Radio Engineering

FEBRUARY, 1937

VOL. XVII NO. 2

DESIGN • PRODUCTION • ENGINEERING

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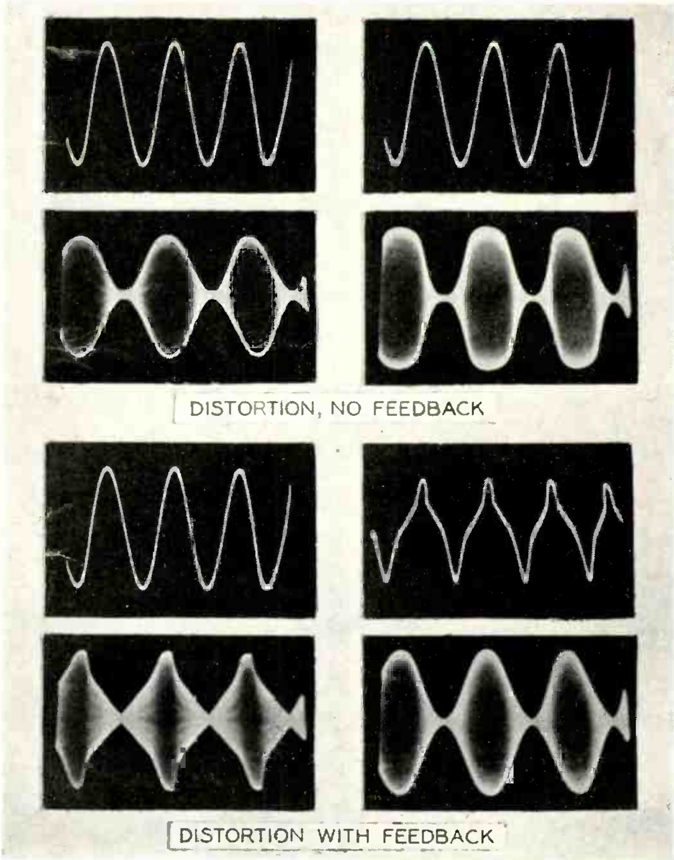

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The Journal of the Radio and Allied Industries

RADIO ENGINEERING

REG. U. S. PATENT OFFICE

W. W. WALTZ • Editor

CONTENTS FOR FEBRUARY

VOL. XVII *Member Audit Bureau of Circulations* NO. 2

COVER ILLUSTRATION

OSCILLOGRAMS SHOWING THE EFFECT OF INVERSE FEEDBACK ON DISTORTION.

(Bell Telephone Laboratories, Inc.)

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Editorial

THIS MONTH

WITH THE HOPE that we won't be accused of being a "Monday morning quarterback" we should like to remark that our thoughts have often turned to the idea of completely shielding a chassis. By this we mean sides and bottom as well as top, front and back. Of course, most chasses are more or less complete these days, but that wide-open space at the bottom certainly affords plenty of admittance for unwanted signals and noise. The studies of E. T. Dickey, reported in full in this issue, certainly sustain this thought. To those with whom we have spent hours and hours arguing this point, we say, "Told you so!"

Graphical analysis is always an intriguing subject—especially to those of us who don't know much about it. The author of our well-remembered series on loudspeakers, Hans Roder, has turned his attention to waveform distortion, with some interesting results.

As we promised last month, material on feedback, as used in Europe, (where it is called counter-coupling) will be found herein. No radical departure from local practice is indicated, but the methods of arriving at the final result may vary somewhat—it might seem as though the European engineers like to take the longest path to a solution.

We thought that you might like to know what the express company thinks about packing radio receivers for shipment. Also, what kinds of waxes and varnishes should be used for certain applications.

All of these, and some more, appear further on.

RADIO-PHONOGRAPHS

UNFORTUNATELY FOR THOSE who like it, the opera season on the air is short, and those who really enjoy music of this kind are seldom content with the relatively few weeks during which the Metropolitan amply fills the Saturday afternoons. Not being a musician (we'll hear from that profession in a later issue) we can't say why the many operatic programs that are available during the summer months don't entirely fill the bill; possibly, opera is so indelibly associated with the Metropolitan that any other source is looked upon more as a proving ground than as the real thing.

But, the Metropolitan, as well as many others, can be obtained on phonograph records, and records have the beautiful advantage of giving grand opera just when the listener wants to hear it, and of giving him—within reason—the opera he wants to hear. And if he wants to interpolate a Sousa march between selections from Carmen, he is entirely at liberty to do so without the risk of losing a part of the opera.

There are any number of arguments equally applicable to phonographs. We believe that there is an excellent market for the radio-phonograph combination, especially if models can be produced to sell at a reasonable price.

It is with these thoughts in mind that we introduce our lead article for this month. There will be more, on specific points, in later issues.

TUBES

IT HAS BEEN rumored that some tube manufacturers are proceeding cautiously to eliminate, or at least reduce the availability of certain of the older tube types. This is a most commendable gesture, spoiled only by the constant stream of new tubes.

Maybe there is an actual demand from the set manufacturers for some of these types, but it looks almost as though some of the tube designers were trying to set some kind of a record for the greatest number of different tube types that can be thought up in any given time.

Add to this ever-increasing tube list the hopeless complications of the tube numbering system, and, boy, you've got something!

AGAIN WE SAY—

THIS IS NO time for the so-called "science writers" of the daily papers to fill space with television material.

In the first place, no one can say definitely just what will be done about programs, or for that matter, just what the final technical details will be.

But, as we have mentioned before, these "minor" points don't concern the papers, and even some magazines are guilty of trying to "jump the gun."

The latest which we have seen have been interviews with several well-known orchestra leaders in which these gentlemen assured their palpitating public that they knew all that was necessary to be known about television technique.

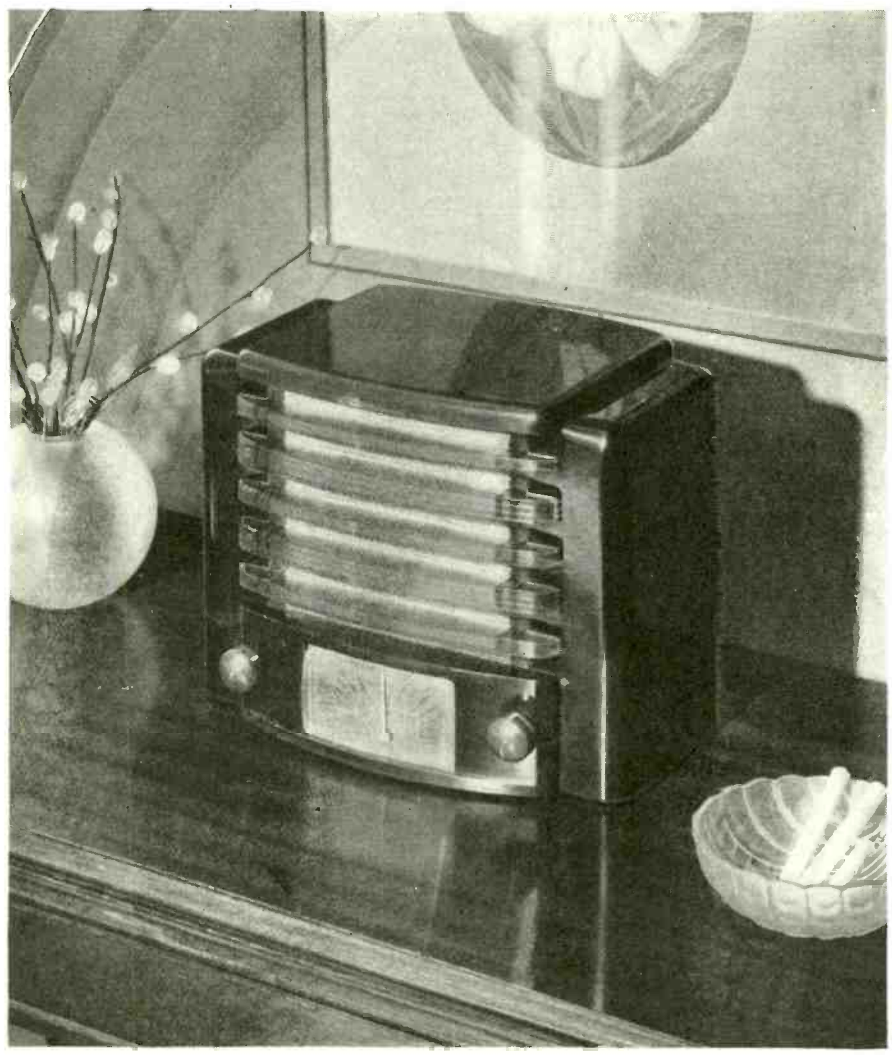
We wonder if it is at all pertinent that the two gentlemen were exactly 180 degrees out of phase with their respective ideas?

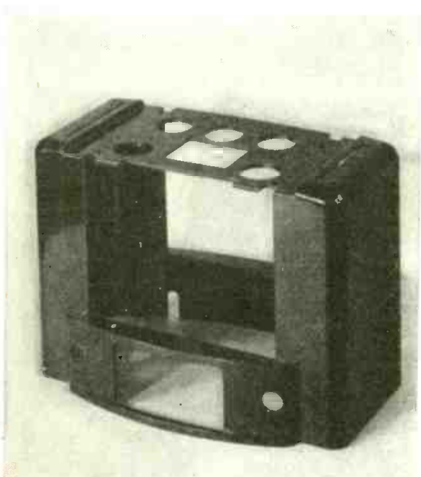
Helping Radio *to set its own Style Standards*

THERE'S a trend in cabinet design today that is definitely *away* from the traditional furniture styles which have influenced radio styling in the past. Step by step, the radio industry is establishing an individual style-identity more appropriate to the importance of radio in modern life.

In the development of these new style standards, Bakelite Molded has played an important part. Its lustrous, fine-textured surfaces, varied colors and high adaptability of form are ideally suited to express modern conceptions of design. Its production merits make possible the forming of quality cabinets at quantity costs.

A recent example of the new trend in styling is the Kadette Classic radio. The body of the cabinet, shown below, is completely formed in one piece, and with one operation of the molding press, through use of Bakelite Molded. All necessary slots and through-holes, and the final surface lustre are provided in the same operation, obviating further machining or finishing.





Radio manufacturers and designers are invited to consult us regarding improved methods for forming either large or small cabinets from Bakelite Molded; also, to write for our comprehensive booklet 50M, "Bakelite Molded."

Photo shows Kadette Classic Radio with rich green Bakelite Molded cabinet. Designed by Carl Sundberg. Also made in black and brown. Molded for International Radio Corp. by Chicago Molded Products Co.

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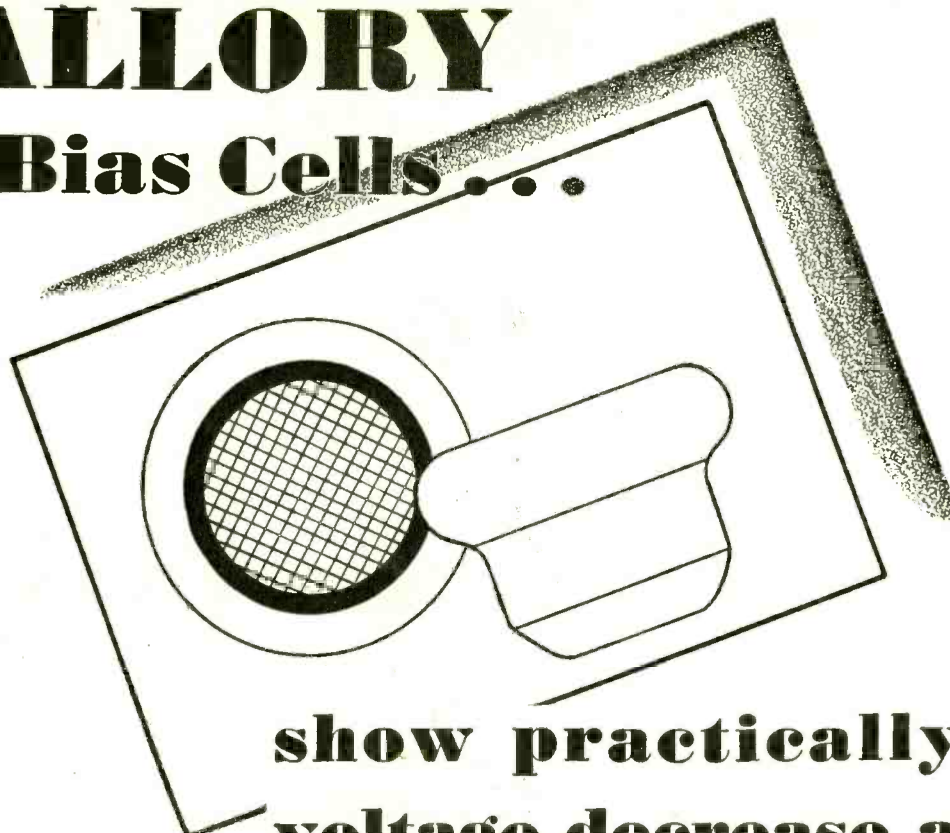
THE MATERIAL OF A THOUSAND USES

MALLORY
Grid Bias Cells . . .



show practically no voltage decrease after three years of service

MALLORY Grid Bias Cells, tested in the Mallory-Yaxley laboratories, show only the slightest decrease in voltage after continuous usage during 1934, '35 and '36. In countless home and automobile radio receivers thousands of Mallory Grid Bias Cells are establishing equally remarkable records for satisfactory service. Last year *more* Mallory Grid Bias Cells were used by *more* set manufacturers than ever before. This year the advantages of their superior characteristics, advanced design and unusual flexibility are winning an even greater recognition.

As a means of providing a constant bias voltage in which no grid currents are required or desired, this Mallory-Yaxley grid bias cell development has been everywhere regarded as an outstanding achievement. Particularly adaptable to receiver chassis layouts because of its small size, the characteristics of the Mallory Grid Bias Cell are unaffected by superimposed AC as high as 360 micro-amperes of any frequency. It is non-reactive at audio frequencies, and the DC resistance ranges between 11,000 and 50,000 ohms on standard production cells.

The Mallory Grid Bias Cell is unaffected by ambient temperatures in the range from minus 40-deg. F. to plus 120-deg. F. There is no change in its characteristics when exposed to a relative humidity of 90% at 120-deg. F. It is easily mounted. It does not develop noise effects.

The success of the Mallory Grid Bias Cell—like all Mallory-Yaxley successes—is based on the willingness and ability to adapt products to manufacturers' specific applications. Put *your* grid bias problems up to Mallory.

P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO., INC.
INDIANAPOLIS INDIANA
Cable Address—PELMALLO

YAXLEY

RADIO ENGINEERING

FOR FEBRUARY, 1937

441-LINE TELEVISION

THE FIRST PUBLIC demonstration of television using 441-line scanning was given by the Philco Radio & Television Corp. at Philadelphia on February 11.

The program, made up of interviews, newsreels, a fashion show, and other entertainment, originated in studios located in the Philco plant at Tioga and C Streets in Philadelphia. The receivers were located at the Germantown Cricket Club, some three miles distant from the transmitter.

The equipment, both transmitting and receiving, conformed in every detail with the recommendations made to the FCC by the Radio Manufacturers Association. (Full details of these proposals were published in RADIO ENGINEERING, July 1936).

The transmitter, with a peak power of 4 kilowatts, operated on a frequency of 49 megacycles. Sound transmission was, of course, over a separate channel (54 megacycles). Many of the observers at the receiving end commented on the excellent quality of the sound as received, as most experience with ultra-high-frequency sound transmission indicated that a considerable amount of distortion might be expected.

In so far as the picture itself is concerned, it can best be described, not by reference to past demonstrations—the improvement was obvious when the 441-line picture was changed to the older 345-line definition—but from the comments of one interested spectator whose technical knowledge was admittedly non-existent. This man remarked, "I'd like to have one of those sets in my own home, and so would lots of other people. However, I understand that the first television sets may cost four or five hundred dollars. That's too much money to spend for any radio set, with or without pictures. But, if they can get the cost down to, say, two hundred it's my guess that the average person would feel that he had his money's worth with entertainment such as that given here." It is worth noting, in connection with these remarks, that the speaker was not a guest at the demonstration, but rather, one whose duties made it necessary for him to be present.

Preceding the television demonstration, J. M. Skinner, president of Philco, spoke briefly, as did Sayre M. Ramsdell, vice-president, and Albert F. Murray, engineer in charge of Philco's television work. Mr. Skinner stressed the need for the frequencies which RMA had requested the FCC to set aside for television; Mr. Ramsdell definitely spiked the impression that has gotten around to the effect that television would supersede sound broadcasting. Mr. Murray's remarks were for the benefit of non-technical guests, describing for them just what he and his associates hoped to do.

Approximately one hundred and fifty persons had been invited to attend both the demonstration and the luncheon given by Philco at the clubhouse.

The Philco camera tube.

THE RADIO-PHONOGRAPH—
A NEGLECTED FIELD

RADIO MANUFACTURERS have never given the phonograph combination the attention that it rightly deserves. Whether or not this is due to a lack of appreciation of the potentialities of the market for combinations we are not prepared to say. It may be that the radio manufacturer figures that he has enough headaches turning out his quota of yearly models without adding to his grief with a line whose sales appeal he seriously questions.

However, an examination of the facts may serve to disillusion those who feel that the phonograph is a "dead letter." No exact figures on record sales are available. but we can say, without fear of contradiction, that improvement in this field is being registered—and we mean material improvement! Records *are* selling, and regardless of whether they are of highly classical music or just plain, unadulterated noise—"swing" music seems to be the latest term for it—the fact remains that it is still necessary to have a motor to turn the disc and some kind of a reproducing system.

