The younger generation of ex-radio-experimenters pick up electronic principles more easily, and become useful recruits for industrial-tube supervision.

Already a number of industrial plants are conducting classes in electronics to give their men a practical understanding of the new things that are coming in everyday factory service.

A typical new French receiving set

[P. Besson, Secretary, Society of Radio Equipment.] The receiver "Integra 357", of the firm Integra, Paris, passes the signal over a band filter to an octode producing an intermediate frequency of 125 kc/sec., amplifies the i.m.f. in an r-f pentode, rectifies by means of a diode-triode and ends with two a-f pentode stages. Delayed a.v.c. is obtained by means of a separate double diode, the second half of this diode being used for silent tuning. The bands covered are 22,000-1,000 m., 550 to 200 m. and 45 to 20 m. The capacity of the switch used for changing from one range to the other is about 80μμf., and in order to obtain accurate tracking it has been found advisable to connect the oscillator grid of the octode to the center of the coil rather than to the end.

Normally one path of the double diode is blocked by part of the bias obtained from the resistor placed in series with the cathode of the first audio amplifier. The intermediate frequency applied over a 150 μμf. condenser to the same path produces flow of d.c. and a voltage drop in the 2 meg. resistor, which for strong signals exceeds the blocking potential and acts, over circuits with suitable time constants, upon the grid of the intermediate amplifier and the control grid of the octode. The second plate of the double diode is connected over a 2 meg. resistor to the cathode and is in the absence of a signal, at the same potential as the cathode. When the intermediate signal acts upon this path it produces a voltage drop which is applied to the grid of the diode-triode and decreases the plate current through this tube and, in consequence, the positive potential of the cathode, 4 or 5 volts, obtained from a 30,000 ohm resistor in series with the cathode. Provided that the signal is strong enough, this reduction allows the diode of this tube to which the intermediate frequency is applied over a transformer, to detect the signal applied to it and to apply it over resistors, condensers and a 500,000 ohm potentiometer to the a-f amplifier. Accurate tuning is achieved by watching a d-c milliammeter which measures the plate current from the octode and the i.m.f. pentode, the lowest reading indicates resonance. The gang condenser with its three units is mounted vertically and rotated by a horizontal screw which displaces at the same time a reference mark. The stations are indicated upon a horizontal cylinder, of which only a portion is visible at a time, depending upon the position of the switch for the different wave-bands.—*Onde él.* 14 (No. 159): 174-190. 1935.



Anti-fading and silent tuning in French receiver Integra 357

Periodicals devoted to television

The increased interest which television is arousing is also shown by the fact that *Fernsehen und Tonfilm,* the German television periodical edited by Prof. G. Leithauser and F. Banneitz, is now to be published monthly instead of every two months, and that its volume is to be increased. It still appears, as for the past year, together with *Funktechnische Monatschefte,* but is now in its sixth year.

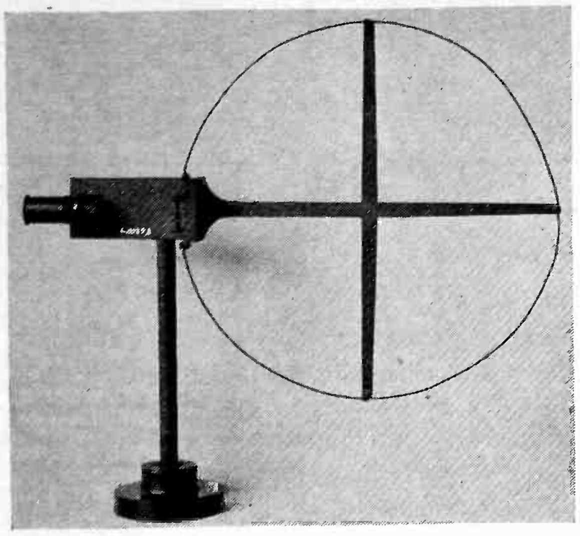
The first number of a French bimonthly television journal has also just appeared. It is entitled *Television et Cinema Sonore,* like its German companion, and is published by Etienne Chiron, 40, Rue de Seine, Paris. The main articles of this first number are: a first installment, "What is Television?" by Bernard Kwal; "The Mechanism of Seeing," by Andrew Michel; "The Discovery of the Photoelectric Effect," by Bernard Kwal; "Telecinematography," by Pierre Toulon; the description of the new Russian television receiver or adapter (30 lines, 1,200 elements), and "Principles of Cinematography," by J. Courant. Bernard Kwal, author of a recent book on television, is editor-in-chief. Previously the journal appeared together with *La T. S. F. Pour Tous,* and is therefore considered as being actually in its fourth year and as the "first television journal in the world."

✦

"Sirufer" iron-dust coils for r.f.

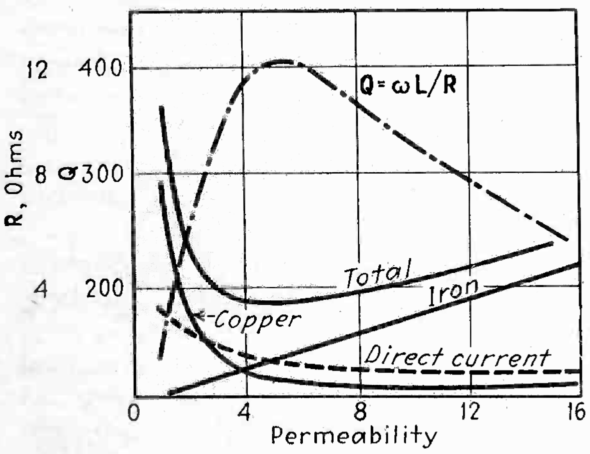
[A. Weiss, Siemens and Halske Laboratory, Berlin.] The losses in iron core coils consist of losses in the iron, mainly eddy current losses, proportional to the square of the frequency, dielectric losses in the insulating materials in core and windings, and copper losses. Eddy current losses are reduced by using very fine iron powder, spherical grains of less than 5 microns (1/5 mil) dispersed in a suitable insulating material which has a crushing strength of at least 16 to 20 tons per sq.cm., the pressure used for pressing cores of various shapes. In the material manufactured by Siemens the eddy current factor w in the formula $R_w = wf^2L$ is reduced to 0:003 at a permeability of 20. With an H-shaped core of this material the Q of a 2 mh. coil amounts to 210 (see Terman, *Radio Engineering,* p. 53) at 1,000 kc.; higher figures

HERTZ RESONATOR



A "kreisförmiger" resonator made and used by Hertz in his famous demonstration of electric waves

(less than six ohms) can be obtained by reducing the permeability by means of air gaps in the core. The dielectric loss amounts to 0.4 ohm when the insulating material has a loss angle of 1/100. Copper losses are lowest when the number of turns is low, or the permeability high, and the cross-section large. The measured losses amount to 1.8 ohm and are due to the electric field of all the windings acting upon any one of the turns. For H-cores the highest Q is obtained for a permeability



Copper, iron, d-c losses vs. permeability; 0.2 mh coil, 1000 kc., litz, 20 strands 0.05 mm, 1/3 winding of air coil

of about five, a value which ensures a proper balance between iron, copper, and dielectric losses. The composite material may be sawed, turned and polished to cylinders, hollow cylinders, rings, E and H shapes. By adding binding materials, a product may be obtained which can be given any desired shape, in particular bobbin form. In this case the coil is mounted upon a two-piece cylinder of Trolitul. Single cylinders allowing the coils to be simply pushed over it have too much permeability to give the highest Q.

