Dr. Robinson Explains the Stenode Radiostat

RADIO NEWS

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FEBRUARY
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CENTS

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RADIO NEWS

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Associate Editor

VOL. XII NO. 8

FOR the first time the full technical description and explanation of the theory of operation of the Stenode Radiostat is given by its inventor, Dr. James Robinson, in the article appearing in this issue entitled "Dr. Robinson Explains the Stenode Radiostat."

Last month Dr. Robinson described the highlights of this new system of reception. The present article, therefore constitutes the first wholly technical description of Dr. Robinson's invention.

* * *

THIS month we publish the second installment of Zeh Bouck's exciting narrative of his flight over two continents. Next month, the crack-up!

* * *

MEMBERS of the RADIO NEWS Radio Association will be interested in the announcement of the $100.00 prize contest, details of which appear on page 714 of this issue.

* * *

NEXT month, Beryl B. Bryant, RADIO NEWS Technical Editor, describes the construction of "The Mighty Mite," an extremely compact superheterodyne of midget proportions.

CONTENTS FOR FEBRUARY

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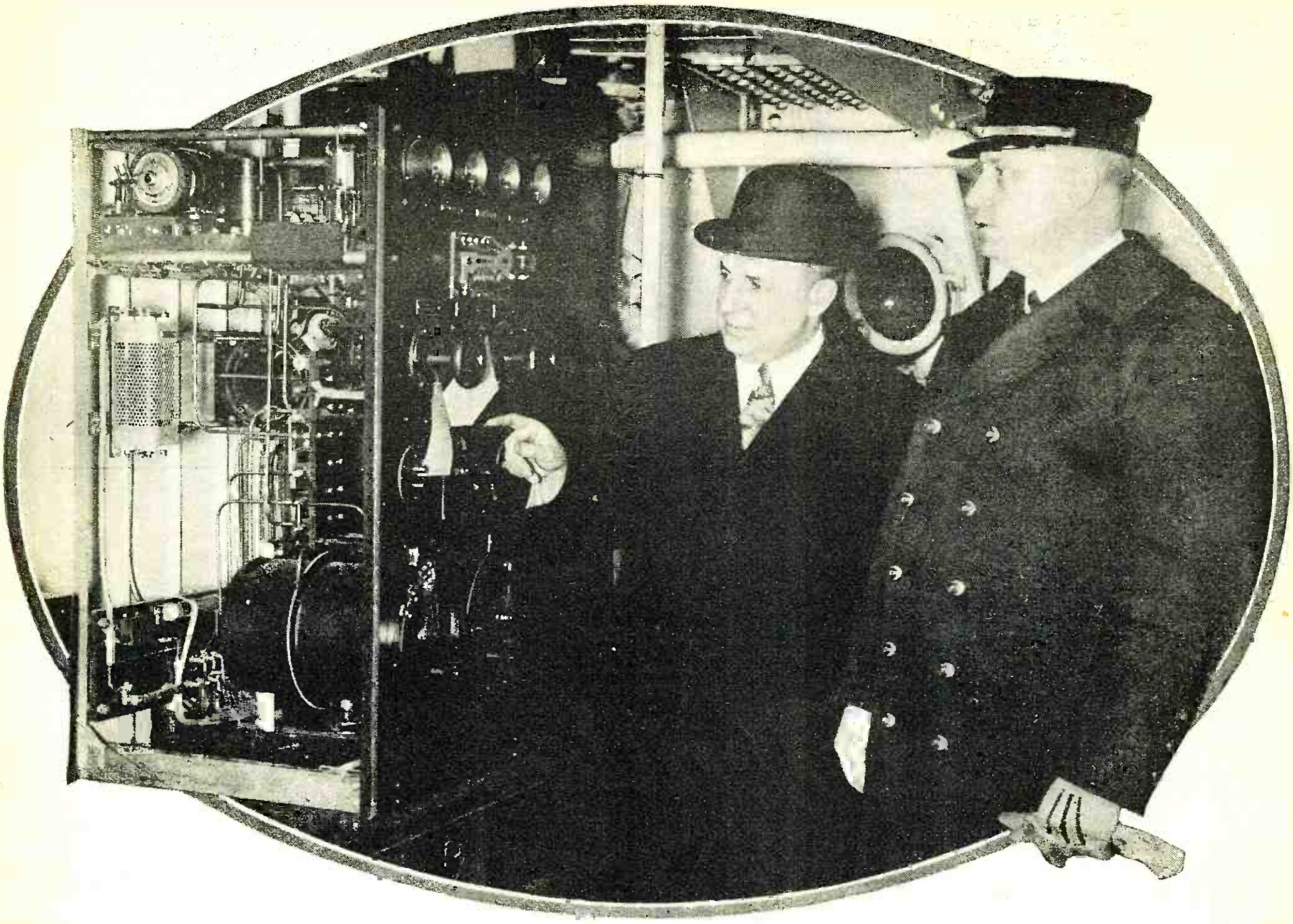
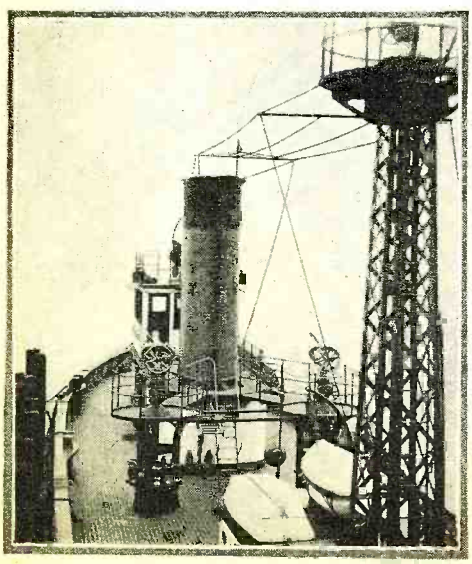
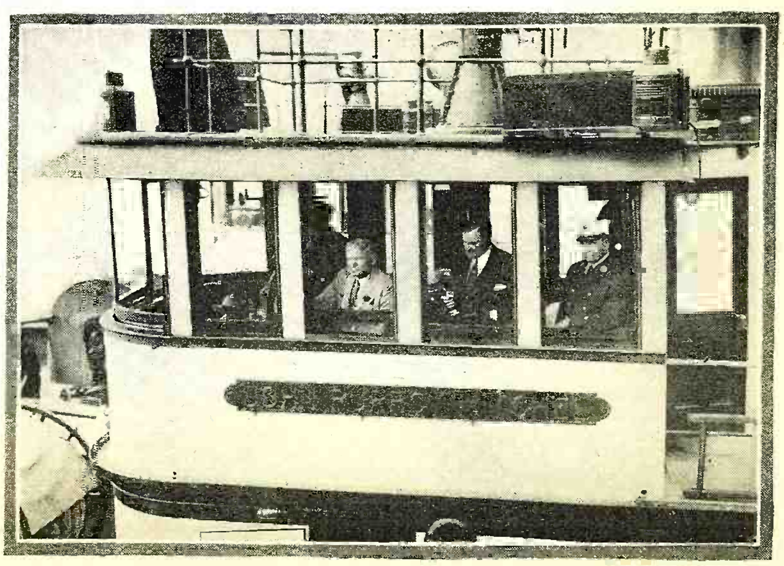


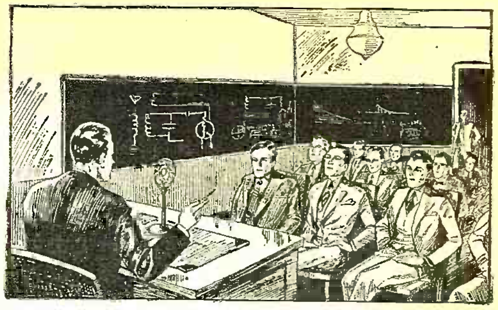
Radio Aids Waterfront Fire Fighting

RADIO has been utilized by Federal and municipal governments for maintaining swift and dependable direction of various emergency services. One of the latest instances is the installation of the Marine Division of the New York Fire Department. Shown above are Albert Goldman, Commissioner of Plants and Structures, and Deputy Chief John J. McElliott, who are looking over the 50-watt W. E. transmitter (WRBE) aboard the Fire Boat *John Purroy Mitchel.* This boat and one other, of the thirteen in active service, are radio equipped. A land station (WCF) of the Department is located at the Battery and has a 400-watt transmitter. The wavelength used is 1,596 kilocycles. The picture below, at the left, shows the position of the antenna aboard the *John Purroy Mitchel.* Below, at the right, are Fire Chief John Kenlon, Fire Commissioner John J. Dorman and Deputy Chief McElliott aboard the *John Purroy Mitchel.*





Have You Joined the Radio News Radio Association?



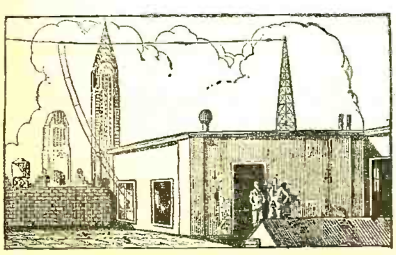
Authorities and leaders in the short-wave field will address gatherings and those listening in, on pertinent technical short-wave subjects

This club has been organized to gather together in a working organization not only amateurs, but the vast army of short-wave broadcast listeners. By means of lectures and code classes, instruction, by way of short waves over the club's transmitter, will be brought to all members. Become a member and get into this thrilling game

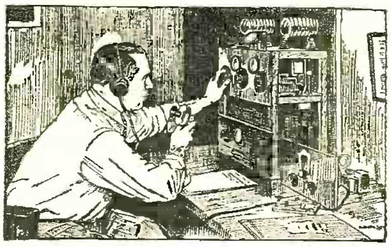
RADIO NEWS magazine believes that there is need of an organization which will enroll the interest of thousands of short-wave fans and be of direct benefit to them. In forming the Radio News Radio Association, with that purpose in view, we are attempting to provide an informal club for the thousands of serious-minded young men who are experimenting with the receiving end of short-wave radio, and, of course, for the transmitting amateurs as well, so that they may get together, personally or on the air, for the exchange of ideas, for a source of technical information and for an organization which will aid in the safeguarding of their interests.

Amateur Activities

Amateur radio activities have been on a steady upward climb ever since this most fascinating work was started some years ago. One organization in particular, the American Radio Relay League, has been instrumental in assisting the rapid development of short-wave radio. It is safe to say that short-wave amateur radio would not be where it is today if it had not been for the guidance and zealous care over short-wave radio of the A. R. R. L. This association has a membership of more than 17,000, and includes practically every transmitting amateur in the country. This number, however, does not begin to include those other thousands of amateurs who are not primarily licensed short-wave operators but who are vitally interested in building better short-wave sets and obtaining better reception over greater distances.



The station and club rooms are located in a four-room pent-house apartment atop a 16-story building in the heart of New York City



At present only a 50-watt outfit, W2RM, is on the air. It works in the 80-meter phone band

See Page 714
for Details of the
$100.00 SHORT-WAVE CONTEST
Open to All Members of the RADIO NEWS Radio Association

It is for both the transmitting amateurs and this latter group of experimenters that RADIO NEWS has formed the Radio News Radio Association.

No Charge for Membership

Membership in the R. N. R. A. is free and open to anyone who is interested in short-wave radio. The only requirement which you must observe is to outline in your application for membership just what you have done in short-wave radio. Tell us if you are an amateur or if merely a s-w broadcast listener, whether you built your set or bought it. If you are neither, but want to learn about this fascinating game then tell us what you intend to do in the way of obtaining a short-wave receiver.

What we have done so far is to prepare the ground work for the organization. Naturally the whole thing can't be completed overnight and as the work of organization goes along we will keep you advised through the pages of the magazine. Our immediate plans include the erection of a 250-watt transmitter and suitable receiving apparatus in our penthouse laboratory. At stated intervals, perhaps twice a month, a local meeting will be held in the club rooms, at which time leaders in the amateur radio field will give technical talks. By means of the transmitter we hope to bring these club activities to the members who, because of residence in places far removed from headquarters, are unable to attend in person.

Ultimately, of course, our aim is by means of a closely co-operating organization to make further advances in the art of short-wave radio, to assist members in becoming capable operators or more experienced technicians and to build up a possible source of trained radio men in the event of a national emergency.

Anyone interested in joining the club merely has to fill out the small information slip printed at the bottom of this page and mail it to the RADIO NEWS Radio Association at 381 Fourth Avenue, New York City.

Mail Coupon for R.N.R.A. Membership

To join the RADIO NEWS Radio Association fill out this information slip and return it to the address indicated. Print the information required in ink.

Name ....

Address................ City.......

Do you own a short-wave receiver?..

What make?.......................

Are you a transmitting amateur?....

What's your call?.................

What kind of a transmitter is used?

....

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Paying $60, $70 to $200 a Week

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H. C. Lewis, Pres. ***Radio Division*** Founded 1899

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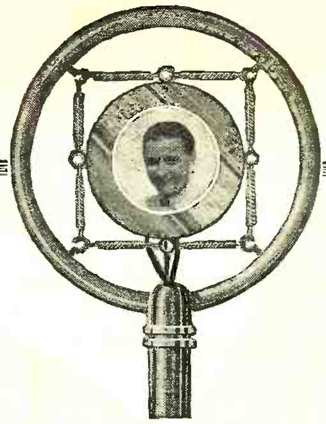


Shall We Have Home Talking Movies?

AMONG the several hundreds of letters which cross our desks each week in the Editorial Department, a great many are addressed to us with a view to finding just how much interest is being manifest in home cinematography and just what is being done to tie up regular home movies with the radio receiver in order to provide home talking movies. In our opinion a great many of the people who are going to be most enthusiastic followers of this new and intriguing hobby will be recruited from that vast group of technicians which took the matter of home-built radio receivers so seriously a few years ago. There are two strong reasons for this belief. First, the doctors, lawyers, financial executives and those in every walk of life who found radio broadcast receiver building such an absorbing pastime have provided themselves with a technical knowledge which is not usually associated with those indulging in a hobby for pastime done heretofore.

After it became possible to purchase a satisfactory broadcast receiver at a very reasonable price, the thrill of accomplishing an extraordinary result by the application of knowledge and mechanical ingenuity acquired through practice was no longer to be had in the radio field. This, of course, did not apply to reception on short waves but most of the experimenters were of the opinion that short-wave reception entailed a study of the telegraph code and until short-wave broadcasting took the important place it has taken in communication, this viewpoint was correct.

Up to a short time ago, there has been little of technical interest which would fill the requirements of serious hobbyists of this nature. The production of home motion pictures, at their best, entails a study of mechanics, optics, illumination and chemistry which is absorbing in the extreme and which fits right into the void which the commercialization of broadcasting has left in its wake.

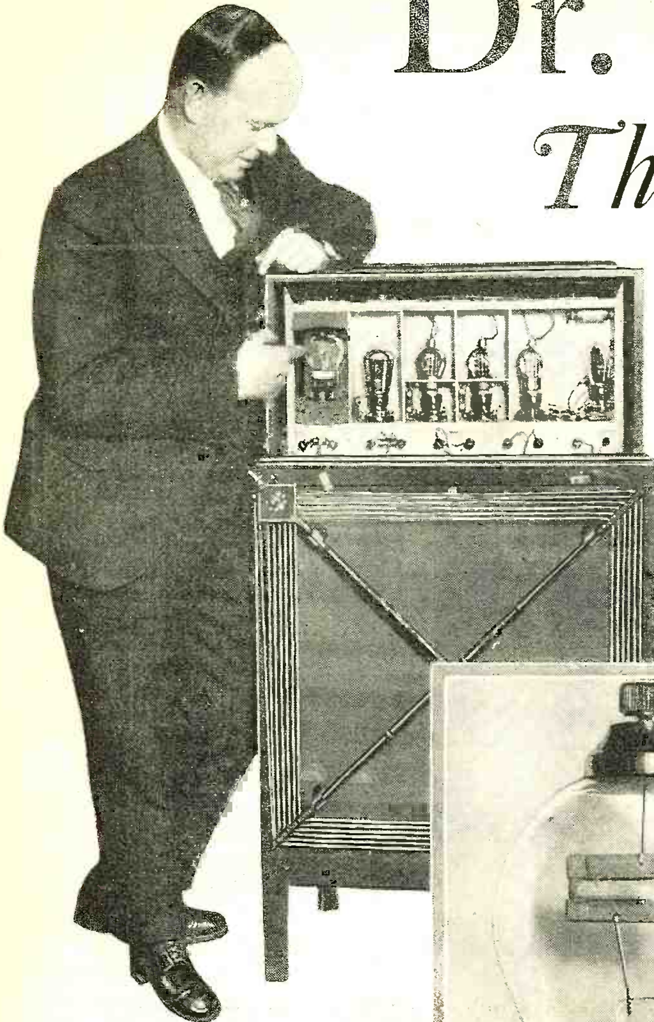
Secondly, most radio hobbyists have become accustomed to spending considerable sums of money in following their hobbies and they have learned to appreciate that although a fair result may be obtained at nominal cost, improvement in the result is usually accompanied by rapidly increasing expense. This is just as true in the field of photography as it is in the field of radio. For instance, a snapshot which would be satisfactory to most people may be secured by using the cheapest kind of camera; a photograph of exactly the same size, but one having the detail demanded by the expert, requires the use of a very much more expensive camera. In the same manner a radio receiver capable of producing tone quality which would satisfy the average ear may be had for a reasonable price but to the trained ear the music produced by such a receiver would not be satisfactory. In order to secure the required degree of tonal fidelity the expert radio man immediately appreciates that considerable expense is involved. The viewpoint of the radio hobbyist is the correct viewpoint for those who contemplate embracing the hobby of motion picture photography. The trained radio man will not expect to secure flickerless home motion pictures with infinite detail if he uses nondescript film, a mediocre camera and a faulty projector with a poor screen. He will recognize the fact that in order to obtain satisfactory results it will be necessary for him to use good film, a good camera, have his developing and printing work done by experts and his projection apparatus and screen of the most efficient type. He will not expect results of this nature from the investment of a pittance.

And with the increasing interest in home cinematography it is but natural to find a similarly increasing interest in home movies with talkie attachments. The tremendous improvement which has been made in the recording and in the reproducing of talking motion pictures in our theatres should indicate very definitely the improvement which the application of intelligence in the field of home talking pictures should bring about within a reasonable time. The study of synchronization, acoustics, compensation in audio amplifiers, and various systems of home recording, will make a most intriguing field for the experimenter.

When it is considered also that nearly all of the technique incorporated in home talking pictures is, to a very large extent, identical with the technique which will have to be mastered with home television, the real significance of our interest in home talking pictures for radio enthusiasts must be apparent.

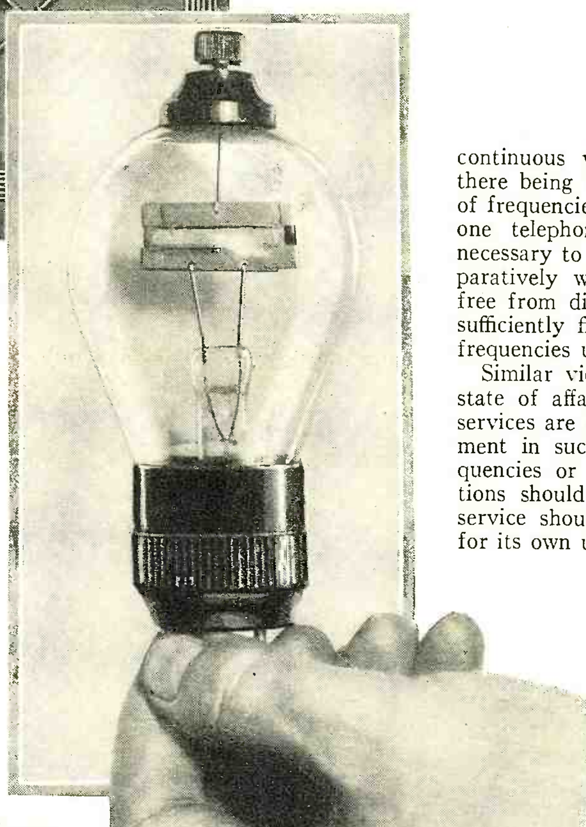
Arthur H. Lynch

Dr. Robinson The Stenode



This is the paper delivered recently Club of America. It is the first full, the principles underlying the theory is also the fifth article published receiver, previous articles having 1930. Others

By Dr. James
D.Sc., Ph.D.,



Above—Dr. Robinson is pointing to the "Quartz Crystal" tube, which is located in the last stage of intermediate-frequency amplification of a regular broadcast superheterodyne. Note the loop attached to the back of the cabinet, for signal pick-up. Below, to the right, is a close-up view of the quartz crystal mounted within an evacuated tube. This crystal is ground to resonate at a frequency of about 100 kc., corresponding to the frequency of the intermediate amplifier

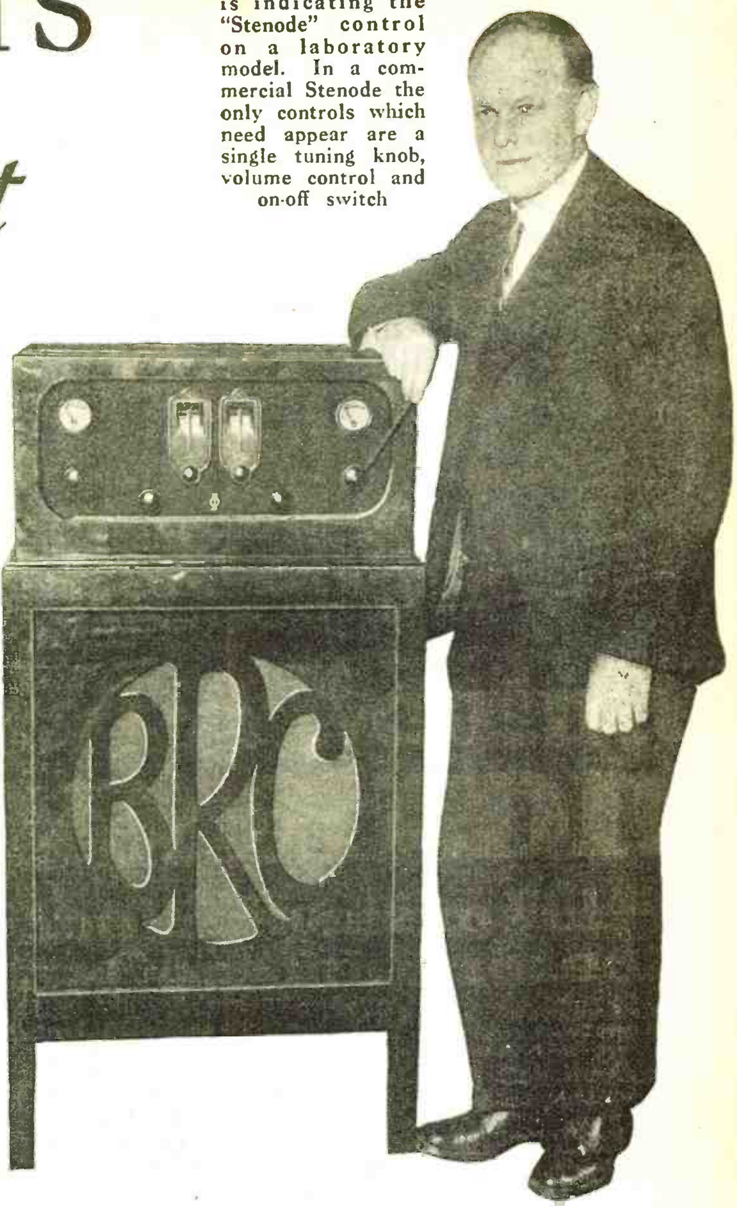
THE Stenode system was conceived as the result of a desire to use the most selective circuits for radio purposes. It has been the constant endeavor of radio engineers and of communication companies to improve selectivity ever since Sir Oliver Lodge introduced the conception of the tuning of circuits. By making circuits more and more selective, it has been possible to increase the number of services which could operate simultaneously, and as the tuning of circuits was improved progress has always been very pronounced as regards such freedom from mutual interference, as well as from general disturbances such as atmospherics.

Since radio telephony became prominent, however, it has been considered that no further advantage would be obtained by increasing the selectivity and, in fact, opinion has been universal that it would be incorrect procedure to do so. The application of Fourier's principles to modulation has shown that when continuous waves were modulated by speech or music, the complicated waves can be resolved into a series of continuous waves of different frequencies, there being thus apparently a large number of frequencies transmitted. Thus, to receive one telephony service, it was considered necessary to receive frequencies over a comparatively wide band, and in order to be free from distortion, the receiver should be sufficiently flatly tuned to receive all these frequencies uniformly.

Similar views apply to telegraphy, and a state of affairs was reached where wireless services are allocated by international agreement in such a way that the Fourier frequencies or side bands of neighboring stations should not overlap. Each telephony service should have 10 kc. allocated solely for its own use. A restriction of this nature obviously places a limit on the use to which radio can be put. Under these conditions the time was soon reached when it was impossible to find a convenient frequency band for any new service.

When there is a complicated modulated wave form, as in the case of speech or music (See Fig. 1), there are many terms of various frequencies up to a maximum of say 5,000 cycles per second. The effect can thus be shown as a series of frequencies extending from n minus 5,000 to n plus 5,000. It is to be remembered that this band changes constantly during the performance of orchestras or during any conversations which are employed to modulate the waves of frequency n and thus what are usually called side bands change as regards the distribution of frequencies and of relative energy in these frequencies, although it can be stated that they are all included in a band whose width is 2_{pm}, where $_{pm}$ is the maximum modulation frequency. It has been assumed, therefore, that as modulated waves can be considered to consist of the transmission of a

Explains Radiostat



Here Dr. Robinson is indicating the "Stenode" control on a laboratory model. In a commercial Stenode the only controls which need appear are a single tuning knob, volume control and on-off switch

by Dr. Robinson before the Radio completely technical description of of operation of the Stenode. It dealing with the Stenode Radiostat appeared monthly since October, will follow

Robinson
M.I.E.E., F.Inst.P.

series of waves extending over a comparatively wide band, it is necessary to receive in an equal manner each of these various frequencies and thus a limit has been placed on the selectivity of receiving circuits. It has been considered essential to have a receiver with a resonance curve which is sensibly flat over this wide range of frequencies, normally 10,000 cycles for broadcasting.

It appeared to me to be of importance to investigate whether the generally accepted deductions from the Fourier theories were of universal application in radio and the first aspect to be studied was whether the restriction on selectivity hitherto regarded as indispensable need necessarily apply.

The universally accepted opinion was that if we employ a receiver with a resonance curve whose effective width is smaller than the frequency range of the side bands, we should be, in popular phraseology, "cutting off the upper side bands." If a receiver with an effective width less than 100 cycles were employed, the foregoing common expression obviously implied that we should eliminate all the side bands of music and speech and leave practically only the pure continuous wave component. Something was wrong in this generally accepted view, because if one considered a very selective receiver such as one employing a quartz crystal to be acted upon by waves of its own frequency, this crystal would build up to a steady state when the waves were of continuous wave form. It is obvious that if a transmitter were keyed at a very slow rate, we should obtain the complete response of the quartz crystal to the transmission, and if the rate of transmission were one signal per second, we should obtain the rise and fall of the response. If the frequency of signalling increased there would still be change of response, but yet general radio opinion stated that if the signalling speed was at the rate of 5,000 signals per second, there would be no change in the response as the upper side bands would be cut off. There can be no discontinuity in the nature of the physical response as we go from a signalling speed of one per second to 5,000 per second, and it is thus essential to examine the whole phenomenon from an entirely different point of view.

Let us consider a resonant circuit which can be obtained in three different conditions as regards the logarithmic decrement, the remaining conditions being constant. Fig. 2A shows resonance curves for these three conditions, the resonance curve A relating to the case of the highest damping and C to that of the lowest damping. We shall examine these conditions by plotting the rate of rise of the oscillations which arrive at the circuits. This is shown in Fig. 2B where we plot the amplitude of the oscillations in the circuit against the time when continuous waves arrive. We find that for the curve A the oscillations build up to a comparatively low steady state, whereas in the case of low damping, C, a large steady state is

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IT is difficult to draw attention to the many excellent features of the Stenode Radiostat system and do it full justice. One feature which is of extreme importance, however, is that its selectivity characteristic is not limited even by the modulation of a closely adjacent carrier, due to the fact that, as Dr. Robinson points out, the modulation interference is attenuated on the same order of the selectivity response of the Stenode. For instance, assuming that the present-day Stenode is tuned to a frequency of 1,000,000 cycles, the beating of this frequency with a second fundamental frequency of 1,001,000 cycles would result in a highly audible 1,000-cycle note. However, if this frequency of 1,001,000 cycles is obtained by modulating a carrier of 1,005,000 cycles with a modulation frequency of 4,000 cycles (one of the resultant frequencies being 1,001,000 cycles) negligible audible interference will be occasioned in the Stenode.

THE EDITORS.

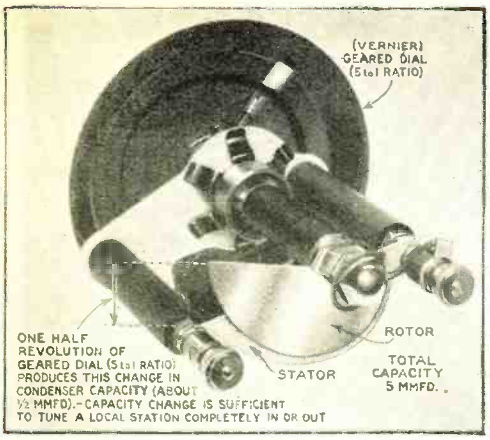
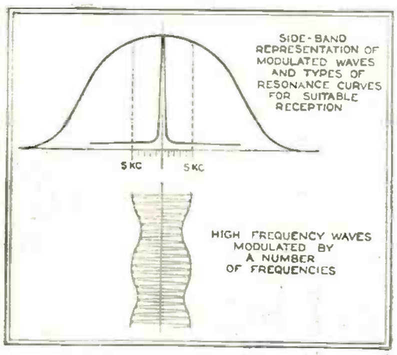


Fig. 1. (Below) Up to the present time the popular conception of the side-band theory has been that for complete fidelity of reception it was necessary to employ receiving circuits sufficiently broad in response so as to embrace a band of frequencies 5,000 cycles either side of a carrier. It would seem then that a resonance curve so sharply peaked as the inner one shown above would tend to cut off the side bands and thus render quality reception impossible. That this is not necessarily so is proven in the Stenode

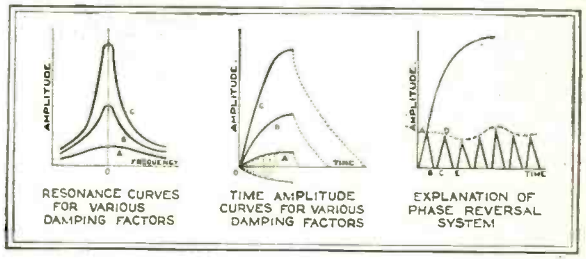
In the Stenode the tuning of the oscillator is so extremely sharp that the regular .0005 mfd. tuning condenser must be shunted by a vernier condenser such as that illustrated above



finally obtained. The amplitude of the steady state in fact is inversely proportional to the resistance in the circuit. Another very important fact emerges from these curves which is that although the curve C eventually reaches a higher amplitude than that of curve A, a longer time is required for it to reach its steady state. In each case here we are considering the waves which arrive to be in tune with the receiver. When the incoming waves cease, the receiver is in a state of oscillation and these oscillations will commence to die away at a rate depending on the logarithmic decrement. In each case we have an exponential fall of the oscillations and for the case of high damping the receiver comes very quickly to rest, whereas for the case of low damping (curve C) a considerable length of time is required for the receiver to come to rest.

Suppose that we make a signal at a transmitter and that we wish the receiver to respond to its full extent and to die down to zero again, it is obvious from these curves that the length of the signal which we can use depends on which of the curves A, B or C, we employ. In the case of curve A, a comparatively short time is required to build to the maximum value and a comparatively short time to die down to rest again, whereas in the case of curve C, a very much longer time is required for the receiver to build up to its maximum value and to die down to rest again. Hence if we make the condition that the receiver must always be allowed to rise to a maximum value and must always come to rest again for any one signal, we arrive at the conclusion that the lower the damping of our receiving circuit, the lower must be the signalling speed of the transmitter.

Let us now examine what would happen if we actually do employ very high signalling speeds for these circuits of exceedingly low damping. In Fig. 3 we again plot the amplitude of response of a very selective circuit against the time, and the actual response of such a receiver to telegraphic signals of two different speeds is also shown. First of all, we shall consider signals as shown at K and we must assume that these signals are made so that the transmitter is active and at rest for equal intervals. For the first active portion, the amplitude of oscillation will build up to the point A. When the incoming waves cease, these oscillations will tend to die away, and as a comparatively long time is required for this process, it is obvious that we cannot afford to ignore the exponential effect, which in fact becomes of very great importance. In the period of rest, however, the receiver will only die away to the point B and it will still be in a state of oscillation when the next signal arrives. This will now (provided we arrange for it to start in the correct phase) build to the amplitude of oscillation of the point C, when the signals again cease. Again, the amplitude falls to the point D in the period of rest when the signals again arrive.



Figs. 2. A, B and C, at the right, show the "build up" curves for circuits of various degrees of damping

Thus for the signals K we find that the receiver continues to build up according to the curve OABCD, finally reaching a steady state with the amplitude varying according to the signals.

Consider now that the signalling speed is increased as shown at Q. The build up curve becomes OABCD, again the amplitude building up to a steady state with a fluctuation, the rate of fluctuation corresponding to the signalling speed but the amplitude of the fluctuation being smaller than in the case where the signalling speed was lower.

Below is illustrated the equipment employed in demonstrating the practicability of the Stenode system. At the left are two constant radio-frequency modulated oscillators, miniature transmitters in fact, the modulation source being either the two electric phonographs with magnetic pick-ups or the General Radio low-frequency oscillator, shown at the right. With these pieces of equipment it is possible to demonstrate that with the two modulated oscillators adjusted in frequency to 5,000 cycles either side of the carrier frequency of an incoming signal to which the Stenode Radiostat receiver is tuned no interference in the Stenode is produced, the desired program being received free and clear of the interference which, on a standard type of receiver, completely blankets the desired reception

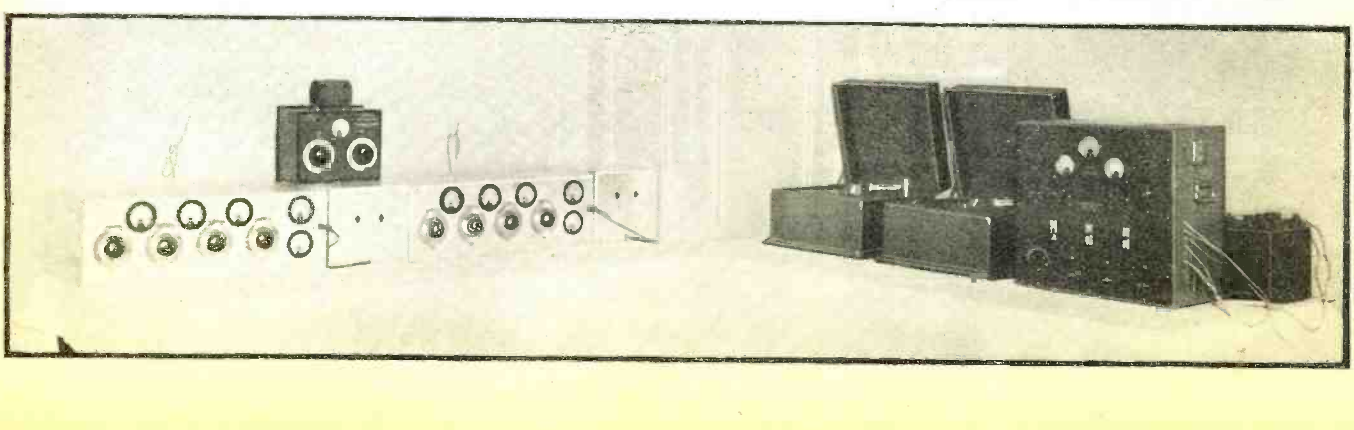
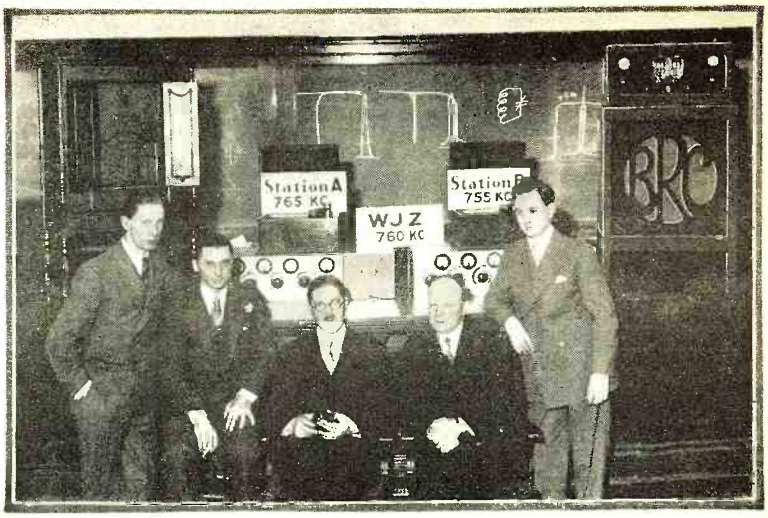


Fig. 3 is sufficient to show that no matter what telegraphic signalling speed is employed, provided that this is lower than the frequency of the carrier waves, we shall have the amplitude of the receiver fluctuating with the signals, the amount of fluctuation depending on the signalling speed.

In place of telegraphic signals as shown at K and Q, it is obvious that we could employ signals of trigonometrical form, instead of being square topped as shown at K and Q. Similar reasoning will apply, and this means that instead of transmitting telegraphic signals of square topped form, we are transmitting signals of trigonometrical form which, in fact, are equivalent to a trigonometrical modulation of the carrier waves. Thus we find that when the carrier waves are modulated by any frequency, we have the amplitude of oscillation fluctuating at the same rate as the modulation, but the amount of the fluctuation depends on the modulation frequency, being greater for a lower modulation frequency. *The important deduction to be drawn is that in this very selective circuit, all modulation frequencies, or all signalling frequencies are present, although not in their original proportions.* We can, in fact, deduce a general principle, which is that when modulated waves impinge on a receiver, the percentage modulation is changed after going through the receiver to an amount which depends upon the logarithmic decrement and also on the modulation frequency. Thus no matter how selective we make a circuit, all modulation frequencies are still present, although they are not necessarily present in their original relative intensities. For extreme selectivity it was apparent that the response of any signalling frequency would be approximately, if not exactly, inversely proportional to the signalling frequency.



This photograph was taken at the occasion of the presentation of Dr. Robinson's paper, printed here, at the Radio Club of America, Havemeyer Hall, Columbia University. From left to right, Humfrey Andrewes; Arthur H. Lynch, Editor RADIO NEWS; Percy W. Harris, Chief Engineer, British Radiostat Corporation; Dr. James Robinson, inventor of the Stenode Radiostat, and Ernest Gardiner

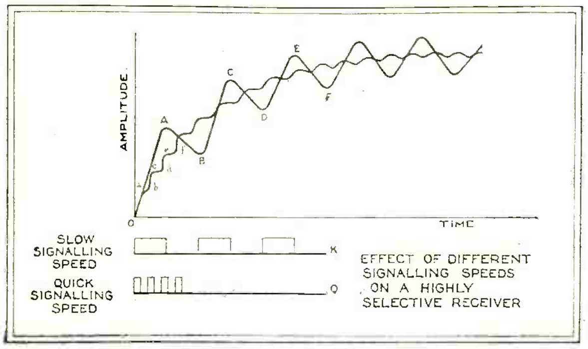


Fig. 3. In a circuit such as that wherein a quartz crystal is employed, thus having low damping, the effect of various signalling speeds or audio-frequency modulation produces an effect as shown above

Having reached this very important deduction, the way was shown to the construction of a suitable receiver, by employing a very selective device and arranging for the correction of the modulation frequencies so that they should appear in their desired proportions. For instance, one method for bringing this about is to pass the modulated waves through a highly selective circuit, such as a quartz piezo-electric crystal, then to rectify the effects and pass the result through a low frequency amplifier which has the characteristic of amplifying the frequencies so that the amplification factor is proportional to the frequency. Thus it is seen that there is no necessity to place a limit on the selectivity of a circuit.

Magnitude of Modulation Response

The conclusion that has just been arrived at that the percentage modulation is reduced as the selectivity increases, helps us to appreciate that the magnitude of the modulated response is not small. Although the *percentage* modulation has been diminished, the *total* response of the circuit at resonance has increased as some resistance has been cut out of the resonant circuit to produce the selectivity. Hence although the percentage modulation is diminished, the *absolute* value of the modulation is not necessarily lowered.

Examining the curves of Fig. 2B it can be seen that the absolute magnitude of the modulations is in fact not smaller for the highly selective circuit C than for the damped circuit A. In each case the amplitude builds up to a steady state where the input of energy into the circuit just balances the dissipation of energy.

We thus have the following results:

1. No matter how selective a circuit may be, all modulation frequencies are present.

2. From a quantitative point of view, the signals need not be weaker than they are in a highly damped receiver.

3. We can now employ selectivity as high as is practically possible and there is no need to place a limit to progress as regards selectivity. We should expect that as the selectivity is improved, such annoying factors as spark and atmosphere interference should be diminished.

4. The percentage modulation of waves is changed after they pass through a very selective device by a factor which is approximately proportional to the logarithmic decrement and approximately inversely proportional to the modulation frequency.

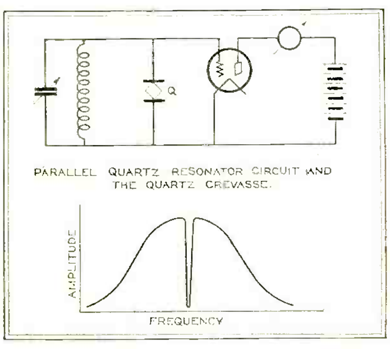
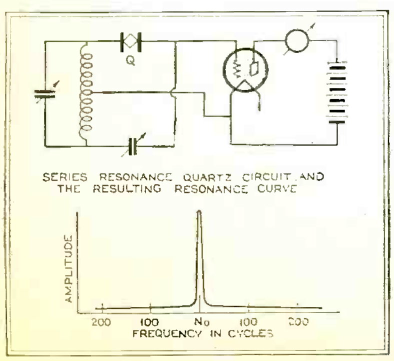


Fig. 4, above, shows a quartz crystal shunted across a tuning circuit, the resultant resonance curve being that shown in the lower part of the figure. Fig. 5, to the left. In order to utilize the crevasse of the crystal resonance curve a series resonance circuit is arranged as shown above. The lower tuning capacity is employed to balance out the capacity of the crystal holder



Extreme Selectivity No Bar to Good Tone Quality

Having established the fact that no matter how selective a receiver may be, it is still possible to receive all modulation frequencies, we shall consider certain practical methods for utilizing these principles in radio.

RECEPTION OF MODULATED WAVES ON A VERY NARROW RESONANCE BAND

THE FOLLOWING ANALYSIS WAS OBTAINED IN DISCUSSION WITH—

Dr. Alexander Russell, F.R.S., Principal of Faraday House, London.

TRANSMITTING WAVES

Let us suppose that the carrier wave has a frequency n_1 and that w_1 equals $2\pi n_1$, then the magnetic flux produced at a point in the receiver may be written $\Phi \sin w_1 t$ when Φ is a constant which depends on the kind of transmitter used, and its distance from the receiver, and t is the time in seconds. In practice Φ is modulated in various ways.

Let us suppose that a pure note $C \sin w_2 t$ is sounding at the transmitter and is modulating the amplitude of the current producing the carrier wave. In this case the instantaneous value of the flux at the receiver with the modulated transmitting current is given by-

$$\phi = \Phi\,(1 + m \sin w_2 t)\sin w_1 t \qquad (1)$$

when m is a constant, independent of the frequency and the time. By trigonometry this may be written

$$\phi = \Phi \sin w_1 t + m\frac{\Phi}{2}\{\cos(w_1-w_2)t - \cos(w_1+w_2)t\}$$

RESONATING RECEIVER

The impressed EMF in the resonating circuit e is given by—

$$e = \frac{\delta\phi}{\delta t}$$

$$= w_1\Phi\cos w_1 t + m\frac{\Phi}{2}\{(w_1+w_2)\sin(w_1+w_2)t - (w_1-w_2)\sin \overline{w_1-w_2}\,t\}$$

If the resonating receiver consists merely of an inductive coil of resistance r and inductance l and a condenser K in series with it we have—

$$e = ri + \frac{\delta i}{\delta t} + \int\frac{i\delta t}{K} \qquad (2)$$

where i is the current in the circuit, where $\int i\delta t = q$ is the charge in the condenser at the time t. Writing for e its value from (1) and substituting in (2) and solving the equation, we get—

$$i = \frac{w_1\Phi\cos(w_1 t + \alpha_0)}{\{r^2 + (lw_1 - \frac{1}{Kw_1})^2\}^{1/2}}$$

$$+\frac{\Phi}{2}m\frac{(w_1+w_2)\sin\{\overline{w_1+w_2}\,t - \alpha_1\}}{\{r^2 + (l(w_1+w_2) - \frac{1}{K(w_1+w_2)})^2\}^{1/2}}$$

$$-\frac{\Phi}{2}m\frac{(w_1-w_2)\sin\{(w_1-w_2)t - \alpha_2\}}{\{r^2 + (l(w_1-w_2) - \frac{1}{K(w_1-w_2)})^2\}^{1/2}} \qquad (3)$$

where $\tan\alpha_0 = \dfrac{lw_1 - \frac{1}{Kw_1}}{r}$

$$\tan\alpha_1 = \frac{l\,\overline{w_1+w_2} - \frac{1}{K\,\overline{w_1+w_2}}}{r}$$

and $\tan\alpha_2 = \dfrac{l(w_1-w_2) - \frac{1}{K(w_1-w_2)}}{r}$

The formula (3) gives the complete solution when the steady oscillating state is attained. In practice the ratio $\frac{w_2}{w_1} = \frac{f_2}{n_1} = x$ is less than one in a hundred. If the resonating receiver is adjusted to resonance with the carrier wave, we have— $lw_1 - \frac{1}{Kw_1} = 0$

Thus $\tan\alpha_0 = 0$ and consequently $\alpha_0 = 0$.

In addition we have—

$$l(w_1+w_2) - \frac{1}{K\,\overline{w_1+w_2}} = lw_1(1+x) - \frac{1}{Kw_1(1+x)}$$

$$= lw_1\{1 + x - \frac{1}{1+x}\} = lw_1\{1 + x - (1 - x + x^2 - x^3 \ldots)\}$$

$$= lw_1(2x - x^2) = lw_2(2 - x) \text{ very approx'ly.}$$

Similarly—

$$l(w_1-w_2) - \frac{1}{K(w_1-w_2)} = lw_1\{1 - x - (1 - x + x^2 \ldots.)\}$$

$$= -lw_2(2+x) \text{ very approx}$$

When x can be neglected, compared with 2 we can therefore write $\tan\alpha_1 = \frac{2w_2 l}{r} = -\tan\alpha_2$.

Hence $\alpha_1 = -\alpha_2 = \alpha$

Thus substituting in (3) the formula for the current i in the resonating circuit is—

$$i = \frac{w_1\Phi\cos w_1 t}{r}$$

$$+\frac{m\,w_1\Phi}{2\{r^2 + 4l^2w_2^2\}^{1/2}}\left\{\begin{array}{l}(1+x)\sin(w_1 t + \overline{w_2 t - \alpha})\\ -(1-x)\sin(w_1 t - \overline{w_2 t - \alpha})\end{array}\right\} \qquad (4)$$

Now the expression inside the large bracket equals

$$\sin(w_1 t + \overline{w_2 t - \alpha}) - \sin(w_1 t - \overline{w_2 t - \alpha})$$

$$+ x\{\sin(w_1 t - \overline{w_2 t - \alpha} + \sin(w_1 t - \overline{w_2 t - \alpha})\}$$

which equals—

$$2\cos w_1 t \sin(w_2 t - \alpha) + 2x\sin w_1 t\cos(w_2 t - \alpha)$$

If $2lw_2$ is greater than $25r$ the error made in assuming that $(r^2 + 4l^2w_2^2)^{1/2} = 2lw_2$ is less than one in a thousand.

We see that (4) can be written— $i = \dfrac{w_1\Phi\cos w_2 t}{r}$

$$+\frac{m\,w_1\Phi}{2lw_2}\left\{\begin{array}{l}\cos w_1 t\sin(w_2 t - \alpha)\\ + x\sin w_1 t\cos(w_2 t - \alpha)\end{array}\right\}$$

The second term in the bracket being multiplied by x, the ratio of the frequencies can in practice be made negligibly small compared with the first. Neglecting it we get finally—

$$i = \left\{A + \frac{B}{f_2}\sin(w_2 t - \alpha)\right\}\cos w_1 t \qquad (5)$$

where $A = \dfrac{w_1\Phi}{r}$ $\quad B = \dfrac{mw_1\Phi}{4l\pi}$ $\quad$ and $\tan\alpha = \dfrac{2lw_2}{r}$

Since we have supposed that $\frac{2lw_2}{r}$ is 25 or greater than 25, $\alpha = 90°$ very approximately and thus (5) becomes—

$$i = \left\{A - \frac{B}{f_2}\cos w_2 t\right\}\cos w_1 t \qquad (6)$$

Comparing (6) with (1) we see that the current in the resonant circuit consists of a modulated carrier wave and would produce an audible note, the frequency of which is f_2.

It is to be noticed, however, that the amplitude of this audible note is inversely proportional to the frequency—the higher the note the smaller the amplitude.

If there are notes of several frequencies, f_2, f_3— sounding at the transmitting apparatus, the current would be given by—

$$i = \left\{A' - \frac{B'}{f_2}\cos w_1 t - \frac{B''}{f_3}\cos w_3 t \ldots\right\}\cos w_1 t$$

where B' B'' are constants which depend on the amplitude of the pure tone sounding at the transmitter.

w_1 = $2\pi n_1$ where n_1 = carrier frequency
w_2 = $2\pi f_2$ " f_2 = modulation "
ϕ = Instantaneous flux.
Φ = Maximum flux amplitude.
m = Modulation factor
e = E.M.F.
l = Inductance (equivalent) of resonating circuit.
K = Capacity " " " "
r = Resistance " " " "

Continued on page 754

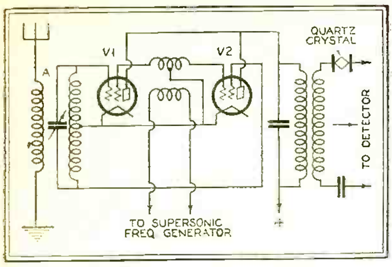
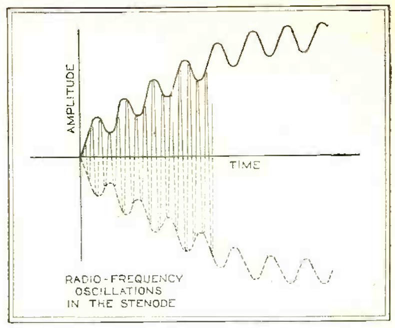


Fig. 6, to the left. By the use of a phase reversal circuit such as that shown it is possible to obtain a suitable Stenode effect as illustrated graphically in Fig. 2C

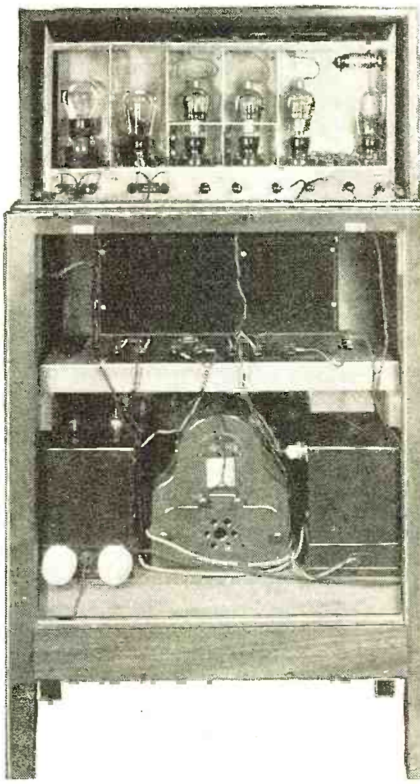
Fig. 8, to the right, illustrates the envelope and radio-frequency oscillation in the Stenode



Highly Selective Receiver With Equalizing Amplifier

It is known that when a quartz crystal is cut in a special manner it has a definite frequency and that it can be employed as a resonator. Professor Cady has shown that when such a quartz crystal is connected in parallel across a resonating circuit and when the resonance curve is plotted, the normal curve is obtained, with the exception that at a very definite frequency a crevasse M appears in the resonance curve as shown at Fig. 4. This crevasse M occurs because at or near this very definite frequency some of the oscillating energy is constrained to pass through the crystal.

Such a resonator is obviously very selective and our object is to employ it not in the form of a crevasse in another resonance curve but merely as a resonator of its own accord. We thus need to obtain our indications actually in the quartz crystal circuit itself and for this purpose the crystal is connected between one end of the resonance circuit and the grid of a tube V1 of Fig. 5. The crystal is shown as Q. Such an entirely new departure in radio reception brings forward a number of peculiar problems, one of them being the fact that it is usually necessary with the crystal to employ electrodes or plates thus providing a capacity which is capable of passing high frequency energy. It is necessary to correct any such effect and one method of doing so is to employ a small condenser connected to the opposite end of the resonating inductance, the filament of the tube being connected to a center point of the inductance. Thus in effect we provide a bridge circuit by means of which undesirable effects of any capacity of the quartz mount can be compensated. Effective reception with such a crystal obviously only occurs for a narrow frequency band and thus in order to employ one such crystal for a range of frequencies it is suitable to employ the supersonic principle, in order that incoming waves can have their frequency changed to that of the crystal. It is not essential to describe in detail these supersonic portions of such a receiver as this principle is well known. Following the quartz crystal rectification is effected, after which a low frequency amplifier is used which is designed to amplify in proportion to the frequency.



A rear view of the Stenode. At the top is the receiver chassis of the superheterodyne, while below are the audio channel and loud speaker-power supply units

Certain special features of rectification are introduced because the percentage modulation is low, although the actual amount of modulation may be quite normal.

