Radio Engineering

JUNE, 1937

VOL. XVII NO. 6

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
- Sound Recorders
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RADIO ENGINEERING

REG. U. S. PATENT OFFICE

W. W. WALTZ • Editor

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DEPARTMENTS

VOL. XVII *Member Audit Bureau of Circulations* NO. 6

COVER ILLUSTRATION

ANNEALING 1/4" ROD COILS FOR SUBSEQUENT WIRE-DRAWING OPERATIONS. THE ANNEALING SOFTENS THE ROD AND HELPS TO PREVENT SCALING DURING THE DRAWING. (Wilber B. Driver Co.)

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Editorial

THIS MONTH

ART REDUCED to mathematical equations! Therein lies the solution to radio cabinets which will overcome the objections that so many persons have, or think they have, against the appearance of a radio set in an otherwise correctly furnished room. Our lead article, the first of a series of three on Dynamic Symmetry and its application to radio design, should help the engineer in that it will remove some of the ideas that "art" means a garret in Greenwich Village, free love, and starvation. Put it so that it can be doped out on a "slip-stick" and art will immediately attract the engineer—perhaps even for reasons other than those advanced by some persons about the undraped figure of the female of the species. We intend to carry on with this subject and try to show that a radio cabinet doesn't necessarily have to be a miniature Chinese pagoda or a condensed version of a box car. It ought to be fun!

By way of explanation—last December when we ran a series of charts for band-pass r-f design, we assumed that there was enough familiarity with the subject existent to warrant a minimum of descriptive text. The mathematics of the subject had been covered in detail in earlier publications; the charts simply provided a relatively easy means of arriving at a solution.

However, our correspondence seems to indicate a different state of affairs, especially in foreign countries where perhaps the earlier discussions are not readily available. For this reason we asked an engineer to set up a problem, to be based on actual rather than assumed conditions, and carry out the solution step-by-step. We sincerely hope that this will serve to remove whatever further doubts there may be regarding the use of these charts for circuit design.

The recent convention of the IRE is reported in some detail. We also show as many of the photos that "Sandy" took as we can possibly find room for. In the event anyone who suffered under the intense glare of the Photofloods doesn't find his likeness reproduced on a later page, we can only apologize and pass the buck to our art department; he's too much concerned at the moment with fishing or gardening or some other of the things to which our suburban contemporaries succumb each summer.

In addition: more criteria for amplifier performance; what's new in tubes (but not WHY!); and something on cathode-ray tube manufacturing practice.

THERE OUGHT TO BE A LAW

THE TROUBLE is that with the things we have in mind a law might not do much good; the NRA tried it, and look where it landed!

What we are talking about are the difficulties and headaches of the parts manufacturers. It seems that these very essential members of the radio industry are being taken for what might best be described as a "ride."

It's only human nature, of course, for anyone to get what he needs for as little money as possible—or even less than that. But there's an ugly word for it these days; the word is "chiseling."

Let the set manufacturer give thought to a few points before he continues, by threats or any other means, to beat down the price of his component parts to or below the cost of manufacture.

First of all, how many receiver manufacturers are able financially to undertake to make their own parts. Machinery costs plenty; trained personnel as much or more.

Any number of parts manufacturers have a back-log, potential or actual, to which they can, and probably will, switch if present practices continue.

Patents covering a great number of the component parts belong to the parts manufacturers. And it would only be just retribution if these patents were withheld or if the set maker was compelled to "pay through the nose" for a license under these patents.

We haven't even completely brushed the dust off the surface of this source of dissension; there'll be more later. In the meantime, let it be recalled that organized baseball and the movie industry had to clean house. Radio might come to the same state of affairs. It certainly will if it doesn't take hold of itself and at least try to solve this most perplexing of its difficulties. After all, there is an answer—but where to find it and how to apply it may be something else again.

NEW DIGNITY AND BEAUTY in Large-Set Styling

WITH the growing acceptance of radio sets as one of the essential furnishings of homes, styling of many large cabinets shows a trend toward increased formality. New simplicity of line, and solid or contrasting colors, provide decorative harmony between the radio and many different styles of household furnishings.

For the design of these newer cabinets, Bakelite Molded is proving highly advantageous. Large models, as well as small, can be completely formed and finished in a single molding operation. The ready adaptability of this material also permits accurate reproduction of practically any shape or design.

In addition, the rich permanent lustre and self-contained color of Bakelite Molded provide an appearance of high quality that is fully confirmed by the practical performance of the material. Bakelite Molded is available in numerous solid colors and handsome duo-tone mottles. On leaving the mold, it requires no further coloring or surface-coating.

We invite radio manufacturers and designers to consult us regarding economies and styling benefits which might be obtained through use of Bakelite Molded in any proposed cabinet design. Also write for useful reference booklet 50M, "Bakelite Molded".

Illustrations show conservative modern cabinet of lustrous black Bakelite Molded. Measures $13\frac{5}{8}$" x $8\frac{13}{16}$" x 21". *Completely formed in one molding operation.*

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STALEMATE! The king is cornered but not captured! Here is the perfect parallel of the situation so frequently met in development work. Everyone who ever tried to improve a product, or better an operation, knows that feeling of frustration—the idea is cornered *but not captured.*

P. R. Mallory & Co. made the acquaintance of many of its present customers in the automotive, radio, electrical and other industries as a result of a "development stalemate". By putting two heads together Mallory products and Mallory engineering advice have supplied the "piece" that turned a "draw" into a "win".

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Rectifiers, condensers, volume controls, switches in all-wave radio sets—the list of industrial applications for Mallory developments is impressive. And when your radio sets need repairing, chances are they will be serviced with Mallory-Yaxley Replacement Parts.

Naturally, a business such as ours does not fall under a standard heading. Its mainspring is the experience, the ability—and above all—the will to fit neatly into your needs. As a starting point to getting better acquainted, we hope you will read the panel summarizing our facilities. We will welcome your inquiry.

The business man's encyclopedia of where to go for help.....

Metal Fabricating Problems where resistance welding may be used—See Mallory for resistance welding electrodes and advice.

Contact Problems involving the making and breaking of an electrical circuit—See Mallory for contacts and engineering assistance (Mallory has served the electrical industry for more than twenty years).

Non-Ferrous Alloy Problems where extreme hardness, high conductivity and great tensile strength are necessary—See Mallory for alloys incorporating these characteristics.

Special Bi-Metal Problems—See Mallory about bi-metals for thermostats and other requirements.

Rectification of A/C to D/C Current Problems—See Mallory for Dry Disc Rectifiers and engineering assistance.

Condenser Problems where A/C or D/C Dry Electrolytic Condensers may possibly be used—See Mallory.

Small and Special Electrical Switches—See Mallory for Selector, Circuit, Tap and All-Wave types.