Matching of the coils is achieved by drilling a hole in the cross-bar of the H and introducing or screwing a rod of Sirufer into the opening. A displacement of 1/10 mm. causes a change of about 10 per cent in *L*.

See also *Electronics,* Jan., 1934, and Nov. 1934.—*El. Nachr.* 12 (No. 2): 47-53. 1935.

✦

Potentials below one microvolt measured by means of d-c amplifiers

[R. Colberg, University of Hamburg.] Modern armored needle galvanometers measure down to 1/1,000 microvolt, moving coil instruments to 1/10 microvolt provided that in the latter case the internal resistance of the source is equal to the resistance of the instrument. Special moving coil galvanometers of low resistance allow one to detect 1/30 microvolt. All these instruments are delicate and expensive. When a d-c contact connected to the input of a four stage d-c amplifier is suddenly opened, a click is produced in the telephone receiver provided that the voltage is above 30 millivolts; below this limit the click becomes drowned in the general shot noise. A better solution is to use the unknown source and a known source of potential of opposite direction for driving a current through a coil which shunts the grid filament capacity of the input tube. When this circuit is suddenly opened, the magnetic energy is discharged, in the form of damped oscillations, and the fluctuations in the grid potential cause a change in the output of the amplifier. With a coil of about 10 hr., C=1/100 μf the resistance of the circuit 20 ohms, the frequency of oscillation 10,000 per sec., the highest voltage is about 5,000 times the d-c voltage. One difficulty discovered in this work is a musical note accompanying the tube noise at open circuit. It must be due to the shock excitation of the resonance frequency of the input circuit by the shot effects of the electrons flowing to the plate. It varies with the number of turns of the coil, and allows one to determine the self-induction of an iron core coil under open circuit conditions.—*Zeits. Physik* 93: 507-527. 1935.

✦

A tube milliammeter for alternating currents

[H. E. M. Barlow.] The diode or triode is placed in a bridge circuit, where the rapid increase of the saturation current when the temperature of the filament rises upsets the balance of the bridge. The balance is indicated by a moving coil galvanometer. The terminal of the a.c. supply connected to the negative side of the filament of the tube is earthed. A condenser, 20 μf for audio and 1,000 μf for 25 cycles per sec., and a choke coil separate a-c and d-c supply. Satisfactory operation is obtained when a second tube, matched so as to give the same plate-current changes for the same changes in filament current, is used as the second arm of the bridge. In this case the response does not vary by more than one per cent for full scale deflection when the frequency is varied from 25 to over one million cycles per sec. Depending on the galvanometer shunt, the instrument gives full deflection for 5, 10, 20 and 30 ma; the a.c. impedance is less than 40 ohms.—Preprint to *Institution of Electrical Engineers Journal.*

✦

Broadcasting over telephone wires

[F. Gladenbeck, German Post Office Research Lab. F. Noack.] In an endeavor to bring radio even to those persons unable to receive programs with the "folks' receiver," or to persons dwelling in districts where broadcast reception is unsatisfactory, the German Post Office Laboratory has carried out a number of tests in Berlin and decided to start with a test on a large scale in Dresden and its environment. The frequencies used are 150 kc, 220 and 250 kc, giving a choice of three programs. Broadcasts can be received by persons who are not subscribers to a telephone, since several short lines can be run from one telephone receiver.—*Tel. Fern. T.* 24 (No. 3): 55-58. 1935. *Umschau 39* (No. 17): 320-323. 1935.

TRANSCEIVER IN OPERATION

L. W. Hermes of Brooklands, England, using high-frequency equipment for two-way communication with aircraft

++ BOOKS ++

FOR ENGINEERS USING ELECTRON TUBES

Geometrische Elektronenoptik; Grundlagen und Anwendungen

(Geometrical Electron Optics, Fundamentals and Applications). By E. Brüche and O. Scherzer. Published by Julius Springer, Berlin, (332 pages, with frontispiece and 403 figures. Price, cloth-bound 28.40 German marks).

THE BOOK OPENS with an account of the modern views on the electron and the nature of light, to make clear the distinction between the wave optics and the geometrical optics of the electron. The geometrical or ray optics of the electron has in practice little to do with the wave nature of the electron; it is based on such facts as that when an electron passes from a space at the potential V into a space with a slightly higher potential, the ordinary laws of refraction apply. The difficulties of constructing a lens on this principle are then discussed; metal films or screens are not sufficiently transparent for this purpose. As shown in successive chapters it is necessary to resort to electric fields in free space, a method which requires a knowledge of the theory of the electric potential near condensers, metal diaphragms and grids, or to magnetic fields, a method which depends on a knowledge of Maxwell's electromagnetic equations. This study leads to the construction of electric and magnetic lenses which have the same properties and defects as lenses in optics. Conditions met in practice make is also necessary to analyze the effects of space charge fields. Space charge fields which occur in discharge tubes have formerly led to the discovery of the free electron.

The second half of the book is devoted to the applications, namely the formation and deflection of electron beams in the cathode ray tube, the electronic microscope and the mass spectrograph. The chapter on cathode ray tubes insists upon the various focusing or lens effects leading to the formation of an image of the cathode upon the anode. The second field of applications is the production of enlarged pictures by the electronic microscope, mainly used for getting pictures of surfaces emitting electrons, and allows to study the emission of tungsten filaments, to examine how far Langmuir's theory of thoriated tungsten agrees with the facts and to check the properties of dull emitters. The method has repeatedly been mentioned in *Electronics* (see, for instance, January and September, 1933). Very high magnifications of the emitting surface, 8000 or more, corresponding to a resolution of the order of 0.05 micron, can be obtained by the use of successive lenses.

Dealing mainly with developments that have taken place since 1930 the book is writen with the enthusiasm of the pioneers looking back upon their first success in a new field of electronics. As mentioned in the foreword this success was surprising even to men considered as authorities in the field and removes, in theory at least, any practical barriers as to the resolving power of the electronic microscope. On the other hand the use of radio tubes with many electrodes and multiple functions and the question of the configuration, and the distortion of their electric fields, makes many parts of the book, particularly in view of the large number of illustrations, of interest to the practical radio engineer with less ambitious plans than those conceived by the authors, who work in the research laboratories of the German General Electric Co.

Elektrische Gas entladungen, ihre Physik und Technik

(Electric discharges in gases in theory and practice). By A. V. Engel and M. Steenbeck. Part II. Julius Springer, Berlin, (352 pages, 250 figures. Price bound 33.50 German marks).

AFTER A brief description of the currents obtained in gases which are ionized from the outside, by radiation, for instance, the book opens with a vivid picture of the conditions in the interior of a strongly but uniformly ionized gas, where the microfield, that is the field in the neighborhood of an electron or ion, is proportional to the number of charges per unit volume, but varies from one charged particle to the other. When intense discharges are sent through neon, the number of positive and negative charges may reach one million million per unit volume, and the microfield 1500 volts per cm. on the average, that is, it is much stronger than the field applied between the electrodes in order to force the current through the gas. Toward the outside the ionized gas behaves as a neutral body (the so-called positive column or plasma). In the case of the self-sustained discharge, a second type of field enters into the picture, namely those regions in which the number of charges of one sign exceeds the charges of the other sign. The space charge regions gain in importance as one passes from the dark discharge to the glow and to the arc discharges. These three types are treated in detail in successive chapters, an attempt being made in each case to decompose the discharge space into its main fields and to set up equations for each of these regions, be it on the basis of a knowledge or an assumption as to the elementary processes of which it is the seat. The agreement found, for instance, between the experimental and the computed value of the cathode fall in argon is quite striking and indicates the progress that has been made in recent years. The description of the various discharge types ends with a section on the stability and the starting of a discharge.