Mechanical reproduction still exists, of course, but entirely in the so-called portable phonographs which are so dear to the hearts of school kids vacationing in a model-T flivver. And even the portables seem gradually to be going electrical.

It would seem, though, that the portable field can be disregarded by the set maker who wants to go in for phonographs. His best market is in the radio-phonograph combination, *priced within the reach of the average buyer of radios*. It must be realized that real appreciation of music is just as evident among the moderate-income classes as in the more wealthy; in fact, these latter all too often "appreciate" the symphony and opera solely for the opportunity which they afford to display the family jewels or to make the newspaper lists of "among those seen." This truth is easily established by noting the long queues patiently awaiting the opening of the ticket windows where the lower-priced seats—and standing room—for the operas and symphony concerts are sold. On the contrary, the "music lovers" among the wealthy are noted for their aversion to reaching the theater before the first act of the opera or the first number on the symphony program are under way. There really isn't any reason at all why the real lovers of good music should not be catered to by the radio manufacturer.

Consider a few of the points that can, and should be given prominence by the engineers assigned to the job of developing a truly moderate-priced radio-phonograph combination: First, is the problem of cost. It must be held low in order that the requirement of moderate price can be met. This immediately eliminates such refinements as volume expansion, unless something else gives way in its favor.

However, we are designing this combination set for those who want music. Is this class of person interested —even mildly—in the horrible mess of distortion and noise that is very frequently the lot of him who dials down to the short waves? We think not! Furthermore, most short-wave programs of interest are picked up and re-broadcast by the network stations.

With that in mind, it is entirely probable that the short-wave features of the proposed radio-phonograph set can be done away with entirely without loss of interest on the part of the prospective buyer. In so doing, the cost of a volume expander circuit might easily be obtained.

Thus far it has been assumed that a reasonable degree of tone quality is available in the set, that is, the audio amplifier and loudspeaker are at least moderately good. In the event they are not, some of the money saved from eliminating the short-wave circuits might well be expended in improving the audio end. Just how this is to be done is a problem which any engineer worthy of the name can easily determine—it is entirely conceivable that something so simple as adequately by-passing a cathode resistor might work (relative) wonders with an otherwise mediocre amplifier.

Along these same lines, is it not probable that by expending even more on the audio amplifier and speaker, volume expansion might be disregarded? After all, very few persons outside of the engineering profession realize the advantages to be gained from expansion, and giving the buyer a system that will respond to most of the recorded frequency range may be all that is necessary to make him an enthusiastic user—and a well-sold buyer when replacement time comes around.

However, volume expansion has its place, and we will return to further considerations of it below.

Again considering the features of a prospective low-cost phonograph combination, let us examine briefly just what can be expected from the record itself in the way of quality.

It is only fair to say that in recent years, the discs have been radically improved and this improvement seems to be extending, although at a less pronounced rate of advancement than was the case a few years ago. Today, the tendency is toward discs that are decidedly better from the standpoint of surface noise; this, in turn, results in an upward extension of the frequency range that can be recorded. Obviously, there was no reason to record frequencies above 5,000 cycles only to have them effectively cut out by the inclusion of a "scratch filter" that cut off at about 4,000 cycles.

Present-day surface noise standards seem to be such that, assuming the record receives reasonable care and is used with the proper needles, frequencies up to perhaps 7,000 cycles can and are being recorded. Any further increase, it would seem, will probably depend upon the ability of the designers to turn out pickups with the frequency range necessary to cover these upper registers, and upon the availability of loudspeakers capable of reproducing them.

With regard to the low-frequency end of the scale, it is here that a limitation, inherent in lateral-cut records, asserts itself to the disadvantage of the designer.

As is well known, records are cut at constant amplitude below about 250 cycles. This results in a gradual decrease in the output of the pickup as the frequency decreases. Furthermore, commercially-available records are "equalized," during recording, so that there is a gradual loss, starting at about 800 cycles, and increasing to a total of 15 db at 50 cycles. This is made necessary by the close spacing of the record grooves; if the amplitude were not reduced with decreasing frequency, "cutting over" from one groove to the next might take place.

The low-cost phonograph must provide some means for the restoration of this loss of low frequencies. Comparatively simple equalizers will do the trick, but such a method presupposes sufficient gain in the amplifier to make good the loss caused by the insertion of the equalizer network. Equalizers, of course, fall into the category of passive networks; that is, they provide no gain, but on the contrary, some loss at all frequencies.

Regardless of how the trick is done, the low frequencies must be restored to somewhere near their relative values, otherwise the reproduction will sound unnaturally "shallow" and little better than from the old acoustic phonograph. After all, it is the low frequencies that carry the tempo or rhythm in music, and their absence is more objectionable than is generally realized.

In the more elaborate and expensive radio-phonographs—for which there is likewise a market, although perhaps not as great as that for the inexpensive combination—the designer can let his imagination and resource have full play. There are so many things that can be done to justify a price of several hundred dollars that it will be difficult to cover them in any detail.

It is here that the volume expander can be used to advantage—not because the wealthier buyer is any better able to appreciate its advantages, but because it does provide a selling point that can easily be demonstrated to the purchaser. It has been said that once a person has had the expander thoroughly demonstrated, its full benefits will always seem to be essential to him. This may be a purely psychological reaction to something new—again, it may be just what it is supposed to be, a realization that here at last is life-like reproduction from a record.

Of expander circuits themselves, there are several more or less well known. Some are quite good; others are expanders purely by courtesy. True, they do give a certain degree of expansion, but inherent limitations prevent a true expander effect. Without attempting to judge the qualifications of one circuit as against another, we are reproducing herewith the diagrams of several circuits which have been developed and used.

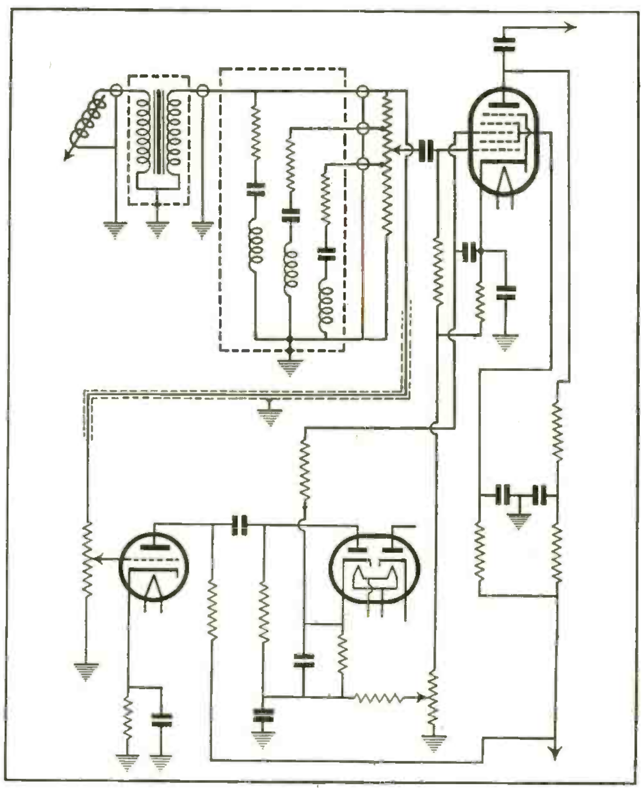
The attention to the reproduced frequency range which the designer of the more expensive models pays should, of course, be greatly in excess of that afforded the cheaper version. Here there is ample room for all kinds of equalizing, even to the extent of an additional stage of amplification the function of which is entirely that of compensation for frequency deficiencies.

The type of pickup employed may be a controlling factor in the degree and kind of equalization, or compensation, which the designer feels necessary. Pickups of the piezo-electric variety are inherently well compensated for the low frequencies when they are worked into the proper value of load impedance. Electromagnetic pickups can, by suitable design of the pickup arm and the moving armature of the pickup itself, be given a rising characteristic toward the low-frequency end of the scale.

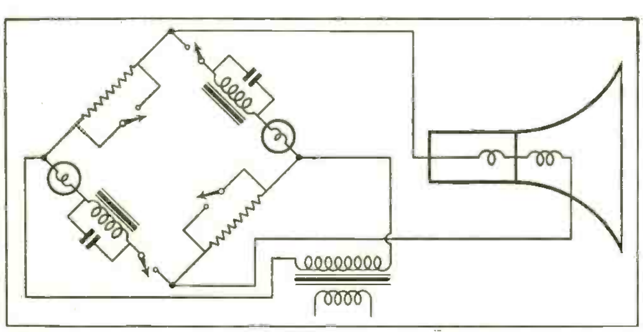
If it should be thought desirable to provide the user with control of the frequency response characteristic of the system—either for use as a true "tone control" or simply to permit certain (older) records to be appropriately compensated—some method similar to that already described in this publication (A. W. Barber, page 5, RADIO ENGINEERING, June, 1936) is by far the most feasible.

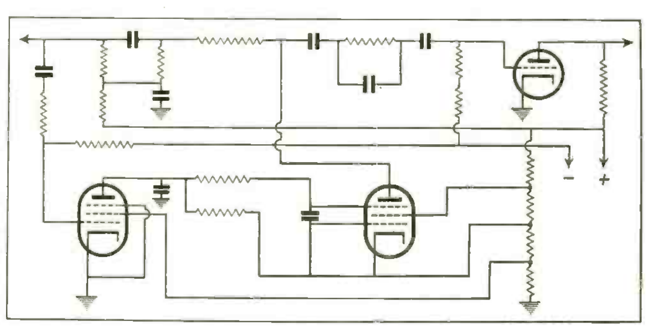
The audio compensating system described by Barber has another and distinct advantage. The compensating circuits are so designed as to be critically damped; this effectively inhibits the generation of spurious oscillations by these tuned circuits, with the net effect that there are no "tailing" notes to mar the reproduction. Two versions of the Barber system are shown in the accompanying diagrams.

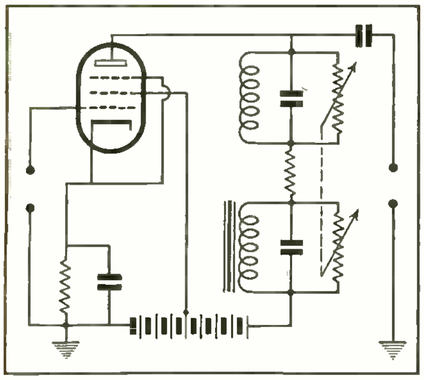
It is possible to effect certain economies in design, where the RCA expander system is employed, by combining the functions of expander amplifier—generally a 6L7 tube is used—with that of the compensator. In this

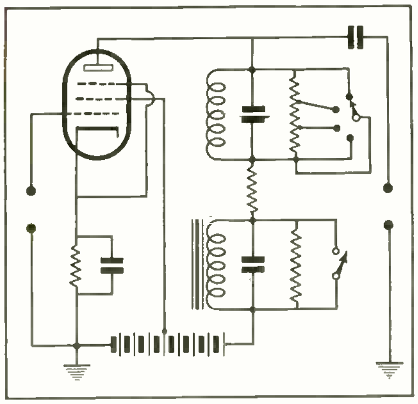


Circuits which have been devised to give volume expansion.









(Top) Circuit providing continuously-variable tone compensation.

(Bottom) This circuit permits variation of the high-frequency response only; the low-frequency compensation is cut in or out at a predetermined point.

case, the tuned circuits which effect the compensation may be located in the plate circuit of the 6L7 expander amplifier. However, it will be seen (from the reference cited above) that the resistances shunting the compensating circuits may be considerably larger than those specified for optimum gain from the 6L7. It will be apparent at once, though, that the damping resistances are shunted by the d-c resistance of the coils of the compensating circuits; this resistance will, in all probability, be sufficiently low so that additional series resistance will be necessary to make the 6L7 function satisfactorily. The other expansion systems shown above apparently do not lend themselves readily to this combining of functions with the compensating stage.

It was mentioned earlier that some kind of a motor was necessary to turn the record. We can immediately disregard the old mechanical motors—which always seemed to run down just at the critical moment regardless of the fact that they were "guaranteed to play three 12-inch records without rewinding"—as being entirely unsuited even for the inexpensive radio-phonograph which we have been discussing above.

Essentially, what is required is a motor, having a compartively low torque, but with a reasonably good constancy of speed. It is, of course, impossible to expect to find a synchronous motor with a speed of 78 rpm: therefore, if a synchronous type is used, a speed-reducing gear train must be inserted between the motor and the turntable shaft. The same remarks apply, with equal force to any type of motor which can be obtained—so far as we are aware—for this class of service; all of them will operate at speeds far in excess of that at which the turntable must revolve, and gearing is necessary to obtain the proper turntable speed.

This gearing seems to be one of the weak links in the chain; there is a tendency for motor vibration to be transmitted through the gears to the turntable where its effect on the pickup can easily be imagined. Gears of various materials have been tried to eliminate or reduce this noise transmission; success has been moderate.

Some help in this particular problem has been attained by a change in the method of mounting the turntable on its shaft. At one time—and except for theater and recording uses; here elaborate mechanical filters were, and are, used to couple the turntable to the shaft, but anyone who has had experience with these can appreciate the inevitable happenings if mechanical filters were to be provided on a home phonograph—the accepted method was to key or otherwise firmly attach the turntable hub to the shaft. Later design practice seems to indicate a "floating" arrangement, whereby metal-to-metal contact is avoided.

In any event, the motor and turntable supplied with the moderate-priced combination should receive enough consideration to insure the user against too much—however much that may be!—mechanical noise, and a reasonable degree of freedom from "wows" on sustained musical notes. This latter is best effected through the medium of a heavy turntable—and, of course, that seems to dictate a motor somewhat more powerful than is customarily the case. However, we wonder if many of the motors which are available cannot, without being seriously overloaded, drive much heavier turntables than those with which they are supplied.

But, the heavier turntable will immediately add a factor which will, probably, increase the cost, although whether or not this increase will be such as to remove heavy turntables from the possibility of low-cost equipment is something that only a mechanical designer is able to determine. The problem is that of insuring that the turntable hub is located "dead center" with respect to the rim of the turntable, and that the weight of the entire table is evenly distributed. In other words, the table must be almost perfectly balanced—statically and dynamically. Failure to attain such a balance can only result in the presence of the highly objectionable "wows" which were previously mentioned.

Recapitulating, then, what is needed is a well-balanced, heavy turntable, driven by a motor of constant speed; a motor that must run quietly, and be so connected to the turntable hub as to prevent the transference of mechanical noise to the pickup via the turntable drive.

In concluding this discussion on radio-phonograph combinations, let us give brief consideration to that most neglected of all musical sources, the records. The manufacturer who assigns to his design staff the job of turning out a cabinet that will hold the records—and hold them so that they are safe from breakage, scratching and the other dangers to which records are subjected—as well as the motor and chassis, will be doing a real favor for the real music lovers who buy his set.

Nothing is more painful than to have a prized record destroyed, either by outright breaking or by the scratches due to having one disc slide over another. The paper envelopes in which records are packed will not stand up any length of time; record albums are satisfactory provided there is some place to keep them. The ultimate in convenience, however, would be a built-in rack, each division of which could hold one—and only one—record. Each partition should be covered with felt, or at least enough felt padding should be provided to insure that the record grooves will never rub over any hard surface. Judiciously placed, this felt would also insure that the records were dusted off before and after each playing.

PREPARING RADIO RECEIVERS FOR SHIPMENT

by W. J. Hoy

Claim Supervisor, Railway Express Agency, New York.

INCREASED PUBLIC buying of radio receivers was clearly indicated in a great expansion of the business of the radio industry handled by the Railway Express Agency in 1936. For several years previous, the smaller portable sets predominated in the express radio traffic, but there were few express terminals last year where the full-sized models did not definitely outnumber the cartons carrying the miniatures and mantel types.

Local express agents in constant contact with dealers could readily sense greater purchasing power on the part of the public and a definite desire, because of improvement in programs and the indispensable character which radio has attained, to have home instruments providing not alone better quality of tone, but also short-wave accessories.

From the very inception of the broadcasting art, radio receivers and transmitters, and tubes of all types have been large traffic items for the express company. But because of the delicate nature of these instruments the proper packing, marking and handling of such shipments has necessitated much study as to their proper preparation for transportation. Express employes have been instructed as to the need for extremely careful handling of all radio shipments.

But outstanding manufacturers likewise realized the vital importance of getting sets and tubes to wholesalers and dealers in perfect condition. As the result of years of experience, they have developed their packing methods to an exact science. In fact, radio sets as they leave the factory travel virtually as "perfect packages," and damage in transit is now a negligible factor.

This question, however, becomes a vital one for dealers and radio service men in returning repaired sets to customers. It is not always a simple matter to return a receiver to the shipping case in which it arrived and have it provide all of the scientific safeguards which the manufacturers put into it at the start. Moreover, radio stores do not have available cases made especially for all sets which they have to ship.

The essentials of proper packing, as practiced at leading radio factories, are generally described in the following:

The ideal container provides well-designed fittings, to afford inside protection to the most delicate parts by a plan of bracing or cushioning adaptable to the needs of the model. The legs of such receivers can not be expected to withstand stress while in transit, unless they are relieved of all weight by free and clear suspension. Braces or blocking on finished surfaces should be suitably padded so as to avoid abrasion and the padding itself be faced with waxed paper to prevent press marks. The container provides sufficient rigidity so as to free the cabinet from what is known as "weaving strains."