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RADIO ENGINEERING

FOR JUNE, 1937

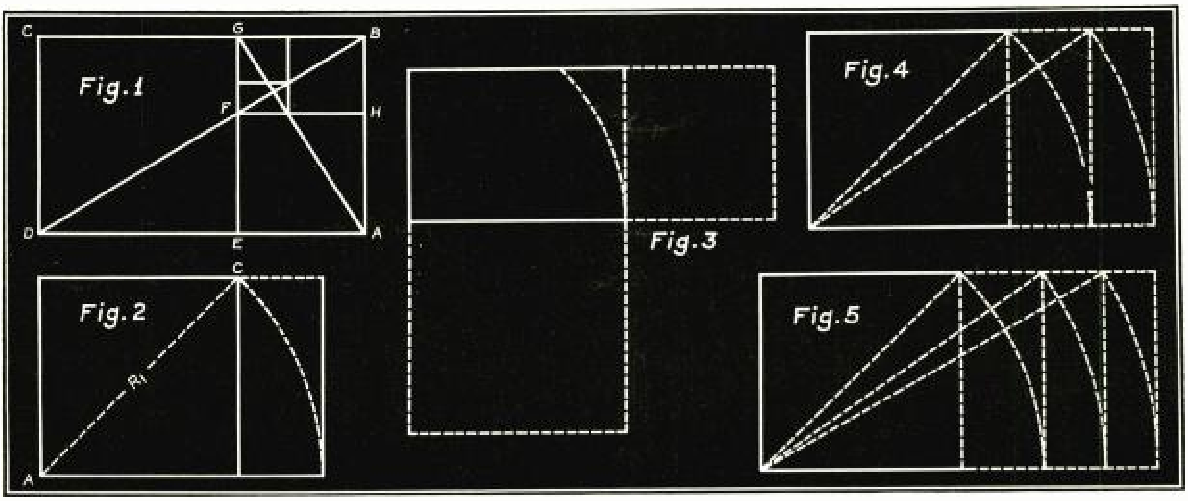
DYNAMIC SYMMETRY IN RADIO DESIGN

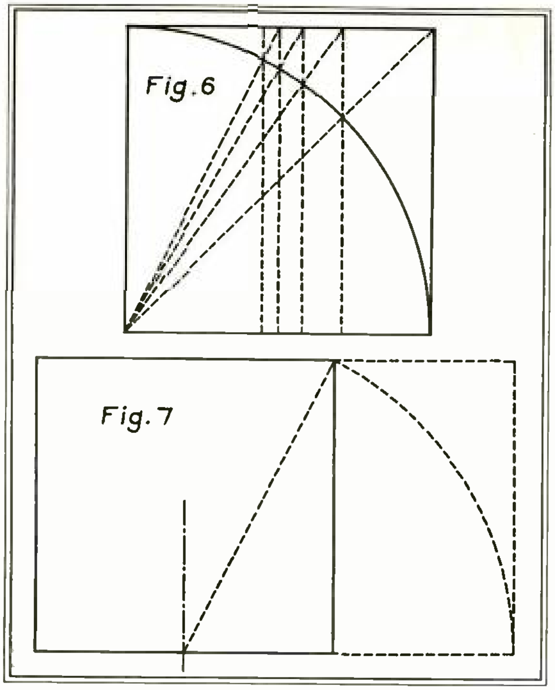
by W. C. EDDY, Lieut. U.S.N. (ret'd)

FARNSWORTH TELEVISION, INC.

JUST WHAT DOES CONSTITUTE good and bad design? How can an engineer take an intangible subject like proportion or composition and translate condensers, tubes, and transformers into a finished arrangement? The answer lies in the relatively new science of Dynamic Symmetry. Here we find nature's laws of design reduced to the common denominator of a mathematical progression. None of us can argue that in Nature we find the basis of all good art and yet few of us have ever considered that in back of this superlative in design there must be some reasoning. In other words, symmetry in nature does not exist by chance. The Greeks, as usual, had a word for it and better still a clear cut analysis of the basic principles. As a result of their understanding and applying this knowledge to their work, today Grecian architecture remains symbolic of the ultimate in design.

Before we get embroiled in the theory of Dynamic Symmetry, let us give a cursory glance at its history. Early Grecian artists were quick to realize that certain of their number possessed the "feel" and produced excellent results, while others would, now and then, come forth with a complete failure. On the strength of this intermittent output of this legendary "Guilde of Grecian Artists," some efficiency expert decided that of necessity, things would have to be brought up to a production basis. If my "extensive" knowledge of Greek History is nearly correct, he therefore hied himself into a remote corner of the Coliseum and went to work. Disregarding the details of his original research, we do know that he emerged some days later with a real solution to the problem. The results of his analysis proved beyond a doubt that good design was encompassed within definite mathematical laws and that departure beyond these boundaries spelled disaster. On the strength of this report, the boys started putting out and with every picture, they "rang the bell," producing the masterpieces that we now refer to as Grecian Art. A period of revolution and political upset obliterated this civilization and along with it, their theories and customs, but necessarily design and art continued. There were, of course, some excellent examples of architecture produced from time to time during the intervening period, but not in the quantities and variations that had marked the Grecian era. In the early part of our century, however, certain specialists





in composition again turned their attention toward uncovering these fundamentals that were known to exist. Principal among these men were Samuel Colman, Jay Hambridge and L. D. Caskey. It is from their original investigations and writings that we derive our knowledge of this new and simplified method of composition called Dynamic Symmetry. These men had succeeded in unearthing again the secrets of nature's designs and proved to their satisfaction that when these principles were applied, the composition was pleasing and that when they were disregarded, the results were negative. I use the words "nature's design" for a reason. The Royal Botanical Society of London discovered, in the early periods of research, that the intersecting spirals of seeds in a sunflower pod always maintained a mathematical relation to each other. For instance, if there were 21 seeds in the short spiral, there must of necessity be 34 in the long one. If the short spiral on the other hand contained 55 seeds, the long spiral had to have 55 plus 34 or 89. This was true for any or all sizes of sunflowers and what was more, they determined that nature had carried this progression throughout its myriad forms of animals and plant life. This, then, was the wedge that broke the problem open and brought to light the sequential theory of arrangement. If we start with unity and add in sequence, we produce a progression or summation of this order 1:2:3:5:8:13:21:34:55:89: etc. In order to illustrate, let us apply this sequence to some geometrical design as in Fig. 1.

If in a rectangle ABCD of some sequential proportions as 8 x 13, we draw a diagonal DB and erect from corner A, a perpendicular AG through this diagonal, we can construct a second rectangle EAGB whose dimensions are proportional to each other as well as to the original figure. If again in this rectangle EAGB we repeat the processes, we produce a third rectangle, again sequential both to itself and the preceding two. This procedure can be duplicated as many times as necessary, the dimensions of the resulting figure always bearing a summative relationship to its predecessor. In Fig. 1, we have shown this progression carried to four rectangles. Translating this into radio terminology, we have created a pure tone or fundamental shape in our original figure and from that have created harmonics of mass sequentially proportional in all respects to this fundamental.

Dynamic Symmetry is a science of design based on these principles of good proportion. It treats of space and areas in sequential proportion to each other and by reason of the fact that this progression in Nature represents life and movement, so in designs created under these laws, we find life and implied motion. To use a time honored phrase, a well proportioned composition is "interesting." In other words, by reason of the elements of conformation that went to make up that particular lay-out, the design as a whole attracts the eye. As the interesting features are multiplied, this emphasis increases until we find that it is both possible and practical to draw attention to any detail by judicious use of the principles of Dynamic Symmetry.

Before we can attempt a plausible explanation of the emphasis granted one design over that of another, we must first derive a method of producing pleasing dynamic shapes in which to create our picture interest. In Dynamic Symmetry, these shapes are known as Root Figures and are geometrical frames of pleasing proportions.

The first and simplest form is Root One, the square. If we were to multiply one side of a unit square by the other the result would still be unity. If as in Fig. 2, we construct a diagonal AC and drop this length as a radius, we determine the length of one side of a Root 2 rectangle. This length, by simple arithmetic is $\sqrt{2}$ or 1.4142 longer than the other side, remaining incommensurable to the shorter side in length.

But Dynamic Symmetry treats of area, not of line. If we lay out a Root 2 rectangle as in Fig 3, and on adjacent sides construct squares, we find that these areas represented are commensurate in area if not in line, the smaller square being the reciprocal of the larger.