Reversal of Phase Method

Another interesting method of employing a highly selective device in a different manner in order to obtain complete modulation frequencies is as follows: Referring to Fig. 2B it is seen that with such a selective device a considerable interval of time is required for the receiver to build up to its maximum amplitude, and at the same time this maximum amplitude is very high. It is, however, not necessary to allow the receiver to reach its maximum amplitude and after a short interval of time when the receiver has built up to a comparatively small value, it is possible to bring it to rest again. This can be done by reversing the phase of the incoming signal. To show how this can be done a diagram is given in Fig 6, a description of which has already appeared in the *Wireless World* of December 11, 1929. In this case, incoming signals are led in opposite phase to the grids of two tubes which are made alternately active at a lower frequency which would normally be supersonic when telephony is being received by leading an alternating voltage of this lower frequency to the second grids in the two tubes. In this way in the combined plate circuit of the two tubes we obtain trains of waves with opposite high frequency phase in the successive trains which are led to the highly selective device. We thus obtain a series of pulses as shown in Fig. 2C, OAB, CDE, etc. The amplitude of these pulses depend on the instantaneous intensity of the incoming waves. After rectification the envelope of these pulses corresponds to the form of the low-frequency waves, so that such a receiver although exceedingly selective will still indicate all the modulation frequencies.

Interference and the Stenode

Once it has been appreciated that all modulation frequencies are present in a receiver of this nature, no matter how selective it may be, certain deductions can be made. The opinion has been universally held that the ideal receiver for broadcast reception should be able to receive equally waves over a frequency band of ten kilocycles and receivers have been designed employing band-pass filters to eliminate waves whose frequency is outside of such frequency band. Such designs have concentrated on methods for obtaining equal response within the required frequency band of ten kilocycles.

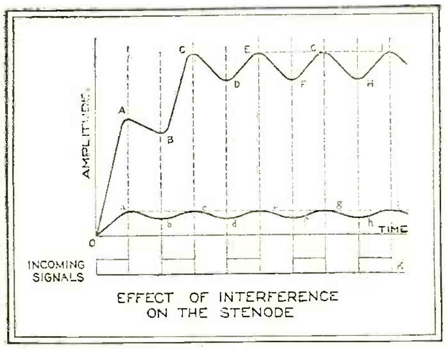
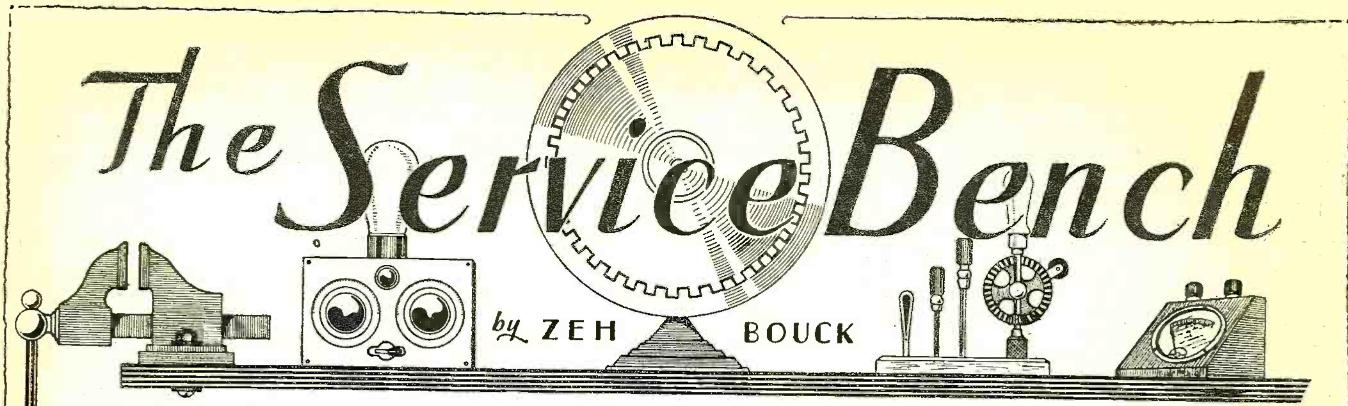


Fig. 7. Here is shown the amplitude of a signal to which the Stenode is tuned, contrasted to that of an interfering signal

In this connection it is important to point out that when the high-frequency circuits of a radio receiver are designed to respond to a wide band of frequencies, such as 5000 cycles either side of the carrier frequency, there is an inevitable loss of the efficiency which comes from utilizing the principle of resonance to its best advantage.

One important result of the work on the Stenode system is the advancing of a definite group of principles hitherto entirely unrecognized, which may be employed by the application of sound engineering to bring about results considered up to now as entirely impossible.

It is now (*Continued on page 752*)



How to Measure Hum—Making and Calibrating a Hum Indicator—Money Hints for the Serviceman—Hunting Down Artificial Static. Receivers Serviced—Radiola, Majestic, Fada, Atwater Kent, Victor, Silver-Marshall

The Business End of Servicing

"Following a course with the National Radio Institute, I entered upon the service business in the spring of 1925. I have never done any advertising in local papers, depending upon my work itself as an advertisement. I have found it an invariable rule that a satisfied customer is the best advertisement in the world.

"My shop is in the basement of my home, and is well equipped to handle the work I do. It is almost a truism that good tools and equipment are half the job well done. I have an audio oscillator, a lining-up oscillator, a tube rejuvenator, several single meters, a Jewell tube tester and the usual small tools.

"My radio service work is a sideline. I am regularly employed as a switchman by one of the railroads here. I only work eight hours a day. This gives me plenty of time to handle all my service calls, though I must admit that occasionally I am as busy as the proverbial one-armed paper hanger.

"My net profits run from $20.00 to $50.00 a week, and I have 250 regular service customers.

"I have only one service contract with a dealer—this with our largest department store. When they instituted their radio department, they offered me the position of serviceman at a salary of $30.00 per week, which, however, I had to turn down. They hired a young chap from a nearby town, and while he got along fairly well at first, he soon ran into difficulties. The manager of the store then called me in and we arrived at an agreement whereby I was to handle his service calls under contract. I receive $1.00 for each call. If this call requires more than an hour's work, I receive $.75 for each additional hour. This proves quite profitable to both the store and myself, as generally the calls require only some minor adjustment or tube replacement.

"I am, as you may observe, convinced that there is a satisfactory return for real honest-to-goodness radio service."

A. A. WILLITS,
Willits' Radio Service,
Fort Dodge, Iowa.

Making Money in Off Season

"My business is running an exclusive radio repair shop in a city of about eight thousand population. As we are some distance from the better broadcasting stations the summer slump is exceptionally bad and I have considerable difficulty to keep going through the summer. I will describe a few of the methods I have used to turn surplus time into dollars and cents.

"I do the work for several of the local dealers and these dealers find themselves at the end of the season with quite a stock of old sets that were taken as trade-ins on new ones. Most of these sets need fixing up a little before they can be sold again next fall. I make the dealer a half-price rate on this work, providing I can do the work at my own convenience when I have nothing else to do. The dealer is glad to agree to this proposition, as it saves him considerable.

"A number of the old sets taken as trade-ins have little or no value for resale. These sets I buy from the dealers at from fifty cents to two dollars each. I then wreck them, keeping the panels, the sockets, the switches, the volume controls, the fixed condensers, the audio transformers and any other parts that I think might have value. When repair work comes in during the busy season I have no difficulty in disposing of the parts at from $5.00 to $10.00 as replacement parts in the sets I am fixing. This is a nice margin of profit and it also makes possible the rendering of a much quicker service to the customer than would otherwise be the case.

"Every radio man knows that many of the present-day a.c. sets work better without a ground connection and some even work better with the ground connected to the aerial binding post. While thinking about this I was struck with the happy thought of using a Federal anti-capacity switch for the purpose of connecting the set in various ways.

"I obtain the anti-capacity switches for a cost of about $1.50 each. I have had a number of small cabinets made at a cost of fifty cents each. These cabinets are four by four inches in size. I then cut up the old panels to the proper size to fit the cabinets and drill the panels and mount the switches on them. Then I put four binding posts on the panel. Two of the binding posts are for connection to the aerial and ground and two are for connection to the aerial and ground binding posts of the radio set. I then wire up the box so that with the switch in one position the aerial and ground are connected as always, and in a second position so that the aerial is connected but not the ground and in a third position so that the ground is connected to the aerial post of the set and the aerial disconnected. Any one familiar with this switch can

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IN his search for the elusive causes of trouble in radio receivers the serviceman fails sometimes to consider how he may best put his technical knowledge to a profitable use—what to charge for his services—how to gauge his profits on new parts—the advantages of a service tie-up with a local dealer—how to negotiate such an association—how to advertise—how to collect unpaid bills—in short, the business end of servicing.

The Service Bench will welcome contributions from its serviceman readers answering any of the questions implied above, and we direct the attention of our readers to the two articles in this issue by A. A. Willits and Vern Peters.

THE SERVICE EDITOR.

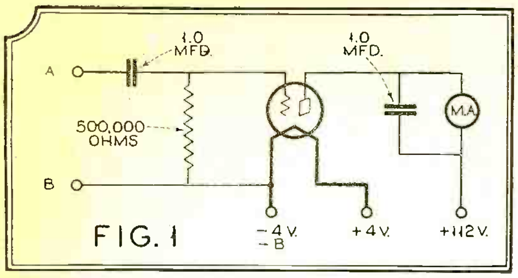
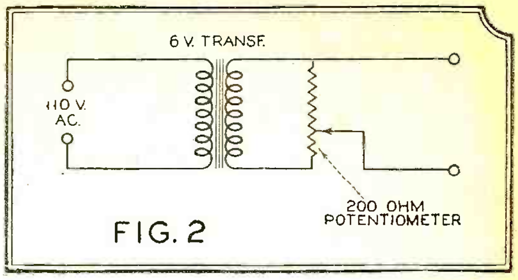


Fig. 1. The simple vacuum tube voltmeter circuit, suitable for hum measurement and similar work. Fig. 2. The circuit employed for calibrating the v.t. voltmeter. This should be recalibrated occasionally



readily see how this can be accomplished. The total time required for construction is about one hour.

"When called upon to service an a.c. radio I demonstrate what this switch will do. Have no difficulty in selling the device for $5.00.

"Another method of obtaining the elusive nickel in the off season is the sending of printed government post cards suggesting a new aerial. The cost is small and we find the returns about one job out of twenty cards mailed. The card reads as follows:

"How long has your present radio aerial been up? If it has been up for over two years it should be replaced with a new one if you want the best in radio reception with less 'static.' Our regular charge for this work is $2.00 per hour plus material. During the present month we will do this work for $1.25 per hour. As a good aerial can be put up in half the time in summer that it takes in the winter, you save 60% on labor by acting now. As usual, we guarantee all work."

VERN PETERS,
Radio Technician,
Havre, Montana.

Measuring Hum Level

The service department of the Temple Corporation has designed a simple v.t. voltmeter for determining the hum factor in the output of a receiver. It is easily constructed and calibrated.

The circuit of the voltmeter, employing a type 240 tube, is shown in Fig. 1, and the calibration arrangement in Fig. 2. The milliammeter may be any reliable instrument reading from zero to 1.5 milliamperes. The type 240 tube is lighted from a four-volt battery without a rheostat.

To calibrate the voltmeter, connect an ordinary step-down bell-ringing transformer to the 110-volt a.c. line, with a 200-ohm potentiometer across the secondary. Connect one side of the potentiometer to point A on the vacuum tube voltmeter, and the arm of the potentiometer to point B. Using the a.c. voltmeter you have in your tube tester, adjust the potentiometer so that you are passing just one-half volt to the v.t. voltmeter. Readjust the potentiometer with half volt variations up to four volts, and note the corresponding readings on the milliammeter. You will notice that the higher the a.c. voltage, the lower will be the reading on the v.t. meter. Use the ordinary graph paper and chart a calibration curve.

The calibration should be checked occasionally, and whenever the type 240 tube is changed.

When using the vacuum tube voltmeter, points A and B are connected across the input to the loud speaker. When the receiver is detuned from the station, the milliammeter will indicate the a.c. or hum level for that set with the particular tube combination employed. Changing tubes will generally change the meter reading, which facilitates the selection of the combination resulting in the lowest hum level.

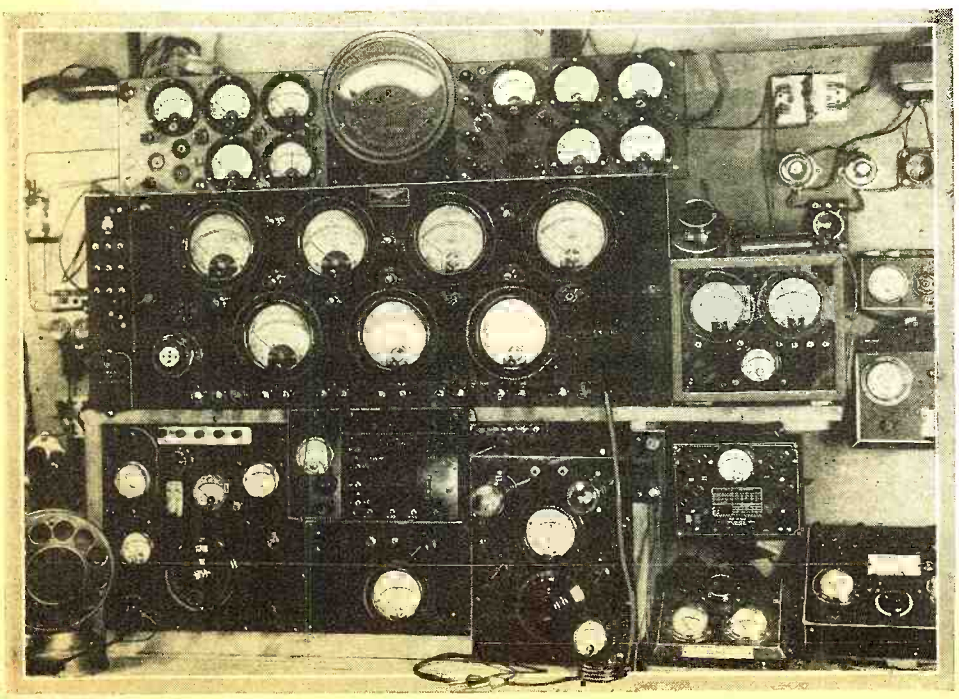
By measuring the hum level on a thoroughly satisfactory receiver, an arbitrary value will be secured for the purpose of comparison.

Running Down Man-Made Static

Noisy reception continues to be a major complaint covering a multitude of sins. In many instances the trouble finds its inception away from the receiver. The Pacific Radio Trade Association has prepared a questionnaire for the serviceman which, by a process of elimination and logical questions, locates such troubles with a minimum of effort and time. The questionnaire includes the following questions:

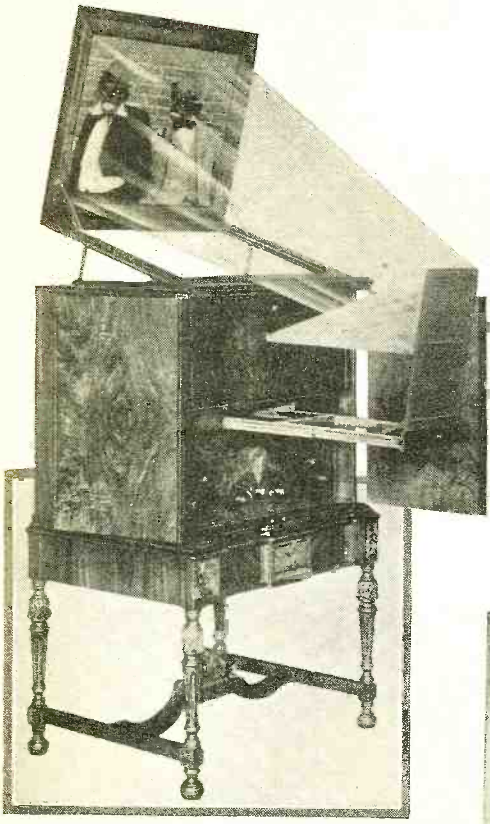
1. Is the aerial of proper length and in one piece?
2. Is the aerial properly insulated from the extreme end to where it enters the receiver?
3. Is the ground wire as short as possible, in one piece, and attached firmly to a cold-water pipe or independent ground?
4. Does the aerial and ground installation comply with local City Ordinance pertaining to same?
5. Have you inspected the attachment plug contacts and light globes in house to make sure they are making good contact?
6. Have you inspected service switch and branch fuse blocks, making sure all connections are tight and all fuses tight in their sockets?
7. Is the service meter of ample capacity to handle complete load of all electrical devices and lights in the house?
8. Is the neutral service wire properly grounded to water pipe?

(*Continued on page* 739)



The service laboratory of T. Sidney Smith, of Bellevue, Kentucky. This laboratory has been constructed in units, the process of assembly having been stretched over a period of three active radio years, and comprises a most elaborate layout for low and high frequency work. Mr. Smith believes in meters

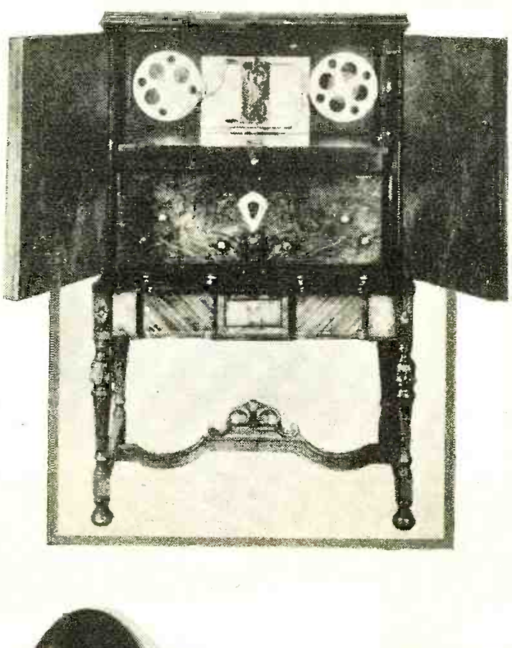
Radio Points the Way to



Improvements in audio frequency amplifiers, loud speakers, the commercial production of photo-electric cells and the development of more accurate mechanical synchronizing systems—all these have hastened the advent of home talking movies. Here are described some of the typical outfits which are now in use. Servicemen particularly are finding a new outlet for greater sales, service and profit in this new field because of their intimate knowledge of radio and mechanics

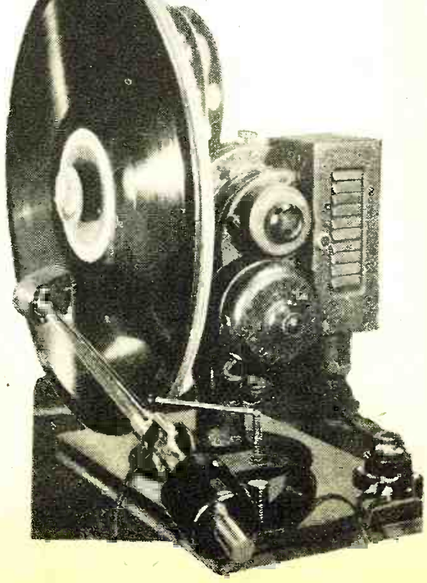
By John B. Brennan, Jr.

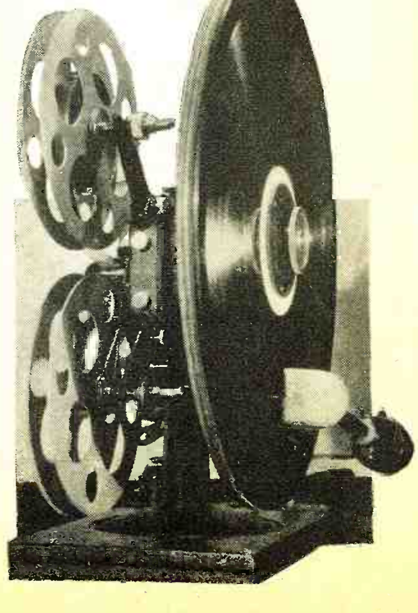
In this one cabinet (above) is contained probably all the eye and ear entertainment which might be required of an evening. The lower portion of the Visonola contains a complete radio receiver with dynamic speaker. The upper portion houses not only the 16 mm. movie projector, but also a synchronous motor which turns the phonograph turntable at either 33 1/3 or 78 revolutions per minute. On a sliding shelf is located a mirror for reflecting the projected images to the screen which is housed in the lid of the cabinet. Above, at the right, is a front view of the Visonola, exposing the movie projector at the top. The audio channel of the radio receiver, below, is used to reproduce the music coming from the record through the electric pick-up



The Victor Animatograph 16 mm. projector and turntable, at the lower left—a unique arrangement where the turntable is geared to the horizontal shaft of the projector and the turntable assumes a vertical position instead of horizontal. By means of a sliding counterbalance the weight of the individual pick-up head used can be neutralized. A spring keeps the pick-up pressed against the groove in the record

Below is a front view of this device. The turntable acts somewhat as a flywheel, thus maintaining constant speed. Other features of the projector itself are a wind-driven vane for speed regulation and a trigger release on the projector motor to prevent a torn film





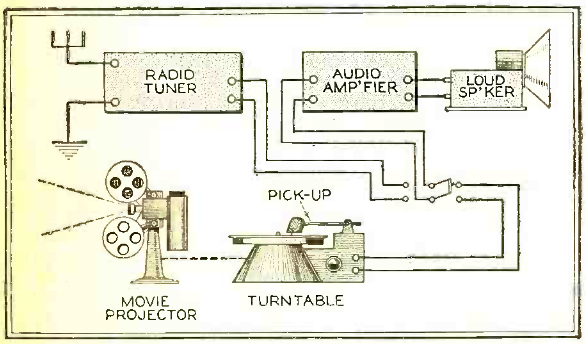
AND now—talking movies in the home!

Not so many years ago the idea of successfully combining sound reproduction with moving pictures, even for commercial usage, was looked upon with not a little scepticism and misgiving.

Today, because of the rapid strides which have been made in successfully synchronizing sound with films, the art has progressed even beyond the purely commercial application and now we find it possible to obtain sound accompaniment for the 16 millimeter or home movie outfits.

In many instances credit is due to the radio art for the many diversified applications of radio principles to other fields of endeavor. It is only natural, with the great improvements made in the past few years in radio reception, radio

Home *Talking* Movies



In this diagram is depicted the various units which go to make up a satisfactory home talking movie outfit. By means of a double-pole double throw switch the audio amplifier of the regular radio installation may be thrown over from radio reception to the phonograph pick-up on the turntable which is mechanically geared, by means of a flexible cable, to the movie projector

The Bell and Howell projector, to which may be attached the flexible shaft from turntables to obtain synchronized sound with pictures

broadcasting and, in particular, in the improvement of apparatus for the more natural reproduction of sound, to wit, the audio amplifying system, that uses other than radio will be found for these new developments. Perhaps the greatest single instance of this nature is the talking movies.

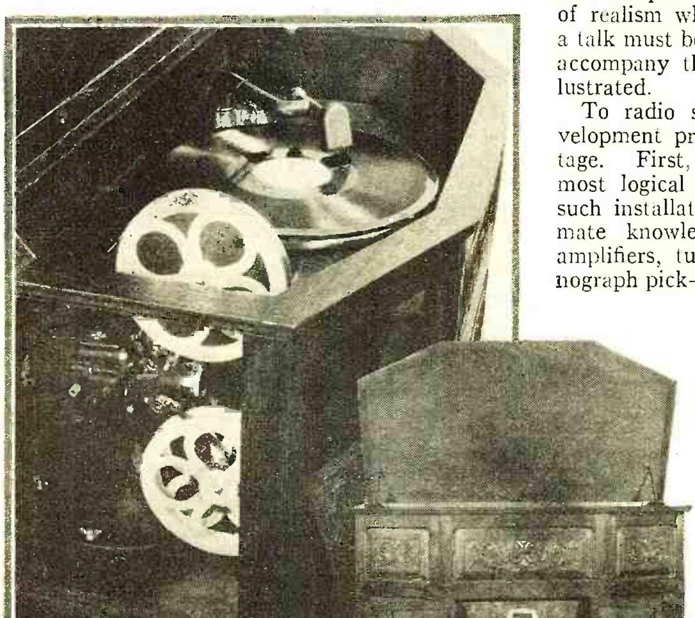
Not until audio amplifiers having well-nigh perfect reproduction characteristics were produced was progress made in the business of practically and commercially synchronizing sound with films.

But, when the practical application did manifest itself, the state of the radio art was at such a high plane that progress was indeed rapid and a hungry public, ever on the lookout for something new, virtually flocked to the talking movies. In a sense it "arrived" overnight and has remained to stay.

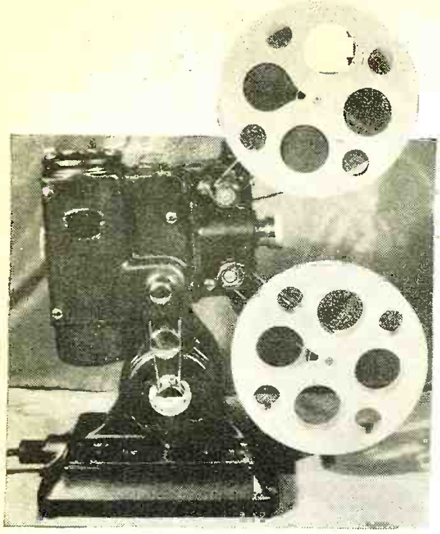
First efforts in combining sound with films naturally succeeded when the phonograph with magnetic pick-up which fed a high-grade audio amplifier was synchronized mechanically with the driving mechanism of the movie projector. Then along came the application of the photo-electric cell in its use as a translator of little wiggly lines, placed on the margin of the film itself, into sound.

Sensing a demand for the use of movie equipment with sound accompaniment in the home, many manufacturers have produced combination units which are entirely practical and are enjoying a growing popularity. As a matter of fact, so popular has become this new eye and ear entertainment that many salesmen and selling agencies have found it advantageous to the completion of a sale to illustrate and describe their products by this method. Then, too, churches, schools and clubs have found it greatly to their advantage to illustrate talks which otherwise would have to be given more or less extemporaneously with the showing of the films or pictures in question, whereas with the new device, the home talkies, it is possible to carefully prepare the script which is to accompany the pictures. Also the combining of sound by means of record or film with the pictures gives the added effect of realism which is not present when a talk must be delivered on the spot to accompany the pictures which are illustrated.

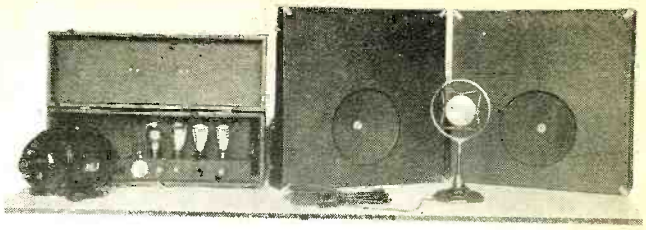
To radio servicemen this new development presents a two-fold advantage. First, the serviceman is the most logical of all people to service such installations because of his intimate knowledge of audio-frequency amplifiers, tubes, loud speakers, phonograph pick-ups, etc. Second, it offers to him a new line of endeavor in the sale and service of this equipment, thereby taking care of so-called seasonal fluctuations in his radio business by the addition of a line



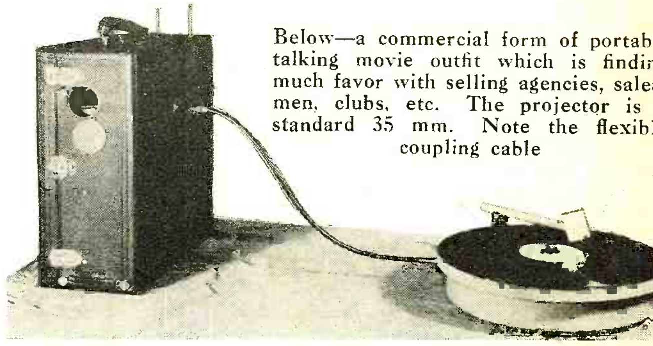
The Bell and Howell Filmotone, a combination radio and home talking movie outfit. The lower illustration shows the general appearance of the pretentious cabinet, with radio receiver in the center portion, while the upper illustration shows the arrangements of the turntable and the projector



(Left) The Ampro projector, to which by means of a flexible cable it is possible to couple a turntable for home talkie use



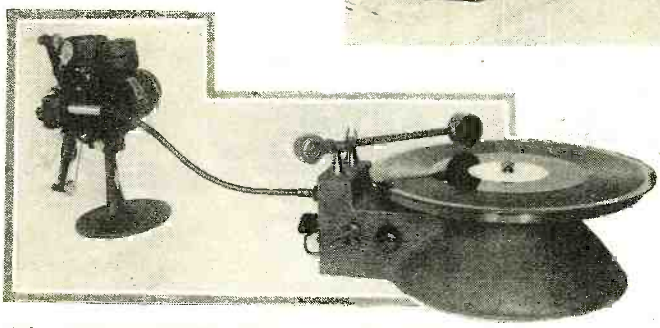
(Above, at right) A portable audio frequency amplifier intended originally for use in public address work, but which can be used quite nicely for the reproduction of sound from records



Below—a commercial form of portable talking movie outfit which is finding much favor with selling agencies, salesmen, clubs, etc. The projector is a standard 35 mm. Note the flexible coupling cable

which in itself fills in the gap of this seasonal nature. Many people who now own a radio receiver having a good audio channel are naturally the best of prospective customers for home talkie equipment.

And, so that the serviceman may become acquainted more closely with the development in this new art, the following description of several of the more outstanding types of home talking movie outfits is offered for his perusal.



The Hollywood Film Enterprise turntable and pick-up, especially designed for use in conjunction with home movie projectors for synchronization of sound. The gear mechanism of the turntable is mounted in the base, together with speed and volume controls. Synchronization between projector and turntable is obtained by the flexible shaft shown

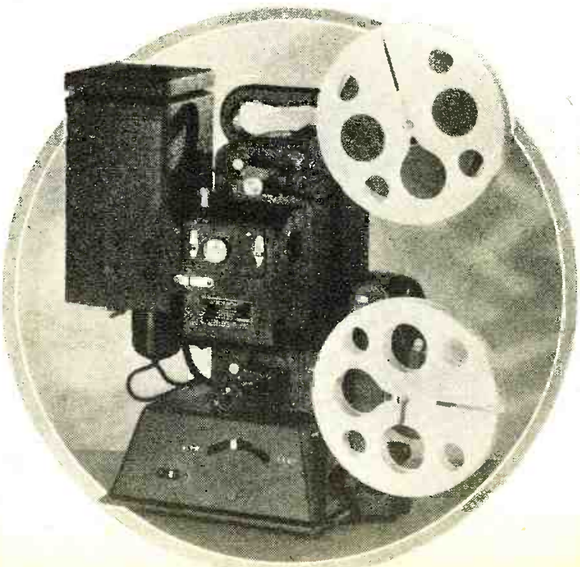
Among the several companies which are now manufacturing equipment which is satisfactory for use in the home as home talking movie outfits, there are: Victor Animatograph Corporation, Bell and Howell, QRS-DeVry, Hollywood Film Enterprises, Toneograph, and Visionola.

Because of its unique construction and seeming departure from accepted principles the Victor Animatograph system of home talking movies will be of particular interest to the serviceman. In the Victor Animatograph arrangement a standard projector is employed to which is attached, by means of shafts, a phonograph turntable which is mounted in a vertical plane. By means of a gearing arrangement the shaft which turns the turntable is coupled to the driving shaft of the projector in such a way that two speeds are obtainable, one for 33 1/3 r.p.m. records, the other for the standard 78 r.p.m. records. By an ingenious arrangement the pick-up arm is pivoted so that the weight of the pick-up head itself is counterbalanced by a sliding weight at the other end of the tone arm, opposite the pivot. A spring which connects to the tone arm allows the pick-up to be pressed against the record in such a manner as to obtain an even pressure at all times during the playing of the record. Once the balance weight at the far end of the tone arm is adjusted to actually balance out the weight of the pick-up head, a state of equilibrium is obtained whereby the pick-up tracks perfectly in the grooves in the record. Synchronization here is obtained by the usual means; that is, a mark on the record indicates the "start" position while one of the frames of the film is also marked "start," and to obtain synchronization it is merely necessary to see to it that the needle from the pick-up is on the "start" position of the record while the "start" frame of the film is in position in the projector.

Other features of the Victor Animatograph are a trigger release which prevents the tearing of film and also a wind-driven speed regulator which maintains constant speed at all times, insuring proper reproduction from the record.

Home talkies, home movies, the radio, and the phonograph, are all made available in one combination instrument, the Filmophone-Radio, just announced by the Bell and Howell Company, Chicago.

A Bell and Howell Filmo Movie Projector, utilizing regular 16-millimeter home movie size film, is used for the pictures and a Howard chassis is the basis of the radio feature.



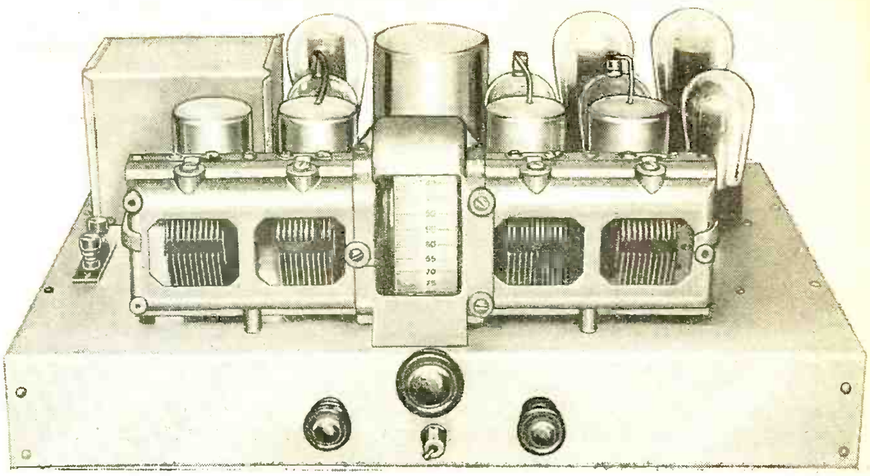
The Ciné-Kodak, another type of projector which may be employed suitably with phonograph turntables, pick-ups and audio amplifier-speaker combinations for the satisfactory reproduction of synchronized sound

The phonograph motor is so arranged that the turntable can be operated at either the standard speed of 78 revolutions per minute for ordinary phonograph records or 33 1/3 revolutions per minute when the records for the sound pictures are played.

The flexibility of the new combination instrument is such that the talkies and also movies without sound can be projected. Again, the pictures may be shown with radio or phonograph musical accompaniment not synchronized with the film. Also, of course, the radio or phonograph are available each by itself if desired.

The QRS-DeVry Company produces a unit which is a combination of 16-millimeter projector and turntable. The turntable is mechanically connected to the motor which drives the projector, thereby obtaining synchronization, while reproduction is obtained through (*Continued on page 742*)

A front view of the receiver, showing the symmetrical arrangement of the tuning controls. Any desired panel material may be used for the panel



How to Build The Sextet Special

A receiver of modern type, designed for quality reproduction, quiet operation and ease of tuning. The builder should experience no difficulty in constructing this receiver, which has ample sensitivity for distant, and good selectivity for local stations. The dimensions are such that it may be fitted into a standard console

By Beryl B. Bryant *and* John Raum*

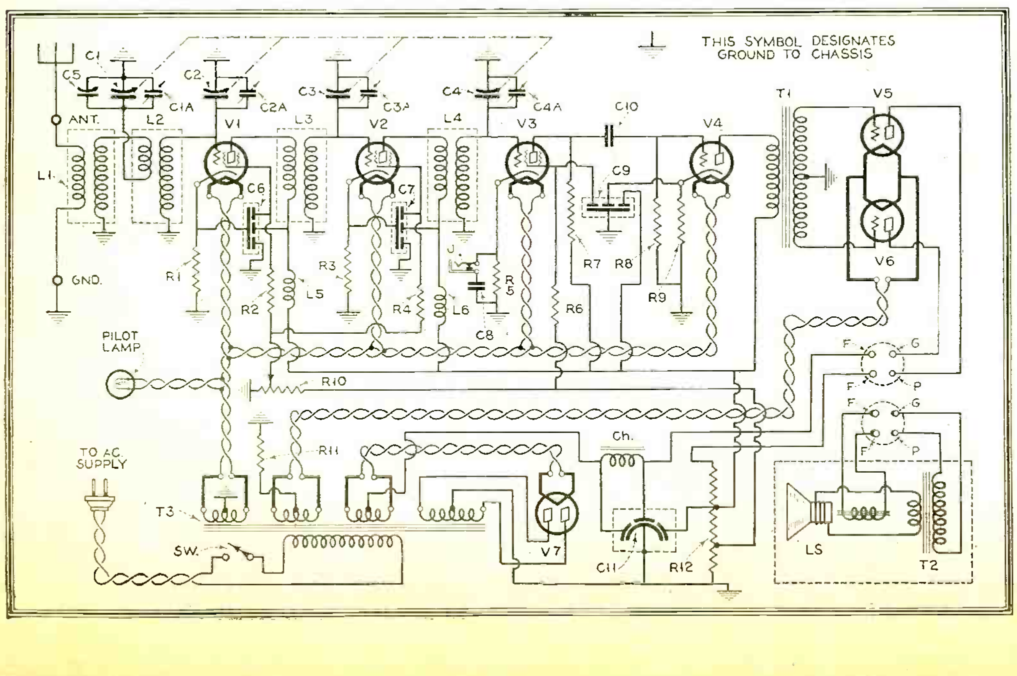
In order to satisfy the demands of many people for a receiver of modern design which combines quietness and ease of operation with good quality and low cost, the writers have spent some time in the designing of such a set. The construction and operation of which is completely described in the following pages.

Essentially the receiver consists of two stages of screen-grid r.f. amplification followed by a screen-grid detector of the power type. The first stage of the audio channel employs a –27 type tube coupled to the detector by resistance coupling. The output consists of –45's in push-pull. A full-wave rectifier of the –80 type supplies sufficient voltage for the operation of all tubes at their rated voltages.

The first r.f. tube is preceded by a one-stage band-pass unit with the purpose of excluding as many of the interfering signals as possible before the desired signal enters the tube. A trimmer condenser has also been placed across the antenna secondary, so that exact resonance to the incoming signal may be secured. It also tends to act as a volume control in the reception of local signals. Due to the low "C" bias on the first and second screen-grid tubes, many powerful local stations impress so great a signal on the grids that it causes detection before the detector is reached, and the natural result is distortion. In order to avert this, the first r.f. stage tube is biased with a 1,000-ohm resistor, which increases the bias to such a value as to make it practically impossible for rectification to take place in these stages.

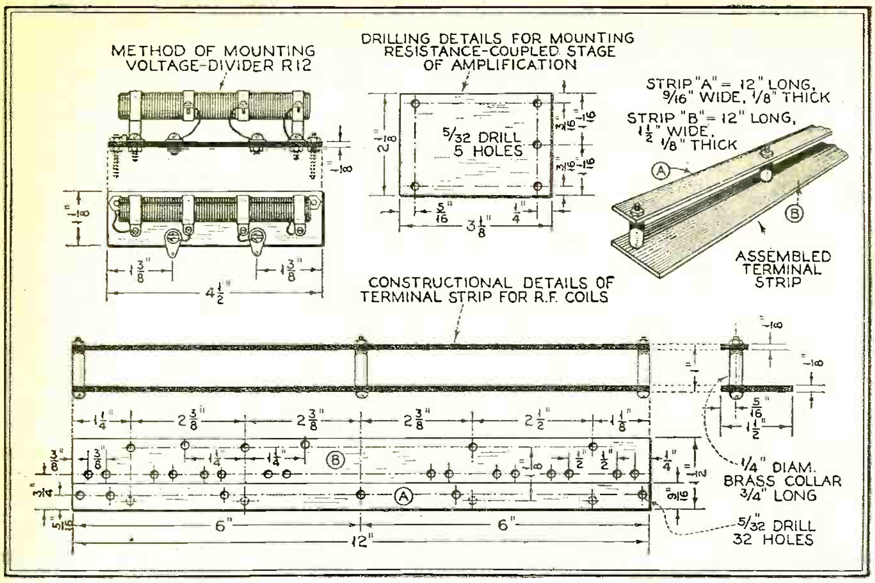
Through the use of resistors and chokes each tube circuit is isolated from its neighbor by by-passing the screen-grid and plate return leads, thus preventing the escape of r.f. currents.

The screen-grid detector is of the power type, with a very high bias, allowing large signal inputs without overloading. The output of this tube is fed into a 2 megohm resistor which provides for the large plate impedance of the screen-grid tube. The



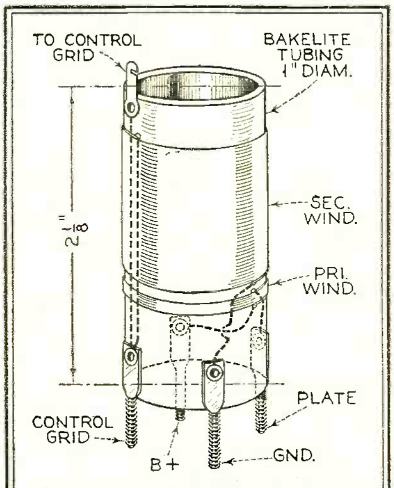
The complete schematic circuit of the receiver, showing the output transformer on the speaker chassis. Note that the common ground returns are made directly to the receiver chassis

*Chief Engineer, Duraum Radio Corporation.



The method of mounting the voltage divider, resistor coupler and the tuning inductances in units simplifies the construction

The dimensions and winding data of the tuning inductances are given in the table. With the exception of the pre-selector coil, all primaries are wound directly over the ground ends of the secondaries



COIL	PRI. WIND.	SEC. WIND.
L1	10 T. No. 36 S.S.C.	120 T. No. 32 E.*
L2	3 T. No. 36 S.S.C.	120 T. No. 32 E.*
L3	50 T. No. 36 S.S.C.	120 T. No. 32 E.*
L4	50 T. No. 36 S.S.C.	120 T. No. 32 E.*
* ENAMELED WIRE		

"B" supply is standard, with large capacities for filtration, making a quiet unit with a smooth output. The 8 mfd. section is brought directly to the 180-volt tap on the voltage divider resistor, R12, so as to prevent any possibility of audio voltages being set up in the "B" power unit and causing audio oscillations.

Chassis Construction

Coming down to the actual construction of the chassis, a sheet of aluminum eighteen inches long by seventeen inches wide is obtained. The width of the sheet is divided into three sections, with the center section twelve inches in width, leaving the two edge sections two and one-half inches in width. The edge sections are now bent at right angles to the center section in such manner as to raise the top or center section two and one-half inches. Then two pieces of aluminum, three inches wide by thirteen inches long, are now obtained and bent over one-half inch at each end and along one side. These pieces should now fit into each end of the chassis plate where they are fastened by screws with nuts, by rivets or welding. The holes for the mounting of the sockets, power transformer and other parts are then scribed on the top of the chassis, as shown in the detailed drawing. The circular holes may be cut out with a fly-cutter or by the slower method of drilling a series of small holes around the circumference, punching out the center and filing down the edges with a half-round file. After all holes are drilled and the burrs removed the chassis should be finished off with a piece of emery cloth, followed by a rubbing with steel wool.

The four pieces of bakelite as shown in the accompanying sketch should now be drilled, as detailed, one for mounting the coils, one for the resistance coupler mounting, one for the bleeder or voltage divider resistor, R12, and one for the mounting of the screen-grid blocking resistors, R2, R4 and R6.

Construction of the Coils

The coils or inductances L1, L2, L3 and L4, shown in drawing, are wound on one-inch diameter tubing which may be either fiber or bakelite. The secondaries are all the same and consist of 120 turns of No. 32 enamel-covered wire. The antenna primary of L1 consists of 10 turns of No. 36 single silk-covered wire, wound over the lower or ground end of the secondary winding. The primary winding of L2 consists of three turns of No. 36 single silk-covered wire wound about one-eighth inch below the lower or ground end of the secondary winding. The coils L3 and L4 have primaries consisting of 50 turns of No. 36 single silk-covered wire, with the winding beginning at the lower or ground end of the secondary.

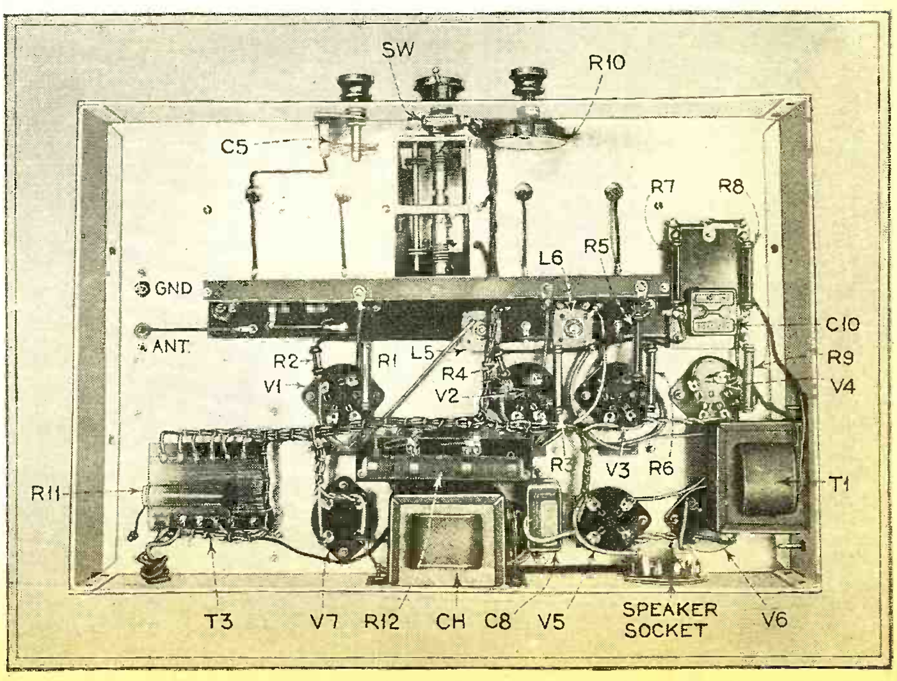
Assembly of Parts on Chassis

Mount all the sockets in their respective positions under the holes already cut out for them. The two filament prongs of each socket should be toward the rear of the chassis.

Next place all the coils on the strip provided, with the grid lugs toward the front. While holding the bakelite strip with the mounted coils in position the first coil shield can is fitted into place and fastened firmly with nuts. The ground return of the secondaries are now soldered to the nearest fastening screw and nut of the coil shield. This procedure is repeated for all the coils, L2, L3 and L4. At this time the balance of the coil lugs are fastened down solidly with soldering lugs and nuts.

The volume control, R10, is now

The arrangement of the parts on the bottom of the chassis is shown in this position. Notice the short leads and absence of confusion in the wiring



mounted in position to the right of the tuning knob, the midget trimming condenser, C5, to the left. The switch, SW, is mounted in the hole directly beneath the tuning knob. The four-gang tuning condenser is then mounted, followed by the mounting of the power transformer, T3, and the large electrolytic condenser, C11, for the "B" unit.

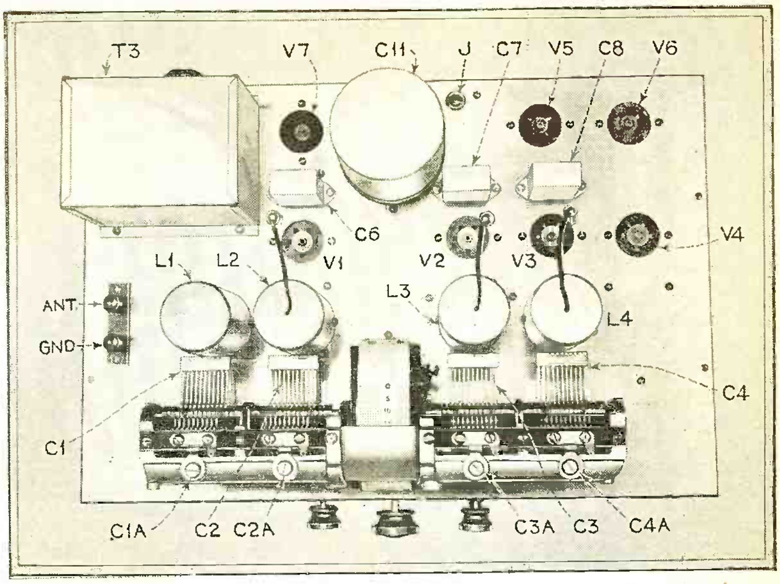
The three by-pass condenser units, C6, C7 and C9, are now placed in their respective positions and the resistor coupler for R7, R8 and C10 is mounted under the chassis directly in front of the first audio tube, V4. The push-pull input transformer, T1, and the filter choke, CH, are left off to facilitate wiring until the receiver is almost completed.

Wiring of the Receiver

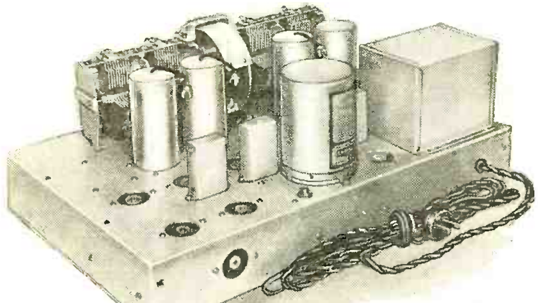
The filament wiring of the various tubes is now connected to corresponding lugs on the sockets.

The connections for the a.c. switch, the volume control and the pilot light are cabled together and brought out toward the filament leads of the r.f. tubes, being joined by the "B" power 180-volt lead about midway. The filament and power transformer leads are then cabled together. The grids of the tuning inductances, L1, L2, L3 and L4, are now connected to their corresponding tuning condenser stator plates which protrude through the four large holes on the top of the chassis near the front. Now connect C6, C7 and C9 to their respective tubes. The black leads of the by-pass condensers are common, the two blue leads are 0.1 mfd. at 200 volts working voltage, and the red leads are 0.1 mfd. at 300

(*Continued on page* 748)

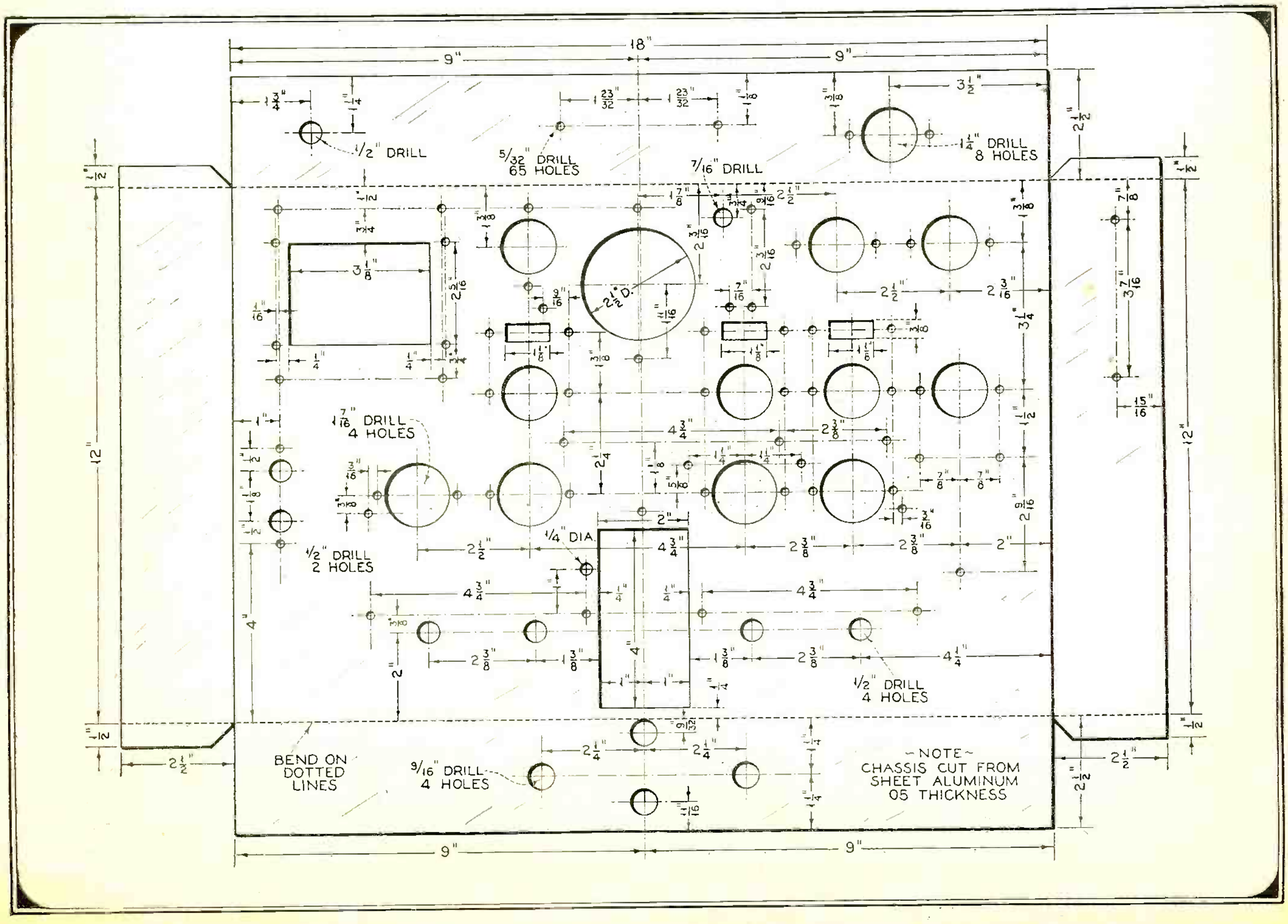


The top view of the receiver shows the shielded inductances placed immediately back of their respective tuning condensers. The corresponding tube sockets are placed as shown to enable short high potential leads in wiring



A rear view of the receiver, showing the convenience of the phonograph pick-up jack and the socket for the speaker plug

The layout dimensions, drilling data and shape of chassis plate are given in detail. The dimensions are marked on a sheet of aluminum cut to shape, before bending along the dotted lines



Getting the "JUNIOR

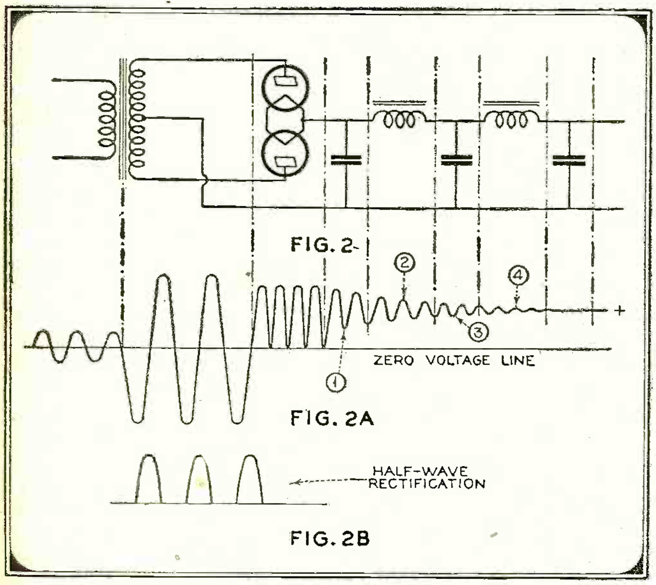
¶ You fellows who have gotten to the stage where you're just thinking about building that long-wanted short-wave transmitter will do well to occupy yourselves for the few minutes it takes to read Don Bennett's second article in his series on the construction of a typical beginner's transmitter.