For the smaller models, usually forwarded in cartons, a proper understanding of the "air-cushioning" principle is desirable. Hollow corrugated pads, commonly termed air pads, are sometimes used, with openings to accommodate tuning knobs. Care must be exercised to see that these openings are large enough to avoid any contact with these delicate parts and that the cushion is deep enough to suspend the model with ample leeway between knobs and carton walls.

Where these knobs are so situated that they run parallel across the face of the model near the center of its height, the face pad should not be placed upside down. If the knobs are only slightly off center, the openings are arranged to permit use of pads in either position, but if this entails openings of a size that would weaken the pad, the latter should be stamped or otherwise marked to avoid incorrect use. The tubes usually installed in the set are held firmly in sockets either by permanent attachments or special temporary arrangement to preclude possibility of loosening in transit.

In the perfect radio package, parts should not be loose, not even the connection plug, because if it is placed in a compartment or package, it gives the purchaser an impression of disorder, to say nothing of the internal damage they may do. Such containers should be marked to indicate the contents and carry suitable caution marks such as "This Side Up," if such positioning is desirable. In the case of cube-shaped containers, address and caution labels should appear on the top surface to facilitate handling and stowing when requested.

Where the construction of a model makes it imperative that "top up" position be maintained, the manufacturer usually supplements "This Side Up" labels with readily recognized signs and aids in the form of extensions on the outer surface of the container. Express agents are usually in a position to give helpful advice in packing matters, although necessarily they do not pose as experts, but they are always willing to do whatever they can to co-operate with shippers in getting their consignments through to the customers in perfect shape.

THE DISTORTION FACTOR

By Hans Roder*

THE DISTORTION FACTOR of a complex wave (Fig. 2) is, by definition:

$$f = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \ldots\ldots}}{I_1} \qquad \ldots\ldots (1)$$

where I_1, I_2, ... are the Fourier or harmonic components of the complex wave. It is the ratio of the rms value of all harmonics over the rms value of the fundamental component.

In what follows, a graphical method is derived for computing the distortion factor f by means of a special polar diagram.

From the theory of non-sinusoidal currents it is known that

$$\frac{1}{2\pi}\int_0^{2\pi} i^2\,dx = I_0^2 + I_1^2 + I_2^2 + I_3^2 + \ldots\ldots (2)$$

where

i = the instantaneous value of the complex wave,

$x = \omega t$

I_0 = the d-c component,

I_1, I_2, ... are the harmonic components, rms.

If i is given, the left side of (2) can readily be found, when using a diagram originally due to Fleming. Plot i in a polar diagram with x as polar angle. (Fig. 1.) The area, resulting thereby, is equal to

$$F_p = \frac{1}{2}\int_0^{2\pi} i^2\,dx \qquad \ldots\ldots (3)$$

From (2) and (3)

$$\frac{1}{\pi} F_p = I_0^2 + I_1^2 + I_2^2 + \qquad \ldots\ldots (4)$$

The component I_0 is proportional to the area F_0 under the complex wave (Fig. 2).

$$I_0 = \frac{1}{2\pi}\int_0^{2\pi} i\,dx = \frac{1}{2\pi} F_0 \qquad \ldots\ldots (5)$$

The component I_1 consists, in general, of a sine and a cosine term:

$$I_1 = \sqrt{a_1^2 + b_1^2} \qquad \ldots\ldots (6)$$

where

$$a_1 = \frac{1}{\pi}\int_0^{2\pi} i \sin x\,dx \qquad \ldots\ldots (7)$$

$$b_1 = \frac{1}{\pi}\int_0^{2\pi} i \cos x\,dx \qquad \ldots\ldots (8)$$

If we plot a curve (Fig. 3) with $y = (\cos x)$ as abscissa and i as ordinate, the area of this curve is

$$F_a = \int_0^{2\pi} i\,dy = \int_0^{2\pi} i \sin x\,dx$$

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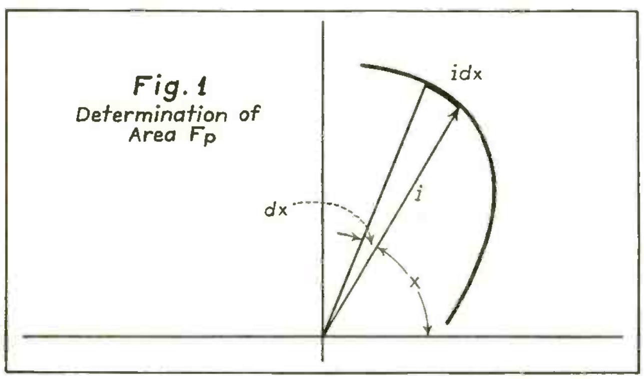


Fig. 1 Determination of Area Fp

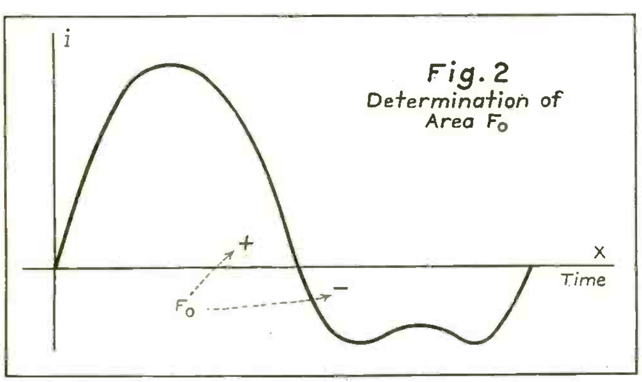


Fig. 2 Determination of Area F_0

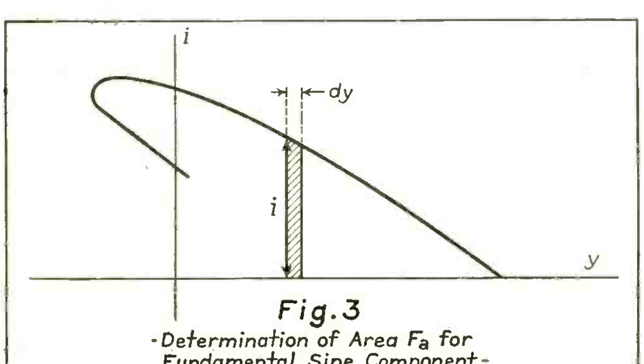


Fig. 3 - Determination of Area F_a for Fundamental Sine Component -

OF A COMPLEX WAVE

In like manner, if we plot i versus z, with $z = \sin x$, we get an area

$$F_b = \int_0^{2\pi} i dz = \int_0^{2\pi} i \cos x \, dx$$

Hence, from (6)

$$I_1 = \frac{1}{\pi}\sqrt{F_a^2 + F_b^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Now, when substituting (9), (5), (4), and (2) into (1) we obtain after a brief manipulation

$$f = \sqrt{\frac{\pi F_p}{F_a^2 + F_b^2} - \frac{1}{4}\,\frac{F_o^2}{F_a^2 + F_b^2} - 1} \quad . (10)$$

For practical application it may be mentioned that the areas F_p, F_a, and F_b can very conveniently be determined in a common diagram (Fig. 5). Drawing a unit circle, the magnitudes sin x and cos x are readily determined as projections of the radius vector. Hence the horizontal axis can be used as the y-axis for the F_a diagram (Fig. 3), while the vertical axis becomes the z-axis for the F_b diagram (Fig. 4). A complete diagram, drawn in this manner, is shown in Fig. 6.

The above method is most useful in cases where the harmonic content is high. With the standard method, it would be necessary to determine a large number of harmonic components. With the present method, only the magnitudes F_p, I_o and I_1 need be determined. In many practical applications, the d-c component I_o and the cosine component b_1 are zero, thereby reducing the number of graphical integrations to only two. For small harmonic content the method may also be used, but requires, of course, large scale diagrams, accurate drawings and careful use of the planimeter. The accuracy obtainable with this method is solely limited by the accuracy of the diagrams and the accuracy of the methods or instruments used for measuring the various areas.

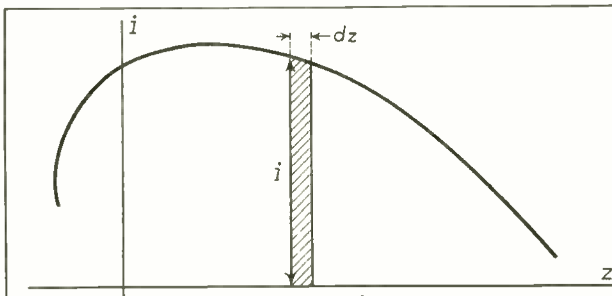


Fig. 4
- Determination of Area F_b for Fundamental Cosine Component -

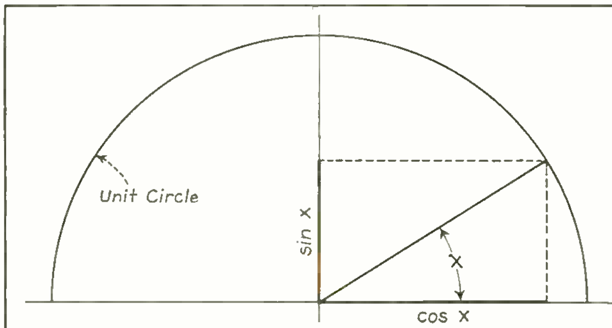
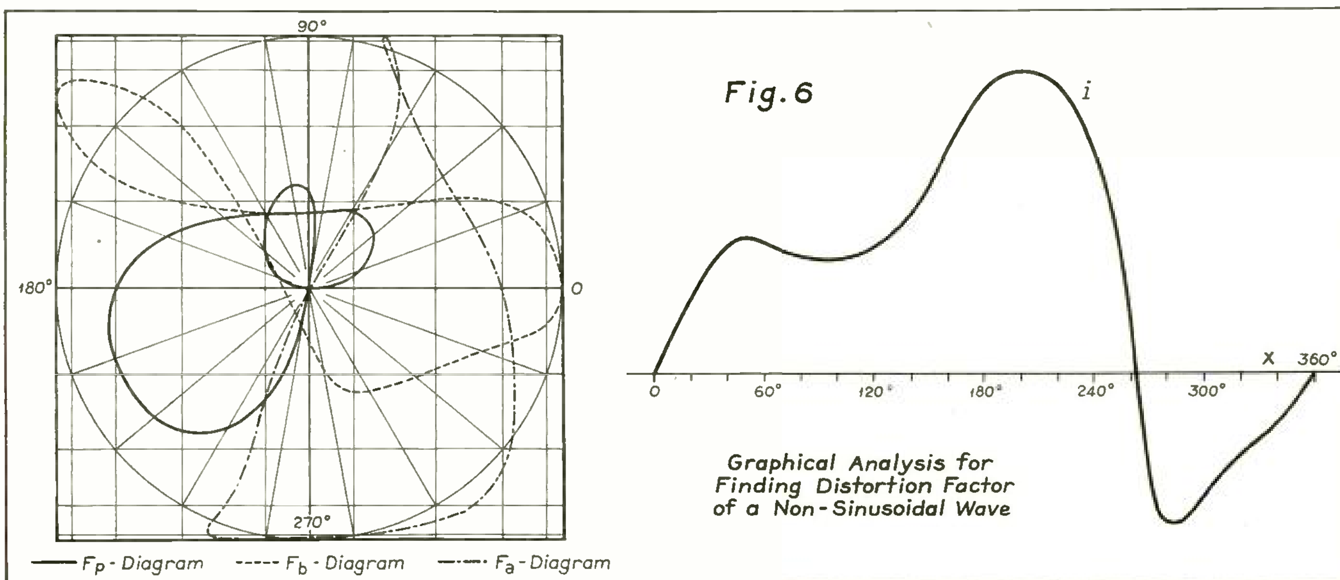


Fig. 5
Common Diagram for F_p, F_a and F_b



Graphical Analysis for Finding Distortion Factor of a Non-Sinusoidal Wave

TESTING A RECEIVER CHASSIS FOR ELECTROSTATIC EXPOSURE

by E. T. Dickey *

The author, in order to obtain data for the use at the FCC hearings last fall, made a number of unique tests on radio receivers to determine just how effective the shielding might be. The results, presented below, are sure to be of great interest to the radio engineer.

THERE ARE THREE principal paths by means of which signals and interfering electric impulses may enter a radio receiver chassis. These are: through the antenna-ground terminals; through the power supply cord (in power-operated receivers); and by direct pickup on unshielded parts of the circuit or tubes. Of these, the first is the one on which the most work has been done and quite complete data is available on receivers tested by this means of signal introduction. On the second means there is not very much quantitative data available, but inspection of the circuits of the receivers of various manufacturers shows that the majority of receivers are now supplied with some means for preventing the entrance of signals over the power cord. The conventional methods involve usually an r-f by-pass capacitor between one or both sides of the power line and ground, or the use of an electrostatic shield between primary and secondary of the power transformer.

Referring now to the entrance of signals by direct exposure of unshielded parts, we find little quantitative data on the degree of seriousness of this mode of pickup. The majority of receivers now on the market use shielding chiefly to prevent circuit instability and it appears that only in a minor number of cases, and then usually in the expensive models only, has much thought been given to shielding for preventing direct pickup by circuit parts. In connection with the collection of data for the FCC hearing last fall, and also the work of the Joint Coordination Committee on Radio Reception of EEI, NEMA and RMA, some tests were made recently by the author in an attempt to evaluate the susceptibility of various types of chasses to electrostatic pickup of signals by exposure of circuit parts.

The essentials of the test set-up consisted of placing the chassis under test between two metal plates, spaced to form a condenser with air as the principal dielectric. The set-up is shown in Fig. 1. By connecting the output terminals of a signal generator to the two plates, it was possible to create an r-f electric field between them. For the frequencies used in this test, the impedance of the capacitor composed of the two plates was large compared with the output impedance of the signal generator. The output readings of the signal generator were therefore taken as the values of the electric field between the plates.

The lower plate was of copper sheet and it was placed on the floor of the double screened cage in which these tests were made. This plate was connected to the inside shield of the cage and to the low potential terminal of the signal generator. The upper plate was of copper screen stretched on a wood frame. It was suspended approximately ½ meter above the lower plate and parallel to it. The high potential terminal of the signal generator was connected to this plate. The area of the plates was sufficiently large with respect to the chassis size, and the spacing between the edges of the plates and the cage walls was great enough so that a reasonably uniform field might be assumed to exist between the plates. An attempt was made to calculate the actual voltage appearing at the various exposed parts of the chassis, but the variations in height of the different parts, together with the lack of information regarding the amount of the total pickup which was contributed by each exposed part, made it practically impossible to arrive at an accurate value. If it is desired to get a rough idea of the electric

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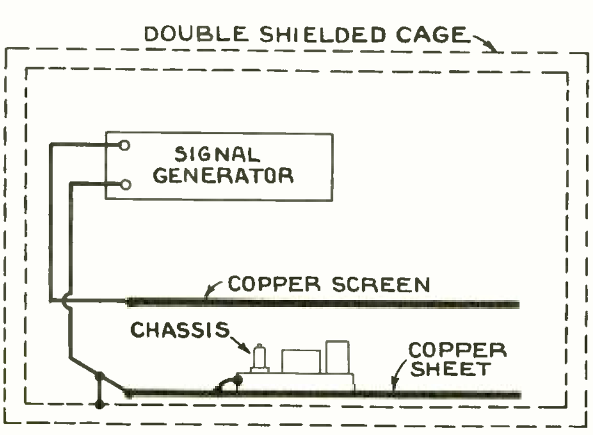


Fig. 1

field intensity to which the chassis was exposed, it might be taken very approximately as equal to the recorded value of voltage per meter, since the spacing between the plates was roughly one-half meter and the chassis exposed parts were of the order of half way between the plates.

In making this test the chassis was tuned to resonance with the signal generator which was modulated 30 percent with 400 cycles. The voltage impressed across the plates was increased until "normal output" was obtained from the chassis. The voltage across the plates was then recorded. The antenna and ground terminals were short circuited to minimize pickup from this point. The volume and other controls were set as in a standard sensitivity measurement. Tests were made at 600, 1,000 and 1,500 kc, and with each chassis in both the normal and inverted positions. In both positions the chassis was connected to the lower plate and in the normal position the chassis rested on that plate. In the inverted position, the lowest point of the chassis was allowed to touch the bottom plate unless the point in question was not a ground potential part of the chassis.

Two low-priced 5-tube chasses and two moderately-priced 9-tube chasses were used in this test. These were chosen from a large number of available chasses since they represented constructions which were rather typical of other chasses. The two 9-tube chasses differed from each other chiefly in the fact that in one (designated 9-1) no special shielding precautions had been taken to prevent signal pickup by exposure of parts, while in the other (9-2) the manufacturer had gone to

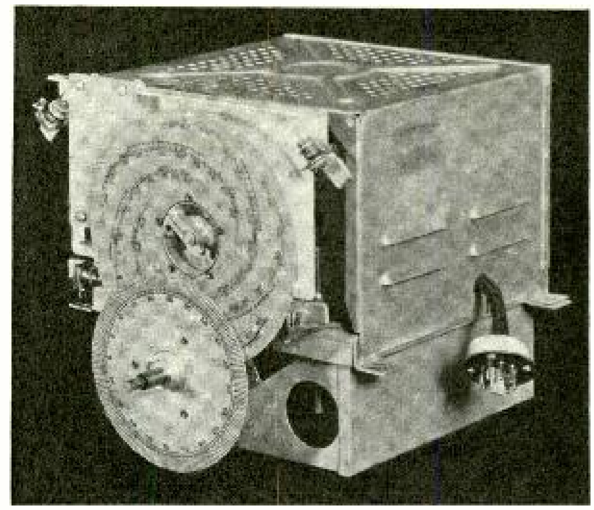


FIG. 3.

considerable trouble to shield both the top and bottom of the r-f portion of the chassis.