A Root 3 rectangle is constructed as in Fig. 4 and the relations pointed out in the preceding paragraphs hold

(*Continued on page* 29)

RETARDING UNDESIRED EMISSION IN VACUUM TUBES

by Bernard H. Porter

ELECTRONIC RADIATION from heated filaments in the presence of supplementary electrodes has been the basic principle giving rise to the vacuum tube now used in a multiplicity of applications as detector, amplifier, oscillator, and modulator. The evolution in the design of the thermionic tube, obviously, has brought with it certain delicate and troublesome problems, among which are those connected with emissivity.

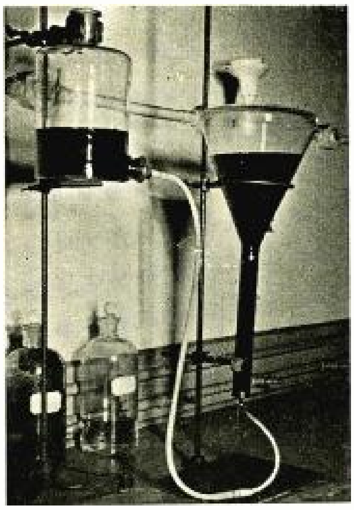
If the grid electrode in a valve is made positive, a small portion of the electrons are deviated from the plate circuit and flow back to the filament through the grid circuit. The electrons that reach the grid, however, are capable of knocking out other electrons from the wires of which the grid is composed. These "secondary" electrons find their way to the more positively charged plate.

In vacuum tubes employed in receiving sets this phenomenon does not usually occur as the grid is generally on a negative bias. In oscillators, though, where a positive potential may be employed, secondary emission can result from electron impact on the grid. Moreover, secondary emission can also take place from the positively charged plate in the manner in which secondary electrons or delta rays are emitted by the anti-cathode of an X-ray tube due to the bombardment of the cathode rays.

The secondary electrons that are knocked out of the grid and plate material by the primary electrons are not confined to the metal itself. In electron devices utilizing oxide-coated cathodes there is a tendency for the alkaline-earth oxides of metal comprising the cathode film to sputter or to evaporate and be deposited upon both the grid and the anode. When considerable power output is employed with such types it is found that both electrodes become sufficiently hot to enable the sputtered particle deposits to become of themselves emitters of electrons. The radiation of electrons from electrodes carrying impurities and which is called "back emission" is present along with the secondary form described above.

The velocity acquired by the electrons in a material due to temperature, the bombardment of grid surfaces by high-speed electrons from without, and the effect of intense potential gradients at the surfaces, are not the only causes for electrons being forced from materials. Electrons may also be dislodged by the application of an electro-magnetic rediation as, for example, light, which imparts to the electrons within the atoms of a metal a vibratory motion of sufficient energy to overcome surface forces and escape into surrounding space. By this photo-electric phenomena, so-called, light from the tube filaments may produce a thermionic emission when the negatively-charged grid cannot receive electrons directly from the filament. X-rays produced in the valve, due to the impact of electrons at the anode, may also cause this effect.

Just as electron emission and the photoelectric effect are increased if an active material such as alkali or alkaline metal is placed upon the hot surface of the tube elements, so are they decreased if a less active material is employed or the temperature lowered. It is, then, with this effect in mind, that the metal in question is often coated with a substance having a high black-body constant.



(Courtesy RCA Mfg. Co., Inc.)

Apparatus for coating the interior walls of a nine inch cathode-ray tube according to the methods of the Zworykin-Batchelor patent No. 1988468.

Hydrocarbon method:[1] Prior to the forming of plate material and grid wires, the metal surfaces are cleansed, oxidized, and then heated to some 900 degrees Centigrade in acetylene gas.[2] A catalytic action of the oxide and metal particles is set up by the reducing effect of the heated gas to decompose the latter and cause deposition of carbon. Frequently, liquid hydrocarbons like petroleum ethers or napthas are vaporized and used in conjunction with the hydrocarbon gas.

In order to make all foreign bodies in the form of oxides, greases, and gas contents of both the metal and its carbon coating non-decomposable under later operating conditions, the carbonized and shaped parts are heated in vacuum at 900 degrees Centigrade. In addition to decomposing the impurities to inert carbide compounds, this treatment assists in cementing the carbon to the metals. After degasification in this manner, the carbon coatings appear to be graphic-like near the metal with an amorphorous carbon layer on the exterior. Carbonized and degased grids may now be exposed to the atmosphere without reabsorbing undesired bodies.

Modification of this method consists of sand blasting or otherwise roughening the metallic surfaces before applying a thin carbon deposit.[3]

A second method of inhibiting emission arises from the demonstrated fact that the characteristics of the valves containing carbonized parts are changed due to the difference in diameter of lateral grid wires and adjacent spacings. It is also felt that the coatings, usually metallic oxides, insulate the grid. These layers must be broken down by heating. Finally, molybdenum, a commonly used metal, does not react well when coated with hydrocarbon to prevent its emissivity. It remains, then, to protect the grid by a film that does not affect the electrical characteristics of the device, yet provide for ample heat radiation and retardation of undesired emissions.

Colloidal graphite method:[4] The coating of electrodes with electric-furnace graphite colloidally dispersed in distilled water, preferably after the metal parts are shaped, consists first of a deoxidation or preglowing treatment. The metallic bodies are treated in a reducing atmosphere or in a vacuum to a sufficiently high temperature to free completely the gas pockets or "pipes" of occluded gases, and to remove oxygen-forming compounds that might affect the graphitizing process. The films are then applied to cleansed electrodes by means of a spray gun or other convenient method. Once dried, the parts are further subjected to one of two heat or "fixing" treatments. Either the sprayed electrode is heated to a temperature of 500 to 800 degrees Centigrade while some reducing gas like hydrogen is injected into the oven or the procedure is carried out in a high vacuum at a temperature of 600 to 950 degrees Centigrade. After either treatment, the graphite coating on the electrode is formed into a black velvety film that is closely adherent and highly tenacious, the process having expelled occluded moisture in the layer and destroyed the protective colloid agents.

While the "fixed" deposit on the grid is relatively thin, its black body constant is comparatively high, so that it serves as a heat radiator to dissipate the combined anode and cathode heat received by the grid in devices similar to the 59 and 2A3 tubes. This characteristic renders a somewhat lower temperature to the coated parts and assists materially in overcoming both the secondary emission and photoelectric effects without detracting from the proper electrical functioning of the grid as a control electrode.

Tube electrodes are also blackened by electrophoretic deposition from a colloidal solution of graphite.[6]

Choice of metals: The present construction employed for a majority of vacuum tubes consists of a carburated nickel plate and grids composed of those metals that recent experiences indicate are not productive of secondary emission. Molybdenum alloy containing a high percent of nickel, mounted on copper supports, is such an arrangement, having no need of a carbon coating whatever, either when used in glass or metal envelopes. Molybdenum grids on nickel supports cause an emission effect, while nickel grids on copper do not.

A comparison between the advantages of hydrocarbon deposits formed with the aid of gaseous vapors like acetylene and sprayed colloidal graphite films, reveal that most manufacturers find the former a cumbersome procedure. Hydrocarbon deposits cannot easily be applied uniformly and, in some instances, are so thick in the vicinity of sputtered oxide particles on the grid that these films contribute to rather than retard secondary emission. Tube plates of carbonated nickel, on the other hand, are obtained easily by the gaseous method and are used extensively. In general, graphite is not applicable to the plates since the fixing temperature is around 1000 degrees Centigrade, at which maximum it tends to flake off. However, graphite is more tenacious than the hydrocarbon films, but requires a careful grid treatment to eliminate later gaseous effects. Hydrocarbon films are said to be free of gas.

