SHORT-WAVE NUMBER

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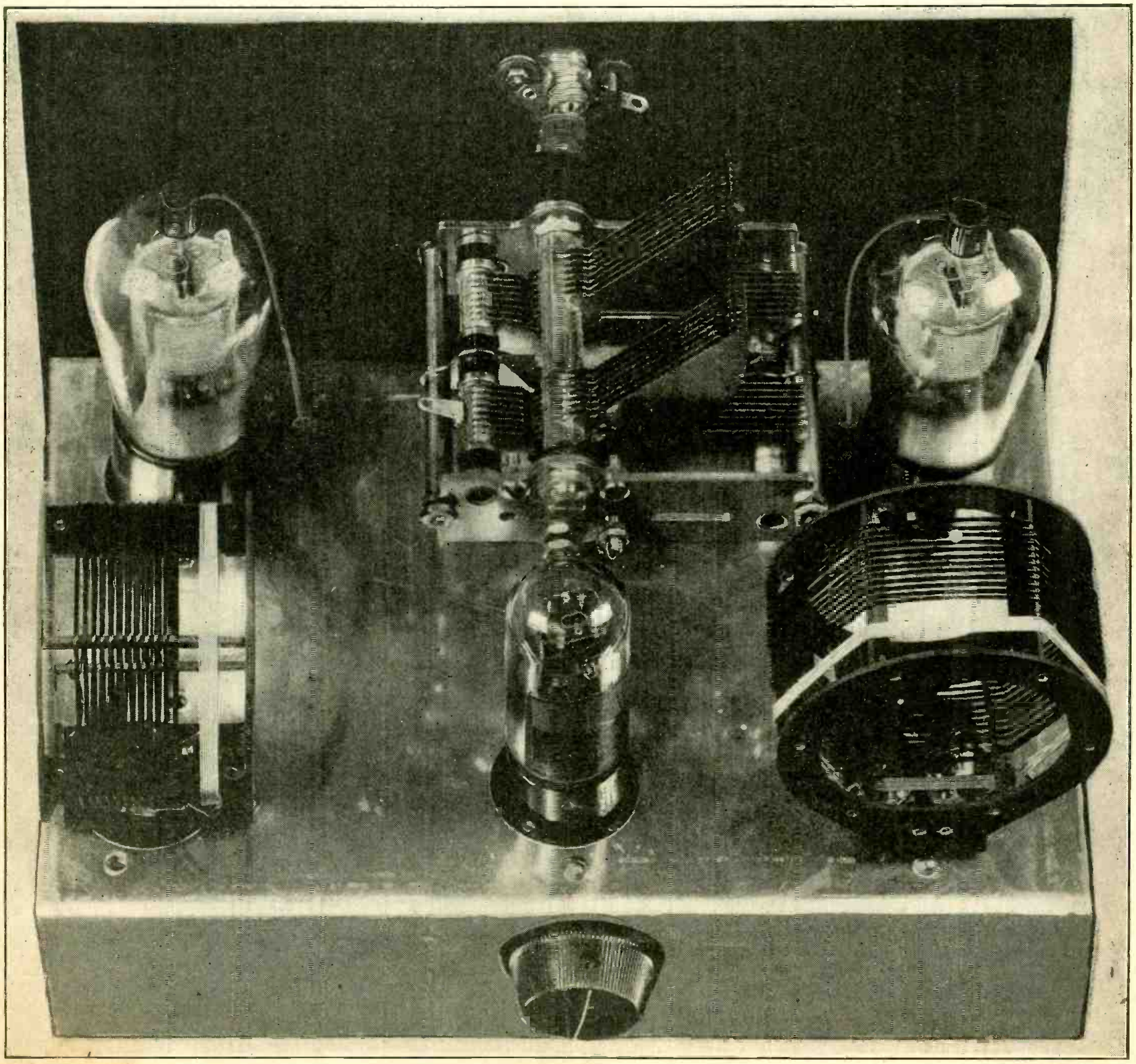

The Short-Wave Diamond, using 2-volt tubes. See pages 14 and 15.

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Short-Wave Coil Winding

New Formula for Determining Number of Turns

Br Brunsten Brunn

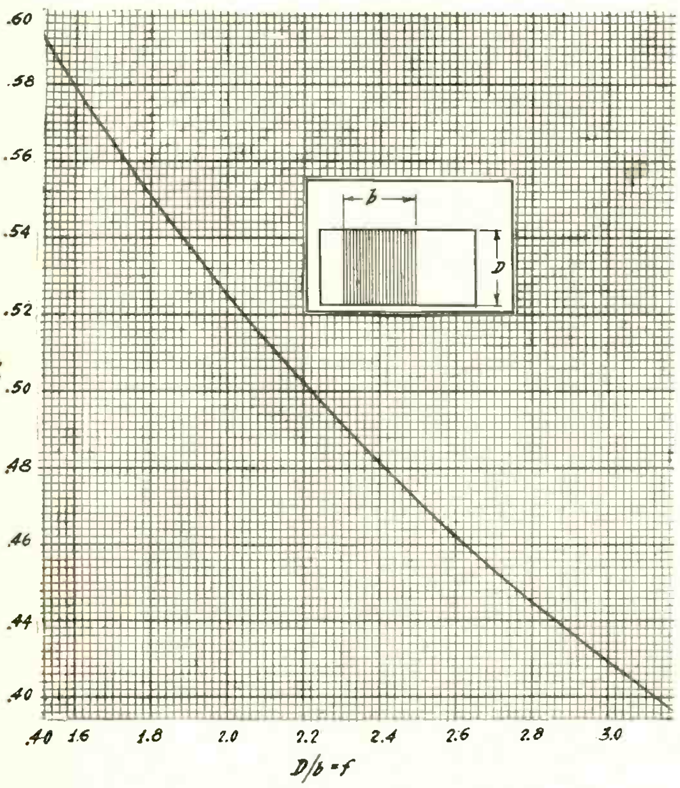


Fig. 1
A curve showing the relationship between factor K in the inductance formula and the shape factor D/b=f.

THERE is much call for short-wave coil winding data. A simple method of determining the turns required is sought, a method that can be applied without the use of tables or complex calculation. And such a method is easily worked out for any particular shape factor of the coils.

Theoretically the best shape factor of a coil is one in which the diameter of the coil is 2.46 times as great as the length of the winding. But this theoretical factor does not take into account the distributed capacity. If this is taken into account the length of the coil should be a little greater than that called for by the theoretical optimum. The Bureau of Standards in Circular No. 74 suggests that the shape factor should be 2.3. But even a little longer coil, relatively, may be used.

In the following we shall assume a shape factor of 2.25, that is, we assume that the diameter of the coil is 2.25 greater than the axial length of the winding. This results in a very simple formula for the inductance of the coil.

If L is the inductance in microhenries, *a* the radius of the coil, and n the number of turns, and if the radius is measured in inches, then $L=.05625an^2$. This is true only if the shape factor is 2.25. Whatever diameter and wire are used the spacing of the turns should be such that the ratio of the diameter to the length has this value. If the diameter is too small or the wire too thick to permit this shape factor, either the diameter should be made larger or the wire should be made smaller.

Example of Finding Turns

Let us illustrate the use of the formula. Suppose we wish to wind an inductance of 100 microhenries and we have at our disposal a form the diameter of which is 2.5 inches. How many turns are required? Substituting in the formula and solving for n we obtain n=38.7 turns. This will give the desired inductance only if the shape factor is 2.25. Since the diameter is 2.5 inches the length of the winding must be 1.111 inches. In this space we must put 38.7 turns, or there must be 34.8 turns to the inch. No. 22 single covered wire winds 36 to the inch. It is easy to determine with any wire at hand whether it is possible to wind 34.8 turns to the inch. If it is not possible a finer wire must be used or else the diameter of the form must be increased.

A good way of determining the number of turns per inch of any wire is to wind a coil one inch long, or a half inch, or a quarter inch, depending on the size of the wire, and counting the number of turns in the fraction of an inch used. This test winding can be done on any convenient form such as a lead pencil or a quarter inch metal rod.

Determining Turns Without Inductance

In many instances it is not necessary to determine the inductance in order to determine the required number of turns to make a coil that will tune to a certain frequency with a given tuning condenser. If we use the above formula for inductance in the well-known formula for frequency, $F=1/6.2832(LC)^{1/2}$, we obtain $nF=950/(CD)^{1/2}$, that is, the product of the frequency and the number of turns is equal to 950 divided by the square root of the product of the capacity of the condenser and the diameter of the coil, F being in cycles per second, C in farads, and D in inches.

This formula is useful in determining the number of turns for different coils in a short-wave set of coils. The capacity in this case is the maximum capacity of the tuning condenser, which is the same for all coils in the set, and D is the diameter of any one of the coils, which should also be the same for all the coils in the set. We see from this formula that the product of the turns and the frequency is a constant, provided only that we retain the same shape factor for all the coils.

Illustrating the Formula

Let us illustrate the use of this convenient formula. Suppose a maximum capacity of the tuning condenser is 200 mmfd. and that the diameter of the coils is 1.25 inches. Then if we express the frequency in megacycles per second and the capacity in mmfd. we obtain the formula nF=60. Remember that F is measured in megacycles, that C is 200 mmfd., and that the shape factor is to be 2.25.

Now let us assume that the first coil is to tune down to 1.5 megacycles per second, that is, to the upper limit of the broadcast band. Then n=60/1.5, or 40 turns. These 40 turns must occupy a space of 5/9 inch on the form, or the wire should wind 72 turns to the inch.

Now let us suppose that the minimum capacity in the circuit is 20 mmfd., which is the remaining capacity when the conden-

(Continued on next page)

Short Wav

Television Also Weighed

A DISCUSSION of short waves, as to their classification and behavior, as well as to their educational possibilities, is contained in a booklet, Information Series, No. 5, of the National Advisory Council on Radio in Education. The topic of the booklet is "Present and Impending Applications to Education of Radio and Allied Arts." The council's committee on engineering developments prepared the report.

Television's status is discussed in another chapter of the report.

No great educational value is expected from short-wave work, except on ultra-high frequencies for limited area reception, this, like television's use in education, being cited as a possibility, not an accomplished fact.

The chairman of the advisory committee on engineering developments is Dr. Alfred N. Goldsmith, vice-president and general engineer, Radio Corporation of America. The members are Dr. W. C. Cady, Wesleyan University, Middletown, Conn.; O. H. Caldwell, former Federal Radio Commissioner; E. K. Cohan, chief engineer, Columbia Broadcasting System; Lloyd Espenschied, high frequency transmission engineer, American Telephone & Telegraph Company; W. E. Harkness, Electric Research Products, Inc.; Prof. Erich Hausmann, Brooklyn Polytechnic Institute; John V. L. Hogan, consulting engineer, New York City; C. W. Horn, plant engineer, National Broadcasting Company; Dr. L. M. Hull, Radio Frequency Laboratories, Inc.; C. M. Jansky, radio engineer, Washington, D. C.; Ray H. Manson, vice-president and chief engineer, Stromberg-Carlson Telephone Manufacturing Co., and R. H. Marriott, radio engineer, New York City.

The Director of the Council is Levering Tyson, and the address is 60 East 42nd Street, New York, N. Y.

The chapters on television and short waves follow, in full:

VI

TELEVISION

Television broadcasting is the transmission by radio of pictures in motion, *e.g.*, to theatres, homes or schools. These pictures may be those of actual persons or events, or may be reproductions of the pictures on a motion-picture film, utilized at the transmitting station. Otherwise stated, the observer in the receiving station will see a reproduction in motion of the persons and objects of an outstanding event, or will see a reproduction of a motion-picture film, in either case transmitted to him by radio.

The facilities required for television broadcasting differ markedly from those required for present-day broadcasting. Entirely different wave-lengths are required for transmission; a much wider band of frequencies is necessary; elaborate pick-up or scanning equipment is necessary in the studio; special monitoring means must be provided; and the transmitting apparatus is more advanced and elaborate in design than is required for telephone broadcasting. The receiving apparatus is similarly of more specialized and advanced design than that suitable for telephone broadcasting. A different receiver is necessary (for wave-lengths outside the present broadcasting band); appropriate scanning means for producing the picture are also required; and a special synchronizing equipment, to hold the picture-production at the receiving end in step with the picture-scanning at the transmitting station, is also necessary.

Advanced Experimentation

Television broadcasting is in an advanced experimental condition at this time. It has not yet been possible to establish transmitting stations capable of giving reliable television service over a considerable area, nor to provide on a commercial scale receivers which give a clear, bright picture of an acceptable color, adequate detail, satisfactory size, freedom from flicker, of sufficiently wide angle of view, and of the requisite steadiness of position. The problems involved are under active investigation, and there is a likelihood that within the next few years equipment of this sort will be commercially available and that at least a moderate number of television broadcasting stations capable of supplying program material to those having suitable receiving equipment will be in operation.

The problem of network syndication of television programs is in a less advanced condition. If a program for a television transmission is recorded on motion-picture film, methods analagous to the electrical transcription described above will doubtless become suitable for syndication. It is also possible that wire line facilities capable of carrying television programs will be developed, although these do not exist even experimentally at this time.

The Federal Radio Commission has made no provisions for television beyond assigning a limited number of fairly wide bands in the short-wave region for experimental use. These bands are already fully occupied and indeed over-crowded, with resulting interference between the various experimenters in their use.

More recently the Commission has also opened some ultra-short wave bands to experimental television broadcasting.

It should also be pointed out that television transmission is peculiarly subject to certain objectionable transmission effects known as distortion, fading, multiple images and the like. These are evidenced by blurred or distorted images or a multicpilicity of images of the same object, and of course render the transmission practically useless unless they are eliminated. It is hoped through proper selection of frequency and method of transmission ultimately to avoid these objectionable factors within a reasonable service range, but at present they constitute an obstacle to the commercial or educational application of radio television.

One of the fairly promising possibilities in this connection is the use of the ultra-short waves, to which reference was previously made. These wave lengths appear to be free from objectional fading phenomena, and have a limited range, and furthermore are capable of modulation to an extent which may permit the transmission of television pictures carrying far greater detail than appears possible on the lower frequencies (longer waves). However, problems of interference from sources of electrical disturbances (for example, automobiles, ignition systems, or household equipment), shadowy effects, standing-wave effects, and certain other variations in transmission will require considerable further investigation. Engineers are devoting their attention to the study and development of the usefulness of these waves. Subsequent reports of this Committee will contain an account of the results of current investigations in this field. Although these short waves can theoretically carry, through their modulation, television pictures of great detail, yet the necessary terminal apparatus for that control of the transmitter and the realization of such detail at the receiving station has not passed out of the research and development stage.

Standards Lacking

It is difficult to present a clear description of what television can accomplish in its present state of development, partly because there are no accepted standards and partly because of the rapid development which is taking place. It may be said that good "close-ups" of one or two persons can be transmitted over limited distances, and that more distant views ("long shots") of simple events are also capable of transmission.

The value of television for educational purposes will be largely dependent upon the amount of detail which the picture can carry. If the development of television during the next few years leads to pictures of such detail that lecture-room demonstrations can be readily and clearly reproduced, and if some impression of the personality of the lecturer can be gained by the observer, and if the range of transmission and reception is such that large groups of people can successfully receive lectures and demonstrations, it is anticipated that television may have a substantial educational value and wide application. If, however, the amount of detail is limited to that now obtainable, it is questionable whether educators will be able effectively to utilize television, even as a partial substitute for the view of the instructor, or of an actual demonstration.

The television equipment available for use in the home or in the school-room is capable at this time of producing an image limited to several tens of square inches in size (for direct viewing without lens magnification). Far more elaborate and expensive equipment has been made, but the amount of power required for its operation, the degree of skill necessary for its attendance, and the initial and maintenance costs place it outside the range of ordinary school use. Such equipment has produced pictures up to several tens of square feet, but they have been limited to the same amount of picture content as the smaller pictures, that is, they have not presented any additional useful detail, and are capable only of being viewed by a greater audience located at a greater distance.

Wide Channel Width

Television from the viewpoint of governmental regulation presents one of the most serious problems. Whereas telephone broadcasting requires channels approximately 10-kilocycles wide, television broadcasting of adequate quality and detail requires channels ten times as wide or more, that is, one hundred kilocycles wide or even several hundred kilocycles wide (unless some radical and unforseen development occurs). The problem of "fitting-in" television channels is engaging the serious thought both of the engineers and of the regulatory authorities, but up to this time it has not been successfully worked out. There are several directions which offer some promise, but the entire project of successful transmission and the location of the requisite wavebands is still in a state of flux. The formulation of definite plans for television for educational purposes can not therefore be advised at this stage.