The results obtained are shown in the curves of Fig. 2. The chasses are designated 5-1, 5-2, 9-1 and 9-2—the 5 and 9 indicating the number of tubes in each of the notations "Top" and "Bot" indicating whether the chassis was right side up or inverted, respectively. It will be noted that one of the 5-tube chasses had considerably more susceptibility to electrostatic pickup than the other. The 9-1 chassis had greater susceptibility than either of the 5-tube chassis, but this is explained chiefly on the basis of its greater sensitivity. The 9-2 chassis on the other hand, in spite of its high sensitivity, had the least susceptibility due to its well-shielded design. This chassis was so perfectly shielded on the bottom that it was impossible to make a measurement on it in the inverted position, the required voltage being beyond the maximum limit of the signal generator (2 volts). In this connection, it should be pointed out that the test described here, using an electric field, does not give information on the possible magnetic field pickup by r-f coils. Since these coils are frequently placed underneath the chassis, the bottom shield is more important in preventing this pickup than the top shield.

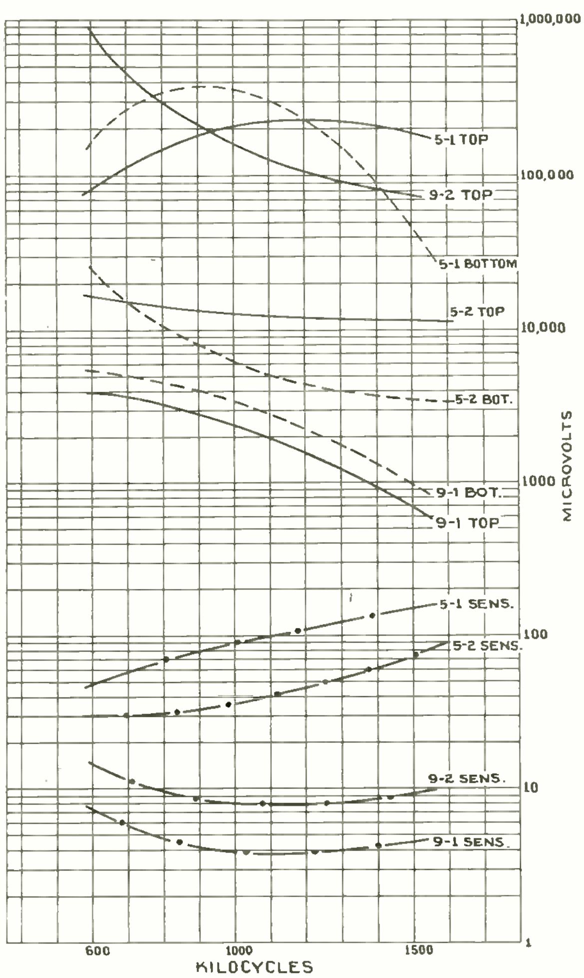


FIG. 2.

From the comparison of the 9-1 chassis and the 5-tube chasses given above it is evident that in comparing the merit of the shielding of several chasses we must take into consideration the sensitivity of the chasses as well as their susceptibility. In any series of susceptibility tests taken under the same conditions, a useful idea of the relative shielding merit of each chassis can be obtained by dividing the susceptibility field voltage by the sensitivity figure for each one. For this purpose the sensitivity curves are given as dot and dash curves at the bottom of Fig. 2 for each chassis under test. Taking an average value of each sensitivity curve and of each chassis susceptibility curve we get the following:

Chassis	5-1	5-2	9-1	9-2
Avg. susceptibility	150,000	7,000	2,000	300,000 (Top)
Avg. sensitivity	90	50	4.5	9
Relative shielding effectiveness	1,700	140	450	33,000

The values for relative shielding effectiveness have been calculated only to two significant figures. Referring to the above table we get a more useful picture of the relative susceptibilities of these chasses. The reason for the good performance of chassis 9-2 is evident when we

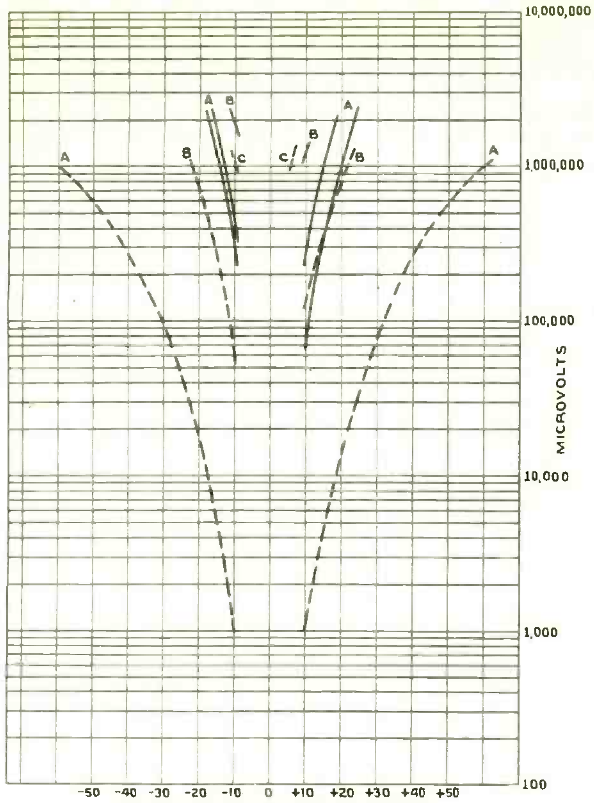


FIG. 4.

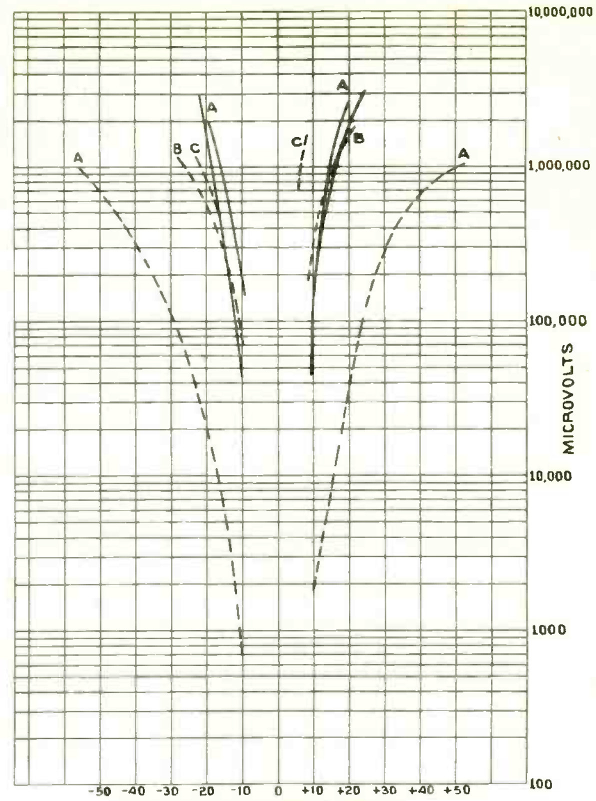


FIG. 5.

examine the shielding of its r-f unit which is shown in Fig. 3. By the extra top and bottom shields in addition to the tube, coil and other conventional shielding, this chassis is given a susceptibility figure approximately 70 times as good as the 9-1, which was essentially the same chassis without the added top and bottom shields.

While working with this test set-up it was decided to make one further test on these chasses to determine whether the pickup of signals through exposure of circuit parts would increase the cross modulation characteristic of the chassis. To make this test, a second signal generator was connected through a shielded lead and shielded dummy antenna circuit to the antenna and ground terminals of the chassis under test. The second generator then became the "desired signal" source while the generator connected to the two plates became the "undesired signal" source. The chassis was tuned to resonance with the "desired signal" at 1,000 kc. and the general procedure outlined for the two signal crosstalk interference tests in the 1933 Report of the Standards Committee of the IRE was followed. The two chasses which had the greatest susceptibility according to the previous test, were tried in this test (5-2 and 9-1). Fig 4 shows the results of the test on chassis 5-2 and Fig. 5 that on chassis 9-1. In both of these figures the results of the present test are shown as solid lines, while in dashed lines are shown the curves obtained by a two-signal crosstalk test taken in the more conventional fashion with the inputs of both signal generators connected to the antenna and ground terminals through appropriate dummy antenna circuits. The letters "A", "B" and "C" designate curves taken with the receiver input from the "desired signal" generator equal respectively to the three IRE Standard Input Voltages of 50, 5,000 and 200,000 microvolts. The two sets of solid "A" curves in Figs. 4 and 5 were obtained with the normal and inverted positions of the chassis and since they were in all cases so nearly equal, no attempt was made to differentiate between them.

It will be noted that the curves obtained by the electrostatic test in Figs. 4 and 5 were always at a much higher field strength than the value of antenna voltage of the equivalent curve taken by introducing the "undesired signal" in the antenna circuit. It, therefore, appears that in a given location, the amount of interfering signal impressed on the input terminals of the chassis due to antenna pickup will be far more important in producing cross modulation than the interfering signal picked up by exposed parts of the chassis.

As a result of these tests we may conclude that except in cases where an extremely small or very inefficient antenna is used, the electrostatic pickup of chassis parts may be disregarded as a means whereby interfering signals to which the receiver is not tuned might enter the chassis. In the case of signals to which the receiver is tuned, however, the first part of the paper showed that in poorly shielded chasses, a considerable amount of pickup might be expected from the exposed parts. This need not concern us if we were always dealing with station signals only. In most locations, however, we have the local "man-made static" level to consider and since this type of interfering impulse covers a wide band of frequencies, we may say that we are tuned to some component of it most of the time. For this reason, inadequate shielding may contribute seriously to the amount of local electrical noise and static picked up by the receiver.

While the tests described here were made only in the broadcast range, there is reason to believe that a chassis found to be poorly shielded in that range will be at an even greater disadvantage in the short wave bands.

In closing the author wishes to acknowledge the work of Messrs. A. A. Joyner and C. E. Torsch who assisted in making the tests outlined here.

THE MEASUREMENT OF INTERELECTRODE CAPACITIES

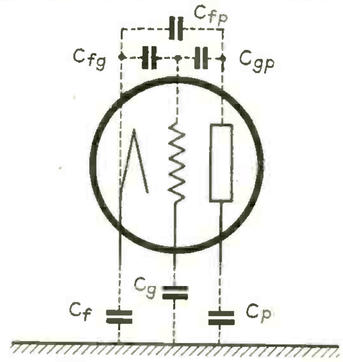
by P. A. Ekstrand

THE INTERELECTRODE CAPACITIES between two electrodes in a vacuum tube can be measured with a capacity bridge by connecting the electrodes to be measured to the unknown arms of the bridge, and bringing the other electrodes to the grounded junction of the ratio arms. However, it may happen that a capacity bridge for the measurement of low capacity is not available. This article describes a substitution method for the measurement of capacity. The only special equipment needed is a calibrated standard variable air condenser. The equations are developed first, and then applied to the actual measurement of interelectrode capacity.

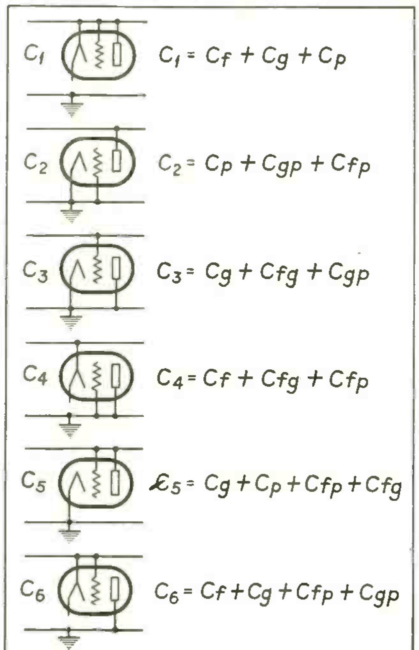
A three-electrode vacuum tube has capacity between electrodes and also capacity from each electrode to ground. In Fig. 1 the capacity of each electrode to the other two electrodes is shown, as well as the capacity of the electrode to ground. Thus the plate has capacity from plate to filament, C_{fp}, and from plate to grid, C_{gp}, as well as capacity to ground, C_p. The capacity between electrodes is designated by the two-letter subscripts while the capacity to ground is given by the single-letter subscript. The capacities usually measured are C_{fg}, C_{fp}, and C_{gp}. The capacities to ground are not fixed, but vary with the location in which the tube is used.

As shown in Fig. 1, there are six capacities, and to obtain these capacities six readings must be made. The combinations to be measured are shown in Fig. 2, where the capacities to be measured are C_1, C_2, . . . C_6, all capacities being measured to ground. For C_1 the total capacity of the three electrodes to ground is measured, giving $C_1 = C_f + C_g + C_p$. For C_2, the filament and grid are grounded, so the capacity at the plate is the plate-to-ground capacity plus the plate-to-grid capacity plus the plate-to-filament capacity. In a similar manner the other equations are written down as given in Fig. 2.

These six equations may now be solved simultaneously for the six desired capacities, giving the following:



Capacities of the Electrodes of a Three-Element Vacuum Tube
Fig. 1



Capacities Measured to Obtain Inter-electrode Capacities
Fig. 2

$$C_{gf} = \frac{C_4 + C_3 - C_6}{2}$$

$$C_{gp} = \frac{C_2 + C_3 - C_5}{2}$$

$$C_{fp} = \frac{C_6 - C_1 - C_3 + C_5}{2}$$

$$C_f = \frac{C_4 + C_1 - C_5}{2}$$

$$C_g = \frac{C_5 - C_4 - C_2 + C_6}{2}$$

$$C_p = \frac{C_2 - C_6 + C_1}{2}$$

These equations will now be applied to the measurement of the capacity of a triode. The essential circuit for making the measurements is shown in Fig. 3. A tuned circuit with a standard calibrated air condenser C_s is made to oscillate by the negative resistance of a dynatron. Other types of oscillating circuits may be used if desired, as long as one side of the calibrated condenser C_s can be grounded. The oscillating frequency should not be too high, as then the changes in lead length will affect the total inductance too much; a frequency of around 300 kilocycles will be satisfactory. The coil should be chosen to give this frequency with the condenser used. The calibrated condenser is set to a convenient point with the capacity nearly all in, and then the unknown capacity is added at C_x. The calibrated condenser is now retuned to the original frequency, and the change in the capacity of C_s gives the added capacity C_x. Note that one side of the circuit is grounded, so that the set-up is easy to handle at radio frequencies. Also, in the derivation of the equations, the total capacity to ground was always used in C_1, C_2 . . . C_6, so the equations apply when measured by the circuit shown in Fig. 3.

To obtain good results, the condenser C_s must be accurately reset to give the same frequency in the oscillating circuit. This can be easily done by listening on an oscillating detector, or on any c-w receiver, and tuning for zero beat. The calibrated condenser can be set still more accurately by introducing an audio signal of around 500 cycles in series with the phones, and tuning so that the audio frequencies from the c-w receiver and the audio oscillator beat. One should be certain always to tune to the same side of zero beat.

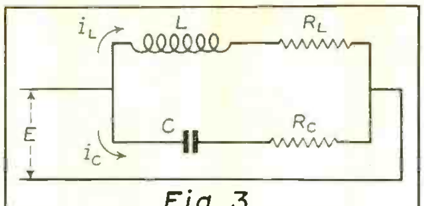


Fig. 3

When making measurements the tube is placed close to the standard calibrated condenser. For C_1 the readings are made with the electrodes connected to A on C_x of Fig. 3. The change in capacity with the electrodes connected and disconnected is the capacity wanted. For C_2 . . . C_6 the ground side should be connected to the condenser ground of C_s while a measurement is made, and the other side connected to C_x at A, recording the change of capacity of C_s when C_s is retuned so that the oscillating frequency is the same as originally. When making the measurements, all the readings should be taken with the tube in the same position so that the tube-to-ground capacity will not change.

After the capacities C_1 . . . C_6 have been measured the interelectrode capacities can be calculated by the equations given above. This method gives accurate results, depending mainly on the accuracy of the standard calibrated condenser and the care taken in making the measurements.

"COUNTER-COUPLING" †

REFERENCE HAS already been made to the fact that developments in radio tubes, and in particular in output tubes, have included an improved purity in reproduction. The immediate means for reducing the distortions in reproduction has appeared to be the introduction of high-output last-stage tubes. At the same time a circuit was evolved which has been employed in a variety of receiving sets and which may be termed that of low-frequency counter-coupling. With this circuit the distortion occurring in the low-frequency part of a receiver is reduced to a very small fraction of its initial value, while at the same time the frequency characteristics of reproduction are also favorably influenced.

If an alternating voltage V_g is applied to the grid of an output tube, an amplified alternating voltage V_a will occur at the load resistance in the plate circuit. A part, nV_a, of this output voltage can be fed back to the input circuit. If this fed-back voltage is in phase opposition to the input voltage V_i we can speak of counter-coupling (or opposed coupling). The amplification is reduced by this counter-coupling, as well as the distortion in almost the same ratio.