The present choice-of-metals feature used for retarding undesired effects has suggested to some engineers that the emission phenomenon is one of contact or surface potentials in metals rather than one of emissivity. Others assume a neutral position by contending that in spite of considerable theory, published or otherwise, the entire story is not yet known. The fact remains that the hydrocarbon method is being outdated gradually by the choice of metals vogue save in a series of valves like the 2A3, 01A, and 59 types. When investigators have developeded the proper art of handling graphite films, its use will undoubtedly spread.

In the 2A3, a power tube having a grid about an inch wide, considerable emission arises. So far this can only be controlled by graphite's ability to cool the grid and prevent sputtered materials from combining with it.

In this connection, it is a question whether the globule-like collections of barium, tungsten, and alkaline earth metals themselves emit a primary emission that is sometimes mistaken for a secondary effect or whether the pure grid element is radiating a real secondary emission of deviated plate electrons. When dispersions of graphite are used, their boiling action, coupled with the minute volcanic eruptions on the grid surfaces, in the presence of high temperatures either frees completely such particles or prevents a permanent alloying with the grid material. In either case, the emission is said to be retarded.

The multiplicity of grid forms has no direct effect on secondary emission, even though it appears that with more grids present and hence the greater tendency of emission, more electrons might be deviated from the plate circuit and returned in the secondary form. This appears not to be the case, however. Usually in a series of grids there is a tendency for one to be a bad actor, the others remaining passive. Rather than carbonize them all in order to eliminate the one rogue, it is common practice to poison the grid surfaces. During this treatment, the tubes may be subjected at high temperatures to currents considerably beyond the normal working range, or they may be bench-operated at low temperatures, depending on what procedure is found the more effective by a trial method. The only exception to this case appears to be the 59 tube. Some manufacturers use graphite on the grid of the 59, primarily for its heat radiating qualities, while others are said to employ lamp black-alcohol mixtures for the same purpose.

While only a few vacuum tube designs employ internal coatings for grounding charges accumulated thereon by those electrons sufficiently intense to penetrate the internal field, it is believed that other tubes would serve more efficiently with age if such deposits were generally used.

Films[6] formed from lamp-black in water, acetone, and alcohol carriers, and aqueous graphite applied to the interior walls of glass envelopes are instrumental in preventing secondary emission from stray electron bombardment. This effect is appreciable in many vacuum tube designs, notably the 57, 58, 6C6, 6D6, 6A7 and 2A7. Stray electrons striking the glass bulbs, if of sufficient velocity, frequently knock out other electrons absorbed by the envelope walls, going in turn to the most positive tube element. Since this action is sporadic rather than continuous in character, the phenomenon is marked by a hissing sound when the device functions. Furthermore, occluded gases contained within the glass comprising the envelopes are often released under electron bombardment. These tend to combine with the cathode coating and thereby decrease operating life.

In general, graphite films will be found more tenacious for the vertical-walled valves designed primarily for automobile receivers, than deposits of lamp-black or similar materials. The latter compounds are scraped off easily when the tube elements are inserted.

A recent survey on the subject of emission in vacuum tubes finds prominent engineers admitting frankly that some of the problems just discussed are only partially licked. They say more research is needed before all aspects of tube emission are known. In brief, the older methods of retarding undesired effects may be out-dated, while the possibilities of later processes are not realized entirely.

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[2]See also "Hydrogen Furnaces for Tube Parts," Radio Engineering, pages 6-7, March, 1936.

[3]Societe des Etablissements Driver-Harris, French Patent 733,668.

[4]G. E. Long, U. S. Patent 1,981,652, assignor to Bell Telephone Laboratories.

[5]N. V. Philips, British Patent 450,788.

[6]H. C. Thompson, U. S. Patent 2,035,003, assignor to RCA. Austrian Patent 140,419.

CONVENTION HIGHLIGHTS

WITH A RECORD registration of eleven hundred and thirteen, the twenty-fifth annual convention of the Institute of Radio Engineers was held at the Hotel Pennsylvania, New York City, on May 10, 11 and 12.

In addition to the usual sessions devoted to technical papers and their discussion, additional entertainment was provided in the inspection trips and an NBC television demonstration which had been arranged for the benefit of the engineers.

Among the interesting papers presented during the technical sessions was that of Walter M. Hahnemann, of C. Lorenz, A. G., Berlin, on *The Ultra-Short-Wave Beacon and Its Field of Application*. The favorable results obtained with this system have led to studying the possibility of using these ultra-short-wave beacons for other purposes of air navigation. Instrument landing with this system is accomplished as follows: the aircraft approaches the airport in the vertical plane of the guide beam and a short distance from the airport it is directed by an outer distance marker to descend, while closer to the airport it is directed by an inner marker to land.

The Brightness of Outdoor Scenes and its Relation to Television Transmission was the title of a paper by Harley Iams, R. B. Janes and W. H. Hickok, RCA Manufacturing Co. Until the last few years devices for the converting of light into television picture signals have required a very large amount of light to give a useful signal. Today, it is practical with such electronic devices as the "Iconoscope"* to transmit pictures of outdoor scenes, even on cloudy days.

An Oscillograph for Television Development, by A. C. Stocker, RCA Manufacturing Co.: Development of high-fidelity television with its essentially transient signal wave shapes, demands an oscillograph with unusually good transient response. Frequency vs response characteristics have proven of small value in the development of such an instrument. An oscillograph having exceptionally accurate response to transient waves and sine-wave response flat from 20 cycles to 2000 kc was described in detail. Test methods using transients of known wave shape were described, and some comparative results given.

Development of the Projection "Kinescope," by V. K. Zworykin and W. H. Painter RCA Manufacturing Company, discussed the general requirements and design of "Kinescopes" for projecting television images. A picture 18" x 24" in size having a brightness in the highlights of 0.9 candles per square foot appears to be an acceptable minimum for home television reception. Several years of developmental work were required before the problems of designing a suitable projection system were clarified. This clarification led to a developmental "Kinescope" which approaches the minimum brightness requirements.

Television Pickup Tubes with Cathode-Ray Beam Scanning by Harley Iams and Albert Rose, RCA Manufacturing Co.: A cathode-ray beam scanning a target will ordinarily generate video signals if the optical image projected on the target causes either a corresponding distribution of potentials over the target surface, or a corresponding variation of the secondary-emission properties of the target surface. A distribution of potentials may be effected by light in a variety of ways: by photoemission, photoconductivity, photovoltaic action, or thermoelectric action. A change of secondary-emission ratio with light is more difficult to obtain, and has been observed in only one tube using a caesium-sensitized silver-oxide photocathode as target. Tubes in which the target consisted of aluminum oxide or zirconium oxide treated with caesium, a thin layer of selenium, a thin layer of germanium, or a copper plate oxidized and treated with caesium have been found to operate by a distribution of potentials over the target surface caused by light.

MELVILLE EASTHAM
General Radio Co.

A paper that attracted considerable interest was *A Circuit For Studying "Kinescope" Resolution,* presented by C. E. Burnett, RCA Manufacturing Co. In this paper the problems of synchronization were discussed. It was necessary to produce synchronization practically free from periodic phase shift between frequencies varying from 30 cps to approximately 2 megacycles. The degree of stability which was obtained with the synchronizing circuits that were developed is illustrated by the fact that photographs can be made of the resolution patterns produced on the "Kinescope," by using a 15-second time exposure.

High-Current Electron Gun for Projection "Kinescopes," by R. R. Law, pointed out that one of the problems in the art of reproducing a scene by television is to secure an image of adequate size. Because of this there has been considerable interest in projection systems where a small, high-intensity image reproduced on the face of a projection "Kinescope" is thrown onto a viewing screen of the desired size by a suitable optical system. The light output of these systems has been limited by the inability of the electron gun to provide a sufficiently large beam current in a small spot.