It should be pointed out that much confusion exists among the public as to the exact meaning of the term "television." Comparatively blurred, dim, flickering and unsteady images, carrying little detail and simultaneously visible to only one or two persons at a given receiver (and then only in a darkened room) are claimed by some to constitute successful television. Equipment capable of yielding such limited results is on the

es Assayed

for Educational Value

market to a slight extent, but is obviously of no significance to educators. From the viewpoint of the educator a picture of an entirely different and greatly superior character, somewhat as specified in a preceding paragraph, is strictly necessary. Any educational project based upon pictures which do not meet reasonably high specifications will find the application of television a handicap rather than an assistance, inasmuch as a poor picture is rather a distraction than an instructional agency.

Television is at present in a state such that in general the mode of transmission and its romantic interest attracts a major portion of the attention of the observer. In consequence it parallels the condition of radio telephone broadcasting at the time when the quality of transmission was at such a level that criticism of the program or of the artist was not practicable because the medium of transmission was not sufficiently precise or constant in its action to enable such criticism to be well-founded. Until television reaches a stage where the mechanics will be forgotten and attention concentrated on the program itself, its utility in education will be small.

VII

SHORT-WAVE BROADCASTING

This falls into the following main classes:

1. Point-to-point international.
   (a) for point-to-point communication, constituting a radio link in a broadcasting system;
2. Mass international,
   (b) for the direct distribution of broadcast signals over large areas.
3. Supplementary national,
   (c) for the direct distribution of broadcast signals over limited areas.

In considering short-wave broadcasting it must be recognized that the field comprehended by the title is so extensive that sub-division is necessary. This sub-division should be with respect to both frequencies and types of service. The frequencies comprising the so-called short-wave structure are generally divided into three groups, as follows:

The range from 1,500 to 6,000 kilocycles represents the "Continental" band; the range from 6,000 to approximately 30,000 kilocycles represents the so-called "International" band; the range from 30,000 kilocycles up to an undefined limit represents the "ultra-short" or quasi-optical band.

Fading Experienced

A preliminary analysis of the characteristics of short-wave transmission will be given. To establish communication between two points by short-wave radio, there must first be selected a number of available frequencies of transmission, which frequencies depend upon the length and direction of the transmission path, the time of day or night, the season of the year, and certain other imperfectly understood conditions (for example, the prevalence of magnetic storms resulting from solar disturbances or other causes). Accordingly, the maintenance of fairly steady communication between only two points by short waves involves the availability of several transmission frequencies (in some cases as many as five, but on the average approximately three). The maintenance of reasonably reliable communication between a single point and a number of scattered receivers is often more complicated and may involve the use of an even greater number of transmission frequencies, with corresponding receiving equipment, and operation possibly on a flexible system of time schedules.

A prominent characteristic of short-wave reception is the so-called fading of the signals. The longer wave signals, particularly in the daytime, are fairly constant in their intensity. On the short waves, however, the signal strength is subject to more or less sudden variations resulting from changes in the intervening transmission path. The changes may be either slow, resulting in a gradual increase and decrease of the signal, or they may be so rapid as to cause audible fluttering of the signal. They are frequently accompanied by distortion of the tone quality of the signal, and sometimes by complete loss of intelligibility or of musical value.

Frequencies Act Differently

Certain frequencies are best adapted for each of these services at particular times. In the following paragraphs these three categories of service are considered, and the application of the various frequencies to each of them is indicated.

In the case of international short-wave telephone circuits, elaborate equipment is employed to minimize the effects of fading. In addition to the careful selection of the most desirable transmission frequency, transmitters are used which are highly directional and which tend to concentrate the radiated energy in a relatively narrow beam. Directional receiving antennas are used. These are connected to receiving sets which have so-called automatic volume controls. An automatic volume control is planned to maintain the output signals at a fairly constant value, regardless of changes (within certain limits) in the strength of the incoming signal. In a still further attempt to reduce the effects of fading, more than one directional receiving antenna is used at a given receiving station. For example, three such antennas may be used, each connected to its individual receiving set. It is found that the fading effects are different on the several individual antennas, that is, the receiving signals may be a maximum in one of these antennas and a minimum on the other two, providing the space separation of the antennas is suitable, and the rate of fading of the signal is not excessively rapid. By combining the output of the three receivers in question, with a suitable automatic switching mechanism, a more nearly steady signal of improved quality (so far as ratio of signal to interference is concerned) is obtained. It will be noted that such an installation is elaborate in that considerable land is required for the antenna systems, and that complicated receiving equipment, such as can not readily be handled except by skilled personnel, is necessary.

Broadcast listeners are acquainted with the fading phenomena which occur at night on the signals from broadcasting stations located at certain distances from the listeners' homes. These fading phenomena in general are not unduly severe. From these effects the broadcast listener can get an idea of fading phenomena on short-wave by imagining them to be multiplied severalfold, both in intensity of swing, in rapidity, and in resulting distortion of tone quality.

Limited Application

Despite these irregularities and largely because of the complex apparatus used, the present status of point-to-point international short-wave communication is reasonably satisfactory. It is now frequently possible to carry programs originating in most portions of Europe, and in certain parts of other continents, directly to the United States with moderately acceptable quality, and to transmit programs from the United States to these countries with equal success. It is to be noted that the radio facilities employed for the purpose are, as above stated, elaborate and especially adapted to the circuits in question.

Broadcasting on short-waves to listeners located at great distances has a limited application at present. Certain countries have utilized such short-wave broadcastsing for the transmission of programs to their citizens located in their colonies. For example, stations in Holland transmit programs on short waves to colonists in Java, and British stations transmit programs on short waves to the various Dominions. A number of short-wave broadcasting stations in the United States are heard by listeners in Central and South America, and even by a limited group of listeners in other countries. Relative to this service, however, it is believed that the major interest of the listener is of a sentimental nature and that the quality of the program as received is on the average poor. Yet, to a colonist situated at a distance from his country of origin a quality of broadcast service which would not otherwise be acceptable may nevertheless satisfy him for a considerable period of time. It is believed that short-wave broadcasts of this sort will continue to enjoy a justified though limited vogue.

The attempts to utilize short-wave broadcasting for local or national transmission have been less successful. The listener is necessarily restricted to comparatively simple antenna systems of limited dimensions and to a receiving set of limited complexity. Further, the average broadcast listener can not be expected to be especially trained in the technique of short-wave reception. Nor is his location, particularly in urban areas, ordinarily free from serious man-made electrical disturbances on these short waves. These disturbances may be minimized by the careful selection of a site. But broadcasting to the public must be generally and conveniently received in the homes of the listeners wherever these may be located.

As a result, the practical value of short-wave national broadcasting has been so slight that the Federal Radio Commission has been unwilling to recognize it as a part of the American broadcasting structure.

The Ultra-Short Waves

The ultra-short waves, when the experimental development of equipment for their use has been completed, may prove suitable for certain types of local broadcasting, either of speech and music, or of television, or both. The characteristics of these ultra-short waves are peculiar, and vary somewhat within the frequency band, which has been termed "the ultra-short wave band." Because of their peculiar characteristics, they may prove to have definite value for educational broadcasting over limited areas.

So far as is now known the characteristics of ultra-short waves are as follows:

The construction of transmitters of any considerable power presents unusual difficulties, as does the stabilization of the frequency of such transmitters. While the percentage of accu-

(*Continued on next page*)

(Other Illustrations on Front Cover)

racy of the setting of such transmitters may be maintained practically as accurately as that of the transmitters of longer waves, a given small percentage of variation nevertheless corresponds to a wide range of frequency fluctuation, because of the extremely high frequencies which are involved. Frequency variations at the transmitting stations of a percentage which would be regarded as tolerable in ordinary broadcasting stations in the existing broadcasting band (550-1,500 kilocycles) become proportionately greater (in cycles) on these ultra-short waves, with a corresponding increased variation in frequency of the transmitted wave. Transmitting antennas for ultra-short waves can be made highly directional if desired, with a considerable concentration of energy in the "beam direction." The size of the transmitting antenna, even for directional purposes, is small. Accordingly, the transmitting antennas can be installed on the tops of buildings of moderate dimensions. If desired, the ultra-short wave transmitters may be made practically non-directional (for ordinary broadcasting service). The transmission path seems to be limited by factors similar to those which control the passage of ordinary light. That is, the transmission of ultra-short waves is quasi-optical. As a result, the successful reception of ultra-short waves does not extend far beyond the optical horizon as viewed from the location of the transmitting antenna. There is no "sky-wave" caused by reflection from an overhead conducting layer. However, there are certain other factors which require attention. Some of the shortest of these waves particularly seem to be affected by atmospheric conditions (rain, heat, and so on), as in ordinary light in its passage through a fog; large conducting obstacles (hills, masses of buildings) cause noticeable shadows; multiple reflection effects in building groups give diffusion of the signal, somewhat like that produced on ordinary light when passing through a fog; electrical disturbances in the neighborhood of the receiving set (automobiles, airplanes, household equipment) cause severe interference (even at distances of a mile or more).

A Possibility

It is possible to modulate successfully a short-wave carrier with the production of far wider side bands than can be produced at the lower frequencies (longer waves). As a result, it may become possible, upon the completion of the necessary development and the production of the corresponding terminal equipment, to send television pictures of considerable detail on the ultra-short waves.

The obtaining of requisite frequency stability in certain types of receiving sets for ultra-short waves also presents a definite problem. If either the transmitter frequency or the frequency locally generated in certain types of receivers fluctuates, an effect similar to that of fading signals will be produced and satisfactory reception will no longer be possible. The number of available channels for simultaneous operation on the ultra-short wave may after more complete development prove to be very great.

As matters stand, however, only a small number of transmitters, the actual usefulness of which at this time can not be definitely foreseen, can be located on the ultra-short waves in any given territory.

So far as international point-to-point communication is concerned, this is equally valuable for educational broadcasts and for ordinary entertainment programs. Prominent educators in one country can address audiences in other countries through the use of such facilities. Attention is directed, however, to the economic aspects of this procedure. The necessary elaboration of apparatus for reliable short-wave communication entails a comparatively high cost of the circuit per minute of operating time. The costs of these international communication facilities is of the order of $1,000 an hour (about $18 a minute), to which must be added the cost of the necessary wire lines to carry the received program to the specific points of distribution. In the absence of commercial sponsorship of educational programs, there will therefore be a comparatively heavy economic burden on the educational institutions utilizing existing international broadcasting facilities.

Summary

International broadcasting on short waves is presumably equally valuable to educational institutions and to other users. The cost of transmission of educational material to persons outside of the United States by American educational institutions is a comparatively small figure. However, the type of service possible is not sufficiently reliable to meet the strict criteria necessary for successful educational broadcasting. The same comment applies to domestic short-wave broadcasting.

In summary, the committee is of the opinion that short-wave point-to-point communication will find a limited educational usefulness; that national and international short-wave broadcasting have little or no existing educational usefulness; and that ultra-short wave broadcasting (if and when developed) may be of use to educational institutions desiring groups of listeners located within limited distances of specially established broadcasting stations.

It is, of course, obvious that lectures or, more broadly, educational material, originating in foreign countries can be transmitted through American broadcasting stations as educational programs through the use of electrical transcriptions. Records of lectures given abroad can be syndicated through educational channels and transmitted from the individual outlet stations. It is to be noted that the exact time at which the lecture in question is recorded is of little interest to the educational outlet station, which will employ it at a time appropriate to the course of instruction. The electrical transcription method of syndicating educational programs in this respect is definitely superior to short-wave national broadcasting, particularly when the economics of the situation are considered as well as the resulting quality of transmission.

Frequency-Wavelength

30,000 to 10,000 kc, 9.994 to 29.98 Meters

kc	m	kc	m	kc	m	kc	m	kc	m
30,000	9.994	26,000	11.53	22,000	13.63	18,000	16.66	14,000	21.42
29,900	10.03	25,900	11.58	21,900	13.69	17,900	16.75	13,900	21.57
29,800	10.06	25,800	11.62	21,800	13.75	17.800	16.84	13,800	21.73
29,700	10.09	25,700	11.67	21,700	13.81	17,700	16.94	13,700	21.88
29,600	10.13	25,600	11.71	21,600	13.88	17,600	17.04	13,600	22.04
29,500	10 16	25,500	11.76	21,500	13.95	17,500	17.13	13,500	22.21
29,400	10.20	25,400	11.80	21,400	14.01	17,400	17.23	13,400	22.37
29,300	10.23	25,300	11.50	21,300	14.08	17,300	17.33	13,300	22.54
29,200	10.27	25,200	11.90	21,200	14.14	17,200	17.43	13,200	22.71
29,100	10.30	25,100	11.95	21,100	14.21	17,100	17.53	13,100	22.89
29,000	10.34	25,000	11.99	21,000	14.28	17,000	17.64	13,000	23.06
28,900	10.37	24,900	12.04	20,900	14.35	16,900	17.74	12,900	23,24
28,800	10.41	24,800	12.09	20,800	14.41	16,800	17.85	12,800	23.42
28,700	10.45	24,700	12.14	20,700	14.48	16,700	17.95	12,700	23.61
28,600	10.48	24,600	12.19	20,600	14.55	16,600	18.06	12,600	23.80
28,500	10.52	24,500	12.24	20,500	14.63	16,500	18.17	12,500	23.99
28,400	10.56	24,400	12.29	20,400	14.70	16,400	18.28	12,400	24.18
28,300	10.59	24,300	12.34	20,300	14.77	16,300	18.39	12,300	24.38
28,200	10.63	24,200	12.39	20,200	14.84	16,200	18.51	12,200	24.58
28,100	10.67	24,100	12.44	20,100	14.92	16,100	18.62	12,100	24.78
28,000	10.71	24,000	12.49	20,000	14.99	16,000	18.74	12,000	24.99
27,900	10.75	23.900	12.54	19,900	15.07	15,900	18.86	11.900	25.20
27,800	10.78	23,800	12.60	19,800	15.14	15,800	18.98	11,800	25.41
27,700	10.82	23,700	12.65	19,700	15.22	15,700	19.10	11,700	25.63
27,600	10.86	23,600	12.70	19,600	15.30	15,600	19.22	11,600	25.85
27,500	10.90	23,500	12.76	19.500	15.38	15,500	19.34	11,500	26.07
27,400	10.94	23,400	12.81	19,400	15.45	15,400	19.47	11,400	26.30
27,300	10.98	23,300	12.87	19,300	15.53	15,300	19.60	11,300	26.53
27,200	11.02	23,200	12.92	19,200	15.62	15,200	19.72	11,200	26.77
27,100	11.06	23,100	12.98	19,100	15.70	15,100	19.86	11,100	27.01
27,000	11.10	23,000	13.04	19,000	15.78	15,000	19.99	11,000	27.26
26,900	11.15	22,900	13.09	18,900	15.86	14.900	20.12	10,900	27.51
26,800	11.19	22,800	13.15	18.800	15.95	14,800	20.26	10.800	27.76
26,700	11.23	22,700	13.21	18,700	16.03	14.700	20.40	10,700	28.02
26,600	11.27	22,600	13.27	18,600	16.12	14,600	20.54	10.600	28.28
26,500	11.31	22,500	13.33	18,500	16.21	14,500	20.68	10.500	28.55
26,400	11.36	22,400	13.38	18,400	16.29	14,400	20.82	10,400	28.83
26,300	11.40	22,300	13.44	18.300	16.38	14,300	20.97	10,300	29.11
26,200	11.44	22,200	13.51	18,200	16.47	14,200	21.11	10.200	29.39
26,100	11.49	22,100	13.57	18,100	16.56	14,100	21.26	10,100	29.69
								10,000	29.98