The circuit of a counter-coupled output tube is shown in Fig. 1; the load is not inserted directly in the plate circuit but is connected up through an ideal transformer with a 1:1 ratio in order to be independent of the direct voltage of the plate battery. If the amplification of the tube is m, we have $V_a = mV_g$. As, furthermore, $V_g = V_i - nV_a$ we thus get $V_a = mV_i - mnV_a$, or:

$$V_a = \frac{m}{1 + mn} V_i ,$$

so that the amplification has been reduced by a factor $(1 + mn)$ by counter-coupling. If n is made so great that $mn >> 1$ then V_a will approach the value V_i/n. Thus as the counter-coupling increases the amplification becomes progressively more independent of m, i.e., of the characteristics of the tube, so that the distortion also becomes steadily smaller owing to the non-linearity of the tube characteristics.

For a closer investigation, express the non-linearity between V_a and V_g as follows:

$$V_a = \alpha V_g + \beta V_g^2 + \gamma V_g^3 + \ldots \quad (1)$$

The alternating voltage V_g is equal to $V_{gm} \cos \omega t$, which substituted in equation (1) gives:

$$V_a = \alpha V_{gm} \cos \omega t + \beta V_{gm}^2 \cos^2 \omega t + \gamma V_{gm}^3 \cos^3 \omega t,$$

To a first approximation[1] this expression may be written as follows:

$$V_a = \tfrac{1}{2} \beta V_{gm}^2 + \alpha V_{gm} \cos\omega t + \tfrac{1}{2} \beta V_{gm}^2 \cos 2\,\omega t + \tfrac{1}{4} \gamma V_{gm}^3 \cos 3\,\omega t$$

We thus have terms containing 2ω and 3ω, i.e., distortions due to the second and third harmonics respectively.

If we denote the amplitudes of the first, second and third overtones of V_a by V_{a1}, V_{a2} and V_{a3}, we then get:

$$V_{a1} = \alpha V_{gm} ,$$

$$V_{a2} = \tfrac{1}{2} \beta V_{gm}^2$$

and $$V_{a3} = \tfrac{1}{4} \gamma V_{gm}^3$$

With counter-coupling we get for the relationship between V_i and V_g:

$$V_g = V_i - nV_a \quad (2)$$

Equations (1) and (2) together express the relationship between V_a and V_i. Let us write V_a also as a power series of V_i; to do this we must first "invert" equation (1), thus getting:

$$V_g = \frac{1}{\alpha} V_a - \frac{\beta}{\alpha^3} V_a^2 + \frac{2\beta^2 - \alpha\gamma}{\alpha^5} V_a^3 + \ldots$$

Substituting from equation (2) we find:

$$V_i = \left(\frac{1}{\alpha} + n\right) V_a - \frac{\beta}{\alpha^3} V_a^2 + \frac{2\beta^2 - \alpha\gamma}{\alpha^5} V_a^3 + \ldots$$

(Continued on page 27)

†"Philips Technical Review," September 1936.

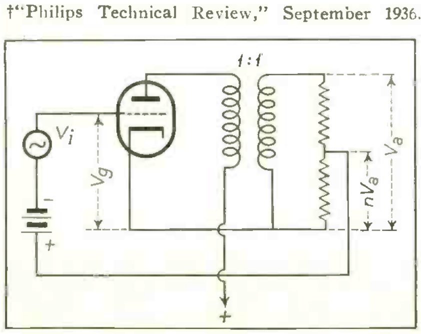


Fig. 1.

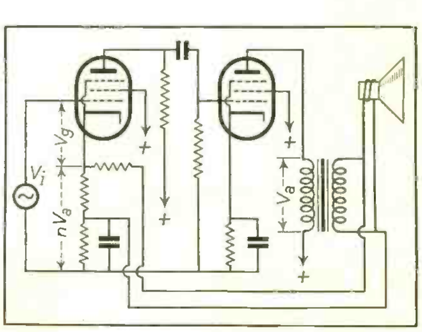


Fig. 2.

SHAKEPROOF

OFFERS A FOUR-FOLD FASTENING SERVICE

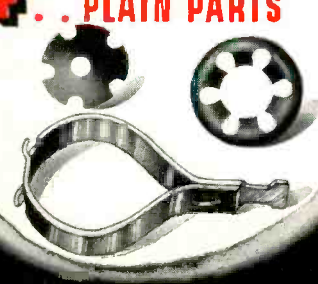
1 LOCK WASHERS
WITH *tapered-twisted* TEETH

AND LOCKING TERMINALS

2 TAPPING SCREWS
WITH STANDARD MACHINE SCREW THREADS

3 SELF-LOCKING SET SCREWS

4 SPRING WASHERS . . PLAIN PARTS



• To the metal products industries of America, the name Shakeproof represents far more than a source of supply. Rather, it has been an inspiration for better assembly methods—reduced unit costs, quickened production and improved performance of finished goods. With a background of precision manufacturing and metallurgical research, Shakeproof's engineering department is continually striving to improve Shakeproof products and develop still better metal fastening methods and materials . . . . . . If you have not taken advantage of Shakeproof's Four-Fold Fastening Service, do so now! Inquiries on specific problems are given immediate attention. Descriptive literature and test samples of any Shakeproof product will be furnished on request. Write us today!

U. S. Patent Nos.
1,862,486
1,909,476
1,909,477
1,419,564
1,782,387
1,604,122
1,963,800
Other patents
Patents Pending
Foreign Patents

SHAKEPROOF LOCK WASHER COMPANY

Distributor of Shakeproof Products Manufactured by Illinois Tool Works

2509 N. KEELER AVENUE, CHICAGO, ILLINOIS

In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

New York · Philadelphia · Detroit · Cleveland · Buffalo · Pittsburgh
Toledo · Milwaukee · St. Louis · Kansas City · Los Angeles

Slide Rule Settings for Circuit Problems.

I. OHM'S LAW

(a) $E = IR$; (b) $I = E/R$; (c) $R = E/I$

(a) Set index on scale C to R on scale D. Opposite I, on C, read E, on D.

(b) Set E, on scale C to R, on scale D. Opposite index of C, read I on scale D.

(c) Set E, on scale C, to I on scale D. Opposite index of C, read R on scale D.

II. POWER DISSIPATION

(a) $W = EI$; (b) $W = E^2/R$; (c) $W = I^2R$

(a) Set index of scale C to I, on scale D. Opposite E, on scale C, read W on scale D.

(b) Set E on scale C to R on scale A. Under 1, on scale A, read W on scale B.

(c) Set 1 to R on scale A. Over I on scale C, read W on scale A.

III. TUBE EQUATION

$$Mu = r_p G_m$$

Use same settings given under I.

IV. FREQUENCY/WAVELENGTH

Set left index of scale CI to 3 on scale D. Wavelength corresponding to any frequency, or vice versa, is found on scale D opposite the frequency on scale CI.

V. INDUCTIVE REACTANCE

$$X_L = 2\pi f L \text{ ohms}$$

Set f on scale CI to 6.28 on scale D. Opposite L, on scale C, read X_L on scale D.

VI. CAPACITIVE REACTANCE

$$X_C = \frac{1}{2\pi f C} \text{ ohms}$$

Set f, on scale C, to 159 on scale D. Opposite C, on scale CI, read X_C on scale D.

VII. LC FOR ANY FREQUENCY

$$f = \frac{1}{2\pi\sqrt{LC}} \text{ or } LC = \frac{1}{(2\pi f)^2}$$

Set f, on scale C, to 159, on scale D, Opposite the index of scale C, read LC on scale A.

VIII. VALUES OF L AND C

Set f, on scale C, to 253 on scale D. Set indicator to index of scale C. Set f, on scale C, to indicator and read LC on D, at opposite index. Opposite L, on scale CI, find C (mfd.) on scale D, and vice versa.

IX. BRIDGE EQUATION

$$R = \frac{AB}{C}$$

Set A, on scale C, to C, on scale D. Opposite B, on scale C, read R on scale D. If the ratio A/C is constant, one setting of the rule will cover several values of B.

This information was abstracted from the Aerovox Research Worker, November, 1936. Complete explanation of the solutions of these problems will be found in that issue.

LOSSES IN MICA

AND SIMPLE TEST PROCEDURE

by H. A. Snow*

IN ORDER to produce mica insulators and other mica pieces for radio use having a consistently high Q, a method of testing and selection of raw mica pieces for their losses, or Q, is essential.

Equipment for rapid testing of such materials is generally available today and has enabled a simple test setup to be made and used in producing extremely high-grade mica insulators. This setup has provided a considerable amount of valuable information regarding mica, and it is thought that some of the data obtained may be of general interest in indicating what may be expected of the ordinary run of high-grade commercial mica.

A few tables have been compiled which show the distribution of such mica pieces in respect to losses, or Q, as disclosed in the routine testing of various lots.

For this purpose, the mica has been divided into four grades, A, B, C and D, which have been arbitrarily set for convenience as follows:

Grade	Drop in Test Circuit Q	Approx. Q of Mica
A	0 to 0.3%	1000 or over
B	0.3 to 0.6%	500 to 1000
C	0.6 to 1.5%	200 to 500
D	over 1.5%	less than 200

The drop in test circuit Q is the actual quantity measured by the test setup, and the approximate Q of the mica has been calculated from the test circuit constants. The Q of the mica is not exact and is given merely as an approximate indication of how the grades have been arranged.

Incidentally, only grade A is accepted for the particular use that this mica is intended, grades B, C and D being rejected as too low in Q.

The following table shows the results of tests on about 1000 pieces of punched mica, tested just as received. The percentage of the total number of pieces falling in each grade is shown in the second column.

Measuring the losses in mica.

Grade	Percent of Total
A	77%
B	10%
C	9%
D	4%
Total	100%

This is an average run of mica, the variations in different lots encountered being shown in the following table:

Grade	Good Mica % Total	Poor Mica % Total
A	90%	63%
B	5%	18%
C	3%	14%
D	2%	5%
Total.....	100%	100%

It has been found that such tests are not sufficient in themselves to select mica suitable for the highest requirements in performance, because upon exposure to high humidities many pieces which pass such a test as shown above will be seriously lowered in Q. For this reason a humidity or "wet" test is made on all mica which must meet rigid requirements of high Q. Such tests are made by exposing the mica, after punching, to air having a humidity of about 90 percent for 24 hours, and making the loss test within 5 to 10 minutes after removal from the high-humidity atmosphere.

The following table shows the average results of such a humidity test on about 3000 pieces, from various lots:

Grade	No. of Pieces	Percent of Total
A	1987	64%
B	552	18%
C	417	14%
D	132	4%
Total......	3088	100%

It is observed that the number of mica pieces falling in the acceptable grade A is only 64 percent as compared with the average for the previous "dry" test of 77 percent.

In a particularly poor lot of mica the number of acceptable grade A pieces has been as low as 45 percent of the total.

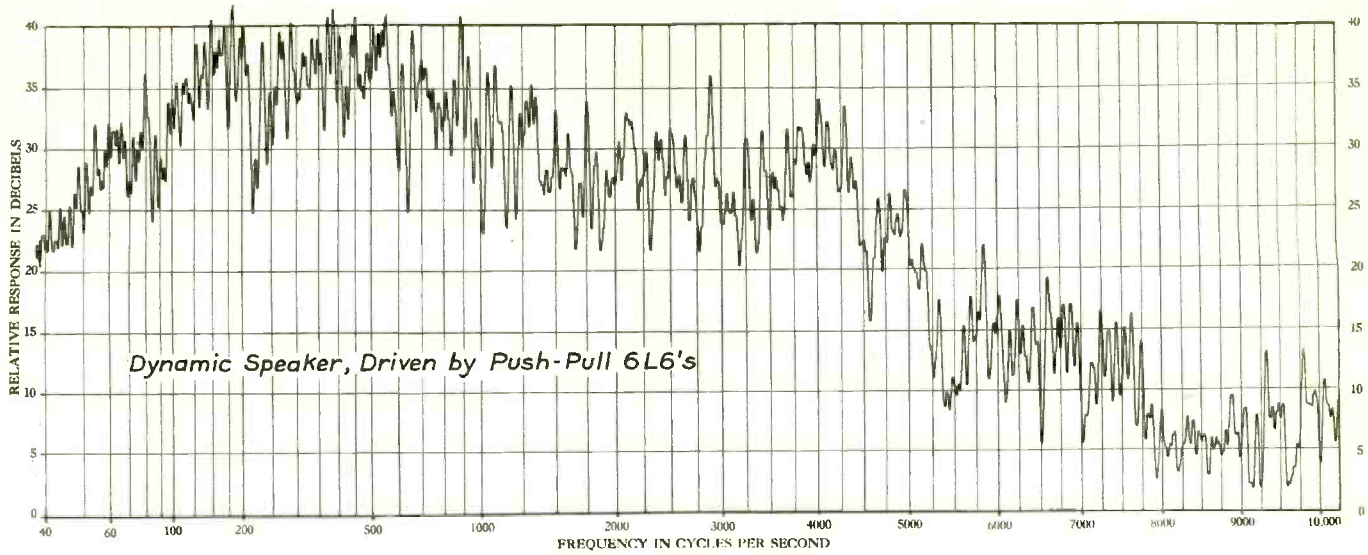
It is quite apparent from this data that when the highest Q is desired in mica, a complete loss test, or Q test, is essential to weed out the poor pieces, even in the best grade mica.

All the mica which was used in the tests described above was the best commercial grade of India condenser mica. Other grades have been used in other tests with varying results, and it is believed that the above data are representative of the best available grade.

The method of testing is apparent in the accompanying photograph. A suitable fixture is connected to the QX-Checker to hold the mica and to apply the electrostatic field through it in the same manner in which the mica is actually used. The Q circuit is resonated without the mica. Then, when the mica is placed in the fixture, the circuit is resonated and the drop in circuit Q, due to the mica, is read on the meter.

The foregoing tests were made at a frequency of 1100 kc with a total Q circuit tuning capacitance of 70 micro-microfarads. The circuit Q was approximately 220.

* Chief Engineer, Boonton Radio Corporation.



AUTOMATIC RECORDING OF AUDIO-FREQUENCY CHARACTERISTICS†

THE NEED FOR a practical means of determining under normal operating conditions the audio-frequency characteristics of microphones, loudspeakers and other apparatus used in connection with the reproduction of speech and music, has long been appreciated. Although standard test setups have been devised to provide accurate indication of audio-frequency performance, the apparatus involved is not easily adaptable to use in the average development or production laboratory and generally cannot be employed except in specially constructed rooms. Moreover, the recording method used in conjunction with most of these standard test setups is manual and, consequently, the production of a complete performance record requires so much time that the operating expense is a serious drawback to all except the largest organizations.

In order to make available to all engineers interested in audio-frequency measurements a practical instrument not subject to the limitations of existing equipment, the Audi-O-Graph has been developed. This instrument incorporates design features which render it suitable for use in any location, so that it may be employed for making tests under actual operating conditions as well as under the artificial conditions of a standard test room.

The requirements for a usable tool, whereby the sound pressure variations of response characteristics for any acoustical or electrical condition, may be secured have been determined to be:

(1) It must be wholly self-contained.

(2) It must be reasonably portable.

(3) It must cover an adequate frequency range.

(4) It must produce a permanent record.

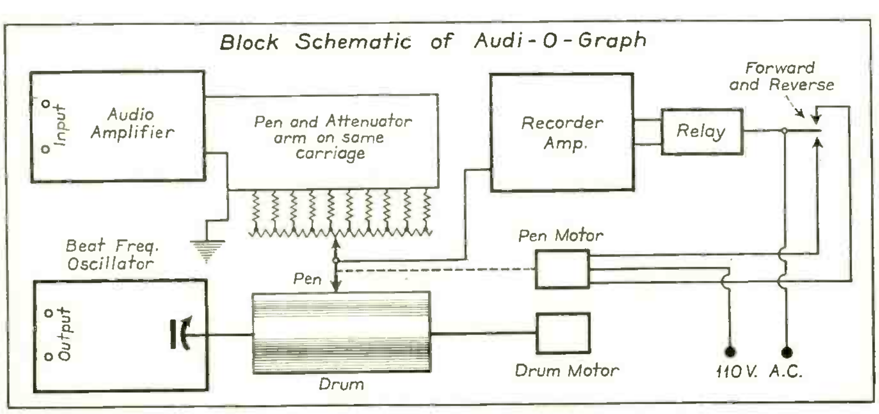
(5) It must be fully automatic.

(6) It must provide a means for rapidly checking the whole or any portion of the record.

(7) It must produce a record having maximum legibility through the frequency range in which variation of performance characteristics is to be studied.

The first requirement for audio-frequency tests is, of course, a source of audio-frequency voltage continuously variable through the frequency range in which tests are to be conducted. This audio-frequency voltage is developed by means of a beat-frequency oscillator. Since the record to be produced must relate definitely to frequency, the main

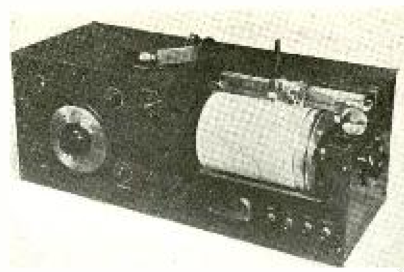
†Tobe Deutschmann Corp.



control of the beat-frequency oscillator is direct connected to the drum of the record chart holder, around the periphery of which is engraved a frequency calibration. In addition to its motor drive, the recording drum has a manual control so that the record chart may, at any time, be set back to allow immediate retracing of any portion of the curve which may appear to be subject to question. The oscillator is also provided with a separate manual control graduated through the entire frequency range. By means of this manual control, the oscillator frequency may be checked against any frequency standard. A cathode-ray type tuning indicator is incorporated in the assembly to facilitate zero-beat adjustment of the oscillator.