The remaining third of the book is devoted to a description of the applications: gas-filled photocells, uses in electrical measurements, corona, electrical precipitation of dust, glow tubes as rectifiers, voltage regulators and light sources, mercury and grid-controlled vapor tubes, ending with two remarkable sections on arc welding and circuit breaker discharges.

The book lays stress upon the electrical rather than the optical or spectroscopic properties of the discharge, an attitude to be explained by the authors' work in the research laboratory of the Siemens concern and also in part by having to take into consideration other recent books on the subject. In their own field, however, the authors apply with great success the results of the most recent scientific work in order to render more precise the general picture available hitherto of the mechanism of the electric discharges which reveals itself as essentially correct. A particularly valuable feature of the book is that it never losses sight of the practical applications which promise to become a more and more important field of electronics.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Permeability-tuned iron core i-f transformer

An iron-core i-f transformer known as the Elwin Linoperm which utilizes permeability tuning, has been announced by the Electrical Winding Corp., 22-26 Wooster Street, New York, N. Y. The variable condensers usually used to bring the circuits into resonance are replaced in this unit by fixed condensers of special construction, insuring low power factor and permanent adjustment. Tuning is accomplished by the use of plungers made of iron core-material, which slide inside of low-loss, litz-wound inductance coils. Screws which protrude through the side of the shield can are used to change the position of the plungers in the coils, thereby changing the circuit inductance, and consequently the resonant frequency.

This type of construction, according to the manufacturers, greatly reduces the changes in adjustment which result from mechanical jarring or displacement, and from the presence of moisture in the trimmer used in conventional i-f transformers. The variation of the trimmer capacity is largely confined to a small rotation of the tuning screw, whereas in the permeability tuned unit, the variation of frequency with rotation is slow and practically linear, being spread over eight turns of the adjusting screw.—*Electronics.*

✦

Sound insulative door

The United States Gypsum Company, 300 West Adams Street, Chicago, Ill., has developed a sound-insulating door which is especially adapted for sound studios and broadcasting stations. It is light in weight, uses regular hardware, and is of ordinary thickness. This door employs a resilient medium, the two sides of the door being separated by resilient spring devices, which allow either side to vibrate under the action of sound striking it, without the vibrations being transmitted to the other side. The resulting sound insulative efficiency is remarkably high.

In outward appearance the insulative door is the same as any other door. Any paneling or finish can be provided to match the other typical doors in the building. The door is easily installed by any good carpenter, in exactly the same manner as any door, and is adaptable to either wood or steel bucks.—*Electronics.*

✦

Precision resistors

A series of precision wire wound resistors constructed in various forms to satisfy both production and laboratory requirements is offered by the Precision Resistor Company, 334 Badger Avenue, Newark, N. J. In the type M non-inductive resistor any value from .25 to 500,000 ohms may be provided in power ratings from ¼ up to 5 watts. These units are particularly suited to use in meter shunts and series resistors. Types A, B and C are available in wattage ranging from 1, 2 and 5. An inductively wound type of resistor is available with a power rating of 10 watts and in a resistance range from 1 to 100,000 ohms. All of these resistors may be custom-built to fit individual requirements in size, resistance value and accuracy tolerance. A circular describing these units may be obtained from the manufacturer.—*Electronics.*

✦

Electrical thermometers

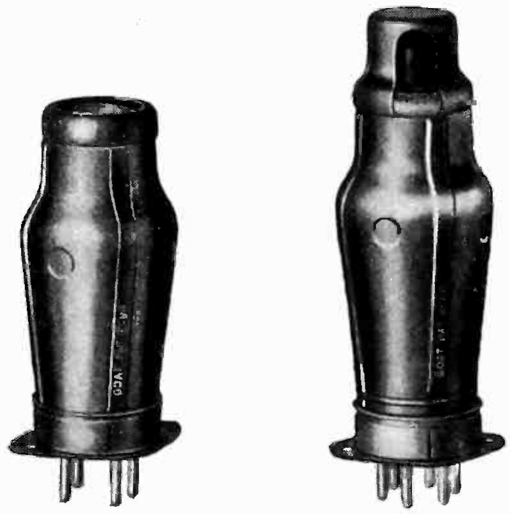
The application of electrical thermometers of the three-lead, null-instrument, electrical-resistance type to the efficient regulation of air-conditioning systems, is fully described in a new bulletin, No. 4001, issued by the Leeds & Northrup Company, 4900 Stenton Avenue, Philadelphia, Pennsylvania.

A length of nickel wire, specially treated, wound, and mounted, is known as a Thermohm, and this is connected through lead-wires to indicating or recording instruments which, while actually measuring resistance, are graduated to read in temperature degrees. An advantage of this method is its accuracy when measuring temperatures at various distances, and at considerable distances. With such equipment the temperature and humidity of an air-conditioning system can be held at correct values with great constancy.—*Electronics.*

✦

Improved form-fitting tube shields

Improved types of form-fitting tube shields are announced by the Goat Radio Tube Parts, Inc., 314 Dean Street, Brooklyn, New York. The new shields, as shown in the illustration, consist of two identical half-shields, which slightly overlap to insure complete enclosure regardless of tube variations. The half shields are fitted into the base, pressed together at the top, and the cap slipped



on. The shoulder of the tube acts as a pivot, so that the halves are forced outward at the bottom, insuring a solid contact at the base with the grounded chassis. The caps and bases fit interchangeably on all types. All sharp edges are rounded, and the clamp ring formerly used has been eliminated, making for high speed in production.—*Electronics.*

✦

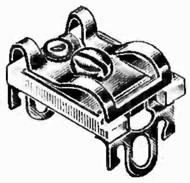
Terminal strip

A new terminal strip which occupies but small space is offered by the Cinch Manufacturing Corporation, 2335 West Van Buren Street, Chicago, Illinois. The strip is made of 1/16 in. bakelite, with contact openings plainly labeled, with collet type contacts. The cord tips used with the strip are standard tube prongs, fitted with fiber insulation grips. A slight flare on the grip prevents slipping in handling. The tips can be soldered simply. The strip is intended for use in radio sets, to provide connection terminals for all external parts and controls, such as dial-light, volume control, speaker control, etc. The strip may be easily riveted to the chassis or can of the set. It is claimed by the manufacturer that a reduction in installation cost and time results from the use of these units.—*Electronics.*

✦

Antidrift trimmer condensers

Because the drifting of trimmer condenser capacities has at times seriously injured radio receiver sensitivity, the research department of Solar Manufacturing Corporation has developed a new small ceramic base trimmer designed to eliminate drifting. Constructional features which might cause drifting have been eliminated. A distinctive feature is that under the pressure of average settings, the top plate has



anchorage at both front and rear. The new trimmer is called the "Perma-Set," and is supplied in maximum capacities of 30 mmf. to 180 mmf. Solar Manufacturing Corporation produces wet and dry electrolytics, paper, mica, and trimmer condensers, with factory located at 599-601 Broadway, New York City.—*Electronics.*