9,990 to 8,000 kc 30.01 to 37.48 m

kc	m	kc	m	kc	m	kc	m	kc	m
9,990	30.1	9,580	31.30	9,180	32.66	8,780	34.15	8,380	35.78
9,980	30.04	9,570	31.33	9,190	32.70	8,770	34.19	8,370	35.82
9,970	30.07	9,560	31.36	9,160	32.73	8,760	34 23	8,360	35.86
9,960	30.10	9,550	31.39	9.150	32.77	8,750	34.27	8,350	35.91
9,950	30.13	9,540	31.43	9,140	32.80	8,740	34.30	8,340	35.95
9,540	30.16	9,530	31.46	9,130	32.84	8,730	34.34	8,330	35.99
9,930	30.19	9,520	31.49	9.120	32.88	8,720	34.38	8,320	36.04
9,920	30.22	9,510	31.53	9,110	32.91	8.710	34.42	8.310	36.08
9,910	30.25	9,500	31.56	9,100	32.95	8,700	34.46	8,300	36.12
9,900	30.28	9,490	31.59	9,090	32.98	8,690	34.50	8,290	36.17
9,890	30.32	9,480	31.63	9,080	33.02	8,680	34.54	8,280	36.21
9,880	30.25	9,470	31.66	9,070	33.06	8,670	34.58	8,270	36.25
9,870	30.38	9,460	31.69	9,060	33.09	8,660	34.62	8,260	36.30
9,860	30.41	9,450	31.73	9.050	33.13	8,650	34.66	8,250	36.34
9.850	30.44	9,440	31.76	9,040	33.17	8,640	34.70	8,240	36.39
9,830	30.50	9,430	31.79	9,030	33.20	8,630	34.74	8,230	36.43
9,820	30.53	9,420	31.83	9,020	33.24	8,620	34.78	8,220	36.47
9,810	30.56	9,410	31.86	9,010	33.28	8.610	34.82	8,210	36.52
9,800	30.59	9,400	31.89	9,000	33.31	8,600	34.86	8,200	36.56
9,790	30.63	9,390	31.93	8,990	33.35	8,590	34.90	8,190	36.61
9,780	30.66	9,380	31.96	8,980	33.39	8,580	34.94	8,180	36.65
9,770	30.69	9,370	32.00	8,970	33.42	8,570	34.98	8.170	36.70
9,760	30.72	9,360	32.03	8,960	33.46	8,560	35.03	8,160	36.74
9,750	30.75	9,350	32.07	8,950	33.50	8,550	35.07	8,150	36.79
9,740	30.78	9,340	32.10	8,940	33.54	8,540	35.11	8,140	36.83
9,730	30.81	9,330	32.14	8,930	33.57	8,530	35.15	8,130	36.88
9,720	30.85	9,320	32.17	8,920	33.61	8,520	35.19	8.120	36.92
9,710	30.88	9,310	32.20	8,910	33.65	8,510	35.23	8,110	36.97
9,700	30.91	9,300	32.24	8,900	33.69	8.500	35.27	8,100	37.01
9,690	30.94	9,290	32.27	8,890	33.73	8,490	35.31	8,090	37.11
9,680	30.97	9,280	32.31	8,880	33.76	8,480	35.36	8,080	37.11
9,670	31.01	9,270	32.34	8,870	33.80	8.470	35.40	8,070	37.15
9,660	31.04	9,260	32.38	8,860	33.84	8,460	35.44	8,060	37.20
9,650	31.07	9,250	32.41	8,850	33.88	8,450	35.48	8,050	37.24
9,640	31.10	9,240	32.45	8,840	33.92	8,440	35.52	8,040	37.29
9,630	31.13	9,230	32.48	8.830	33.95	8,430	35.57	8.030	37.34
9,620	31.17	9,220	32.52	8,820	33.99	8,420	35.61	8,020	37.38
9,610	31.20	9,210	32.55	8,810	34.03	8,410	35.65	8,010	37.43
9,600	31.23	9,200	32.59	8,800	34.07	8,400	35.69	8,000	37.48
9,590	31.26	9,190	32.63	8,790	34.11	8,300	35.74		

Making Resistance Work

Wrong Screen Voltage and Excessive Gain

By Herman Bernard

RESISTANCE coupled audio amplifiers have had an uphill fight with experimenters, because they have tried them and in many instances found them extremely troublesome. It is no secret that skilled scientists have found them troublesome, too, but it need not surprise any one that a resistance coupled audio amplifier can be worked by almost any one. The question is, what method shall be used to get around the trouble.

Good quality, of course, is obtainable from a resistance coupled audio amplifier. However, if the amplifier oscillates then very wretched quality, or no quality at all, is obtainable. This oscillation may be at any audible frequency, most commonly present at the frequency of a motorboat engine, hence called motorboating. But the shrill steam whistle effect also is due to the same cause, only the frequency of oscillation is higher. Sometimes the amplifier oscillates at higher than an audio frequency, which might seem to do no harm, but harmonics of that frequency gain undesired amplitudes, and when such notes are struck, blasting is heard. There are other causes of blasting associated with oscillation in audio amplifiers.

Two Limiting Factors

There is no doubt a limiting factor applicable to the amount of amplification per stage that can be used with a given system, where there are more than one stage. Usually a three-stage amplifier will give greater trouble than a two-stage one, because the overall amplification is greater, so not only the per stage gain but the overall as well has to be considered. Hence high-gain tubes can't be worked to the utmost in multi-stage resistance audio.

If low-frequency oscillation is present, as in motorboating, it is permissible to reduce the value of the grid leaks in the audio system. While theory calls for certain minimum values, practice makes its own minimum. The amplifier has to amplify clearly and well, and the grid leaks may be reduced to whatever value is required. Usually this is not less than 0.5 meg. With the new pentodes, for instance, the general recommendation is to use 0.5 meg., the terrific gain of the tube no doubt being the reason.

It might be assumed that lowering the grid leak value, which lowers the amplification, injures the low-note reproduction. It reduces it from what it would be with higher leak values, but it is difficult to see injury, for the amplification on low notes was too intense to start with, hence the motorboating at the engine frequency. Over-emphasis of low notes is just as distorting as preponderance of sensitivity in any other frequency region. The fact that the lows are cut a little more than the highs by the low-leak method is advantageous, for the fault in the amplifier is remedied more effectively where the corrective is needed, but the reduction is less where not needed. So the cure is attractive.

Two Connections Suggested

Two circuit aids are usually offered. One is that of reducing the voltage applied to the detector, by inserting a 50,000 ohm resistor from B plus to the end of the plate load, and bypassing this resistor to ground or cathode with a 1.0 mfd. condenser. This is called a resistor-capacity filter. The other, in case the detector is a screen grid tube, is to put a 100,000 ohm or similar value resistor from screen to the voltage source that otherwise would be applied to the screen. Since there will be radio frequency in this resistor, there will be a severe damper on the detector circuit unless this resistor is bypassed. Almost any value of condenser can be used for radio frequency purposes, from .0005 mfd. up. Values of 1.0 mfd. and more begin to be effective on middle audio component as well, but if audio bypassing is in mind 4.0 mfd. would represent a better starting value.

Sometimes the oscillation in the audio amplifier is due to radio frequency oscillation acting as a trigger, and as soon as the radio amplifier is stopped from oscillating, the audio amplifier behaves also, although it remains unstable. The fact that radio frequency trigger action would set off the audio amplifier so readily proves the presence of audio instability. Therefore first be sure the r-f end is not oscillating, usually testable by motorboating being noticed on only the lower waves of the broadcast band.

The question of what circuit to use depends a good deal on the radio frequency amplifier. For one stage of radio frequency amplification and a detector (with or without regeneration) no results in satisfactory volume will be achieved unless there are three stages of resistance coupled audio, or one resistance stage with push-pull transformer coupled output, or other combinations to bring up the volume to the intimated level, that is, a gain of around 500, anyway.

Detector Bypass Condenser

For two stages of t-r-f, leak-condenser detector, with screen grid detector tube, particularly if a-c operated at highest recommended voltages, two stages will be enough, if the first audio tube is a

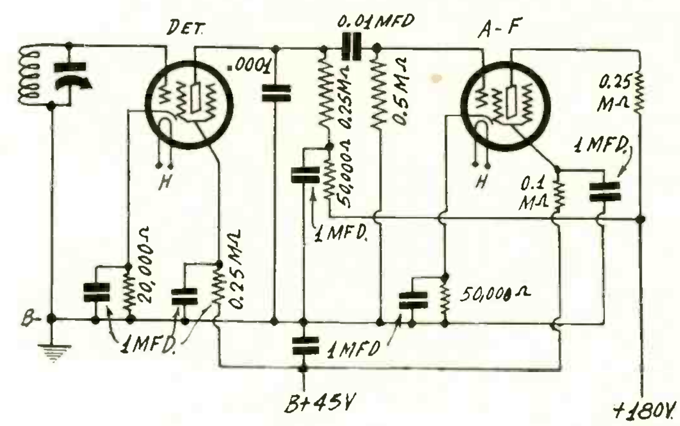


FIG. 1

The hookup for a 224 or 236 detector as screen grid tube and for a screen grid first audio tube. Power detection is used. The applied detector screen voltage may be 45 volts. Usually 45 volts applied to the screen is sufficient, 75 volts too high, as it makes the screen's effective voltage higher than the plate's.

screen grid tube, and the output tube is a pentode. If the output is not a pentode the volume will not be great enough to satisfy most persons in reception of so-called weak stations.

It will be found in some instances that a small bypass condenser from plate to ground or to cathode, in the detector circuit, has to be omitted, as there is enough capacity inherent in the circuit to provide a low impedance to radio frequencies, thus detouring them, and the usual condenser, if added, cuts the volume severely. If a filter is desired it may be just a radio frequency choke coil of substantial inductance, commercial rating 10 millihenries or more.

Generally for a-c circuits the grid leak for detection of broadcast waves need not be greater than 2 meg., and the grid condenser may be .00025 mfd., provided with clips, if a tubular leak is to be used. Since the sensitivity of the detector depends considerably on the value of leak, correction for too high gain throughout, at audio frequencies, may be provided by reducing the detector leak value. This is because the detector is an audio tube. When this is done to a value of less than 1.0 meg., then the detector's sensitivity is about on a par with that of a negatively biased detector.

For negative bias the resistor, from cathode to B minus, for screen grid tubes in a-c circuits, may be 20,000 to 40,000 ohms, where the plate load is a resistor of from 250,000 to 350,000 ohms.

Low Screen Voltage For Detection

The screen voltage for detection should be much lower than many suppose, and since it is difficult to measure the effective value without a vacuum tube voltmeter, it is well to measure the value for the r-f screen grid tubes, where the voltmeter holds good, and put a resistor between detector screen and the screen voltage for the r-f tubes, equal to at least three times the value of the plate load resistance. Preferably return the screen to 45 volts, using 250,000 ohms (Fig. 1). The value is not critical, and the more usual recommendation of 100,000 ohms may be followed. The current is small. The drop in 100,000 ohms might be around 10 volts, while that in 250,000 ohms may be 12 volts, due to the higher resistance cutting down the current, thus causing a voltage drop not proportionate to that where the current was larger.

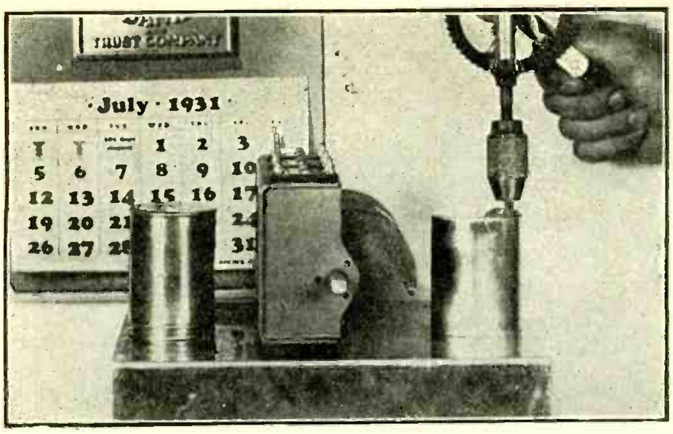
The usual type of metes can not cope with voltage measurements where the drop is caused by current flowing at 4 microamperes, where the meter draws hundreds of times as much.

Chain of Dynatron Oscillators

The whole voltage question is one worthy of serious study in connection with resistance coupled amplifiers. Who knows what the effective plate voltage is? If a screen grid tube is used it is desired to have the screen voltage certainly less than the plate voltage, but in many instances the difference is in the other direction, and no wonder oscillation is present. The audio amplifier may be a chain of dynatron oscillators!

Any one with a good voltmeter has the makings of a resistance meter, and every one should have a resistance meter. It consists simply of a current meter, say a 0-1 milliammeter or even more

(*Continued on next page*)



Starting work on the set.

A Small T R F S

Author Enjoys Locals with Good

A broadcast set that cost me very little to build, and which is affording very satisfactory results, is the one shown in Fig. 1. I am interested only in listening to local stations, with finest quality, and do not want large volume. I get the locals, also some distance, and certainly enjoy most excellent quality. Also, the set is compact.

The tubes are of the new automotive series. The 236 screen grid tubes are used as radio frequency amplifiers, detector, first and second audio, while the 238 pentode is used as output tube and the 237 general purpose tube as rectifier. The heater supply is a 20-volt filament transformer, two tubes being in series across the secondary, in three instances, accounting for the six tubes used, and actually affording 7.5 volts, due to the load of 0.9 ampere.

The parts cost me around $20, not including tubes, and it is the best $20 worth I have obtained in radio so far, to my way of thinking, especially when tonal results are compared to those of similarly priced sets that are flooding the market.

"No Aerial or Ground"

The way I run the set I "use no aerial and no ground," to repeat the popular erroneous phrase. What is meant is, that I do not have to connect any aerial or ground wire to the set, for the alternating current lighting line provides both aerial and ground.

As is well known, one side of the line usually is grounded by the lighting company. The other side is called the "high" side. These distinctions refer particularly to radio frequency. The grounded side may be at a zero radio frequency voltage, dead for pickup purposes. However, for 60 cycles the grounded side is just as live as the high side.

The distance between the point where the ground connection is made by the lighting company, and the convenient outlet used by you, may be so long that there is an effective antenna, and you can pick up radio waves no matter in which of the two directions you insert the plug in the wall socket. This is actually so in every instance in which I have made a test. However, better results are obtained, usually, if the grounded side is picked up for low radio frequency potential purposes. You can easily tell the difference, either by the increase in volume, or the better stability that results when the preferred method of connction is used. Sometimes an otherwise stable set will squeal if the wrong side is picked up.

Shorting Danger Avoided

A condenser is connected between the intended high side of the line and the beginning of the antenna winding of the first radio coil. Thus shortening danger is avoided. The grounded connection takes care of itself, due to the connection of one side of the line to the chassis, used as B minus, which chassis is presumed to be metal. I used aluminum.

The diagram shows where an outdoor aerial, or a cold water pipe ground, or both, may be connected, without shorting danger, in case one so desired. Of course the pickup will be greater, but the apparent selectivity will be less. No condition is normally to be expected whereby insufficient pickup will be provided without the external connections.

On all stations local that I tune in, except two, the volume control has to be retarded for my comfort. The two referred to are small ones in the low power in outlying parts of the New York metropolitan area, and their waves suffer some phenomenal attenuation, possibly due to tall-building obstruction since the buildings are of steel. The same two stations always have been feebly received on all sets I ever had, and don't interest me much, anyway.

Values of constants are imprinted on the diagram, except as to a few points. C1, C2 and C3 constitute the three-gang condenser, which, if .0005 mfd. will require 80-turn secondaries on 1.25 inch diameter, whereas if .00035 mfd. is used, 92 turns would be wound. The wire is No. 32 enamel. The primaries are 20 turns, one-eighth inch from the secondaries, on same form. These coils fit right in shields of 2.5 inch diameter, and of about the same height. The shields have screw caps, so the coil form may be secured to the shield proper, to the bottom, with nut and bolt, and holes drilled in the side for bringing out the leads. Then the cap may be screwed on independent of any coil or other connections. There are other ways of doing it, of course, including the total assembly on the cap, with leads through the cover, so that the shield itself is simply attached to the chassis, and the coil inserted automatically as the cap is screwed on.

These small shields will permit of mounting underneath the chassis. As I built the set two of the coil shields were on top, but if I had to do it over again I'd put them on bottom, and so I am showing a sketch calling for this.