This paper described an electron gun giving large beam current in a small spot. The design of this electron gun is based on the results of the present investigation which show that the ratio of the current in the first cross-over inside the radius r to the total space current is:

$$I/I_s = 1 - \varepsilon^{-ar^2E}$$

where E is the voltage applied to the first-cross-over-forming system and a is a constant for any given cathode temperature, potential distribution and geometry. Inasmuch as the total space current varies approximately as $E^{3/2}$, the concentration of current in the first cross-over increases very rapidly with voltage.

The *Effects of Space Charge in the Grid-Anode Region of Vacuum Tubes* was another interesting paper. It was presented by Bernard Salzberg and A. V. Haeff, RCA Manufacturing Co. According to the authors the main effects of the space charge are to introduce de-

*Reg. Trade Mark, RCA Mfg. Co., Inc.


LEFT: WATTS
RIGHT: GARLICK
AMERTRAN


LOUIS MARTIN
RCA RADIOTRON


DR. ALFRED N. GOLDSMITH
CONSULTANT


DR. FULTON CUTTING
COLONIAL


A.H. BROLLY
FARNSWORTH
TELEVISION


JACK SCANLAN
THE MUTER CO.


C.E. BURKE
GENERAL RADIO


SAM BARAF
U.T.C.


STANLEY SONDLES
MAGNAVOX


H.J. SCHRADER
RCA MFG.


WM. M. BAILEY
CORNELL-DUBILIER


P.A. ANDREWS
CONT'L MOTORS


DAVID JOHNSON
BENDIX PRODUCTS


RAY ZENDER
LENZ ELECTRIC


S.H. SHALLCROSS
SHALLCROSS MFG.CO.


HUGH KNOWLES
JENSEN


LEFT: WM. NAUMBERG
WM. BRAND CO.
RIGHT: J.S. WELWOOD
INT'L NICKEL


GUS. E. RICHTER
AMERICAN LAVA


JOHN SMACK, JR.
S.S. WHITE DENTAL

SNAPSHOTS

DR. BEN KIEVIT
HYGRADE - SYLVANIA

DR. I. H. BRANDEL
OHIO CARBON

DR. ZWORYKIN
RCA

W. R. SPITTAL
FERRANTI ELEC.

LEFT: R.M. PURINTON
RAYTHEON
RIGHT: GEORGE CONNOR
HYGRADE - SYLVANIA

JESSE MARSTEN
INT'L RESISTANCE

CHARLIE GOLENPAUL
AEROVOX

HAROLD G. BEEBE
ISOLANTITE

J.H. WILLIAMS
GOAT RADIO TUBE PARTS

LAUREN McMASTERS, Jr.
SWEDISH IRON & STEEL

MAXIMILIAN WEIL
AUDAK

LEFT: H. WESTMAN
I.R.E
CENTER: L.C.F. HORLE
CONSULTANT
RIGHT: JOHN CLAYTON
GENERAL RADIO

KEN JARVIS
NORWALK ENG.

GEORGE MUCHER
CLAROSTAT

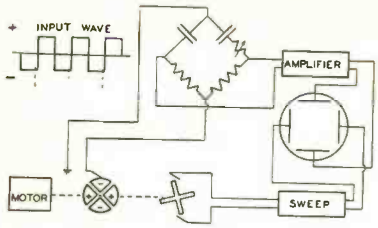
J.E. VOLLMER
STACKPOLE CARBON

SAM PLACE
SYNTHANE

LEFT: H.L. SAUMS
RIGHT: THOMAS F. KELLY
ANACONDA WIRE & CABLE

W. H. FRYLING
ERIE RESISTOR

ALLEN B. DUMONT
DUMONT LABS



A circuit for measuring condenser characteristics.

partures from the linear potential distribution of the electrostatic case; to set an upper limit to the current which can be collected at the anode, the value of this maximum current being a function of the grid-anode spacing and grid and anode voltages:

$$(I_a)_{max.} = 2.334 \times \frac{(V_g^{1/2} + V_a^{1/2})^3}{a^2}$$

$\times$ Area (amp); to introduce instabilities and "hysteresis" phenomena in the behavior of the tube; and to increase the electron transit time in this region.

In their paper on *Characteristics of the Ionosphere and Their Application to Radio Transmission,* T. R. Gilliland, S. S. Kirby, N. Smith and S. E. Reymer, National Bureau of Standards, presented results of ionosphere measurements near Washington, D. C., made at normal incidence over the period May, 1934 to December, 1936 inclusive.

Radio circuits as extensions of wire-line facilities to permit presentation of programs from points not otherwise accessible have now become an integral part of broadcasting, according to W. A. R. Brown and G. O. Milne of the National Broadcasting Co. Some of the more important problems involved in relay broadcasting and brief descriptions of the equipment developed for this service as well as its operation under field conditions were given in their paper *Ultra-High-Frequency Relay Broadcasting.* Portable relay broadcast transmitters of various powers and frequencies and their associated receivers were demonstrated.

A New Method of Measurement of Ultra-High-Frequency Impedance, by S. W. Seeley and W. S. Barden, RCA License Lab., dealt with a new and simple method for measurement of resistance and reactance at frequencies in the neighborhood of 100 mc. The method described provides a degree of accuracy higher than that obtained by previous and more complicated systems. It uses the incremental capacitance of a very small condenser as a standard. The absolute capacitance of this element need not be known. The indicating device is a vacuum-tube voltmeter whose deflection law (but not absolute calibration) must be known.

A Wide-Range Beat-Frequency Oscillator, by J. M. Brumbaugh, RCA Manufacturing Company, is concerned with the development and operation of an instrument having output ranges of 20 to 3,000,000 cycles (logarithmic scale), and .0004 to 45 volts, with automatic output-level control. A description was presented of the oscillator, r-f amplifier, detector, video amplifier, "AVC," and control circuits, with remarks on the attainment of stability. Design of the incorporated wide-range tube voltmeter, semi-automatic curve recorder, and oscilloscope, was discussed.

Wherever condensers and resistors must be of very high quality there is justification for measuring their characteristics with a degree of accuracy which

W. H. DOHERTY
Bell Telephone Labs.

does not obtain for ordinary audio- and radio-frequency work, according to W. D. Buckingham, Western Union Telegraph Co., in *Measurement of Condenser Characteristics at Low Frequencies.* It is known that the capacitance of a condenser may change with temperature, time, air pressure, voltage, frequency.

A condenser with absorption is equivalent to a pure capacitance shunted by other pure capacitances in series with resistances. Through the use of circuits and apparatus associated with the oscilloscope the equivalent values of a condenser in direct and retarded capacitance, may be determined by a process similar to that used in balancing an artificial line. A bridge system is set up and the known condenser is balanced by a pure capacitance shunted by a number of branch circuits consisting of capacitance and resistance in series.

Higher Program Level Without Circuit Overloading, by O. M. Hovgaard and S. Doba, Bell Telephone Laboratories, described a device designed to enable broadcast stations to increase their effective signal level without raising their input power or increasing their licensed carrier power.

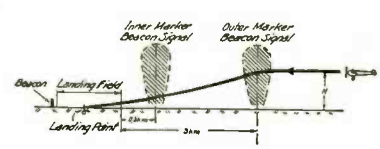
In the paper *"Radio Methods for the Investigation of Upper-Air Phenomena with Unmanned Balloons,"* H. Diamond, W. S. Hinman, Jr., and F. W. Dunmore, National Bureau of Standards, pointed out that experimental work conducted for the U. S. Navy Department on the development of a radio meteorograph for sending down from unmanned balloons information on upper air pressures, temperatures, humidities, and wind conditions had led to radio methods applicable to the study of a large class of upper-air phenomena.