✦

Moisture proof cartridge condensers

A new series of paper foil cartridge condensers having a triple-sealed moisture-proof container is announced by the Aerovox Corporation, 70 Washington Street, Brooklyn, N. Y. Features claimed for these units are: (1) thorough wax-coating of the non-inductive section of selected paper and foil, (2) use of a sturdy wax-impregnated tubing with imbedded aluminum foil, (3) liberal wax-sealed ends in place of usual spun-over ends. In tests at 98% relative humidity these triple-sealed units indicate a life four and one-half times as long as that of conventional tubular condensers. These units are especially desirable for export and for use in humid climates.—*Electronics.*

Velocity microphone

A professional type velocity (ribbon-type) microphone has been announced by the Amperite Corporation, 561 Broadway, New York City, under the type number SR 80. This microphone, which lists for $80, has the following electrical characteristics: Flat within 3 db from 25 to 12,000 cycles per second with appreciable response at 14,000 c.p.s. The output level is minus 65 decibels. The directional characteristics are such that the pick up is limited to an angle of 120 deg. on the front and back side. An output impedance of from 50 to 200 ohms can be provided with other values on special order. High grade cobalt steel magnets, an aluminum alloy for the ribbon, and complete elastic coupling between microphone and stand are among the mechanical features.—*Electronics.*

✦

Public address system for restaurants

A new current product of the Universal Microphone Co. at Inglewood, California, is an "Ordering 'Phone Box" for use in cafés, restaurants, night clubs and other spots where a remote control ordering system is used.

The microphone control box is 3½ x 5 x 2 inches, and weighs a pound and a half. It is threaded for standard half inch pipe conduit.

There is a "press" button for use when speaking, and the press button switch is double pole, single throw, for single button microphones and three pole, double throw for two button microphones. Light signals include the green for okay and the red for "in use."

The new Universal device is supplied without wiring, but with two circuit diagrams for any number of stations in either AC or DC operation.

In actual usage, common feeders may be extended any distance and boxes may be added or deducted on the circuit without disturbing the remaining stations.—*Electronics.*

✦

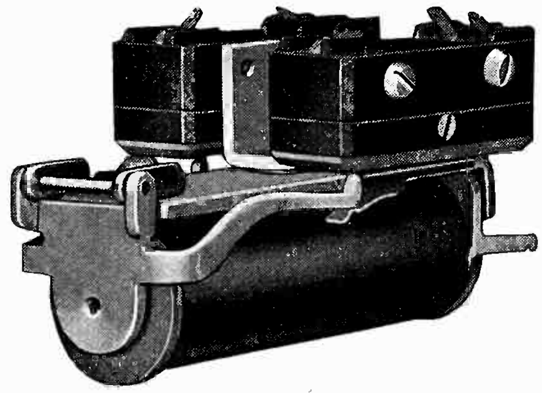
Portable ac-dc record player

A high fidelity disk reproducer of the play-back type is offered for sale by the Presto Recording Corp., 139 W. 19th St., New York City. The outfit which operates on a.c. or d.c., has a 16-in. turntable and speeds of 78 or 33⅓ r.p.m. The amplifier used is flat from 40 to 9000 cycles and provides a 3-watt output. The entire mechanism is mounted in a portable carrying case, and its total weight is 50 lb. Seven tubes are used, 2-76, 2-48, and 3-25-Z-5. Space is provided in the machine for use of a still projector so that 35 mm. still pictures can be shown synchronously with the spoken words on the disk. A full 15-min. record can be accommodated on the instrument.—*Electronics.*

✦

Micro-switch relays

The illustration shows one of a new series of relays developed by Automatic Electric Company, Chicago, for miscellaneous remote control purposes, suitable for switching A.C. loads with very small D.C. controlling currents. Each unit consists of an Autelco relay, equipped with one or two Burgess micro-switches. The latter device is a well-built, sturdy switching assembly, which gives fast, positive snap action with minimum motion of the relay armature. Operating time is only .002 to .010 second and release time .005 to .250 second. The contacts of the micro-switch are rated as: break contacts, 10 amperes; make contacts, 6 amperes, at 110 volts, A.C. The contacts are not rated for D.C. loads. The relay is furnished only to operate on



D.C. from 6 to 220 volts. One or two micro-switches, of make, break, or break-make type, can be furnished. The relay may be mounted on an angle bracket, with no provision for a cover or on a bakelite base with cover, the base being equipped with studs for switchboard mounting.—*Electronics.*

✦

Electrostatic microphones

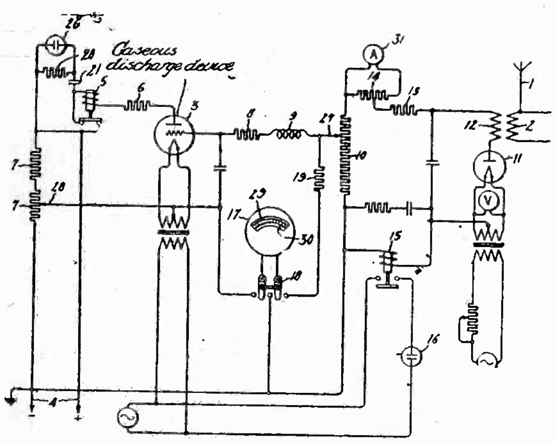
Two new electrostatic microphones have been announced by the American Microphone Co., 1915 South Western Avenue, Los Angeles, California. These microphones are of the high impedance type and can be fed into the grid at the first amplifying tube without using a matching transformer. The manufacturer claims the following features for the microphone: No inherent noise; unaffected by atmospheric moisture or barometric changes; no cavity or structural resonance effects; and the ability to operate 200 ft. or more from the first amplifying tube. Model GA, for stand mounting, lists at $20, while model GB, a hand type complete with switch lists at $25.—*Electronics.*

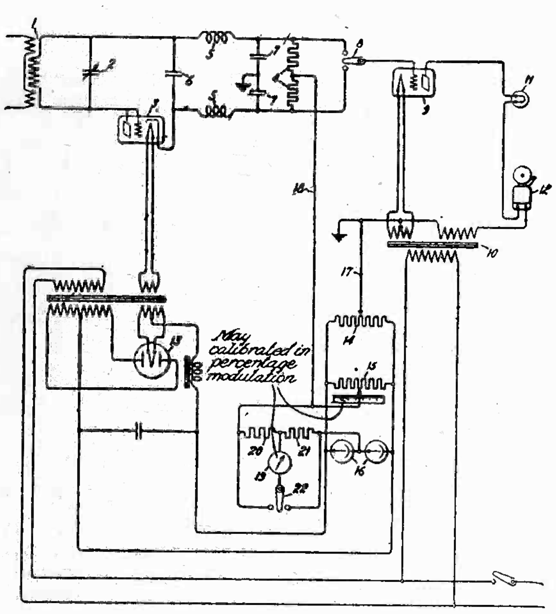
U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Radio circuits

Short wave generator. Within a triode envelope is a small condenser, one electrode of which is electrostatically coupled to the anode and the two electrodes are electrically connected to the cathode and the control grid. E. W. B. Gill, R.C.A. No. 1,995,175.

Modulation measurement. Apparatus for indicating the percentage of modu-





lation. No. 1,999,869 to R. B. Dome and No. 1,999,872 to George W. Fyler, both to G. E. Co.

Shadow tuning indicator. Method of varying the illuminated area of a graduated member to indicate tuning. U. L. Smith, W. E. & M. Co. No. 1,997,702.

Static elimination. Two circuits, one tuned to the desired frequency which also picks up static, and another tuned very near the desired frequency but not near enough to get the carrier wave but which picks up static. These are then balanced in the output. C. N. Loewenstein, Columbus, Ohio. No. 2,000,142.