The small diameter of the coil makes the use of the small shield all right. The thing that determines the shielding effect is the co-efficient of coupling between the coil and the short-circuited turn. The shield is the short-circuited turn, for it is indeed the same electrically and physically as a complete turn of flat wire. The inductance drop, due to the shield, is relatively small, in this instance. In fact, at first I overshot the mark with too many turns, thinking that I'd add one-third more than the number required for non-shielding as per the inductance formula, but only 10 more turns were needed, or one-seventh more than the formula's prescription.

This may be of any value, but it is suggested that it be 5,000 ohms or more. R1 should be about half of R2, or, if some other proportion is to obtain, R1 should be less than half of R2. The value of R3 may be anything you desire, except that it should be no more than one-fifth of R2. Its object is to

The volume control is a potentiometer, R2. give a great useful range of the potentiometer by avoiding zero screen voltage, or, in fact, negative screen voltage, since the

LIST OF PARTS

Three shielded radio frequency transformers, secondaries wound for the capacity of three-gang condenser to be used. See text.

One 30-henry B supply choke coil.

One 20-volt filament transformer.

One three-gang .0005, .00035 mfd. or similar tuning condenser.

Three q equalizing condensers, 20-100 mmfd. (E).

One block of three 0.1 mfd. condensers.

Two 1 mfd. bypass condensers.

One 4 mfd. electrolytic condenser.

Two 8 mfd. electrolytic condensers.

Two 0.01 mfd. mica condensers.

Two 0.0015 mfd. mica condensers.

One .00025 mfd. grid condenser with clips.

Two 300 ohm flexible biasing resistors.

One potentiometer, R2, and two limiting resistors, R1 and R3. See text.

One .01 meg. pigtail resistor (10,000 ohms).

Three 0.05 meg. pigtail resistors (50,000 ohms).

One 0.02 meg. pigtail resistor (20,000 ohms).

One tubular grid leak, up to 5 meg.

Two 0.25 meg. pigtail resistors (500,000 ohms).

wound resistor, or

One 600 ohm wire-

two 1,200 ohm in parallel. See text.

Four binding posts.

One front panel.

One vernier dial.

One AC switch.

Six UY sockets.

PROBLEMS OF RESISTANCE

(*Continued from preceding page*)

sensitive instrument, with a resistor and a battery in series, the ends open for binding posts across which the unknown is to be connected. For 1.5 volts in the battery the resistor is 1,500 ohms, also this combination is a 0-1.5 volts voltmeter. However, for practical purposes you should use a larger resistance value and a larger battery voltage, as then you can get some idea of the resistance values up to around 500,000 ohms. The phrase "some idea" comes to mind because of the extreme difficulty in obtaining scale legibility at high resistance values, or any values of resistance that must be read near the zero end of the voltage or current scale.

Assuming you can measure a resistor's value, even approximately, due to difficulty of reading the scale, you can measure the current in a circuit with a resistor in place therein, and knowing the value of the resistor can determine the voltage drop and subtract that from the meter-measurable applied voltage. You then have the effective voltage, say, on the screen, except that the bias voltage must be subtracted also, because we desire the voltage from cathode to screen or cathode to plate.

If you will be careful about keeping the screen voltage low, and not depend on even large values of resistance dropping much voltage in the screen and plate circuits, where about 0.3 and 0.1 milliampere prevail, respectively, then you will get much nearer to the fine results obtainable with resistance audio.

It is important, in a-c circuits, to have the B supply particularly well filtered, using a total of 16 mfd. or more, and a large inductance choke, and not overtax the choke with current, as that drops its inductance, otherwise there will be hum present.

The fact that such precautions must be taken against hum is commendable, for it proves that the extremely low frequencies of hum, 120 cycles principally, and 60 cycles incidentally, are amplified well, as they are in any good audio amplifier.

You do not need any particular scale registered on your meter. Suppose you have a 0-1 milliameter. Then if you use 9,000 ohms and a 6 volt battery source, *e.g.*, dry cells, you can take the scale readings as found for current, and convert them

et That Cost $20

Quality and Medium Volume

reference point is the cathode, and one side of the potentiometer to ground would permit, at that extreme setting, a return to a point negative in respect to cathode by the amount of the negative bias on the tube.

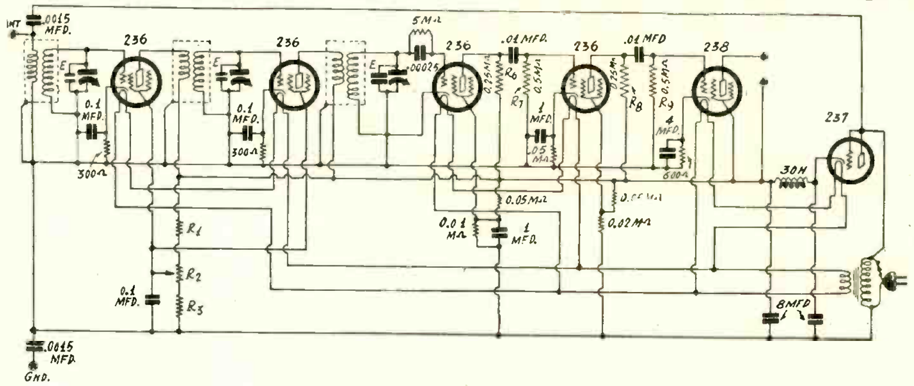
The only resistor that carries any current to speak of is the one marked 600 ohms. A wire-wound resistor is preferable here. Even two 1,200 ohm wire-wound resistors may be used in parallel. That is how I got around it, as all the other resistors I had were of the grid leak pigtail type (except the tubular 5 meg.), or were of the flexible wire-wound type for smaller current. Yet two such flexible types of 1,200 ohm will suit nicely, as they will stand 3 watts, and nothing like that is required. Less than 1 watt is used.

The circuit can be used by those having direct current electricity supply in their homes by ignoring the rectifier, and series connecting all tube heaters (five of them) in series again with an extra resistor, the total across the line. For 110 volts the resistor should be of 260 ohms and for 220 volts (as obtained in some direct current districts) it should be 470 ohms. But these resistors carry really large current, 300 milliamperes, so their wattage ratings (actual) are, for the 260 ohms, 22.55, and for the 470 ohms, 42.45 watts. So in the first instance a commercial rating of 50 watts will be all right, and in the second a commercial rating of 75 or 100 watts.

The direct current set will work only if the plug is in the socket in a particular direction, for the polarities are vital. One way gives a negative plate voltage.

Even in the case of direct current it is important to provide a good filter, and the same one would be recommended. The hum can be so low that you can not hear it even with no program on, only the set's rushing sound being audible. Now, since the circuit will produce a hum unless a filter of proportions approximately as stated is used. A 1 or 2 mfd. condenser next to the rectifier, all right in other filters, will not do here, because this is a single-wave rectifier and also there is a relatively high voltage between all cathodes and heaters. Whether single-wave or full-wave rectification is used makes no difference, provided the filter is of sufficient electrical proportions to reduce the hum to the allowable amount or less. The tolerable limit is 5 per cent. ripple voltage.

The resistor may be 225 and is not critical, since the current is only 0.3 ampere (300 milliamperes), and the voltage to



The circuit of a small tuned radio frequency receiver with resistance coupled audio that can be built at small cost. Screen grid tubes account for the sensitivity.

be dropped in the resistor equals the total line voltage less the voltage for the six tubes. The computation is as follows: Assuming root square values, which most a-c meters read, take the number of tubes and multiply by the voltage desired for each. Say you desire 8 volts. Then you want a total of 48 volts for the six tubes. The line voltage, say, is 110 volts. The difference is 62 volts, but for simplifying the arithmetic call it 63 volts. Therefore the resistance should be 63 volts divided by 0.3 ampere, or 200 ohms, to give 8 volts to each tube, but we will use less.

Omitting Transformer

No less a resistance than 200 ohms should be used for this circuit, while 225 ohms may be included, or any value somewhat in that neighborhood, the result then being that each tube will get less than 8 volts. The 225 ohm value will afford about 7.5 volts.

The simple resistor for direct current drop may be used no less for alternating current, hence transformer omitted.

The resistor carries 0.3 ampere, remember. The wattage therefore is the resistance times the current squared. The resistance, 200 ohms, times .09 ampere, equals 18 watts. As in practice, the commercial rating should be about twice the actual wattage (because of manufacturers' optimism), 36 watts commercial rating is desired. This is not a standard value, so 50 watts would be selected, if possible, otherwise 25 watts would be used. The 25-watt type would get somewhat hot, but harmlessly.

The wattage also may be computed by multiplying the current and the voltage, or 0.3 ampere times (using the approximation voltage) 60 volts, equals 18 watts.

The current, 0.3 ampere, applies to the heater circuit and the series resistor, and of course has nothing to do with the B voltage or current, for that current, flowing through the B supply choke coil, will not exceed 40 milliamperes.

It will be apparent that if enough tubes are used, no series resistor will be necessary. At 110 volts a.c., fifteen tubes could be hooked up with heaters on series and connected across the line.

The heater current would be the same. However, the B current would be large, say 80 milliamperes, which, however, is large only in respect to the expectations for the automotive type tubes. In high-powered radio sets we are not at all unaccustomed to 80 and 100 milliampere B current flow. The only requirement is that the choke shall have sufficient inductance to be a real choke at such current value.

I do not know what kind of a circuit to suggest using fifteen tubes, and I do not suggest using fifteen tubes, but merely mention the point as being of interest.

A man who had luncheon with me the other day said something about a fifteen-tube set, as follows:

"The set would be a superheterodyne, of course. There would be two stages of tuned radio frequency amplification, modulator and oscillator, accounting for four tubes. There would be three intermediate amplifier stages and a detector, accounting now for a total of eight tubes. The audio channel would consist of one resistance-coupled stage and one push-pull stage, three more tubes, except that I prefer the push-pull stage to have two tubes in each section in parallel, because of the relatively low plate voltage, say, 100 volts d-c. Thus we arrive at thirteen tubes. Do not forget to include a rectifier, which is fourteen tubes, while if I had my way I'd include an automatic volume control tube, and there are your fifteen tubes. Good afternoon!"

AUDIO AMPLIFICATION

to resistance values by using the absolute values of the following table:

Meter Reads in Milliamperes	*Resistance of Unknown Under Above Conditions*
0.05	111,000
0.10	51,000
0.15	31,000
0.20	21,000
0.25	15,000
0.30	11,000
0.35	8,140
0.40	6,000
0.45	4,333
0.50	3,000
0.55	1,900
0.60	1,000
0.65	231

If the meter has a total of 20 divisions, one division represents 0.05 ma, so the eye can estimate one-half of this on the scale, bringing one extreme to 231,000 ohms, or one-quarter of a division at 471,000 ohms. The other extreme is zero resistance, at 0.667 millampere. The 231 ohm resistance is the practical low limit.

Of course there are good transformer-coupled, impedance-coupled and combination-coupled amplifiers. Resistance coupling is not the only thing, but it is the best so far, if one can attain stability, and it is well worth trying for. All the television receivers, which need wide audio frequency response for clarity of definition in pictures, have resistance coupled amplifiers, principally three-stage.

If a resistance coupled amplifier causes trouble that you can't remedy otherwise, and the first or second audio tube is a screen grid tube, change connections and insert a 227 ahead of the output tube. The bias for the 227 may be obtained through bypassed 5,000 ohms, that for the 224, etc., through bypassed 50,000 ohms, both for amplification, but the 227 should not have a plate load higher than 100,000 ohms.

How to Determine Voltages M

Effective Potentials Due to Small Curre

By J. E. A

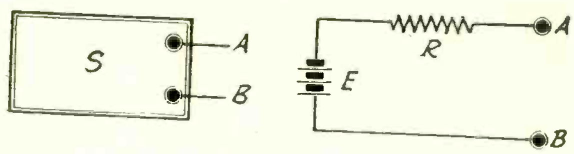


FIG. 1

The voltage of an unknown source and a resistance of unknown value may be measured with two voltmeters of two different known sensitivities. The meters are connected across A and B in succession.

SERVICE men and radio experimenters often place too much reliance on voltmeters. For example, they will plug into a certain socket to measure the plate voltage, or the screen voltage, and find a certain reading. They assume that the reading they get is the correct voltage on the element in question. Sometimes when they find an exceptionally low value they assume that something is wrong with the set. They may know that the applied voltage is 180 volts and they may not get more than 30 volts effective, or even less. Such a discrepancy is certainly large enough to question, but it is not enough to justify the assumption that something is wrong with the circuit. Very likely it is just the voltage reading that should be expected when everything is as it should be.

Another point which has worried some experimenters and service men is the discrepancy between the readings obtained by two different voltmeters at the same points when the readings are taken by the two meters successively. One meter may read 70 volts while another may not read more than 30 volts. Now that is a queer situation and certainly one of the meters is wrong! At least that is the conclusion that is often drawn from the data obtained. This thing happens so frequently that it may be worth while to discuss the matter in detail. One reason why the second situation does not occur more frequently is that service men seldom measure the voltage at the same points with two different voltmeters. They place too much reliance on the accuracy of the first and only reading, as stated.

An Example Out of Practice

An example of this type came to the writer's attention quite recently. He was present when a service man tested a circuit. A test set was plugged into a certain socket for the purpose of measuring the screen voltage on one of the tubes. The instrument read 50 volts. This reading was about correct because the plate voltage was 135 volts. Yet the writer made the assertion that the screen voltage was too high and it was for that reason that the circuit did not function properly. The service man relied too strongly on the accuracy of the voltmeter reading. He insisted that the voltage was no higher than 50 volts. And he was correct while the meter was in the circuit, but the point is that the voltage was much higher when the meter was disconnected, that is, under actual operating conditions of the circuit.

As a demonstration of the unreliability of voltmeters under certain conditions the voltage between the screen and the cathode was measured with two different voltmeters, one having a sensitivity of 1,000 ohms per volt and another having a sensitivity of 66.67 ohms per volt. One meter, the more sensitive, gave a reading of 70 volts while the other gave a reading of 32 volts. Now which of the two meters gave the correct voltage? Certainly both meters were not correct. And why did the two meters give different results? When they were tested on a battery they gave the same reading, both when they were connected across the battery successively and simultaneously. Both meters were all right. Then why did they give different readings?

The Reason Why

There are two reasons why they gave different readings. First, they had different sensitivities, and second, there was a resistance in the circuit through which the current required by the voltmeters had to flow. The drop in this resistance was different in the two cases and this difference showed up on the meters.

Let us explain more fully how the difference arises and also how the correct voltage and the value of the resistance in series may be determined from the known factors. Consider the left drawing in Fig. 1. Let A and B represent the two points across which the two voltmeters are connected, first one and then the other. The box S contains a source of voltage, say a battery, and in addition a resistance in series with the battery. Both the voltage of the battery and the value of the resistance in series with it are unknown. But when we connect the two different voltmeters, one after the other, we get two different readings. The battery voltage does not change; neither does the resistance. But the voltage across the terminals A and B changes with the meter used.

If we know the ohms per volt of the two voltmeters and the two different voltage readings we have sufficient data to determine both the voltage of the battery and the value of the resistance. At right in Fig. 1 we have removed the box showing the circuit inside. The circuit may not actually be as simple as that but effectively it is, and when we get the E and R we get effective values. If the circuit is just as indicated we get the actual values of E and R.

When we connect meter S1 we have a current I1 through the circuit, which is the current required by the meter to cause the deflection. This deflection is indicated on the meter scale as a voltage V1. Now we can apply Ohm's law to the simple circuit. It is $E-RI1=V1$. That is, the voltage reading on the meter is the battery voltage diminished by the voltage drop in R.

Now let us connect the other meter S2 across A and B. This will give an indicated voltage V2 across A and B. In this case the current in the circuit is I2, which is required by S2 to cause a deflection V2. As before, by Ohm's law we have $E-RI2=V2$, E and R are the same in these two equations and we know V1 and V2 by the readings on the two meters. We can therefore

List Prices of Tubes

The following table gives the prevailing price lists of the various tubes

Tube	Price	Tube	Price	Tube	Price
227	@ $1.25	551*	@ $2.20	WD-11	@ $3.00
201A	@ $1.10	171A	@ $1.40	WX-12	@ $3.00
245	@ $1.40	112A	@ $1.50	200A	@ $4.00
280	@ $1.40	232	@ $2.30	222	@ $4.50
230	@ $1.60	199	@ $2.50	BH	@ $4.50
231	@ $1.60	199	@ $2.75	281	@ $5.00
226	@ $1.25	233	@ $2.75	250	@ $6.00
237	@ $1.75	236	@ $2.75	210	@ $7.00
247	@ $1.90	238	@ $2.75	BA	@ $7.50
223	@ $2.00	120	@ $3.00	Kino	
235	@ $2.20	240	@ $3.00	Lamp	@ $7.50

*This table comparable to the 235.