The audio frequency generated in the instrument is available for application to any audio-frequency system, or for modulation of a 1000-kilocycle carrier developed by an auxiliary radio-frequency oscillator incorporated in the instrument. Consequently, it is possible to measure the overall characteristics of radio receivers, as well as to check the performance of the audio section alone.

After having provided a means of developing a suitable audio-frequency voltage, it is necessary to provide a means of recording automatically the variations in sound pressure or audio-output voltage of the apparatus under test while an audio-frequency voltage, constant in amplitude but continuously variable in frequency, is impressed upon its input. In the equipment being described, a multi-cell crystal microphone is employed for receiving the variations in loudspeaker output. The reason for the use of this type of transducer is that it can be maintained under normal operating conditions with an output response characteristic which will not deviate more than one decibel from a mean response level over the operating range of the instrument.

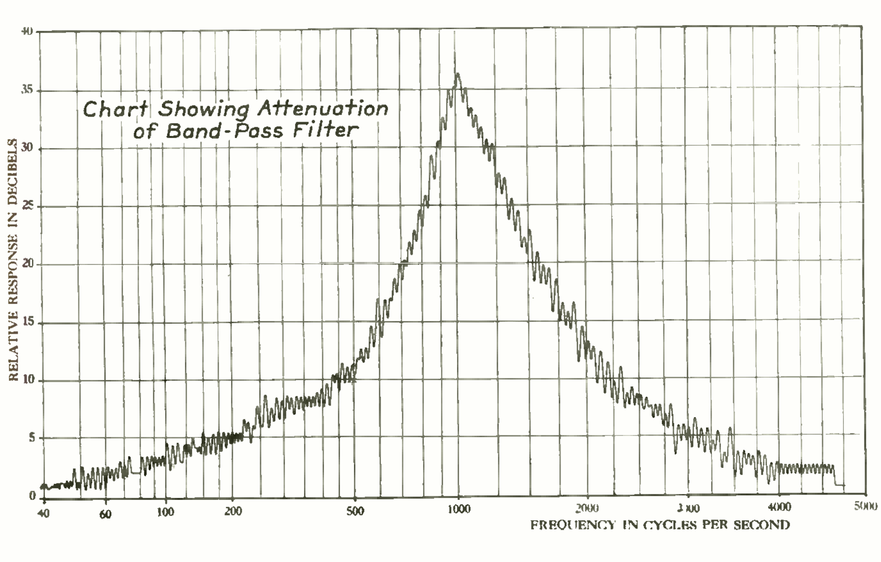


The output of the microphone is impressed upon an audio-frequency amplifier whose output circuit is connected to an electro-mechanical bridge assembly of the constant output type. The construction and connection of the bridge assembly are such that a motor-operated controller maintains a constant input balance. The attenuator is direct connected to a pen carriage holding a pen which records the amount of unbalance resulting from changes in the microphone output with variation of frequency. Since the re-balancing operation is under accurate control, it is possible to establish a logarithmic relationship between the variation in the microphone output and the recorder position so that the plotting of a linear decibel scale having any convenient range may be accomplished. The device as now constructed has a forty-decibel range comprising eighty steps of one-half decibel each. This range is sufficient for recording the most extreme variations in loudspeaker response. Throughout the range of recording, the frequency-response characteristic of the audio-frequency oscillator, microphone, amplifier, and control assembly is not allowed to deviate more than one decibel, so the calibration of the record chart may be considered sufficiently accurate for all normal calculations without correction.

By adjusting the speed of the motor which drives the recording drum, the time required for securing a complete chart may be varied between one minute and approximately ten minutes; as a rule, a recording time of two and one-half to three minutes is sufficient.

The accurate recording of complex frequency response characteristics can be quickly re-checked on the same record sheet, if desired, by employing different colors of recording ink for each operation. Loudspeaker response characteristics that have been recorded in rooms with an average amount of reverberation have shown no recorded peak deviations in excess of one decibel for five superimposed traces.

In acoustical studies, in which it is desired to determine the characteristics of audio-frequency filter systems and to check the effect of audio filters, the Audi-O-Graph has an important application. Through the use of this instrument, it is possible to secure a rapid and accurate graphic record showing the relative attenuation of band-pass filters and indicating the bandwidth, cut-off frequencies, and sharpness of cut-off.



BOOK REVIEW

HANDBOOK OF ENGINEERING FUNDAMENTALS, O. W. Eshbach, E.E., M.S., Editor-in-Chief, published by John Wiley and Sons, Inc., New York, 1081 *pages, price* $5.00.

This is the first volume in the proposed new Wiley Engineering Handbook Series. Since mathematics, physics and chemistry form the basis of all engineering, these are the fields dealt with in the new volume. This book has been designed to present a complete summary of the facts pertaining to the fundamental theory underlying engineering practice.

The first section presents a selection of mathematical and physical tables, including new and revised tables of the American Handbook Series, in which particular attention has been given to arrangement, typography and general convenience. In addition to tables on engineering constants, properties of numbers, logarithms, trigonometric and hyperbolic functions, there is included a series of tables of conversion factors for weights and measures arranged in order of dimensional sequence, tables of integrals, standard structural shapes, and physical properties of metallic and non-metallic materials.

This handbook should serve admirably to provide those portions of engineering theory that are so frequently forgotten. The same remark might well apply to those who, on occasion, must refer to some branch of engineering knowledge other than that in which their training and experience lie.

R. D. R.

FINISHES FOR RADIO APPARATUS

by Gustave Klinkenstein *

THE MANUFACTURING REQUIREMENTS of few other products are more exacting than those of the radio receiver. The receiver is made up of devices of the greatest delicacy and sensitivity, and yet it must be adapted to mass production, it must be capable of withstanding service conditions encountered almost anywhere on earth from the equator to the polar regions, and, to be commercially successful, the quality of its performance must be maintained at a high level for a long period of time. Failure of any part at any point may put the receiver out of service or seriously injure its tonal qualities, so that not only must its design be right, but all materials entering into it must be selected with the utmost care.

The modern radio receiver has, in fact, been made possible because manufacturers of radio parts and materials have cooperated closely with the radio engineer. Everything going into a successful receiver must be exactly fitted to the part it is to play, and even such details as finishes and cements have to be developed for this service through special research work and exhaustive laboratory and service tests if they are to be suitable.

The importance of this point is, however, not always appreciated by radio engineers. Because the various grades of these products look much alike, it is often assumed that there is no real difference between them. Yet if the wrong grade is used for a given purpose it may cause a breakdown after the receiver is in service or it may unnecessarily add to the cost of production.

For example, take the simple case of a finish for a fixed condenser. Here, apparently, any kind of metal lacquer or enamel can be used. But this is not true. Condensers are usually filled with hard wax and this wax is sure to get on to the surface to be finished. It can be cleaned off with a special solvent, but a perfect cleaning job is impossible except at too high a cost for the operation. Hence, the proper finish to use in this case is one that can absorb a large proportion of wax from the surface without losing its adhering properties. This requires a specially selected finish, since most lacquers and enamels will eventually flake off if applied over wax.

Again, take the case of the cements used in the manufacture of loudspeaker cones. In the first place, in order to get the best mechanical results, a specially developed grade of cement should be used for each cementing operation on each grade of stock. This may require the use of a number of different cements to take care of production requirements. Secondly, each one of the cements should be so compounded that its drying rate and other properties synchronize accurately with the "tempo" of the production process in which it is being used, in order that there may be no unnecessary delays anywhere. Obviously, an intimate knowledge of cements is required to lay out a line for each style of cone that will insure the most satisfactory product at the lowest production cost per unit.

As many radio engineers are not familiar with the variety of special radio finishes and cements that are available to them, it may be of interest to give a partial list of the product developed by one manufacturer.

Quick-Drying Lacquers and Enamels, Loudspeaker Cements

For Coils: Insulating enamel No. 32; high dielectric strength, resistant to moisture; good coverage; for machine dipping only.

Insulating enamel No. 45; gives heavier protective film, for machine or hand dipping.

Insulating enamel No. 52; thinner coating, less waterproof, for machine or hand dipping.

For Porcelain Resistors: Heat resisting enamel, adheres to porcelain, resists heat, supplied in many colors, so as to permit color identification of resistors.

For Condensers: Special cleaner thinner No. 31 for removing surplus wax.

Black condenser enamel No. 29, which adheres to greasy surfaces.

Tube Shields: Bronze liquid No. 67, for tinned shield, to be mixed with aluminum bronze powder, giving a finish resembling cadmium plating.

Plate lacquer No. 136, for aluminum shields—special heat-dissipating lacquers for shields that tend to overheat.

Loudspeaker Cones: Clear or slightly pigmented lacquers that have water-resistant properties specially developed for different kinds of paper used in making cones.

Chassis and Metal Parts: Mahogany crystal enamel No. 101, an air-drying finish that covers imperfections and produces a decorative effect in one sprayed on coat. Special decorative finishes for chassis.

Loudspeaker Cements

No. 54—quick setting, for general use with paper, leather or cardboard.

No. 15—similar in adhesive properties, but slower drying for hot-press work.

No. 28—heavier bodied, for use with heavy papers.

No. 21—special hot-press cement; dries in 10 seconds so that it can be hot pressed at 250 to 300 degrees F without bubbling and becoming porous.

No. 56—very heavy body, for cementing leather to cardboard ring supports.

No. 75—extra fast drying, specially developed to hold thin flexible lead wires on to the back of the paper cone. A small drop fastens the wire in place almost instantly.

No. 66—heavy body, for giving coils a protective coating or fastening insulating fabric to small cylindrical coils.

No. BM—for cementing bakelite or metal to other materials; high in viscosity to prevent flow after it is applied.

This list can be greatly extended but it is long enough to illustrate the large number of finishes and cements being used in radio manufacturing.

In general, it may be said a special finish or cement is needed for each kind of material, each kind of service, and each manufacturing operation. The number of possible combinations, therefore, becomes virtually infinite.

As a matter of fact, the manufacturer of finishes cannot hope to standardize his products nor indulge in mass production. He finds that practically every case is a special one requiring a special product, and that furthermore, a somewhat different product is needed with every change in manufacturing conditions and processes and every special service requirement. He is, therefore, compelled to render highly special service, and to act in an advisory capacity to the users of his product, with the object of securing the best possible results at the lowest production costs.

There was a time when every expe-

(*Continued on page 27*)

*Maas & Waldstein Co.

RMA NEWS

RMA CONVENTION JUNE 8-9

The thirteenth annual convention and Membership Meetings of the RMA will be held Tuesday and Wednesday, June 8-9, at the Stevens Hotel, Chicago. The RMA Convention will immediately precede the Radio Parts Manufacturers National Trade Show which begins June 10 at the Stevens Hotel, continuing through June 13. The RMA annual cabaret-dinner will be held Wednesday evening, June 9, in the Stevens Grand Ball Room, and the annual radio industry golf tournament is scheduled Thursday, June 10.

The RMA Convention plans were made by the Association's Board of Directors at its meeting January 13 at Chicago, with President Leslie F. Muter presiding. The Convention arrangements and details will be announced later.

SHOW EXHIBITS BY SET MANUFACTURERS OPPOSED

Exhibition of receiving sets in trade shows and public shows, by set manufacturers or distributors, is not helpful to business and is not approved, according to a show policy determined unanimously by the RMA Board of Directors at its meeting in Chicago on January 13. RMA set manufacturers are being requested to refrain from such exhibitions and also to request their distributors not to participate in such shows.

The RMA Board adopted formal resolutions following a questionnaire of set manufacturers by the Association, with unanimous sentiment in opposition to such exhibition of receiving sets. The RMA resolutions follow:

"Whereas this Board has given careful consideration to the advantages and disadvantages of exhibiting receiving sets in trade shows and public shows, and

"Whereas receiving set manufacturers of this Association were canvassed by questionnaire on such advantages and disadvantages, and

"Whereas answers to such questionnaire by receiving set manufacturers clearly manifest the opinion that the disadvantages and the expense of such exhibitions do not warrant the manufacturer of receiving sets to exhibit at such shows or to support them financially directly or indirectly and that exhibiting thereat deters rather than promotes the sale of receiving sets,

"RESOLVED, That this Board considers the exhibition by manufacturers of receiving sets as detrimental to the industry and therefore condemns the practice and strongly recommends to its receiving set manufacturers not to exhibit or to support financially, directly or indirectly, any trade or public shows;

"RESOLVED, That the manufacturers of receiving sets be requested to urge upon their distributors not to participate in such shows."

NATIONAL TRADE SHOW OPENS JUNE 10

Announcement is made, following negotiations of several months, of a Radio Parts Manufacturers National Trade Show, to be held at the Stevens Hotel, Chicago, June 10-13, and a similar show in New York, October 1-3. Joint management of the shows, for radio parts and accessory manufacturers, has been arranged with the RMA and the Sales Managers Clubs of Chicago and New York.

Formal endorsement of the shows by the RMA was given by the Association's Board of Directors at its meeting in Chicago, January 13, and it was also arranged to hold the annual RMA Membership Meetings and Convention at the Stevens Hotel on June 8-9, immediately preceding the June parts and accessory trade show. During the June show the annual convention and meetings of the Sales Managers Clubs and the Institute of Radio Service Men also will be held. Ken Hathaway of the latter is managing director of the shows.

Details of the arrangements for conducting the shows are given in the following announcement:

"The Radio Parts Manufacturers National Trade Show has been incorporated as a corporation, not for profit, to sponsor, promote, and conduct national exhibitions of (1) replacement parts, test and laboratory equipment for the service man; (2) public-address equipment; and (3) amateur and short-wave equipment. The formation of the above-mentioned corporation was agreed upon at a meeting of representatives of the Sales Managers Clubs and the Parts Division of RMA at a meeting held in Chicago on November 16, 1936; and the first meeting of the Board of Directors of the Corporation was held in New York City, December 16, 1936.

"The Show Corporation is the result of more than six months of negotiation, during which time the leaders of the industry were endeavoring to effect an arrangement that would be all-inclusive as to representation and scope. The By-Laws, as adopted at the December 16 meeting, require that two of the members of the Board of Directors shall represent companies that are members of RMA and two shall represent companies that are members of the Sales Managers Club. The Directors hold office for one year and are elected at the annual meeting of the member-exhibitors held during the Chicago National Trade Show.

"The Board of Directors as now constituted consists of A. A. Berard, Arthur Moss, S. N. Shure, and Fred D. Williams. Messrs. Moss and Williams represent RMA; Berard and Shure represent the Sales Managers Clubs.

"The officers are Mr. Shure, president; Mr. Berard, vice-president, and Mr. Moss, secretary-treasurer.

"Managing Director of the shows conducted by the Show Corporation will be Ken Hathaway of Chicago.

"The Chicago National Show will be held at the Stevens Hotel, June 10-13, inclusive, and the New York Show will be held October 1-3, inclusive. The hotel site for the New York show has not been selected definitely.

"These shows have the full endorsement of the Sales Managers Clubs, as well as Radio Manufacturers Association.

"The Institute of Radio Service Men, 'The Representatives,' and the Sales Managers Clubs, have arranged to hold their annual convention or meeting during the 1937 National Trade Show at the Stevens Hotel.

"Ken Hathaway, Managing Director of the Shows conducted by Radio Parts Manufacturers National Trade Show, in a letter dated January 18, states that applications for forty-eight booths at the Chicago Show have been received since the announcement was sent to the trade on January 7.

"Out of the thirty-nine manufacturers who have contracted for space, nine of them have taken two booths, the maximum number of booths a single exhibitor may occupy. Assignment of booth numbers has already begun."

OCTOBER LABOR INDICES

Wage developments in the radio manufacturing industry and tapering off of seasonal employment are indicated in the last report, for October, 1936, of the U. S. Bureau of Labor Statistics. The Federal Bureau has also revised its indexes of employment, adjusting them to the Federal census of manufactures totals for 1933.

Radio factory employment last October increased only .9 percent over September, according to the current October federal report, and October employment was 5.4 percent less than that during October, 1935. The October radio employment index figure, based on the new index of the 1933 census was 218.3. The October index figure, based on the former index of the official three-year average of 1923-25, was 264.2 compared with the similar September index figure of 261.7.

An interesting wage development was the official report of an increase last October of 10.5 percent in radio factory payrolls over the previous month of September, 1936. The October payrolls, however, were only .2 over those of October, 1935. The October payroll index figure, based on the new 1933 census index, was 177.9. Based on the former three-year average of 1923-25, the October payroll index figure was 186.0, compared with a similar September payroll figure of 168.3.

Average weekly earnings during October of radio factory employees were reported at $21.55, an increase of 9.5 per cent over September, 1936, and 5.8 percent over weekly earnings during October, 1935. The October national average of all manufacturing industries was $23.46, while the national average of all durable goods manufacturing establishments was $26.45.

Average hours worked per week in radio factories last October was 40.1 hours, an increase of 5.5 percent over average hours during September, 1936, but a decrease of 1.4 percent compared with October, 1935. The national average work hours of all manufacturing industries during October was 40.5 hours, while the national average of non-durable goods manufacturers was 42.4 hours.

Average hourly earnings last October of

radio factory employees were 54.0 cents, an increase of 4.0 percent over average hourly earnings in September, 1936, and an increase of 7.7 percent over average hourly earnings in October, 1935. The national average hourly earnings of all manufacturing industries was 57.3 cents and that of non-durable goods manufacturers was 61.8 cents.