¶ Last month Mr. Bennett described the mental perplexities of "Gus" and the solicitousness of his friend in getting him set straight on the path to the "first transmitter."

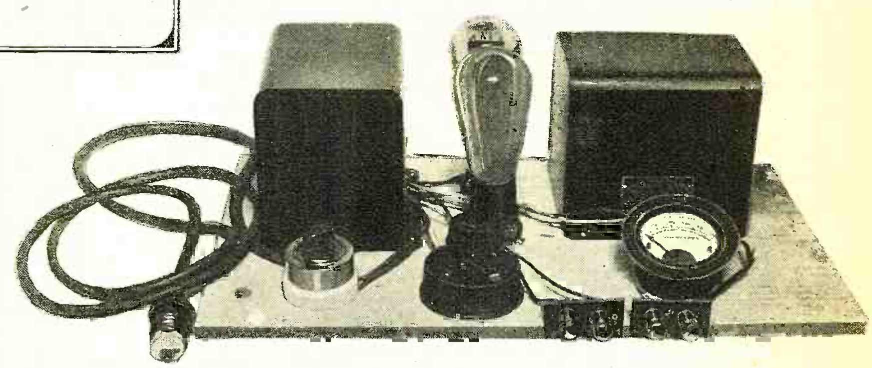
¶ This month Gus puts his Junior Transmitter on the air and Mr. Bennett describes the adjustments which must be made to the transmitter and power supply to obtain the best "note" and greatest "DX." THE EDITORS.

By Don Bennett

PART TWO



To the left, a diagrammatic representation of a power supply circuit, showing how, at Fig. 2A, the applied alternating current is stepped up, rectified and filtered. Fig. 2B shows the effect of half-wave rectification. Below is illustrated the extremely simple layout of the Junior Transmitter's power supply unit



"HELLO, Gus. When are you going to give me the dope on the power supply for my transmitter? It's been a week now since I finished the set and it's gathering dust waiting for a chance to perk."

"I'll be around tonight with all the dope."

"Oke. I'll sharpen all the pencils in the place for your funny pictures. See you later."

* * *

When Gus arrived at my house that night he opened up with, "How many kinds of power supply are there?'

"Easy. I know that one. Batteries and tube rectifiers."

"That all?"

"Yep."

"Wrong."

"Huh?"

"You're wrong. There are two kinds of battery supplies, dry cells and wet storage cells and the storage cells can be either the lead acid type or the alkaline. Then there is the motor generator and the dynamotor. Then for all a.c. work we have the power supply made up of a high-voltage transformer, a rectifier of some kind and a filter. For rectifiers we can draw on the electrolytic or chemical type, the thermionic which is the tube you mentioned, the hot-cathode mercury and the mercury vapor arc."

"Wow! How do you expect a guy to pick out what he needs from all that bunch?"

"That's just it, you pick out what you need, what best fits the purpose you intend to put it to. Also your pocketbook enters into the discussion to some extent. Batteries, while they give pure d.c., are expensive when you need enough volts to drive your 510's. For a low-power receiving tube job they're fine. A motor generator costs plenty, but if you live in a direct-current district there is not much else you can do except use a rotary converter to make a.c. and then use a regular a.c. power supply. The electrolytic rectifier is an old amateur stand-by but it is usually messy and always requires a lot of attention, filling the jars and reforming the electrodes if you are off the air for a while. The dynamotor is of course a help in country districts where the 32-volt system is all the power available.

"Then you have the hot-cathode mercury vapor rectifier that is ideal for handling high voltages and relatively high currents, but you don't need a voltage for your job high enough to warrant a rectifier of this type. The mercury vapor arc is also best for high voltages and currents, but the expense rarely makes it desirable for a low-power amateur installation.

"There remains the thermionic rectifier which is ideal for your purpose. It has a comparatively low cost, is easy to assemble and the upkeep expense is very low. For the current you draw, about 130 milliamperes, two -81 tubes will do the trick in a most satisfactory manner.

"Incidentally, when speaking of a power supply, don't forget that it is also necessary to supply current for the filaments of your oscillator tubes. You can buy a transformer with filament windings wound right on it for the rectifier tubes and also for your oscillator filaments. This makes a very convenient layout and also reduces the expense somewhat; always a desirable feature.

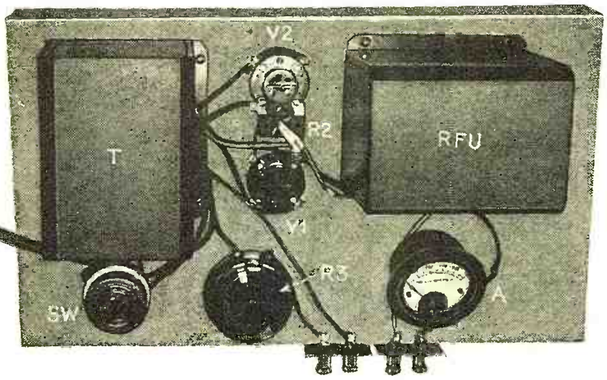
"The new Government regulations require a direct-current plate supply in the interests of good transmission and reduction of QRM (interference). Direct current means that your rectified a.c. must be filtered and well filtered. In addition to that it must be capable of maintaining a constant voltage,

"Transmitter" *on the Air*— *The* Power Supply

Last month the breadboard "Junior Transmitter" was described. Here are given the details for constructing the power supply unit for an extremely efficient type of short-wave transmitter. The author has intentionally built the outfit in the simplest way possible so as to make it extremely easy for a newcomer in the amateur game to duplicate the construction as described

otherwise your signals will fluctuate and produce modulation of your frequency. A high-C circuit such as we are using, with a large capacity in the tanks of the transmitter will help maintain stability of your frequency, but it is best to build your plate supply so that the whole transmitter will be as efficient as possible. Poor regulation, that is, a large variation in the load and no-load voltages, will cause chirps when the transmitter is keyed, and that is very undesirable.

"Let's make up a list of the parts you need and draw out the circuit. Then we can build it up and discuss the filtering action. Here's the circuit (Fig. 1), and you can see that you'll need a transformer (a General Radio type 565-B will do nicely), two sockets, one for each rectifier tube, two 2 mfd. condensers, a 4 mfd. condenser and two chokes. The General Radio rectifier filter combines all these and simplifies the wiring and mounting jobs. Then you'll need a rheostat for the filaments of the oscillator and we'll mount that right on the power supply. Then we should have a bleeder resistor to put across the output in order to have a drain regardless of whether or not the transmitter is oscillating. It improves regulation immensely because it drains the condensers and prevents them from getting all charged up with a lot of hop that is released when the key is pressed causing a surge, possible frequency shift and a lot of conditions not found in the well-operated transmitter. This resistor should be of such value that it draws about 10% of the total plate current. We'll use a 25,000-ohm resistor. Then we'll need in addition to the baseboard some more of those 138-Y binding posts we used in the transmitter and miscellaneous screws and soldering lugs. Then we'll need a center-tap resistor for the center tap of the -81 filaments. It would be a good idea to have this adjustable so that you can get the exact center. That will help to get pure d.c.



In this top view of the power supply the parts are lettered to conform with the circuit diagram given below

"In constructing the power supply, there are several points to remember. Perhaps the main one is—use good heavy wire all through. The filament circuits carry several amperes and should be fused in addition to main fuses in the primary circuit of the transformer. Then it is always a good stunt when hooking up the plates of the -81's to solder your wire to both grid and plate terminals on the sockets. Occasionally, but fortunately not very often, the plate lead is brought out to the grid prong by mistake, and unless you have taken the precaution to short the socket contacts you won't get any juice through. It is a good idea to put a fuse of the proper size, say ¼ ampere, in the high-voltage line in case anything goes wrong in the transmitter; it'll save a lot of expensive equipment maybe!

"It is sometimes a wise plan to mount the power pack on a metal baseboard, say aluminum about 1/16th inch thick, reinforced with a wooden base. It is possible, but not as good, to use a heavy aluminum foil, soldering all joints in several places to form good bonding and then grounding the whole. It has been found in certain instances that this will help clear up a poor note. Might be a good idea to start off with it.

"Maybe it would be a good idea to explain to you just how the filter works to give you d.c. Then you can dope out for yourself just what is necessary if you don't get it immediately. Incidentally, you can test the filtering with a pair of earphones in series with the power supply, but *don't put them on your head;* let them lay on the table and if you can't hear any hum from six inches away, you are getting as near d.c. as you want. Remember, *don't* put them on your head. Several hams that have tried it are now only memories. Six hundred or so volts across the (*Continued on page* 750)

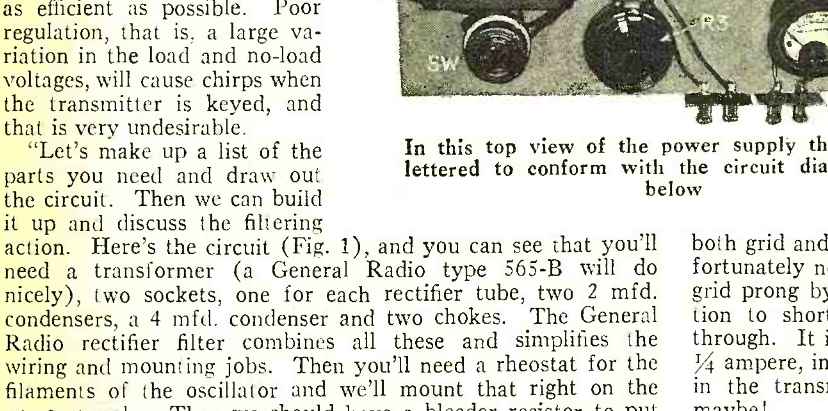


Fig. 1. Circuit diagram of the power supply device. The lettered symbols refer to the parts employed as follows: T, General Radio 565-B transformer; V1, V2, type 481 rectifier tubes; R. F. U., General Radio 527-A filter unit; R1, 25,000-ohm bleeder resistor; R2, General Radio 437 center tap resistor; R3, General Radio 214-A rheostat, 2 ohms, 2.5 amperes; A, Jewell 0-150 or 0-200 milliammeter

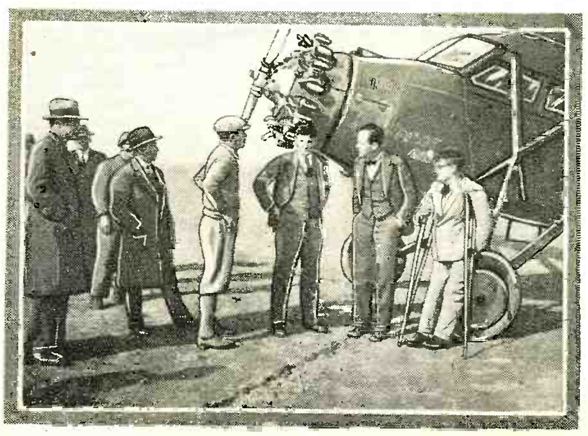
Tests, Tangos

This is the second of Zeh Bouck's articles flight of the "Pilot Radio." In it are including what is believed to be a Bouck worked the New York Times some interesting adventures between tains pictured above are "The

WITH the successful conclusion of our radio tests with the New York *Times,* the crew of the good plane "Pilot Radio" directed their inquiring minds toward the diversions of Colon and Cristobal. Cristobal, C. Z., is a city within the city of Colon, Panama; a technical frontier demarking the Canal Zone, which is U. S. A. territory, from the Republic of Panama. Previous to the prohibition law it was difficult to tell where Cristobal ended and Colon began, but now with one side of a street lined with bars and cabarets and the other with candy shops and souvenir establishments, the international boundary is readily identified. Unfortunately, most of the souvenirs are acquired on the Colon side. The Hotel Washington is owned by the U. S. Government, and is located just within the limits of Cristobal. The hotel is technically dry—like the U. S. A. However, if the weary traveler dining in the hotel's beautiful salon craves an automatic alcohol rub the head waiter will send around the corner (like any efficient headwaiter in the States) for the desired stimulus. But you must consume it in the dining-room. Under no circumstances must the drink be conveyed, extra-abdomen, to another part of the hotel. This would be a violation of the national prohibition law.

But the Boulevard Bolivar is definitely outside of Cristobal—both sides of the street. Here are located the Atlantic and Metropole cabarets and one hundred similar establishments concentrated within the ten short blocks of "boulevard." A business depression is unknown to these oases—as a matter of fact, it is the one place in Panama where people go to escape from the effects of business and other depressions. And with relays of bartenders these places thrive twenty-four hours a day, three hundred and sixty-five days a year, regardless of holidays, religious and secular. These cabarets are well populated by a species of female, self-styled "artists" and "entertainers." The matter of entertainment is rather doubtful, but artists they are in making money for their particular cabaret. They cast themselves rapaciously at your table, and you buy drinks for yourself and them. They invariably order something fancy, such as an "Atlantic Cocktail" or the "Metropole Punch"—a thimbleful of white liquid served with a tiny straw in a liqueur glass. If you are of an inquiring turn of mind, you will investigate and discover that this ambrosia is weak milk—at one dollar per weakness. When the bill finally comes through you will fight with the manager over paying eight dollars a bottle for champagne but smile complacently when dealing out one hundred dollars a quart for milk. And both the milk and the girl are well skimmed.

THE ability to operate a radio telegraph transmitter has, from days of Marconi's early experiments, been a free pass to world-wide adventure and the finest foundation for the development of a lucrative engineering profession. Horace Greeley might say today—"Learn wireless, young man"—visit distant lands, afloat or awing, developing at one time a background of experience and a knowledge of fundamental science, that will contribute immeasurably to the success of whatever vocation you may choose in later years!



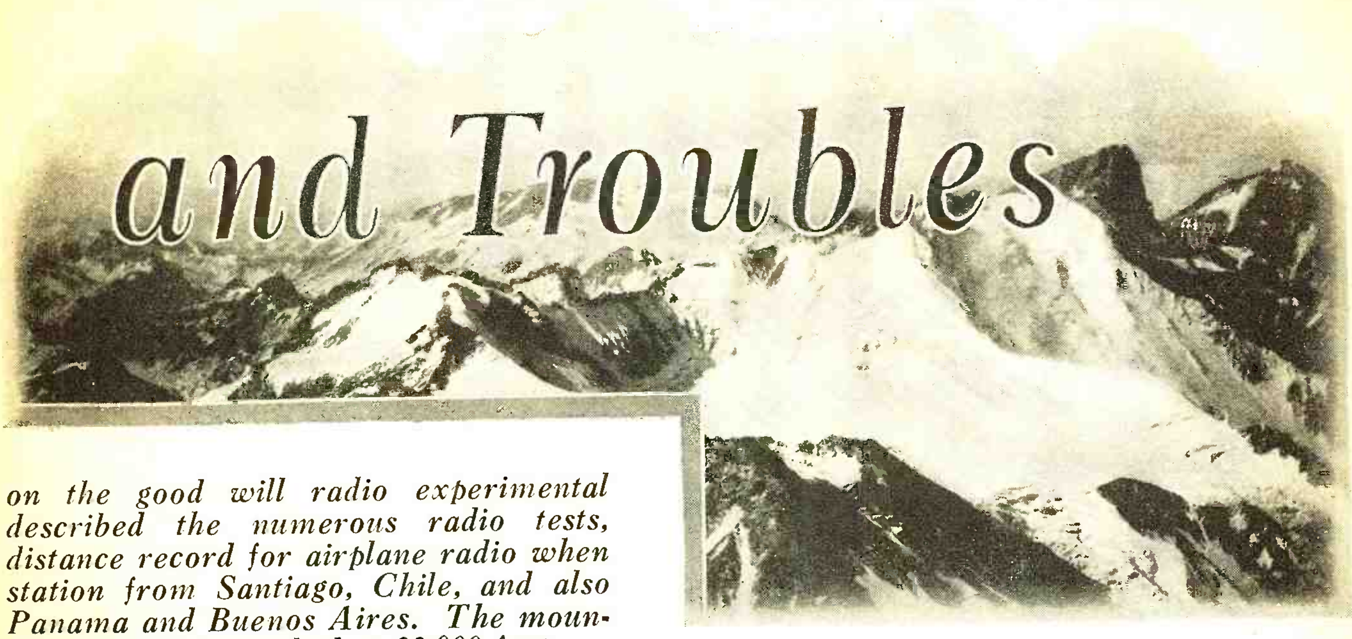
The arrival at Santiago de Chile, after a forced landing, the night before in a cow pasture at Quinteros. The crew of the plane, standing right to left, are: the author, Captain Yancey, commander, and Emil H. Burgin, pilot

Deserted in Panama

The next hop of the "Pilot Radio" was from Panama to Talara, Peru. There were no intervening fields for a land plane and a straight line measured twelve hundred miles with two-thirds of the flight over the water. Filling the wing tanks, we could carry enough gas to make it with a reasonable margin of safety. However, Burgin was skeptical of the plane's ability to get off with a full load from France field—not overlarge and softened daily by the afternoon rains. So it was decided to leave me behind, with all luggage, to follow the next day on one of the regular Pan-American-Grace planes that fly from Panama to Santiago de Chile. It was with mingled sentiments that we saw them off at daybreak Sunday morning, June the eighth. The idea of an eight-hundred-mile over-water hop in a land plane had no particular appeal to us, and yet, in the possible advent of trouble, we might be of more service on the plane than in Panama.

In an effort to improve the

and Troubles



on the good will radio experimental described the numerous radio tests, distance record for airplane radio when station from Santiago, Chile, and also Panama and Buenos Aires. The moun- Hump," photographed at 22,000 feet

cooling of the motor, which had been running rather hot, most of the cowling had been removed, as well as the exhaust ring, the exhausts stabbing the morning twilight with sharp blue flames as the motor "revved up." The plane taxied down by the officers' quarters and headed into the longest stretch of field. Eddie Burgin gunned her tentatively. We shook hands with both him and Yancey, and they were off. From our position it seemed as if the plane were sluggish and would never rise. The forty-five seconds between the first slow lurch and the visible lifting of the wheels were interminably long. A mile away, as Eddie zoomed the plane over the housetops, we saw there was plenty of climb in the old bus and realized that another hundred and fifty pounds or so would have made a negligible difference. However, here we were in Panama, for a whole day, with nothing on our mind but sandflies.

Back in the operations office, we learned by radio that bad weather between Washington and Atlanta, Georgia (!), had held up the Pitcairn mail plane, southbound for Miami, which in turn delayed the Miami, Havana, Puerto-Cabezas, Panama, plane. This meant that our plane would not get off until Monday afternoon at the earliest. It later turned out that the Miami plane stuck in a soft field at Puerto-Cabezas, and we did not leave Panama until Tuesday morning.

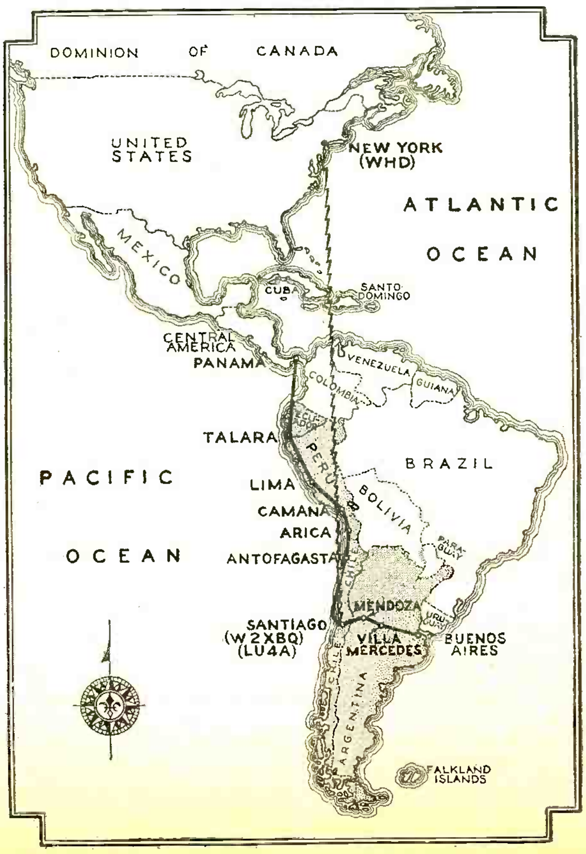
Entertaining Peruvian Royalty

It's a small world. That evening, while finishing dinner in the dining-room, a familiar figure walked up to the table. It turned out to be a Peruvian whom we had once considered as a possible participant in our good-will flight. When he informed us that he was staying at the Peruvian Consulate, we immediately dispatched him for a Peruvian visé on our passport—the only visé we really required for entry into South America. He returned in a half hour with the desired credential and signified his wish to see the town—to go places and do things. We took him to Bilgray's, where Evelyn Nesbit is thawing out in the tropics, and then to the Atlantic. About one a.m. we assumed charge of his pocketbook, and shortly after four in the morning, closing time in the cabaret section of the Atlantic, we deposited him gently on the steps of the Peruvian Consulate, tucked his money back into his pocket and left the Señor in a beautiful state of diplomatic immunity.

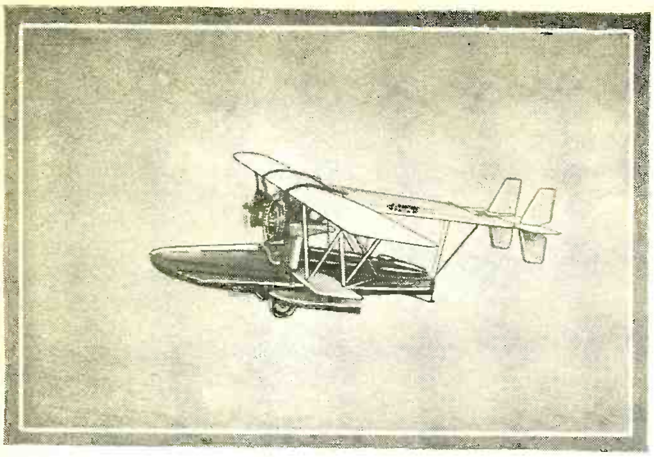
South America

Tuesday morning, shortly after daylight, we took off in a Panagra duck (the Sikorsky amphibian) with Dinty Moore at the controls. We were accompanied by a flight mechanic, radio operator and one passenger, an Englishman. The passenger found occasion to remark that "Dinty" seemed a rather unusual sort of a given name and inquired as to its philological significance. We informed him that it meant absolutely nothing—that every Moore was a Dinty Moore. "Rubbish," replied the Englishman, immediately referring to Thomas Moore, and we each gave the other up as hopeless.

We hedge-hopped across the Isthmus to the Pacific side and flew low over the water under a falling ceiling. We ran into several rain squalls, skimming the ocean like a skipping stone, and out into the tropic sun again just north of Buena Ventura. We gassed up here, and found it next to impossible to take off with the heavy load on a mirror-like bay. Dinty would give her the gun and rock her for all he was worth, the hull porpoising into the blue sea like a submarine. Finally he taxied her around, crossing his own wake, and, with the vacuum broken under the hull, got the boat up on the step and finally into the air.



The flight from Panama to Buenos Aires described in this article. The wavy line shows the record radio communication between the plane and WHD



The Panagra Sikorsky amphibian on which the author flew from Panama to Talara, Peru, and from which he communicated direct with Miami while approaching Guayaquil, Ecuador

It was just about this time that Dinty discovered that he had divided the gasoline between the wing tanks and the seat of his pants. He began moving about with the jerky technique of a chicken on a stove, finally swung the controls over to the flight mechanic, took his pants off and held them out in the slip stream. The Englishman wanted to know why he was doing this, and I explained that it was customary to signal a port upon leaving, that we had forgotten our flags, and that Dinty was doing the next best thing. This explanation seemed logical and our friend subsided with an "Oh. I say, quite interesting."

Three hours later we dropped in on Tamacao, in Ecuador, and just at dusk we arrived at St. Helena, where we put up for the night.

We took off the following morning, at dawn, and flew across the mountains to Guayaquil. En route the operator worked WKDL at Miami, Florida. Two additional passengers, a man and his wife, boarded the plane at Guayaquil, which left us short exactly one seat. So the radio operator went aft while I took his chair and stood his watches. About nine-thirty in the morning, Talara, dry and dusty, climbed up over the horizon, and we could smell the oil minutes before we landed.

Talara is the South American base of the International Petroleum Company, and here, concentrated within a few hundred square miles, is one of the largest oil-producing territories in the world. About two degrees south of the equator, the climate is most equable and delightful. The nights are so cool that natural gas is burned in the fruit orchards to take the chill out of the air. The International Petroleum Company employs some twenty thousand men in Talara. At the time of our visit there were eighteen white women distributed among Talara and two towns, five and ten miles south, fifteen of whom were wives of officials. This feminine paucity is somewhat of a problem, and the company's doctors, two very wise medicos, recommended that a reasonable supply of women be imported. However, this advice did not appeal to the company, and they got two new doctors instead.

Talara had apparently been a little too much for Yancey and Burgin, and they had taken off Monday for Lima. We were to follow on the first Panagra plane. This enforced a stop-over in Talara for three days, during which we listened to the Schmeling-Sharkey fight via short-wave radio, which, by the way, was rather a thrill. Bocaccio and short-wave radio are the principal recreations in Talara.

The Land of the Incas

From Talara down we flew over a land where desolation itself approaches grandeur. Barren mountains, rising five thousand feet above the sea, claw with jagged peaks at a blue and brazen sky. The hills are without foliage and the brilliant sun casts them into highlights and shadows, like mountains on the moon. Here and there, crowning some sandswept peak, is an Inca temple, reliquary of an ancient race who saw, with Maxfield Parrish, a stimulus to worship in the mystery of bleak shadows. In the valleys and on the plateaus Inca cities flow with the sands of time into the dust that surrounds them. Just below Trujillo are the ruins of an old civilization—a city that before the coming of Pizzaro thronged with half a million people.

Only as the plane approaches Callao, the port of Lima, is the monotony of the barren waste relieved by a touch of green, and at Lima we land in a fertile valley.

As we circled the field we saw the "Pilot Radio," red and a glint of gold, awaiting us on the line-up. And we found the remainder of the crew in the Grand Hotel Bolivar, sitting around with watches in their hands. It seems that someone had invented a "six o'clock club," the members of which pledged themselves to soft drinks before six o'clock in the evening. It was now four-thirty, and the strain was pretty bad. Finally they compromised and decided to go by New York daylight saving time.

Every once in a while the six o'clock club was revived, but it never met with any continued success.

Our Evening in Lima

Yancey and Burgin were well acclimated to Lima by this time—indeed, they were rather blasé Peruvians, and, with an early start ahead of us the next morning, they were for turning in as soon as the six o'clock club adjourned. Ordinarily this might have been a somewhat indefinite hour, but tonight they left us to ourselves and Lima at about nine o'clock, with the suggestion that we take in the only sight in Lima, a dancer by the name of Firpo who put on quite a show at a cabaret called the "Greasy Spoon." We wandered over there about ten, found a table and sat around expectantly. At eleven, the place was rapidly becoming deserted, so we tossed a yawn and a few pesos at a waiter and returned to the hotel. The next morning we bitterly upbraided the remainder of the crew.

"So you call this a wild town?"

"It sure is. How'd you like Firpo?"

"Firpo? Good lord, the show was over when I got there and they started closing up the place at eleven."

"The show was over? Why, the show doesn't start until two a.m.!"

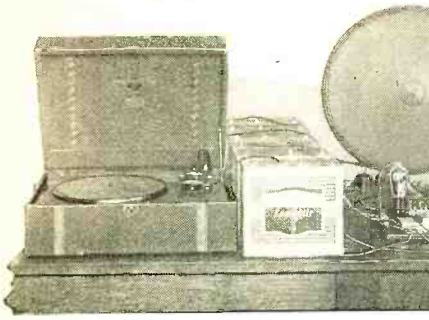
And so we'll have to go back to Lima one of these days, to stack Firpo up against Texas Guinan and Helen Morgan.

It appeared that my friends had seen both Firpo and the American Ambassador while in Lima, and his excellency with the ambassadorial staff was on the field that morning to see us off. (Firpo was not in evidence.) We got off to an early start, but twenty minutes south of Lima the oil pressure dropped, and we were forced to return.

We lost an hour or so, which made our arrival at Arica that evening somewhat problematical. Ten miles south of Lima the grass and verdure blended off into desolate desert again, and the hills and mountains unrolled beneath us. Far to the left, perhaps a hundred miles inland, Las Cordilleras, or Los Andes, towered ten to fifteen thousand feet above us, vast snow-covered vertebrae extending three thousand miles along the backbone of South America. (*Continued on page* 734)

On the Las Cerillos aerodrome, Santiago, for a radio test with the New York *Times* station. The plane is surrounded by the Chilean army. Bouck is in the plane, with Captain Yancey standing alongside

The equipment set up in RADIO NEWS laboratory. From left to right, turntable "B" batteries, amplifier and "A" batteries



A Two-Volt Tube Loftin-White Amplifier?

By George E. Fleming

We present this article in response to repeated demands from our readers for a Loftin-White battery-operated audio amplifier, using the new two-volt tubes. In spite of minor drawbacks, the circuit is excellent and one that will find varied uses in the hands of the experienced experimenter

WITH the advent of the new battery tubes of the 232 and 231 type, a new convenience has been offered the radio public. In these tubes, all the ruggedness and economy of a.c. tubes is had, and by operating them from the new "Air Cell," one is relieved of the necessity of either recharging storage cells, or frequently replacing dry cells. It is only natural, therefore, that many of our readers wanted a Loftin-White amplifier circuit utilizing these tubes.

The actual design of such a circuit was simplicity itself, but the circuit had obvious drawbacks that made us hesitate in offering it to our readers. However, the requests have continued to come in at such a rate that we have decided to design the little amplifier, and present it, being very frank about its advantages and disadvantages. When the job was finished and hooked up, we decided that the disadvantages were very much less than we at first thought.

Looking at the photograph above, we are immediately struck with the very small size of the amplifier, by comparison with the associated apparatus. Actually, the entire unit was built on a baseboard 7 by 9 inches. This board should be thoroughly dried, stained, and shellacked, such treatment being necessary to insure good electrical insulation, and to prevent moisture absorption in the future. The necessary parts should be mounted on the board in somewhat the same manner as is shown in Fig. 2, although this exact layout need not be followed. The tube sockets here are at the extreme top of the base board. This is so that the connecting wire from the plate of the first tube to the grid of the second tube could be run direct, and kept isolated from the other wiring in the circuit. The low capacity effect thus obtained is largely responsible for the excellent high-frequency response. Another contributing factor in the reduction of capacity effect is the fact (*Continued on page 736*)

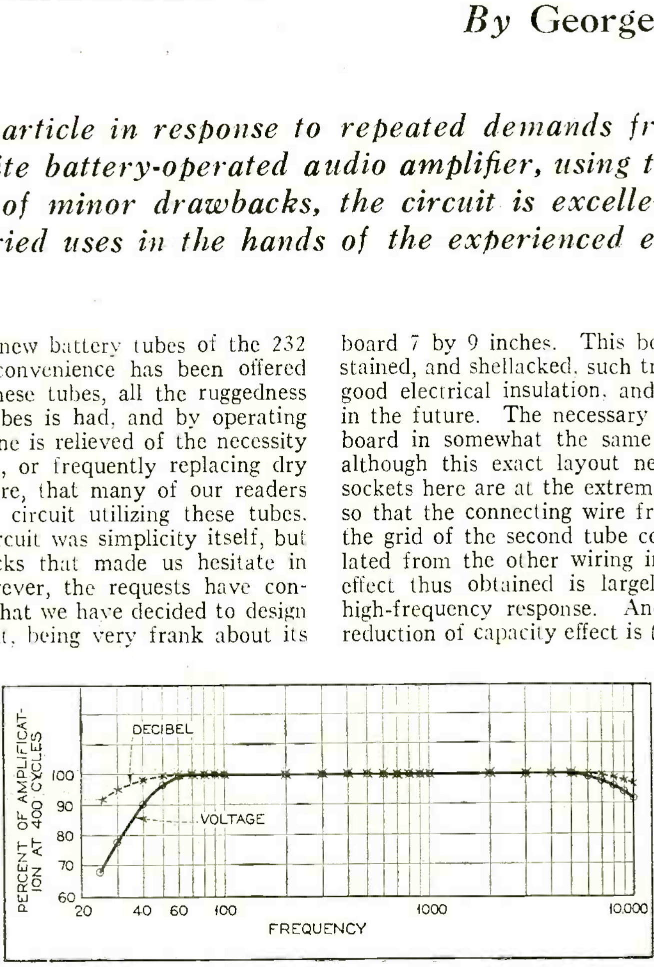
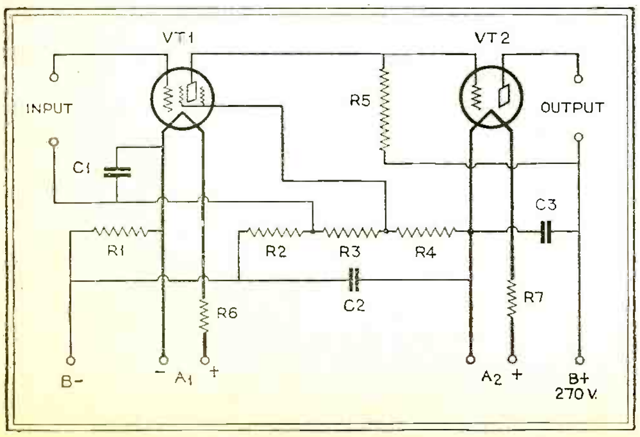
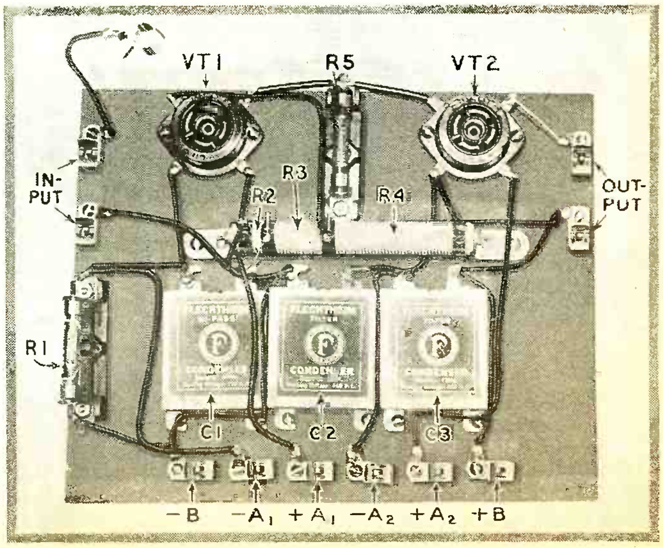


Fig. 3, to the left, shows a practical flat response from 60 to 5,000 cycles, with only a slight falling off at 10,000 cycles

Fig. 2. (Below) A photograph of the completed amplifier, showing the layout of the various parts and its general simplicity of construction

Fig. 1. (Below) The schematic circuit diagram of the battery-operated Loftin-White audio-frequency amplifier. Notice that the diagram corresponds quite closely to the actual parts layout

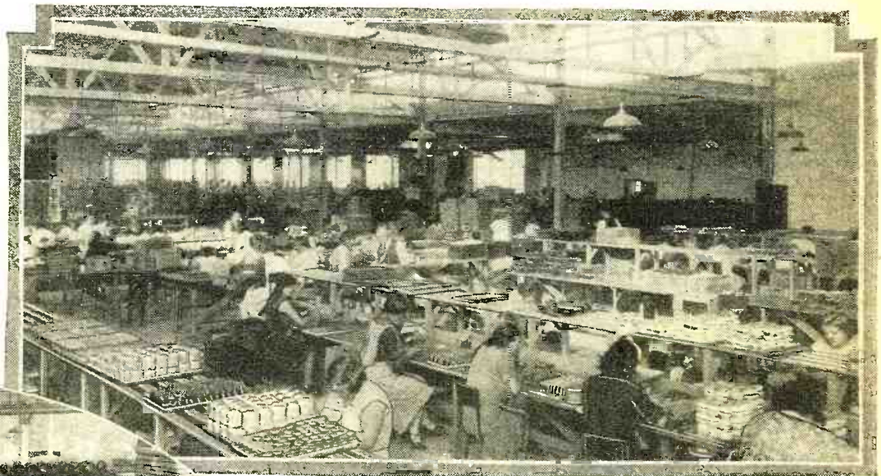


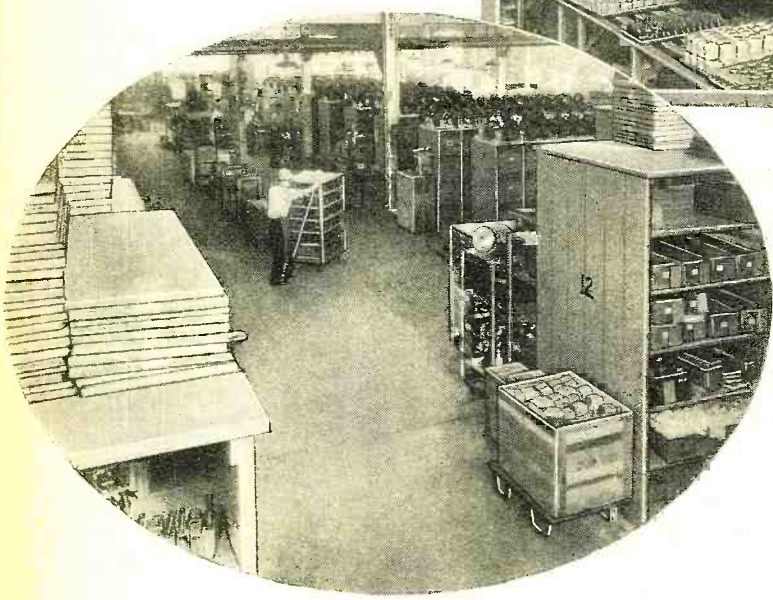


From Circuit Desig...n

A pictorial trip through the factory of stock rooms, coil winding department, design This is another of the picture displays in radio plants and

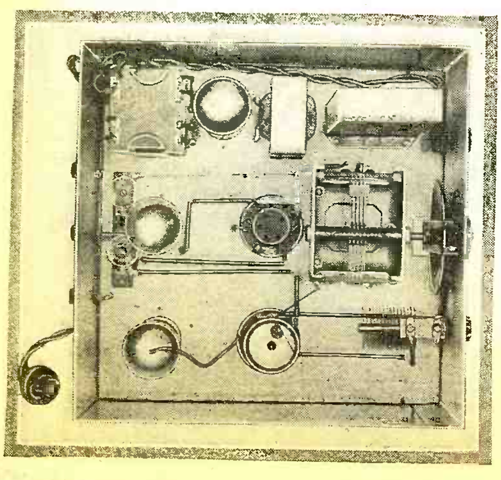
McMurdo Silver, founder and president of Silver-Marshall, Inc., one of the largest manufacturers of radio parts and custom-built superheterodynes in the world





Above, the coil winding department where the enormous number of coils are made that are required daily in the construction of Silver-Marshall Superheterodyne receivers. At the left is the 12,000-foot, centrally located stock room into which all material flows and from which it is drawn as needed by the various departments. All preliminary inspections of raw materials are also made here which greatly speeds up operations in manufacturing departments

(Right)
Because of the precision methods of manufacture required in the making of superheterodynes, all wiring in Silver-Marshall receivers is pre-formed and laced into cables by forty girls in this Cable Forming Department

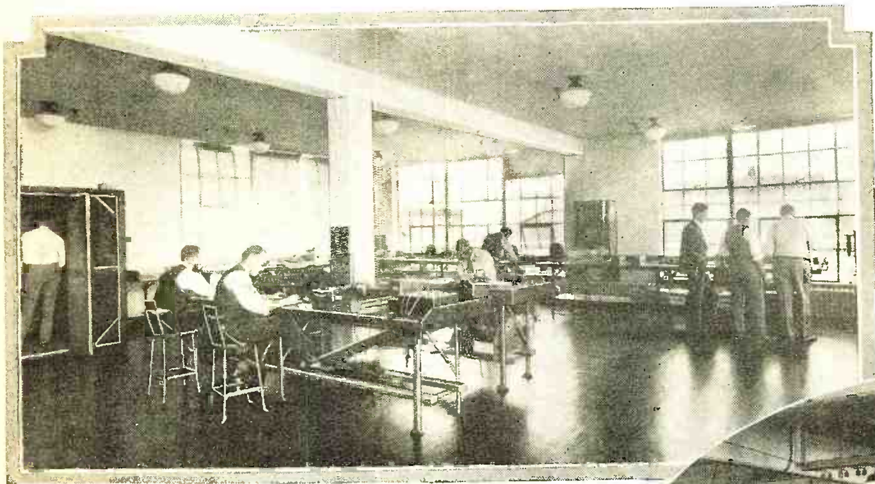


(Left)
Top view of an S.-M. 738 Short-Wave Converter, showing the exactness with which assembly is carried out at the Silver-Marshall factory

to Freight Car

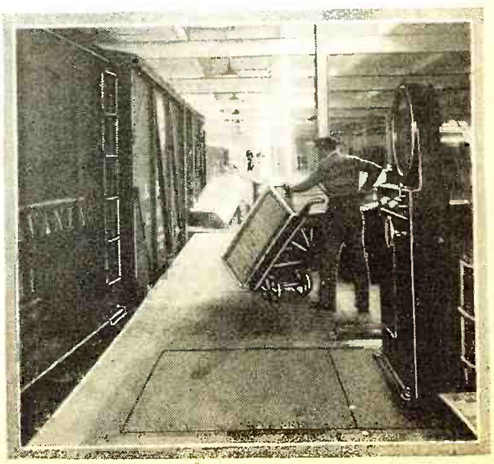
Silver-Marshall, Inc. showing the huge laboratory and production test positions. the RADIO NEWS series showing modern manufacturing procedure

William J. Frisbie, for four years Factory Superintendent with Silver-Marshall, Inc. The present plant was laid out to his specifications



Above, part of the research laboratory at the factory, where the all-famous S.-M. circuits are developed. From here they go downstairs to the factory laboratory, where working models are designed. From the production lines, which are pictured at the right, the completed receivers go over a conveyor system through the test booths, where the tuning condensers are aligned and the receivers are tested for sensitivity

(Left)
Detailed view of one of the six testing booths at the Silver-Marshall factory. These booths are arranged strategically along the production line, the receiver chassis entering through a window, shown at the left



(Right)
The standard-gauge railway terminal in the Silver-Marshall factory, where raw material is unloaded. Freight cars are reloaded with outgoing merchandise before they leave the plant

A Universal Power Amplifier—Speaker Unit

By James Millen*

Good tone quality is a prerequisite of satisfactory radio entertainment. Thus we presuppose the use of a good audio channel and a suitable loud speaker. The unit job described here has been designed with these outstanding features in view and, as is pointed out by the author, is suited also for use with home talking movie outfits

THE development of three orders of home sound entertainment—the radio, the electrical reproduction of the phonograph, and the home talkies—demanded a single satisfactory amplifier-speaker combination for the most economical enjoyment of these modern day recreations. Offhand, it might appear that there is little if any difference between the reproducing techniques associated with phonograph records and the similar disks accompanying the various sound films now available for home production. However, phonograph records are recorded under ideal sound conditions, while the records accompanying films are necessarily made under circumstances contributing first to good photography, which often limits the advantageous placing of the pick-up and the acoustic properties of the set. Also phonograph recordings are almost exclusively musical, which effectively hides a multitude of distortive sins, while the slightest lack of naturalness in the sound-film *speaking* voice is immediately irritating, even to the average ear. This detracts from the illusion of sound and sight identity, which, at its best, is rather tenuous. And with the probable introduction of sound-track recording (on the film itself) in home talkies, the universal amplifier must assume the major responsibilities associated with still another system of sound reproduction.

The essential differences between the sounds of the various reproduction systems is a matter of quality, in the order of radio first, the phonograph second and movie recording last. These variations are fairly predictable and consistent frequency discriminations and can be corrected either electrically or acoustically. When employing a moving coil speaker, the ratio of bass to treble reproduction can be varied through a considerable range merely by altering the degree of baffle—by moving the speaker closer to or farther away from the hole in the baffle board or cabinet. A movement of one-half inch is generally sufficient.

It was determined, as a starting point, to design a well-nigh perfect amplifier and speaker unit—a combination characterized by practically straight-line amplification and reproduction over the entire audio spectrum. By making the unit compact, the variations in baffling effects would be facilitated and the combination might be described as truly universal.

The circuit of the amplifier is shown in Fig. 1. This is unconventional in several respects. The bias to the first audio amplifying tube is secured by an IR drop through a resistor that is also part of the "bleeder" network, providing a grid voltage less influenced by instantaneous values of plate current, which practically eliminates frequency distortion and the introduction of harmonics. To achieve a similar effect with the usual system would require a by-pass condenser in the order of ten microfarads across the biasing resistor.

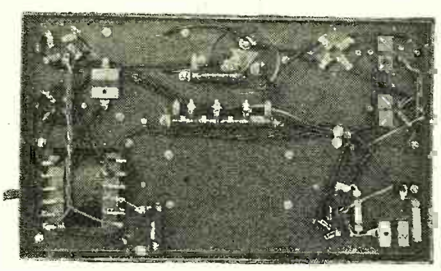


Fig. 3. (Below) Sub-panel view, showing the transformer and resistor connections

Fig. 5. (Right) The amplifier-speaker unit may be easily mounted in the standard console type of radio cabinet. It is shown here used in conjunction with the National MB-30 radio-frequency unit

A protective resistor is connected in the positive lead, next to the rectifying tube. This protects the tube during the surge period when the electrolytic filter condenser is forming. Its inclusion also reduces the peaks of the current wave which are generally responsible for the rapid deterioration of the rectifying filament. The filter condenser is protected from line surges, at the same time insuring the rectifying tube against immediate dissolution should a short circuit occur or one of the push-pull tubes break down.

The first amplifying stage is resistance coupled to the output of the detector tube, which eliminates the possibility of hum pick-up due to the proximity of inductive circuits to the power transformer. When the combination is used with a radio receiver—the r.f. amplifier and detector—the amplifier-speaker unit will be necessarily spaced sufficiently from the detector to

*National Company.

JAMES MILLEN hardly needs any introduction to readers of RADIO NEWS. *For the past five years he has been intimately identified with the design of some of the finest audio and radio amplifying apparatus. The unit described here is only one of the many excellent designs of his and we have no hesitation in recommending its use to our readers.*
THE EDITORS.

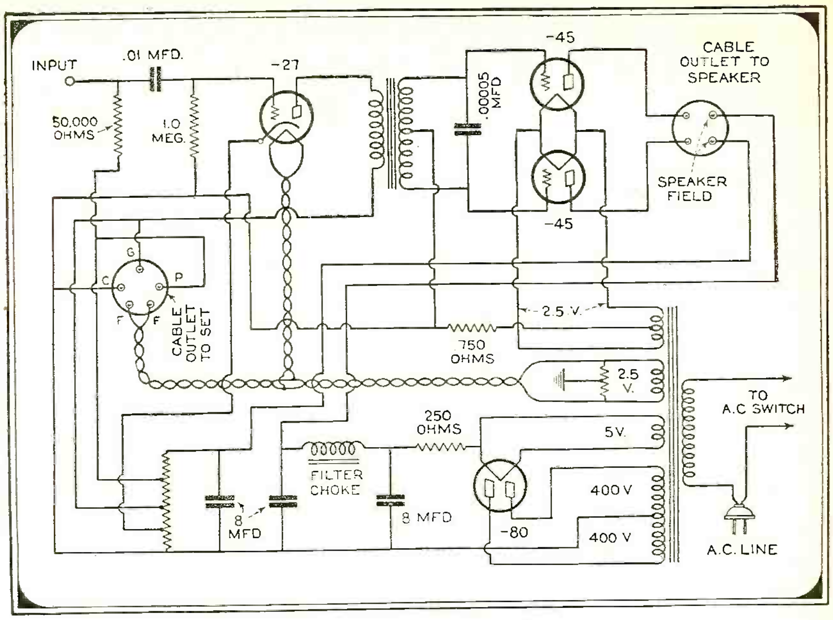


Fig. 1. The circuit diagram of the universal amplifier-speaker unit for radio, phonograph and home movies

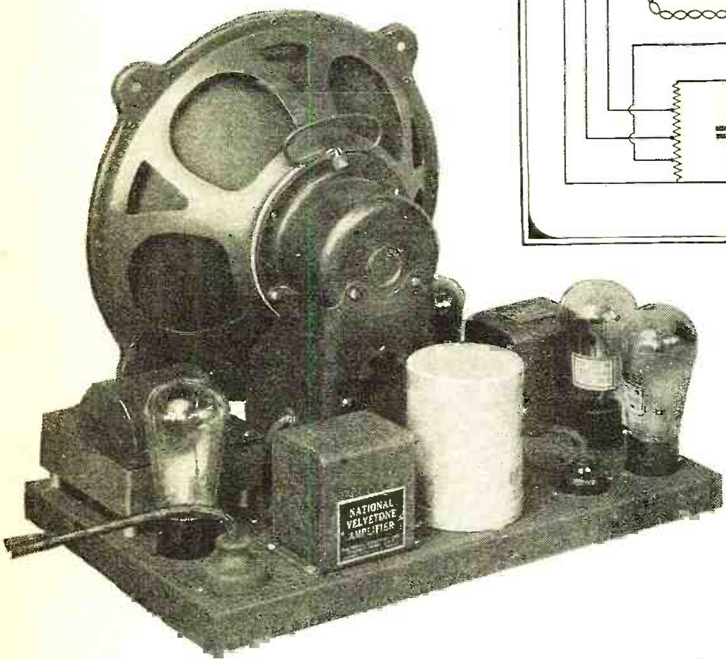


Fig. 4. The complete amplifier-speaker unit, representing several electrical and mechanical features of sound reproduction engineering

eliminate hum pick-up at that point. The result is (always providing a properly designed r.f. unit is employed) a complete radio installation with the lowest possible hum factor.

A relatively low voltage is applied to the plate of the first audio tube. The value selected is the lowest voltage sufficiently high to swing the grids of the push-pull tubes well over the distortionless maximum without introducing distortion in the first stage itself. The lowered first tube plate voltage results in a reduction of plate current with the virtual elimination of second and third harmonic generation due to core saturation in the push-pull input transformer. Laboratory measurements indicate an increased amplification of the bass notes in the order of 30 per cent. with this sub-normal plate voltage due to the utilization of the maximum primary impedance.

The secondaries of the push-pull transformer are independent of each other, being wound in opposite directions, to obtain truly balanced performance. The core of the push-pull transformer is of a new high permeability nickel iron, resulting in a compact transformer with an improved frequency curve.

The overall characteristics of the amplifier are shown in the curve, Fig. 2. The slight rise at 5,000 cycles occurs in that part of the audio-frequency spectrum where attenuation is particularly noticeable in both radio and recorded sound—due in the first instance to the general falling-off characteristic of most broadcasting stations, and in the records, to the wear on the needle and on the high-frequency tracks.

The amplifier output transformer is built directly into the speaker by the manufacturer, insuring correct operation, in reference to input impedance, regardless of the type speaker. A new type of transformer has been developed for use with this unit. Pitch and similar sealing compounds have been avoided, and the transformer adequately mounted in the open air, providing more than sufficient ventilation even when the unit is completely enclosed in a cabinet. The filter condensers are of the recently developed self-healing dry electrolytic type having a total capacity of 24 mfd. and insuring quiet, hum-free operation. Modulation hum and line noises, so frequently an undesirable characteristic of power amplifiers, have been eliminated in this design by the inclusion of an r.f. filter in the a.c. line.

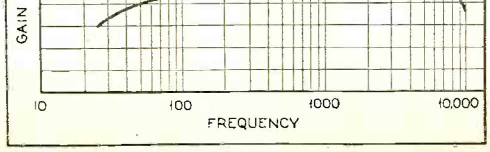


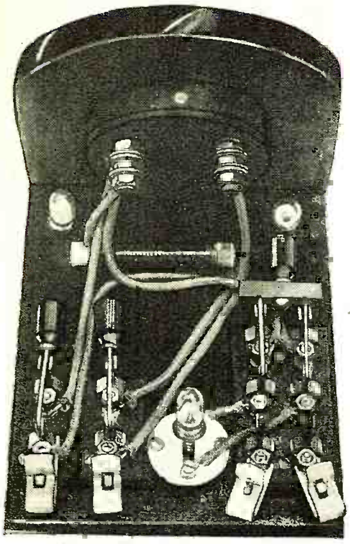
Fig. 2. The over-all frequency characteristics of the amplifier-speaker combination

The speaker has a 500-ohm field and is mounted in the front center of the amplifier chassis. It is connected electrically to the amplifier by means of a readily detachable plug and cable arrangement, making it possible to ship the speaker separate from the chassis without complicating the final assembly and installation. The amplifier-speaker combination is connected to the receiver, to supply the necessary filament and plate operating voltages, by means of a similar cable. The amplifier input is connected to a single binding post, regardless of whether the amplifier-speaker unit is operated from a radio receiver, phonograph or other reproducing device.

The amplifier-speaker combination requires one type -27 tube, two type -45 tubes and one -80 rectifier.

When employed to amplify and reproduce the output of any high-grade r.f. amplifier unit this amplifier-speaker will provide perfect reproduction with the average degree of baffle, such as is generally afforded by the cabinet area surrounding the speaker hole. With such a receiver, the speaker will be pushed firmly against the opening. The general design of the unit is such as to facilitate placing and adjustment in almost any standard console type of cabinet.