Meters Don't Read Accurately

nts in Loads Often Baffle Experimenters

Anderson

determine both E and R, provided only we can obtain the values of I1 and I2.

Getting the Currents

If we know the sensitivity of the two meters in ohms per volt we can easily get the two current. In the first place the ohms per volt of a meter is the reciprocal of the current drawn by the meter at full scale, and the current at any other reading is proportional to the reading. Thus we have the current at any reading as soon as we have the ohms per volt and the maximum reading of the meter. Let us first solve the two equations in E and R in terms of V1, V2, I1, and I2. The equations are:

$$\begin{cases} E - RI1 = V1 \\ E - RI2 = V2 \end{cases} \qquad (1)$$

Subtract the lower one from the upper one to eliminate E. Then we get RI2—RI1=V1—V2. Factoring the first member we get R(I2—I1)=V1—V2, and dividing both members by I2—I1 we get

$$R = (V1 - V2)/(I2 - I1) \qquad (2)$$

To get E we can substitute this value of R in either of equations (1). Let us substitute it in the first. We obtain E=V1+I1(VI—V2)/(I2—I1) or

$$E = (V1I2 - V2I1)/(I2 - I1) \qquad (3)$$

Thus we have expressions for both E and R in terms of known or easily ascertainable values.

Now let us find expressions for I1 and I2 in terms of known values. Let M1 be the maximum voltage on the scale of meter S1 and let M2 be the maximum voltage on meter S2. We can apply Ohm's law to obtain the current, if we do not care to obtain it by simple proportion. The voltage across the meter S1 is V1, and the total resistance in the meter is M1r1, in which r1 is the ohms per volt of the meter. Thus we get I1=V1/M1r1

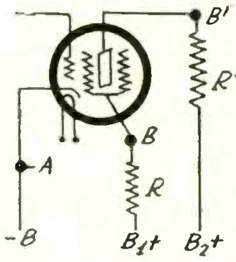


FIG. 2
When current is drawn in addition to the current drawn by the meter, as in this case, the resistance is obtained correctly but the value of E is the effective, and desired, voltage.

for the current in the first meter. Similarly we get I2=V2/M2r2 for the current in the second meter.

To solve the problem we first obtain the currents I1 and I2 from these formulas and then substitute the values in the formulas for E and R.

An application of the formulas to a specific case will help to clear up the process. Let meter S1 have a sensitivity of 1,000 ohms per volt and a scale of 0-100 volts. Then r1=1,000 and M1=100. When this meter was connected across the terminals A and B the reading was 70 volts. That is, V1=70 volts. The other meter S2 had a sensitivity of 66.67 ohms and a scale of 0-150 volts. Thus r2=66.67 and M2=150. This meter gave a reading of 32 volts when connected across terminals A and B. Hence V2=32.

Using these values we obtain I1=70/100x1,000 and I2=32/150x 66.67 amperes, or I1=0.7 and I2=3.2 milliamperes.

Now we can substitute these values, together with V1 and V2, in equations (2) and (3) to get R and E. From (2) we get R=(70—32)/(3.2—0.7), or 15.2 thousands of ohms, or 15,200 ohms. From (3) we get E=(70x3.2—32x0.7)/(3.2—0.7), or 80.64 volts.

Thus we have obtained the actual voltage E of the battery and the unknown resistance R in series with the battery by measuring the voltage across the terminals A and B with two different voltmeters of known characteristics. It will be observed that both meters gave the wrong voltage and that the more sensitive meter gave a result much less in error than the other meter.

When Method Is in Error

Even this method is not applicable in all cases. Suppose that the screen voltage on a tube is measured and there is a resistance in the screen lead. The tube itself requires some screen current and this flows through the resistance as well as the current required by the meters. The method then gives the value of the resistance correctly but the voltage is in error by a small amount. The voltage obtained in this instance is not the voltage of the battery but the voltage that is applied to the screen, and that really is what is desired. Hence the method is directly applicable to the measuring of the effective voltage on the screen, or on the plate, although the voltage of the source is not obtained when there is current through R other than the current required by the meter.

The method is extremely useful and it should be kept in mind always and applied whenever the circuit is such that the effective voltage is different from the applied voltage, that is, whenever the voltage is applied through a resistance. The test for the necessity for using the method is the existence of a discrepancy of the readings of two meters of different sensitivities. The only other method of measuring accurately the effective voltage is by use of a voltmeter that draws no current, such as a vacuum tube voltmeter. The two meter method is usually more convenient than a vacuum tube voltmeter.

Fig. 2 shows a case where the method may be used for measuring effective voltages. For the effective screen voltage the two points for connection of the voltmeters are A and B, and for the effective plate voltage the two points are A and B[1]. R and R[1] are the two unknown resistances in the case. In both of these cases extra current is drawn and the value of E obtained is the effective value, which is the desired voltage.

Standard Frequency Schedule

Once a week the Bureau of Standards sends out highly accurate signals on 5,000 kc from WWV. The frequency is piezo controlled and is accurate to much better than one part in a million. The power of the station is 1,000 watts and the standard signals should be receivable in most parts of the country provided a suitable short wave receiver is used for their interception.

5,000-Kilocycle Transmissions

2 to 4 p.m. and 10 p.m. to 12 midnight, Eastern Standard Time

August	*September*
11	8
18	15
25	22
..	29

Multifrequency Transmissions

Frequencies in Kilocycles

Eastern Standard Time		
p.m.	p.m.	September 1
2.00	10.00	6,400
2.18	10.18	7,000
2.36	10.36	7,600
2.54	10.54	8,200
3.12	11.12	8,800
3.30	11.30	9,400
3.48	11.48	10,000

Design of Converter Coils

When there are two tuners in a short wave converter, the oscillator and the r-f tuner, there seems to be no relation whatever between them, especially when the intermdiate frequency is high. One reason is that any signal may be received at two settings of the oscillator, and these two require entirely different settings of the r-f tuner, usually requiring a change of coils.

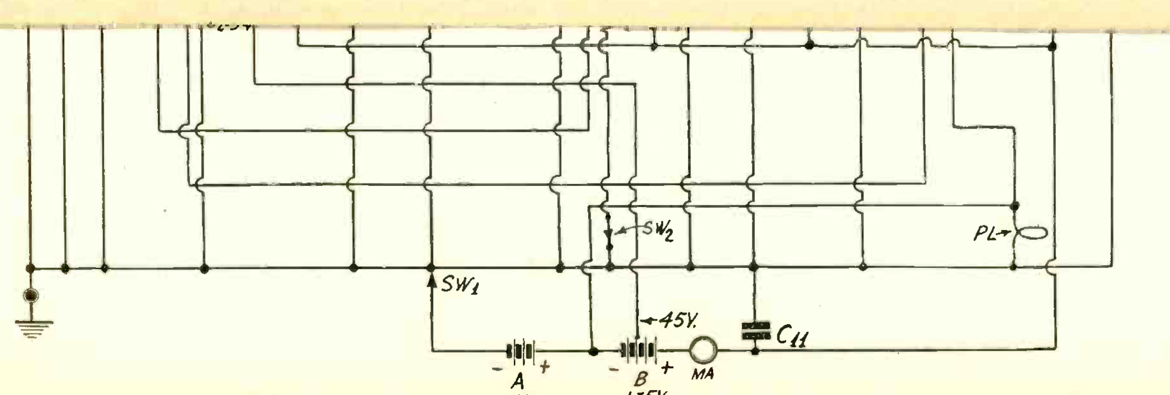
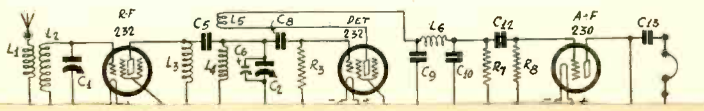


FIG. 13
The circuit with filaments of the 2 volt tubes in series, across a 6 volt storage battery.

A Short-Wave Set

2-Volt Tubes Used with 6-Volt Storage

By J. E. Anderson and



the A battery voltage. So invariably in practice C plus is connected to A minus.

Again an option is present as to connection of the B battery to the A battery to unite them into a common circuit. This is to use either A plus or A minus for the B minus connection. Here

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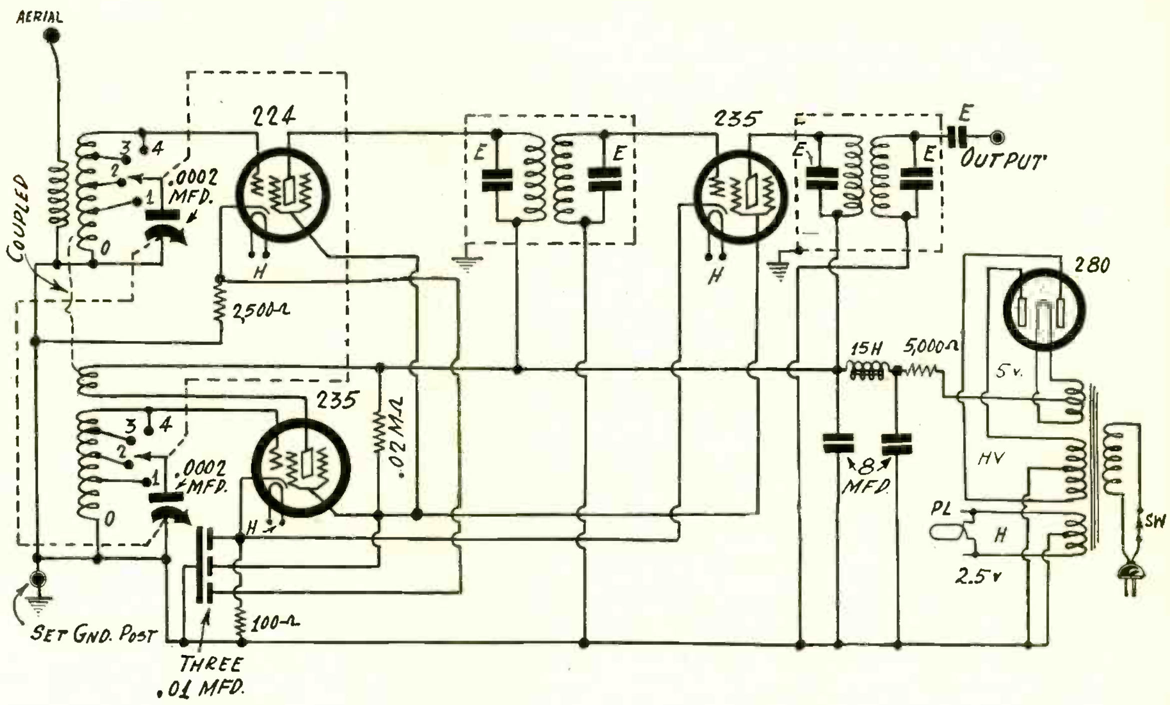

FIG. 940
The circuit of a three tube short-wave converter in which the frequency ranges are selected by means of switches. There is an intermediate amplifier and a B supply built in.

I AM looking for an all-wave converter, but one that is especially suited for the reception of short-waves. I intend using it with a broadcast receiver that is not very sensitive, so that I should like to have at least one stage of radio frequency amplification after the detector tube in the converter. Will you kindly publish such a circuit if it is convenient to do so?—W. B. N.

In Fig. 940 is a diagram of such a converter. It contains an oscillator, a detector, and one stage of intermediate amplification with two tuned circuits in the intermediate level. It also contains the rectifier and filter required to supply the necessary plate and screen voltages.

* * *

Squawking Short-Wave Converter

I HAVE built a short-wave converter in which there is one tuner for the radio frequency and one for the oscillator. All I can get out of it is a lot of squawks, which seem to appear on certain combinations of the two condensers. What do you think the trouble is?—W. R. B.

The squawking is undoubtedly heard when the two tuned circuits are set at the same frequency and it is due to a type of overloading. Reduce the coupling between the oscillator and the modulator. Possibly you are using a too low an intermediate frequency, so that the two tuned circuits have to be set too near the same frequency in order to generate the desired intermediate frequency, and then the circuits jump together.

* * *

Inductance of Straight Wires

DOES a straight wire have inductance or is it necessary to coil it up to get inductance? If a straight wire has inductance is it enough to take into account in short-wave receivers?—G. W. J.

Yes, a straight wire has inductance as well as a coiled wire. Any conductor, no matter what shape, has inductance when a current flows in it. However, there are certain forms of coils that have very low inductance. For example, two straight wires of equal length joined together at one end and placed very close to each other have a very small inductance. So-called non-inductive resistances are wound this way. While the inductance of a straight wire, such as a connecting lead in a circuit, has a very low inductance, it is not negligible in short-wave circuits where the lumped inductance, that is, the coil inductance, is small. In some instances the inductance of a short length of straight wire is the only inductance required. A short piece of straight wire also has capacity.

* * *

Measuring Short-Wave Current

IF a thermo-couple milliammeter is calibrated on alternating current of low frequency can it be used to measure accurately currents of frequencies in the short-wave region, for example, 30,000 kc?—E. W. H.

If the thermo-couple has been constructed for radio frequency measurements it can be used on very high frequencies after it has been calibrated on low frequencies. The two leads carrying the current to the thermo-junction must be short so that they have negligible self-inductance and distributed capacity. The thermo-couple is about the only reasonably accurate current meter that we have for use in high frequencies.

* * *

Impedance of Small Choke

WHAT is the impedance of a choke coil of 20 microhenries at 30,000 kc? Is it high enough to be of any use as a choke in plate and screen leads?—T. R.

It is about 3,770 ohms. It is high enough to be of some good in the leads, but it would be better to increase the inducance if this is done without increasing the distributed capacity. It requires only 1.4 mmfd. to tune the 20 microhenry coil to the frequency in question.

* * *

Hertz Antenna

WHAT is a Hertz antenna? What distinguishes it from an ordinary antenna?—F. R. T.

A Hertz antenna consists of two equal conductors running in opposite directions from the point where it is excited by the oscillator. The wires are usually horizontal. The ordinary antenna might be called the Marconi antenna. It is vertical and one end is grounded, the excitation being at or near the ground end. The horizontal portion of a Marconi antenna serves only to insure that the current in the vertical portion is everywhere approximately the same. In the Hertz antenna large balls or other large conducting bodies are often placed at the ends to insure that the current everywhere between is approximately the same. Without these arrangements the current at the extremities would be zero.

* * *

Resonant Shunt Against Interference

I HAVE a sensitive amplifier which amplifies one frequency which I don't want. Can you suggest a way of getting rid of this without killing the amplifier at other frequencies?—S. T.

One way of suppressing an interfering signal is to put in a parallel resonant circuit in series with the line somewhere and tuning this to the interfering frequency. The more selective this circuit is the more effective it will be in suppressing the interference and the less it will affect other frequencies. Another way is to put in a series tuned circuit across the line and tuning this to the interfering frequency. This will act as a short circuit to this frequency. The more selective this circuit is the more effective it will be against the interference and the less effect it will have on other frequencies. In extreme cases the series parallel tuned circuit and the shunt series tuned circuit may be combined for a practically complete suppression of the interference. The series parallel tuned circuit has an extremely high impedance to the interference so that signal cannot get through. The shunt series tuned circuit has a practically zero impedance so that the coupling becomes zero.

* * *

Discrepancy Between Two Voltmeters

I HAVE two different voltmeters both of which are supposed to be accurate and they do read the same when I connect them across a battery. But when I attempt to measure the plate voltage on a tube I get entirely different readings. What is the cause of the discrepancy?—A. B. L.

The causes of the discrepancy are a resistance in series with the meters and the fact that the meters have different sensitivities or ohms per volt. The meter which requires the more current reads the lower voltage. In one instance the reading of a 1,000 ohms per volt was 70 volts and that of another having a sensitivity of about 66.7 ohms per volt was 32 volts. In this case there was a resistance nominally of 20,000 ohms which caused the difference. Apparently, the fixed resistance was nearer 15,000 ohms than 20,000.

* * *

Principle of Short-Wave Converter

WILL you kindly give a brief explanation of the principle of the short-wave converter? I have built several of them and they all work, but I believe if I really understood the principle that I could make them work better.—F. R. T.