Aids to navigation. No. 1,999,232 to F. Eicke, Ship Control Corp. A direction-finding device. No. 1,998,429, airplane landing guide, to F. J. Andre, H. C. Stark. No. 1,998,834 to C. R. Englund, B.T.L., radio guiding system. No. 1,999,047, a system for landing aircraft, to W. M. Hahnemann, C. Lorenz.

Transmission line. Connecting a push-pull amplifier to an antenna by means of a three-wire transmission line, the center wire of which is grounded to prevent conduction of currents flowing in the same direction in the two conductors of the line. I. J. Kaar, G. E. Co. No. 1,998,960.

Short wave receiver. Use of a trap circuit in converting short wave signals into long wave signals, the wave trap being simultaneously tuned to prevent impressing signals of the long wave length by the converter upon the broadcast receiver. H. M. Lewis, Hazeltine Corp. No. 2,000,084.

High frequency conductor. Flexible co-axial conductor for high frequency transmission. Ludwig Walter, Telefunken. No. 2,000,679.

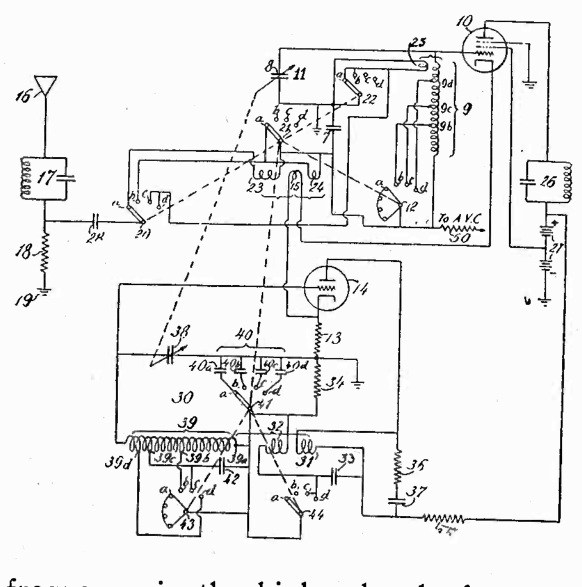
Wide band system. Terminal arrangement for use on a radio system capable of transmitting a band of frequencies whose width is many times the width of the audible frequency range, whereby the frequency band may be utilized for several signaling channels. Lloyd Espenschied and E. I. Green, A. T. & T. Co. No. 2,000,130.

Transmission line. A two wire line with a short circuit connected across one end, and high frequency apparatus connected across the line at points approximately one quarter wave length from the short circuit connection. N. E. Lindenblad, R.C.A. No. 2,000,032.

Telegraph receiver. A continuous wave code signal receiver comprising a super-regenerative receiver adapted to modulate signals at an audible rate. Y. Marrec and G. A. Beauvais, France. No. 1,999,247.

Superheterodyne. Amplifying collected signals of a selected frequency, impressing the signals on a composite first detector oscillator, deriving from extremely strong signals a direct current component which is used to decrease the amplification of the collected signals when such extremely strong signals are suddenly collected. W. S. Barden, R.C.A. No. 1,997,991.

Superheterodyne. Minimizing the required frequency range of the oscillator by maintaining the oscillator frequency higher than the selector frequency in the lower band and lower than the selector

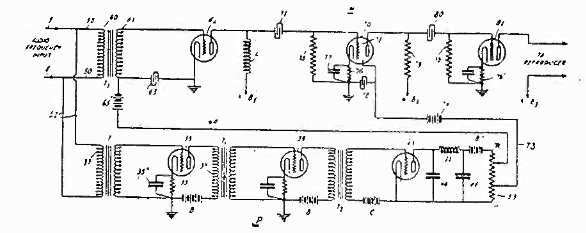


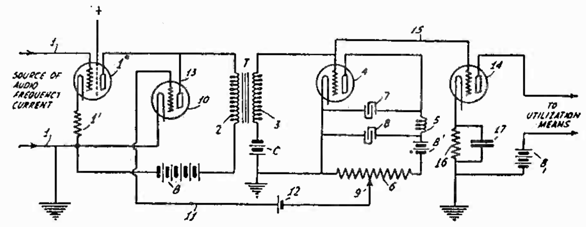
frequency in the higher band of a two band receiver. H. A. Wheeler, Hazeltine Corp. No. 2,000,113.

Frequency multiplier. Use of an amplifier whose input impedance varies with voltage and which supplies an output current substantially proportional to the input potential, using a source of a-c at a potential sufficient to cause changes in the input impedance, and an input circuit for the amplifier, comprising a network, the impedance of which varies with frequency. F. E. Terman, Stanford University, Cal. No. 2,000,362.

Band filter. Band pass filter coupled by capacity with the coupling arranged to be substantially critical at the mid-point of the network tuning range. K. Posthumus and T. J. Weyers, R.C.A. No. 1,996,831.

Automatic tone control. Several patents to W. v B. Roberts, R.C.A., on combined automatic volume and tone





control and automatic audio amplifier control. Nos. 1,993,859-1,993,861, inclusive.

Frequency multiplication. Use of a cathode ray system for producing high frequencies. Bernard Salzberg, R.C.A. No. 1,999,884.

Automatic volume control. A gain control potential which varies automatically with the magnitude of the input of the amplifier has applied to it a second gain control potential which varies automatically as the function of the first gain control potential. A. W. Barber, R.C.A. Reissue No. 19,493.

Push-pull amplifier. An input coupling system using a triple grid tube for driving a push-pull amplifier. H. A. Wheeler, Hazeltine. No. 1,997,665.

Power supply system. A source of e-m-f having internal resistance and reactance has a shunt of a resistance and a reactance of opposite sign to that of the internal reactance of the device. The square root of the ratio between the reactances is equal to either of the equal resistances. I. J. Kaar, G.E. Co. No. 1,998,321.

Antidistortion device. A system for correcting distortion at high frequencies by means of an interstage coupling circuit. Wolfgang Kautter, Halske. No. 1,999,566.

A-c amplifier. Obtaining linear amplification of d-c voltages by modulating a local high frequency current, amplifying the modulated carrier and reversely feeding back a fraction of the detected current whose reciprocal is small relative to the degree of amplification. Klaas Posthumus, R.C.A. No. 1,996,830.

Detector amplifier. A diode tetrode in a single envelope for simultaneous detection and amplification. Van der Ven, van der Mark, and Tellegen, R.C.A. No. 1,997,397.

Automatic typewriting system. W. S. Lemmon, International Business Corp. No. 2,000,764 and 2,000,765.

Television, recording systems, etc.

Television system. Apparatus for transmitting moving images by reducing the apparent motion to a degree substantially below the point of persistence of vision, transmitting the image at a slow rate, reproducing it at a slow rate, and then raising the rate of motion of image to normal, transmitting only the portions of the image which are moving. Edgar H. Felix, Radio Inventions, Inc. No. 2,000,694.

Anti-noise circuit. Means of eliminating ground noise in a sound recording apparatus. Barton Kreuzer, R.C.A. No. 1,999,700.

Image formation. Apparatus for converting the electric current analogue of an image into a real image by means of light cells. Noel Deisch, Washington, D. C. No. 2,000,379 and 2,000,380.

Glow tube. A source of light for producing a photographic record of light wave variations comprising an ionizable gas within an envelope. T. W. Case, Auburn, N. Y. No. 1,999,653.

Picture transmission. Method of successively scanning elementary areas of a picture to produce light variations, interrupting the light variations at a rate proportional to the rate of scanning to produce a synchronizing signal, etc. C. F. Jenkins, R.C.A. Reissue 19,561.