It should be noted that average weekly earnings are computed by the Bureau of Labor Statistics from figures furnished by all reporting establishments. Average hours and average hourly earnings are computed from data supplied by a smaller number of establishments, as all reporting firms do not furnish man-hours statistics. The number of radio factories reporting and contributing to the federal statistics is not given.

Compared with the wage reports in the radio manufacturing industry, similar reports of the automobile industry are interesting. The October federal report stated that average weekly earnings in automoble manufacture were $30.40; that average hours worked per week in the automobile industry were the same as in radio manufacturing, 40.1 hours. Average hourly earnings during October in the automobile industry were 76 cents.

EXCISE TAXES PROBABLY REMAIN

Any possibility for repeal or reduction of federal excise taxes, including the 5 percent radio tax, was virtually closed by President Roosevelt in his budget message to Congress on January 8 recommending continuance of all of the special excise or so-called "nuisance" taxes. Congress is expected to follow the President's recommendations and adopt a general resolution to continue all excise taxes at their present rates, including the 5 percent radio tax.

Action by Congress to continue the excise taxes is scheduled after returns from the March 15 revenue collections are received. In the President's budget message it was estimated that the radio tax next year should yield $7,570,000 in revenue, far beyond any past returns from this tax. Treasury estimates of future radio and other excise revenue were based on improved business prospects.

It has not been determined whether, in extending the excise taxes, the Congressional committees will hold any hearings. The RMA has been assembling data on many reasons for repeal of the radio tax and is prepared for any possible action looking to its repeal or reduction.

EXPORTS BREAK ALL RECORDS

All monthly records for radio exports were broken last October with a total exportation of $3,246,129, according to the October report of the U. S. Bureau of Foreign and Domestic Commerce, which showed an increase of 19.6 percent over exports of $2,714,113 in October, 1935. The exports of receiving sets and also parts and accessories was the largest in any month on record. The previous record in radio exports was established in November, 1935, with a total of $2,892,778, but the radio exports last November were slightly under this previous peak, totaling $2,587,819.

October Report

Receiving set exports last October numbered 74,905 with a dollar value of $1,987,503, compared with 63,552 sets valued at $1,659,892 in October, 1935.

Tube exports last October were 868,480 units valued at $366,888, against 667,185 units valued at $307,320 in October, 1935.

Exports of radio parts and accessories last October were $702,677 against $542,160 in October, 1935.

Loudspeakers numbering 35,875 valued at $69,829 were exported last October, compared with 27,751 speakers valued at $51,882 in October, 1935, and October exports of transmitting apparatus were $119,232 against $152,859 in October, 1935.

November Report

Receiving set exports last November numbered 63,299 with a dollar value of $1,605,800, compared with 74,982 sets valued at $1,959,569 in November, 1935.

November exports of tubes were 655,682 units valued at $251,595, against 614,595 units valued at $276,070 in November, 1935.

Exports of radio parts and accessories last November were $567,532, compared with $485,069 in November, 1935.

Loudspeaker exports last November were 22,637 units valued at $44,230, compared with 23,928 units valued at $50,748 in November, 1935.

Exports of transmitting apparatus last November were $118,662 against $89,636 in November, 1935.

455 KC INTERMEDIATE FREQUENCY ASKED BY RMA

Assignment of the frequency of 455 kilocycles as an intermediate-frequency standard for the industry has been requested of the Federal Communications Commission by the RMA. The RMA request was made at the January 18 engineering conference of the FCC, conducted by Chief Engineer T. A. M. Craven.

A protected intermediate frequency of 455 kc is regarded as the best obtainable for radio set manufacturers. If this protected frequency is allocated by the Federal Commission, assurances have been given that it will be an established standard and utilized by the industry.

Application for the 455 kc frequency was made with the formal approval of the RMA Board of Directors, following informal conferences with the engineering staff of the Federal Communications Commission. The engineering steps were first conducted by the RMA committee on broadcast receivers and later by a special committee, headed by G. E. Gustafson of Chicago as chairman.

RMA OPPOSES OKLAHOMA TAX

Convening in 1937 of forty-three state legislatures almost immediately developed special legislation to tax radio. In Oklahoma a "luxury" tax bill was introduced proposing a 10 percent sales tax on a large number of articles, including radio, refrigerators, automobiles, musical instruments, sporting goods, cosmetics, etc., and also radio broadcasting. Opposition to the proposed levy on radio was organized immediately by RMA, for elimination of radio from the bill.

Immediate notice is received by the RMA legislative department, of which A. H. Gardner of Buffalo is chairman, of introduction in state legislatures of all bills affecting radio. In nearly every state the RMA has special legislative committees organized. An unusual number of legislatures are in session this year.

FCC REPORT OUTLINES BROADCASTING IMPROVEMENTS

General power increases in broadcasting, a fundamental recommendation made by the RMA, featured a report to the Federal Communications Commission on January 12 by its engineering department. The report, resulting from the Commission's hearings last October on broadcast allocations, was made by Chief Engineer T. A. M. Craven and Assistant Chief Engineer Andrew D. Ring, with important recommendations for great improvements in broadcasting.

Minimum power of 50 kw on clear channel stations, a specific recommendation made at the hearings by RMA, was urged in the report, together with general power increases, at the discretion of the Commission, for other stations.

Reduction in the number of clear channels from 40 to 25 also was recommended by the Commission's engineers; on superpower stations the engineers said there were social and economic factors, in addition to engineering, which should be considered.

Retention of 10 kc channel separation was recommended in the engineering report and also opening of the 1,510-1,600 kc band for regular broadcast service under three alternative plans providing from 40 to 500 additional stations as the Commission may choose.

It is inadvisable at present to specify standards of receiver selectivity, the report stated, and postponement of standards for receiver fidelity also was recommended, for further study and ascertainment if "the receiver industry is willing to adopt voluntarily some standard which all will use as a guide."

At the Commission's hearings last October, on which the official engineering report is based, the RMA recommendations for higher power in broadcasting were presented by Bond Geddes, executive vice-president-general manager of the Association, and RMA engineering recommendations and data by L. F. C. Horle.

CONSUMER PAMPHLET ON RADIO INTERFERENCE

"Good Radio Reception" is the title of a consumer booklet on radio interference being distributed by RMA, the Edison Electric Institute and the National Electrical Manufacturers Association. RMA members may secure copies at printing cost by request to Chairman Virgil M. Graham, care of Hygrade Sylvania Corporation, Emporium, Penna.

The interference booklet was prepared by the Joint Coordination Committee on Radio Reception of the three industry Associations. It deals with various types and remedies of interference, detailing antenna installation, set interference, atmospheric disturbances, house wiring, etc.

GOVERNMENT SAYS TELEVISION NOT READY

Television is not ready for the public, according to the FCC in its annual report submitted recently to President Roosevelt and Congress. Following is the official statement of the Engineering Department in the Commission's report:

"While the technique of television has progressed during the past year, it seemed generally the consensus of opinion that television is not yet ready for public service on a national scale.

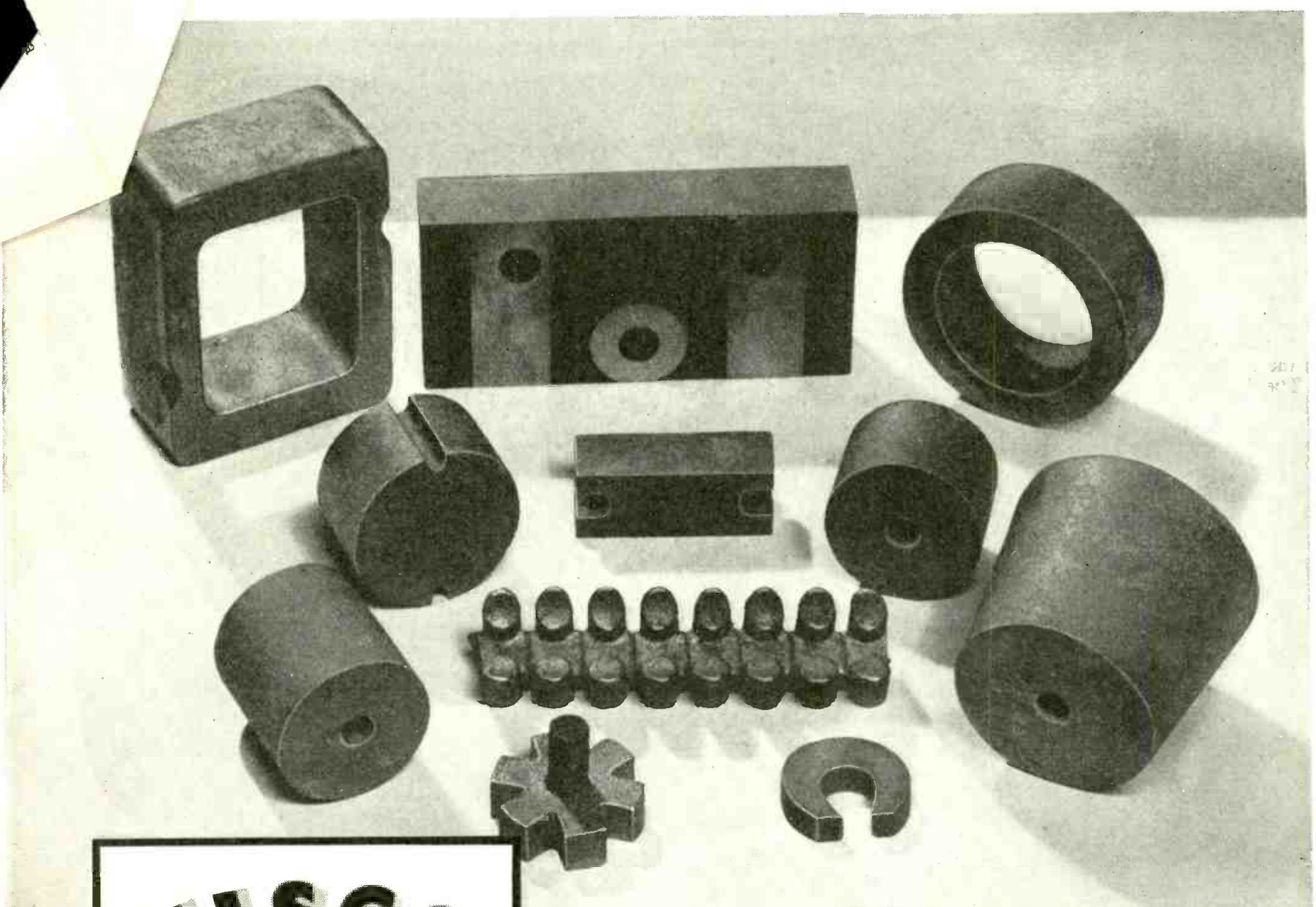
"There are numerous obstacles to be overcome and much technical development is required before television can be established on a sound national scale. Nevertheless, the rate of progress is rapid and the energies of the laboratories of the country are being concentrated on the technical development of television."

The Commission further reported rapid

(*Continued on page* 30)

permanent
MAGNETS-ALNICO

A L solid throughout...smooth surfaces... fully tested for magnetic properties



TISCO
ALNI-ALNICO PERMANENT MAGNETS

ESTABLISHED 1742

Illustrated are a few of the many permanent magnets now being produced by TISCO . . . America's oldest producer of specialty alloy products. Produced in a modern, self-contained magnet plant . . . with equipment especially designed to permit rigid control in melting, heat treating and final testing . . . TISCO magnets fully meet the rigid requirements of the electrical, radio and other fields. Quotations, as well as engineering and design assistance, available on request. Consult the TISCO office near you, or write direct . . .

TAYLOR-WHARTON IRON AND STEEL COMPANY
HIGH BRIDGE, NEW JERSEY

News Of The Industr

BENDIX FORMS NEW RADIO COMPANY

The formation of a new corporation, absorbing four radio and aviation equipment companies, was anounced recently by Vincent Bendix, head of the Bendix Aviation Corporation. The new organization will specialize in radio equipment for communications and navigational purposes for the aircraft industry, with particular attention to blind flying and safety in landing under adverse weather conditions.

The companies which have been brought together to form the new organization include the Radio Research Company, Inc., of Washington, D.C., the Radio Products Company of Dayton, Ohio, the W. P. Hilliard Company and Jenkins & Adair, both of Chicago. The new concern, largest of its kind in the world due to the widespread resources of the parent Bendix Corporation, will be staffed with more than one hundred engineers and technicians and will have plants and laboratories in Chicago, Dayton, Washington and Oakland, with field experts operating in every part of the nation.

The Bendix Radio Corporation, the new unit's name, will be headed by Mr. Bendix as president and other men who have held executive positions with the four companies which have been absorbed.

— RE —

CAPITA FORMS ECCO CORP.

Announcement has been made that Emil R. Capita has organized the Ecco High Frequency Corporation. The company's address is 120 West 20th Street, New York, N. Y. High-frequency converters, accessories for induction heating and bombarding are among the products of this organization.

— RE —

RADIO RECEPTOR MOVES

The Radio Receptor Co., Inc., manufacturers of dynamic microphones, public-address and speech-input equipment, transmitting apparatus, etc., have announced the removal of their office and factory to 251 West 19th Street, New York, as of February 1.

— RE —

JOHNSON OCCUPIES NEW PLANT

The E. F. Johnson Company, Waseca, Minnesota, manufacturers of radio transmitting parts, have completed and are now occupying a new factory and office building. The building is very modern in construction with about 8,000 square feet of space, which is approximately three times the space previously available. The additional space and new equipment which has been installed, together with increased personnel, makes possible a continued rapid increase in business. L. W. Olander, for several years employed as transmitter engineer with the RCA Manufacturing Company and previously with the Bell Telephone Laboratories, has accepted the position of chief engineer. He is engaged in the development of new transmitting equipment and improvements based upon the most modern advances in the field.

TAYLOR-WHARTON ENTERS MAGNET ALLOY FIELD

The Taylor-Wharton Iron & Steel Co., High Bridge, N. J., has started a new plant division for the exclusive, large-scale production of magnetic alloys such as Alni, Alnico, etc. Limited scale production of these materials proved that certain exclusive methods were so desirable that quantity production would be entirely feasible. New quality control methods have been devised as a result of which castings of these alloys will be available to meet rigid mechanical and electrical specifications.
RE

— RE —

NEW EDITION OF RCA TUBE MANUAL

The RC-13 Receiving Tube Manual has just been issued by RCA Radiotron Division of the RCA Manufacturing Co., Harrison, N. J. This manual, in addition to a complete listing of RCA tubes and their characteristics, has sections devoted to discussions of circuit applications, simple tube calculations, etc. A new section on the use of many of the tubes in resistance-coupled circuits, will be found to be unusually complete.

— RE —

FERRANTI BULLETIN

A circular describing this company's latest line of audio and power transformers and chokes has just been released by Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y. Copies are available from the manufacturer.

— RE —

AIR EXPRESS GROSS REVENUE UP 66½ PERCENT FOR 1936

Gross revenue from air express shipments for 1936 was 66½ per cent above the gross revenue of the old and new contract airlines for 1935, the Air Express Division of Railway Express Agency announced.

For the first quarter gross revenue was up 55 percent; for the second quarter, 77 percent; third quarter, 56 percent; fourth quarter, 76½ percent.

Shipments for the year totaled 467,120. By quarters, shipments showed a steady uptrend, as follows: first quarter, 79,963; second, 113,198; third, 118,635; fourth, 155,324.

The average weight per shipment for 1936 was 8.23 pounds; for 1935 the average was 7.67 pounds.

The average estimated length of haul (distance flown) for 1936 was 763 miles; for 1935 it was 838 miles.

— RE —

EXPORTERS' BULLETIN

Ad. Auriema, 116 Broad Street, New York, N. Y., has compiled a bulletin covering all of the products which this company handles for export. The bulletin is completely cross-indexed. Copies will be furnished to all inquirers from outside the U. S. and Canada.

LEEDS & NORTHRUP CIR

Circulars describing seve of interest to laboratories an test departments have been re the Leeds & Northrup Comp Stenton Avenue, Philadelphia, Pa.

The apparatus includes high-fr resistance boxes, limit bridges, capac and conductance bridge, shielded ratio and a quick-acting dp-dt switch that may used for reversing the connections to circuit.

Copies of these bulletins may be obtained from the manufacturer.

— RE —

MURRAY ADDRESSES FRANKLIN INSTITUTE

Public service rather than public exploitation is the motivating force impelling television engineers in their preparations for high definition commercial television in the future. This was revealed January 20 at a meeting of the Franklin Institute, Parkway at Twentieth Street, Philadelphia, by Albert F. Murray, engineer in charge of television, Philco Radio and Television Corporation.

"Firmly believing that the users of television should have the right to enjoy high definition pictures, as nearly nationwide coverage as possible, the possibility of a selection of programs, all these with the easiest possible tuning and at the lowest possible receiver cost, the Radio Manufacturers Association have formulated recommended television standards. We hope the Government will adopt these standards," Mr. Murray stated.

— RE —

1937 HAMMARLUND CATALOG

The Hammarlund Manufacturing Co., 424 West 33rd Street, New York, has just published their 1937 catalog of radio parts. The fifteen pages of the catalog are devoted to unusually complete descriptions of the products of this well-known manufacturer. The unusual layout of this catalog, a creation of Lewis Winner, makes it exceptionally convenient to use.

— RE —

INTERFERENCE ELIMINATION BOOKLET

A condensed summary of the subject of eliminating man-made interference in domestic and auto-radio installations is contained in a handy little booklet just released by Continental Carbon, Inc., of Cleveland, Ohio. Each form of interference is discussed briefly and methods of attacking it are disclosed. The booklet is of vest pocket size, 24 pages, and well illustrated.