The principle is quite simple and is exactly the same as that of the superheterodyne receiver. The signal desired has a certain frequency. Let us call it F1. The oscillator in the converter generates another frequency. Let us call this F2. Both are impressed on the modulator tube, or the detector in the converter. A difference frequency, either F1-F2 or F2-F1. This is the intermediate frequency. In the ordinary superheterodyne this is fixed by the tuning of the intermediate frequency amplifier. In the converter it is fixed by the tuning of the broadcast receiver, and may be any value between 550 and 1,500 kc desired. Whatever intermediate frequency is selected by the setting of the broadcast receiver tuner, the oscillator is changed, that is F2 is changed, until the difference frequency, either F1-F2 or F2-F1, is equal to the frequency to which the broadcast receiver is tuned. Then the desired signal F1 comes through. As F2 is changed by turning the condenser on the oscillator different signal frequencies F1 come through. In nearly all cases of converters and in commercial superheterodyne it is the F2-F1 frequency that is tuned to. That is, the oscillator frequency is higher than the signal frequency by the amount of the intermediate frequency. If there is a radio frequency tuner in the converter it is tuned to F1, the oscillator is tuned to F2, and the broadcast receiver is tuned to F2-F1.

* * *

A Buffer Tube

WHAT is a buffer tube in a radio frequency amplifier and what is its purpose?—B. H. R.

It is an amplifier which is strictly unidirectional, that is, such that the signal frequency can pass from the grid to the plate but not in the reverse direction. There must be no regeneration in it. Its purpose sometimes is to prevent oscillations from backing up through the antenna and sometimes to prevent amplified oscillations from backing up to a piezo crystal or other master oscillator as an aid in stabilizing the frequency.

* * *

Coupling in Short-Wave Converters

WILL you kindly suggest different methods of coupling the oscillator and the modulator, methods that may be tried in an experimental way, to find which method is best.—I. C.

If you have a radio frequency tuning condenser in the grid circuit of the modulator, one method is to connect a loop of wire between this coil and the oscillator coil. Take a turn or two around the oscillator coil, run the wire over to the radio frequency coil and take a turn or two around that and then join the two ends by close twisting or soldering. Vary the turns on both or either. Possibly you will get plenty of coupling by taking half a turn around each coil making a simple loop. You can also connect a grid leak between the grids of the two tubes, varying the value of the leak. Similarly you can connect a small condenser between the two grids, varying the capacity. You can also wind a few turns around the oscillator coil and connect these turns in the grid return, or grid lead, of the modulator, or the cathode lead, or the screen lead, or in the plate lead. Another way is to place the two coils side by side, varying the distance between them until the degree of coupling is right. About six inches may be found to be about right.

* * *

Natural Frequency of Small Choke

I HAVE a small diameter choke supposed to have an inductance of 100 microhenries and a distributed capacity of 2 mmfd. What is the natural frequency of this choke and what is its impedance at the natural frequency?—S. V.

The natural frequency of the coil is 11.24 megacycles per second and its impedance at this frequency is 5/R megohms, where R is the radio frequency resistance of the coil. If R should happen to be 5 ohms the impedance is one megohm, and it is a pure resistance.

* * *

Short-circuiting Unused Turns

I UNDERSTAND that when the inductance in an all-wave receiver tuner is changed so as to cover different frequencies it is better to short-circuit the unused turns than to leave them open. I am planning to build such a receiver with direct tuned impedance coupling. Will you kindly show by means of a diagram how the short-circuiting switches should be arranged to change the inductance property?—W. T.

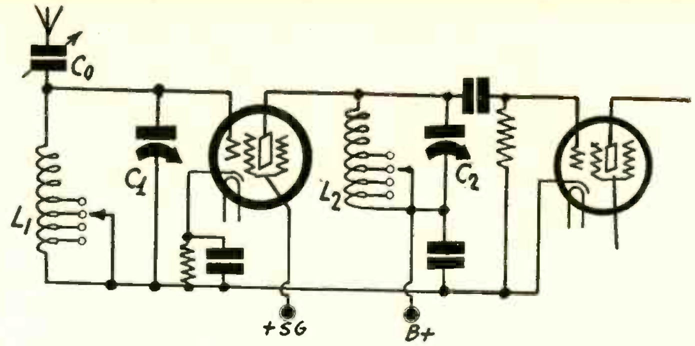

FIG. 941

When taps are used instead of plug-in coils to change the frequency ranges in an all-wave receiver or short-wave converter it is preferable to short-circuit the unused turns as illustrated in this figure.

In Fig. 941 is a diagram showing how the inductance in the antenna circuit and also that in the interstage coupler are changed by means of switches so that the unused turns are shorted. Note that in each case the switch is connected to the low potential side of the tuned circuits.

* * *

Increase of Resistance With Frequency

WHAT causes the resistance of a coil to increase with frequency and how great is the increase?—E. S.

The increase in resistance is due to the skin effect, or the tendency for the current to travel in a thin layer on the surface of the wire. This layer is thinner the higher the frequency and therefore less of the conducting material is actually carrying current when the frequency is high. The amount of increase depends on the material of the wire, its diameter, and the manner in which it is bent or coiled. The resistance at high radio frequencies might well be 25 times higher than the zero frequency resistance for a copper wire ordinarily used for coils.

* * *

Frequencies for Television

IN what frequency range are the television stations working at this time? About how many active television stations are there? —W. H. J.

Most television stations are operating in the range from 2,000 to 2,950 kc and there are about 20 active stations sending out visual programs, all on an experimental basis. For a list of the more important stations see August 1st issue of RADIO WORLD.

* * *

Measuring Effective Resistance of Rectifier

CAN you suggest a method of measuring the effective resistance of a rectifier like the 280 together with that of the filter choke? —H. B.

One way of obtaining the effective resistance is to take a regulation curve, that is, taking the output voltage for a large number of different currents. Plot the output voltage against the current. From the slope of the curve at any point you can get the resistance because it is the ratio of a small voltage change to the corresponding current change. Another method, which amounts to the same thing, is to measure the output voltage by means of two different voltmeters, one of high sensitivity and other of low sensitivity. If the sensitivity in ohms per volt is known for both meters, both the effective resistance and the effective voltage in the circuit can be computed from the two readings. The solution of the problem is a matter of algebra. The resistance value is the ratio of the difference between the two voltage readings to the difference between the two currents. Either current may be obtained by dividing the voltage readings by the full scale reading times the resistance per volt. For example, if the meter is a 0-150 instrument and the resistance per volt is 66.67 ohms and the reading in volts is 50 volts, the current is 50/150 x 66.67, or 5 milliamperes. For detailed explanation see an article on this subject in this issue. Also see answer to A. B. L. above.

* * *

Connection Between Weather and Reception

IS there any definite relation between weather conditions and radio reception, such as temperature and barometric pressure? —B. W. R.

If there is it has not been found yet, but there is no doubt that there is some relation. Certain relations have been found between reception and the moon and sun. Since they affect weather there must be a relation between weather and reception. The moon and the sun affect the barometric pressure as well as the height of the Kennelly-Heaviside layer, but whether or not the change in air pressure extends as high up as the layer is not known. It probably does not.

A THOUGHT FOR THE WEEK

SOMEBODY asks us if we consider it extraordinary that RADIO WORLD *should have taken in* 15.9 *per cent more cash for subscriptions during a recent ten-week period of* 1931 *than we had taken in during the same period of* 1930, *per own published statement in these columns. We replied: "Why extraordinary? We have been trying to produce a paper that would interest and be of actual value to our many thousands of readers. Then instead of listening to the calamity howlers, we started on a subscription campaign that netted fine results. Others in the radio field have done the same thing once they were sure they had something the public wanted. Isn't that the usual story? And we're not going to stop working along the same lines, either, no matter what happens in Europe or Wall Street —and there you are!"*

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Tenth Year

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Our Side

READERS have been telling their frank opinion in uncensored letters published in Forum, a regular department of RADIO WORLD, saying that insufficient details are given about many circuits, while others complain that sometimes mistakes appear in diagrams.

Since comment on any diagram or text necessarily is published in a subsequent issue, the original subject matter makes an unmolested appearance, and it is only fair that the comments should be published without backfire in the same issue. Such has been the case in every instance. Whatever the reader had to say was said, and that was an end to it, for that issue. However, there is no harm, we hope, in now pursuing the discussion on the basis of readers' comments printed in previous issues.

As for the lack of constructional details concerning many diagrams, that is due to the nature of the article that they illustrate. There are, in general, two types of technical articles printed; one is theoretical and the other is constructional. Any technical article not primarily intended actually to expound the construction of the circuit or device under discussion should be classed as theoretical, and any article intended to detail the actual construction, so that the author's handiwork will be duplicated, is constructional, even though some theory usually attends the constructional article.

It should go without saying that both types of articles have their merit and value.

Unfortunately, the word *theoretical* calls to mind for many persons a freak circuit, something untried and untested, a scientific dream, as it were, but in its true sense *theoretical* simply means founded on theory, and theory is a formulated code based on experience. It is theoretical, for instance, that the resistance present, when the potential difference is 2.164 volts and the current flowing is 1.082 ampere, equals 2 ohms, not because the statement is fallacious or absurd (for it is true), but because the writer has never actually reduced to practice and measured a circuit in which there were that potential difference and that current. Yet Ohm's law is invoked, and Ohm's law is based on experience, in fact, has never been proven wrong in a single instance.

So, assuming that there is nothing in the word *theoretical* to make one shudder, let us consider that nearly all radio knowledge is obtained from theoretical treatises and nearly all of an individual's radio knowledge therefore is itself theoretical. Who could ever hope to build even a small fraction of all the radio circuits ever published

It is from the theoretical discussions that novices get their first glimpse of radio technique, and are impelled finally to try their hand at some construction. It is from theory that one gets his background of the activities and performances, the problems and the phenomena, associated with radio. Therefore let us respect theory, and recognize its worth.

It therefore follows that constructional details of the most intimate sort are not to be expected in theoretical articles. If some coils and condensers are shown without values given, without statement of number of turns, size of wire, diameter of tubing and spacing between turns, if the article is theoretical such details really are out of place. More important still, the diagram reveals fully what it was intended to reveal, and illustrates the point being made, even though it does not illustrate what was not intended.

As for constructional articles, it is certainly incumbent on RADIO WORLD to print plenty of them, and we believe this is done. It is our special delight to find a really worthwhile circuit and print the building details, giving every blessed fact that the author and editors can think of, that would be of assistance to the builder, particularly the novice.

We believe there is still a great interest in home construction of radio sets, both broadcast and short-wave types, as well as all-wave sets and short-wave adapters and converters.

If more space has been devoted recently to short waves, it is only because a substantial percentage of our readers demand that. Every mail we receive, every issue we print, confirms the present tremendous interest in short waves which we would be remiss to ignore.

Another point discussed in recent letters is the proportion of technical to non-technical articles or news. Some readers don't want any news, but demand more technical matter. A much smaller percentage asks for more news, and fewer hookups. We take a middle course. It is not fair to deprive either group of what they want. The technical section always outbulks the news section.

Some diagrams illustrating circuits do contain errors, once in a while, an admission we make without defense, pointing out that the erratum list in "Proceedings of the Institute of Radio Engineers" is sometimes quite considerable, principally as to mathematics, while weekly radio publications, and even monthly and quarterly radio periodicals, print erroneous diagrams. Such diagrammatic errors usually arise from an author's correct diagram being incorrectly copied by a draughtsman, and the error escaping the author and editor, especially as the author writes with his original diagram before him. We do not find any percentage of diagrammatic erors lower than our own, although comparing our weekly even with monthlies and quarterlies, without regard to the greater speed of a weekly turnout.

That there is room for improvement in all directions is conceded.

The Experts Report

THE technical committee of the National Advisory Council on Education in Radio has prepared a report dealing with educational possibilities of radio, and two of the chapters, dealing with television and short waves, are published in full in this issue. The signatories are distinguished radio technicians and they are said to be in full accord on all the conclusions stated. It is therefore highly interesting to read what they have to say.

"Television broadcasting is in an advanced experimental condition at this time," states the report. "It has not yet been possible to establish transmitting stations capable of giving reliable service over a considerable area, nor to provide on a commercial scale receivers which give a clear, bright picture of an acceptable color, adequate detail, satisfactory size, freedom from flicker, or sufficiently wide angle of view, and of the requisite steadiness of position. The problems involved are under active investigation, and there is a likelihood that within the next few years equipment of this sort will be commercially available."

The chairman of the committee, Dr. Alfred N. Goldsmith, of the Radio Corporation of America, and some of the members of the committee, are associated with the television experimental work of large chains and individual stations, so that the opinion comes from those who might be expected to state, without bias, in an educational and non-commercial report of this kind, exactly what the status of television is, and what the prospects are, as these appear to the well-informed.

And it so happens that in the discussion of short waves there is a glint of greater possibilities in the future, with no great enthusiasm for program broadcasting on these frequencies under present conditions. But the report bears in mind the average listener, and describes him as not fitted to get the best results from short-wave reception. The short-wave fan of to-day is not an average listener, but a skillful set operator, himself a technician, and so the report on short waves must be read in the light of the difference in treatment that must apply to two entirely different types of listeners.

The Master Stroke

THE greatest tribute to the importance of radio is Radio City, now in course of construction in New York City, where it will constitute an immense and beautiful monument to radio and allied arts, as well as a cultural center with a greensward and the usual saddening statuary. Imagine any building enterprise being estimated at $250,000,000! Imagine 5,000 human beings daily active on the site, three months work, or more, for persons who sorely need it, with 20,000 other hands active in their labors incidental to supplying the materials and fixtures! Seething industry, commercial bravery, inspired planning, boundless confidence! These, too, the endeavor typifies, besides the lasting monument that will rise to radio.

Behind it all is the steady hand of John D. Rockefeller, Jr., for it was he who furnished the courage and the money that made Radio City possible. It is perhaps his greatest stroke, and one that reaffirms the strength of his moral and executive fibre. Born to boundless riches, the junior Rockefeller might as well have been born to poverty, for he had the makings of success, and easily overcame the handicap of immense riches, to become one of America's model citizens. Not only the 25,000 who profit directly by the needed work they get, nor the millions in this land who will recognize anew the demonstration of his genius, but the world at large will shower on him unselfishly the high praise he deserves for his undertaking. His is a business enterprise, not to be confused with his benefactions that are carefully strewn about the world. The project is to be self-supporting. Nevertheless there is in it every evidence of the high purpose, the intellectual supremacy, and the fine sense of recognition and proportion that mark his many philanthropies. The master touch is there, so are the deft vision and the high resolve.

Forum

Good Advice From Texas

LAST evening I purchased a copy of Radio World from a local newsdealer. The copy was dated July 18th and is the first copy I have purchased or read since 1923.

At that time I was a regular reader of your magazine but after a while I discontinued reading it on account of the great amount of advertising matter prevalent in the magazine with the near exclusion of technical articles. Now, perhaps you do not know it but radio men delight in technical articles written by authorities in a clear and understandable fashion, remembering that all readers are not college professors and mathematicians. Of course, we want the math, but give examples as to how you arrive at the figures.

Now, about the magazine I bought yesterday evening. There was a noticeable improvement over what I was familiar with in 1923. I read the magazine from cover to cover, but most readily absorbed the contents from page 3 (the first text page) to and including page 15. The rest of the magazine held little interest for me.

In regard to the Forum page, I heartily concur with Mr. P. B. Kehoe, Mr. La Verne Scheffler, Mr. F. C. Rotger, also Mr. E. L. Sievers, in the comments they make. I think the gravest mistake any magazine could make is the omission of values, the publication of incomplete diagrams and lack of detail.

As an example of this, in the July 18th issue I refer you to Fig. 2, page 8. There is no B minus connection in this diagram.

I would experiment and try connecting it to A plus or A minus, but I would feel surer were it printed on the diagram.

Now, again, refer to Fig. 936, page 15. This circuit is conspicuous for its lack of values. Not only that, but there are a couple of details that might be added or explained to make the circuit diagram more understandable.

Again, the article by J. E. Anderson and Herman Bernard, entitled "Short Wave Circuits," was good in every way except that there is an entire lack of information in the text regarding the coil shown in Fig. 10. This looks as if it might be something good, but there is no comment made about its use in a circuit, how it works, etc. The coil really should be shown in a complete circuit with magnified details of the coil.