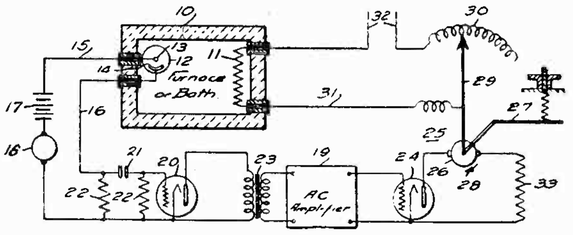
Television circuit. Apparatus for developing a voltage wave comprising a saw-tooth component and an impulse component for scanning purposes. W. A. Tolson, R.C.A. No. 1,999,378.

Sound recording circuit. Circuit for a.v.c., dynamic coupling by inter-tube devices, etc. John Hays Hammond, Jr. No. 1,998,617, No. 1,998,620, inc.

Electron tube applications

Power control apparatus. Grid control rectifier circuit. E. R. Wolfert, Westinghouse. No. 2,000,729. No. 1,998,938 to A. H. Mittag, G.E. Co. No. 1,998,950 to W. D. Cockrell and No. 1,999,013 to M. A. Acheson, both to G.E. Co.

Automatic heat control. Apparatus for controlling temperature of a medium



comprising an a-c amplifier. E. D. Wilson, WE&M Co. No. 1,994,904.

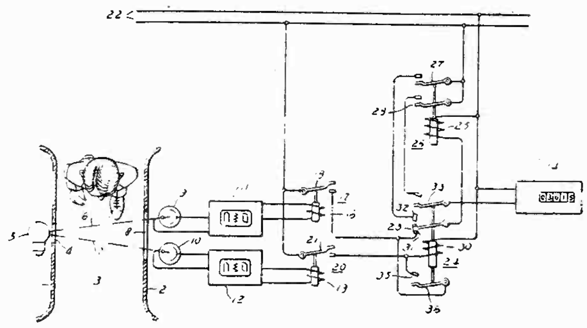
Heating system. Apparatus for uniformly heating several similar objects of various sizes by means of a high frequency field. A. B. Page, G.E. Co. No. 1,998,332.

Rail inspection apparatus. Magnetic test equipment comprising means for passing an electrical current through a test piece, a member of material exhibiting the Hall effect, etc. R. F. Edgar and C. Concordia, G.E. Co. No. 1,998,952.

Meter. A light sensitive method of electric metering. D. A. Young, WE&M Co. No. 2,000,731.

Photographic devices. No. 2,000,589 to A. B. Fuller, Eastman Kodak Co. on a light sensitive exposure control apparatus. No. 1,999,556 to J. R. Balsley, Movietonews, Inc., automatically regulating the intensity of a printing light. No. 2,000,037, O. Riszdorfer, Budapest, automatically determining exposure.

Counting circuits. Patents No. 1,995,881 to W. D. Cockrell; No. 1,995,890, to



H. W. Lord, both to G.E. Co. Photoelectric methods.

Sorting machine. Light sensitive method of sorting records, International Business Machines. Michael Maul. No. 2,000,404.

Telautograph. Cathode ray device. See Electronics, January, 1933. Allen B. Du Mont, Upper Montclair, N. J. No. 2,000,014.

Tone control. Frequency-compensating shunt connection in an interstage coupling circuit. A. Bierwirth, R.C.A. No. 1,997,762.

Linear detector. Method of adjusting the amplification rate to bring amplified energy within the restricted range of linear response in a detector which is partially square-law and partially linear. Stuart Ballantine, R.C.A. No. 1,998,859.

Feedback amplifier. Reduction of distortion by the feedback of distortion components originating in the amplifier back to the input. H. S. Black, B.T.L., Inc. No. 2,000,505.

Voltage regulator. Maintaining the output potential on a d-c current generator substantially constant. A. A. Steinmetz and H. M. Ward, W. U. Co. No. 1,998,741.

Synchronizing apparatus. No. 1,994,908 to G. De Croce, Westinghouse E&M Co.

Power control. F. G. Logan, Ward Leonard Co. No. 1,997,179.

Arc welding apparatus. No. 1,994,907 to J. W. Dawson, Westinghouse, and 1,995,810 to Hans Klemperer, Westinghouse.

Measuring apparatus. System for testing and controlling the production of a material by means of the combination of a standard and a sample of the material and a light sensitive cell. W. A. Darrah, Chicago, Ill. No. 1,996,233.

Determining the force of gravity. Piezo-electric crystal method. H. C. Hayes, Washington, D. C. No. 1,995,305.

Patent suits

1,403,475, H. D. Arnold; 1,403,932, R. H. Wilson; 1,507,017 and 1,507,016, deForest; 1,811,095, Round; Re. 18,579, Ballantine and Hull; D. C., S. D. Calif. (Los Angeles), Doc. E 468-M, RCA vs. H. Bell (Harold Bell Radio Mfg. Co. Decree for plaintiff, holding infringement, Feb. 2, 1935.

1,507,016 and 1,507,017, DeForest; filed March 28, 1935, D. C., S. D. N. Y., Doc. E 80/76, RCA vs. H. F. Lyman.

1,297,188 (a), I. Langmuir; 1,573,374, P. A. Chamberlain; 1,707,617, 1,795,214, E. W. Kellogg; 1,894,197, Rice & Kellogg, same, D. C., N. D. Ill., E. Div., Doc. 14333, RCA et al. v. Eagle Radio Co., Inc., et al. Consent decree holding patents valid and infringed Feb. 23, 1935.

1,297,188 (b), 1,573,374, P. A. Chamberlain, 1,707,617, 1,795,214, E. W. Kellogg; 1,894,197, Rice & Kellogg; 1,618,017, F. Lowenstein, Re. 18,579, Ballantine & Hull, filed Mar. 28, 1935, D. C., S. D. N. Y., Doc. E 80/77 RCA et al. v. Fox Radio Corp. et al.

1,403,475, H. D. Arnold; 1,403,932, R. H. Wilson; 1,507,016, L. de Forest; 1,501,017, same; 1,618,017, F. Lowenstein; 1,702,833, W. S. Lemmon; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull, D. C., N. D. Ill., E. Div., Doc. 14332, Radio Corp. of America et al. v. Eagle Radio Co., Inc., et al. Consent decree holding patents valid and infringed Feb. 23, 1935. Same, filed Mar. 2, 1935, D. C., S. D. Calif. (Los Angeles), Doc. E 550-C, RCA et al. v. J. L. Misrach (United Radio Stores).

1,978,568, Crossley & Neighbors, High-frequency inductance; 1,982,690, W. J. Polydoroff, Selective radio circuit, filed Mar. 1, 1935, D. C., N. D. Ill., E. Div., Doc. 14,342, Johnson Laboratories, Inc. v. Meissner Mfg. Co. et al.

1,828,094, H. Andrewes, Electrical frequency-changing apparatus of the thermionic type, D. C., M. D. Pa., Doc. 1083, Radio Patents Corp. v. Penn Electrical Engineering Co. Dismissed without prejudice Apr. 6, 1935.

1,231,764, F. Lowenstein; 1,618,017, same; 1.403,475, H. D. Arnold; 1,465,332, same; 1,403,932, R. H. Wilson; 1,702,833, W. S. Lemmon; 1,811,095, H. J. Round; Re. 18,579, Ballantine & Hull, D. C., S. D. Calif. (Los Angeles), Doc. E 254-J, Radio Corp. of America et al. v. F. T. Cawood (Cawood Radio Co.). Decree for plaintiff, holding infringement Feb. 2, 1935. Doc. E 256-H, RCA et al. v. V. F. Sexton (Radio Products Sales Co.). Decree for plaintiff Feb. 2, 1935.