— RE —

STANDARD TRANSFORMER APPOINTMENT

Jerome J. Kahn, president of the Standard Transformer Corporation, manufacturers of Stancor transformers, univerters and electric fans, announces the appointment of Everett E. Gramer as vice-president in charge of engineering and production.

FINISHES FOR RADIO APPARATUS

(*Continued from page 22*)

rienced production engineer and finisher knew about all that was needed about the qualities and properties of finishes and kindred products. But that time is past. Modern research has developed such a number of useful raw materials for finishes, and such a wide variety of properties can now be secured by properly utilizing these materials, that only a specialist in the subject can hope to select the most suitable product for a given application.

It is, therefore, advisable for the radio engineer to call in a finishing specialist to help him with his finishing and manufacturing problems in the early stages of the production plans for a new product. His advice and assistance will undoubtedly help to speed up production, reduce costs, and increase the serviceability of the product.

Nothing has so far been said on finishing wood or metal radio cabinets as this subject is usually outside the field of the radio engineer. However, as all those concerned with the production of radio receivers are interested in their successful marketing it can be pointed out that rapid strides have been made in ornamental finishes in recent years and the radio engineer should keep in touch with these developments through the finishing manufacturer with whom he has dealings. Special mention can be made of a modern type of finish which is especially designed for the mass production of high-grade products. One of its features is its resistance to scuffing and marring during the production process, which greatly reduces rejections and thereby increases the reliability of cabinet deliveries.

"COUNTER-COUPLING"

(*Continued from page 16*)

After "inversion" this equation becomes:

$$V_a = \frac{\alpha}{1+\alpha n} V_i + \frac{\beta}{(1+\alpha n)^3} V_i^2 + \frac{\gamma(1+\alpha n) - 2\beta^2 n}{(1+\alpha n)^5} V_i^3$$

which neglecting the small terms as usual may be written as follows:

$$V_a = \alpha \frac{V_i}{1+\alpha n} + \frac{\beta}{1+\alpha n}\left(\frac{V_i}{1+\alpha n}\right)^2 + \frac{\gamma}{1+\alpha n}\left(\frac{V_i}{1+\alpha n}\right)^3$$

We have thus obtained the nonlinear relationship between V_a and V_i with counter-coupling.

In the same way as adopted above we get for the amplitudes of the first, second and third harmonics the following expressions:

$$V_{a1} = \alpha \frac{V_{1m}}{1+\alpha n},$$

$$V_{a2} = \tfrac{1}{2} \frac{\beta}{1+\alpha n}\left(\frac{V_{1m}}{1+\alpha n}\right)^2$$

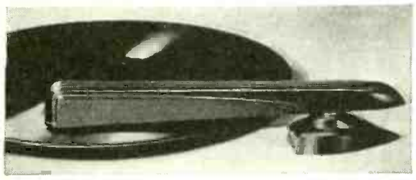
$$V_{a3} = \tfrac{1}{4} \frac{\gamma}{1+\alpha n}\left(\frac{V_{1m}}{1+\alpha n}\right)^3$$

We thus see that to obtain the same output voltage V_{a1} when introducing counter-coupling an input voltage $V_{1m} = (1+\alpha n)V_{gm}$ is required, so that the amplification is reduced $(1+\alpha n)$ times; at the same time V_{a2} and V_{a3} are reduced in the same ratio.

In the above discussion we have in every case assumed a plate resistance independent of the frequency. Actually the load is provided by a loudspeaker whose impedance varies considerably with the frequency. At the resonance point, which is usually situated between 50 and 100 cps, the impedance is a maximum. Above this point it is practically constant over a specific range, increasing again at still higher frequencies. It is evident that this variation in impedance will affect the fluctuations in loudspeaker current or the loudspeaker voltage as the frequency varies and hence also the purity of reproduction. Counter-coupling thus offers a means whereby an arbitrary choice of the frequency characteristic can be made. If for instance for all frequencies the same fraction of the voltage V_a at the load is taken as the counter-coupled voltage, which will correspond to a fixed fraction n, the voltage V_a will vary progressively less with the frequency as the counter-coupling increases; eventually $V_a = V_i/n$, i.e., quite independent of the frequency. If, on the other hand, more powerful reproduction is desirable over a specific frequency range, for instance in the higher notes, the counter-coupling can be so adjusted that it is smaller for the range in question than for other frequencies.

Fig. 2 shows a further circuit in which the counter-coupling is not applied to the grid circuit of the output tube but to the grid circuit of the preceding amplifying tube. This offers, *inter alia*, the advantage that not only is the distortion in the output tube reduced but also the distortion in the whole of the two-stage low-frequency amplifier.

NEW PRODUCTS



SHURE CRYSTAL PICKUP

The Shure "Zephyr," first of a series of crystal phono-record reproducers, has just been announced by Shure Brothers, 225 W. Huron Street, Chicago.

The "ZEPHYR" is said to be a notable example of modern design in both form and performance. Tonearm and base are attractively streamlined in black bakelite moulded. Wide-range frequency response, sufficient output to operate through the audio system of a modern radio receiver, and the new exclusive built-in "needle-tilt" method of reducing tracking error are among the important technical features.

— RE —

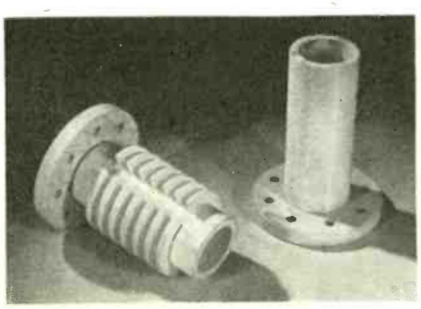
PHENOLIC RESINS

General Plastics, Inc., North Tonawanda, N. Y., announces a new line of improved thermosetting phenolic resins in both liquid and powdered forms designed for numerous industrial bonding applications. Certain types, when used with rubber and drying oils or by themselves in impregnating or bonding loose or woven asbestos, give the finished product a higher heat resistance, more strength and a uniformly stable coefficient of friction. Other resins in this series are used to improve the properties of fixed resistance units or the bonding or ground cork in the production of stronger, more flexible and more heat-resisting gasket stock. Still other forms are used for the production of laminated tubes using the dry resin process with excellent results.

— RE —

HI-Q PARTS

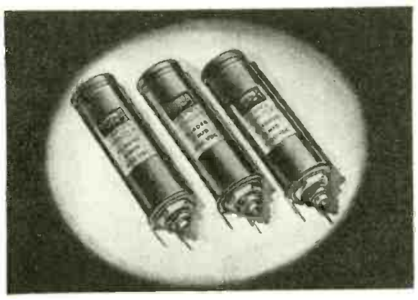
A line of Hi-Q parts for critical radio circuits and assemblies has been announced by Boonton Radio Corporation, Boonton, N. J. The line includes threaded and grooved Isolantite forms for coils and high-frequency transformers, complete inductors and aluminum shields, flat sockets, mica insulated binding posts, jacks and terminals, and other handy parts. A bulletin may be had by addressing the company.



DYKANOL CONDENSERS

The Cornell-Dubilier Corp., South Plainfield, N. J., has developed a series of condensers, known as Type TL Dykanol, for service where reduced size, weight and cost is required in conjunction with high voltage ratings and low power factor. These condensers are said to combine the favorable characteristics of the larger electrolytic units and the compactness of the can-type condenser.

Complete information will be furnished by the manufacturer.



INSTRUMENT SWITCHES

Small size, ceramic insulated instrument switches have been announced by the Shallcross Mfg. Co., Collingdale, Pa. These switches are said to exhibit extremely low leakage; they may be obtained with either brass or silver contacts, and in single or double deck style.

— RE —

BELFONE INTER-COMMUNICATING SYSTEMS

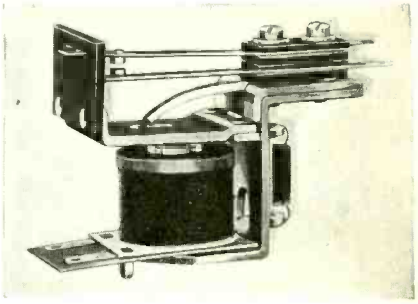
An announcement has been received from Bell Sound Systems, Inc., Columbus, Ohio, manufacturers of the Belfone intercommunicating equipment, of a new and improved system. It is said that this new equipment embodies advantages far in advance of anything that has previously been developed along the line of inter-communicating equipment. In addition to having a greater fidelity of tone, more convenience of operation, and being simpler to install, it provides for a wider range of applications.

— RE —

BRUSH MICROPHONES

The Brush Development Company has placed on the market a 3" spherical, crystal sound cell microphone. As reported by Brush engineers this microphone (AR-4S3P) has the highest output of any sound cell microphone produced. The output level is -60 db (zero reference = 1 volt per dyne per sq. cm.). This higher sensitivity characteristic makes this microphone ideal for public-address of broadcast applications where longer leads are required with a minimum loss of output.

A companion microphone (AR-2S6P) has a slightly lower output but has the advantage of still longer leads as a high-impedance microphone. Another feature of this microphone is that it can be supplied with a transformer for operation into low-impedance equipment (50 and 200 ohms).



GUARDIAN PRODUCTS

The Guardian Electric Manufacturing Co., 1621-27 West Walnut Street, Chicago, Ill., has just announced a new relay in which are said to be featured compactness and contact flexibility, permitting the use of more circuit control in less space.

This company also manufactures solenoids, step-up switches, contact switches, etc. Full details on this line of equipment may be obtained from the manufacture.

— RE —

RECTIFIER TUBE

The Continental Electric Co., of Geneva, Illinois, announce the introduction of their new mercury rectifier charger bulb, type 2-RA-6, the first of a line of commercial rectifiers to be produced by them.

The electrical characteristics of the CE-TRON 2-RA-6 are as follows:

Filament volts	2
Filament amperes	13
Output	6 amperes
Inverse peak voltage	300 volts

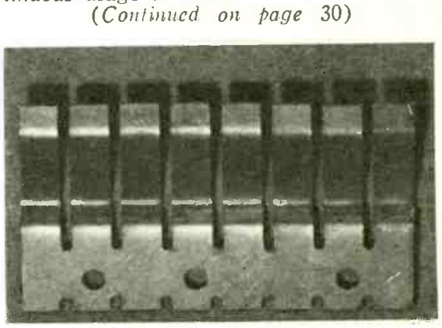
The 2-RA-6 is designed for use in battery chargers or any other device where rectified alternating current is desired.

— RE —

CINCH GROUNDING WIPER

The newly Cinch developed tempered spring steel grounding wipers are provided with rivet holes for riveting or with mild steel rivets for spot-welding. These wipers for auto set covers, having one to eight fingers, fit either curved or flat surfaces. The problem of properly constructing set covers to have complete electrical shielding, thereby eliminating extraneous disturbances, is solved by any one of the several types of wipers made by Cinch Manufacturing Corporation, 2335 W. Van Buren Street, Chicago, Illinois. The resiliency of these dependable wipers is not affected by continuous usage or abuse.

(*Continued on page* 30)

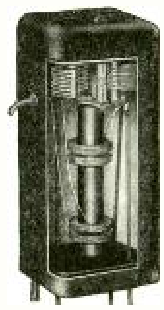


NEW PRODUCTS

(*Continued from page* 28)

MILLER I-F TRANSFORMERS

The J. W. Miller Co., Los Angeles, Cal., has announced an i-f transformer which employs air dielectric trimmer condensers. These condensers are said to be unique in that about 70 percent of the total capacity is fixed, the remaining 30 percent being variable to permit alignment. It is claimed that these trimmers exhibit a high degree of stability.



CONSTANT-IMPEDANCE OUTPUT ATTENUATOR

The need for a constant-impedence attenuator capable of handling considerable power with low insertion loss, has now been met by the Clarostat Series CIA output attenuator. This control is recommended as an output level control for power amplifiers, or as an input attenuator for individual loudspeakers in a public-address system. It is said to dissipate 25 watts of power continuously regardless of setting, and has a minimum insertion loss of 1.3 decibels. Standard input impedances available are 8, 15, 50, 200, 250 and 500 ohms. Other impedances available to order.

Made by the Clarostat Mfg. Co., Inc., Brooklyn, N. Y., the new attenuator is in the form of a compact control with perforated metal case. It measures 4" long by 3¼" diameter, and is provided with black circular metal dial plate and bar type knob. A special detent-action switch selects the 16 attenuation values, and prevents "in between" switch positions with accompanying impedance mismatches. The three screw terminals are on the rear face. The control is linear up to 45 decibels, in steps of 3 decibels, with an end position of infinite attenuation. Impedance from load end is approximately three times the line value.

A power switch is provided as an optional feature, actuated by the bar knob. The sp-st switch may be used to turn speaker field on or off.

NEW SYLVANIA TUBES

Sylvania Type 6Y7G is a complete Class B power amplifier tube having ratings and characteristics identical to those of type 79. The tube is equipped with an octal base. Type 6Y7G may also be employed as a combination voltage amplifier and phase inverter. It is applicable only to Class A output systems.

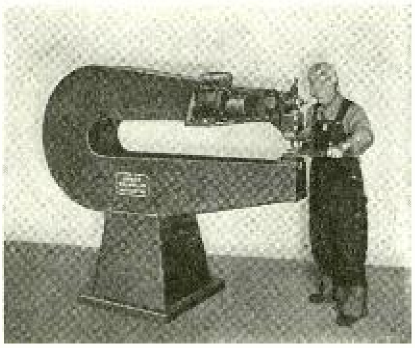
Sylvania 6A5G is a heater type power amplifier triode designed for the same service as Types 6A3 and 6B4G. The ratings and characteristics are identical to those of Type 6B4G except for the Class A power rating which is 3.75 watts for Type 6A5G. The tube is equipped with an octal base. All eight pins are present, although pin Nos. 1, 4, and 6 are not connected. This tube is quite free from hum so that no potentiometer is required for hum balance.

— RE —

TEMPERATURE-INDICATING PAINT

A new paint which changes color with increase of temperature has been marketed by The Efkalin Company, 804 East 141st Street, New York, N. Y. Intended as a protective indicator, some of these paints return to their original color on cooling; others are permanently affected.

— RE —



METAL SHEAR

A new high-speed shear for irregular shapes constructed primarily to cut 12 gauge stainless steel or alloys of similar types has just been completed and shipped by Libert Machine Company, Green Bay, Wisconsin, manufacturers of shears. This large shear designated as Model 1060, is made with an all steel frame fabricated and welded instead of the usual cast iron frame, ⅝" and ⅞" plate, to take care of all stresses and strains. It has a throat depth of 60 inches, instead of the usual 36 inches, and will maintain the same cutting speed as the standard shear, the manufacturer announces.

— RE —

METAL CABINETS

A line of black crystallized-finished steel cabinets, supplied in knock-down form for easy assembly by amateurs. experimenters and service men, has been brought out by the Insuline Corporation of America, 25 Park Place, New York, N. Y. There are seven sizes. the smallest measuring 9 inches long, 5 inches wide and 6 inches high and the largest 18 by 12 by 9 inches.

RMA NEWS

(*Continued from page* 24)

progress in development of facsimile communication and stated that the potentialities of facsimile service are of sufficient importance to require close attention to the results of experiments in application in commercial use.

CREDIT COMMITTEE MEETING

The monthly meeting of the RMA Eastern Credit Committee was held January 20 at the Hotel New Yorker, in cooperation with the National Credit Office, the official credit information agency of the RMA.

Detailed credit data under discussion at the RMA meetings may be secured by all Association members upon application to the National Credit Office of New York.

CANADIAN SALES

Canadian manufacturers during November 1936 sold 30,272 receiving sets valued at $2,734,484, compared with 29,199 sets valued at $2,849,790 in November 1935, according to reports to RMA through the cooperation of the Canadian RMA. The Canadian sales in November included 22,471 a-c sets valued at $2,195,710; 7,673 battery sets valued at $531,342, and 128 automobile sets valued at $7,432. Canadian inventories on November 30 were 45,267 sets and projected Canadian production to February 28 was 27,921 sets.

PAYNE NEW CHIEF OF ELECTRICAL DIVISION

John H. Payne, for many years an export trade executive of the Westinghouse Co., is the new chief of the Electrical Division, U. S. Bureau of Foreign and Domestic Commerce which is active in promoting electrical and radio sales. Mr. Payne succeeds the former Division chief, Andrew W. Cruse, who transferred recently to the Federal Communications Commission as assistant chief engineer of its telephone division. Department of Commerce officials consulted RMA and other organizations whose industries are served by the Electrical Division in selection of Mr. Payne to head the Electrical Division.

AWARDS FOR ARC WELDING PAPERS

To stimulate intensive study of arc welding, $200,000 will be distributed by The James F. Lincoln Arch Welding Foundation, Cleveland, O., among winners of 446 separate prizes for papers dealing with this subject as a primary process of manufacture, fabrication or construction in eleven major divisions of industry.

The principal prize winner will receive not less than $13,700. Other prizes range from $7,500 to $100—the latter sum to be awarded each of 178 contestants who receive no other prize, but whose papers are adjudged worthy of honorable mention.

In order to assure equal competitive opportunity, similar prizes are offered in the eleven major divisions of industry covered by the contest. These divisions are: Automotive, Aircraft, Railroad, Watercraft, Structural, Furniture and Fixtures, Commercial Welding, Containers, Welderies, Functional Machinery and Industrial Machinery.

INDEX TO ADVERTISERS