A thorough comment should be made in the text regarding each figure or diagram submitted, and each diagram should be complete in every detail, with values stated, inductance couplings indicated, gang control, shielding, and what not. I believe it a good idea to show inductances in the relative positions they occupy on the form and by all means the number of turns, size and kind of wire, diameter of coil and the value of the condenser used with said coil, should all be shown or explained in any text. The problem of LC ratio is not a simple one to the average radio man.

Now, laying aside all comment that has gone before, I hereby apply for membership in the Short Wave Club. By the way, give us lots more dope on short waves; the construction of all types of receivers, circuits, theory, etc.

I shall continue to buy a few more copies of Radio World but hope to see an improvement. If I do, I shall gladly subscribe.

Trusting that this letter serves to point out ways and means whereby your magazine may be improved and hoping that some of these suggestions be given due consideration.

Edward W. Bayard, E.E., R.E.,
743 Heights Boulevard,
Houston, Texas.

Sparkles

By Alice Remsen

The Long-Suffering Dial

TURN the dial, turn the dial, turn the dial sadly,
List to the singers who're singing so badly.
Twirl the dial, whirl the dial, hurl the dial madly,
List to the singers they're singing so badly.
Hear the soprano go flat on high "C"!
And mark well the basso who fumbles his "G"!
Turn to the right and the fiddles need tuning,
Dial to the left and the crooners are crooning.

Turn the dial, turn the dial, turn the dial sadly,
Twirl the dial, whirl the dial, hurl the dial madly!
Just wait a moment—it's not goin' to hurt you.
Patience is really your most needed virtue.
You'll hear some music that's surely worth while,
If only you'll just keep on turning the dial.
So turn the dial, turn the dial, turn the dial gladly.
You'll find that some stations are not doing badly.

* * *

A **CROONERS' CONVENTION** was held up at Irving Berlin's one afternoon recently; at least it seemed so—for there met in Georgie Joy's office: Little Jack Little, dressed for hot weather a la Mark Twain, in a smartly cut white linen suit; Whispering Jack Smith, tall and broad-shouldered, sporting a perfectly stunning tie; Mildred Hunt, looking lovely, as usual, now in a blue linen suit and panama hat; escorting Mildred was the handsome tenor, Charles Cannefax, resplendent in navy blue and white. The occasion?—Oh, yes, I almost forgot—we were all there to rehearse Berlin's latest songs, "Begging for Love" and "Me," two corking tunes, very croonable, and sure to be heard plenty over the air-waves this season.

* * *

WELCOME LEWIS IS DOING splendidly on her new program with Harry Salter's orchestra. I always knew she would if she got the right chance. Little Welcome is the whole thing, singing in her own inimitable style and talking, too. She is the new Coty Melody Girl on WABC every Thursday evening at 9:15, a fifteen minute program during which there isn't a dull moment.

* * *

IF YOU'RE FOND OF THRILLS listen to the Eno Crime Club over WABC on Mondays and Wednesdays. Murder, mystery and other malign manoeuvres will reward you. The Witches' Tale on Mondays over WOR will also help to make your hair stand up straight.

* * *

BIOGRAPHICAL BREVITIES

Landt Trio and White

DAN, Karl and Jack Landt and their piano accompanist, Howard White, were born in Scranton, Pa. A few years ago they were singing for the fun of it at social gatherings in their native town. Dan at that time was a house painter, Karl taught chemistry in the public schools and the kid, Jack, had just entered high school. The folks in Scranton who had heard them sing told them that they were good, and it was not long before the brothers joined forces and started to sing for a thrilling sum over the local Scranton stations, WGBI and WQAN.

There they met Howard White, who ran a bakery and had picked up piano playing during odd moments. White couldn't read a note of music and still can't. He plays from memory in a most unorthodox fashion, getting an unusual instrumental effect that blends well with the voices of the Landt Trio, playing for the most part in a minor key, improvising the bass notes.

"I hit the black keys most of the time," is the way he explains it.

Shortly after the Landt brothers took on White as their accompanist they decided to leave for the Big Town where it is harder and easier (sometimes) to crash the gates of popularity than in any other city in the world.

The very first day they arrived in New York they were given an audition by the National Broadcasting Company. It happened that a commercial buyer of radio time was in the control room. He liked them and signed them up.

The boys made an instantaneous hit with the radio public and have stayed that way ever since; in fact, their morning program "On the 8:15" is one of the best-liked features on the network.

The Landt Trio and White are one of the hardest working groups in radio. Every morning they are up at 5 o'clock and are at the NBC studios at 6:45. They rehearse their morning fifteen-minute program for an hour and, after they come off the air at 8:30, they return home to Jackson Heights, Long Island City, and go over the latest songs, arranging them for harmony in their own unusual style.

The three brothers live with their parents and sister. White also makes his home with them.

Dan Landt, the eldest of the brothers, is 29 years old. Karl is 21 and Jack is just 18. Howard White is 28 years old. None of the quartet is married, although their fan mail contains hundreds of mash notes each week. And let me tell you, young ladies, they are four fine boys, good looking, smart dressers, slim and healthy, with merry laughing personalities and thousands of friends both on and off the air.

* * *

Sundry Suggestions for Week of August 9

Ruth Etting and Dave Rubinoff
WEAF.. 8:00 p. m. Aug. 9
Choir Invisible
WOR .. 9:00 p. m. Aug. 9
Toscha Seidel
WABC.. 3:00 p. m. Aug. 9
Lanny Ross WEAF..12:00 noon Aug. 10
WOR Minstrels
WOR .. 8:00 p. m. Aug. 11
Vee Lawnhurst and Muriel Pollock
WJZ .. 7:15 p. m. Aug. 12
Footlight Echoes
WOR .. 9:30 p. m. Aug. 12
John Charles Thomas
WJZ .. 9:30 p. m. Aug. 13
Little Symphony
WOR .. 9:00 p. m. Aug. 14
Alice Remsen
WOR ..10:00 p. m. Aug. 15

* * *

[**If you would like** to know something of your favorite radio artists and announcers, drop a card to the conductor of this column. Address her, Miss Alice Remsen, Radio World, 145 West 45th Street, New York, N. Y.]

BEARDS GROWN ON NOTABLES IN VISION DEBUT

In preparation for the advent of television on a commercial basis, the Columbia Broadcasting System has instituted a regular service from W2XAB, New York City, with the avowed idea, however, that it is strictly experimental. The purpose is to gain empirical knowledge of the difficulties and problems, so that proper solution may be applied.

Thus Columbia follows its rival chain, of the National Broadcasting Company, which has a few experimental television transmitters in operation, and is planning more, one of them atop the Chrysler Building, in New York City, affording the highest aerial in the world, measured from the ground.

Moustache and Beards

The opening of Columbia's service was marked by the appearance of stage, screen and political notables, including Mayor James J. Walker, Guy Lombardo, the orchestra leader, and Natalie Towers, Columbia's "television girl."

It has become the practice to select a girl who seems to have the necessary coloration, acting ability and good looks to provide interesting pictures. Dorothy Knapp is National's television girl in the East, and Ann Sawyer on the Pacific Coast.

On the opening night those who tuned in the short wave carrying the television noticed that Mayor Walker appeared to have a moustache, while Lombardo and, above all, Miss Towers, seemed to have a beard. This added a touch of merriment to the proceedings, and as the event was one of joviality, nobody's feelings were hurt. The only sad part about it was that both the Mayor and Lombardo had recently emerged from the barber's chair, which only heightened the comical injustice, while the effect on Miss Towers is beyond comment.

Lightning Plays Havoc

A thunderstorm, with attendant static, marked the first transmission. Such conditions work havoc with television fidelity, and to them are ascribed the freak results of bearded lady and ill-kempt gentlemen. However, still pictures of these and other principals before the microphone, for audible component on WABC's broadcast wave, and before the photo-electric cells for television pickup for short-wave transmission, confirm the fact that the beards and moustache were the work of diabolical nature, and not mortal man or woman. Also the Mayor's beard had no political significence, since it was truly accidental.

Besides, the station holds all three personages in high esteem. No, it was the storm. Magnetic disturbances, due to sunspot activity even when the sun is down, or to stormy electrical charges playing pranks, are stock reasons for such informalities. It is not a contest to determine how funny a face the television control operator can confer on a station's honored guests.

Rapid Progress Expected

E. K. Cohen, W2XAB's techincal director, aside from mustache and beards, said that television today is to be compared to the phonograph in 1910, the moving pictures in 1905 and radio itself in 1920. He prophesied that television will advance with at least equal rapidity, so that outdoor scenes on a grand scale will be reproductible in the home, finally in colors. He said 1932 holds great promise for television.

W2XAB uses 500 watts, on 2,750 to 2,850 kc (109 to 105.2 meters), 60 lines per frame.

Cells Blamed for Whiskers

The beard-growing tendency of television transmission has been experienced from the start, and experiments are being conducted to devise a means of overcoming this defect.

Not only beards, but freckles and other splotches have been improvised by the tricky television system.

One explanation given of this phenomenon is that the photo-electric cells used are of the potassium type, sensitive particularly to the blue end of the color spectrum, and not sensitive to red. Hence a bluish shadow, offset by red, reproduces as an "ornament."

The result of this characteristic of the potassium cell, it is said, has been dark splotches and a tendency to fasten a beard on the subject.

Caesium cells are very sensitive to red and somewhat sensitive to blue, so schemes are being worked out to use the two types in combination, with a proper proportion of the number of cells, to establish relative equality of sensitivity.

SERVICE MEN'S INSTITUTE NEAR

Following several local attempts by others to found and perpetuate organizations of radio service men, a group of workers in the field has inaugurated a national body, the Institute of Radio Service Men, with headquarters at 400 West Madison Street, Chicago, patterned after the Institute of Radio Engineers.

The service man's institute has the indorsement of several large manufacturers of radio sets, who recognize the advantage of a national body, so that high standards of capability may be atttained in servicing radio receivers. Service work is of great importance to the manufacturers, who at present are largely using authorized service bureaus, although there are many independent service men in this country.

The central bureau is intended to serve as a clearing house for the problems of the service man, so that both information and questions may be sent in. It is intended to publish a periodical, similar to "Proceedings" of the Institute of Radio Engineers, but with the prime intention of dealing with service problems, rather than design factors.

Diagrams of commercial receivers are to be printed, also expositions of the most common troubles found in particular receivers, and methods of remedying these. Papers will be read at meetings, and these papers are to constitute, to some extent, the contents of the periodical, although papers not delivered as talks also will be printed, as is the case with "Proceedings.'

The official beginning of the Institute of Radio Service Men will be staged in conjunction with the Radio-Electrical World's Fair, at Madison Square Garden, New York City, September 21st to 26th, inclusive. At the public show in Chicago, in October, the activities will be further promulgated, and somewhat later it is planned to hold a convention, when details will be discussed regarding the establishing of chapters in various cities.

LEEDS MAKES AMATEUR BID

Leeds, 45 Vesey Street, makes a showing with parts for amateurs to use in their short-wave transmission and reception. The company has a listening monitor, a dust-proof crystal holder, a 50 watt socket, a short-wave receiver and copper coils of very thick wire diameter.

WORK STARTED ON RADIO CITY; JOBS FOR MANY

Radio City, the largest building project in the world's history, is now in the process of construction. This time constructive beginning really means destruction, as the first work is digging, and there will be plenty of that. Eight steam shovels made their welcome appearance, with a hundred trucks and 300 men, at the site bounded by Fifth and Sixth Avenues, between Forty-eighth and Fiftieth Streets, New York City.

It is a $250,000,000 project and it is expected that in three months work will be completed, so that the 31-story office building, the International Music Hall (world's largest theatre), a 66-story skyscraper with the largest floor space of any building on earth, a sound picture theatre and the statuesque plaza will be ready for a truly grand opening.

Work for 25,000

John D. Rockefeller, Jr., through corporations he controls, is financing the project, which, it is expected, will give work to 5,000 men when in full swing, their activity centered right on the site, and to 20,000 other persons because of the labor involved in furnishing the steel, bricks, woodwork, metalwork and other materials and fixtures.

The west side of the site, between Fiftieth and Fifty-first Streets, is being worked first, where the 31-story office building will be erected. Radio-Keith-Orpheum will occupy much of the space in this building.

The record International Music Hall, seating capacity 6,500, will be beside the office building, while between Forty-ninth and Fiftieth Streets, on the west, the skyscraper will raise its 2,250,000 square feet of beautiful bulk.

Radio Activities

The National Broadcasting Company and the Radio Corporation of America will occupy the first twelve floors of this immense structure. The broadcasting company's executive offices, studios and technical plant, will be there, including elaborate television transmission facilities, as the company expects that next year television will be ready for the public. The broadcasting, television and photophone work will be done in a wing of the main structure.

Todd, Robertson, Todd Engineering Corporation and Todd & Brown, Inc., have charge of the work, while the architects are Reinhardt & Hoffmeister, also Corbett, Harrison & MacMurray, and Hodd & Foulhoux.

Baldwin in Person Is Making Earphones

Nathanial Baldwin personally has taken over the equipment heretofore used by Nathaniel Baldwin, Inc., in the manufacture of headphones, and also unassembled parts and unused materials.

"The increasing demand for the headphones, and particularly for instruments giving faithful sound reproduction, promise continuation of this business in a substantial way," he says. "I expect to improve the headset in every way possible, and to guarantee the instruments against defective material and workmanship, repairing or replacing any instruments free of charge which may be defective in any way in which the manufacturer is responsible."

He is located at 3477 South Twenty-third East, Salt Lake City, Utah.

BOARD RULE BY "ONE MAN" PUT TO COURT TEST

Washington.

WENR, WLS and WGN, all of Chicago, have appealed to the District of Columbia Court of Appeals from a recent decision of the Federal Radio Commission involving license renewals.

The Commission renewed the licenses of WENR and WLS pending determination of the case of WTMJ, Milwaukee, which has asked permission to operate on 870 kc, which is now used by the two cited Chicago stations. The license of WGN was renewed under similar conditions pending the outcome of the case of WCFL, also of Chicago, which has asked to operate on 720 kc, which is now used by WGN.

The appellant stations contend that the conditions imposed by the Commission would deprive them in advance of any right to operate on their present frequencies after the Commission has rendered its decision in case the decision is adverse to the appellants. They also claim that the decision "deprives them of liberty and property" and "takes private property without just compensation," and complain that no notice or hearing was given or hearing held, and the action is void for want of a quorum, as, in fact, only one Commissioner acted, the others even being out of the city at the time.

Replogle Heads DeForest Engineering Staff

The DeForest Radio Company, of Passaic, N. J., announces the appointment of D. E. Replogle as chief engineer. For the past two years Mr. Replogle has been assistant to the president of the Jenkins Television Corporation, and full charge of the engineering and production activities of that organization. Prior to that period he was identified with the Raytheon Manufacturing Corporation, heading its licensee engineering service and much of the research work. He will continue to guide the engineering activities of the Jenkins Television Corporation, whose products are manufactured by the DeForest Radio Company.

Pilot Universal Set

Pilot Radio & Tube Corporation, Lawrence, Mass., is stressing its all-wave Universal receiver, which uses cams for inductance changing, and thus avoids plug-in coils. The receiver is of the table model type. A kit of parts may be obtained if preferred.

JENKINS FOR TELEVISION

Jenkins Television Corporation, Passaic, N. J., has a television receiver, also obtainable in kit form, and all the necessary television adjuncts, including photo-electric cells, neon lamps, scanning discs, magnifiers, etc.