The method of frequency compensation is obvious and simple. The closer the speaker is to the opening, the greater the ratio of bass to treble reproduction. If the output is muffled or drummy, there exists a preponderance of bass, and the speaker should be moved back slightly. As the baffle effect is decreased, the emphasis of the low notes will disappear, until finally reproduction (*Continued on page* 745)



How to Build A

Lieut. Wenstrom comes to the assistance of the radio experimenter who is unable to afford costly electrical measuring instruments. With the comparison meter and different size miniature bulbs, he tells how various measurements may be made that are comparable in accuracy to those of the expensive laboratory standard instruments. Radio-frequency and alternating current measurements are made with a d.c. instrument

The back view of the meter, showing the placement of the switches, meter shunt, and the miniature socket for the flashlight bulb. Note the two extra bulbs immediately behind the panel. They are employed for additional meter ranges

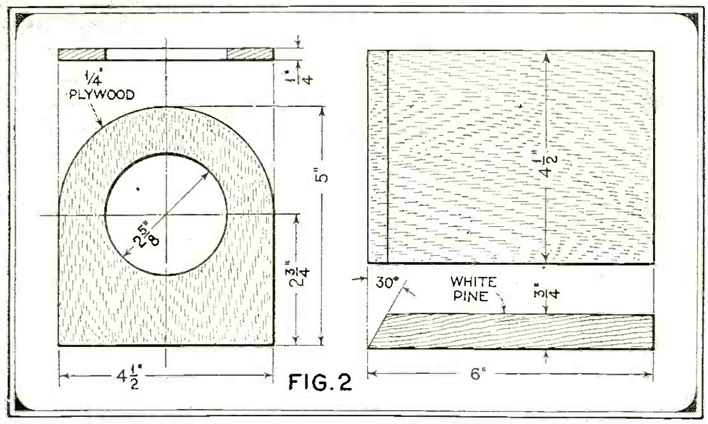


FIG. 2

The dimensions are given here for the wooden panel and baseboard

PROBABLY every one has heard in childhood the story about the churl who threw away the broken sword and the king's son who used the discarded blade in winning the battle. Somewhat the same principle can be applied in the matter of radio instruments. Very excellent ones exist, but the cost of a complete set of meters for all desired current ranges in direct current, alternating current and radio frequency is likely to exceed the immediate budget of most servicemen or experimenters. And in radio-frequency measurements even the instruments on the market have some disadvantages. The scale of a hot wire or thermo-couple meter is so crowded at the lower end that no sort of accurate readings can be made. This means that to cover adequately the range between a few milliamperes and perhaps half an ampere or more, several meters must be purchased. In the lower ranges, particularly, they are often inaccurate, always expensive and easily ruined by a momentary current overload. Hence there is a real need for a cheap instrument capable of making alternating current and radio-frequency measurements.

The general principle of home-made solutions for the instrument problem is the use of shunts, resistances and other relatively cheap circuit arrangements to increase the versatility of a meter already available, and the device described in this article is no exception to the rule. It makes one instrument do a great deal more, however, than the conventional multi-range voltmeter or milliammeter set-up. The starting point is a good milliammeter rated anywhere between 0-10 mils and 0-100 mils, such as most experimenters already have at hand. The meter actually used in construction was a Weston model 301 having a range of 0-50 mils. By means of an easily constructed shunt the d.c. range is extended to 500 mils, using the same scale. That in itself is quite ordinary practice. But in addition switching arrangements are provided so that a flashlight bulb can be lighted alternately by direct current passing through the meter and by the alternating or radio-frequency current to be measured. A rheostat adjusts the direct current until there is no change in filament brilliancy when it is thrown from one circuit to the other. The a.c. meter then indicates the effective value of the alternating current passing through the lamp.

At first sight it might appear that such a scheme would be mere guesswork, but in actual practice it has been found that alternating current can be measured by this visual comparison method with an accuracy better than ± 10 per cent. At high radio frequencies the switch and wiring capacities enter into the question and accuracy is somewhat less, but even so, it is not uncommon to find a fairly expensive thermo-couple meter as much as 20 per cent. off. When the frequencies are really high it is difficult to measure currents because they refuse to stay put on conductors anyway, and the bulb method compares favorably with other more elaborate ones. For straight scale d.c. measurements the accuracy is that of the meter—around ± 0.01 per cent for the model 301. For the 10x scale the d.c. accuracy depends on the care with which the shunt is made and on the room temperature; it should be around ± 2 per cent.

The comparison meter has at least two important advantages. Its initial cost is scarcely more than that of the d.c. meter used in its construction. And in the measurement of small alternating currents what might be called the burn-out risk, perhaps twenty dollars when stock instruments are used, is reduced to an equal number of cents! The model shown here measures, in addition to the direct current ranges, alternating or radio-frequency currents from about 50 mils up to 500 mils by using three interchangeable bulbs. By special methods the lower limit can be pushed down to 5 mils and the upper limit extended as far as 2 amperes. The mechanical construction is simplicity itself and is readily apparent from the photographs and circuit diagrams.

For direct current work S1 is closed, shorting out the double-pole, double-throw switch S3, and the d.c. terminals only are used. With S2 open the meter reads directly on

APPROXIMATION TABLE
FOR ROUGH ESTIMATES OF A.C. OR R.F. CURRENT FROM BULB COLOR. *PROBABLE ERROR ABOUT ± 25%*

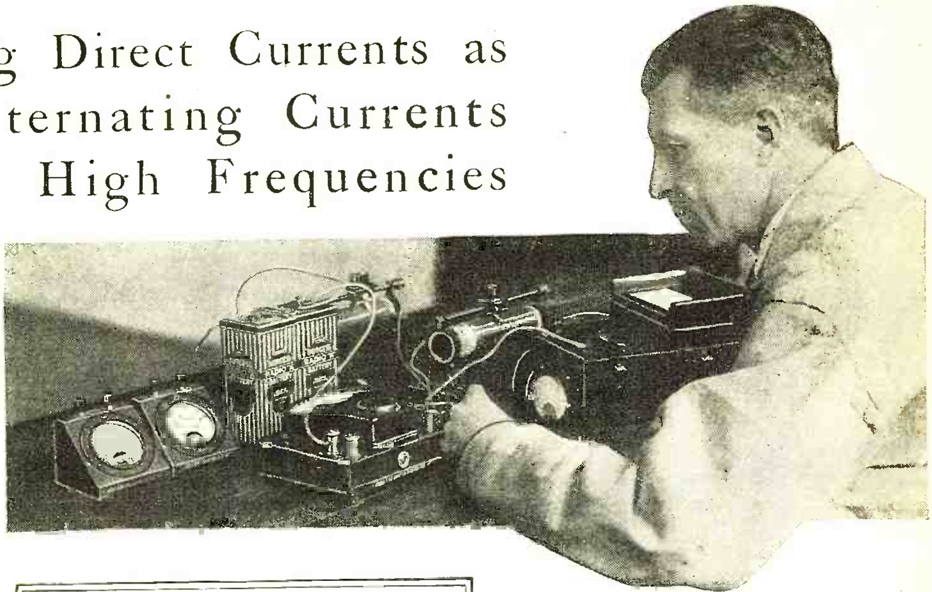
BULB	CURRENT IN MILLIAMPERES			RESISTANCE IN OHMS	
	RED	YELLOW	WHITE	COLD	HOT
6 V. DIAL	50	100	150	10	35
3.8 V. FLASH	100	200	300	3	12
2.3 V. "	140	200	260	2	8
2.5 V. DIAL	240	340	500	1	5
1.25 V. LANTERN	550	650	750	.2	.6
6 V. 3CP. AUTO	300	450	600	2	10
6 V. 6 CP. "	400	600	900	1	7
6 V 21 CP. "	1A.	1.5A.	2A.	.5	3

A table giving the approximate current through various miniature bulbs at different filament illumination

Comparison Meter

for Measuring Direct Currents as Well as Alternating Currents at Low and High Frequencies

By
Lieut. Wm. A. Wenstrom



At work in the laboratory checking the comparison meter described here against costly standard instruments

its normal scale, 0-50 mils. When S2 is closed, it connects the shunt in parallel with the meter, so that the latter now reads 0-500 mils. In other words, if the meter reads 40 divisions with S2 open, the needle should drop down to four divisions when S2 is closed. Adjusting the current to 40 mils and then closing the switch is incidentally the simplest way to check the shunt.

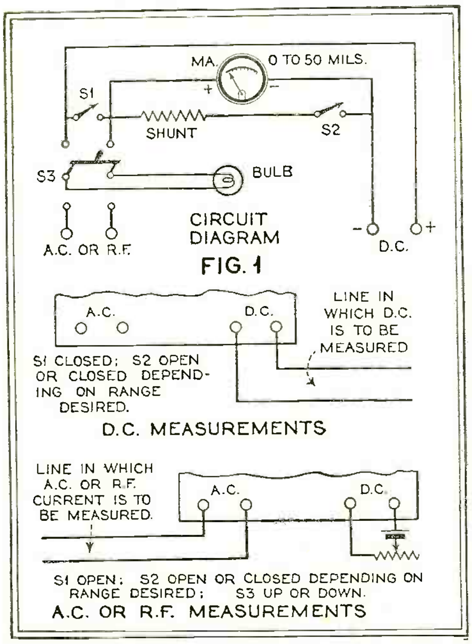
It will do no harm to describe the shunt in some detail. The theory, of course, is that the current divides, most of it passing through the shunt and a small fraction through the meter. If we desire to multiply the meter scale reading by a factor X, then the combined resistance of shunt and meter must equal the meter resistance divided by X. Applying Ohm's law for resistances in parallel, we have:

$$\frac{1}{Rs} + \frac{1}{Rm} = \frac{1}{Rt} = \frac{1}{\frac{Rm}{X}}$$

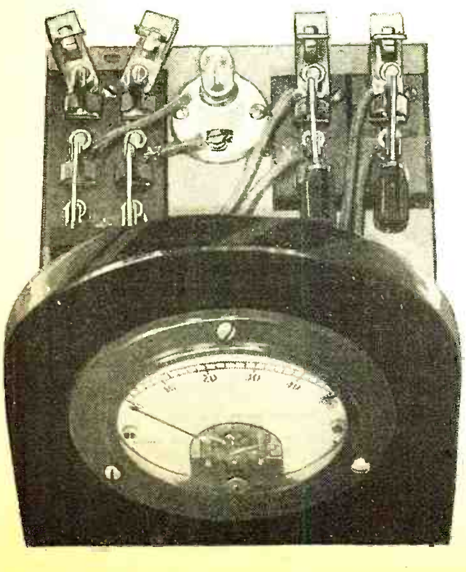
where R*s*, R*m* and R*t* are the respective resistances of shunt, meter and combination. In the case under consideration the scale multiplying factor is 10 and the meter resistance is about 2 ohms, so the equation becomes:

$$\frac{1}{R} + \frac{1}{2} = \frac{1}{\frac{2}{10}}$$

which gives R*s* = .22 ohms. The shunt might take any one of several forms, but the one decided on was enameled copper wire. Although copper has a high temperature coefficient, errors due to this cause will not run over 2 per cent., and copper wire is always easily obtainable. The size should be such as to give the required resistance within a length which can be conveniently wound on a small wooden dowel. Number 24 wire runs 38.94 feet to the ohm, giving an indicated length of 8 feet 7 inches. When the wiring and switch contacts are considered, the shunt proper must be a trifle lower, and it is well to try the shunt before winding it, starting with excess length and cutting off small pieces until the scale reads correctly. The scale reading could be similarly increased to 5 amperes maximum, if desired, by using about 3 feet 2 inches of No. 18 bell wire having a resistance of 0.0202 ohms.



(Above) The circuit connections of the comparison meter, with special circuit modifications shown for d.c. and r.f. or a.c. measurements



(Left) Looking down from the front of the comparison meter, the experimenter will note that the a.c. or r.f. connections are made to the switch on the left

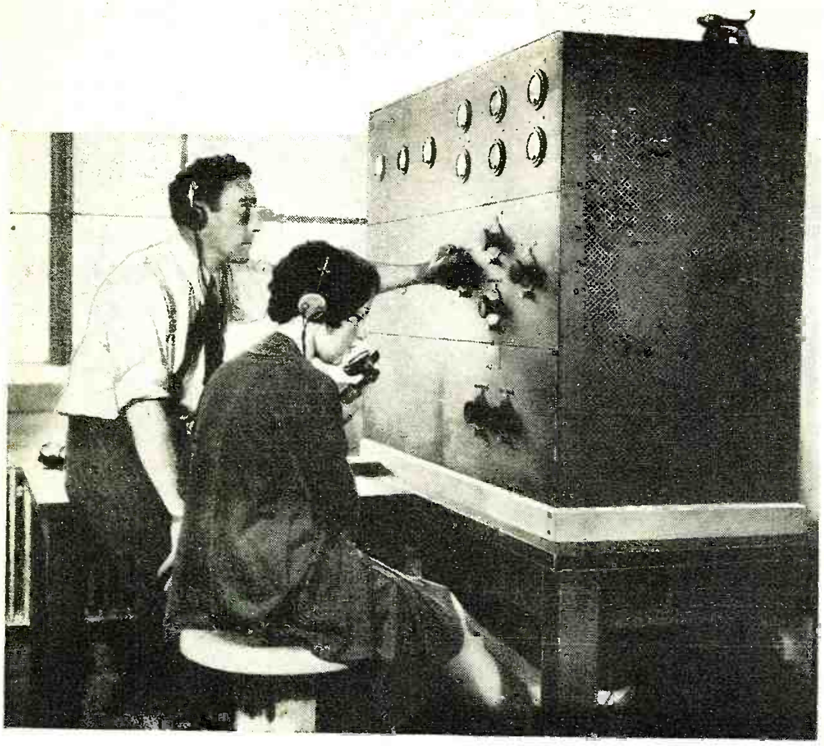
It is a good plan, if possible, to calibrate the meter both with and without shunt against standard instruments in a laboratory. On this test the eight-dollar 301 showed up beautifully, being exactly in step with the more expensive instrument all along the scale. With the shunt the combination meter read 5 mils low at 100 mils, 10 mils low at 200 mils, 5 mils low at 300 mils, 5 mils low at 400 mils, and exactly even at 500 mils due to shunt heating.

An alternating current meter is so designed that it measures the effective value of the current. This is the same as the total heating effect of the current, and is found mathematically by adding up the squares of all the instantaneous current values and taking the square root of their mean. The root mean square value is thus found in the case of a sine wave to be about 0.707 times the current's maximum value. If, however, we find a direct current which gives (*Continued on page 738*)

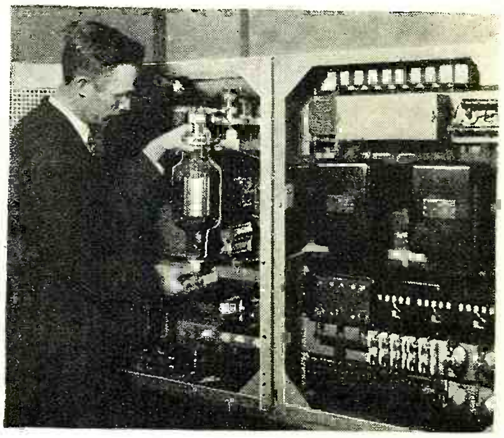
Radio

By

Henry K. Hudson*



Tuning the transmitter at one of the twenty-two ground stations of the Boeing System. The young lady seated at the radiophone apparatus is talking with a pilot flying a Boeing mail-passenger plane 14,000 feet above sea level and 152 miles distant

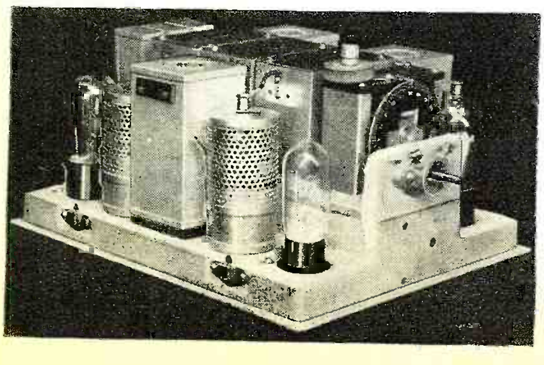


Shown above is the rear of the rectifier and oscillator panels of the transmitting equipment installed in the ground station

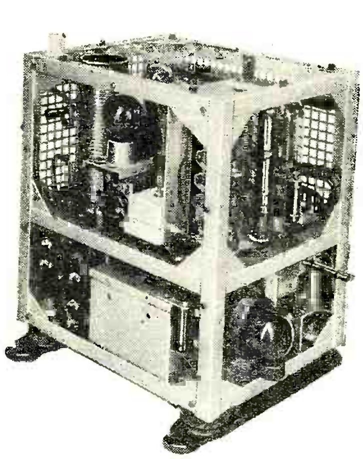
A PILOT flying over the Pacific Coast mail-passenger airway operated by Boeing System approached a division airport, only to find it heavily blanketed by a thick belt of clouds. The flyer knew his general position with regard to the landing field, by checking his various instruments, but he was unable to cope with the problem of landing his ship through the fog without direction. The air transport company had installed a complete two-way radio-telephone communication system, which was promptly brought into play to assist the pilot. Officials at the division airport heard the sound of the plane's engine overhead, and corroborated the pilot's impression of his position. They then informed him that there was a ceiling of 1,000 feet, and that the field was clear for landing purposes. The pilot, in possession of such invaluable knowledge, guided his plane down through the clouds, emerged over the airport and effected a safe landing.

Previous to the installation of the radiophone, the pilot would have had to cruise around in the hope of finding a break in the clouds through which to glide to earth, or to retrace his course. If Colonel Lindbergh had been able to converse by radio to ground officials when he arrived over a fog-bound Chicago airport several years ago with the air mail, he would not have had to "bail out" and join the Caterpillar Club, but could have kept his parachute strapped to his back and been directed to a safe landing by means of the plane-ground voice-communication system.

*Boeing Air Transport, Inc.



At the left, the chassis of the remotely controlled airplane receiver



Above is a close-up view of the radio transmitter used in the planes

Boeing System, which operates the Chicago-Oakland-San Francisco and Seattle-San Diego air mail, passenger and express airways, has completed full radiophone installation on its lines, which are 1,938 miles and 1,204 miles in length. They rank as the two longest mail-passenger airways in the United States, and the radiophone chain established on them is probably the most complete of its kind in the world. It represents two years of research and experimentation on the part of company communications engineers.

The radio is one of the most recent, yet one of the most important safety features developed for commercial air transportation. Previous to the advent of the radio-telephone as applied to aircraft, safety of planes in flight rested largely with the pilot, his judgment of weather and his ability to cope with emergencies. Before his take-off he received his weather reports and instructions, but once in the air, any changes in conditions were problems confronting him for solution without assistance from the ground personnel.

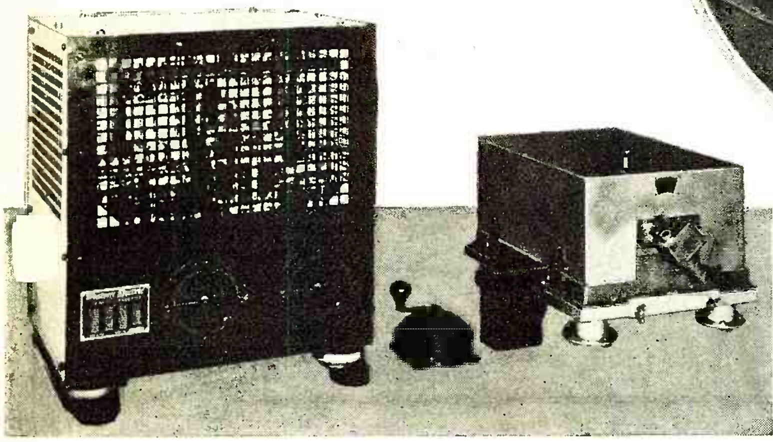
The needs for effective radio communication with planes may be summarized as follows: (1) a method of following the course in fog or weather conducive to low visibility; (2) a means for transmitting weather reports to the pilots; (3) a means for landing safely after having reached the terminal airport in unfavorable weather; and (4) a means for receiving information from the pilot.

The problem of evolving a method by means of which the pilot could keep on his course in unfavorable weather has been solved with the development of the directive radio beacon broadcast, operated by the Department of Commerce. This system of code signal broadcasting warns the

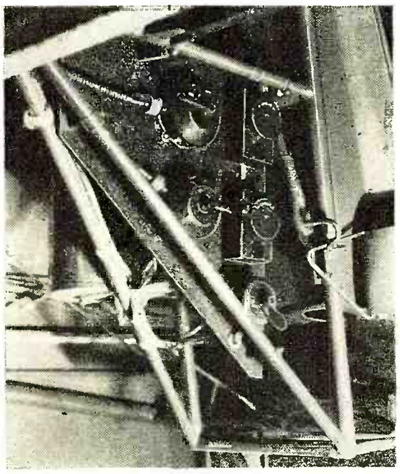
Charts the Air-Course

Twenty-two ground radio stations, each having a dependable range of 200 miles, maintain constant radio contact with all of the Boeing System's planes which are aloft on the 3,000 miles of radio-blazed Transcontinental and Pacific skyways. By this most modern use of radio, pilots are apprised of constantly changing weather and flying conditions

The microphone used by mail pilots is attached to their helmets in the manner shown above. Operation of the plane-to-ground communication system is easily conducted—the pilot merely changing from transmission to reception by turning the switch



Shown above is the equipment for plane installation, which weighs but 100 pounds altogether. The receiving and transmitting equipment for the radio-telephone installation in planes is remotely controlled from the pilot's cockpit



At the right, a close-up view of the pilot's radio remote controls in the plane

pilot of any deviation from the established route and enables him to fly a direct line.

Partial or whole solutions to the other problems have been effected by the development of the plane-ground radiophone. A description of the installation on the Boeing System airways will suffice to give a general idea of the communication system.

Ground stations have been established at 200-mile intervals along the two airways, there being fourteen along the transcontinental route and eight on the Pacific Coast line. These stations have an effective transmitting and receiving radius of 200 miles.

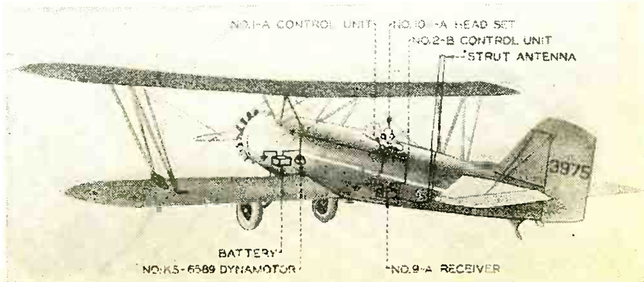
All mail and mail-passenger planes of the Boeing fleet are equipped with necessary apparatus, the keynote of which is simplicity of operation. The entire equipment for the plane weighs but one hundred pounds, and it is practically automatic in operation. The earphones are attached to his helmet, as is the microphone, which is constantly in front of the pilot's lips.

The operator at the ground station takes care of the tuning once the pilot is in flight, and the plane equipment requires practically no adjustment while in the air. The pilot merely changes from transmission to reception by turning a switch.

Officials in charge of the development of the radiophone settled upon a streamlined dural mast, projecting above the plane in the rear of the pilot's cockpit, as the most effective form of antenna, discarding the trailing wire type because of its inconvenience, and, in certain cases, potential danger.

A major part of the labor required to perfect the radiophone was expended in the bonding and shielding of the airplane to eliminate interference emanating from the aircraft itself. The ignition system of the plane proved to be the greatest source of interference, and considerable effort was (*Continued on page* 746)

Below is a schematic phantom view showing the position in a mail plane of the various parts of the radio installation



Some Theory of Push-Pull

In order to obtain a comprehensive understanding of the principles underlying push-pull amplifier operation it is necessary to be thoroughly familiar with the production of pure sine waves, harmonic analysis and other kindred items which have a pronounced effect on tonal quality in an audio channel. The authors here have reviewed these introductory subjects and next month will continue with a discussion of the push-pull amplifier itself

THE characteristic that a push-pull amplifier has of delivering large amounts of undistorted voltage or power output has led to its almost universal adoption in systems where a high-grade quality output is not only desirable but essential. Such systems, as referred to above, exist in high-quality broadcast transmitters and receivers, talking picture and public address amplifiers, etc.

While numerous articles have appeared in various technical books and periodicals dealing with the subject of push-pull amplifiers, it may perhaps appear presumptuous to write another article on exactly the same subject. However, it has been the experience of the authors that the majority of these articles, while they undoubtedly propound correctly the theory of push-pull amplification, omit, or fail to explain some of the very fundamentals necessary for a thorough comprehension of the subject. The authors of these articles naturally assume that the reader possesses the fundamentals necessary. However, the average reader obtains his knowledge of any subject from various technical articles. Different authors, writing on the same subject, naturally, due to the different manner in which they obtained their technical knowledge (since no man is born with knowledge), present these same subjects, each with a different method of attack. Realizing this, your authors will endeavor to first present the fundamentals so that the reader will review the theory in the same light as do the authors. In so doing it is hoped that a less hazy impression of the theory of push-pull amplification will be obtained than if these fundamentals were omitted.

MUCH has been written concerning the principles underlying the theory of push-pull audio-frequency amplification and in quite a few cases the authors have assumed that the reader already has a knowledge of the basic fundamentals. To many this has been a decided hindrance.

We are fortunate, therefore, in being able to present to RADIO NEWS *readers this first of a series of articles wherein the authors have gone right to the core of the subject, explaining in detail the elements which, for a proper understanding of the subject, must be kept in mind constantly.*

THE EDITORS.

Harmonic Analysis

Different shapes of curves have different names, and in the majority of simple curves the names given are obtained from their mathematical derivation. A wave is merely a graph which shows the relation (in a case of a voltage) between the value of the voltage and the particular instant of time at which the voltage has that value. The shape of the wave (voltage or current) existing in a.c. work has the familiar shape shown in Fig. 1 and it is called a sine wave.

Just why the curve has the shape shown in Fig. 1 is as follows:

Assume a wire rotating in a magnetic field as shown in Fig. 2A. The upper pole is a north pole and the lower pole is a south pole. Now, a wire cutting a magnetic field at right angles to the field will develop a voltage between the ends of the wire. The amount of this voltage depends on (1) rate of cutting the field, (2) length of wire in the field, and (3) the strength of the magnetic field being cut. If the wire loop is being rotated at constant speed and the length of wire is always the same, then the voltage generated in this wire depends entirely on the angle at which the wire loop cuts the magnetic field. The intensity of the field being constant and from north to south, the voltage generated in the wire then is at maximum when it is moving at right angles to the field and zero when it is moving parallel to the field. The voltage for various positions of the wire is shown in the sketch at the right of Fig. 2C.

In mathematics the sine of an angle in a right triangle is defined as the ratio of the length of the side opposite the angle to the length of the hypotenuse of the triangle.

This is indicated by the triangle in Fig. 2B. The ratio of the length of the side, BC, to the length of the hypot-

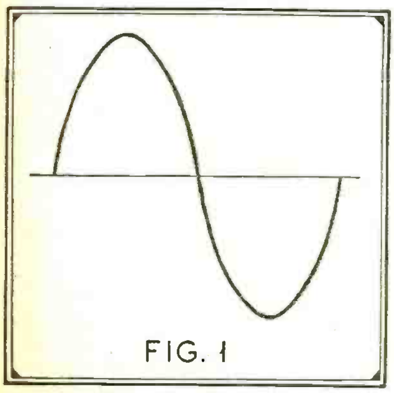


FIG. 1

Fig. 1, to the left. The schematic illustration of a.c. sine wave forms

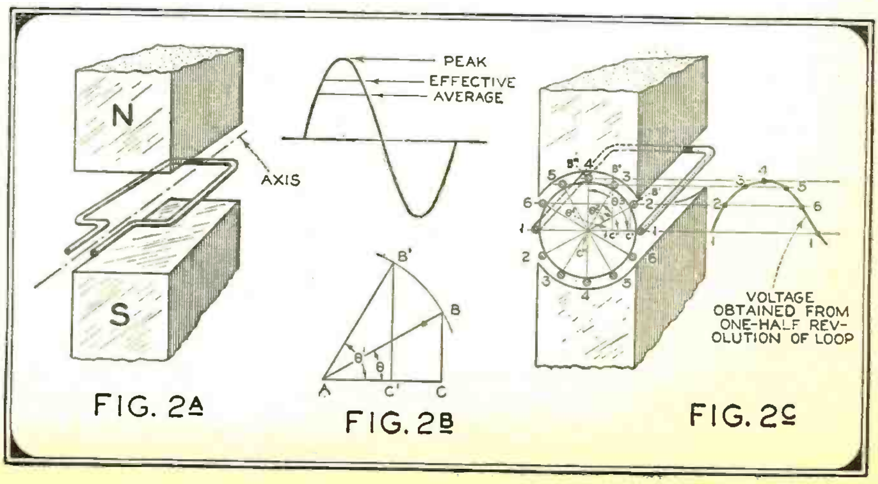


FIG. 2A FIG. 2B FIG. 2C

Figs. 2A, 2B, 2C, to the right, shows the position of a wire loop in a magnetic field, and curves indicating the value of voltage generated at the various positions of the loop

Audio Amplification

By Louis Martin
and
John F. Lorber*

enuse, AB, is called the sine of the angle. In symbols:

$$\sin \theta = \frac{BC}{AB}$$

If the size of the angle be increased from θ to θ_1, and if the length of the hypotenuse remains the same, then the sine of the angle θ_1 is larger than the sine of the angle θ. Or in symbols:

$$\frac{B^1C^1}{AB^1} = \sin \theta_1 \text{ is greater than } \sin \theta.$$

This can be seen from an inspection of Fig. 2B. In this figure $AB = AB^1$, but B^1C^1 is greater than BC. Therefore sin θ_1 is greater than sin θ. The larger the angle θ becomes the greater the sin of θ becomes, until $\theta = 90°$. At this point $\frac{B^1C^1}{AB^1} = 1$ and $\sin \theta_1 = 1$. If θ is made larger than 90°, then the sin of θ decreases from its maximum value to zero.

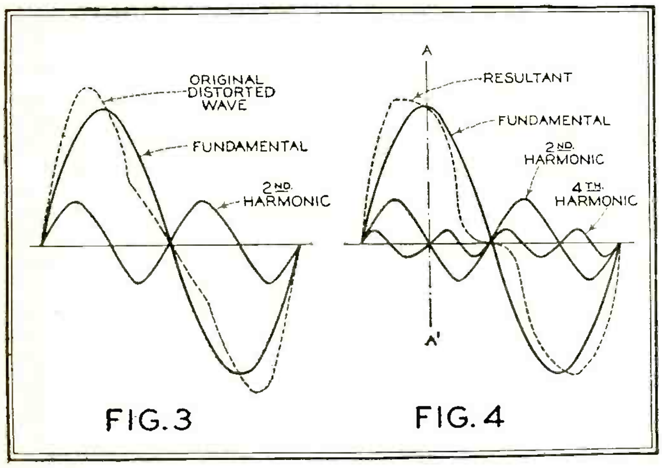


Fig. 3 illustrates the breaking down of a sine wave. Fig. 4 shows a distorted wave composed of the fundamental, 2nd and 4th harmonic frequencies

Consider now the diagram of Fig. 2C. When the ends of the wire are in position 1 no voltage is generated, since the wire is moving parallel to the main field. In position 2 the voltage generated is small, being given by the length B^1C^1. When the wire reaches positions 3 and 4 the magnitude of the voltage generated is given by the lengths B^2C^2 and B^3C^3, respectively. For position 4 the voltage generated is at maximum, the wire cutting the field at right angles. The lengths B^1C^1, B^2C^2, B^3C^3 correspond to the instantaneous values of the voltage generated when the wire reaches positions 2, 3 and 4, which also correspond to angles θ_1, θ_2 and θ_3.

For any position of the loop, the sine of the angle made with respect to the horizontal position (which corresponds to zero voltage in the wire) is given as the ratio of instantaneous value of the voltage to the maximum value. Thus:

$$\text{sine } \theta = \frac{\text{instantaneous value}}{\text{maximum value}}$$

or in symbols:

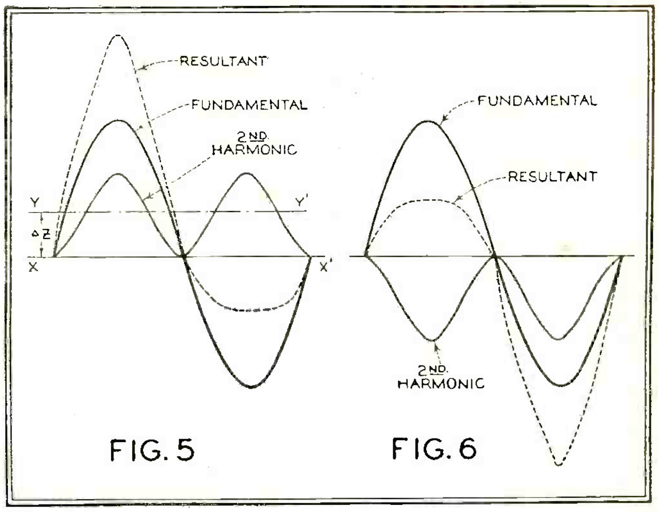


Fig. 5 illustrates the presence of a strong 2nd harmonic with the fundamental. Fig. 6 illustrates the presence of a strong 2nd harmonic, but 180° out of phase in comparison to Fig. 5

or:

$$\text{sine } \theta = \frac{\varepsilon}{E_m} \qquad \varepsilon = \text{instantaneous value}, \quad E_m = \text{maximum value}$$

$$\varepsilon = E_m \sin \theta$$

The shape of the curve merely shows the manner in which the instantaneous value of the voltage varies as the loop completes one revolution. It must not be supposed that if it were possible to see the voltage existing between the terminals of the loop, it would have the shape as shown in Fig. 1. The proper viewpoint to assume is that the intensity of the voltage existing would vary from instant to instant in the manner pictorially represented by Fig. 1. The effective (r.m.s.) average and peak values are as indicated in Fig. 2.

By definition any wave is a distorted wave if it does not follow the variations specified by a sine shape. Since all calculations are based on the assumption of a pure sine wave, then, if a distorted wave is present, the proper corrections must be applied to compensate for this irregularity. Distorted waves result from various causes, such as unsymmetrical design of an alternator, overloading of a vacuum tube or by the use of iron-core inductances. The latter two will be discussed more in detail later.

If a distorted wave is present, then formulas which were originally derived on the assumption of the application of a pure sine wave will yield erroneous results if a distorted wave is used. For convenience a distorted wave may be resolved into a pure sine wave of the same frequency as the distorted wave (which pure sine wave is known as the fundamental), plus pure sine waves of frequencies which are multiples of the fundamental frequency. These latter waves are known as harmonics. Any distorted wave is a composite of a fundamental and harmonic frequency. This is illustrated in Fig. 3.

Referring to the figure, the original distorted wave can be completely resolved into a fundamental and a second harmonic, but this is a rare occurrence. Usually not only the second, but the second, third, fourth, fifth, etc., harmonics must be added together with the fundamental to obtain the original distorted wave. However, different types of distortions can be resolved into a fundamental and either even or odd harmonics. By this is meant that if a given distorted wave can be conveniently resolved into a fundamental and, let us say, even harmonics, then it must not be supposed that absolutely no odd harmonics exist, but rather that the maximum amplitude of the odd harmonics that must be (*Continued on page* 744)

*RCA Institutes, Inc.

Congress Considers Problems of the "Fifth Estate"

By Martin Codel

AMERICA'S "fifth estate" approached the forthcoming short session of Congress, which convened December 1 and expires on March 4, with little of the trepidation that marked its previous attitude toward the legislative rulers of radio.

For one thing, the major broadcasters—nearly 200 of them—are more than ever homogeneously organized in their National Association of Broadcasters, which concluded its recent Cleveland convention by appointing Philip G. Loucks, young Washington attorney and former newspaperman, as its managing director and ordering its headquarters moved from New York to Washington.

For another, the hue and cry over the "radio trust" has been heeded by the Department of Justice to the extent that an anti-trust case is being prosecuted in the federal courts. Consequently, that industrial aspect of radio is more or less out of the hands of Congress and may no longer be expected to obscure the pressing problems of broadcasting, which are much nearer to the interests of the average citizen.

Radio broadcasting, nevertheless, faces a crucial interval between the opening of the lame-duck session and the organization of the Seventy-second Congress in December, 1931. Many and complex are its domestic and international problems, and these are considerably ramified by the political situation which will determine whether there will be a new outcropping of radio leaders in Congress.

On the international side, Congress inevitably must take cognizance of the growing opposition of Canada and Mexico, particularly the latter, against the "squatter sovereignty" exercised over the major portion of the broadcasting spectrum by the United States. American dominance is readily explained: American inventive genius and business enterprise have been quickest to realize the potentialities of radio.

On the other hand, the rights of other nations to a share of the broadcasting facilities cannot be dismissed as mere academic theory. In fact, Mexico is already building stations on the channels now occupied by stations in the United States and Canada, with much resultant interference to the latter. Canada has been more passive in its demands. But the fact remains that diplomatic negotiations for a new division of facilities must soon take place between the North American nations—and the fact also remains that, unless new facilities are somehow found, they may be taken away from this country.

Some see the widening of the broadcasting band to include more channels as a solution; others think technical advances, such as synchronization of chains of stations on identical wavelengths or narrowing the paths of broadcast transmission, may solve the problems before the legislators and diplomats need to be called upon.

On the domestic side, the problem of high power, overcrowded channels and sectional rights have been complicated by the demand of organized educators for more and better broadcasting assignments in the interests of educational programs. They intend going to Congress to recommend the permanent assignment to them exclusively of at least 15 per cent. of all the broadcast wavelengths, which means, again unless new technical advances come soon (such as the invention by Dr. James Robinson of the Stenode Radiostat), that these must be taken away from those who now have them.

The broadcasters' association naturally opposes the educators' demands, and a merry fight is in prospect here—a fight between those now entrenched in broadcasting and sustaining themselves by "selling time" and those who want to gain new or stronger footholds in broadcasting because they think they can do a superior job in the non-entertainment fields. Among the latter also—and they are no inconsiderable factor—are the labor people and the agricultural interests, not to say religious interests, who feel that they too should also be recognized with allotments of channels that will give them radio outlets.

With respect to high power, the matter may be said to be in the lap of the gods. Chief Examiner Ellis A. Yost is expected to recommend to the Federal Radio Commission shortly that the remainder of the four cleared channels designated for high power in each of the five zones, or 20 channels in all, be filled by stations seeking 50,000 watts which he will designate.

This means that only nine of the 26 applicants for 50,000 watts will achieve their purpose, unless the Commission decides to open up the other four cleared channels in each zone, or 20 more, to high power also. Whether the Commission will do this apparently rests with Congress, for it appears now that the Commission has been biding its time in reaching a decision until the temper of Congress should have been sounded.

On that score it seems a certainty that those who raise the loudest hue and cry in Congress will get their way, and, recognizing this fact, some of the smaller broadcasters are preparing to fight the extension of high power and even to ask for a reduction in the number of cleared channels. One of the leaders in the effort against high power, which the engineers almost unanimously approve as the most effective way of reaching rural and remote radio listeners, will be Oswald F. Schuette, secretary of the Radio Protective Association.

(*Continued on page* 741)

Current

Highlights and Sidelights of What's ing Political Problems Affecting Radio, the Radio Manufacturers and an Enlightening Radio Offer an Insight to Only

Radio Makers Turn Eyes Toward Foreign Outlets

THROUGH the medium of broadcasting, the only branch of radio that is progressing full sails up and full speed ahead through the stilly sea of business, the radio manufacturing industry proposes to develop new and permanent outlets for its products.

Dealt a severe blow by the current business depression, several of the farther sighted makers of radios and radio materials see strong trade prospects in foreign trade. They intend using long-distance broadcasting in the development of that trade, hitherto scarcely skimmed because of the greater and more immediate profits that have existed in the domestic market.

The sale of radio receiving—and some transmitting—equipment is the real motive behind recent applications to the Federal Radic Comission for permission to utilize the relay short waves for sending American-staged sponsored programs for rebroadcasting abroad, particularly in Latin-American countries. The sponsors would be American radio manufacturers and the programs, though staged in this country, would be suited to the particular tastes of the countries of destination.

It is a noteworthy fact that few, if any, of the radio manufacturers have curtailed their expenditures for broadcasting in spite of the business letdown. The reason may either be satisfaction with the pulling power of radio or an appreciation of the fact that they, the manufacturers, have too great a stake in the maintenance of program excellence to allow it to deteriorate by failure to support broadcasting.

At any rate, the radio manufacturers account far more than any other single industry for the income of the chains, whose joint income exclusive of profits from the sale of their program talent has reached $18,798,359 for the first nine months of this year to compare with $18,729,571 for the whole of 1929.

Certainly there is no philanthropy in the desire to broadcast special programs for reception in foreign countries. The real motive is the creation and development of foreign markets for radios—and also for other American-made goods. The radio makers believe they can repeat abroad, particularly in the countries of Latin America, which is a natural sphere of trade and where purchasing power is normally quite high, the history of American radio: first, the offering of fine pro-

(*Continued on page 751*)

Comment

***Happening in the Radio Arena. Perplex-
Trend Toward Foreign Market Outlets for
Discourse on Dominance of Young Men in
a Few of the Topics of the Day***

All Branches of Radio Honeycombed With Youth

RADIO is essentially a young man's game. Probably no other industry of major consequence, unless it be aeronautics, boasts as many very young men in high positions.

The reason isn't hard to find: radio itself is relatively young, for broadcasting sprang into being only ten years or so ago, and with its growing popularity there developed the receiving set and associated manufacturing industries. Then, too, radio has drawn and is still drawing from the ranks of those youthful hobbyists known as amateurs for much of its man power.

Small wonder, then, that older heads in this and other businesses have frequently paraphrased Greeley's famous counsel and have advised: "Go into radio, young man."

David Sarnoff is probably the industry's outstanding example of young genius and success. A Russian immigrant boy when he came to this country in 1900, he had scarcely passed his 39th birthday last February when the directors of the Radio Corporation of America elevated him from the post of vice president and general manager, to which he had risen from office boy, to the presidency of that corporation.

But there are even younger men in the high places of the industry that was born of an idea that fixed itself in the mind of a young experimenter named Guglielmo Marconi some 33 years ago. Ellery Stone, president of Kolster Radio Corporation, and A. H. Grebe are only about 35. William S. Paley, president of the Columbia Broadcasting System, has scarcely passed his 28th birthday; the vice president of Columbia, Sam Pickard, former member of the Federal Radio Commission, is 33, and Columbia's brilliant Washington executive, Harry Butcher, is but 28.

McMurdo Silver, president of the Silver-Marshall Radio Company, of Chicago, is only 28. Nathan Chirelstein became president of the Sonatron Tube Company at 30. Herbert Hoover, Jr., son of the President, is the radio director of Western Air Express at 28.

Though he looks much younger, M. H. Aylesworth, president of the National Broadcasting Company, is 44. As in its parent companies, the N. B. C. is honeycombed with mere youths. George F. McClelland, its general manager, is 36; Mark Wood, its secretary, is 30, and G. W. Johnstone, in charge of press relations, is 30. All its vice presidents are in their thirties, John Elwood being 34; George Engels 39; Niles Trammel 36, and Frank Russell 34. Nor are there any graybeards on the technical or announcerial staffs, where the ages run around 30 and under.

He may look older, but William S. Hedges, president of the National Association of Broadcasters, is merely 35. One of the broadcasting fraternity's real youngsters is Ralph Atlass, who heads WBBM, Chicago, at 26. Broadcasting stations throughout the country reveal a similar array of youthful talent in all classes of work. Among the artists, it is interesting to observe that Hugo Mariani, famous radio orchestra leader, only recently passed his 30th birthday.

Youth mingles with maturer years on the scientific and legal side of radio. In Washington, one of the brightest of the bright young men of the engineering staff of the Federal Radio Commission is Gerald C. Gross, who is only 28. Lieut. E. K. Jett, another assistant engineer, is 37. The chief engineer, Dr. C. B. Jolliffe, confesses to 36; V. Ford Greaves, assistant chief engineer, to 46, and Andrew D. Ring, assistant, to 31. Lieut. Comdr. T. A. M. Craven, U. S. N., who is almost invariably included in American delegations to international radio conferences, is 37. Col. Thad Brown, general counsel, is 43, but his three assistants, Ben E. Fisher, Paul D. P. Spearman and Duke M. Patrick, are 40, 32 and 30, respectively.

The Commissioners themselves are mostly older men, Chairman Saltzman owning to 59, Judge Sykes to 54, Judge Robinson to about 60 and Commissioner Lafount to "around 50." Commissioner W. D. L. Starbuck is 44.

At the Bureau of Standards, Dr. J. H. Dellinger, radio chief, is 44. The chief of naval communications, Capt. S. C. Hooper, is 43. Maj. Gen. George O. Gibbs, chief of the Army Signal Corps, confesses to be "nearing the retiring age," which means he has been out of West Point about 30 years.

Such notable figures in the radio art and industry as Dr. Lee DeForest, Gen. James G. Harbord, A. Atwater Kent, Hiram Percy Maxim, Nikola Tesla, Dr. L. W. Austin, Dr. A. Hoyt Taylor, Dr. Frederick E. Kolster and William D. Terrell have all passed their meridian. But Dr. Alfred N. Goldsmith, who heads the engineering staff of the R.C.A. is only 41; John Hays Hammond, Jr., noted inventor, is 40, and Maj. Edward H. Armstrong is 38. John V. L. Hogan confesses to being "about 40," as does Lloyd Espenschied of the American Telephone & Telegraph Co., whose able confrere, Laurens Whittemore, is just 38. Harry Evans, Westinghouse's superintendent of broadcasting, is 32.

In the field of radio regulation, older

(*Continued on page 751*)

Television Proposed on Ultra-High Waves

EVEN before the convening of the informal conference on television, called in Washington Dec. 3, the Federal Radio Commission has more or less revealed its intention of opening up liberal bands of ultra-high frequencies, or extreme short waves, for the so-called visual broadcasting services.

Only this week the Commission took under consideration a report of one of its examiners, Elmer W. Pratt, recommending the allocation of the 43,000 to 44,000 kilocycle band (6.97 to 6.81 meters) for use by an experimental television station which the Milwaukee Journal proposes to establish as an auxiliary of its broadcasting station, WTMI.

The purposes of this station is "the exploration of the very high frequencies" above 23,000 kilocycles (13 meters), which is the limit of the spectrum now divided by international agreement. The Milwaukee newspaper proposes to find out if the very short waves are not the most suitable for television, and accordingly was recommended for an allotment of a band 1,000-kilocycles wide. John V. L. Hogan, noted radio inventor and engineer, is to supervise the experiments, the first of this character to be undertaken by such a private agency.

While four of five bands of short waves, each 100 kilocycles wide, have been reserved in the normal short-wave band for television experiments, Mr. Pratt pointed out that Gerald C. Gross, Commission engineer in charge of television, has indicated that the following bands might also be made available: 35,300 to 36,200 kilocycles; 39,650 to 40,650 kilocycles; 43,000 to 46,000 kilocycles and 50,500 to 51,500 kilocycles—that is, bands of short waves ranging from 8.5

(*Continued on page 749*)

$100.00 *in Prizes* For the Winning Design of a S-W Transmitter and Receiver

Any member of the RADIO NEWS *Radio Association can compete for these awards. Fifty dollars will be awarded to the originator of the winning short-wave transmitter design and fifty dollars will be awarded to the originator of the winning short-wave receiver design. You can win either or both of these prizes. Contest closes May 10, 1931. Read the entry and contest rules below*

THE formation of the RADIO NEWS Radio Association is so recent that it is hardly in order to forecast its future. Nevertheless, applications for membership have been received in such overwhelming numbers that, on the face of it, it is evident that today there is a most profound interest in all matters pertaining to short-wave radio.

It has been the experience of the editors that owners of transmitters and receivers alike are loud in praise of their own particular outfit while all others, in their minds, are relegated to the scrap heap. After a fellow has tried a number of various circuits and arrangements it is only natural that, coming upon one that really satisfies, he was willing to stack it up against all comers.

Here's a chance for such fellows to turn their enthusiasm into dollars.

In order to stimulate this interest to a higher degree RADIO NEWS announces a contest, open to all members of the RADIO NEWS Radio Association, in which a prize of fifty dollars will be awarded for the design of the short-wave receiver adjudged to be the best, and a prize of fifty dollars for the design of the short-wave transmitter adjudged to be the best.

What RADIO NEWS wants you to do is to send in your idea of what in your estimation is the best transmitter or receiver. Your entry should consist of 1, a circuit diagram; 2, sketch of constructional details; 3, photographs showing general idea of construction; 4, details of coil winding and construction and any other information which is pertinent to the construction of either the transmitter or receiver; 5, a 1500-word article describing the particular features of the circuit employed and the construction of the outfit itself. This description also should contain instructions for the use of the receiver. In the case of the transmitter, directions for tuning and generally placing the outfit "on the air" should be given.

You may compete for either or both of the fifty-dollar prizes.

A commission of five judges will determine the winners on the bases of, first, upon the accuracy and practicability of either the transmitter or receiver described; second, upon the completeness of the manuscript and sketches submitted; third, the actual results obtained in practice with the item described. (It is not necessary that the entrant must have built the item described, although in cases where this has been done, greater credit will accrue, especially when records of results obtained and actual photographs of the device are submitted.)

Contestants should write (typewritten, preferable) their descriptions on one side of the paper only, and should number all figures, sketches, photographs, etc., so that they can be identified easily. Since the contest is open only to members of the RADIO NEWS Radio Association, those who wish to apply for membership may make use of the coupon below.

The Contest Rules Are as Follows:

1. All contestants must be members of the RNRA.
2. Contestants may enter either or both of the prize contests (Transmitter or Receiver).
3. Manuscripts should describe completely the construction of the transmitter or receiver and should not be less than 1500 words in length.
4. Manuscripts should be accompanied by the necessary drawings, sketches, diagrams, photographs, etc., with which to illustrate the text.
5. All entries should be addressed: *Short-Wave Contest Editor, Radio News, 381 Fourth Avenue, New York City.*
6. The contest closes May 10, 1931. Manuscripts postmarked later than midnight, May 10, 1931, will not be considered.
7. The Editors reserve the right to accept manuscripts other than the prize winners for publication at regular space rates. Prize winning manuscripts will also be paid for at customary space rates when published.
8. Manuscripts from contestants will not be returned.
9. Announcement of the prize winners will be made in the August, 1931, issue of RADIO NEWS.

The Radio News Radio Association

Some months ago the idea was conceived of forming a club open in membership to all those who in any way were interested in short-wave activities, the main purpose being the dissemination of information through the channels of such an association which would be of benefit and interest to short-wave fans.

In the beginning it was thought that such a club would be purely a local affair, confining its activities to those living within New York City and its immediate vicinity. Such a great interest was manifest that it was finally decided to make the association national in scope.

Present plans for the Association contemplate a weekly or semi-monthly technical talk to such short-wave fans as can assemble at a suitable meeting-place in New York City, these talks to be carried by way of short-wave transmission to Association members who reside in distant cities.

Temporarily a 50-watt transmitter has been installed atop the 16-story building which is the home of RADIO NEWS and at a later date it is hoped to install a more pretentious outfit.

As announced last month, W2RM, the headquarters transmitter of the RNRA, was scheduled to go on the air, on the 80-meter band, three times a week (Monday, Wednesday and Friday, 8:00 p.m.) with code lessons for beginner members, these code lessons being transmitted at various speeds. Due to a number of difficulties which have arisen in connection with the removal of the transmitter to another adjacent location and the erection of a new antenna, it has not been possible to maintain this schedule completely, although in the near future it is hoped that these transmission schedules may be resumed.

Incidentally, these amateurs who (*Continued on page 764*)

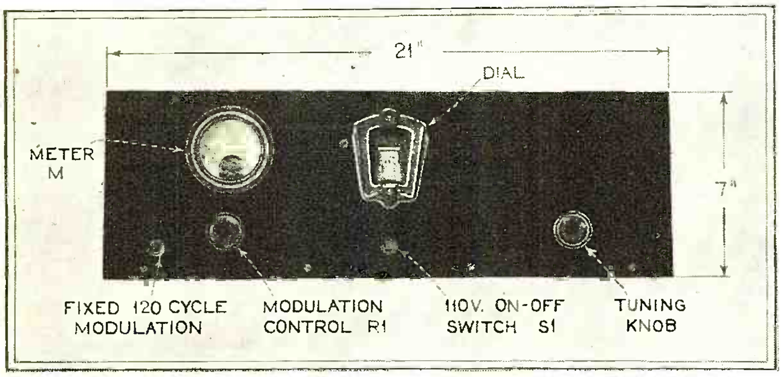
Building and Using the All-Purpose Modulated Oscillator

This versatile instrument fits the special needs of the serviceman, as well as those of the custom set builder. Heretofore separate units, consisting of the r.f. oscillator, audio oscillator and power supply, have been connected together on the bench. In this instrument all three units are made into a single device of small size

By Donald Lewis

THE instrument described in this article is designed for use by servicemen and home experimentors in connection with laboratory tests necessary during the construction or repair of radio receivers. It is not difficult to construct and it will be found of tremendous usefulness in the laboratory. It consists essentially of an oscillator on which any type of modulation can be impressed. In a sense therefore, we might call it for want of a better name a miniature broadcasting station, powerful enough to lay down a good strong signal over the area of an ordinary laboratory.

Many readers may immediately feel that this instrument is essentially the same as an ordinary modulated oscillator, but in many ways it is quite different. The usual type of modulated oscillator, although a very useful device in its own field, is in certain respects somewhat limited. This is usually designed for modulation at only a single audio frequency, the percentage modulation is usually fixed and is frequently 100 per cent. The modulated oscillator designed for operation on raw a.c. is modulated at a fundamental frequency of 30 cycles, which is too low for best results. Actually in such circuits the harmonics of the fundamental modulated frequency are probably of more importance. It would obviously be desired to have available the modulated oscillator system, which could be modulated in any desired manner. To reach its maximum usefulness, such a device must therefore be designed so that we can impress on it constant audio tones of any desired frequency or impress on it voice and music picked up preferably from a phonograph record since this is the simplest way to obtain such modulation. The instrument should also be completely a.c. operated so that it may be left in operation for long periods of time without having to worry about such things as recharging or renewing a battery. If we revise the ordinary modulated oscillator to conform with these ideas we would find that we had constructed the unit described in this article. From actual use the unit described in the following paragraphs has been found to be of great practical usefulness; it performs all the functions of the ordinary modulated oscillator, but having better wave form and modulation characteristics it performs many tasks much more satisfactorily.