1,913,604, W. A. MacDonald, Wave signaling system; 1,852,710, L. A. Hazeltine, Antenna coupling system, filed Mar. 4, 1935, D. C., E. D. N. Y., Doc. E 7508, Hazeltine Corp. v. Superior Cabinet Corp. et al.

1,755,114, L. A. Hazeltine, Unicontrol signaling system; 1,755,115, same, Variable condenser, filed Jan. 10, 1935, D. C., N. D. Ill., E. Div., Doc. 14,285, Hazeltine Corp. v. Stewart-Warner Corp.

1,881,324, H. E. Metcalf, Signal reproducer, D. C., N. D. Ill., E. Div., Doc. 13104, The Magnavox Co. v. Quam-Nichols Co. et al. Dismissed without prejudice Dec. 4, 1934.

1,855,168, C. L. Farrand, Loudspeaker, D. C., N. D. Ill., E. Div., Doc. 12469, Utah Radio Products Co. et al. v. Goldblatt Bros., Inc. Dismissed without prejudice Nov. 23, 1934. Doc. 12536, Utah Radio Products Co. et al. v. Triangle Electric Co. Decree as above.

1,901,331, E. S. Pridham, Electro-dynamic loud speaker, D. C., N. D. Ill., E. Div., Doc. 13105, The Magnavox Co. v. Arlab Mfg. Co. et al. Dismissed Dec. 3, 1934. Doc. 13187, The Magnavox Co. v. Arlab Mfg. Co. et al. Dismissed without prejudice Dec. 4, 1934. Doc. 13199, The Magnavox Co. v. Quam-Nichols Co. et al. Dismissed Dec. 3, 1934. Doc. 13200, The Magnavox Co. v. P. H. Tartak. Dismissed without prejudice Dec. 5, 1934.

INSTITUTE OF RADIO ENGINEERS

Tenth Annual Convention

DETROIT . . . JULY 1, 2, 3 . . . HOTEL STATLER

PROGRAM

SUNDAY, JUNE 30

4 p.m.-6 p.m.
Registration

MONDAY, JULY 1

9 a.m.-10 a.m.
Registration and opening of exhibition

10 a.m.-12:30 p.m.
Official welcome and technical session. Addresses of welcome by Stuart Ballantine, President of the Institute; and H. L. Byerlay, Chairman of the Convention Committee.
Technical Session—Large Meeting Room

"Electron Beams and Their Application in Low Voltage Devices," by H. C. Thompson, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

"Frequency Control by Low Power Factor Line Circuits," by C. W. Hansell, F. H. Kroger and P. S. Carter, RCA Communications, New York, N. Y.

"Design and Equipment of a 50-Kilowatt Broadcast Station for WOR," by J. R. Poppele, Station WOR, Newark, N. J.; and F. W. Cunningham and A. W. Kishpaugh, Bell Telephone Laboratories, New York City.

10 a.m.-11 a.m.
Official greetings at ladies headquarters

11 a.m-5 p.m.
Trip No. 1. Ladies sight-seeing trip

12:30 p.m.-2 p.m.
Luncheon and inspection of exhibits

2 p.m.-3:30 p.m.
Technical Session—Large Meeting Room

"Automatic Selectivity Control," by G. L. Beers, RCA Victor Division, RCA Manufacturing Company, Camden, N. J.

"Automatic Frequency Control," by Charles Travis, formerly of RCA License Laboratory, New York City, read by D. E. Foster, RCA.

"Radio Panel Lamps and Their Characteristics," by J. H. Kurlander, Westinghouse Lamp Company, Bloomfield, N. J.

2 p.m.-3:30 p.m.
Technical Session—Small Meeting Room

"Magnetron Oscillators for Generating Frequencies from 300 to 600 Megacycles," by G. R. Kilgore, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

"An Unattended Ultra-Short-Wave Radio Telephone System," by N. F. Schlaack and F. A. Polkinghorn, Bell Telephone Laboratories, New York City.

"Some Notes on Piezo Electric Crystals," by Issac Koga, Tokyo University of Engineering, Tokyo, Japan.

3:30 p.m.-6 p.m.
Trip No. 2. General Motors Research Laboratory

6 p.m.-7 p.m.
Inspection of exhibits

TUESDAY, JULY 2

9 a.m.-10 a.m.
Registration and opening of exhibition

10 a.m.-11:30 a.m.
Technical Session—Large Meeting Room

"Recent Developments of Class B Audio- and Radio Frequency Amplifiers," by L. E. Barton, RCA Victor Division, RCA Manufacturing Company, Camden, N. J.

"General Theory and Application of Dynamic Coupling and Power Tube Design," by C. F. Stromeyer, Revelation Patents Holding Company, New York City.

"Notes on Intermediate-Frequency Transformer Design," by F. W. Scheer, S. W. Sickles Coil Company, Springfield, Mass.

10 a.m.-11:30 a.m.
Technical Session—Small Meeting Room

"Some Theoretical Considerations Relating to Vacuum Tube Design," by G. D. O'Neill, Hygrade Sylvania Corporation, Salem, Mass.

"Ratings and Operating Information on Large High Vacuum Tubes," by R. W. Larson, General Electric Company, Schenectady, N. Y. and E. E. Spitzer, RCA Radiotron Division RCA Manufacturing Company, Harrison, N. J.

"Analysis of the Operation of Vacuum Tubes as Class C Amplifiers," by I. E. Mouromtseff and H. N. Kozanowski, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

10 a.m.-11:30 a.m.
Trip No. 3. Ladies Shopping Tour

11:30 a.m.-6 p.m.
Trip No. 4. Greenfield Village

6 p.m.
Exhibits close

7 p.m.
Annual Banquet and entertainment. Main Banquet Room

WEDNESDAY, JULY 3

9 a.m.
Registration and opening of exhibition

10 a.m.-11:30 a.m.
Technical Session—Large Meeting Room

"A New Tube for Use in Superheterodyne Frequency Conversion Systems," by C. F. Nesslage, E. W. Herold, and W. A. Harris, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

"A New Type of Gas-Filled Amplifier Tube," by J. D. LaVan and P. T. Weeks, Raytheon Production Corporation, Newton, Mass.

10 a.m.-11:30 a.m.
Technical Session—Small Meeting Room

"Ultra Short Wave Propagation Overland," by C. R. Burrows, Alfred Decino, and L. E. Hunt, Bell Telephone Laboratories, New York City.

"A Note on the Source of Interstellar Interference," by K. G. Jansky, Bell Telephone Laboratories, New York City.

"Comparison of Cosmic Data with Characteristics of the Ionosphere at Washington," by E. B. Judson, National Bureau of Standards, Washington, D. C.

"A Study of Radio Field Intensity Versus Distance Characteristics of a High Vertical Radiator at 1080 Kilocycles," by S. S. Kirby, National Bureau of Standards, Washington, D. C.

11 a.m.-6 p.m.
Trip No. 5. Ladies luncheon and sight-seeing trip

11:30 a.m.-1 p.m.
Luncheon and inspection of exhibits

1 p.m.-6 p.m.
Trip No. 6. Ford Motor Plant

4 p.m.
Closing of exhibits

Dr. Travis's paper deals with the control of the local oscillator in a superheterodyne for the purpose of centering the signal carrier in the i-f band despite inaccuracies of manual tuning and oscillator drift.