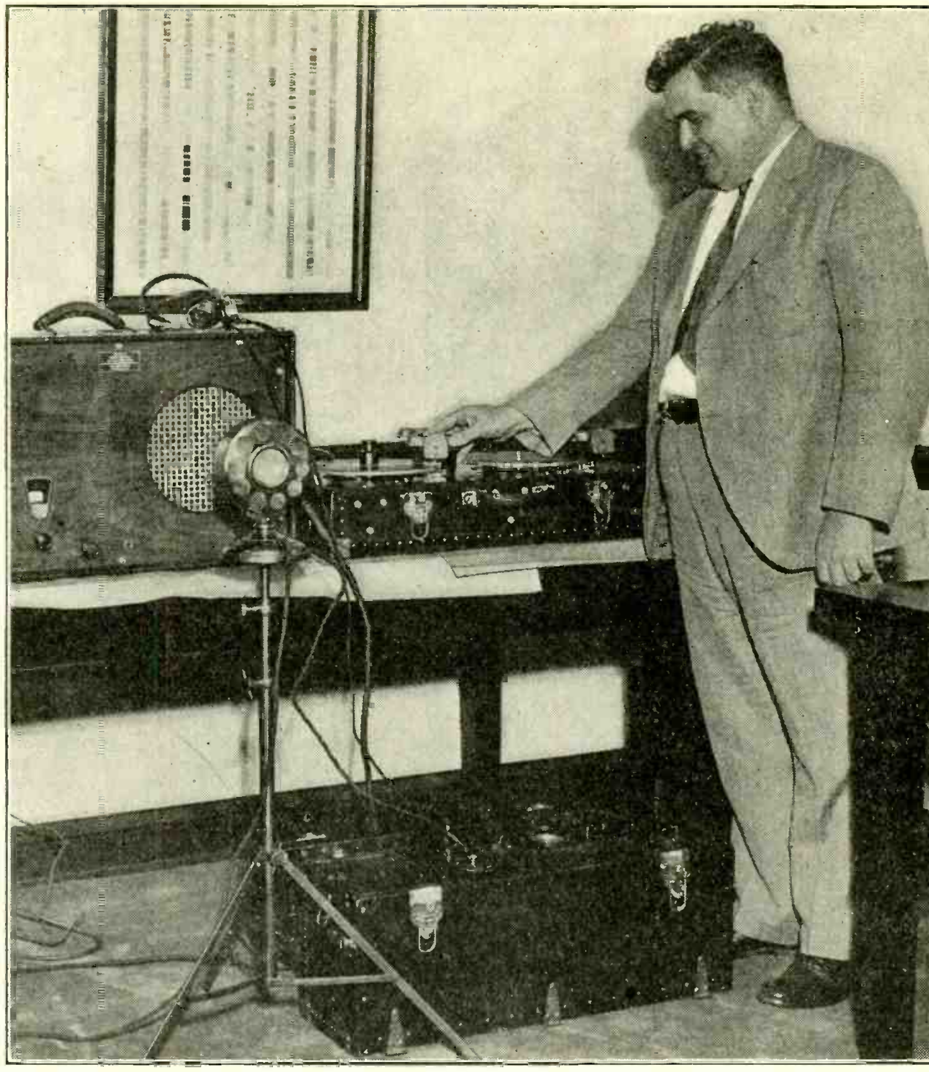
INSULINE'S SET

Insuline Corporation of America, 80 Cortlandt Street, New York City, has a short-wave receiver, also a television kit.

TELEVISION RECEIVER

A television receiver kit is marketed by Radiotechnic Laboratories, Inc., 1271 Bedford Avenue, Brooklyn, N. Y.

"RECORDING DETECTIVE" IS DEMONSTRATED



(*Acme Newspictures, Inc.*)

Apparatus designed by RCA Photophone and built for it by RCA-Victor, so that broadcasting station programs may be recorded as evidence of the type of program transmitted, is being worked by Dr. C. B. Jolliffe, chief engineer of the Federal Radio Commission. The records will be used as evidence at hearings on license renewals. The station is tuned in with the set (top left) while a microphone picks up the program and delivers it to an audio amplifier (on floor) that feeds the recording heads on the twin turntable.

TELEVISION PARTS

Arthur M. Pohl, 3541 Michigan Avenue, Detroit, Mich., announces television discs at very moderate prices. These discs are obtainable for reception of all the types of television transmission on the air. There are two main types, flexible cardboard and aluminum. If preferred, the discs are obtainable undrilled. The standard shaft on motors accommodates the discs when a cast aluminum hub is used. Also, neon lamps are supplied.

CONVERTER FOR SG SETS

Radio Constructors Company, 357 Twelfth Street, Oakland, Calif., has a short-wave converter for "short waves on any screen grid receiver." It is of the midget type, in a cabinet, without plug-in coils, and contains its own power supply. The tubes are one 224, two 227 and one 280. The company also has a short-wave receiver.

10-TUBE SHORT-WAVE SET

H. M. Kipp Co., Ltd., 447 Yonge Street, Toronto, Ontario, Canada, has an all-wave set, 9 to 190 meters on short waves, 190 to 5,000 meters, for broadcast and code reception. There are four stages of r-f and two stages of a-f, the total number of tubes being ten. Plug-in coils are used.

DELFT IN SHORT WAVES

Delft, 524 Fairbanks Avenue, Oakland, Calif., features a coil-winding kit, an all-electric short-wave receiver kit, a short-wave portable receiver kit, a short-wave wavemeter, and a short-wave transmitter, besides short-wave coils.

BAIRD RECEIVERS

Baird Television receivers are made by the Short Wave and Television Corporation 70 Brookline Avenue, Boston, Mass. A kit is obtainable if preferred. Plug-in coils also are made by this company.

WE'RE DELIGHTED—AND ENCOURAGED!

A recent survey of Radio World's subscription orders for ten weeks from May 2nd to July 3rd, 1931, proved that the amount paid by new and old subscribers during those ten weeks was 15.9% more than was paid during the corresponding period of 1930.

We're going to try and increase this percentage for the whole year—and know full well that this can be accomplished only by turning out a paper that gives the service expected by a particular and ever-growing radio public.

THE PUBLISHERS.

Thrill Box in New Improved Form

Improved in appearance and operation, with coils available making the wave coverage from 9 to 850 meters, the National Thrill Box, using variable mu tubes, provides better performance than ever. This circuit was a sensation when it was first introduced to the public, more than a year ago. Amateurs, airplane companies, home set-builders and short-wave fans generally recognized it as one of the outstanding short-wave devices. Its record of foreign reception is exceptional.

Clearer reception is provided in Summer on short waves, as a rule, than on broadcast waves, and since large chains are sending out their programs on short waves there is the added advantage of having a short-wave set for regular feature program reception.

Single tuning control is employed, the spread of frequencies is wide for each band covered by the particular coil used, while the audio channel is a fine one, with push-pull output.

The AC model provides utterly humless operation, and is obtainable in two types, either with 227 push-pull or, in a special model for extra volume, with 245s in push-pull.

"Handbook of Short-Wave Radio," published by the National Company, 61 Sherman Street, Malden, Mass. (50c.), tells a great deal about the constructional side of short waves, and deals not only with the Thrill Box, but with many other and different circuits, as well as treating of the phenomena of short-wave reception.

A free bulletin on Thrill Box, short-wave parts, etc., is obtainable. Ask for Bulletin No. 146-W and mention RADIO WORLD.

Hammarlund Offers Short-Wave Condensers

Hammarlund Mfg. Co., 424 West Thirty-third Street, New York City, has added the junior midline condenser to its list of parts for sale through jobbing channels. Formerly this item was sold only to manufacturers. Because of its extremely small size it is in high vogue right now, besides, the workmanship is of Hammarlund's well-recognized precision type. The total plate swing is inside a 2-inch diameter. The condenser comes in various capacities, from extremely tiny ones up to .00035 mfd. Short-wave converters and other devices use this condenser.

Besides, Hammarlund has radio frequency chokes and air-wound plug-in coils for short waves.

Soon, it is hoped, details will be announced of the latest addition to the Hammarlund products, an all-wave superheterodyne. This receiver has been in the works for nearly a year, which goes to show how much time and care have been devoted to its perfection prior to offering it to the public.

TRAUL FEATURES ULTRADYNE

Traul Radio, 1075 Atlantic Avenue, Brooklyn, N. Y., has the parts for the all-wave Ultradyne, embodying the well-known principle of superheterodyne operation used by Robert E. Lacault, who died last year. The design work was almost completed when he died and it was carried to completion by competent engineers.

BLAN ACTIVE IN TELEVISION

Blan the Radio Man, 89 Cortlandt Street, New York City, is specializing on television parts. He features Samson short-wave condenser, a balanced resistance coupled audio amplifier and short-wave plug-in coils of the tube base variety.

Polo Has All-Wave Midget Receiver

Polo's newest product, the AW-5, an all-wave midget receiver.

One of the first manufacturers to come out with an all-wave midget set is Polo Engineering Laboratories, of 125 West Forty-fifth Street, New York City. The set is sold complete with five tubes, all ready to operate. The tubes are one 235 variable mu, one 224 screen grid, one 227, one 247 pentode and one 280 rectifier.

The speaker is housed in the Gothic cabinet, along with the chassis. The parts used are of expert manufacture, and include a National modernistic dial. The wave band selection is made by means of a rotary switch on the front panel. This switch is of the four-point double throw type, actuating two tuned circuits at once. A trimming condenser, manually operated, and a volume control with AC switch attached, account for the other knobs.

Repeated tests of this midget, known as the AW-5, have proved that it is a dependable and practical circuit, giving excellent broadcast reception, as well as short-wave coverage from 15 to 200 meters. There is enough frequency overlap between respective settings of the switch to insure full coverage. "There is no missout," stated Gus Eklund, chief engineer of the Laboratories, "for I took exceptional pains to see that the full coverage feature was included."

Audio sensitivity and good tone are accomplished by using a select audio channel and a dynamic speaker. The field coil of this speaker is used as the B supply choke. The filter capacities exceed 18 mfd.

The circuit has been carefully engineered. The set was tested in RADIO WORLD's laboratory and found to be very excellent. The ease of control was particularly gratifying, in view of the sensitivity developed.

Polo also is featuring its improved short-wave converter, the new DX-4, using two variable mu tubes (235), one 224 and one 227. This converter, when connected to a broadcast set, brings in short waves. The use of plug-in coils is retained in this model short-wave converter. There are a new modernistic cabinet and a new layout of parts, with improved performance, in the DX-4.

WOOD SUPERSONIC CONVERTER

Manson Wood & Co., Wakefield, Mass., is producing the Wood Supersonic Short-Wave Converter, using four tubes: two 224, one 227 and a rectifier, built in a good-looking oblong cabinet. A switch controls wave band changing, so there are no plug-in coils.

REL RECEIVER

Radio Engineering Laboratories, 100 Wilbur Avenue, Long Island City, N. Y., has a short-wave receiver for amateurs particularly.

Intermediate Coils for Short Waves

Intermediate frequency transformers, peaked at 450 kc, and highly suitable for intermediate amplifiers to be used with short-wave superheterodynes, are manufactured by Supertone Products Corporation, which has just moved into two buildings that it exclusively occupies at 27 to 35 Hooper Street, Brooklyn, N. Y. These transformers are in aluminum shields, with screw cap, and may be mounted either perpendicularly or horizontally, with the two condensers for frequency matching easily accessible. High inductance honeycomb choke coils are used, with primary and secondary tuned, as the transformers are intended to work out of screen grid tubes, finally into any type of second detector. The transformers afford high gain with as high a selectivity as tonal considerations permit. The high inductive reactance accounts largely for the extra gain.

In the same type shield Supertone manufactures intermediate transformers peaked at 175 kc, which may be used by home constructors, or by service men for replacement of transformers in factory-made supers, because the shield is small, being 2½ inches in diameter and 2¾ inches high.

Precision workmanship characterizes the transformers.

A table of short-wave stations, arranged on the basis of their hours on the air, in Eastern, Central, Mountain and Pacific Time, is obtainable from the corporation on application. Address Supertone Products Corporation, 27 to 35 Hooper Street, Brooklyn, N. Y., and ask for Table W. Mention RADIO WORLD.

Low Loss Coils

A short-wave coil is manufactured by Transcontinental Coil, Inc., 50 Church Street, New York City. Low loss and mechanical strength are claimed. There are coils for the following bands; 10 meters, 20 meters, 40 meters, 80 meters, 160 meters and broadcast. The capacity to use is .00014 mfd. However, if .0005 mfd. is used with the 160 meter coil, the broadcast band will be covered. Otherwise with .00014 mfd., the broadcast band is then split between two coils.

INTERNATIONAL DUO

The International Radio Corporation, Fourth and William Streets, Ann Arbor, Mich., has brought out the International Duo, a midget all-wave receiver. The company debated the manufacture of a converter or a receiver and decided on the receiver. There are two dials on the front panel, one to be used for short waves, the other for the broadcast band. A front panel switch takes care of band changing.

HY-7 SHORT-WAVE SET

Hatry & Young, 119 Ann Street, Hartford, Conn., noted individually as amateurs, and now radio trade personalities and magazine publishers, have the HY-7, an assembled but unwired kit, to constitute a short-wave receiver. National parts are used for the tuning adjunct and in some other places.

COLORED PLUG-IN COILS

Four coils of the tube base plug-in type, with different colored bakelite to distinguish them, are sold by Radio Trading Company, 25 West Broadway, for use with .0001 mfd. to cover from 15 to 210 meters. The receptable is a UX socket.

"EXPLORER" CONVERTER

"The Explorer" is the name of the plugless short-wave converter manufactured by Radio Mfg. Co., 695 Grand Street, Brooklyn, N. Y. Two tubes are used. Band selection is by front panel knob switch.

RESISTORS
and Mountings

Plate Circuit

0.25 meg. (250,000 ohms) Brach resistor, for all screen grid tubes. Order Cat. BRA-25, at....12c
0.1 meg. (100,000 ohms) Brach resistor for all except screen grid tubes. Order Cat. BRA-10, at 12c

Grid Circuit

1.0 meg. Brach resistor for grid leak. Order Cat. BRA-100 at....................12c
2.0 meg. Brach resistor for grid leak. Order Cat. BRA-100, at....................12c
Carborundum grid leak for highest detector sensitivity. The leaks are marked "5 to 7 meg," because values in this range are present. Order Cat. CAR-57, at....................12c

Biasing Resistors

.005 meg. (5,000 ohms) Brach resistor. Order Cat. BRA-005, at....................13c
.015 meg. (15,000 ohms) Amsco resistor. Order Cat. AMS-15, at....................14c
.025 meg. (25,000 ohms) Amsco resistor. Order Cat. AMS-25, at....................14c
[The above resistors are of the tubular type and require a mounting. Lynch moulded bakelite mountings, Cat. LYM, at....................15c]

Filament Circuits

1-ohm Brach resistor, to afford 5 volts for four ¼ amp. tube when source is 6 volts. Supplied with mounting capacity 2 amps. Order Cat. BRA-1, at 22c
2-ohm Brach resistor, to afford 5 volts when two ¼ amp. tubes are supplied from a 6-volt source. Furnished with mounting; capacity 1 amp. Order Cat. BRA-2, at....................20c
4-ohm Brach resistor, to drop 6 volts to 5 for one ¼ amp. tube. Mounting supplied at this price. Order Cat. BRA-4, at....................18c
30-ohm Brach resistor. To drop 3 volts to 2 volts on 232 and 230 tubes; use two of these resistors in parallel. Order Cat. BRA-30 (mounting supplied); price is for TWO sets at........22c

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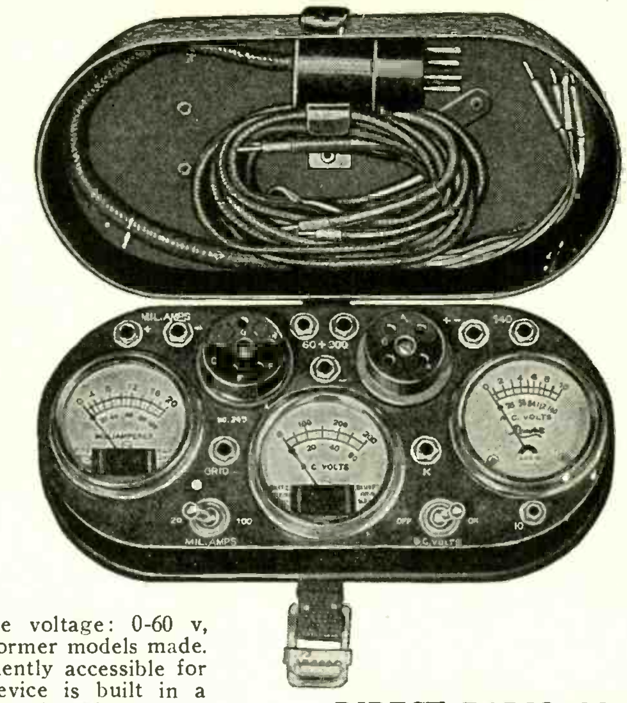

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