The panel arrangement is simple and neat. The various controls are indicated to correspond to the lettering of the circuit diagram

Let us examine in some further detail just what is needed in such an instrument. First we need an oscillator capable of being tuned to any frequency within the broadcast band. Secondly we need a modulation circuit so that the output of the oscillator may be caused to vary in accordance with the audio frequency modulation. All modern broadcast transmitters use what is known as Heising modulation and this method can readily be used in this test unit. Ahead of the modulator tubes is required an audio amplifier of sufficient gain so that the modulator tubes may be fully loaded if desired. We must also have a gain control in the audio amplifier system so that the percentage modulation may be lowered to any desired value. To supply a source of fixed audio-frequency modulation either one of two methods may be used. We can connect an audio oscillator to the input of the system or we can introduce a ripple in the plate voltage supplied to the oscillator and modulate its output in this way. In addition we also require plate and filament voltages. Plate voltages can, of course, be obtained from a rectifier and filter system and filament voltages from low voltage windings on the power transformer.

That the unit described in this article meets all these requirements can be appreciated by examining the circuit diagram, Fig. 1, and the various photographs. The oscillator is a type -27 heater tube connected to a Hartley oscillator circuit. The coil is tapped at

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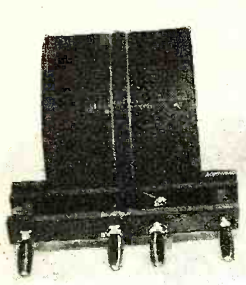
A Handy Instrument for the Experimenter's Laboratory

MODULATED r.f. oscillators of various types have appeared from time to time, but all had a common fault, the power supply. In the instrument presented here the power is obtained from a well-filtered -80 rectifier. We believe this instrument to be one of the first if not the first to be completely a.c. operated.

THE EDITORS.



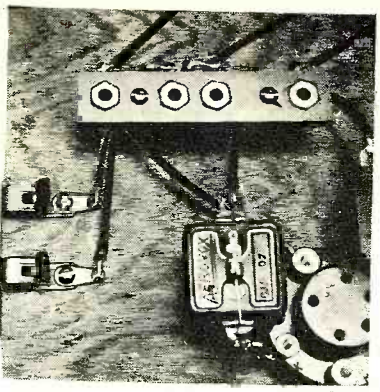


Fig. 2. Constructional data on the coil used in this test unit is shown at the right. If the dial is to accurately indicate the frequency, it is essential that the coil construction be carefully followed. Above is close-up of the oscillator coil and its mount. A general idea of the coil construction can be obtained. The plug-in feature makes it possible to use this test unit for short waves by using smaller coils mounted on plug-in forms

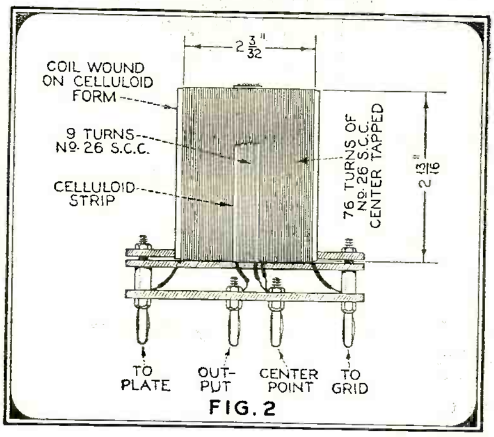


FIG. 2

the center and this center-tap connects to the rotor section of the variable tuning condenser. In order to make the shaft of the tuning condenser "cold" a double condenser is used so that the mid-point may be at ground potential. The plate circuit of the oscillator tube is shunt fed through an r.f. choke.

To cause the oscillator plate voltage to vary in accordance with the audio modulation the Heising system is used. In this method the plates of the modulator tubes, which in this case are 2 type –27's in parallel, are directly connected to the plate of the oscillator. All of the plates are fed with plate voltage through a common audio-frequency choke coil. The circuit may be analyzed in various ways, but a method as good as any is to consider that the choke coil, called the Heising choke, causes the current supplied to the tubes to be constant. Then as the modulator plate currents are caused to increase and decrease in accordance with the audio-frequency voltages impressed on the grids of the modulators, the modulator plate circuits take more or less of this fixed value of current flowing through the Heising choke. Since the total current is fixed it follows that when the plate currents of the modulators increase that the plate current of the oscillator decreases; a decrease in modulated current conversely causes an increase in oscillator plate current. These variations in oscillator plate current are in accordance with audio-frequency voltages impressed on the modulators. This is equivalent to saying that the oscillator plate current is modulated by the audio-frequency voltages.

The plates of the oscillator and modulator tubes are supplied with approximately 200 volts from the plate supply unit. This gives the modulator grids a bias of about –15 volts, and if the modulators are to be completely loaded it follows that the audio transformer connected to their grid circuits must supply an audio voltage with a peak value of 15 volts. It is therefore necessary that some audio amplification precede the modulator tubes. Assuming that the ordinary phonograph pickup puts out about 0.5 volts the gain required is 30. This is somewhat more than can be obtained with good fidelity from a single stage. For this reason we have used in this unit two audio amplifier tubes coupled with low ratio transformers. The gain is then sufficient to permit the use of phonograph pickups giving comparatively low output voltage; if more than sufficient audio-frequency voltage is obtained it can always be reduced by means of the variable resistance connected across the pickup.

Since the fundamental ripple frequency from a full-wave rectifier is 120 cycles it was considered advisable to arrange the circuit so that part of the filter system could be removed. In this way it was found possible to increase the ripple output and thereby modulate the oscillator tube at 120 cycles. This forms a very convenient and effective method of obtaining a fixed modulating frequency. Of course, if a higher fixed modulating frequency is desired it can be obtained by connecting a small audio oscillator to the input of the audio amplifier system. For many uses, however, the 120 cycle modulation will be found entirely satisfactory.

Before describing in detail the construction and operation of this testing unit we would like to indicate some of its uses. It can, of course, be used for practically all ordinary tests on receivers. Set up at some convenient point in the laboratory it provides a steady known signal that can be used in aligning condensers and in neutralizing. If the input to the audio amplifier is obtained from a beat-frequency oscillator (a number of excellent oscillators of this type have been described in past issues of RADIO NEWS) the system may be used to check quality by gradually varying the audio frequency over the entire range. It can be used to detect rattles and vibrations in any part of the receiver under test—a test which could not be performed unless one had available a good strong signal whose modulation could be fixed at any desired audio frequency. It can also be used to check oscillation in a receiver. It will be found very valuable in tracing down the microphonic howls. Sometimes the microphonic howls are due to coupling to the

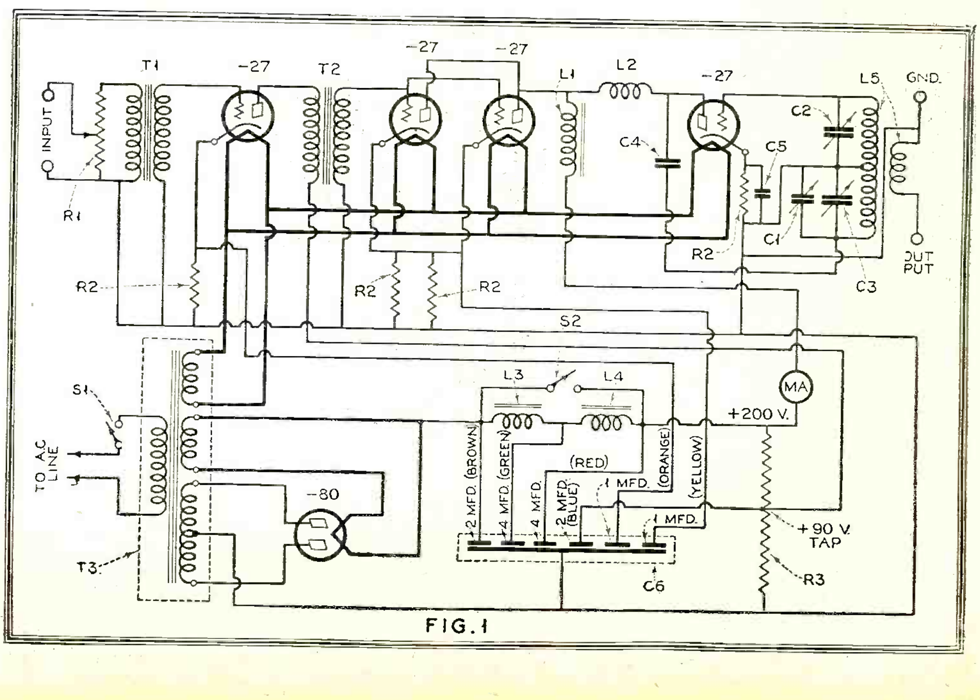


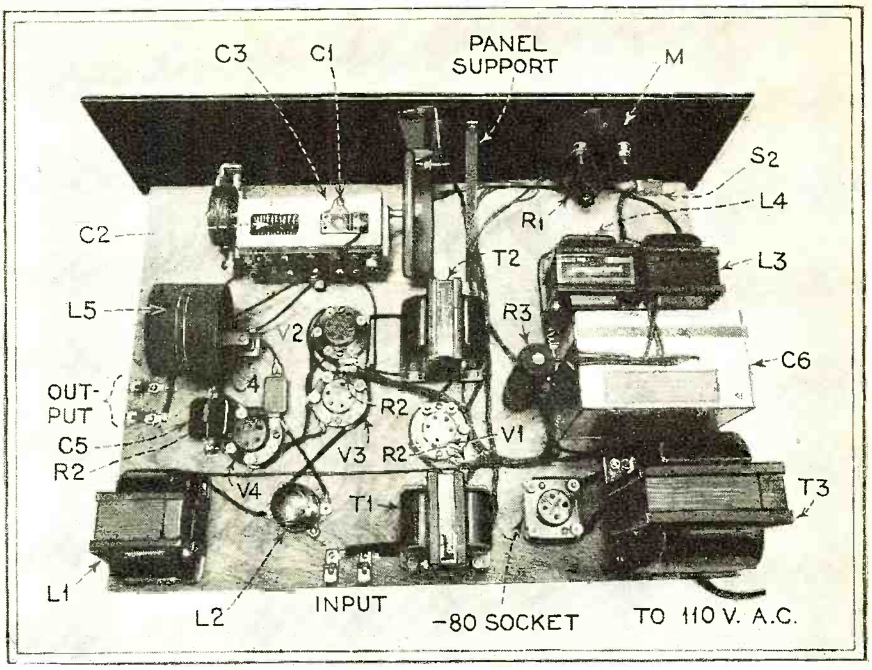
FIG. 1

Fig. 1. The circuit of this "all purpose" modulated oscillator is given in this figure. It consists of a –27, V4, used as an oscillator and modulates by two –27 tubes, V2, V3, connected in parallel. The modulator tubes are preceded by an audio amplifier using two 1.2 ratio audio transformers and a type –27 amplifier tube. The percentage of modulation can readily be controlled by the resistor, R1, connected across the first transformer, T1

r.f. amplifier system, sometimes to feedback between the loud speaker and the audio amplifier tubes, but almost invariably the effect occurs most prominently at particular frequencies. By varying the frequency of the modulation the exact cause of the microphone howl can readily be determined.

The unit will also prove very helpful in checking for cross talk and determining whether any rectifying action is occurring in the r.f. amplifier tubes. It is very difficult in laboratory tests to check for cross talk since the signal produced by small oscillators is not strong enough. From this unit, however, sufficiently strong signals can be obtained to definitely determine whether or not cross talk occurs.

A complete circuit diagram of the unit is given in Fig. 1. The input terminals should be connected across the phonograph pick-up or other source of audio-frequency voltage. The resistor R1 serves to control the amount of modulation by regulating the value of audio-frequency voltage impressed across the first audio transformer T1. The first audio transformer supplies voltage to the grid of the amplifier tube V1 which in turn feeds in to the second audio transformer T2 whose secondary supplies excitation to the grids of the two modulator tubes V2 and V3. Plate current for the modulators is supplied through the Heising choke coil L1, the current through the choke being read on the 0-50 milliampere scale meter M; in normal operation the two modulator tubes take about 5 mils each and the oscillator about 8 mils, making the total current as read on the meter about 18 milliamperes. Although no definite tests on the percentage modulation have been made the maximum depth of modulation is apparently about 60 or 70 per cent. The meter, M, serves as a very good indicator of the maximum modulation obtainable without distortion, for if the maximum permissible modulation is not being exceeded, the meter needle should remain stationary. If the modulation control resistor, R, is turned on too much, the modulator tubes will be overloaded and the meter needle will begin to wobble. The fluctuation of the needle should be held to a maximum of about 10 per cent. (about 2 milliamperes) for best results.



This view shows the arrangement of the apparatus on the baseboard. All of the parts have been lettered to correspond to the circuit diagram and the list of parts. This view shows the placement of the parts so clearly that the constructor should have little difficulty in laying out the apparatus

To prevent r.f. currents from passing from the oscillator circuit over into the modulator circuit, an r.f. choke coil L2 is connected in series with the plate circuit of the oscillator tube. The oscillator circuit, as mentioned previously is of the Hartley type. In this circuit the tuning capacity must be connected across the entire coil so if a single condenser is used the shaft will be at a high r.f. potential and hand capacity effects will be experienced. For this reason a double rotor condenser is used, each half of which has a capacity of 0.0005 mfd. This makes it possible to connect the rotor to the center tap of the oscillator coil and this point can be grounded to eliminate hand capacity.

From the standpoint of uniform response, the Heising choke coil should have an inductive reactance, at the lowest desired audio frequency, of at least twice the plate resistance of the modulator circuit. In this unit the modulators are two type -27's giving a combined Rp of about 5000 ohms. The choke used has an inductance of 40 henries giving a reactance of 15,000 ohms at 60 cycles; the inductance is sufficient therefore for good results even below 60 cycles.

The coil construction (see Fig. 2) and condenser characteristic are such that it is possible to use a dial calibrated in kilocycles and obtain quite accurate kilocycle settings by simply adjusting the dial to the desired frequency, as indicated on the dial. For more accurate work a calibration chart can be made by tuning-in signals from various broadcasting stations whose frequencies are known, adjusting the oscillator dial to give zero beat note, and then noting the frequency and dial setting on the chart. Before this is done, however, the dial should be made to track as accurately as possible by tuning in a station transmitting around 1400 or 1500 k.c., adjusting the dial so that it indicates the frequency of the station and then varying the small mmfd. mica variable condenser C to give a zero beat note. The figures in Table 1, indicate the accuracy obtained when this method is used. It should be obvious that the errors are small enough to permit setting the frequency by dial reading, when making all ordinary types of tests.

TABLE 1

DIAL READ.	CURRENT FREQ.	ERROR IN KC.
1500	1500	0
1126	1130	4
937	940	3
787	790	3
746	750	4
654	660	6
570	570	0

The oscillator coil is mounted on pin jacks which plug into a base. This permits the ready replacement of the coil by others covering different frequency bands. In this manner the unit can be easily adapted for use on shorter wavelengths. Constructional data on the coil for the broadcast band is given in Fig. 2, although we suggest that the coil be purchased, since accurate spacing of the turns is necessary if the dial is to indicate accurately the frequency.

The construction of the units should present no difficulties if the various pictures and the circuit diagram are carefully studied. The entire unit can be built on a baseboard measuring about 14x20 inches. The following parts were used in the construction of this model:

R1 Yaxley Input Modulation control resistor, Type MJP-115 potentiometer, 11500 ohms.
R2 Durham Type MF 4 1-3, 2500 ohm bias resistors.
R3 Hammarlund Type RHQ-31-T Voltage Divider.
C1 Hammarlund Type EC70 Compensating Condenser.
C2, C3 Hammarlund Twin Rotor Tuning Condenser Type BSD-50.
C4 Sangamo 0.002 mfd. mica condenser.
C5 Sangamo 0.02 mfd. mica condenser.
C6 Hammarlund filter block type CHQ-31.
L1 Hammarlund type C-40 filter choke.
L2 Hammarlund r.f. choke type RFC-85.
L3, L4 Hammarlund type C-40 filter chokes.
L5 Hammarlund special modulated-oscillator tuning coil.
S1, S2 on-off toggle switches, Hart & Hegeman.
T1 Hammarlund type AF-1 audio transformer.
T2 Hammarlund type AF-1 audio transformer.
T3 Hammarlund power transformer type PT-31-T.
Hammarlund SD drum dial for ¼" shaft. (*Con. on page* 747)

A department devoted to the presentation of technical information, experimental data, kinks and short-cuts of interest to the experimenter, serviceman and short-wave enthusiast

WELL, fellows, here we are back again in the lab for our little monthly chat. Before we get into full swing on the subjects selected for this month's chat, it is well to point out again that in this department, "In the Radio News Laboratory," is combined the former departments devoted to the experimenter, serviceman and short-wave enthusiast in "The Forum."

Those among you who have ideas about laboratory work, experiments, hints for the serviceman and short-wave fan should not hesitate to submit them to the editor of this department. Payment at regular space rates will be made for all contributions accepted for publication.

More Dope on Feeder Systems

Our first contribution this month is from Harry F. Washburn (W2CL-W2CMQ) of Mount Vernon, New York. He writes:

I HAVE read the article on the single-wire feed Hertz antenna by Mr. E. A. Clem, which appeared on page 348 of RADIO NEWS for October, and am enclosing some information which I believe will be of interest to those using this type of antenna. Mr. Clem did not agree to the common belief that the placing of the feeder affects the operation of the system, and I would like to set forth a few reasons which prove that correct placing of the feeder means difference between success and failure with this antenna.

There has been much discussion on the operation and construction of the single-wire feed Hertz antenna as to the radiating properties of the feeder. The recent article of Mr. E. A. Clem, W9FBE, states that the placing of the feed wire has only the effect of tightening or loosening the coupling between antenna proper and feeder, the radiation of the feeder being dependent upon several other factors.

There are a few fundamental facts concerning antenna operation which will be of great help in understanding the construction of the above system. Every antenna has radiation resistance dependent upon the frequency of the transmitter. Every feed line has a characteristic impedance. Unfortunately, these characteristics are not alike and one must be matched to the other. Thus the reason for placing the feeder at so many feet from one end of the antenna. When the impedance of the feeder is matched to that of the antenna standing waves are eliminated on the feeder and little or no radiation takes place. (Proc. of I. R. E., October, 1929, p. 1840.)

A glance at Fig. 1 will show what is meant. Fig. 2 illustrates the antenna system when it is operating correctly.

Another fact overlooked by most amateurs is that perfect operation can only be obtained when the transmitter is operating on the fundamental frequency or harmonic of the antenna. Operation away from the fundamental more than a few

(*Continued on page* 760)

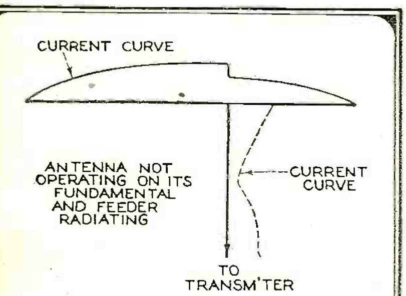


FIG. 1

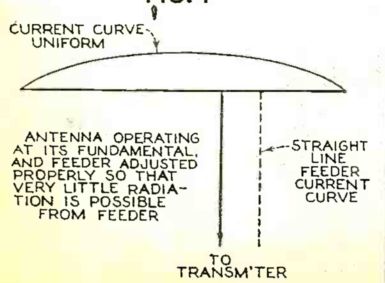
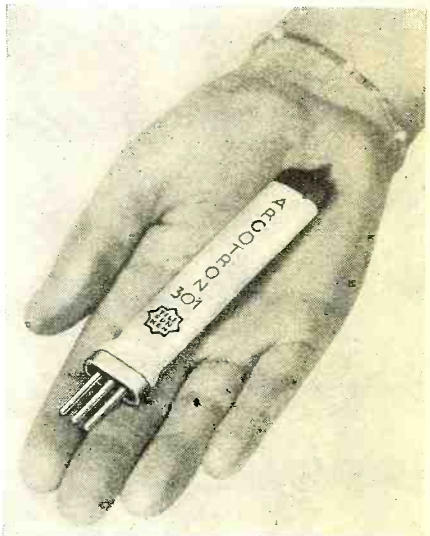


FIG. 2

The Remarkable Bar-Tube

By S. McClatchie



MR. S. McCLATCHIE, a man who has traveled extensively in Europe, observing radio conditions and developments, and is in a position of authority to write on European radio matters, has submitted two items of interest and we are pleased to pass this information along to our readers. One concerns a new electrostatic type of loud speaker and the other, the new bar tube, both developments of German scientists.

THE Germans have a brand-new tube based on a very old idea. Away back in 1906 De Forest tried putting the grid of his "audion" on the outside of the bulb. But it wasn't a practical success. Later experimenters (Round, 1914; Weagant, 1915) fared no better. No one succeeded in getting any worth-while amplification. And now suddenly in the year 1930 German engineers are showing us that it can be done. In fact, the new tube is sponsored by the Telefunken Company (which is the German RCA), production is in full

(*Continued on page* 758)

Listen In on Russia

Editor, RADIO NEWS:

I have some information regarding Russian stations that might be of some interest to you and RADIO NEWS readers.

Station RA97 has been changed to RV15. On week days they operate on 70.2 meters. They have a "Red Banner" program every Sunday. Week-day programs from 19:30 to 24 p.m. Khabarovsk Time. The first part of every program is English. They also inform that in winter they start to broadcast at 16 and 17 o'clock (local time.)—CLIFFORD H. MCCULLOUGH, East Liverpool, Ohio.

Out of the daily flow of mail to your editor's office two letters were considered to be of such striking contrast as to warrant publication. These two letters comment on the Stenode Radiostat receiving circuit, the invention of Dr. James Robinson of England.

The first letter is from Aaron Holcomb, of Phoenix, Arizona; the second is from Dale R. Schilling, of Chicago, Illinois.

Mr. Holcomb writes: "A fellow can hold himself just so long, then he ups and says something. Dr. Robinson seems to have something new, but not to the amateur or experimenter that gobbles up RADIO NEWS or information from the technical staff of RADIO NEWS.

"Just look back to the 1929 edition, Vol. III of "1001 Radio Questions and Answers," see pages 22 and 23, Question 44. On these pages are answers to any questions arising as to how "new" Dr. Robinson's Stenode Radiostat really is.

"Dr. Robinson used an old idea and put it to a new end, the wrong end. I'll venture there are hundreds of experimenters right here in the U. S. who have been using this same principle for the past year.

"This 'new idea' sure is a bang. And I would like to hear from builders of 'supers' who build around the quartz crystal."

For the information of those readers of RADIO NEWS who do not possess a copy of the 1929 edition of "1001 Radio Questions and Answers" let us say that question No. 44. which appeared on pages 22 and 23 of this book dealt mainly with the subject of two-point reception on the earlier models of superheterodynes and discussed a means for eliminating this disagreeable feature. A diagram was published in connection with this question illustrating the circuit for a floating beat device involving the use of a sharply tuned oscillator. To obtain such a sharply tuned oscillating circuit Mr. Walter Van B. Roberts, who provided the information which formed the answer to question No. 44, said: "The fixed oscillations may be generated by a separate local oscillator tube as in a 'super,' or *an oscillating crystal.* The latter method *suggests* the most interesting possibilities, *though it also injects technical difficulties to tax any but the advanced amateur."* The italics are ours. Moreover, it should be borne in mind that the quartz crystal in Dr. Robinson's Stenode Radiostat is *not* used in an oscillating circuit but is used as a *resonator.*

Mr. Dale R. Schilling writes: "I'll bet I am expressing the view of every dyed-in-the-wool reader of RADIO NEWS and amateur experimenter when I ask that you publish detailed 'how-to-build' articles on the Stenode Radiostat, together with recommendations as to American parts which will work satisfactorily."

IN further explanation of the policy of RADIO NEWS in regards to the technical mail addressed to the Technical Information Service for reply, the following will be of interest and importance to those who may require the services of this department:

1. All questions and inquiries concerning requests for technical information should be typed or legibly written, on one side of the paper only, and accompanied by a stamped addressed envelope.

2. Inquiries should be addressed as follows:

RADIO NEWS
Technical Information Service
381 Fourth Ave., New York City

3. To subscribers, this service will be rendered without charge.

4. For non-subscribers, a charge of one dollar will be made for each inquiry of reasonable length.

5. Involved inquiries entailing much research or engineering will have special fees applied; when the information is supplied the questioner will be informed of the special charge.

6. All inquiries must be accompanied by the coupon below, properly filled out. Technical Information Service,

RADIO NEWS, 381 Fourth Ave., New York City.

I am a subscriber and enclose no fee ☐.

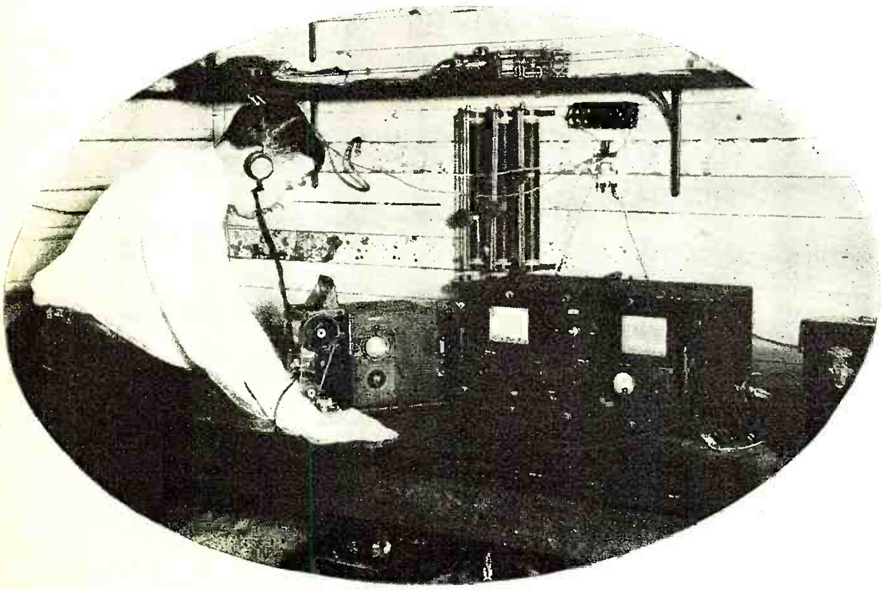
I am not a subscriber and enclose a fee of $1.00 ☐ in payment for the answering of my inquiry which is attached.

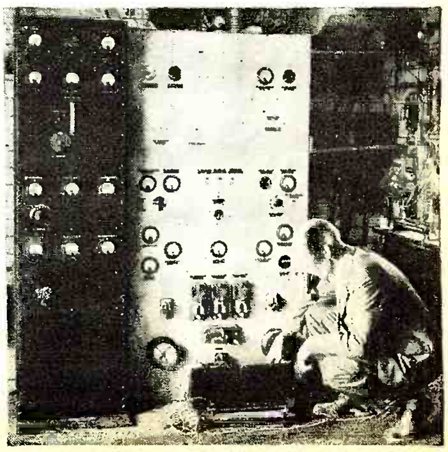
Name..................................

Address..................................

Navy Radio Engineers Study Round the World Signals

The mysterious phenomena of high-frequency radio signals which encircle the earth and return to the receiving station in the form of weird echoes, and which sometimes cause interference on high-speed recording equipment on certain frequencies, are being studied by engineers of the Naval Research Laboratory in Washington





Above, to the left, is shown Dr. A. Hoyt Taylor, noted high-frequency expert, and past president of the Institute of Radio Engineers, at the transmitter which was used in the tests. To the right, the special Navy receiver and oscillograph used at the receiving end. Leo C. Young, of the laboratory staff, is the operator

~RADIO NEWS HOME LABORATORY EXPERIMENTS~

Simple Methods of Measuring Tubes

ALTHOUGH the laboratory measurement of the characteristics of tubes is a rather complicated task, it is not difficult for the experimenter to build apparatus that will give (considering the simplicity of the apparatus) surprisingly accurate results. In this Home Experiment sheet are described some simple tube measuring devices with which the experimenter can measure the amplification constant, mutual conductance and plate impedance of the more common types of tubes. With the apparatus dynamic and static characteristics can also be plotted; dynamic characteristics show the characteristics of tubes in an actual circuit and static characteristics show the operation of the tube without relation to the circuits into which it normally works. After all, it is upon tube characteristics that the radio engineer must base the design of radio receivers; every experimenter really interested in knowing more about radio should understand the meaning of the various tube characteristics, how they are determined and be able to measure in his own lab the constants of tubes.

The Meaning of the Three Constants of a Tube

Amplification Constant equals
Change in Plate Voltage
divided by
Change in Grid Voltage

The amplification constant shows the relative effectiveness of the grid and plate in controlling the flow of electrons.

Plate Impedance equals
Change in Plate Voltage
divided by
Change in Plate Current

The plate impedance, frequently referred to as the a.c. plate resistance, indicates the resistance to the flow of a.c. currents between the plate and the filament of a tube.

Mutual Conductance equals
Change in Plate Current
divided by
Change in Grid Voltage

The mutual conductance indicates the amount of a.c. plate current produced by each a.c. volt on the grid of the tube.

There are two simple methods of measuring the amplification constant of a tube. Both methods have much in common, but one uses d.c. voltages entirely and the other the use of an audio oscillator and a pair of earphones. The amplification constant of a tube is an indication of the comparative effectiveness of the plate and grid voltages in the control of the electron flow from the filament to the plate. The grid, being nearer to the filament, is a much more effective control. If, for example, a tube has an amplification constant of 8, it means that a certain change in grid voltage is 8 times more effective than the same change in plate voltage. If we changed the grid voltage by say 2 volts, then the plate voltage would have to be changed by 2 x 8 or 16 volts to produce the same effect on the plate current.

Let us take a more specific example. Suppose we place 90 volts on the plate and —4.5 volts on the grid of a type -01A tube. The plate current will be about 2.5 milliamperes. Now suppose we reduce the grid voltage by 2 volts, bringing the grid voltage to —2.5 volts. We would then find that the plate current would read about 4 milliamperes. Now in order to nullify the change of 2 volts in the grid circuit we would find it necessary to reduce the plate voltage to 74 volts in order to again make the plate current 2.5 milliamperes. Therefore a change of 90 — 74 or 16 volts in the plate circuit has the same effect on the plate current as a grid voltage change of 2 volts. Therefore the amplification constant is 16 divided by 2, or 8.

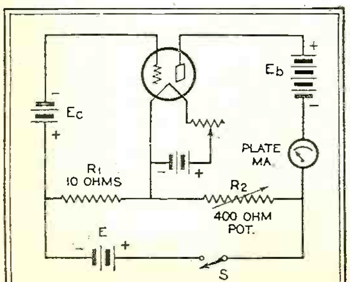


FIG. 1

This is all there is to the determination of the amplification constant of a tube. We simply have to change either the grid voltage or the plate voltage a certain amount and then determine the change in voltage on the other element necessary to bring the plate current back to its original value. And whenever in the future we read that a tube has a certain amplification constant we should remember that it simply signifies the relative effect of the plate and grid voltages; that if we change the grid voltage a certain amount that it is equivalent to changing the plate voltage by mu (amplification constant) times the grid voltage change.

The amplification constant can be measured by keeping in mind the points explained above, but it is more easily measured using a very simple circuit arrangement. The simplest circuit is shown in Fig. 1. Here we have a tube supplied with plate voltage Eb and a grid bias voltage Ec, these two values being those at which the amplification constant is to be determined. In addition we have two resistors, R1 connected in the grid circuit and R2 connected in the plate circuit. Connected across these two resistors is a battery E, in series with a switch S. Now when we close the switch a current, I, will flow through R1 and R2 and by Ohm's law the voltage drop across R1 will be

Voltage across R1 = IR1

and the voltage across R2 will be

Voltage across R2 = IR2

Dividing the second equation by the first (just simple algebra) we have

$$\frac{\text{Voltage drop across R2}}{\text{Voltage drop across R1}} = \frac{IR2}{IR2} = \frac{R2}{R1}$$

But the resistance R1 is in the grid circuit and therefore when the key is pressed the voltage on the grid is changed by a value equal to IR1. Therefore the voltage drop across R1 produces a *change in grid voltage,* which is an important part of the measurement of amplification constant. Recalling the explanation given in the preceding paragraphs we will realize that to determine the mu (amplification constant) of the tube we will have to change the plate

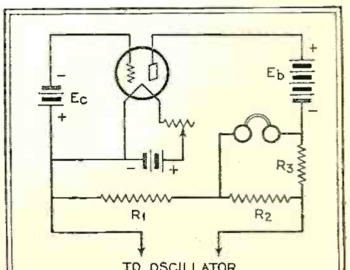


FIG. 3

voltage by an amount equal to mu times the change in grid voltage and when this is done the plate current will be the same before the key is pressed and after the key is pressed. Now if the grid voltage is changed by an amount equal to IR1, then to give no change in plate current the plate voltage will have to be changed by mu times IR1. The change in plate voltage is due to the voltage drop across the resistor R2 connected in the plate circuit, the voltage drop being equal to IR2. Therefore IR2 must be made equal to mu x IR1. In equation form:

$$\text{mu} \times IR1 = IR2$$

and, dividing by I, we have

$$\text{mu} \times R1 = R2$$

$$\text{mu} = \frac{R2}{R1}$$

In other words, when R1 and R2 are so adjusted that pressing the key produces no change in the reading of the plate milliammeter, then the amplification constant of the tube is simply equal to R2 divided by R1. In use we can fix R1 at say 10 ohms and then simply adjust R2 until pressing the key produces no change in plate current. For R1 we must use a calibrated variable resistance. A good 400-ohm potentiometer with a dial may be used with quite accurate results. If we obtain no change in plate current with the dial set at say 50° (100 division dial), then the resistance will be half of 400, or 200 ohms. 200 divided by 10, the value of R1, gives the tube an amplification constant of 20.

The method is most accurate when the value of the voltage E is very small. In using the method E should therefore have the lowest value which will permit accurate adjustment to the balance point. A 4.5-volt "C" battery is usually satisfactory. The polarity makes no difference; in one case we decrease the grid voltage and increase the plate voltage, and if the battery is reversed we increase the grid voltage and decrease the plate voltage. No matter what the polarity of E, the balance point will be obtained at the same setting.

For most accurate results the measurement of amplification constant should be made with very small changes in grid and plate voltages. By slightly altering the circuit of Fig. 1 we can obtain a method, using a.c. instead of d.c. to change the voltage, that makes it possible to obtain more accurate measurements. It is of course useless to use the a.c. method if the experimenter must rely on an ordinary 400-ohm potentiometer for R2, but if a good calibrated variable resistance is available the system using a.c. can be used.

In the a.c. method we replace the battery E and the switch S with a small a.c. oscillator. The plate meter may or may not be left in the circuit, but it is not used for determining the balance point. Instead we use a pair of earphones in the plate circuit. The complete arrangement is shown in Fig. 2. The audio oscillator need consist simply of a –99 or a –01A type tube connected as indicated. The transformer T is a standard push-pull output transformer, the secondary of which is connected across R1 and R2. The fixed condenser C across the primary controls the frequency of the oscillation. This condenser should have a value such that the circuit oscillates at about 1,000 cycles, a frequency to which the ear and earphones are quite sensitive.

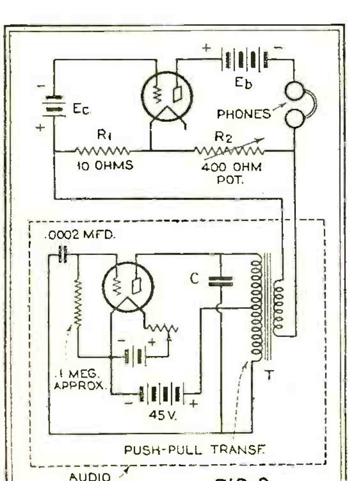


FIG. 2

TABLE 1

TUBE No.	AMPLIFICATION CONSTANT			PLATE IMPEDANCE				MUTUAL CONDUCTANCE
	R_1	R_2	Mu	R_1	R_2	R_3	Rp	(CALCULATE FROM Rp AND Mu)
1	10	90	9	300	300	10,000	10,000	900
2	"	83		"	245	"		
3	"	97		"	395	"		
4	"	80		150	250	"		
5	"	77		"	325	"		
6	"	85		"	300	"		
7	"	75		300	200	"		
8	"	70		"	275	"		
9	"	80		"	350	"		
10	"	65		"	175	"		

TABLE 2

FOR TUBES WITH A PLATE IMPEDANCE IN THE ORDER OF—	R_1 SHOULD HAVE A VALUE OF—
2000 OHMS	50 OHMS
5000 "	150 "
10,000 "	300 "
30,000 "	1000 "

In the use of this system we simply turn on the oscillator, listen in the earphones and then adjust R2 until no sound is heard in the earphones. The sensitivity of the arrangement can of course be increased by using an audio amplifier to boost the signal before it is impressed on the earphones; the amplifier input would be connected across the points where the earphones are connected in Fig. 2. Having determined the point at which no sound is heard in the earphones, we note the value of R2, divide it by 10, the resistance of R1, and the quotient is the amplification constant of the tube.

The circuit for measuring the plate impedance of a tube is shown in Fig. 3. This circuit is really more simple when used with earphones and oscillator, since if d.c. is used some arrangement is necessary to balance out the normal current through the meter. But since every experimenter has a pair of earphones and an audio oscillator can be easily built, there is no reason why the a.c. method, with the greater accuracy it permits, should not be used. In Fig. 3, Ec is the grid voltage and Eb is the plate voltage at which the tube is to be tested. As in measuring amplification constant, the circuit is balanced by adjusting R2, the 400-ohm potentiometer, until there is no sound in the earphones. The plate impedance is then equal to

$$\text{Plate impedance} = \frac{R1 \times R3}{R2}$$

The value of R1 depends somewhat on the plate impedance of the tube being measured. The values in Table 2 will adequately cover the usual range of tubes.

For tubes with a plate impedance in the order of	R1 should have a value of
2,000 ohms	150 ohms
5,000 ohms	150 ohms
10,000 ohms	300 ohms
30,000 ohms	1,000 ohms

Those experimenters who want to build up these simple bridges will of course prefer to combine the circuit for measuring amplification constant with the circuit for measuring plate impedance. The combined circuit is therefore shown in Fig. 4. The two double-pole, double-throw switches serve to arrange the circuit for the measurement of amplification constant when (*Cont'd on page* 743)

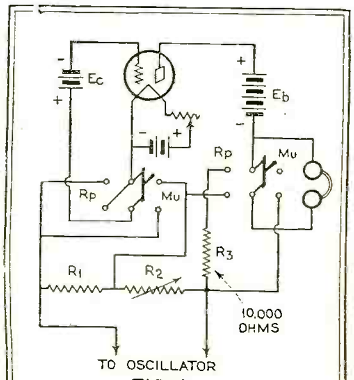


FIG. 4

The Junior RADIO Guild

LESSON NUMBER SEVENTEEN

Using Mathematics in Radio

Algebra and Its Application to Radio Engineering

PART THREE

NO progressive study in radio engineering can be made without the use of algebra, and this is appreciated more fully when one attempts to study the various advanced designs of radio equipment. It is sometimes difficult to the beginner, who picks up an algebra textbook, to realize that what he learns there will be of great importance to him later in the analyses of electric circuits in radio. But it will be shown here how it is an aid in analyzing tube circuits and radio apparatus design, as well as a help to good engineering.

Algebra deals with the letters of the alphabet and we associate them in certain expressions which become helpful in the understanding of many problems.

A summary of algebra shows that there are several fundamental algebraic expressions which must be studied in order to understand the various engineering phases of radio which are of interest. Among these expressions which are undertaken here and which are shown later to be of practical importance in radio design are the following:

1. The addition of algebraic expressions.
2. The subtraction of algebraic expressions.
3. The multiplication of algebraic expressions.
4. The division of algebraic expressions.
5. Fractions.
6. Simultaneous equations.
7. Imaginary quantities.
8. Quadratic equations.

No attempt is made here to show all the various steps required for a complete analyses of these expressions, but it is the purpose of this series to show a few applications of how the algebra can be used in practice. As a textbook for those students who are interested further in studying more of the details of algebra, the following book is highly recommended, as it is one which is popularly used in the upper grades of high schools and colleges—"Algebra for Colleges and Schools," by H. S. Hall and S. R. Knight, revised by F. L. Sevenoak, published by the Macmillan Company, New York City.

TO beginners in radio the importance of the fact that the common ordinary garden variety of mathematics (the kind of mathematics which to some seemed so pointless when taught in the elementary and lower classes of high school) is quite necessary to the later assimilation of a knowledge of geometry, trigonometry and calculus cannot be stressed too much. For the truth of this it is only necessary to question those in the radio game who have been unfortunate enough to have slipped up on this part of their education and now wish that they had the opportunity to go back to school again.

RADIO NEWS is glad to present to its readers this third of a series of articles prepared by Mr. J. E. Smith (President, National Radio Institute) on the use of mathematics in radio. The first of the series appeared in the December, 1930, issue of RADIO NEWS, the second in the January, 1931, issue. Others will follow.
THE EDITORS.

The Addition of Algebraic Expressions

If the letters a, b, c, etc., or x, y and z express the values of certain quantities, then we can write various expressions to be added. Thus, $5 + 3 + 9$ can be expressed by the letters $a + b + c$, or may be written in bracket form, $5 + (3 + 9)$ as $a + (b + c)$. Likewise, $5 - 3 + 9$ can be expressed by $a - b + c$, or as follows, $5 - (3 - 9)$ is $a - (b - c)$. This study of the addition of algebraic expressions leads us to the relations of the signs, "plus" or "minus" and shows how these expressions are placed within brackets. Brackets () are used to indicate that the terms within them are to be considered as one quantity, and by noting how these bracketed forms are affected by the signs + and —, we shall state the following rules:

(a) When the bracketed form is preceded by a + sign, the expression is not changed by removing the brackets ().

(1) This is evident from the above consideration, as any expression $3 + (8 + 6) = 17$ is the same as $3 + (14) = 17$, and removing the bracket $3 + 14 = 17$.

(b) When the bracketed form is preceded by a — sign, the expression is not changed if the sign of every term within the bracket is changed.

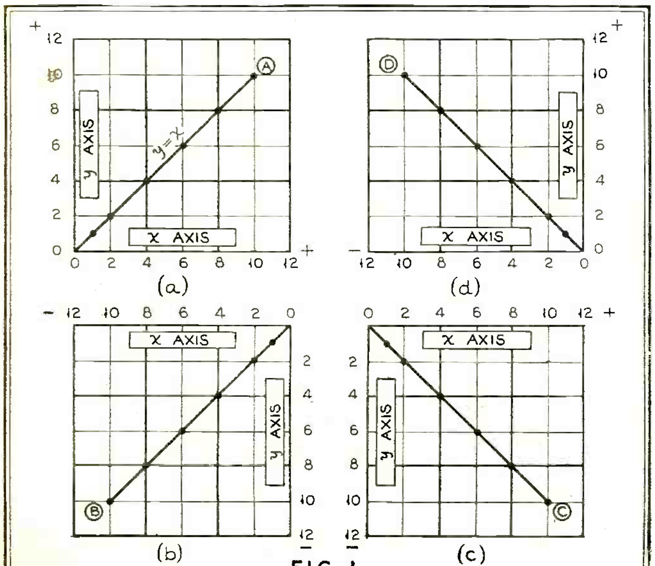


FIG. 1

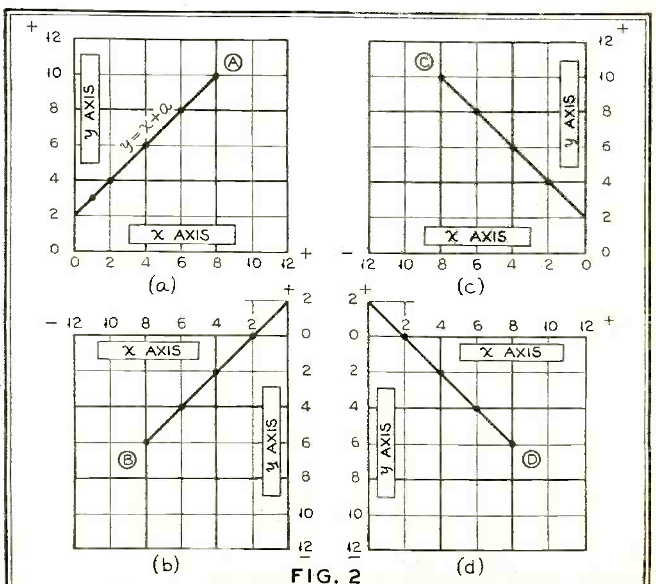


FIG. 2

(1) Thus, from the above consideration, as any expression $3 - (8 + 6)$ is the same as $3 - (14) = 3 - 14 = -11$, we can maintain the same expression by removing the brackets and changing the signs of every term within the brackets, thus: $3 - 8 - 6 = -11$.

Examples:*

Find the sum of:

(1) $a + 3b + 4c$; $2a + b + c$; $5a \pm 2b + 2c$.

To indicate the method:

$= (a + 3b + 4c) + (2a + b + c) + (5a + 2b + 2c)$.

$= a + 3b + 4c + 2a + b + c + 5a + 2b + 2c$

adding like terms.

$= 8a + 6b + 7c$. Answer.

(2) $3a + b - c$; $-a + 3b + 2c$; $4a - 2b - 3c$.

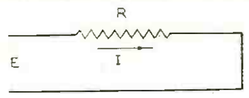


FIG. 3

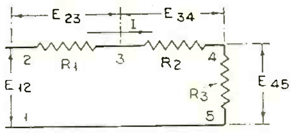


FIG. 4

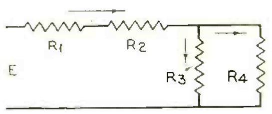


FIG. 5

(17) $-1/3a - \frac{1}{4}b$; $-2/3a + \frac{3}{4}b$; $-2a - b$.

(18) $-2a + 5/2c$; $-1/3a - 2b$; $8/3b - 3c$.

The Subtraction of Algebraic Expressions

Subtraction, as we always think of it, is the inverse of addition, or the opposite operation and it is in the performing of examples in subtraction where the change of signs by the use of brackets plays such an important part.

Thus, in subtracting:

$6a - 3b + 2c$ from $8a + 6b - 5c$

$= (8a + 6b - 5c) - (6a - 3b + 2c)$.

Remembering the rule of signs:

$= 8a + 6b - 5c - 6a + 3b - 2c$

$= 8a - 6a + 6b + 3b - 5c - 2c$

$= 2a + 9b - 7c$. Answer.

Again, subtract

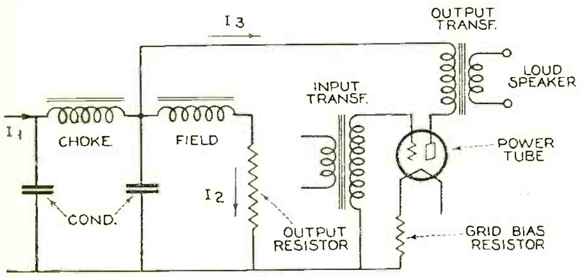


FIG. 8

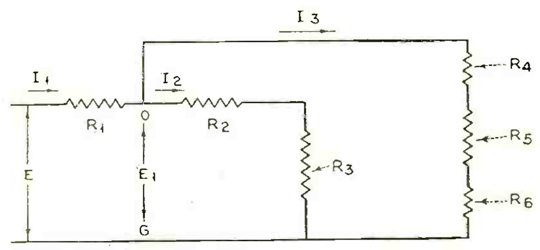


FIG. 9

To indicate the method:

$= (3a + b - c) + (-a + 3b + 2c) + (4a - 2b - 3c)$

$= 3a + b - c - a + 3b + 2c + 4a - 2b - 3c$

adding the like terms—

$= 6a + 2b - 2c$. Answer.

(3) $a + 2b - 3c$; $-3a + b + 2c$; $2a - 3b + c$.

It is more convenient to arrange the letters in column form.

To indicate the method:

$$\begin{array}{r} a + 2b - 3c \\ -3a + b + 2c \\ 2a - 3b + c \\ \hline 0 \end{array}$$

0 Ans.

(4) $3a + 2b - c$; $-a + 3b + 2c$; $2a - b + 3c$.

(5) $4a + 3b + 5c$; $-2a + 3b - 8c$; $a - b + c$.

(6) $-15a - 19b - 18c$; $14a + 15b + 8c$; $a + 5b + 9c$.

(7) $-16a - 10b + 5c$; $10a + 5b + c$; $6a + 5b - c$.

(8) $-5ab + 6bc - 7ca$; $8ab - 4bc + 3ca$; $-2ab - 2bc + 4ca$.

(9) $5ab + bc - 3ca$; $ab - bc \pm ca$; $-ab + bc + 2ca$.

(10) $x + 7 + z$; $2x + 3y - 2y$; $3x - 4y + z$.

(11) $2a - 5b + c$; $15a - 21b - 8c$; $3a + 34b + 7c$.

(12) $47x - 53y + z$; $-23x + 15y - 3z$; $-22x + 48y + 15z$.

(13) $2ab + 3ac + 6abc$; $-5ab + 2bc - 5abc$; $3ab - 2bc - 3ac$.

(14) $x^2 + xy - y^2$; $-z^2 + yz + y^2$; $-x^2 + xz + z^2$.

(15) $x^3 - 4x^2y + 6xy^2$; $2x^2y - 3xy^2 + 2y^3$; $y^3 + 3x^2y + 4xy^2$.

(16) $\frac{1}{2}a - 1/3b$; $-a + 2/3b$; $\frac{3}{4}a - b$.

To indicate the method:

$$\begin{array}{r} \frac{1}{2}a - 1/3b \\ -a + 2/3b \\ \frac{3}{4}a - b \\ \hline \frac{1}{4}a - 2/3b \end{array}$$

$\frac{1}{4}a - 2/3b$. Ans.

For, remember that $-a$ is the same as $-4/4a$, and $\frac{1}{2}a$ is the same as $2/4a$.

*Note: The majority of examples herein are taken from the algebra textbook by Hall and Knight referred to above.

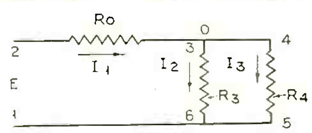


FIG. 6

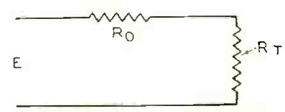


FIG. 7

$2a + b + 3c$ from $7a + 3b + 8c$

$= (7a + 3b + 8c) - (2a + b + 3c)$

$= 7a + 3b + 8c - 2a - b - 3c$

$= 7a - 2a + 3b - b + 8c - 3c$

$= 5a + 2b + 5c$. Answer.

Now, it can be shown that a more convenient way of doing this example is to arrange the numbers in column form where all the signs of the terms in the lower line are changed.

$$\begin{array}{r} 7a + 3b + 8c \\ -2a - b - 3c \\ \hline 5a + 2b + 5c \end{array}$$

Answer by addition.

Subtract:

(1) $3a - 6b + c$ from $2a - 7b + 3c$.

(2) $5a + 7b + 2c$ from $3a + 11b + c$.

(3) $4a - 3b + c$ from $2a - 3b - c$.

To indicate the method: It is not necessary that the signs be changed as indicated above, but mentally perform the operation.

$$\begin{array}{r} 2a - 3b - c \\ 4a - 3b + c \\ \hline -2a - 2c \end{array}$$

Answer.

(4) $a - 3b + 5c$ from $4a - 8b + c$.

(5) $2x - 8y + z$ from $15x + 10y - 18z$.

(6) $15a - 27b + 8c$ from $10a + 3b + 4c$.

(7) $-11ab + 6cd$ from $-10bc + 3b - 4cd$.

(8) $-16x - 18y - 13z$ from $-5x + 3y + 7z$.

(9) $-ab + cd - ac + bd$ from $ab - cd + ac - bd$.

(10) $3ab + 5cd - 4ac - 6bd$ take $3ab + 6cd - 3ac - 5bd$.

(11) $-2x^3 - x^2 - 3x + 2$ take $x^3 - x + 1$.

(12) $-8x^2y + 15xy^2 + 10xyz$ take $4x^2y - 6xy^2 - 5xyz$.

(13) $3xy - 15xz + 8xz$ take $-4xy + 2yz - 10xz$.

(14) $-8x^2y^2 + 15x^3y + 13xy^3$ take $4x^2y^2 + 7x^3y - 8xy^3$.

(15) $-8a^2x^2 + 5x^2 + 15$ take $9a^2x^2 - 8x^2 - 5$.

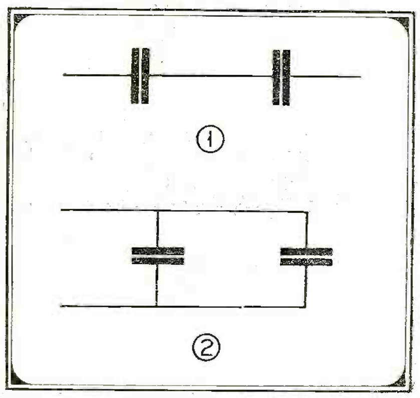
Algebraic expressions, when plotted on squared paper, show some very interesting results, and (*Continued on page* 755)

RADIO NEWS INFORMATION SHEETS

Condensers in Series and Parallel

OFTEN it is desirous to increase or decrease the capacity in a circuit or perhaps a condenser of the desired value is not at hand for some particular use or experiment.

When it is desired to reduce the capacity of a circuit without disturbing or rebuilding the apparatus, another condenser may be placed in series. This may be either fixed or variable. Again the serviceman, on a call, may have two .001 mfd. condensers but requires a .0005 mfd. condenser.



Condensers in Series

The capacity of condensers in series is the reciprocal of the sum of the reciprocals of the condensers.

$$\text{Thus: } C = \frac{1}{\frac{1}{C1} + \frac{1}{C2}} = \frac{C1 \times C2}{C1 + C2}$$

Example: The serviceman required a .0005 mfd. condenser but had only .001 mfd. condensers in his kit. By using two .001 mfd. condensers in series he obtained:

$$C = \frac{1}{\frac{1}{.001} + \frac{1}{.001}} \text{ or } \frac{.001 \times .001}{.001 + .001}$$

$$= \frac{.000001}{.002} = .0005 \text{ microfarad}$$

Generally speaking, two condensers in series will have a capacity less than either of the condensers alone.

Condensers in Parallel

The total capacity of condensers in parallel is the sum of their capacities.

Thus: $C = C1 + C2$.

As, for example, a serviceman needed a 4 mfd. condenser for filter block replacement, but having in his kit only one 2 mfd. and two 1 mfd. condensers, he placed them in parallel.

Thus: $C = 2 + 1 + 1 = 4$ mfd., as required.

Suppose the serviceman required a 2 mfd. filter condenser to work on 400 volts but had a number of 2 mfd. 200-volt condensers. He therefore made two banks of two 2 mfd. condensers and placed them in series.