L. E. Barton of RCA Victor, well known for his work on Class B amplifiers will present recent developments in audio and radio amplifiers. "Radio Panel Lamps and Their Characteristics," is the title of a paper by J. H. Kurlander of the Westinghouse Lamp Company. A new type of gaseous amplifier tube developed in the Raytheon laboratories will be described by J. D. LeVan and P. T. Weeks. A new tube for use in superheterodyne as frequency conversion will be presented by C. F. Nesslage, E. W. Herold and W. A. Harris of RCA Radiotron. Intermediate-frequency transformer design will be discussed by F. W. Scheer of the F. W. Sickles company.

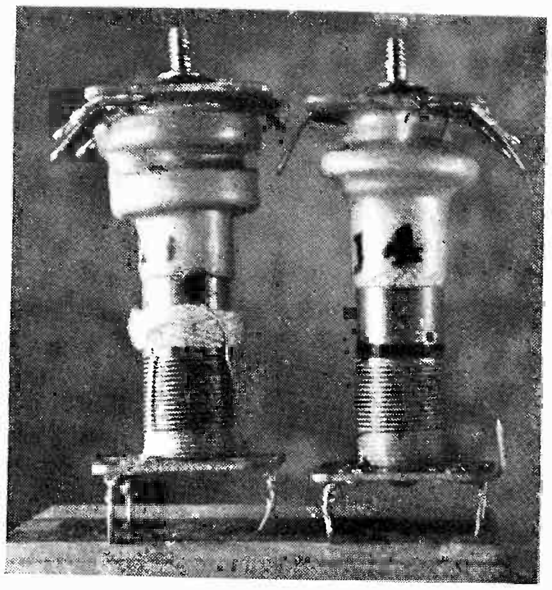
Other papers will cover the many aspects of the radio field, including the results of recent work on radio transmission phenomena.

As an example, the paper by C. R. Burrows, Alfred Decino, and L. E. Hunt of the Bell Telephone Laboratories gives a new formula for the field strength of an ultra-short transmitter after propagation over level terrain and relates the experimental evidence to back up this formula. Tests on antennas of various heights and on various frequencies of transmission indicate that the formula holds within reasonable accuracy. Additional formulas will be presented showing the attenuation when the curvature of the earth tends to eclipse the direct radiation from the antenna. Furthermore, earlier formulas for transmission over hilly country have been verified for frequencies of the order of 17 to 100 Mc.

Further work on the use of low power factor lines for controling frequency will be reported by C. W. Hansell, F. H. Kroger, and P. S. Carter of RCA Communications. The laws governing the design and performance of lines used for such purposes on high frequencies have been worked out and applied by these engineers at the Riverhead, Long Island, and Rocky Point stations. Tests indicate that the stability of transmitters in the region of 20,000 kc. will be as great when controlled by lines as are transmitters on lower frequencies when controlled by piezo-electric crystals. The effects of temperature have been worked out and methods developed for reducing the temperature effect on frequency.

Methods of producing very high frequencies in appreciable power will be described by G. R. Kilgore of RCA Radiotron who uses magnetron oscillators at frequencies of 300-600 Mc and produces several hundred watts.

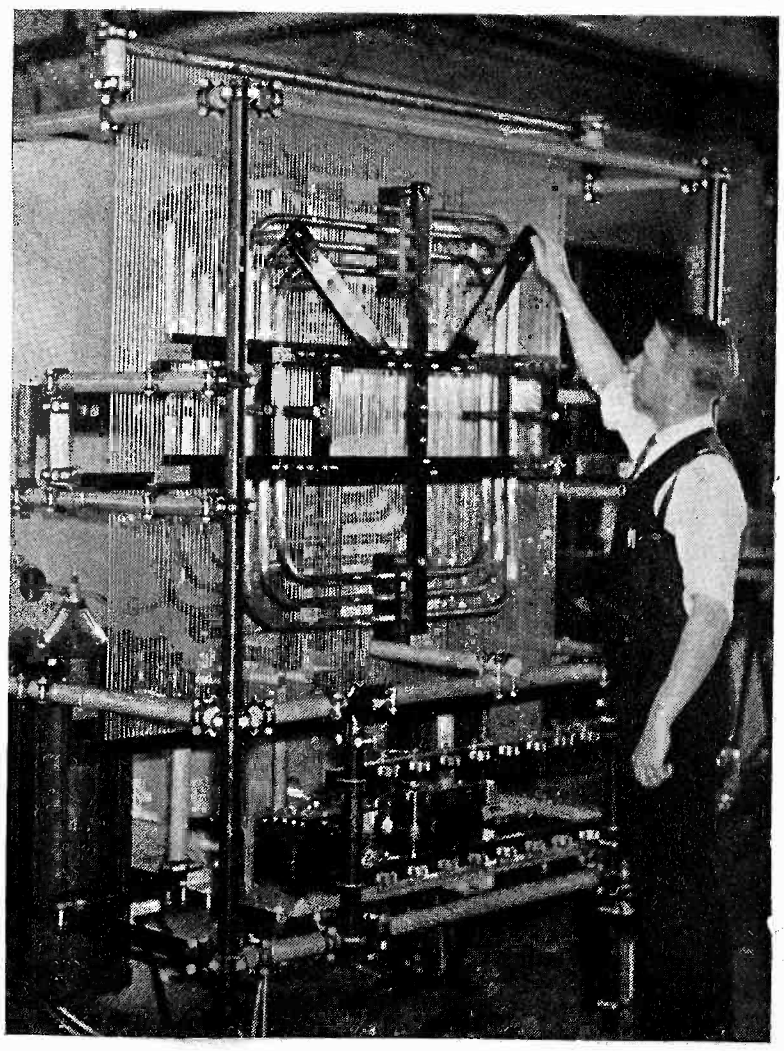
Cosmic data relating to radio phenomena will be discussed by E. B. Judson of the National Bureau of Standards and Karl G. Jansky of the Bell Laboratories. Mr. Jansky will offer a note on a possible source of the interstellar interference discovered by him some time ago. His present theory is that this radiation proceeds from the stars in the Milky Way or from the instellar matter distributed throughout this system.



Humidity resisting multi-band receiver coils

The field intensities of WBT as recorded by 7 automatic recorders ranging from 45 to 450 miles from the vertical radiator will be discussed by S. S. Kirby of the Bureau of Standards. Other papers of interest to broadcast engineers will be those relating to the operation of tubes as class C amplifiers, by I. E. Mouromtseff and H. N. Kozanowski of Westinghouse; that relating to the design and equipment of the new 50-kw. WOR station given by J. R. Poppele of WOR and A. W. Kishpaugh and F. W. Cunningham of the Bell Laboratories; Notes on Piezo-electric Crystals by Isaac Koga, of Tokyo; and a paper on large high vacuum tube ratings by R. W. Lerson of the General Electric Company and E. E. Spitzer of RCA Radiotron.

A paper on the general theory and application of dynamic coupling in power amplifiers will be given by Charles F. Stromeyer. The unattended high-frequency telephone link between Green Harbor and Provincetown, Massachusetts, will be described by N. F. Schlaack and F. A. Polkinghorn of the Bell Laboratories. G. D. O'Neill of the Hygrade Sylvania will give a paper on vacuum tube design showing how to use standard tube parts as test parts for new tubes which will give sufficient data from which the final design can be made. Several interesting examples of this method will be described.



KYW electrostatic screen