The theoretical considerations concerning losses in ground systems were advanced in the paper prepared by G. H. Brown, R. F. Lewis and J. Epstein, RCA Manufacturing Co., entitled *Ground Systems as a Factor in Antenna Efficiency.* These considerations indicate the feasibility of antennas much less than a quarter wavelength tall, for low-power broadcast use. The desirability of large ground systems was also indicated.

The paper by John F. Morrison, Bell Telephone Laboratories, on *Simple Method for Observing Current Amplitude and Phase Relations in Antenna Arrays* described a simple apparatus arrangement for observing the relative amplitudes and phases of the currents in the elements of a multi-element radiating system.

A Multiple Unit Steerable Antenna for Short-Wave Reception, by H. T. Friis and C. B. Feldman, Bell Telephone Laboratories, discussed a receiving system employing sharp vertical plane directivity, capable of being steered to meet the varying angles at which short radio waves arrive at a receiving location.

The convention was brought to a close with the annual banquet during the course of which the Institute Medal of Honor was presented to Melville Eastham of the General Radio Company in recognition of his work in the field of radio measurements. The Morris Liebmann Memorial Prize was awarded to W. H. Doherty of the Bell Telephone Laboratories, Inc., for improvements in the efficiency of r-f power amplifiers.



Schematic arrangements of landing method.

RECENT TUBE DEVELOPMENTS

Despite our aversion to an ever-increasing number of tubes to mess up the present numbering system, there does seem to be some demand for them from the circuit people. Discussed herein are some of the types released during the past months, their characteristics and applications.

ENGINEERING DEVELOPMENT moves at a rapid pace and in one year numerous improvements in circuits and component parts can be expected. Of the component parts, some of the greatest changes and improvements have been made in the field of vacuum tube design and manufacture.

Several years ago manufacturers declared a moratorium on new types and for a period of almost a year there were no new type tubes or important changes in the characteristics of tubes already developed. In the year just ended many types have been introduced, a sufficient number, in fact, almost to make up for the year when there was no active development.

It is true that many of the octal-based glass tubes which appear under new type designations are standard glass tubes equipped with the octal base. The fact that the octal base affords some advantage is proved by the constantly increasing use of these octal-type tubes as compared with the older equivalents.

A table of direct equivalents between the octal-based glass tubes and standard types is shown below. It is unnecessary to comment on these types other than to remark that some manufacturers are producing the 2-volt filament type r-f amplifier tubes as tetrodes and others are manufacturing these tubes as pentodes. It is believed that there will be added to the type designation of the pentode amplifiers the letter P and to the tetrode amplifiers the letter T. Thus there may be both 1D5GT and 1D5GP tubes available. This situation is the result of the discovery that the addition of a suppressor grid to the older tetrode r-f amplifier greatly improved its performance. Unfortunately, some of the older receivers will not operate satisfactorily with the improved tube, necessitating the manufacture of both.

Since the distance from the bottom of the tube prongs to the elements inside the tube is approximately the same for both the octal-based glass tubes and the standard glass types, it will be found that in addition to being equivalent in characteristics, these tubes have practically identical internal capacitances. Through the use of a glove shield with a special grounding contact, which slips on over the octal guide key and shield prong on the base, the octal-type glass r-f tube can be used by a receiver manufacturer so that either the octal glass tube or its metal equivalent can be plugged into any of the sockets without interference from the contact fingers or contact ring commonly riveted to the chassis as a grounding mechanism for the glove-type glass tube shield.

As new glass tubes are developed, it is expected that the octal base will be used. This procedure has been followed on all of the new types in the past year with the exception of the tuning indicator tubes. Mounted horizontally, it is probable that the small 6-prong standard base would provide a more secure support than could be had with the smaller prongs and guide key of the octal base.

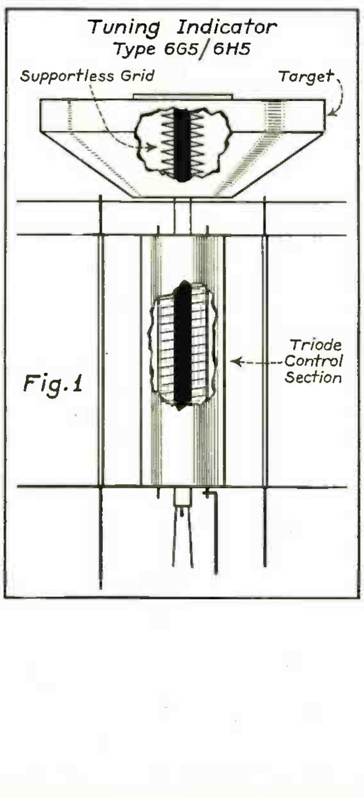


Fig. 1

A short summary of characteristics on the newly developed tubes follows:

In the line of two volt filament type tubes for battery operation, there are types 1E7G, 1G5G and 1J6G. Taking these three tubes in the order given, type 1E7G is a double or twin pentode with each section matching the 1F4 in general characteristics. The output at 135 volts on the plate and screen of each section is 650 milliwatts and this is obtained with a peak signal voltage from grid to grid of only 15 volts. Type 1G5G is the most recent development in the two volt series. This tube, designed for efficient output with only 90 volts on the plate and screen, delivers 300 milliwatts of audio power with an input signal of approximately 6 volts. The 1G5G, because of its ability to operate at 90 volts, provides one answer to the problem of reasonable output from a portable receiver. The third tube, type 1J6G, is almost identical to the standard Class B type 19. However, to make the filament current an even multiple of 60 milliamperes for series-parallel operation with other two volt filament type tubes, the filament current of the 1J6G was made 240 milliamperes. This compares with 260 milliamperes filament current in the type 19 tube.

Passing to the 6.3 volt type tubes, the first of the group of new types is the 6A5G. Type 6A5G is an octal-based triode of the heater cathode type. It has characteristics similar to those for types 6A3 and 2A3. The initial data issued on this tube did not clearly indicate a connection between the cathode and heater. In the 6A5G, the cathode is directly connected to the center of the heater.

Another new tube in his group is type 6C8G. This tube is a double triode having a high amplification factor. The cathodes are of the unipotential type and are connected to the base pins separately. The combined heater current for both sections is 0.300 ampere. The 6C8G was designed primarily for phase inverter operation with resistance coupling and will produce from 60 to 80 volts output depending on supply voltage and circuit conditions. Thus it may be used to drive practically any of the present Class A output tubes.

To be taken as one group are the new low heater current tubes requiring 0.150 ampere at 6.3 volts. The group included a tuning indicator tube, type 6N5; a pentagrid converter corresponding to the 6A8G, type 6D8G; a triode which approximates the 6C5G, type 6L5G; an r-f pentode amplifier corresponding in application to the 6U7G or 6D6, type 6S7G; and a duplex-diode triode which approximates the 6Q7G, type 6T7G/6Q6G. The combination designation of this last type is explained by the fact that when originally issued, the tube had only one diode plate and was called type 6Q6G. Circuit requirements called for a second diode plate and accordingly this second plate was added and a new designation chosen so that the old type number would remain as a part of the identification symbol. Of course, type 6C8G which is described above can be included in this group since each of its heaters and cathodes corresponds to the same elements in the 0.150 ampere heater group. All of these low heater tubes are being watched with interest by engineers interested in automobile type receivers. Although the tubes were introduced primarily for use in storage battery operated home sets, it is possible that they will find application in auto radio service where the saving in heater current would be desirable.