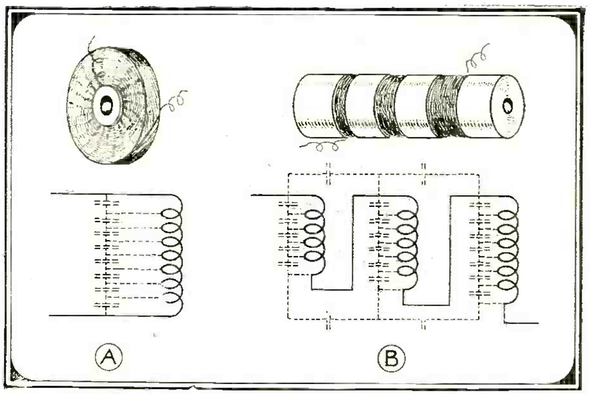
$$\text{Thus: } \frac{(2+2) \times (2+2)}{(2+2) + 2+2} = \frac{4 \times 4}{4+4} = \frac{16}{8} = 2 \text{ mfd.}$$

RADIO NEWS INFORMATION SHEETS

Notes on Radio Frequency Chokes (Part 1)

RADIO-FREQUENCY chokes are classified in two general types, those that are polarized and those that are not.

The purchaser may find all manner and variety of radio-frequency chokes—long and thin, short and thick, lateral, layer, slot and helical-wound. Such variety, to say the least, is confusing, and for proper circuit function chokes must be selected not only for their inductance but for their size, shape, placement in the receiver as well as their actual electro-physical characteristics.



Generally speaking, a choke is thought of as a coil of wire having a certain inductance, when as a matter of fact it has inherent or distributed capacity. The latter is the troublesome characteristic of all chokes to greater or less degree, though minimized considerably in the polarized type.

In Fig. A is shown a choke of the lateral-wound type, or it may be jumble-wound in a single slot. A small capacity exists between each turn, as shown by the dotted lines in the schematic diagram. These capacities are in series and in shunt, as will be seen, to the entire winding and to each individual turn, resulting more or less as a short circuit for the radio frequencies, and causes the formation of resonant circuits within the choke. These conditions, when of a large degree, make for a worthless choke.

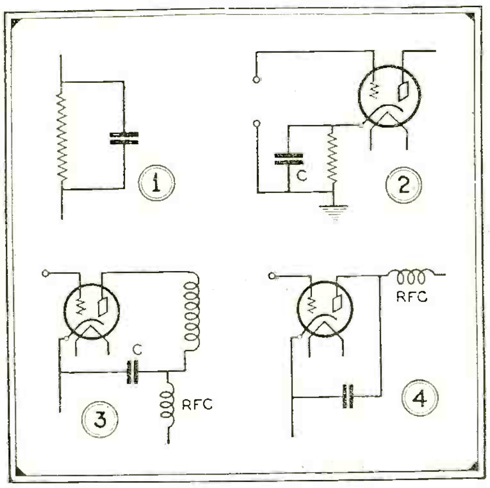
The Fig. B shows a slot-wound choke. Each winding is of a different number of turns and of a different size, connected in series. This method of construction overcomes to some extent the peaking or resonant points and tends to reduce to a minor degree the distributed capacity. As a first-class choke it is still wanting, although better than the first type shown.

The user should select a choke having a natural period at just above the frequencies on which it will be used to block or divert. For the broadcast frequencies this value should be from 8 to 10 millihenries, having a natural period of from 350 to 425 kc., depending on the degree of distributed capacity.

The greater the frequency the larger the wire that should be used in making the choke.

RADIO NEWS INFORMATION SHEETS

By-passing (Part 2)



IN Fig. 3 is represented the frequency block or by-passing system used in the plate circuit of a radio-frequency tube or as an audio-frequency block in the plate circuit of an audio-frequency stage.

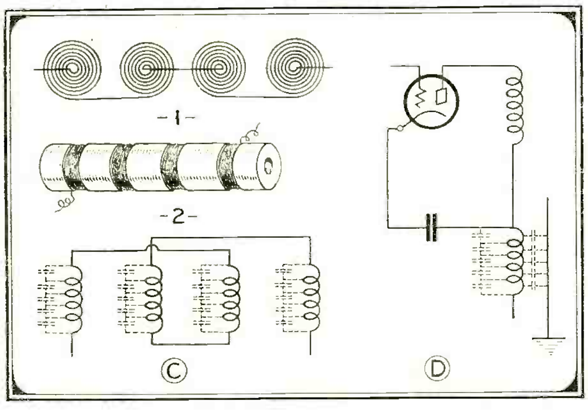
The value of the by-pass condenser when used for audio frequencies is calculated in the same manner as calculated for the bias resistor. For radio frequencies, the value is calculated to as near a zero value as possible in relation to the impedance of the radio-frequency choke, RFC. For this calculation 500 kc. is taken as the lowest frequency involved in t.r.f. receivers. Assuming the inductance of RFC to be 10 millihenries, the inductive reactance is calculated from the formula 2 $\times$ pi $\times$ f $\times$ L; where L, the inductance, is expressed in millihenries, f is the frequency in kilocycles and pi is 3.14.

Solving, the inductive reactance will be 3,140,000 ohms. However, due to the distributed capacity and other losses of the choke, RFC, a value of about 50 per cent. is assumed. The by-pass condenser can be 10 ohms or less. Solving for the by-pass condenser value by the capacity reactance formula, we get C equals .003 mfd. Allowing further losses introduced by circuit wiring and the arrangement of the parts, and to bring the value to a more convenient commercial size, the minimum value is selected as .006 mfd. Actual experience has shown that values up to and including 1 mfd. promote greater circuit stability and sensitiveness. Wherever possible such values should be used.

Fig. 4 shows the use of a by-pass condenser in the detector plate circuit of the detector tube. This by-pass condenser is used to by-pass the radio frequencies around the input of the audio system. The selection of the proper value depends primarily on the by-passing of all radio frequencies without the attenuation of the high audio frequencies. No real line of separation exists between low radio frequencies and the very high audio frequencies, the latter within the super-audible range of frequencies. Actual experiment and research indicates a value from .0005 to .001 mfd., and gives a well-balanced ratio between by-pass of r.f. and the suppression of high audio frequencies.

RADIO NEWS INFORMATION SHEETS

Notes on Radio Frequency Chokes (Part 2)



THE figure C1 outlines the principles of the helical-wound type. This choke is far more satisfactory than the two types previously mentioned. It has a very low distributed capacity in addition to practically no resonant peaks within the range of frequencies it is used to block or divert. The peaks that will exist will be in the very high frequencies.

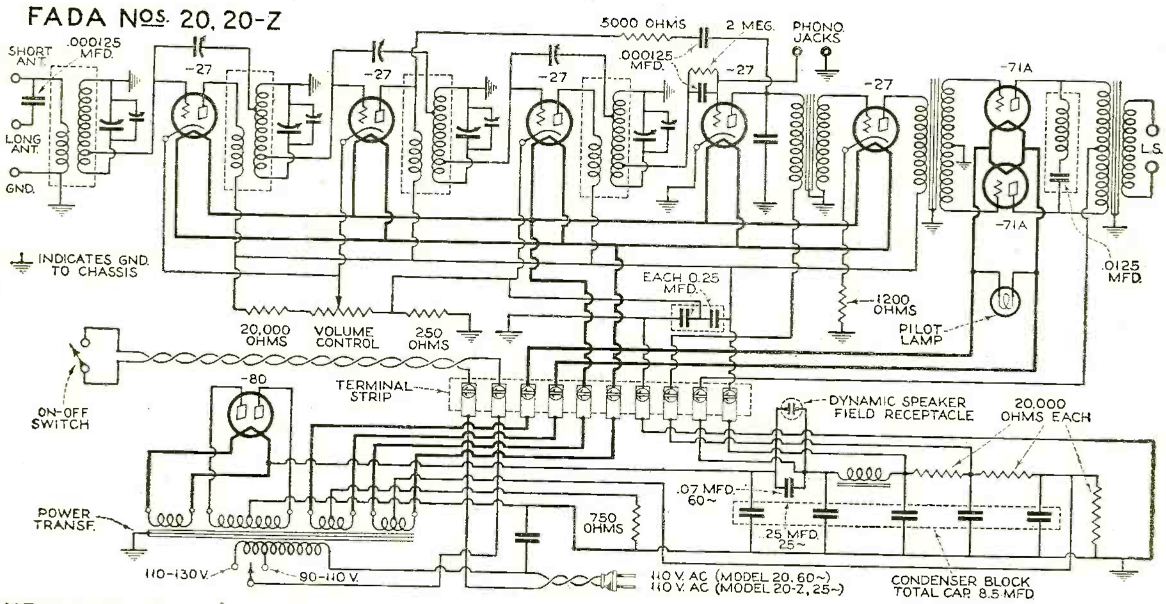
The figure C2 outlines the principles of the polarized choke, both pictorially and schematically. These chokes are connected as shown, resulting in definite high and low potential ends, thus its characteristic of being polarized.

Care should be exercised in the placement of the choke in the receiver. The choke should be well isolated to be effective. Its field should be placed as far away from shielding or other metal parts as possible, as otherwise its resistance and distributed capacity will be increased. The effect is shown in figure D. Should it be necessary to place a choke close to shielding or other metal, the field of the choke should be at right angles. Mounting screws passing through the winding is extremely bad practice. The removal of such metallic cores has in many cases overcome circuit oscillation and instability. It is preferable to cement the choke to a dowel, then using a small brass wood screw for fastening the assembly to the chassis or shielding. If possible, each choke should be placed in individual shielded compartments, with at least one inch of space on all sides.

For frequency blocks in circuits such as intermediate amplifiers where the tuning is fixed, the chokes may be tuned to reject the frequency to which the amplifier is adjusted. To accomplish this successfully it is necessary to tune each rejector circuit by a calibrated grid-dip or other type radio-frequency oscillator. If the units are tuned before assembly in the receiver circuit, the introduction of circuit and tube capacities will alter the resonant period, in which case they will not be effective in the rejection of the frequencies.

In many instances the use of resistors as frequency blocks is more effective. When using resistors, it is necessary that their resistance be within a tolerance of 2 per cent. of that calculated.

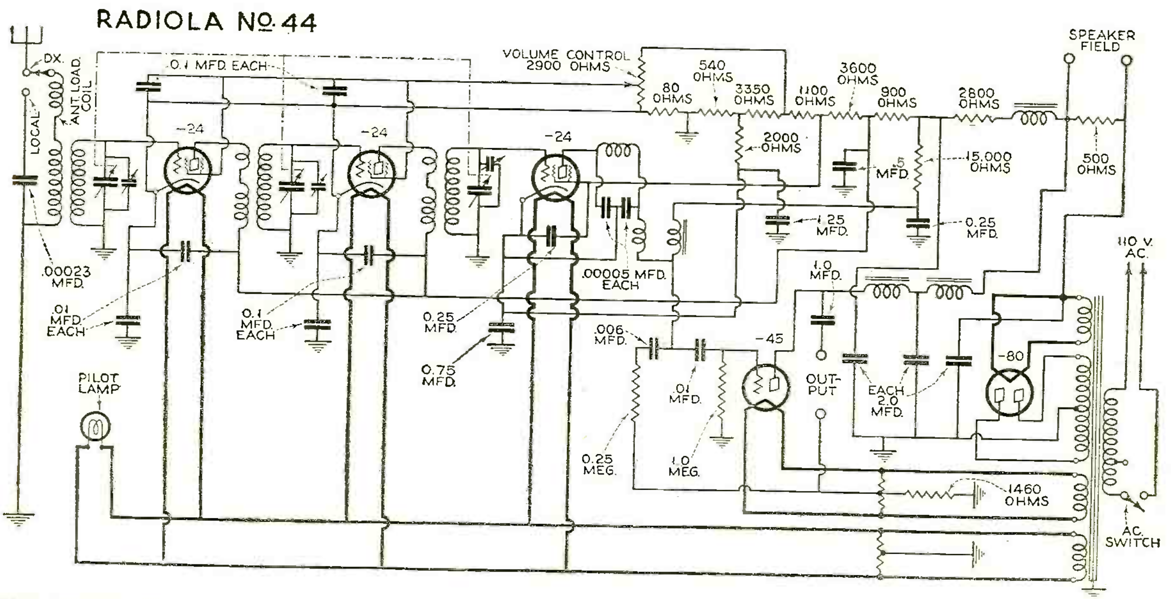
Radio News Manufactured Receiver Circuits



THE Fada 20 and 20-Z are alike except that in the 20-Z a power transformer is used that is satisfactory for 25-cycle lines. The receiver is of the neutrodyne type, utilizing five type -27 tubes in the three radio-frequency stages, detector, and first audio stage. Push-pull type -71A tubes are used in the output stage. An -80 tube is used as a rectifier. Provision is made to excite the field of the dynamic reproducer by utilizing it as a choke in the filter circuit.

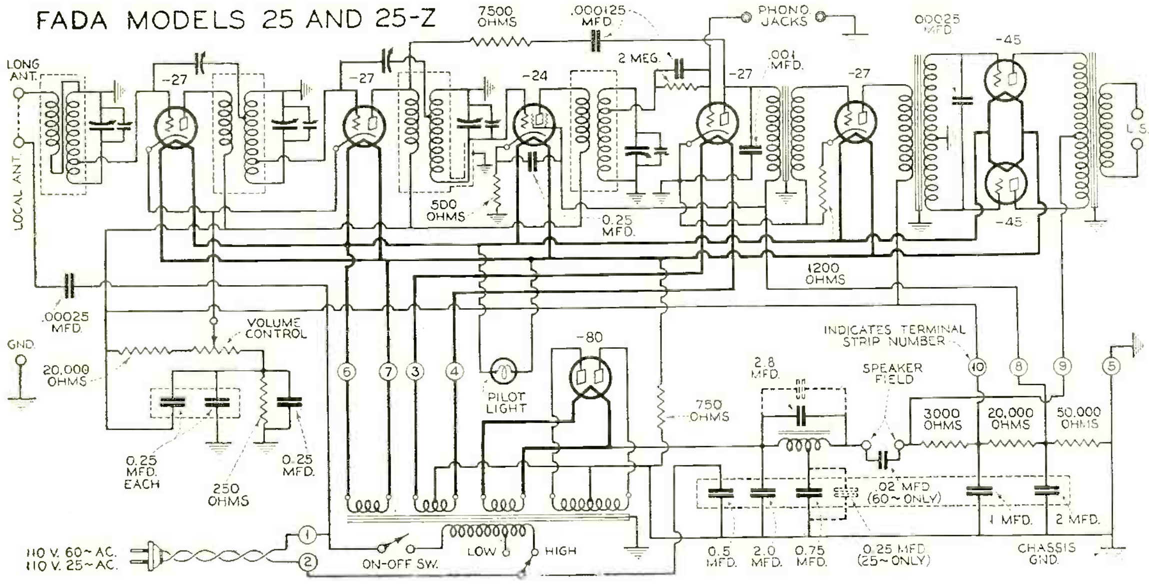
An unusual feature of the receiver is found in the fact that a small amount of regeneration is introduced in the radio-frequency amplifier, which materially improved both sensitivity and selectivity. At no time can this regeneration become sufficient to cause annoying oscillation. Provision is made for phono pick-up.

Radio News Manufactured Receiver Circuits



THE Radiola 44 is a four-tube receiver of quite unusual characteristics. Two stages of radio frequency amplification are used, employing type -24 tubes. The coupling between these tubes consists of a radio-frequency transformer whose primary is wound with one turn of wire very closely coupled to the grid end of the secondary, and the remainder of the primary is wound at the low potential end of the secondary. This gives both capacity and inductive coupling and tends to keep the coupling constant throughout the frequency spectrum. Another -24 tube is used as a power detector, resistance coupled to the power output stage. Chokes and condensers are used in the plate circuit of the detector to keep the radio frequency present in this circuit off of the grid of the output tube. The output tube used is a -45 type, while an -80 is used as a rectifier. The output tube is choke and condenser coupled to the loud speaker.

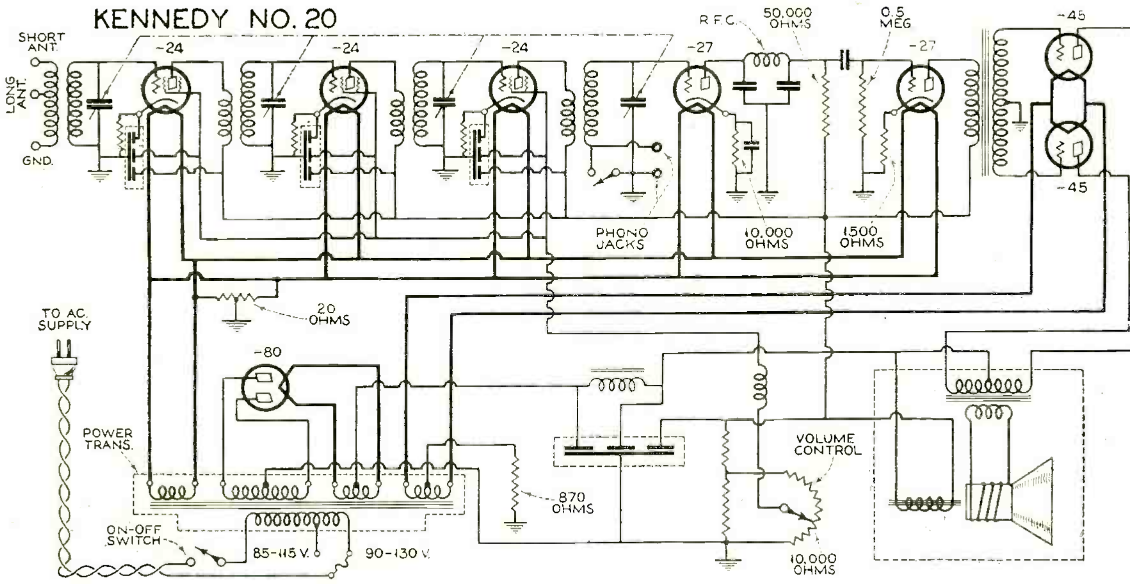
Radio News Manufactured Receiver Circuits



THE Fada Model 25 and 25-Z is an eight-tube receiver, utilizing two -27 type tubes, and one -24 type in the radio frequency stages, a -27 tube in the detector, and first audio stages, and two -45 type tubes in the power output stage, in a push-pull arrangement. An -80 type tube is used in the power supply. A neutrodyne circuit is employed in the radio frequency amplifier to insure stability, while a small amount of regeneration is employed to increase the gain, and selectivity. At no time can this regeneration become sufficient to cause squealing. On local stations, no antenna is necessary, the radio frequency energy picked up by the power lines being utilized.

For all around use, an antenna post is provided. The power supply is arranged to operate from any line voltage between 100 and 130 by appropriate taps on the primary circuit of the power transformer.

Radio News Manufactured Receiver Circuits



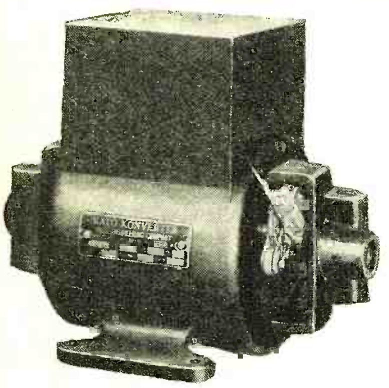
THIS receiver, the Kennedy Model 20, is of conventional design and sound engineering principle. Eight tubes are employed, three -24's in the radio frequency stages, two -27's in the detector and first audio stage, and two -45's in the power output, push-pull stage. The first audio stage is resistance coupled, the push-pull stage being transformer coupled. Volume control is accomplished by varying the screen-grid voltage on the r.f. tubes. Provision is also made to plug in a phono pick up. In the power supply, an 80-type tube is used to furnish all necessary potentials except the a.c. for the filaments, which of course is obtained from the power transformer.

The power transformer has taps on the primary side to permit operation from line voltage ranging between 85 to 130 volts. The speaker field is excited by utilizing it as a part of the filter circuit.

NEWS *from the* MANUFACTURERS

Converter

Kato Engineering Company, Mankato, Minn., announces a new rotary converter for the operation of any standard all-electric receiver. This device has been de-

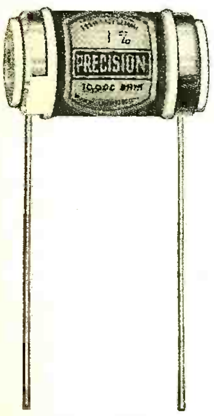


veloped to operate with 32-volt farm lighting plants. The unit itself contains and will permit a.c. operation without making any changes in the receiver. No transformer is used and the output is carefully filtered.

Radio-Phono Combination

The Excello Products Corporation, Chicago, Illinois, is manufacturing a new radio-phonograph combination known as model R279. This is furnished with complete phonograph equipment, Excello Radio with three screen-grid tubes and dynamic speaker.

Wire-Wound Resistor



International Resistance Company, 2006 Chestnut Street, Philadelphia, Pa., is bringing out a wire-wound resistor of unique design. This resistor is molded and contact which provides the usual difference of open contacts formerly incurred in the spot soldered or spot welded joints. The pigtail construction makes for ease in assembly. These resistors have other features explained in a new catalog.

Clarion Appoints Export Sales Promotion Manager

Transformer Corporation of America, Chicago, Illinois, announces the appointment of Frank San Roman, Jr., as export sales promotion manager.

Mr. Roman has been active in the radio industry abroad for many years and was chiefly identified with the introduction and popularization of the all-electric type receiver in the South American market. It was during his engineering training that he became interested in exports, initiating his career under the tutelage of General Electric X-Ray Company, manufacturers and exporters of X-Ray apparatus.

Circuit Tester

Weston Electrical Instrument Corporation, Newark, N. J., has brought out a model 563 instrument tester for checking resistance, voltages and circuit continuity during the process of manufacture and for service and installation work on many types of electrical apparatus.

This model consists of a Weston model 301, 3¼ inch diameter meter with two resistance ranges—5,000 and 50,000 ohms—mounted in a black Bakelite case with a Bakelite panel; a toggle switch for

range selection; a self-contained 1.5 volt flashlight cell; a leather strap carrying handle and a pair of 30-inch leads with test prods.

A feature of this instrument is a voltage adjuster which compensates for change in potential of the self-contained battery. To make this compensation, it is only necessary to short circuit the binding posts and adjust the pointer to zero ohm position on the scale.

Radio Fuses

Littelfuse Laboratories, 1772 Wilson Avenue, Chicago, Ill., announces a new line of renewable high-voltage Littelfuses. They afford protection in the range from 1000 to 10,000 volts in circuits of 1 ampere or less.

This will afford protection to the equipment used in amateur and power broadcasting, sound pictures, television, and amplifiers of all kinds.

Fuses are offered in 1/16, ⅛, ¼, ⅜, ½ ampere sizes in voltages at 1000, 5000 and 10,000 for a.c. or d.c. current; 1 and 2 ampere sizes are being developed.

Receivers

The Commonwealth Radio Mfg. Co., of 847 W. Harrison St., Chicago, Ill., announces a line of superheterodynes, consisting of three models—Model 91, which is illustrated here, a low-boy, Model 92, a high-boy, and Model 93, a phonograph

combination. The chassis is compact in design, the power pack being integral with the tuner. Tubes used are 4-224, 2-227, 2-245, and 1-280. The full output of this receiver is ably handled by the new Trimm, Jr., Stadium Speaker. Tone control is also included. The cabinets are designed along the latest vogue, stressing a simple beauty that pleases all.

This same concern also announces a new line of 6-tube receivers bordering on the midget class, but of a little more advanced design. The tubes used are 4-

224, 1-245, and 1-280. The new type "litz" bank wound coils are employed. The line consists of Model 13 (illustrated here), mantel cabinet; Model 14, taboret console; Model 51, low-boy console; and Model 53, phonograph combination.

Remote Control Device

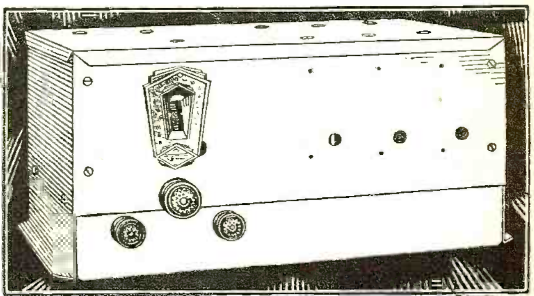
Announcement of a remote control device by means of which a radio receiver located at a distance from the listener is automatically tuned to the desired stations by merely pressing appropriate buttons has just been made by the RCA Radiola Division. The new automatic tuning and remote control equipment, which has been incorporated in two new Radiola superheterodyne receivers, includes a duplicate set of push buttons on the radio panel that also permit automatic tuning at the radio receiver itself.

"It is well known from a study of the

(*Continued on page* 730)

SM

Now You Can Have *Seventy Stations* in Twenty Minutes!



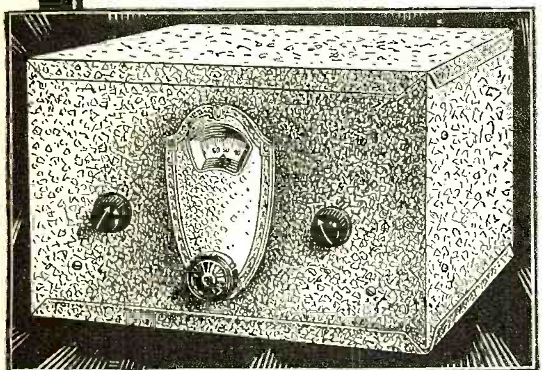
S-M 714 *Superheterodyne* Tuner

The 714 *Superheterodyne* Tuner is the finest piece of radio equipment it is possible to produce today—just as the famous Sargent-Rayment 710 was the "boss of the air" in its day. A stock model in the Silver-Marshall Main Laboratory at Chicago brought in clearly and distinctly, and at room volume, *ninety-three* stations, one after the other, including Cuba, Mexico City, and *every* station on the west coast that was on the air! Over a period of a month you should be able to log every station in the call book that is within reason.

The 714's excellence isn't an accident—it is the result of two years of painstaking development in the great S-M Laboratories under McMurdo Silver's personal supervision. It contains eleven tuned circuits (over twice as many as the most expensive t. r. f. sets): two, in a dual-selector, precede the first '24 r. f. tube, two are between the r. f. and '24 first detector, and one is in the '27 oscillator circuit. It uses a factory-aligned and tested 443 screen-grid i. f. amplifier, having in itself six tuned circuits. Imagine, if you can, adding six more tuned circuits to the 710 or 712—and all six tuned to a single frequency!

Tubes required: 4—'24's, 2—'27's.
Price (tuner only), completely factory-wired, tested and RCA licensed, less tubes................$87.50 *List*
Component parts total..$76.50 *List*

The 714 Superheterodyne Tuner can be used with any standard audio amplifier but operates at its maximum with the S-M 677B. It is a combination two-stage amplifier and power supply. It furnishes the necessary heater and plate supply for the 714 and takes its power from any 105-120 volt, 50-60 cycle source. Tubes required: 1—'27, 2—'45's, 1—'80.
Price, completely factory-wired, tested and licensed, less tubes.............................$82.50 *List*
Component parts total..$68.50 *List*



Foreign Programs in Your Home

The S-M 738 Converter turns *any* broadcast receiver into a short-wave *superheterodyne* with a range of from two to ten thousand miles, for to every bit of the sensitivity and selectivity of your broadcast set, is added the power of *three more tubes!*

There is nothing that the most expensive commercial short-wave receiver will do, in the way of distance, that the 738 will not duplicate and beat—and at one-third the cost. Under favorable weather and local receiving conditions, it will bring in every American short-wave broadcaster and the principal foreign stations.

It is built in a beautiful black crystalline case with a hammered silver dial—entirely at home in the finest living-room.

The wired model can be hooked up in three minutes—you merely remove the antenna lead from the broadcast receiver and connect it to the antenna post of the converter; then run two leads from the 738 to the antenna and ground posts of the broadcast set—and tune it in. A switch can be easily arranged to throw the set from long to short waves at will.

It tunes by a single dial (which tunes the oscillator circuit) and an auxiliary midget condenser.
It will give, in addition to short-wave broadcasting, phone and i.c.w. where there is any carrier modulation at all.
Included in the list price are eight coils (four pairs) which cover the wave length range of from 18 to 206 meters.
Tubes required: 1—'24, 1—'26, 1—'27.
Price, completely factory-wired, tested and RCA licensed, less only tubes.......................$69.50 *List*
Component parts total..$59.50 *List*

Get Your Free Copy of the S-M General Parts Catalog

Check the coupon for your copy of the SILVER-MARSHALL 1931 GENERAL PARTS CATALOG. The Radiobuilder, Silver-Marshall's official publication, tells the latest news of the great S-M laboratories. Fill in the coupon for a sample copy.

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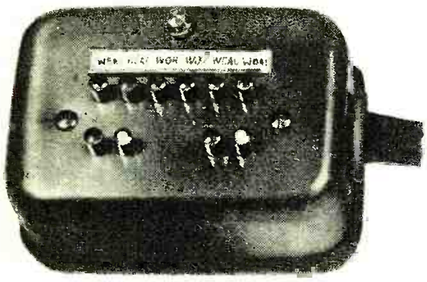
----Send me, free, your NEW 1931 CATALOG with sample copy of the RADIOBUILDER. Also Data Sheets as follows: (*Enclose 2c for each Data Sheet desired.*)
----No. 25. 714 Screen-Grid Superhet Tuner.
----No. 23. 738 Short-Wave Superhet Converter.

Name..

Address..

(*Continued from page* 728)

habits of radio listeners that few set owners listen to the programs of more than three or four stations, under ordinary circumstances," said Mr. Ernest H. Vogel, Sales and Advertising Manager of the Radiola Division, in making the announcement. "The new automatic tuning and remote control device, therefore, provides six "pre-selected" programs and, by a simple adjustment, any other stations desired. With a twenty-five-foot length of a new type of cable-tape, it is a simple matter to extend complete and effortless operating control of the radio set to any desired location. This connecting tape, which is only an eighth of an inch

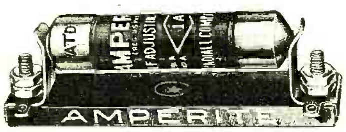


thick and an inch wide, is superior to the ordinary cable because it may be unobtrusively laid under the carpet or run along the molding. As many remote control units as desired may be connected to the one receiver, thus a small tablet containing the push buttons may be conveniently placed near a favorite easy chair, a bridge table, etc.

The remote control unit consists of a small bronze-finished tablet having a set of six buttons, for as many stations, with small spaces underneath to indicate the station call letters. Two more buttons turn the receiver on and off, and a slight pressure on two other push buttons increases and diminishes the volume. A tiny jewelled pilot lamp lights when the set is in operation and indicates by its varying brilliance whether a station is tuned-in to its most sensitive spot on the dial. To tune-in distant stations or other stations not pre-selected pressure is released on the buttons at the moment the desired station is heard clearly.

Storage-Battery Operation of the New 2-Volt Tubes

The exceptionally high efficiency of the new -30 and -31 types of 2-volt tubes makes them particularly attractive for use in the old battery receiver quite as well as in the latest receivers especially designed for them. When using a 6-volt



storage battery, however, it becomes necessary to reduce the applied voltage to 2 volts. For this purpose, the Amperite Corporation, New York, has introduced two new Amperites, namely, the 630 and 631 types for the -30 and -31 tubes, respectively, operating on a 6-volt battery supply.

Battery Charger

A new charger for six-volt batteries, operated on a 105-120-volt, 60-cycle, alternating current has been brought out by Permacharge, Inc., 4394 Pearl Road, Cleveland, Ohio.

The unit consists of a small, compact charger which is permanently attached to the engine separating board of the car. The size of the unit is 6×4×2¾". Two wires lead to the charger, one of which is attached to the ammeter, and the other grounded to the frame of the car.

Current is received from an ordinary light socket by means of a 12′ cord. The charger has a special taper feature, which eliminates the possibility of over-charging the battery, and a special plug which prevents feed-back of battery circuit.

Permacharge has no bulb, acid or vibrator, using instead a dry metallic rectifying element.

Developments in Precision Wire-Wound Resistors

By the Engineering Staff
International Resistance Company

While a tolerance of 5 or 10 per cent. plus or minus stated resistance value is considered satisfactory in the general run of radio production, there are certain applications that call for tolerances of 1 per cent. or less. Hence the need for precision wire-wound resistors.

It is no simple matter to produce resistance units of an accuracy of 1 per cent. or less, not only with regard to the initial resistance value, but, what is of greater importance, the permanency of the resistance value. Not only must the unit be wound to the precise value, but all manner of precautions must be taken to maintain that value during the useful life of the unit.

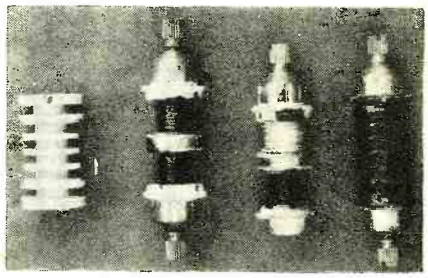
For several years past, our organization has studied the question of precision wire-wound units, quite aside from the metallized resistor problems. The matter of obtaining resistance values of 1 per cent., ½ of 1 per cent. and even ¼ of 1 per cent. tolerance, in regular production, has received careful consideration. Following the attaining of the close tolerance, the next object of our research and engineering development has been to maintain the precise resistance value under actual service conditions. As a result of months of effort, we have succeeded in developing a line of precision wire-wound resistors of novel design and construction that function in the manner sought.

Nickel alloy wire, carefully gauged, has been selected. This wire is enameled and subjected to a high-insulation voltage test. Contrary to common practice, the wire is the largest possible size consistent with the size of the resistor. This overcomes insulation problems and provides a more rugged unit.

The next step is winding. A special winding process has been developed, which gives unbroken insulation throughout. Tests are made directly through the insulation, so as to prevent the shorting of turns due to the breaking of the insulation for testing purposes. The wire is wound in the grooves or sections of a finned ceramic form. The form employed is a ceramic having a low coefficient of expansion, low moisture absorption, extremely high resistance, and very close mechanical tolerances. Its low coefficient of expansion prevents breakage of wire under operating conditions. The wound form is impregnated in a special varnish, which hardens with higher temperatures instead of softening as the wax coated forms do.

Still another consideration is the contact established between the ends of the winding and the terminals. An exclusive moulding process gives a long length of contact actually moulded into the end assembly. This prevents any corrosive action from attacking the wire, and forms a protective seal. It also eliminates the weakness of spot soldering or welding operation, poor contacts and wire breakage.

The completed units are subjected to a five-minute flash load at double normal wattage rating, which serves to locate the slightest flaw. The units are then

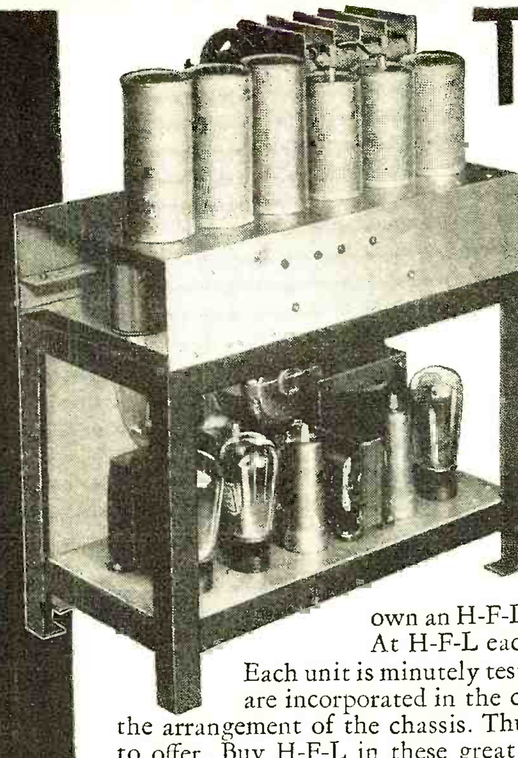


tested on accurate resistance bridges to the tolerance required—1 per cent., ½ of 1 per cent., or ¼ of 1 per cent.

Various sizes and types of precision wire-wound resistors have been placed in production, ranging from a compact two-section unit to a large eight-section unit. A wide range of resistance values is offered in the various types and sizes. It may be interesting to note that the sectional winding form permits of using two or more sizes and kinds of wire for the winding. By means of this construction it is possible to use a fairly high resistance wire in one section and a low resistance wire in one section and a low resistance wire in another section thereby obtaining extreme accuracy. Obviously, if only high resistance wire is used, it must be evident that a close tolerance becomes extremely difficult, especially since one turn of high-resistance wire may throw out the unit beyond, say ¼ of 1 per cent.

(*Continued on page* 764)

NEW IN EVERY WAY



The Diffe ence is in the Making!

The Advantage is Yours the H-F-L Way

The fine things are always hand made. This is especially true in radio. The art advances so fast, that huge factory-set-ups for mass manufacture cannot keep pace. Only a few may ever own an H-F-L—such quality receivers cannot be built in quantity. At H-F-L each receiver is hand made to the precision of a watch. Each unit is minutely tested before inclusion in the set. The latest discoveries are incorporated in the circuits. The most advanced designs are followed in the arrangement of the chassis. Thus, your H-F-L receiver gives you all that radio has to offer. Buy H-F-L in these great expectations—you will not be disappointed!

THE LITTLE GIANT MASTERTONE

MAKES ITS FIRST BOW TO FAME IN THE FIELD OF FINE RADIO

HOPKINS BAND REJECTOR SYSTEM

Entirely new! New in circuit arrangement—new in chassis design. America's outstanding builders of fine radio now produce a supremely fine low-priced superheterodyne receiver for everybody.

A real sensation is this set. It challenges all comparison. Quick as a flash, it falls into tune with the station selected. With microscopic fineness, it accepts that signal to the exclusion of everything else in the air. Even background noises cannot creep in. With bounding power, it reaches to the outposts of the world in its reception range. With enrapturing tone, it transports you to new heights of musical enjoyment. New miracles of this wizard-like art are brought to produce an entirely new superlative performance. Yet, all this you get at surprisingly low cost. No more to spend than for ordinary radio!

Sensational New Circuit!

To combine 10-kilocycle selectivity with beautiful tone quality has been the dream of every radio engineer. But, not until the perfection of the Hopkins Band Rejection System was this possible. Now in the Mastertone this is accomplished. Far away stations, on bands adjacent to powerful locals, are brought in with clarity, volume and full strength. No compromising of tonal reproduction by side band clipping. Tune to the station desired and *all* the energy in that channel is accepted and reproduced. All adjacent stations are entirely avoided. Reception is *precise*, *definite*, unhampered! The Hopkins Band Rejector System is exclusive with H-F-L and is found in no other receivers.

WORLD WIDE RECEPTION POWER

Extreme Selectivity

The full value of screen grid tubes brought to perfection. Reach out to the far corners of the earth for unforced, clear-as-a-bell reception. The sensitivity is greater than 1 micro-volt per meter—*all over the dial*. This sensational circuit arrangement always provides the reliable 10-kilocycle separation at all volumes—high or low, at all wave lengths, on local or far distant stations.

Single-Unit Chassis

A cascaded, one-unit chassis of great ruggedness. Built like a skyscraper of steel and aluminum. The dynamic speaker is integral with the chassis. All delicate parts enclosed and protected from accidental injury. All units securely anchored so that after years of use it still functions perfectly. Very compact, measuring only 21 inches high, 16 inches wide and 8 inches deep. Ideal for use in consolette or for inbuilding in the wall.

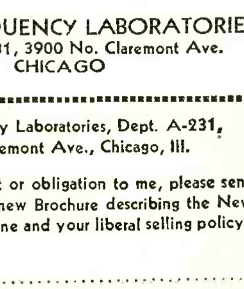
Beautiful Console Model

This wonder receiver is now available in a modern, walnut console in striking design. Neat, compact, but a fitting companion to the finest furnishings the home might have. And, best of all, it comes at a price lower than the market has ever offered. Here we have a complete, ultra powerful, beautiful tone superheterodyne receiver at a cost even less than must be paid for an ordinary trf set when secured through the usual channels.

SINGLE UNIT CHASSIS

Write for Whole Story

Learn how you can test this record-breaking, sensational new receiver and see and hear for yourself. Know the amazing price. Find out about the great new circuit embodied in it. Hear the enthusiastic praise of those who have already tuned it! All this will be brought to you in a little Brochure which will be be sent to you FREE on request. *Mail* the Coupon now and soon begin to enjoy radio in all its possibilities.



DEALERS: Write for Special H-F-L Franchise.

10 KC STATION SEPARATION

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Without cost or obligation to me, please send me a copy of your new Brochure describing the New Little Giant Mastertone and your liberal selling policy.

Name..............................

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AMERICA'S LOWEST PRICED FINE RADIO

H·F·L

LITTLE GIANT «MASTERTONE»

A Super-Heterodyne

WITH THE HOPKINS BAND REJECTOR SYSTEM

Mike-roscopes

By

Harriet Menken

BERTHA BRAINARD has been made program manager of the entire chain at NBC, which means that the hand that is reputed to rock the cradle now rules the studios! The moment I entered Miss Brainard's office at 711 Fifth Avenue and saw that all the lamps were lit in broad daylight, I knew that here history was made by astute General Brainard. Flowers graced the vases, drapes hung on the walls, in the corner stood a diminutive green Torch Song piano with the names of the great of the earth carelessly scribbled upon it, while behind an ornamental desk reigned Bertha Brainard, her titian hair coloring the room. When you leave that office, be you continuity scribe, production man or irate client, you have said "yes" with a smile to whatever plan this very prepossessing lady has proposed. At that you're probably the winner; because it's ten to one Miss Brainard's plan for you is the best that radio can offer. I need not tell you that there is a forceful brain back of all this allure.

Miss Brainard is not married. Rumor whispers that she has mislaid a husband or two, but who cares? Surely not I, who admire the lady more than I can say—nor need you, gentlemen, as there is no husband on the tapis at present. Miss Brainard began her career with Theatre Talks over WJZ when it was still in Newark, and you all know those were the times when air wasn't much more than just air, to radio fans! Since I discovered all this, I look at my own Theatre Talks over WOR on Wednesdays with a great deal more interest.

EDDIE CANTOR went on the air recently via the Columbia chain. Eddie told me that he was a little worried because you couldn't see his feet, hands and eyes while broadcasting, but he hopes he gave you "sure-fire stuff anyway." He sang his favorite song for you, "My Baby Cares For Me," the one from "Whoopee."

Mr. Cantor told me, "Anybody can make people cry, it doesn't need an actor to do that—I'd rather make them laugh! If I can make one out of twenty people forget their troubles for an hour, I'm satisfied. What man or woman do you know who hasn't sorrow enough in their lives? When they go out, they want to laugh."

Mr. Cantor was born in New York City, is 38 years old, is married, has five daughters, a home in Great Neck, Long Island, and one in California, and while in New York City he stops at the Savoy-Plaza Hotel, where this interview took place. "Have some lunch," Eddie asked me cordially. "Well, then, a ham sandwich? No? Well not for me, I'm having buttermilk."

Mr. Cantor thinks the greatest actor of the century is Charles Chaplin. Five out of six actors and actresses I interview say the same thing. Such popularity must be deserved.

Eddie was in St. Louis this winter with Mrs. Cantor, who was operated upon there, and the comedian says his wife complained of the doctor's fee and said she wouldn't have had the operation if she'd known it would be so costly—just for ten minutes.

Eddie said he explained to her it wasn't the ten minutes they were paying for but the thirty years of skill and experience back of it—"the same thing's true of an actor," Mr. Cantor said. "You may think we make a lot of money in a short time, but you must consider the lifetime of effort back of it." Mr. Cantor tells me he has an arrangement by which he hopes to have made about $50,000 a week doing the screen version of "Whoopee."

IT seems that the tall man who writes plays and eats lunch at the Algonquin dashed into print in a New York metropolitan sheet to the effect that "the development of the purely mechanical part of film production in Hollywood has become one of the major miracles of history. . . . The cameramen there are far ahead of the directors, actors, and scenario writers in efficiency, intelligence and general desirability." It continues in this fashion. Irving Reis, control engineer of Columbia on the Philco Hour and many other important programs, pointed out to me the other day that the control operator is likewise coming into his own soon. He pointed out the analogy with the cameraman in movies, whom he too told me, though born to blush unseen, was now being paid easily $1500 a week and over for his services besides receiving neckties and candy from movie actresses.

Mr. Reis is editor of *Under Control*, a magazine dealing with his profession.

WHEN I met Merlin Aylesworth, NBC's president, I knew why this was a most successful ether chain. Yes, instantly. Mr. Aylesworth is one of those men, dynamic, understanding, one of the few who know what it's all about. As a rule, my slogan is, Put Not Your Faith in Presidents. They're often dumbheads, poppa's boys, whose best assets are that they know how to press a button or mutter, "Tell Montmorency to have the Rolls here at 3:30." So Mr. Aylesworth was to me in the nature of a Delightful Surprise.

Merlin Aylesworth first saw daylight out in the corn country, Iowa, 43 years ago. He's been chairman of the Public Utilities Commission of Denver, Colorado, and let's kodak as we go: NBC's president was managing director of the National Electric Light Association. I bet there was some light shed on the situations while Mr. Aylesworth handled them!

BILL PALEY, Columbia's young president, is a different type altogether, much younger tho' quite wise, but the boy's K. O. too. In fact, I'm all for the presidents of the two largest chains in the "land of the spree and the home of the marcel wave," as one of radio's artists says. Mr. Paley, known to his girl friends (and he picks them beautiful !! —) as Bill, has a likable manner and is very good-looking. He makes it a point—I'm afraid it's only a point—to be democratic to us commoners, and only the very cynical among us hardened souls direct the effort. In fact, my only quarrel with Mr. Paley is that when he lived in the apartment above mine he let his bath run over, causing a leak in the ceil-

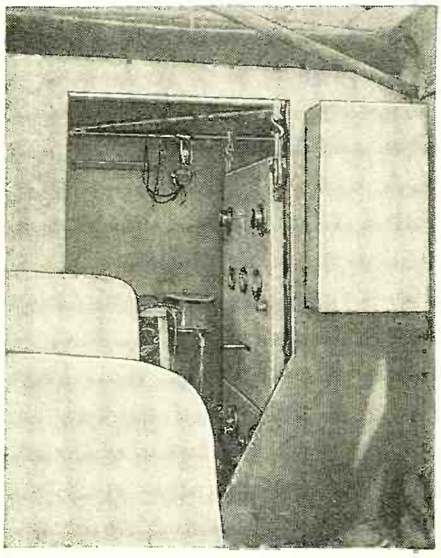
(*Continued on page 757*)

Tests, Tangos and Troubles

(*Continued from page 700*)

Within sight of snow, it was stifling hot in the plane, and the motor temperature steadily crept up within the danger zone. It seemed impossible to climb above the strata of heat radiated directly from the sun and reflected by the burning sands beneath. We headed for the coast, cooling the motor as we lost altitude with half throttle and flew out a mile or two over the Pacific. The Japanese-Humboldt current flows south along the west coast of South America. This is a cool current of water, in counterdistinction from our own and familiar Gulf Stream. Hugging the waves, the cool was instantly felt, and the needle of the oil thermometer responded with a satisfying drop.

The shore-line for hundreds of miles is ragged and barren, a sheer drop of desolate rocks to the sea without sand or beach. We flew farther out over the Pacific (we might have been a hundred miles off shore, without it being more risky), avoiding the bumps that whined around the rocky capes with the violence of a gale. Within twenty-five miles of shore the sky is almost invariably overcast, with low clouds rolling in against the crags. We escaped fog, but rain and a falling ceiling often forced us to within twenty-five feet of the ocean.



Looking aft into that part of "Pilot Radio's" cabin given over to radio

During our entire flight down the coast of South America, our sole radio contact was with CPC at Yacuiba, Bolivia. This station is owned by the Standard Oil Company, and in their co-operation with the flight a definite schedule was designated and maintained by CPC. While repeated contacts were made, it was difficult to work CPC consistently due to the fact that we often flew so low over the water that it was impossible to use the trailing wire antenna; and when an effective length could be let out it was often so bumpy that flying with the weight of the operator aft in the radio shack was unsafe. However, CPC was always on the job, and we take this opportunity to thank the Standard Oil Company and the operators for their splendid efforts.

As the sun dropped low over the western rim of the Pacific, it became evident that we could never make Arica before dark, and an indefinite town by the name of Camana seemed the only intermediate break in the cloud-topped palisades. There should have been a landing field at Camana, but a quick inspection in the deepening dusk failed to disclose anything conventionally like an airport. However, a crowd of natives running below waved us to a long stretch of sand, and here Eddie put the plane down with his usual finesse.

By this time my Spanish had been augmented beyond inquiries for the toilet and demands for change, and with only a reasonable amount of difficulty I succeeded in getting someone to stay with the plane all night. With even less trouble we commandeered an automobile and, if the driver obeyed my instructions of "vamos al el hotel mejor de la cuidad," the best hotel in the city must have been the only hostelry there! Yancey had taught us that there is one thing edible the same the world over, and when in doubt order ham and eggs—so "ouevos y jamon" it was. With little inducement to sleep, we were up before dawn. Arriving at the field with the sun, I found our guard asleep with his head on the belly of his burro, alongside of the smoldering ashes of a bonfire—kindled just under the gas tanks in the starboard wing!

We pushed on to Arica, and then through to Antofogasta, again racing the shadows of night, and picking our way through the mountains that separate the city from the flying field.

We stopped overnight at the Grand Londres Hotel. You will find most hotels in South America Grand Something or Another. The "grand" is prefixed to impress you with the palaciousness of the establishment—which otherwise would go unsuspected.

It was here that we heard, for the first time, the legend of the Hump. The Hump refers to that part of the Andes separating Santiago from Mendoza in Argentina, and is the section of the Cordilleras most often flown over. It is considered by fliers as about the worst bit of flying anywhere in the world, and as the years pass and flying tongues wag, the Hump is taking on a living personality, becoming a sort of aeronautical Chimera. Congregate a few South American pilots in the bar of some "Grand" hotel, and sooner or later someone will start in—"Well, talk about bumps, why, the last time I flew the Hump . . ."

A pilot by the name of Benway, who was imported by Pan-American-Grace to fly the Hump, told the story about himself—how he made two flights over with Colliver. On what Colliver maintained was a fairly mild afternoon, the bumps tossed Benway around the cabin of the Fairchild, and he finally passed out when the fire extinguisher flew up from the floor and hit him on the back of the head.

(*Continued on page 735*)

Tests, Tangos and Troubles

(*Continued from page 734*)

Benway, and he said it himself, refused to fly the Hump.

Then Bob Reeve—flying the Antifogasta-Santiago run—recalled that Guillaumet, the Frenchman, had just been lost in the pass, and that one of the Nyrba Fords had come through with the wing tips flapping six feet, shearing off some two thousand rivets! Another pilot by the name of Travers, learning we were due to fly the Hump, chimes in with the story about Red Williams and the J-6 Kingbird who hit a bad bump on the Mendoza side and glided back to the field with both motors torn loose from the mounts. Red Williams wouldn't fly the Hump again in a balloon.

Hump or no Hump, we started off enthusiastically enough the next morning for Santiago—enthusiasm that was dampened somewhat when we were forced back fifteen minutes after the take-off with low oil pressure. Again time out and head winds held us up, and later afternoon found us flying ten miles out from shore (still hugging the Japanese-Humboldt current) with Valparaiso and Santiago entirely too many miles to the south. Suddenly one of the top cylinders started puffing black smoke and the engine roughened. The decision to head for shore was unanimous. It was with something distinctly akin to relief that we again saw land, even mountainous land, beneath us. A hundred miles of mountains lay between us and Santiago. We were flying at about ten thousand feet, when the last rays of the setting sun shone up from the sea rim against the roof of the cabin and the under surface of the wing. Sunset at ten thousand feet meant dusk on the shore, and dark night in the valleys. We could not make it, and it behooved us to find a landing place with all dispatch. Losing altitude rapidly, the effect was that of night coming on with terrifying swiftness. On the ground, trees and houses were almost indefinite shapes. Eddie picked on a cow pasture, and slipped the ship to a perfect landing. We found out later that, in approaching the landing, we had glided directly over the Quinteros airport less than half a mile away!

I volunteered to stay with the ship all night to keep the cows away, these animals having a particular fancy for airplane fabric. Yancey and Burgin journeyed into town and brought me back blankets, sandwiches and wine. I drank the wine, gave the cows a serious lecture on the terrors of indigestion and turned in. The plane was still with me in the morning.

Shortly after daybreak we flew over to the airport and took on twenty-five gallons of gasoline. While we were gassing up, it being time for our morning schedule with CPC, we ran out an emergency antenna and worked him from the ground, much to the amazement and interest of the Chilean navy which surrounded the plane. Several of the officers were operators, and we delayed our departure long enough to explain some of the high spots of aircraft radio.

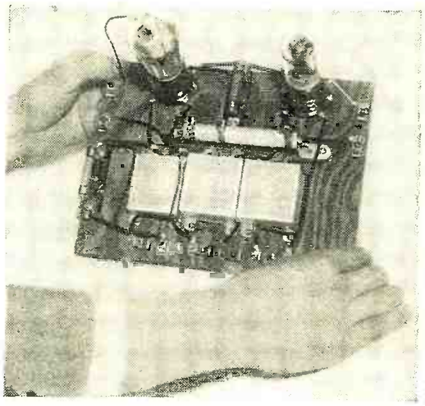
(*Continued on page 737*)

A Two-Volt Loftin-White Amplifier

(*Continued from page* 701)

that the internal capacity of the 231 tube is inherently low. The high-frequency cut off of an amplifier of this type is almost entirely determined by the incidental capacity in this plate-grid circuit.

Just below the tube sockets, and in the same plane, is placed the special tapped resistor arm, designated in the wiring diagram as R2, R3, and R4. This was mounted by using two brass angle pieces, one at each end of the resistor, and held to the baseboard by wood screws. Two grid leak mounts are also used, one between the two tube sockets for the plate-grid resistor, and the other on the extreme right of the board, for the biasing resistor of the first tube. Three 1 mfd. condensers are used, placed as shown, in the circuit. One of them bypasses the bias resistor of the first tube, the second is across the resistance arm, and the third closes the audio path from B plus to the filament of the output tube. Two ten-ohm rheostats (R6 and R7) should be used, one in the positive leg of each tube filament. These are not shown in the pictures, but their use is necessary, and they should be so adjusted that exactly 2 volts is applied to the filaments. Once adjusted, these rheostats should remain untouched to serve as fixed resistors. This adjustment is best made with a voltmeter. With the exception of the binding posts, or fahnestock clips, and screws, these are all of the parts used in the construction of the amplifier. The wiring should be done in the "point to point" method, the push back type of wire being very convenient.



Some idea of the compactness of this amplifier may be obtained from this illustration

The disadvantages of this circuit, of which we have spoken, lie in the fact that it is necessary to use high B voltage, 270 volts, and separate filament supplies for the two tubes. However, neither of these drawbacks are too serious. To begin with, the total overall drain of the system is in the order of 9 milliamperes, so comparatively small B batteries may be used without too frequent replacement. This drain is considerably smaller than would be necessary for any other type of amplifier of equal gain, so while higher B voltage is necessary, it rather becomes "six of one, and a half dozen of the other." Exactly the same condition prevails in the filament supply problem. While necessary to use two separate supplies, the drain from one is only 60 milliamperes, while from the other, 130 milliamperes are required. At these low current values, the batteries used here will last for very long periods of time, so that the eventual costs will about equal each other. The new type of "Air Cell" is shown in the photographs, but we are by no means limited to its use. Dry cells will give equally satisfactory results, two being required for each tube. This is the reason that rheostats are placed in the filament circuit instead of fixed resistors.

In Fig. 3, the response curve of this amplifier is given. It is quite unusual to see a curve as good as this on any other type of amplifier, and better even than most of the Loftin-White circuits, particularly at the high frequencies. An amplifier of this nature will find many uses in the hands of an experimenter. When working out of a photo-electric cell, for instance, it is customary to use about three stages of battery-operated transformer-coupled amplification, working into an a.c. main amplifier, which is also transformer-coupled. No matter how good the transformers may be, some distortion will be present in every stage, and in cascade amplifiers, the distortion squares per stage. So after six or seven stages, the distortion is bound to be enormous. If an amplifier of the type described here be substituted for the transformer coupled pre-amplifier, the signal will be delivered to the main amplifier without appreciable distortion, and the resultant overall signal will be tremendously improved. Another place suggests itself for use of the Loftin-White battery amplifier, and that is as a remote amplifier for broadcasting. The same condition prevails here that was mentioned above, regarding the multiplicity of amplifier stages in use. For the same reasons also, the overall response is vastly improved. This has been proved in actual tests with one of the metropolitan broadcasting stations.

Aside from the two uses mentioned above, and the obvious ones, such as phonograph amplification, etc., such exceptional amplifying ability is bound to be of vast importance to the serious experimenter or engineer.

Parts List

- C1 1 Mfd. 250 volts Flechtheim condenser.
- C2 1 Mfd. 450 volts Flechtheim condenser.
- C3 1 Mfd. 450 volts Flechtheim condenser.
- R1 20,000-ohm Electrad grid leak type resistor.
- R2 875-ohm special Electrad resistor, type J458c.
- R3 4625-ohm special Electrad resistor, type J458c.
- R4 11,375-ohm special Electrad resistor, type 458c.
- R5 250,000-ohm Electrad grid leak type resistor.
- R6 10-ohm rheostat.
- R7 10-ohm rheostat.

Tests, Tangoes and Troubles

(*Continued from page 735*)

An hour's flight from Quinteros brought us to the Los Cerillos flying field in Santiago, our last stop on the west coast of South America

Diplomatic considerations complicated the matter of radio tests, and it was only with the presence of an armed guard, an interpreter, a Chilean operator and a monitoring station that we were permitted to work WHD, in New York City. Matters were further complicated by the fact that the tail wheel assembly had been broken in taxiing across the field, and the search for a welder of adequate experience was proceeding with customary South American dispatch. Four expressions roll with oiled facility from Latin tongues—"momentito," "momento," "manana" and "pasada manana"—just a second, just a moment, tomorrow and the day after tomorrow.

So we ran out our emergency antenna, and one evening, after waiting a half hour in the rain for the commandant of the field and a regiment of militia, we finally put through a hopeful, WHD WHD WHD WHD de W2XBQ. We'd be blasé indeed to deny the thrill that coursed through our veins when the familiar five-hundred-cycle whistle of the New York *Times* transmitter came back at us, sweet and clear. We worked WHD on several nights—over what we believe to be the longest distance ever covered by airplane radio, and this with emergency transmission on the ground—the only repeat ever requested being a single word in a Spanish message from the commandant of the field to the military attaché of the Chilean embassy in Washington.

The next morning we took off for Argentina. We climbed for an hour and a half before pushing our nose over the most desolate grandeur nature ever tossed skyward—through the southern pass of Las Cordilleras at seventeen thousand feet. The snows flow from the arrogant peaks down to the shores of Diamond Lake like white lava, and the vast range seems a sea of mountains. To our south was Acondagua, towering eight thousand feet above us, to the majesty of the highest peak in the Western Hemisphere.

We did not strike a bump until, with the motor cut, we were sliding down the Argentine side. Here the warm air from the Pampas eddied with the cold winds of Los Andes, and we were tossed around. But nothing unusual.

Good-bye Pacific—good-bye the west coast. We flew the whole three thousand miles of you and twenty-nine hundred of them over water in a land plane!

IN his next article, Zeh Bouck describes the record-making radio experiments in Buenos Aires, including two-way direct communication with New York, and the relay communications whereby telephone conversations were carried on, over the longest circuit ever attempted—from the airplane to Sydney, Australia. The flight is continued, from B. A. through Rio and to Great Exuma Island with the thrilling story of the first successful SOS ever transmitted from an airplane.

How to Build a Comparison Meter

(Continued from page 707)

the same heating effect as an alternating one, the steady value of the d.c. gives our effective a.c. value without any mathematics. This principle is used in the comparison meter for reading the effective values of alternating currents. As mentioned above, high radio-frequency currents are not likely to follow completely the paths laid out for them. If the meter is used exclusively for radio-frequency work it would be better to use a large porcelain knife switch with greater blade separation for S3. This would, however, make the whole instrument larger and less handy. With this exception, the principles used in measuring high- and low-frequency currents are exactly the same.

A flashlight bulb is the key part in a.c. measurements. The a.c. to be measured is run through the bulb, which lights at a certain brilliancy of red, yellow or white. Then by a flip of S3 the bulb is removed from the a.c. circuit and thrown in series with battery, rheostat and milliammeter. The rheostat is adjusted until flipping S3 back and forth produces no visible change in brilliancy. With the bulb in the d.c.

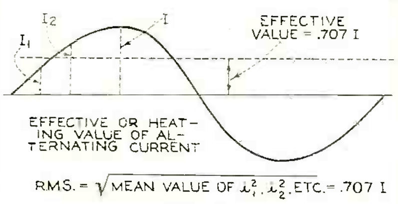


FIG. 3A

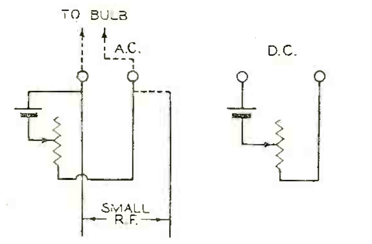


FIG. 3B

circuit the milliammeter then reads the desired effective value of a.c. In a laboratory test the home-made comparison meter was connected in series with a standard a.c. milliammeter, a resistance and 60-cycle supply. When the standard meter read 150 mils the comparison meter gave 140 mils (accuracy ± 7 per cent.) and with the standard at 250 mils the bulb instrument gave 240 mils (accuracy ± 4 per cent.)—results surprisingly good for such visual estimation.

Three interchangeable bulbs give the desired current ranges. The first is a 6-volt radio dial bulb, which begins to glow dull red at 40 or 50 mils, burns yellow at about 100 mils and turns white at a current slightly below its normal 150 mils. The next bulb is of the small 2.5- or 3.8-volt flashlight variety. Either will do, but the 3.8-volt bulb has a wider range, extending from 100 mils to 300 mils. Finally, a 2.5-volt radio dial bulb carries the range up to 500 mils. Bulbs not in use are kept in holes drilled in the baseboard.

If one desires to extend the range still further a 6-volt 6-cp. auto bulb will carry it to 1 ampere and a 6-volt 21-cp. headlight bulb will go to 2 amperes. For these, of course, a different type of socket is needed.

Sometimes one wishes to measure current in a straight radio-frequency circuit such as an antenna, where the bends and switches of the comparison meter will introduce serious inaccuracies. Or again, due to surges from a high inductance it is undesirable to open the a.c. circuit repeatedly with S3. In these cases a bulb can be inserted directly in the a.c. circuit and compared visually with the bulb in the meter, which is run continuously on d.c. As an added refinement the two bulbs can be interchanged and the measurements repeated.

There is a real need for a cheap instrument capable of measuring radio-frequency currents of the order of 5 or 10 mils. The smallest stock radio thermocouple (0-125 mils) gives no readings below 10 mils. An ingenious method of indicating the antenna current of an extreme low power transmitter, for example, is to shunt the bulb by a battery-rheostat combination which will bring the filament up to a dull red color before the radio-frequency is superimposed on the d.c. At this point in the color scale the filament responds readily to slight current increases. The 6-volt dial bulb, for example, visibly changes to a brighter red with 3 or 4 mils current increase.

When this color change due to superimposed r.f. has been carefully noted, S3 throws the bulb to the all d.c. circuit. Then the bulb is again brought up to the same starting dull red and the milliammeter reading noted. The rheostat is advanced just enough to change the color by the same amount as did the superimposed r.f., and the milliammeter again read. As the increase of d.c. current has produced the same filament color effect as the superimposed r.f., the effective value of the latter is given approximately by the difference between the two milliammeter readings. This method is less accurate than higher current measurements because it depends more on memory. It would be advisable here to use the two bulbs, one permanently in the d.c.-superimposed r.f. circuit and the other permanently in the all-d.c. circuit. In any case, the plan has possibilities for making rough measurements of very small r.f. currents.

While any standard parts may be used, the following ones were employed in the writer's instrument:

1 Weston model 301 milliammeter, 0-50.
2 Marco s.p.s.t. knife switches.
1 Marco d.p.d.t knife switch.
1 shunt (see text).
1 flashlight bulb socket, porcelain.
3 bulbs (see text).
Wood frame (see Fig. 2).

The Service Bench

(*Continued from page* 689)

9. Are the service wires to building touching anything between pole and building?

10. Have you reversed attachment plug in socket to reduce hum in speaker?

11. Have you checked voltage in house, making sure it is correct for the receiver?

12. Have you noticed more than 5-volt fluctuation in voltage?

13. Are any of the following appliances in use in building: Elevators? Ice machines? Ventilating motors? Dish washers? Sewing machines? Vacuum cleaners? Washing machines? Hair driers? Vibrators? Furnaces (automatic)? Water heaters? Violet ray? Diathermy? Electro-therapy devices of any other kind? X-ray? Electric heating pad? Electric blanket Fire alarm systems? Battery charger (full or trickle charge)? Electric flashers of any kind? Neon signs? Radio amateur transmitter? Automatic electric iron? Miscellaneous?

14. Are those devices (if any) properly equipped with filters?

15. If so, are you sure these filters are not broken down?

16. Are other sets in vicinity having same interference?

17. Have you personally checked tubes before inserting in receiver?

18. Are you sure aerial and ground connections are not reversed?

19. Is the loud speaker lead separated from the aerial?

20. Is the aerial lead separated from the ground lead?

21. Is the aerial separated from the power leads?

22. Do any of the tubes seem to make improper contact to sockets?

23. Is the voltage correct on (2) filaments, (b) grids, (c) plates of all the tubes?

24. Is the voltage control (if any) set at the proper tap?

25. Is there any extraneous noise in the loud speaker when the aerial and ground are disconnected?

26. Is there any noise in the speaker when one of the r.f. tubes is removed from the socket while the set is in operation?

27. Is the customer satisfied with the reception?

28. Are you satisfied with the reception?

29. Can anything be done to improve the reception?

30. If so, have you notified the customer to this effect?

31. If outside interference is present, have you notified the proper authorities?

Changing the Electrical Supply System

C. Washburn, Jr., radio and electrical engineer of Jacksonville, Florida, and with the Electric Distribution Department of that city, sends along some first-hand information on outside interference and the manner of its final elimination.

"The trouble in question was heavy interference on a Silver a.c. screen-grid set. At this point it might be well to bring out

(*Continued on page* 740)

The Service Bench

(*Continued from page* 739)

the fact that we have come to distinguish certain types of interference from other types by describing them as primary and secondary troubles. As most radio and electrical men know, a distribution system is made up of high-voltage feeders known as primaries, usually having a voltage of 2,300 to 3,800 volts, which feed transformers located at certain points, and which transformers feed low-voltage networks of 110 and 220 volts to which the various house services are connected. These low-voltage networks are known as secondaries. Also, there are high-voltage circuits independent of those already mentioned which supply the street lights.

"We have found that primary troubles, *i.e.*, crosses or grounds on the high-voltage feeders and street light circuits, can be picked up and, with the exercise of considerable patience, run down with the aid of a portable loop-operated battery-type superheterodyne receiver, such as the Radiola 25. But, in our experience, the secondary troubles which occur on the low-voltage secondary wires such as tree grounds, grounds in houses, loose connections, etc., are very difficult if not impossible to bring in on the battery-operated superheterodyne, but on a sensitive a.c. set will sound as if the whole electrical system were about to break down. This is due, as far as we can tell, to the fact that the a.c. set is directly connected to the wires in which the trouble lies.

"To get back to the Silver set in question, the interference peaked at about 700 kilocycles and was loud enough when the volume control was advanced to be heard all over the house and out into the street. The portable superheterodyne was brought into action and located right under the electric pole line in front of the house and not a trace of interference could be picked up. As a matter of information, let me say that up until a short time ago all the lighting secondary lines were either single or three-phase ungrounded lines, but recently the department has started the task of changing over this system to the three-wire 110-220 grounded neutral system. However, the locality where the Silver set was located had not yet been changed over. So a voltmeter was connected from each side of the secondary line to ground. One side showed full 110 volts to ground, thus indicating that an accidental ground was on the line. Linemen were sent up the poles and it was found that the trouble was inside of one or more of the houses and not on the outside line. Accordingly, a report was made to the city electrical inspector, who sent out two inspectors to run down the trouble in the houses. While waiting for the inspectors to make their tests the suspected houses were disconnected from the mains, the Silver set was operated, and the trouble had almost entirely disappeared.

"The houses were cut on again and the trouble reappeared. When the inspectors arrived tests were made again, but the heavy ground had gone off the line and only a slight ground remained. However, the trouble still showed up on the Silver set. Evidently the trouble was fluctuating, and varied from time to time. As a last resort the superintendent decided to change over this locality from the single-phase ungrounded system to the grounded neutral system as explained above. The line work was done and the neutral wire was grounded at the transformer pole, but still the interference showed up on the Silver set. Then the gang of electricians which follows the line gang and makes ground connections in the houses reached the particular house where the Silver set was located. As soon as the ground was made in the house the interference disappeared, to our great relief.

"Since that time another locality which had interference that could not be run down, or even picked up on the battery superheterodyne, has been changed over to the grounded neutral system with a similar relief from interference."

It is suggested by the Service Editor that a copy of Mr. Washburn's contribution accompany any complaints registered with local lighting companies by the serviceman. Aside from its technical significance, its moral value, as an indication of what one city is willing to do to improve radio reception, may be most beneficial.

Intra-Set Noises

The following contribution clears up a few of the noise problems more intimately associated with the radio installation itself:

"Of the many complaints we have received this season, describing intermittent reception, the majority of these have been traced to poor tubes and faulty soldering. In reference to the latter, it would pay the dealer to have his serviceman inspect the soldering in all sets before they are offered for sale. In almost every receiver I have inspected this season I have found one or more connections that is a resin joint, or otherwise poorly soldered.

"Some of the oustanding complaints of intermittent and noisy reception have been the following:

Complaint	Make	Trouble
A	Majestic	Resin joint grid contact on socket
B	Fada	Tube element not soldered to prong.
C	Atwater Kent	Connection to voice coil broken under tissue of cone.
D	Victor	Voice coil poorly soldered at speaker terminal strip.
E F G and H	Majestic	Grid too close to cathode of 27 tube.
I	Atwater Kent	Open filament in type 80 tube — open where supported at top of filament.

"These tube troubles may often be associated with particular receivers due to the fact that they are generally supplied with the sets.

"Of course, we have the usual run of window lead-in strips that are broken under the insulation, and lead-in wires similarly broken that make and break contact as they sway. I had several cases of intermittent reception and noise caused

(*Continued on page* 741)

The Service Bench

(*Continued from page* 740)

by broken clips on the lead-in strips. The owner would wrap the lead-in wire around the end of the strip, making a poor contact that would often vary with footsteps in the house.

"We have experienced little trouble during the past year with audio transformers, speaker coils or tube sockets, all of which is encouraging evidence of the fact that the manufacturers are giving us better products."

H. W. HUDDLESON & SON,
Auto and Radio Service and Merchandise,
Vandalia, Mo.

Improving Selectivity of RCA 16, 17, 18, 41, 33

"Where a locality is found where interference is abnormally objectionable, the above t.r.f. models can be improved by soldering an eight-inch piece of wire to the grid of the first 226 (input tube). This wire is then led to the second or third r.f. coil and wrapped around the coil enough to produce the desired result. If wrapping the wire around one coil does not produce greater volume and better selectivity, extend the wire so as to wrap the third coil a few times also. When this method is employed it is best to adjust to a low wavelength station in order that uncontrollable oscillation is not produced. Sometimes all that is necessary is to run the wire near the two coils. In this event the location of the wire can be fixed with a thumb-tack through it to the board. A simpler method is to make a few turns of the aerial lead-in at the set and placing the looped lead in proximity to whichever coil gives the best results. Do not disturb any of the regular connections of the set."

H. F. PITZER,
North Arlington, N. J.

Congress Considers Problems

(*Continued from page* 712)

While Mr. Schuette's organization is primarily composed of smaller radio manufacturers fighting alleged monopolistic efforts in the radio industry, he has also organized a broadcast division whose membership is to consist of low-power broadcasters who fear being crowded out of radio by the more powerful stations. Although the engineers can show that on modern receivers high power generally creates no ill effects, Mr. Schuette insists that the trend toward greater powers is a trend toward monopoly and the exclusion of the little fellow.

Mr. Schuette is the man who carried the "radio trust" fight to Congress, with the result that a government suit for dissolution of the alleged monopoly was undertaken.

Home Talking Pictures

(*Continued from page* 692)

the use of a standard electric phonograph pick-up.

The Toneograph Jr. Home Talkie 16-millimeter portable projector and reproducer is an outfit somewhat along the same lines as that one mentioned directly above; that is, it combines a projector to which is mechanically geared a turntable having an electric pick-up. This outfit is mounted in a suitable carrying case, making it quite portable.

Several manufacturers have found it distinctly to their advantage to produce simply the turntable-pick-up unit which is suitable for use with 33⅓ and 78 revolutions per minute records. The turntable, and in particular the one manufactured by the Hollywood Film Enterprises, is provided with a flexible steel shaft with suitable coupling unit so that the turntable may be connected mechanically to any of the existing types of home movie projectors, such as that manufactured by Victor, Bell and Howell, or Eastman Kodak. In this way those people who now own a projector simply require the addition of such a turntable to their present equipment to make of it a satisfactory home talking movie installation. On these turntables is usually mounted such controls as volume control, speed control, output terminals of the pick-up, etc. With the exception of the Bell and Howell Filmophone, all of the outfits mentioned so far require the use of an external audio channel and loud speaker with which to complete the entire sound reproducing arrangement, the most convenient one being that provided in the usual radio receiver. In the case of Bell and Howell outfit the audio amplifier which is in the Howard radio receiver is used for that purpose.

One of the most complete outfits is that manufactured by the Visionola Manufacturing Company. In one cabinet is contained a 16-millimeter film projector, a turntable which is capable of turning at either 33⅓ or 78 revolutions per minute, an electric pick-up, a complete radio receiver and a loud speaker. In addition, the cabinet is so built that by means of a reflector mounted on the end of a sliding shelf located below the projector it is possible to reflect the projected film up on to a small screen mounted in the lid of the cabinet. Or, if it is desired to project the film on a large surface, then the services of the tray are dispensed with and the film is projected on the wall or screen or other large surface which is employed for that purpose.

Manufacturers who up to now have devoted themselves solely to production of equipment of a radio or allied nature have found it advisable to market apparatus which is suitable for use with home talking movies, and in this group are those manufacturers who produce high-quality audio-frequency amplifiers, electric turntables and electric pick-ups. They include such manufacturers as National Company; Ferranti, Inc.; Samson Electric Company; Amplion Corporation of America; Amplex Instruments Corporation; Electrad, Inc.; Webster Electric Company; Audio Frequency Laboratories, Inc.; Radio Receptor Co.; Pacent Electric Company; Audak, and others.

There is one other angle of this situation which will be of interest to the serviceman, and that is that quite a number of the large commercial movie producing companies of America are finding it to their advantage to make available some of the most popular and up-to-date film attractions in the 16-millimeter size, together with records for sound accompaniment. In this group are Universal Pictures, UFA, Fox and Warner Brothers. Others will undoubtedly follow. These companies are arranging to make these films with their accompanying records available on the library plan, whereby distributors in all of the large cities have these films and records on hand and rent them out for a nominal sum.

RADIO NEWS is glad to announce that it has obtained the co-operation of the Victor Animatograph Corporation in an attempt to provide a workable system, whereby it will be possible for home experimenters, servicemen, etc., to record sound on films or records. The Victor Animatograph Company has very generously agreed to place at the disposal of the laboratory of RADIO NEWS the various moving picture equipment which will be necessary in the carrying out of this work. Other companies have very generously agreed to supply us with such items as electric pick-ups, photoelectric cells, audio-frequency amplifiers, loud speakers and films.

A Correction

Editor, RADIO NEWS:

There are several erroneous statements concerning the A. R. R. L. Standard Frequency System in two items appearing in November RADIO NEWS to which I, as Director of the A. R. R. L. Standard Frequency System, wish to call attention. The two items are headed "Amateurs Arrange Standard Signals" (page 470) and "Amateur Standard Stations" (page 476). The first is credited to the Radio News Bureau.

The transmission of standard frequency signals for amateurs by special stations designated by the League as Official Standard Frequency Stations has been going on since 1926 and the statement that "the American Radio Relay League . . . will permit outsiders to utilize the 'ham' radio channels for the first time in amateur history" is absolutely contrary to fact. The stations are not "outsiders" but are special A. R. R. L. Standard Frequency Stations authorized to utilize the amateur bands only for the transmission of standard frequencies sponsored by the American Radio Relay League. The System enjoys the co-operation of the United States Bureau of Standards and the frequency standards utilized for the transmissions have their

(*Continued on page* 749)

Home Lab. Experiments

(*Continued from page 721*)

they are both thrown to the "mu" side; with the switches in the other position the circuit will measure the plate impedance Rp.

It is not necessary to arrange any circuit for the measurement of mutual conductance, since it is readily calculated if we know the plate impedance and amplification constant of the tube. The mutual conductance is:

$$\text{Mutual conductance} = \frac{\text{Amplification constant}}{\text{Plate impedance}}$$

This gives the mutual conductance in "mhos." But the mho is too large a unit for convenient use and we therefore use micromhos; we find the same case in condensers where the unit is the farad and is so large that we generally use microfarads, millionths of a farad. Since it takes a million micromhos to make one mho, the following formula for micromhos is

$$\text{Mutual conductance in micromhos} = \frac{\text{Amplification constant} \times 1{,}000{,}000}{\text{Plate impedance}}$$

In Table 1 is given a group of figures showing the results of some measurements on a group of tubes. With these figures and the formulas given in the preceding parts of this Experiment Sheet the reader should be able to calculate the three constants of the tubes from the data given in the table. We will work out the first case for tube No. 1 and we suggest that the reader work out the others.

With tube No. 1 a balance was obtained with R1, 10 ohms, and R2, 90 ohms. The amplification constant is equal to

$$\text{Mu} = \frac{R2}{R1} = \frac{90}{10}$$

$$\text{Mu} = 9$$

and this value of 9 was entered in the fourth column of Table 1.

When measuring Rp, the values shown in the table were obtained at balance. The formula is

$$Rp = \frac{R1 \times R3}{R2} = \frac{300 \times 10{,}000}{300}$$

$$Rp = 10{,}000$$

and this value was placed in column 8.

The mutual conductance in micromhos is found by multiplying the amplification constant by 1,000,000 and dividing by the plate impedance. In this case we have

$$\text{Mutual conductance} = \frac{9 \times 1{,}000{,}000}{10{,}000} = 900 \text{ micromhos}$$

With this one example worked out the reader should have little difficulty in filling in the remaining blank spaces in the table; and if he feels so inclined to build up a simple tube measuring unit and actually determining the constants of a number of tubes.

Push-Pull Audio Amplification

(*Continued from page* 711)

added to give the original distorted wave is so small compared to the maximum amplitude of these even harmonics necessary that the odd harmonics may be completely neglected. The reverse, of course, is also true regarding a distorted wave containing a predominance of odd harmonics.

It cannot be stressed too strongly that even though we speak of a distorted wave as containing harmonics, that these harmonics exist as separate waves distinct from the distorted wave, but rather the reaction of the distorted wave upon the circuit is exactly the same as if the distorted wave were replaced by a fundamental frequency and associated harmonics.

It can be determined from the shape of the distorted wave whether it contains even or odd harmonics or whether it contains both even and odd harmonics.

Distorted waves, as previously stated, result from various causes. Let us first consider the shape of a wave resulting from a vibration originating, let us say, from a violin string. Also let us suppose that this wave contains a predominance of even harmonics. If only the second harmonic is considered, then the shape of the resultant wave is as shown in Fig. 3. If the second and fourth harmonics are great enough to be considered, then the resultant wave will have the shape shown in Fig. 4.

An inspection of the resultant curves of Figs. 3 and 4 reveal that the general shape is exactly the same. Each loop of the wave is unsymmetrical about a line drawn through the center of the loop such as AA^1 in Fig. 4. The left side of the loop has not the same shape as the right side of the loop. This type of resultant curve containing even harmonics is present in outputs of musical instruments and voice. The currents flowing through the primary of a transformer, with the secondary open and no direct current flowing through the primary, has the shape of the curve in Fig. 3, which is due to the hysteresis loop of the iron. It should be noted that the amplitude of the upper loop is equal to the amplitude of the lower loop.

Figs. 7A and 7B. Two types of waves containing odd harmonics where in one case (7A) the odd harmonic lies entirely on one side of the zero axis while in the other (7B) it is symmetrical about this axis

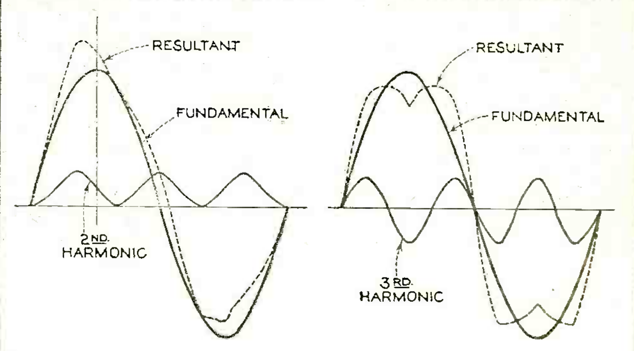


FIG. 7A FIG. 7B

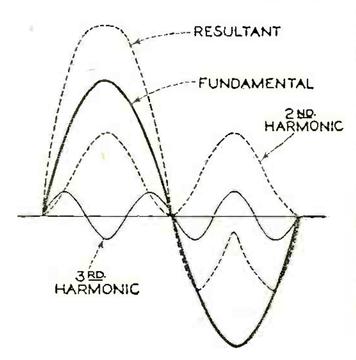


FIG. 8

Fig. 8. The resultant wave obtained by a combination of a fundamental, a third and a second harmonic

There exists another type of distorted wave which bears a very definite relation to quality of reproduction. This type of wave is the main cause of distortion in amplifiers and is shown in Fig. 5. An analysis of the above shape reveals the presence of a very strong second harmonic. This shape would result if an amplifier tube were worked below the midpoint of the straight portion of the grid voltage-plate current curve. The flux variation in the core of a transformer would have this shape if the core were first saturated by sending d.c. through the primary winding and then superimposing the pure sine wave of voltage. The fundamental and second harmonic of this type of distortion is as indicated in Fig. 6. Both Figs. 5 and 6 are similar in shape except that they are 180° out of phase.

It is to be particularly noted that in these types of distortions the second harmonic is entirely above or below the zero axis. This must be so if the amplitude of one loop is greater than the amplitude of the other loop. A physical explanation of this is as follows.

Let the line XX^1 in Fig. 5 represent the normal plate current in a vacuum tube with no signal impressed. Then if a signal now be impressed on the grid of the tube and this tube is worked on the

(*Continued on page* 746)

Book Review

This Thing Called Broadcasting, by Dr. Alfred N. Goldsmith, vice-president and general engineer of R.C.A., and Austin C. Lescarboura, formerly managing editor of *Scientific American.* Published by Henry Holt & Company.

Written with a popular appeal, the book treats of radio as a vital force in our civilization; first depicting in vivid dramatic style the hectic, turbulent history of broadcasting as a science and industry, then its many influences on our daily lives.

The chapter headings, which indicate the style and content of "This Thing Called Broadcasting," include The Cradle of Broadcasting, The Gold Rush of the Air, Staking the Wave Length Claim, Who Are the Broadcasters?, Building the Radio Program, The Announcer and His Rôle, Who Pays the Broadcast Bill?, and The Broadcaster Spins His Network Web. Other chapters treat of radio's influence on politics, sport, the home, education, the church, farmer, business.

The authors of this book, both identified with radio since its earliest days, imbue their work with authoritativeness and vivid reminiscences, interspersed with delightful anecdotes. The style is pungent and for the most part swift, in keeping with the rapid rise of that powerful, hurtling force which forms the subject of the book.

This Thing Called Broadcasting should interest not only the radio devotee but likewise those who thrill in following through with one of the most potent forces in the moulding of our civilization.

A Universal Power Amplifier-Speaker Unit

(*Continued from page* 705)

is tinny. Where the amplifier is to be permanently mounted in a radio cabinet, and still used for all three purposes, it is suggested that a screw arrangement, operated by a knob in front of the set, be devised to accomplish a half-inch fore-and-aft movement of the amplifier-speaker unit.

When used with home talkies, it is desirable that the speaker be placed directly behind the screen, or immediately under it, never to one side. The screen used should always be the largest it is possible to project upon—the limiting factor being the distance from and the defining power of the projector. A balance between the visual and audio components of the sound-movie is essential to the illusion of life. The intensity of the visual component depends upon the size of the picture and the brightness, and that of the sound component upon the loudness. The larger and brighter the picture, the more volume it is possible and desirable to use in the sound reproduction. With small pictures the volume should be varied (generally decreased below the usual radio intensity) until a psychological combination is attained that best preserves the illusion that the figures on the screen are singing and talking.

Push-Pull Audio Amplification

(*Continued from page* 744)

curved portion of its characteristic, the shape of the distorted wave will be as shown in Fig. 5. The average plate current is now raised from the line XX^1 to the line YY^1, an increase of ΔZ. This is evident from the different amplitudes of the wave. The increase in plate current being greater than the decrease, the average value (as read by a d.c. meter) will be higher. This is similar to the action which takes place in a detector tube. When a signal is impressed, the average plate current rises (in a linear detector). Incidentally it is a known fact that the detector introduces a strong second harmonic. It is also to be noted that the fundamental does not produce an average increase in plate current, since both loops are equal, but it is the harmonic introduced that is the cause of this increase. The steady increase must rise to the axis of the second harmonic since a line drawn through this axis is the average of the harmonic wave. It therefore follows that if in any wave shape having one loop greater than the other a strong second harmonic exists which lies on the side of the zero line having the greater loop.

The shape of a wave containing harmonics is dependent entirely upon the manner in which the harmonics have been introduced. If these harmonics have been introduced by the device producing the sound, then the resultant wave form, even though it departs from a true sine wave, is not ordinarily spoken of as being distorted, but it is said to be complex, for the reason that the harmonics so introduced are essential for naturalness and intelligibility. It is only the harmonics present that enable one to discriminate between one instrument and another or one voice and another. Since the harmonics introduced by a vacuum tube or any electrical device are of a parasitic nature and were not present in the original sound itself, the waves resulting from these parasitic harmonics are said to be truly distorted.

A study of waves containing odd harmonics indicates the presence of two general types. One where the odd harmonic lies entirely on one side of the zero axis and one where it is symmetrical about the zero axis. These two types are indicated in Figs. 7A and 7B, respectively. An examination of the resultant distorted wave of Fig. 7A shows that the upper loop is not symmetrical about a line drawn through the center of the loop, the amplitude of the upper loop is greater than the amplitude of the lower loop and that the base width of the upper loop is greater than that of the lower loop.

A study of the resultant wave of Fig. 7B shows that each loop is symmetrical about a line drawn through the center of the loop and the amplitude of both loops are the same.

It is extremely difficult to obtain the distorted wave indicated in Fig. 7A, but the shape shown in Fig. 7B is of a more common complex nature and is present in sound produced by voice, musical instruments, etc. The resultant obtained by a combination of a fundamental, a third harmonic symmetrical about the zero axis and a second harmonic which lies entirely above the axis is shown in Fig. 8.

There are, of course, many other types of distorted waves which may result from the addition of even and odd harmonics, but all of them cannot be taken up in a discussion whose scope is somewhat limited. For more detailed analysis the reader is referred to "Speech and Hearing," by H. Fletcher, or "Waves and Impulses," by Steinmetz. The above types, however, have a direct application in push-pull amplifiers.

Radio Charts the Air-Course

(*Continued from page* 709)

necessary before success was attained in shielding the spark plugs, the leads from the plugs to the magnetos, and the magnetos themselves. Another offender was the static electricity discharged throughout the ship where one piece of metal could rub against another. A thorough system of bonding was developed to eliminate this type of interference.

The power supply for the transmitter and receiver consists of two dynamotors, one for the transmitter and the other for the receiver. The dynamotors derive their power from the ship's storage battery. This system of power supply was settled upon in favor of the engine-driven and wind-driven generators. The former cannot be operated in the event of motor-failure, and the latter is out of commission when the ship is on the ground, particularly in the case of motor trouble.

With the radiophone in operation, ground stations, in complete possession of weather and traffic information, are constantly informed of the exact position of the aircraft in flight, know the precise conditions the pilots are encountering, know where to direct the pilots for safe flying and safe landing, and know absolutely that the pilots are receiving the information and acting accordingly. In turn, pilots supplement weather observations made by airway bureaus with their own knowledge of the conditions as they meet them.

The important effect of radio upon safety of air transportation is apparent when one considers that the majority of accidents occurring on air transport lines could have been avoided by means of the control which radio communication permits. Without doubt, radio communication contributes greatly to our present safety in air travel.

Book Review

The Manual of Short-Wave Radio, by Zeh Bouck, published by National Company, Malden, Massachusetts, price 50 cents.

Between the covers of its recently published book, the National Company of Malden, Massachusetts, has gathered together some of the most pertinent and timely information of a technical and constructional nature on the subject of short waves and short-wave receivers which it has been our pleasure to observe.

Many times the demand has manifested itself for a source of information which would supply just the kind of data contained in the National Short-Wave Manual. To readers who pride themselves in keeping abreast of the times, we heartily recommend this mine of short-wave data. In its pages are contained reprints of articles taken from Radio News while much information presented was originally contained in articles appearing in QST.

Zeh Bouck, well known to readers of Radio News for his articles on aviation radio, is the compiler of this book.

Practical Testing Systems, by John Rider, published by Radio Treatise Company, Inc., New York, price $1.

John Rider has presented in his latest book a text which will be invaluable to servicemen. Literally a text book, the information contained in its pages will do much to aid the serviceman in a more complete understanding of the methods of testing, and the various types of instruments which have come into wide use by servicemen.

Some of the chapters deal with: Measuring Instruments; Resistance Units; Oscillators; Tube Testers; Vacuum Tube Voltmeters—Capacity Tests; Audio and Output Systems, etc.

Building the All-Purpose Modulated Oscillator

(*Continued from page* 717)

Hammarlund short wave coil mount (4 prong), type LWC-B.
4 Benjamin 5-prong sockets.
1 Benjamin 4-prong socket.
Baseboard 20" x 14" x 13/16".
Panel 7" x 21" x 1/8".
Four clips.
Weston 50 mA Model 301 meter.

The results obtained from the use of this instrument in the laboratory have been very satisfactory. The fidelity of response is excellent, equivalent certainly to those obtained for an ordinary broadcasting station, if care is taken, by watching for fluctuations of the plate meter, to keep the input to the modulators below the point at which the modulator tubes overload. In addition to being a very useful laboratory instrument, the construction and operation of the unit will give the experimenter useful information and experience in the operation of modulators and oscillators.

The Sextet Special

(*Continued from page 695*)

volts working voltage. The red leads should be used on the plate return leads. The blue leads are used to by-pass the screen-grid and the bias resistors, as shown, with the black leads of the condensers connected directly to the cathode terminals of the sockets. Beginning at the antenna post, the few leads that are left should be connected in sequence to the detector. Now place the strip of bakelite for the various resistors in its position and wire in the bias and the screen-grid blocking resistors. Next, wire the resistance coupler between the detector and the first audio tube, also putting in the 2,000-ohm bias resistor for the first audio tube, V4. The push-pull transformer, T1, can now be placed in position and wired into the circuit. The plates of the -45 tubes, V5 and V6, are connected to the grid and plate terminals of the LS socket, V8. The "B" supply filter condenser is now mounted and wired, leaving the 8 mfd. lead for the resistor, R12, unconnected until the bleeder is mounted. The choke, CH, is now placed in position and is connected to the 2 and 4 mfd. sections of the filter condenser, C11. This about completes the wiring of the receiver and it should now be carefully checked over by comparing each connected lead with the schematic wiring diagram shown here.

Compensation and Operation of the Receiver

After being thoroughly convinced of the accuracy of the wiring the tubes should be placed in their sockets, the speaker plugged in, and the a.c. line connected to the light socket. With the volume control turned on full the plate and screen-grid voltages should be measured. They should read 180 and 75 volts, respectively. If the voltages are either higher or lower than this, vary the sliders on R12 until the correct voltages are reached. Now, without an antenna and with the volume control on full, tune the receiver to a station on the lower end of the dial. Compensate C1A, C2A, C3A and C4A in turn, beginning with the detector stage, by means of a wooden dowel or bakelite rod filed down to a screwdriver tip. When the peak volume has been reached, rotate the dial through its entire range and one will find, barring errors, that the receiver is operating at full efficiency. If oscillations occur with the volume control on full, bring the screen-grid voltage down until they disappear.

Trouble Shooting

If no signal is heard upon connecting up the set, test all the tubes for defects. In the event that they are perfect, plug the phonograph pick-up in the jack J1. This test definitely places the trouble in either the r.f. or audio end. If the trouble is in the audio circuit, test all the transformer windings and the resistance-coupled stage for continuity. This test will locate any trouble in the audio section. Now test the "B" supply unit for voltages. If the transformer fails to deliver the proper voltages the trouble is either a blown condenser, open choke or burned-out resistor. The field winding of the loud speaker may also be open. If the trouble lies in the r.f. section, test all the coil windings for continuity. Also test the grid, plate and cathode resistors for open circuits, and the by-pass condensers for short circuits.

No exaggerated claims are made for this receiver other than simplicity. If properly constructed and balanced it will have a tone quality and receptive ability comparable with that obtained by many of the higher-priced manufactured receivers.

Parts Required

- 1 DeJur-Amsco type 4-gang tuning unit with drum dial, pilot light and C1A, C2A, C3A and C4A trimming condensers (C1, C2, C3, C4).
- 1 Cardwell midget condenser, type 603A, five plates, .000015 mfd.
- 3 Aerovox by-pass condensers, three .1 mfd. sections, type BP3 (C6, C7 and C9).
- 1 Aerovox by-pass condenser, type 260, .25 mfd. (C8).
- 1 Aerovox moulded mica condenser, .01 mfd. (C10).
- 1 Aerovox electrolytic condenser, 0-2-4-8 mfd. (C11).
- 2 Erie, Lynch or Durham 1,000-ohm, 1-watt pigtail resistors (R1, R3).
- 2 Erie, Lynch or Durham 5,000-ohm, ½-watt pigtail resistors (R2, R4).
- 1 Erie, Lynch or Durham, 30,000-ohm, 1-watt pigtail resistor (R5).
- 1 Erie, Lynch or Durham 4-megohm pigtail resistor (R6).
- 2 Erie, Lynch or Durham 2-megohm pigtail resistors (R7, R8).
- 1 Erie, Lynch or Durham 2,000-ohm, 1-watt pigtail resistor (R9).
- 1 Electrad 5-watt truvolt resistor, 800 ohms (R11).
- 1 Electrad 50-watt truvolt resistor, 12,000 ohms (R12).
- 1 Electrad super-tonatrol, 0 to 50,000 ohms (R10).
- 1 set Duraum tuning inductances or to specifications (L1, L2, L3, L4).
- 2 Duraum r.f. chokes (L5 and L6).
- 1 Duraum input push-pull transformer (T1).
- 1 Duraum power transformer (T3).
- 3 Eby -24 wafer sockets (V1, V2, V3).
- 1 Eby -27 wafer socket (V4).
- 2 Eby -45 wafer sockets (V5, V6).
- 1 Eby -80 wafer socket (V7).
- 1 Eby blank wafer socket for speaker connection (V8).
- 1 Yaxley type 702 jack (J).
- 1 Duraum chassis base, type 7P.
- 1 Duraum power transformer cover, type 7T.
- 4 Duraum coil shields, type V.
- 1 Duraum 30-henry, 100-ma. iron-core choke (CH).
- 1 Jensen, Rola or any good loud speaker with 2,200-ohm d.c. field coil and 15-

(*Continued on page 762*)

A Correction

(*Continued from page 742*)

official calibration from the National Frequency Standard at Washington. The number of stations is limited to three and all are operated by highly qualified amateurs who receive no payment for the service.

The standard frequencies are transmitted only according to schedules approved by the A. R. R. L. and regularly published in the League's official organ, QST. These schedules specify transmissions on certain Friday evenings, Friday and Sunday afternoons, and Saturday mornings. The statement that "One of these stations will be on the air every evening . . ." is therefore erroneous. The schedules are arranged so that each station transmits regularly spaced frequencies in a single amateur band during a scheduled evening, afternoon, or early morning period, and occupies a single frequency (channel) for not more than eight minutes during a transmisison. The schedules are arranged to occur in four-week cycles with no station having more than six transmissions in the four weeks.

The stations are: W6XK, in charge of Harold Peery, Chief Engineer KHJ, The Don Lee Broadcasting System, Los Angeles, Calif.; W9XAN, in charge of Frank D. Urie, Director of Research, The Elgin Observatory, Elgin National Watch Co., Elgin, Ill.; and W1XP, in charge of Howard A. Chinn, Round Hill Research, Massachusetts Institute of Technology, South Dartmouth, Mass. The licenses of these stations authorize the use of the amateur bands only for the transmission of standard frequencies sponsored by the A. R. R. L. Station KHJ is not licensed to transmit such schedules, as stated in the item appearing on page 476 of November RADIO NEWS.

I assure you that the publication in RADIO NEWS of accurate news items concerning the A. R. R. L. Standard Frequency System is welcomed and trust that the above corrections will be brought to the attention of your readers.

Sincerely yours,
JAMES J. LAMB,
Director, A. R. R. L. Standard Frequency System.

Television Proposed on Ultra High Waves

(*Continued from page 713*)

to 5.8 meters.

This will be among the primary considerations at the television conference, to which have been invited all television experimenters and at which they will also take up the subjects of interference in the television bands and the selection of channels for synchronizing sound with vision.

Getting the "Junior Transmitter" on the Air

(*Continued from page* 697)

ears is absolutely and positively fatal.

"But, anyway, here's how it works. We'll draw a simple schematic here (Fig. 2) of the power supply, leaving out some of the actual parts. Right below it, as I explain, I'll draw what an oscillograph would show as to what happens at each point. You see (Fig. 2a), the 110-volt a.c. is introduced into the primary. It is 60-cycle a.c. and the oscillograph would show a swing above and below a zero line. By induction, a voltage is set up in the secondary of the transformer that is of a higher voltage but it still swings both sides of the line. Then it is introduced into the rectifiers and as they will only allow current to pass in one direction, we suppress the negative half of the cycle, but as we are using full-wave rectification, one tube supplies a pulse from its positive half cycle and then the other tube supplies a pulse from its positive half cycle. The secondary of the transformer is really two secondaries, one feeding each rectifier tube. Half-wave rectification would look like this (Fig. 2b).

"Now we start on the filter. The rectified a.c. first encounters a condenser and charges it. The property of any condenser to charge and then discharge causes it to discharge as soon as the voltage starts its down swing again. This prevents the voltage from reaching the zero line, and the oscillograph would look like this (point 1 in Fig. 2a). The current then goes through the choke and the inductance of the choke causes a lag. This lag prevents the peak voltage from building up again and the smoothing action goes on (point 3 in Fig. 2a). The current then meets and charges the second condenser and as soon as the down swing starts this second condenser discharges itself and smooths out the voltage line still more (point 3 in Fig. 2a). The inductance of the second choke then smooths out that little peak until it is almost flat (point 4 in Fig. 2a). The last condenser then boosts up the line until it is smooth and we have pure d.c. (or should have). Now, when you get the set on the air, if your monitor shows any 60-cycle modulation, you know where to look for it. Incidentally, you can check the setting of your variable center-tap resistor by listening in the monitor. You should get a steady note when you reach the exact electrical center."

"Is it possible to use less material in the filter, Gus?"

"Yes, you can cut it down to one choke and two condensers, what is known as a brute force filter, but then you don't get the good d.c. that the law calls for and that good and efficient operation demands."

"I've seen circuits that show a separate transformer for the oscillator filaments. Why don't we do that here?"

"A good question. Expense is the answer. It is best to have a separate filament transformer, especially if your transformer has poor regulation. A poorly regulated transformer will cause a drop in all the secondaries, including those that supply the filaments. This means a lowering of the temperature of the transmitting tubes and a consequent shift of frequency. Therefore a separate transformer is highly desirable and as soon as you feel you want to spend the money for one, put it in."

"Gus, you said that a fellow who lived in a d.c. district could use a rotary converter or a motor generator, but how about the fellow who lives out in the country and only has a farm lighting system? What does he do?"

"He can get a 32-volt dynamotor. That usually has a 300-volt winding on the high side, and while it restricts him to low power, if he adjusts his transmitter properly, he can get out. You know, the fellows on the other side of the Atlantic are restricted to very low power, and yet they certainly get out. Why, in Germany they are limited to 100 watts total input to the transmitter, including the filament supply. Some of our gang with their quarter kilowatts would howl if the government suddenly shut them down to that."

"Don't think I'm dumb, Gus, but how about these fellows up around Niagara Falls and in other sections where they have 25-cycle current? How about them?"

"They have to use a different transformer, one with more iron in it or more wire."

"Don't I need any meters in the power supply?"

"Yep. Almost forgot that. You must have a milliammeter of about 150 mils rating—d.c., of course. You could have a voltmeter across the output of the power supply, but it is not at all necessary. For the milliammeter, you might use a Jewell, panel mounting type. Get the panel mounting type because I think you'll want to dress up the transmitter before very long, and meters are a swell adornment for a panel.

"Get busy now and put that together. When you have it hooked up I'll come over and help you get on the air. By the way, did you get your license yet—your operator's license?"

"Operator's and station both."

"Attaboy. Outside of the license, the most important parts of a ham station are the monitor and frequency meter."

"Do I build them both? Hadn't I better get the parts?"

"Don't rush. The monitor is important in getting on the air, but you can build that out of a lot of parts you have laying around the house and we can throw it together in an hour or so when I come over again."

"O.K., Gus. CUL."

"Dit dit."

"Dit."

Next month Gus will explain to his amateur friend how to adjust the transmitter for operation in the amateur bands.

All Branches of Radio Honeycombed with Youth

(*Continued from page* 713)

heads predominate, though Senator C. C. Dill will not admit that 46 is a very ripe old age. Senator Couzens, chairman of the Senate committee having radio in charge, is 58, and Rep. Wallace White, Jr., who had the same post on the House side and who was recently elected to the Senate, is 54. On the other hand, Louis G. Caldwell, former general counsel of the Federal Radio Commission and now chairman of the communications law committee of the American Bar Association, is only about 40. B. M. Webster, Jr., also a former counsel of the Commission and now also in private practice, is just 30, a year or two younger than Paul M. Segal, his former assistant and present associate, and Phillip G. Loucks, counsel and prospective secretary of the National Association of Broadcasters.

In Europe, Sir Basil Phillot Blackett, chairman of the recently formed cable-radio communications monopoly, is 48. Dr. Meissner, the famous German radio scientist, is 47.

It is youthful zeal, at any rate, which makes many of the oldsters as keen about radio as a hobby or profession as any of the youngsters. Hiram Percy Maxim, the inventor, says he was 40 when he first began to learn the code: now he heads the American and world amateur radio organizations, from whose ranks all the communications companies draw liberally for the young men who are the mainstays of their ship and shore systems.

Radio operating has many older hobbyists not in radio as a business. For example, there is Henry B. Joy, former president and now director of the Packard Motor Co., who holds a radiotelephone operator's license. Then there is Gano Dunn, president of the J. G. White engineering corporation, who attended radio school not so long ago, passed a government quiz for a first class commercial operator's license, and now works his own wireless on his private yacht.

Radio Makers Turn Eyes Toward Foreign Outlets

(*Continued from page* 713)

grams, and, then, the creation of a desire among the populace to acquire the instruments for hearing them.

Since the business depression is worldwide in scope, the American export trade in radio is lagging along with the domestic trade. The latter is now marked by the losses or extremely low earnings currently revealed by some of the leading manufacturers.

Some of the radio makers are turning to other lines to diversify their output, and thus we find them producing electric refrigerators, home talking picture equipment, electric clocks, combination broad-

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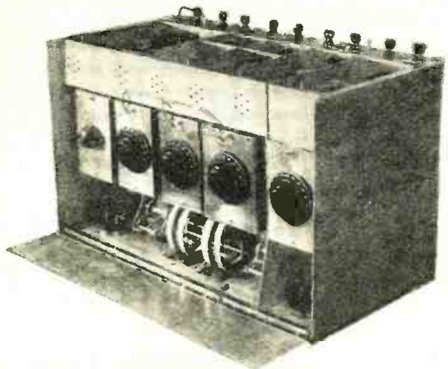
See page 749 for Special Radio News Subscription Offer

The Stenode Radiostat

(Continued from page 687)

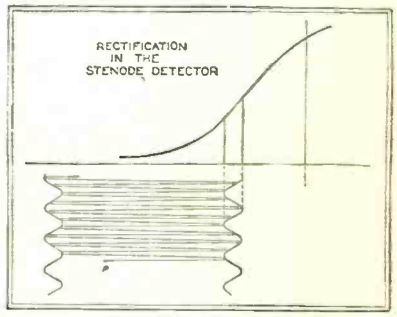
necessary to consider in what manner interference will be caused by waves of frequencies different from that to which the selective receiver is tuned.

What will happen if the interfering frequency is nearer than ten kilocycles? The general conception of the side-band theory appears to be that when the carrier frequency is nearer than ten kilocycles, interference should be experienced. A general discussion on the nature of side-bands took place in the pages of *Nature* early in 1930, and various scientists, particularly Fortescue and Glazebrook, recalled the fact that simple modulated waves—*i.e.,* waves of frequency n modulated at frequency p—do actually give resonant response in a receiver at the three frequencies n, n + p and n — p. Because of this it might be considered that if the interfering carrier frequency is 1,000 cycles away and has a modulation of 1,000 cycles, one of the side-bands so produced will fall directly on the resonance curve of our receiver and will thus produce considerable interference. Whilst there is no doubt that under such conditions the receiver would be excited, no interference is actually produced because this interfering side-band is purely of continuous wave form and it will operate in conjunction with the desired carrier wave to determine the maximum amount of build-up in the receiver, and the preceding discussion has shown that the desired signals are the variations of this maximum build-up. The probability that we should obtain an interfering station with a prolonged note of such frequency that it produces a side-band accurately on the resonance curve of the receiver is very small with the Stenode and this probability diminishes as the selectivity of the receiver is increased.



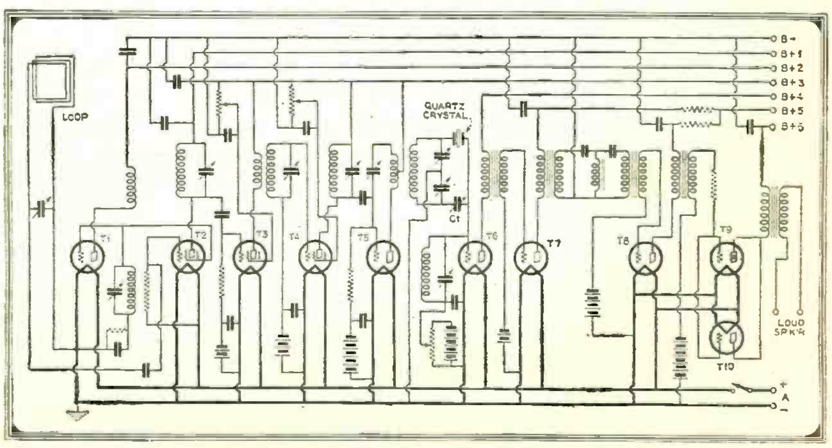
The tuner section of the Stenode lying on its face and showing the tuned intermediate stages

A more general case is that the interfering station will have a modulation frequency of variable intensity which produces a side-band accurately on the resonance curve of the receiver and in this case intensity of this side-band is very much lower than when one constant note is being produced. The variation of intensity in this case is at a very slow rate, being controlled by the speed of manipulation of musicians and is thus at a rate of the order of one per second.