TABLE OF DIRECT EQUIVALENTS
GLASS TUBES

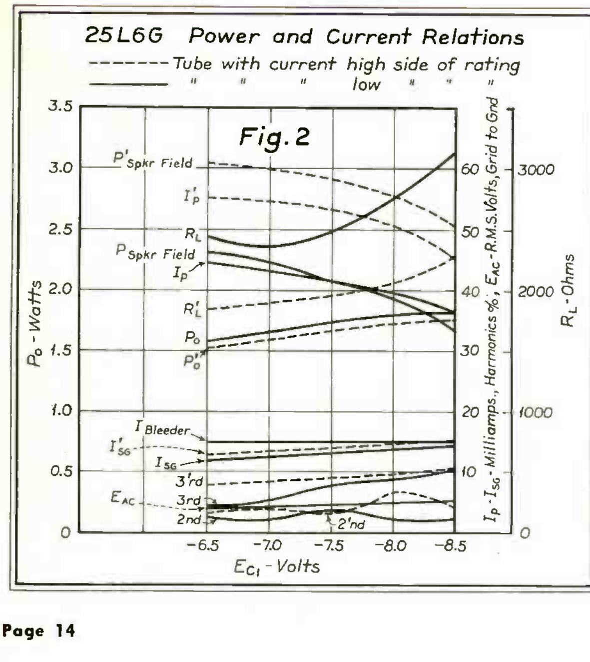
Octal Based Glass Type	*Standard Glass Type*	*Description*
1C7G	1C6	Converter
1D5G	1A4	R-f Amplifier
1D7G	1A6	Converter
1E5G	1B4	Detector-r-f Amplifier
1F5G	1F4	Pentode Output
1F7G	1F6	Duplex Diode Pentode
1H4G	30	Triode Amplifier
1H6G	1B5	Duplex Diode Triode
5U4G	5Z3	Full-Wave Rectifier
5V4G	83V	Full-Wave Rectifier
5X4G	5Z3	Full-Wave Rectifier
5Y3G	80	Full-Wave Rectifier
5Y4G	80	Full-Wave Rectifier
6A8G	6A7	Converter
6B4G	6A3	Triode Power Amplifier
6B6G	75	Duplex Diode Triode
6B8G	6B7	Duplex Diode Pentode
6F6G	42	Pentode Output
6J7G	77	Det.-r-f Amplifier pentode
6K6G	41	Pentode Output
6K7G	78	R-f Amplifier Pentode
6N6G	6B5	Double Triode Output
6N6MG	6B5	Double Triode Output
6N7G	6A6	Twin Triode
6P7G	6F7	Triode Pentode
6U7G	6D6	R-f Amplifier Pentode
6V7G	85	Duplex Diode Triode
6Y7G	79	Twin Triode
25A6G	43	Pentode Output
25Z6G	25Z5	Voltage Doubler-Rectifier

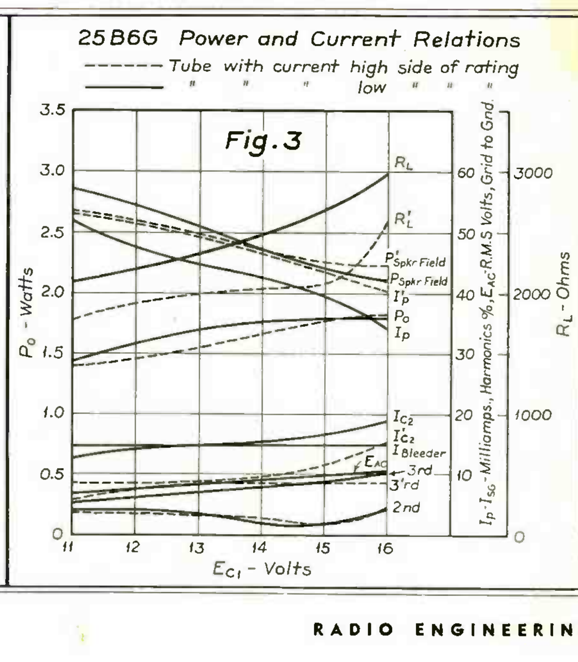
Continuing with new tubes of the conventional heater construction, a type which is not particularly new but which deserves attention is the 6F5G, or in the metal group, type 6F5. This triode is generally associated with the 6Q7 or 6Q7G combination duplex-diode triode whereas the 6F5G actually corresponds to the triode section of type 75 or 6B6G. The amplification factor of the 6F5G is 100. Thus, in a balanced amplifier or phase inverter system using two tubes, the 6F5 or 6F5G would combine with a 75 or 6B6G. To provide a high mu triode which might be used in balance with the 6Q7 or 6Q7G, the type 6K5G tube was developed. This triode has an amplification factor of 70, which matches that characteristic in the 6Q7 or 6Q7G.

For high-frequency oscillator use, the 6J5G tube was developed during the year. This tube is a triode of exceptionally high mutual conductance, which is achieved by the close spacing of small elements. Roughly resembling the 76, type 6J5G has internal capacitances only slightly greater than the 76, while its amplification factor is higher, plate resistance lower and its mutual conductance is approximately 25 percent greater than that of the older triode. The result, in oscillator application, is a tube which will operate over a much wider band of frequencies than can be covered by any of the older oscillator tubes.

Types 6L6 and 6L6G have been covered so completely in technical articles that it is unnecessary to mention them beyond remarking that the design developed in these tubes has provided manufacturers of amplifiers and public-address equipment with higher output and better quality than any prior tube development except at great expense for component equipment. Also, the application of inverse feedback or audio degeneration has made possible new standards of audio performance with these power amplifiers.

The introduction of the "beam power" principle in the 6L6 brought out the





advantages to be gained with audio tubes incorporating that design and, as might be expected, other similar tubes for lower power classifications were developed during the last year. One of these, type 6V6G, corresponds in size and power classification with the 42 and its "G" equivalent type 6F6G. This tube, with a power output of 4.25 watts and a heater current of 0.450 ampere is being used in many of the new automobile receivers both singly and in push-pull. Also new are the 25L6, 25L6G and 25B6G. These three tubes for ac-dc use are similar in output, ranging from 1.5 to 2.0 watts depending upon the effective voltage available between plate and cathode. The 25B6G differs from the 25L6 and 25L6G in that the operating bias is —15 volts compared with —28 volts for the last two types. In a later paragraph, reference is made to the operating performance of these two tubes.

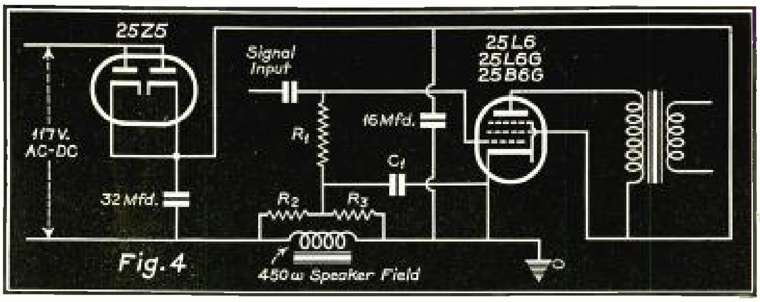


Fig. 4

Another new 6.3 volt tube is the 6Z7G, a twin triode Class B output tube with a total heater drain of 0.3 ampere. At a plate voltage of 180, the power output is 2.2 watts with a load resistance of 15000 ohms and 80 milliwatts grid drive. With a load resistance of 20000 ohms and 320 milliwatts grid drive, the power output is 4.2 watts. This tube provides economy of plate power, the plate current being only 10 milliamperes with no signal. In this respect it represents a decided improvement over the 6A6 for medium power output work. The tube operates with zero bias.