Note how rectification is obtained in the Stenode by utilizing only that portion of the r.f. excursions which constitute the variation in amplitude

We must thus look to other causes for any possible interference and we shall now consider what interference is obtained from the carrier wave of a neighboring station. The curve shown in Fig. 5 may be taken as a typical resonance curve of a highly selective circuit, and it is seen that an adjacent station will produce an



For practical purposes a superheterodyne circuit is employed in the Stenode, since then only one crystal need be employed (in the i.f. amplifier), as shown in the circuit above

The Stenode Radiostat

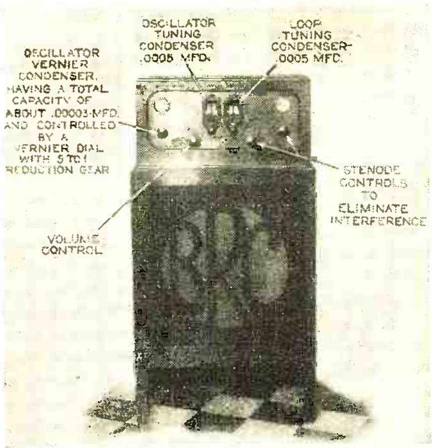
(*Continued from page 752*)

effect on the selective receiver even though this effect is small. In most of the experiments up to date, it is found that such a carrier does produce a small interference and, although this does not form part of the present paper, means can be employed to remove this interference. For the moment, however, we shall discuss the nature of this small interference of a carrier frequency. Let us consider the build-up effects that are obtained in our selective receiver by such an interfering station in a similar manner to that in Fig. 2B. In the first place, if the interfering station is of continuous wave form of frequency n, we have the build-up of the signals as shown at oaceg, Fig. 7, whereas for a signal of the same intensity actually in tune the build-up for continuous waves is OACEG. For the interfering stations we have a low maximum value for the amplitude. Consider the case at the point e when a signal has just ceased. We have here the case of forced oscillations which have built up a small amplitude. At the time given by e the receiver is actually being forced to oscillate at a frequency n1, which is different from the natural frequency of the circuit n0. When the input of energy ceases, the receiver will continue to oscillate in its own natural frequency n_0 and the oscillations will die away according to an exponential curve determined by the damping of the oscillating circuit. As the initial amplitude of the oscillation at e is small and as the damping is minute, we shall have the receiver dying away to the point f in the spacing interval, when there is no incoming energy. This exponential curve is of the same family of exponential curves as that given at EF and the slope of ef is further, very much lower than that of EF.

When the next signal arrives at e the receiver will build up to the point g (provided that the phase of the incoming signal is correct) and the total result is that the incoming signals give a maximum oscillation which is small, with a variation of amplitude which is still smaller. Thus the interfering station, when of continuous wave form, produces energy given by oaceg and, when this interfering station is modulated, we still have this same energy with a small variation of amplitude corresponding to the signals, *i.e.*, oabcdefg. In fact, qualitatively, it is apparent that the percentage modulation of the interfering signals is of the same order as that for the signal which is in tune with receiver.

The result has thus been obtained that when we have waves of a frequency n_0 modulated by speech, music or the like, and when we employ a very selective receiver, the modulation response is maximum when the receiver is tuned accurately to the frequency of the incoming waves and that this response rapidly diminishes as the receiver is progressively detuned from this frequency. By making a receiver of the highest possible selectivity, the modulation response of a transmission whose frequency is less than 5,000 cycles away from that of the receiver can be made negligible. This result is in accordance with our earlier conceptions of tuning, but at first sight it appears to be a contradiction of the side-band theory. This latter theory is an application of the Fourier analysis to radio, and in consequence it has been considered to be a correct interpretation of all facts of modulation.

It is, however, very significant that there are certain phases of radio analysis where it is customary to employ the actual modulated waves instead of the Fourier components, such as, for instance, in problems of rectification, and it begins



Above, the various control and tuning knobs of the Stenode are labeled to indicate their function

to be a case for consideration as to whether the side-band theory as at present formulated, being merely a statement of Fourier's analysis, gives a complete statement of the case.

The case has not been completely analyzed so long as problems of rectification and detection have been omitted. Then again it must be remembered that the Fourier components are changing in amplitude and frequency for the general case of modulation, such as for speech, music, telegraphic signals or television. Another consideration is that the Fourier analysis gives values for the amplitudes, frequencies and phases of the various components, and the question of phase shows that we cannot apply simple arithmetical addition to these various components. This becomes of great importance in the case of the Stenode where the receiver is exceedingly selective. Still another factor which must be considered in the case of the Stenode is that we must take into account free oscillations which are given by the exponential term in the solution of the basic differential equation for oscillating circuits. With ordinary receivers, it is usually unnecessary to consider the exponential term, as it is of small importance, but with the Stenode it cannot be ignored.

There is one other very important con-

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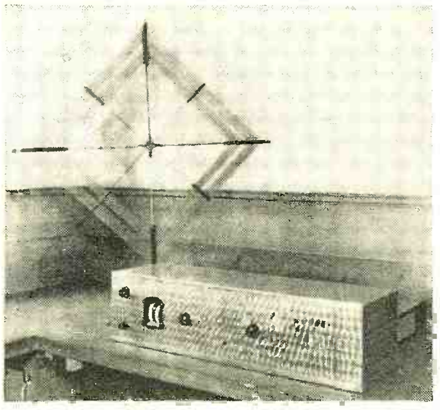
The Stenode Radiostat

(*Continued from page 753*)

sideration in connection with the exponential term. The effect of this term is large in the Stenode and it is not easy to subject it to mathematical computation. Its value at any instant depends on the actual amplitude of oscillation in the selective circuit and as this amplitude is changing for modulated waves the value of the exponential term is also changing. When one attempts to apply the side-band analysis to the Stenode, the question arises as to the vectorial addition of various side-bands effects. Such addition can be made provided that each term is entirely independent of the other terms,



An early experimental model of a Stenode receiver used in the laboratories of the British Radiostat Corporation

but when the exponential term is of large importance the side-band effects are not independent of each other and thus simple addition cannot be applied.

These considerations show that the application of the Fourier analysis to the complete radio equipment is not quite simple, and that when new facts are brought forward, as in the present case of the Stenode, the application of the Fourier analysis must be made in a manner to include the whole of the phenomena.

Summary

The Stenode system is a departure from hitherto universal practice, where it was considered necessary to employ a broadly tuned receiver in order to receive all the side-bands of the transmitting station. In fact, the Stenode system makes it possible to increase selectivity to the utmost practical limit and still obtain all modulation frequencies. While employing selectivity of a much higher order than normal, it is possible to obtain all modulation frequencies and to apply a low-frequency amplifier which may be designed according to a clearly defined law that the amplification factor is proportional to the frequency and thus to obtain satisfactory fidelity. Another result is arrived at that there is a large improvement possible in the ratio of signal to interference, whether the latter may be from natural or other causes. From a quantitative point of view, the signals are at least as strong as they are in the normal highly damped receiver. Some of the effects of the Stenode system can be expressed in the form that the percentage modulation of waves is changed after the waves pass through a selective device by a factor which is proportional to the logarithmic decrement and inversely proportional to the modulation frequency. It further brings out the possibility that modulated stations can be placed considerably closer than 10 kilocycles apart without interference and with perfect fidelity.

Equation (6) can be written—

$$i = A\left\{1 - \frac{B}{Af_2}\cos w_2t\right\}\cos w_1t$$

$$= A\left\{1 - \frac{m\delta n}{2\pi f_2}\cos w_2t\right\}\cos w_1t$$

where $\delta = \frac{r}{2nl}$

Thus the modulation factor which for the input is m becomes for the output

$$\frac{\delta}{2\pi} \times \frac{n}{f_2} \times m$$

and we have the result that a very selective receiver changes the modulation factor by the factor—

$\frac{\delta}{2\pi} \times \frac{n}{f_2}$ where

δ is the logarithmic decrement
n is the carrier frequency and
f_2 is the modulation frequency

The above is a continuation of the mathematics shown on page 686.

Demonstration at Columbia

AT the conclusion of his paper before the Radio Club of America, Havemeyer Hall, Columbia University, Dr. Robinson and his engineering associates, who have come to America with him, demonstrated the practical application of his theory in the working of a superheterodyne receiver incorporating his invention.

On the table before the audience was a Stenode receiver. Off to one side was a standard commercial type of superheterodyne receiver. In the rear of the room, along the side wall, was situated the two constant frequency modulated radio-frequency oscillators with phonograph pickups and turntables. The Stenode was tuned to WJZ at 760 kilocycles; one of the oscillators, designated as "Station A," was tuned 5 kilocycles away at 765 kc., while the other, designated as "Station B," was tuned five kilocycles the other side of WJZ at 755 kc.

When Dr. Robinson's receiver was turned on with the Stenode part of the circuit unbalanced, it functioned much as any other receiver would. A violent interference with WJZ's signals was received because the two oscillating stations, "A" and "B," created a strong heterodyne as well as a strong modulated interference. However, when the Stenode

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engineering designs are often checked and hastened by indicating the characteristics of certain functions. We think of a result as being dependent upon a certain variable, and if the letter y is taken as dependent upon the value of x, we state that y is a function of x and can be expressed as $y = f(x)$ or as $y = x$.

Representing Algebraic Expressions by Graphs

Let us investigate the algebraic expressions, y and x, such that

$$y = x$$

Now, assigning certain values to x:

If x is	the corresponding value of y is
0	0
1	1
2	2
4	4
6	6
8	8
10	10

and we see that by plotting the values of y, as shown in Fig. 1 (a), gives an algebraic expression of a straight line, 0A. Assigning certain negative values to x, such that—

If x is	the corresponding value of y is
0	0
—1	—1
—2	—2
—4	—4
—6	—6
—8	—8
—10	—10

and we see that by plotting the values of y, as shown in Fig. 1 (b), gives the expression of a straight line, 0B.

Again, let us investigate the expression $y = -x$, and observe the characteristic taken by y when numerical values are assigned to x.

If x is	the corresponding value of y is
0	0
1	—1
2	—2
4	—4
6	—6
8	—8
10	—10

and if x is	the corresponding value of y is
0	0
—1	1
—2	2
—4	4
—6	6
—8	8
—10	10

Thus, the lines generated become respectively 0c in Fig. 1 (c) and 0d in Fig. 1 (d).

Now, extending the investigation, consider the algebraic expression of a point which moves in a plane such that its ordinate (y) is always equal to its abscissa (x) plus a quantity (a). This can be expressed, then:

$$y = z + a$$

Assigning various values to x, when a is equal to, say, (2), we have:

If x is	the corresponding value of y is
0	2
1	3
2	4
4	6
6	8
8	10

Observing the graph of this algebraic expression, we obtain the straight line 2A in Fig. 2 (a). It is interesting to note that the straight line does not now pass through the origin, but through a point depended on the value of (a).

Assigning various negative values to x:

If x is	the corresponding value of y is
0	2
—1	1
—2	0
—4	—2
—6	—4
—8	—6

and we obtain the straight line 2B in Fig. 2 (b).

Again, investigating the expression $y = -x + a$ and assigning positive and negative values to x, graphs of these algebraic expressions are shown respectively in Fig. 2 (c) and (d).

Application of Algebra in Radio

Circuit Relations

An analysis of a representative radio receiving circuit will be made at this time to show the various relations of how algebra can be used for a better understanding of circuit designs. A complete understanding of direct current circuits, and the relations of the direction of currents and voltage drops throughout a system prepared the method of showing these relations for the instantaneous voltages and currents in alternating current networks.

Consider the circuit of Fig. 3. We have from Ohm's law that—

$$I = \frac{E}{R}$$

Therefore, if any two of the constants, I, E or R, are known, the third may be obtained from the relations:

$$E = IR \text{ and } R = \frac{E}{I}$$

If the circuit consists of three resistances in series, as indicated in Fig. 4, the total resistance will be the sum of R1, R2 and R3, and applying Ohm's law:

$$E = IR \text{ where } R = R1 + R2 + R3$$

Thus:

$$E = I(R1 + R2 + R3)$$
$$= IR1 + IR2 + IR3$$

From which:

$$IR3 = E - IR1 - IR2$$

Thus we see that the voltage drops across R3 can be expressed as the algebraic sum of the supply voltage E, and the potential drops IR1 and IR2. It is noted that the "algebraic sum" takes into consideration the relative signs plus or minus of the various functions.

Kirchhoff's Laws

We have applied one of Kirchhoff's laws for direct current circuits, which can be stated:

(a) That in any closed circuit in an electrical system the algebraic sum of the potential drops and the electromotive forces is equal to zero.

Thus, in Fig. 4, there is an impressed e.m.f. (electromotive force) which is dis-

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tributed throughout the circuit and forces the current through the various resistances. It is evident that the sum of the potential drops around the circuits (which can be considered as counter e.m.f.'s) is just equal to the impressed e.m.f. E. Therefore:

$$E12 = E23 + E34 + E45$$

We note that when there is an impressed e.m.f. the law can be stated:

(b) That in any closed circuit the algebraic sum of the potential drops around the circuit is equal to the impressed e.m.f.

If the circuit consists of resistances as shown in Fig. 5. R1 and R2 can be replaced by a resistance $R0 = R1 + R2$, and Fig. 6 will be the equivalent circuit. Assuming a definite direction of current as indicated (usually a right-hand or clockwise direction is used), we have that the current flowing towards the junction $0 = I$ is equal to the currents I2 and I3 flowing away from the junction 0.

This relation may be expressed by Kirchhoff's other law, which states:

(c) That the algebraic sum of the currents flowing toward a junction point in a direct current circuit is equal to zero. This can be stated in another way:

(d) That at any junction in a circuit the sum of the currents flowing towards it is equal to the algebraic sum of the currents flowing away from it.

Applying rule (b) to the closed circuit 1236 of Fig. 6:

$$E = I1\ R0 + I2\ R3$$

and since it is evident that in the closed circuit 3 4 5 6,

$$I2\ R3 = I3\ R4$$

Kirchhoff's laws can be stated:

(e) If there is no electromotive force in the closed circuit, the sum of the potential drops in one direction is equal to the sum of the potential drops in the opposite direction.

Since, in the above discussion of the closed circuit 3 4 5 6, we find that the potential drop E45 is opposite to the potential drop E63 (taking a clockwise direction).

Now, applying rule (d):

$$I1 = I2 + I3$$

Summarizing the known equations of Fig. 6 we have:

$$\text{(A)}\quad E = I1\ R0 + I2\ R3$$
$$\text{(B)}\quad I2\ R3 = I3\ R4$$
$$\text{(C)}\quad I1 = I2 + I3$$

These are three simultaneous equations, which can be solved as follows:

From (c): $I3 = I1 - I2$

Substituting this value of I3 in (B):

$$I2\ R3 = (I1 - I2)\ R4$$

Completing the expression:

$$I2\ R3 = I1\ R4 - I2\ R4$$
$$I2\ R3 + I2\ R4 = I1\ R4$$
$$I2\ (R3 + R4) = I1\ R4$$

$$\text{(D)}\qquad I2 = \frac{I1\ R4}{R3\ R4}$$

From (A):

$$\text{(E)}\qquad E - I1\ R0 - I2\ R3 = 0$$

Substituting (D) in (E):

$$E - I1\ R0 - \frac{I1\ R3\ R4}{R3 + R4} = 0$$

Completing the expression:

$$E = I1\ R0 + I1\ \frac{R3\ R4}{R3 + R4}$$

Thus:

$$E = I1 \left[R0 + \frac{R3\ R4}{R3 + R4} \right]$$

This expression shows that by the use of simultaneous equations we have been able to analyze the circuit of Fig. 6 such that we can replace it by the circuit of Fig. 7, where

$$R1 = \frac{R3\ R4}{R3 + R4}$$

This can be proven in another way where it is remembered that two resistances in parallel have the relation

$$\frac{I}{R} = \frac{I}{R3} + \frac{I}{R4}$$

from which

$$Rt = \frac{R3\ R4}{R3 + R4}$$

The above application of circuits is of fundamental importance, for the theory of alternating current systems is directly derived from these simple rules as outlined in Kirchhoff's laws. It is seen that the expressions involved were dealing with the algebraic addition and subtraction of functions and also the use of simultaneous equations which shall be further studied under this subject of "Using Algebra in Radio."

Let us consider the circuit of Fig. 8, which represents a standard rectified system of a radio receiver with its power stage of amplification. A direct current, I, from the rectifier tubes will flow through the choke coil to 0, and thus divide —I3 going through the power tube, and I2 through the output resistor.

Can this system, from a d.c. standpoint, be represented by the circuit of Fig. 9? We know that a power tube of the –45 type operates at a voltage of approximately 250 with a current of about .030 ampere, at a grid voltage of 50. From Ohm's law:

$$R = \frac{E}{I} = \frac{250}{.03} = 8300 \text{ ohms.}$$

This represents the d.c. resistance of the tube. For the grid bias resistance

$$R = \frac{50}{.030} = 1670 \text{ ohms.}$$

Therefore, Fig. 9 represents the equivalent circuit of Fig. 8, where

R1 = d.c. resistance of the choke

R2 = d.c. resistance of the field winding of a loud speaker

R3 = output resistor

R4 = d.c. resistance of the primary of output transformer

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R5 = equivalent resistance of power tube
R6 = grid bias resistor.

The voltage E can then be predetermined. Since the drop across the tube is known, the respective IR drops across the primary of the output transformer and the grid bias resistance can be calculated. Thus, the voltage across E1 is known. Since the current drawn by the field is known, the total current through the choke coil can be calculated. Thus:

$$E = I1\ R1 + I2\ (R2 + R3)$$
$$\text{or } E = I1\ R1 + I3\ (R4 + R5 + R6)$$

NOTE—The continuation of this series will be found in the next and succeeding issues of RADIO NEWS.

Below are listed all of the lessons which, with the exception of July, 1930, have appeared regularly since September, 1929, in the pages of RADIO NEWS. Inquiries relative to obtaining issues containing these lessons should be addressed to the Circulation Department, RADIO NEWS, 381 Fourth Avenue, New York City.

Mike-roscopes

(*Continued from page 732*)

ing at a most inopportune moment, if a moment for a wet ceiling can ever be called opportune.

Bill was born with a silver spoon in his mouth—or was it a cigar?—for until this radio affiliation he served as vice-president of the Congress Cigar Company, founded by dear old Dad. (Strains of La Palina, please.) He was born in Chicago, but if you want to know where he has been all of your life, and if you take my advice, you do, it is in Philadelphia. Mr. Paley is 29 years old. He is considered an expert on tobacco, and where there's smoke——!

FAN mail at Columbia recently included—a letter to Georgia Backus, actress, from a man who said she reminded him of his first sweetheart; a poem to Ted Husing, announcer, made up of the letters of his child's name Peggy May Husing. And Lilian Buckner, an auburn haired Columbia singer, receives orchids from an unknown fan each time she goes on the air.

Prevaricating about the number of fan letters they receive is getting as common among broadcasters as hedging about your golf score is among golfers. When an artist tells me he's getting umteen thousand letters a week, without offering anything, I subtract 500, multiply by nothing and divide by two. As Henry Burbig says, "I'm leffin' at you!"

ISN'T it too bad that the girl you're looking for doesn't often materialize, that "not impossible she"? But in Irene Bordoni, who has come to you over the air quite frequently of late via NBC, you may picture perhaps something like her—at any rate, a dashing brunette, a fascinating creature with big, dark eyes, who wears pearls and diamonds galore, has a maroon car and is charming and gracious.

Miss Bordoni was born in Corsica, the

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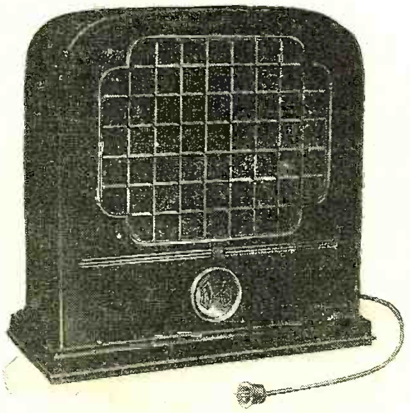
The Remarkable Bar-Tube

(*Continued from page* 718)

blast, and thousands of receivers based on the new tube are being turned out.

The new tube is the result of the striving for better and cheaper midget sets. Midget sets in Germany aren't just a sideline; they are the main stand-by this year. And a radio set which we find ridiculously cheap at $59.50 would be altogether too expensive for the average German family. The German radio industry is figuring that about $39.50 will be the average price paid for a radio set this year. A real radio outfit for about $40, speaker, power supply, tubes, and everything—that is the problem. The solution offered by Telefunken is based on the bar-tube.

The bar-tube derives its name from its appearance. The tube is long, thin and bar-shaped. Inside are the plate and filament, but the filament is *alongside* instead of inside the plate, as heretofore. A conducting layer is sprayed on the outside of the tube. And this coating is the grid! Very funny, but it's a fact.


A typical, low-priced German midget receiver which is operated by a.c.

The bar is made only in two types, a detector and an amplifier for resistance coupling. The former is gas-filled and provided with a tubular plate, the latter is of the high-vacuum type, and has a straight wire running parallel to the filament serving as the plate. Of the three prong terminals, the center one leads to the plate and the two outer ones to the filament. The base consists of a metal collar, which serves to establish contact with the grid. The filaments are quite thin and heat up instantly, in contrast to previous a.c. tubes.

Although raw a.c. is applied to the filaments, there is no hum in the output. This is due particularly to the peculiar characteristics of the detector tube, which is quite sensitive to alternating potentials of audible frequency. In the bar detector, the rectification is the result of the difference of inertia betwen the emitted electrons and the ions of the gas filling. This difference of inertia is considerable only for alternating potentials of high frequency. Thus, the modulated high-frequency signal is rectified and passed on to the following amplifying tubes in the usual manner, without any loss of low notes whatever. Still the a.c. current on the filament does not modulate the output. Nature is very obliging in this new tube.

The insensitivity of the bar to a.c. hum has two great advantages. In the first place, there is no need for indirect heating of the cathode; a simple and inexpensive filament serves the purpose. In the second place, there is a considerable saving of parts in the power-unit, as considerably less smoothing is required. These two considerations make the bar chiefly valuable in connection with a.c. sets. They are not at present used for d.c. or battery sets.

Due to the peculiar method of rectification above referred to, the bar-detector requires no grid leak, grid condenser or grid bias. This means a further saving of parts.

As the flow of electrons between filament and anode is not controlled by an interposed grid, as heretofore, the application of a biasing potential to the grid of the bar has no appreciable effect. The flow of current in the anode circuit is independent of the static potential of the grid. This results in two important peculiarities. In the first place, it is of course impossible to plot a curve of these tubes in the usual way, as they have no static characteristic. And in the second place, it is obviously unnecessary to isolate the constant plate potential of the detector from the grid of the following bar-amplifier. Thus all coupling elements are saved. The detector anode is simply connected directly to the following grid.

The bar amplifying tube contains no gas, and amplifies of course all audible frequencies. The amplification factor is about 30. This tube is followed by a power tube of the usual type. The hook-up is for a three-tube set with feed-back. The outfit is intended only for local and short-distance reception, but this is about all that is claimed for our own midget sets.

The advantages of the bar-tube may be summed up as follows:

1. Grid leaks, grid condenser and coupling condenser are saved. The use of an audio transformer is of course quite superfluous.

2. There is a considerable saving in the cost of tubes. Bar-tubes of both types list at one dollar less than standard a.c. tubes, a saving of $2 per set.

3. The bars heat up instantly. In spite of direct heating and thin filaments, there is no a.c. hum.

4. Due to the insensitivity to hum and to the absence of grid-bias, there is a considerable saving in the power unit.

5. Bar-tubes are extremely compact and require very little cabinet space.

Bar-tubes have the disadvantage that they are not suited to r.f. stages or to the power stage. Thus far they appear to be chiefly applicable to cheap 3-tube sets. In connection with more expensive receivers employing r.f. stages there does

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The Remarkable Bar-Tube

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not at present appear to be any very great saving attached to their use. The German radio industry is this year confining its practical application to sets of the type illustrated. The German industry is taking midgets a lot more seriously than we are. The development of the bar-tube is evidence of this.

The Telefunken midget employing bars is illustrated here. This includes speaker, power unit and tubes, all for $40 list. The set is very well made and is quite handsome. The emphasis is laid on high quality at low price. A magnetic speaker is used. The power output is about 1 watt. It is to be borne in mind that this set covers a range of from 200 to 2,000 meters, to meet European broadcasting conditions. A set of this type for 200 to 600 meters could be made more cheaply.

I must emphasize before closing that the quality of reproduction is not at all impaired by the peculiar characteristics of the bar-tubes. They do not neglect any frequencies in the musical scale or otherwise cause any distortion. The efficiency of the bar-detector is up to par for signals of reasonable strength, but amplification in the detector stage is largely dependent on feed-back. The bar amplifier with a mu of 30 gives very satisfactory amplification. The chief weakness of the German sets from an American standpoint is lack of selectivity. For the intended ranges of reception, sensitivity is quite sufficient. It is to be hoped that American engineers will be given a chance to see what they can do with bar-tubes.

A New Loud Speaker

By S. McClatchie

THE electrostatic loud speaker is coming into its own. There is evidence of this from various quarters. For years it was but a scientific novelty. But there is one man in the world who has always believed in it. This man is the well-known tone-film pioneer, Hans Vogt of Berlin, Germany. With Dr. Engel, now of Fox Films, and Massolle now working with the German tone-film trust, he started work away back in 1919 on the electrostatic loudspeaker. For over ten years he has devoted himself to its perfection, and at last all difficulties have yielded to his efforts.

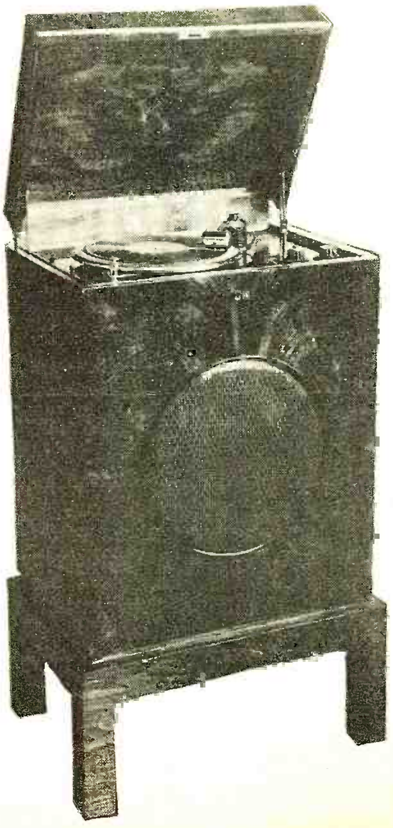
The new Vogt speaker is named the Oscilloplane. The quality of reproduction is quite out of the ordinary. It is certainly equal to the best of the electro-dynamics. Yet the construction of the Oscilloplane is far simpler and more rugged than that of any other loud speaker heretofore commercialized. In fact, the essential elements consist of but three parts.

Fig. 1 shows the parts as well as the assembled speaker. The stationary electrodes are moulded in plates of ribbed bakelite. Between these is stretched a diaphragm of very thin, light and strong metal. The alloy of which this is composed was developed by Vogt through years of experimentation. In addition to these three main parts, there are only a front cover-plate with associated holding-ring, and the necessary screws for assembly. No perishable material of any sort is used. The diaphragm is tightly stretched, and the dielectric is air.

Instead of the field current required by dynamic speakers, a field potential of 1000 volts, with no current flowing, is required by the Oscilloplane. This potential is obtained from a suitable additional winding on the power transformer. As no current is used, a very small tube serves as rectifier. This represents a material saving, as compared to the large copper-oxide rectifiers required by dynamic speakers.

The diaphragm of the Oscilloplane lies between the two stationary electrodes in

(*Continued on page 760*)



A German phonograph which utilizes the Vogt electrostatic receiver

A New Loud Speaker

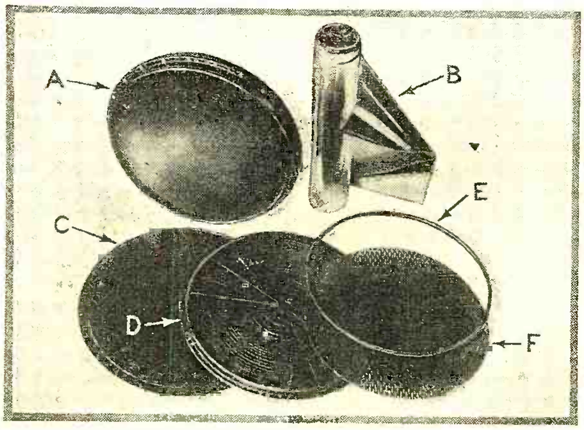
(*Continued from page 759*)

a homogeneous electrostatic field, just as the coil of the electrodynamic lies in a homogeneous magnetic field. The receiver output is connected directly to the outside electrodes and to the conducting diaphragm.

The reproduction of the electrostatic speaker is especially remarkable in the upper musical range. The voice particularly is reproduced with almost startling clearness. Vogt has in addition succeeded in overcoming the previous weakness of electrostatic speakers, which was in the rendition of low notes. In its present vice is not being manufactured by the patent-holders. Instead, licenses are being given to manufacturers to build and use the device.

The Oscilloplane is of course not suited to use with present sets, as some alteration is required to supply the necessary biasing potential. It must be combined with outfits designed for it. In addition to use by manufacturers of receiving sets, it will doubtless also find application in theatre and public address work.

The electrodynamic now has a serious



A, the assembled oscilloplane; B, a roll of the diaphragm material; C and D, stationary electrodes moulded in ribbed bakelite; E, holding ring; F, cover plate

form, the Oscilloplane appears to reproduce frequencies below 100 quite as well as the best dynamic speakers.

The shallow form of the new speaker is of advantage in building into cabinets. The exceptionally rugged construction insures long life. The simplicity of design makes the speaker very economical to build. The cost of manufacture is said to be only about $3.50.

The Oscilloplane Holding Company of Berlin is managing the international patent rights to the Oscilloplane. The de-

competitor. It will be interesting to see how the competition works out. Of course, the diaphragm of the electrostatic cannot carry out the large amplitudes handled by the cone of the dynamic, but to make up for this the diaphragm is given a large area. With sufficient area in the electrostatic, the two speakers should be quite on a par as to volume. As to quality, there is possibly no great choice. But as to simplicity, the electrostatic, and particularly the Oscilloplane, is very far ahead of its competitor.

Antenna Feeder Systems

(*Continued from page 718*)

kilocycles reduces the effectiveness greatly.

The proper way to determine the correct frequency of operation is by use of the monitor. Set the transmitter in operation and adjust the frequency as near as possible to the fundamental of the antenna. Now disconnect the feeder from the transmitter and listen on the monitor. If, when the feeder is connected, the frequency of the transmitter changes more than a few hundred cycles, the transmitter is not tuned close enough to the frequency of the antenna. The transmitter should be adjusted until connecting the feeder has very little effect on the frequency. After this has been done, *leave the transmitter alone* and begin work on the feeder. If it is possible to shunt a flashlight across one or two feet of the antenna at the center, do so, and vary the position of the feeder until maximum brilliancy is indicated. A radio-frequency ammeter would be better for this test, but the flashlight bulb is satisfactory. Another bulb can be placed in the feeder and this should begin to get dim as the lamp in the antenna gets brighter. Bear in mind, however, that this test is only correct when the transmitter is tuned to the fundamental frequency of the antenna. Changing the frequency of the transmitter distorts current and voltage distribution, causing wrong indications of the lamps.

Whether the feeder is clipped on the transmitter plate coil directly or through a coupling coil makes little difference in the efficiency, but the latter method often reduces key clicks.

This type of antenna is very efficient if adjusted correctly, but only well-adjusted systems operate effectively and satisfactorily.—HARRY F. WASHBURN.

Visual Broadcasting Still an Experiment

Television is still an experiment.

Of that fact the American public, and especially prospective purchasers of radio sets, may rest assured on the testimony of a majority of the most eminent authorities in the field of television research. If television is "around the corner," that corner is many, many miles away and the rate of approach to it is a snail's pace.

One came away from the Federal Radio Commission's conference on "experimental visual broadcasting," as the Commission officially styles television, with the conviction that many years must yet elapse before the average radio listener can be expected to take television to his bosom.

For the layman minded to tinker, or for the technician willing to delve more deeply into the devious details of the visual broadcasting art, there are televisors and televisor kits now on the market and there are visual broadcasts to tune in daily from more than a dozen experimental stations. Fortunately for the television experimenters, there are thousands of people so minded, and their observations and criticisms as well as the work being done in the laboratories will all contribute to the ultimate perfection of sight by radio.

Many and various were the claims of achievement advanced during the conference. Only one really startling claim was made, however. The inventor and his backers give all assurances that they will substantiate that claim before the month and the year are out.

Philo T. Farnsworth, Mormon youth from Utah, announced to a skeptical audience that he has perfected a system of television which reproduces 300-line moving pictures of actual scenes and objects after radio transmission over a band of wavelengths only six kilocycles wide. Audible broadcasting requires 10 kilocycles, and few television experimenters will admit that they can do with less than 100 kilocycles.

Made possible by what he will describe only as a "revolutionary new tube which eliminates electrical scanning," the Farnsworth system is said to have accomplished "practical electrical television as against experimental mechanical television." Hence, says the inventor, commercial television is here.

Has it real entertainment value? Do its results approximate what must be the criterion of acceptable television—the motion picture screen, or at least home movies? It remains for the young inventor, who has been conducting his researches in San Francisco, to show. None of the others has as yet.

Efforts to open the four bands of visual broadcasting frequencies to the use of commercially sponsored television programs, now under Commission ban because the channels are reserved as experimental, were effectively sidetracked by Dr. C. B. Joliffe, the Commission's chief engineer, who asserted that that matter was one of policy to be determined by the Commission itself.

Several of the visual broadcasters say that they have advertising clients eager to experiment with the broadcasting of pictures of their products, labels, trademarks and the like. Why shouldn't those advertisers be allowed to defray part of the exceedingly great expense of research, they asked. Why can't they be permitted to prepare for the new technique of visual advertising by radio which some day will take its place alongside audible advertising?

The tangible results of the conference were several. A voluntary reallocation of the stations using the four short-wave bands set aside for television experiments was decided upon and almost immediately thereafter the Commission ordered it in effect on Dec. 15, 1930. It was decided to keep all television stations occupying the same 100-kilocycle bands at least 150 miles apart. The television engineers agreed that, whenever asked, they would swap their 2850-2950 kilocycle band for aviation's 1600-1700 kilocycle band, a shift the Commission engineers said aviation is anxious to make.

In addition, the conferees resolved that the Commission set aside for future television development three bands of ultra-high frequencies, or extreme short wavelengths not now reserved by international treaty, without necessarily limiting the paths of transmission to the present 100-kilocycle width. They specified 23,000-46,000, 48,500-50,300 and 60,000-80,000 kilocycles. Then they urged that no audible broadcasting be permitted on the visual broadcasting channels but that other experimental sound channels.

Following is the complete log of licensed television stations, their channels, calls, powers, operators and locations, which becomes effective December 15:

Call Letters	Power (watts)	Company	Location
		2000-2100 kc	
W3XK	5000	Jenkins Laboratories	Wheaton, Md.
W2XCR	5000	Jenkins Television Corp.	Jersey City, N. J.
W2XAP	250	Jenkins Television Corp.	Portable
W2XCD	5000	DeForest Radio Company	Passaic, N. J.
W9XAO	500	Western Television Corp.	Chicago, Ill.
W2XBU	100	*Harold E. Smith	Nr. Beacon, N. Y.
		2100-2200 kc	
W3XAK	5000	National Broadcasting Co.	Bound Brook, N. J.
W3XAD	500	RCA Victor Company	Camden, N. J.
W2XBS	5000	National Broadcasting Co.	New York, N. Y.
W2XCW	20000	General Eelectric Co.	S. Schnectady, N. Y.
W8XAV	20000	Westinghouse Elec. & Manufacturing Co.	E. Pittsburgh, Pa.
W9XAP	1000	Chicago Daily News	Chicago, Ill.
**W2XR	500	Radio Pictures, Inc.	Long Island City, N. Y.
		2750 2850 kc	
W2XBO	500	United Research Corp.	Long Island City, N. Y.
W9XAA	1000	Chicago Fed. of Labor	Chicago, Ill.
W9XG	1500	Purdue University	W. Lafayette, Ind.
		2850 2950 kc	
W1XAV	500	Shortwave & Television Lab., Inc.	Boston, Mass.
W2XR	500	Radio Pictures, Inc.	Long Island City, N. Y.
W9XR	5000	Great Lakes Broadcasting Company	Downer's Grove, Ill.

* I hour daily (1 to 2 P. M.)

** Subject to operation between 5 and 7 P. M., with shared operation after 10 P. M. and between 2 P. M., by agreement with other licensees within 150 miles of W2XR.

The Stenode Radiostat

(*Continued from page 754*)

part of the circuit was adjusted to function, WJZ's signal was received clearly and without interference from either of the two local stations "A" and "B".

Then as a further demonstration, the capacity of the 100 micromicrofarad vernier condenser which was connected in shunt across the 500 mmfd. main oscillator tuning condenser was varied by means of a five-to-one reduction dial. A half turn of the knob of this dial was sufficient to tune from full volume of WJZ and out of resonance to silence. The change in capacity necessary to obtain this effect was approximately ½ mmfd. In addition, by the tuning of only the vernier condenser through a portion of its total capacity, it was possible to tune through WJZ and on one side of it receive clearly and without any interference station "A" and on the other side of it receive clearly and without any interference station "B." As a matter of fact it was observed in the tuning of this vernier through the resonance points of these three stations, that a space existed on the dial between station "A" and WJZ and WJZ and station "B".

The Stenode receiver was then turned off, all of the tuning adjustments remaining untouched. The standard commercial type of superheterodyne was turned on. It was impossible to receive WJZ without interference sufficiently strong from stations "A" and "B" to completely ruin WJZ's reception.

At this point the plate supply to the tubes in station "A" was turned off, with the result that a portion of the interference heard in the commercial type of superheterodyne receiver was eliminated. Then the plate supply to station "B" was similarly turned off with the result that all of the interference heard in the standard superheterodyne was eliminated, leaving only the clear uninterfered with reception of WJZ's signal.

A lively discussion followed the conclusion of the demonstration. In an early issue of RADIO NEWS we will publish the questions asked and Dr. Robinson's answers which he gave to these questions.

The Sextet Special

(*Continued from page 748*)

ohm voice coil with attached output transformer (LS. T2).

1 piece bakelite 12 inches long by 1½ inch wide by ⅛ inch thick.
1 piece bakelite 12 inches long by 9/16 inch wide by ⅛ inch thick.
1 piece bakelite 3⅛ inches long by 2⅛ inches wide by ⅛ inch thick.
1 piece aluminum 18 inches by 17 inches by 3/32 inch thick.
2 pieces aluminum 13 inches long by 3 inches wide by 3/32 inch thick.
1 pilot light for 2.5 volts.
2 small Kurz-Kasch knobs for R10 and C5.

Sundries—screws, nuts, soldering lugs, solder, wire, etc.

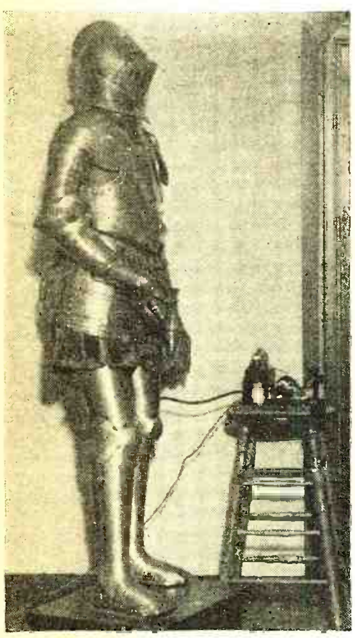
Mike-roscopes

(*Continued from page 757*)

same place as Napoleon, and like him, wishes she could conquer the world. She told me of her intention to appear in a musical comedy called "Collette." Perhaps as you read this it will be an actuality. I asked beautiful Irene to name her favorite rôle, and she laughed, "I haven't had it yet," and told me that, alas! her ideal rôle would be the type she is not fitted to portray.

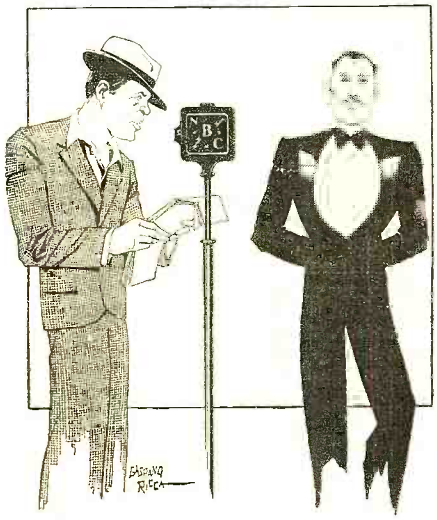
Perhaps some of you may be interested to know that when I asked Miss Bordoni what qualities her ideal man must have, she answered, "So many, I can't find him." Her positive statement is "I am not married, and it seems that I never was." As to love, "it's a problem," says the lady who makes eyes at you over the air though you cannot see them. "If you marry an artist, he's jealous; if you marry a banker, he doesn't understand; it's not simple, this love," said Irene Bordoni, shrugging her shoulders.

MANY and many of you saw the mechanical man at the Radio Fair early this season and I imagine you've seen similar ones at your own radio shows. Could



you bear with a totally non-technical "just a girl's" viewpoint on the creature? Well, some of us named the chaperon at our Fair in New York "Sir Walter Relay." I saw him when he was only a man in the making, just a bunch of tubes and —well, you tell me—and then again when he was completed. Outside of something that looked like egg on his chin and a disagreeable mien, I found him quite like most other men—mechanical! Anyway, I was the first woman to speak to Sir Walter—and all he did was whistle!

FLOYD GIBBONS, the Headline Hunter whom you hear on Sunday nights via NBC, always broadcasts with his hat on. Some people don't like Floyd because he talks so quickly, others like him for that very reason. Difference of opinion not only makes



horse-racing, but radio stars! I admit as I watched the rapidity with which Floyd fired his speech at you (he reads it), I felt like the little boy at the circus who looks at the kangeroo and yet says "There ain't no such animal".

Mr. Gibbons prepares to go on the air by spraying his throat, opening his tie and collar, noting his glass of water which the page brings him, and pushing his hat back a little on his head. He broadcasts sitting down at a table.

"After the ball was over" one evening, some of us went to Mr. Gibbons' home in a New York hotel where his wall is covered by hundreds of autographed pictures, mostly of girls, and yet the ex-newspaper man and soldier of fortune tells me he's never been in love. But men are like that—getting them to admit they're in love is like trying to batter down the Rocky Mountains with a rabbit's foot! Floyd told me: that the man he admired most was Richard Harding Davis, the woman he admired most was his mother, that if he had to live his life over again, he'd still want to do the same things, that he was born in Washington, D. C., in 1887, and that he has read his own obituary in the newpapers twice!

ONE of the most picturesque production men at NBC is Arthur Snyder. Arthur is the production man on Palmolive, Mystery Ship and other programs. Mr. Snyder is one of those men! A woman knows at a glance—a soldier of fortune, been everywhere, done everything, hand-

(*Continued on page 764*)

Radio Makers Turn Eyes Toward Foreign Outlets

(*Continued from page* 751)

cast and short-wave receivers, midget sets and a variety of other products. But even here they are meeting the sales resistance felt in almost all other lines of business due to the general depression.

$100.00 in Prizes

(*Continued from page* 714)

are duly licensed to operate a transmitter and who reside in or near New York City and who wish to volunteer as operators of the code classes, should communicate with John B. Brennan, Jr., RADIO NEWS, 381 Fourth Avenue, New York City.

R. N. R. A.

I am a short-wave fan and wish to join the RADIO NEWS Radio Association. It is understood that membership in the organization entails no financial or other responsibility on my part.

I do / do not own a short-wave receiver.

I do / do not own a short-wave transmitter.

Call letters..........

I do / do not contemplate building a short-wave receiver.

I do / do not contemplate building a short-wave transmitter.

My name is ....

My address is ....

....

Manufacturers' News

(*Continued from page* 730)

And so a line of precision wire-wound resistors have been developed for regular production, so as to supply the growing needs for resistors of extremely close tolerances. While the present applications are primarily for measuring instruments, laboratory procedure, and the more delicate forms of radio work and allied technique such as talking pictures, photo-electric cell circuits and so on, there is certain to be more and more demand for precision resistors as the production gets well under way. The various unique features of the new resistors have been covered by patents.

Mike-roscopes

(*Continued from page* 763)

some, speaks in a low, intense voice. Incidentally, he'd make a swell announcer. Mr. Snyder tells me he's been an actor on Broadway, a production man in Minneapolis on WCCO, and I'm sure there are lots of things he didn't tell me.

Blind Youth Passes Amateur Radio Test

Taking his examination orally, Clarence McPherson, 22-year-old blind youth of 914 South Seventh St., Kansas City, has qualified for an amateur radio operator's license and expects to be on the air shortly to communicate with fellow "hams" throughout North America.

William J. McDonell, assistant radio inspector at Kansas City, reported to William D. Terrell, radio chief of the Department of Commerce, that McPherson passed the code test of 10 words per minute by listening to an oral sentence and then tapping it out on the key. Then he answered the radio theory questions "sufficiently to warrant a passing mark."

Some Profit, Some Lose in Broadcasting

Here are some new sidelights on the fiscal operations of some of the leading broadcasting stations in the United States, as compiled by counsel for the Federal Radio Commission following recent hearings on high power at which all were asked identical questions concerning their finances for the purposes of the legal record.

Twenty of the 26 stations applying for maximum powers of 50,000 watts were considered for this compilation, because all are operating on cleared channels with powers of at least 5,000 watts. The statistics are regarded here as fair averages for such stations.

Ten of the 20 stations showed an average annual profit each of $29,000. The other 10 showed average losses of $54,000 annually. These figures do not charge off the intangible factors of self-advertising, promotion and good will accruing to the owners of the stations.

The average total investment in a 5,000-watt station is $189,000. Seventy per cent. of the programs served to listeners is of the sustaining or non-profit-making character, the other 30 per cent. being sponsored or paid for by advertisers and bringing the only direct income available to stations outside of talent booking. Music comprises about 57 per cent. of all programs.

The average advertising rate per hour is $310 for evening hours, and about half that amount for the daytime hours. Monthly incomes from advertising average $21,500 per station. The average operating cost of each station per month is $22,000, of which the talent payroll consumes $12,500 and other employees $6,400.

The average area of quality service for a 5,000-watt station is 35 miles, and its "reasonable service area" was estimated at 88 miles. Power increases to 50,000 watts, most of the witnesses agreed, would at least double the consistent high quality service area while increasing the reasonable service area beyond calculation. It was estimated that the cost of a 50,000-watt transmitter would be about $250,000—but all were more than willing to accept the obligation.

Probing Nature's Effects on Radio

That Mother Nature often plays havoc with broadcasting is only too well known by radio listeners everywhere. The degree and character of radio's dependence on season, time of day, weather and geophysical phenomena are very little known. Scientists only now are trying to find out by employing the "statistical method" of measuring broadcasting wavelengths over long periods of time.

One such experiment has been undertaken by the Bureau of Standards, which has developed an automatic recording apparatus for making regular continuous measurements of broadcast transmissions. This apparatus is now in operation at its field station at Kensington, Md. The observations being made there and those of various other laboratories may some day plumb the mysteries of static and fading and the dependence of wave propagation on various meteorological and geophysical phenomena.

At the Kensington station, according to the Bureau of Standards, a fixed vertical untuned antenna picks up the signal of a broadcast station and a superheterodyne receiving set changes its frequency to one in the intermediate range and amplifies it. The output of the receiving set is automatically measured and recorded on moving scaled paper by a commercial potentiometer recorder used in a three-electrode vacuum-tube peak-voltmeter circuit.

Thus a curve is obtained showing the intermediate-frequency peak-voltage output of the receiving apparatus at each instant of the period of the record. Radiating and receiving systems must remain substantially constant and must be checked frequently.

Records Calibrated

"The records," says the Bureau of Standards, "are calibrated in microvolts per meter, and the records with this calibration are, therefore, graphs of the variations with time of the field intensity of the broadcast signal at the receiving antenna. Differences between daily calibrations have been made very small by keeping the receiving set under temperature control and by taking proper care of voltage supplies and tubes.

"The apparatus described has been used for several months to measure the daytime field intensity of one station. Recently the hours of recording have been extended to cover the entire transmitting hours of the station. In order to include both day and night field intensities in the same output scale, a logarithmic relationship between the input and output of the receiving system is essential.

"This has been roughly attained by using a single stage of screen-grid amplification ahead of the superheterodyne receiving set and by having the potential of the screen-grid controlled by the mechanism of the recorder in such a way as to reduce the amplification of the set as input voltages are increased. The present calibration of the output scale covers all but the highest signal peaks, and the records show the diurnal variations in the intensity of the signal."

See our Special Subscription Offer on page 749

INDEX TO ADVERTISERS

Russia Sends Group to Study Radio

Quietly and unobtrusively, the chief of the international department of Soviet Russia's Commissariat for Posts and Telegraphs, Dr. Eugene V. Hirshfield, has been visiting in the United States for the last two months in quest of first-hand information about American methods of broadcasting and radio communications.

Except for a few persons in the radio industry whom he and his colleagues contacted, Dr. Hirshfield's presence went almost unnoticed until announcement was made that the long-planned direct radio-telegraph circuit between New York and Moscow had finally been inaugurated.

Though he is only 31 years of age, Dr. Hirshfield is Soviet Russia's outstanding radio leader, having headed various delegations sent by his government to international conferences on radio and communications. As such he is well known to many of the American leaders in radio, and in fact spent some time with several of the Washington officials during his recent tour.

He came to this country accompanied by V. B. Shostakovich, chief of the radio department of the Commissariat, and H. Bransburg, manager of its experimental radio station, partially to exchange the visit of Col. Samuel Reber, vice-president of R.C.A. Communications, Inc., who visited the Soviet Union in 1929. Much of Soviet Russia's radio equipment is being purchased in the United States, and the R.C.A. has a contract for the exchange of technical assistance with the Soviet Weak Current Trust, which produces radio equipment.

It was American technical aid which helped construct the 100,000-watt broadcasting station at Moscow which, until the Americans built a similar station near Rome, was the highest powered in Europe. The short-wave station which makes direct communications with New York possible on an every-day basis is also partly the product of American genius.

Would Erect 2-Watt Station Costing $50

This being an era of higher power for broadcasting, it came almost as a shock to the Federal Radio Commission when G. T. Rugland, high school superintendent at Appleton, Minn., applied for authority to erect a new broadcasting station to operate with only 2 watts of power on the wavelength of 1310 kilocycles.

Two small tubes of the type used in the average radio receiving set would be employed to control the power output of this tiny station which, according to the applicant, would cost only $50 to erect. Mr. Rugland asks permission to be on the air only five daytime hours and one evening hour each week in order "to give expression to the talent of the pupils of this community."

The lowest powered broadcasting station now operating in this country is WQDM, St. Albans, Vt., using 5 watts on 1370 kilocycles, but its owner, A. J. St. Antoine, has just applied to the Commission for an increase to 100 watts. Commission engineers recall that in the last few years there have been applications for new stations to use one-tenth of one watt and three-fourths of one watt, both of which were denied.

Scrambling Radio Conversations

Trans-Atlantic radio-telephony, now open to eavesdropping by persons properly equipped with short-wave receivers, may be made completely unintelligible to all but the intended destination of conversations by new "word scrambling" devices being worked out by American and foreign scientists. The Department of Commerce has a report that one such device was recently tried out with success on the Dutch radio-telephone circuit between The Hague and the Dutch East Indies.

Can You Distinguish Phonograph Records?

Of 16,274 radio listeners participating in a recent test in Germany, only 52 were able to distinguish correctly between the playing of phonograph records and actual studio broadcasts of speech and music. The test was conducted from the Stuttgart station of the German Broadcasting Corporation.

The German test constrained *Wireless World*, the leading British radio periodical, to make the following comment anent the British Broadcasting Corporation's broadcasts, which often include phonograph records but never without announcement to that effect:

"We would suggest that, without necessarily making any announcement to the effect, the B.B.C. might from time to time introduce records in their programs in order to see whether the public is able to distinguish the difference, and we are inclined to think that the majority of the listeners would often prefer a gramophone record performance by first-class musicians to a first-hand rendering by such poorly qualified amateurs as sometimes appear in the present programs."

Choose Trans-Pacific Radio Sites

Sites for the radio-telephone stations which will connect North America's telephone system first with the telephone system of Hawaii and eventually with those of Alaska, the Philippines, Japan and Australia have been selected, and service to Hawaii is scheduled to begin in January, 1932. The 20-kilowatt transmitting station which will operate on channels between 14 and 44 meters will be located at Dixon, Calif., near Sacramento, and the receiving station will be located at Point Reyes, Calif., just northwest of San Francisco.

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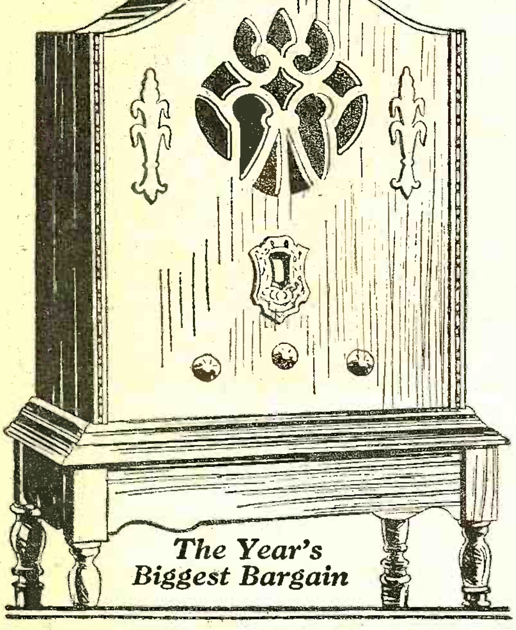

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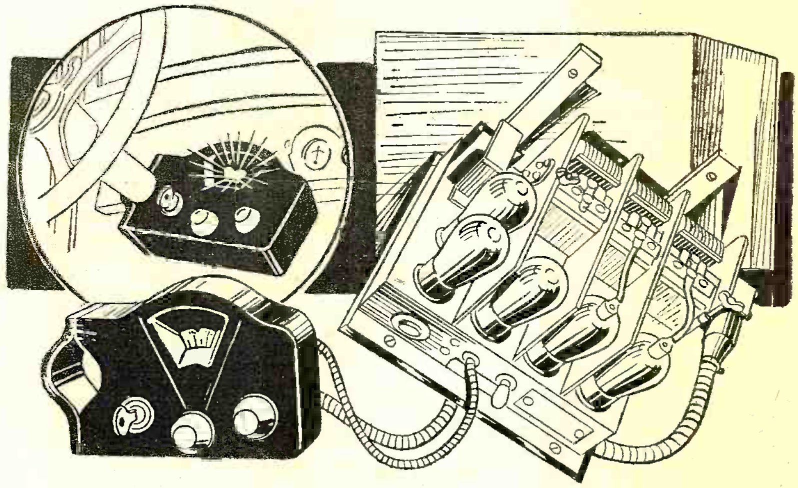

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