Among the rectifiers, the tiny 0Z4G for automotive use is new. This tube with no filament to draw power has practically a constant voltage drop over its entire operating range of current output and therefore provides good regulation for heavy plate current output tubes.

Another new rectifier for automobile receiver service is type 6W5G with an output rating of 100 milliamperes maximum from the filter. The tube is of the heater cathode type drawing 0.9 empere at 6.3 volts. It is of the full wave type.

Also in the list of new rectifiers is type 5W4G, the glass counterpart of the metal 5W4. This rectifier has a filament and so far as ratings are concerned, it may be classified with the octal based tubes corresponding to type 80. However, the 5W4G in its final design may have a smaller bulb.

The latest rectifier development, produced especially for auto radio, is the 6ZY5G. This tube has a 300 ma heater and is rated for 40 ma drain from the filter. It will provide some improvement in lowered heater drain in comparison with type 84, which the 6ZY5G resembles.

The type 913 one-inch cathode-ray tube, while not strictly a tube applicable to radio receivers, belongs with this class in size and in the methods used in manufacturing the tube. The 913 has already replaced larger cathode-ray tubes to a considerable extent in the field of portable service oscillograph equipment and it has many uses in connection with general laboratory work. The method of construction employed in the tube, which is cased in a metal shell similar in size to the shell used on the type 6L6 tube, permits good separation between the glass target at the end of the tube and the deflection plates. The sensitivity is reasonably high, therefore, and the 913 can be used without an amplifier for many types of investigation.

In addition to the ac-dc "beam power" tubes, a new combination pentode and rectifier tube has been developed. This tube is designated 25A7G and it is rated appreciably higher in output than the similar maller 12A7, which it is replacing.

Among metal tubes there have been few additions. The types 6L6 and 25L6 have been mentioned in connection with a description of the "beam" amplifiers. Type 6B8, introduced early in the past year is a combination duplex-diode pentode with characteristics approximating those for the old type 6B7. Types 5W4 and 5T4 are new all metal rectifiers corresponding approximately to the 80 and 5Z3 respectively. In general, the metal rectifiers are rated somewhat below the corresponding glass rectifiers.

The development of tuning indicator tubes which make use of the cathode ray principle has been rapid throughout the year. In addition to the original 6E5, there are now types 6G5/6H5, 6U5, 6AB5, 6T5, and 6N5. All except type 6T5 present the same appearance looking on the target face. A variation in grid voltage on the control triode varies the shadow angle and thereby defines the tuning of the receiver in which the indicator is used. The type 6T5 indicator target pattern is circular, expanding and contracting with changes in the control grid voltage. The 6G5/6H5 and 6U5 indicators are alike in characteristics. The former is in an ST-12 bulb and the latter in a T-9 bulb. The 6N5 and 6AB5 both operate with a heater current of 0.150 ampere. The former is in an ST-12 bulb and the latter in a T-9 bulb. The two differ by a slight amount in the control voltage required to produce a zero shadow angle.

One of the most interesting developments in connection with the tuning indicator tubes has been the addition of a control grid to the target portion of the tube. Formerly depending on emission saturation to maintain a constant target current, there were variations in the target current of more than 500 percent over the normal life of the tube. The target and cathode formed a diode with nothing to limit the current passing between them except the cathode emission. The addition of a grid, connected to the cathode, permits the use of a normal emission cathode surface and limits the target current to small variations with changes in line voltage and the changes which occur normally through tube life. Fig. 1 shows a cut-away view and indicates the target section grid which is mounted without a support side-rod. Such a rod would cast a fixed shadow which would not be desirable.

In Figs. 2 and 3 are shown the output performance curves for the 25L6 or 25L6G and for the 25B6G in a recent ac-dc design which makes use of the speaker field as the filter choke and bias supply. As a filter choke, the speaker field presents ample impedance, and by using it for bias the total of the bias voltage is made available as additional effective plate voltage. Power, distortion and currents are shown plotted for values of bias voltage. For each value of bias voltage, the grid input signal voltage peak is equal to the bias. Fig. 4 shows the circuit of the output stage. Resistor R_1 can be the usual value of input resistance. Resistors R_1 and R_2 can be selected to provide the proper bias for the tube used. Condenser C_1 can be small and may not be required.

In conclusion, it may be said that tube design engineers have kept the engineers engaged in application well occupied during the past year and that the total number of tube types today has reached a staggering total.

DISTORTION IN HIGH-FIDELITY

by Reuben Lee

Westinghouse Electric & Mfg. Co., Inc.

AN INCREASING DEMAND for high audio fidelity has resulted in amplifiers with flat frequency characteristics over a wide frequency range. Until recently this emphasis on flat characteristics has not given proper recognition to the fact that freedom from distortion is not guaranteed thereby, even in a properly adjusted amplifier. It will be shown here that the same factors which tend to produce drooping frequency characteristics also produce distortion, usually to a greater degree. Poor frequency response and distortion can be related in amplifier design, in such a manner as to indicate the way to avoid both. Fallacies in some common assumptions regarding amplifiers will also be pointed out.

Curves illustrating the performance of transformer-coupled amplifiers are based upon the equivalent diagrams developed in Figs. 1 to 5.

Fig. 1 shows the equivalent circuit for an amplifier at low frequencies. For the resistive loads of audio practice the leakage reactances may be omitted. Then if the transformer is regarded as having a 1:1 turns ratio the diagram of Fig. 2 results, where the tube and primary winding resistances are combined into R_1, and the load and secondary winding resistances into R_2. Further, if high-quality core material such as Hipernik is used, the effect of the core loss equivalent resistance R_N is negligible, and the diagram simplifies to that of Fig. 3.

Low frequency performance derived by ordinary circuit theory from the circuit of Fig. 3 is shown in Fig. 6. This curve is drawn from the typical example of a triode working into a load resistance of twice the tube plate resistance. The tube is considered as a generator having internal resistance R_1 and constant generated voltage μe_g.

Fig. 6 is the transformer voltage ratio, plotted as "db down" from 1000 cycles versus the ratio X_N/R_1. The frequency of 1000 cycles is chosen merely as that at which the ratio X_N/R_1 is very large; this is true because of the high 1000-cycle primary reactance of a well-designed transformer. Proper amplifier tube operating conditions are of course assumed.

As the frequency increases, the transformer primary inductive reactance also increases until it has practically no effect upon frequency response. This is true for 1000 cycles in Fig. 6. It is also true for high frequencies; in other words, the primary inductance has an influence only on the low-frequency end of the frequency characteristic curve.

A well-designed transformer has uniform voltage ratio throughout a considerable frequency range, from the frequency at which X_N ceases to exert any appreciable influence, upwards to a zone which we shall designate as the high frequency end of the amplifier frequency range.

The factors which enter to influence the high frequency response of an amplifier are transformer leakage inductance, winding capacitance, tube impedance and load impedance. Hence, a new equivalent diagram, Fig. 4, is necessary for the high frequency end. Here the winding resistances are combined as in Fig. 2. The winding capacitances are shown as effectively across the windings. If we combine the primary and secondary leakage inductances and capacitances, omit X_N as if it were infinitely large, and drop the factor a^2 as before, we obtain the circuit of Fig. 5. Here X_L is the leakage reactance of both windings, X_C the capacity reactance of both windings and R_2 the load resistance, all referred to the primary side on a 1:1 turns ratio basis.

From Fig. 5 the curves of Fig. 7 are derived. They are plotted with the frequency ratio f/F as abscissas, F being the resonance frequency of leakage reactance and winding capacitance. The fidelity at high frequencies evidently depends upon the ratio B of transformer capaci-

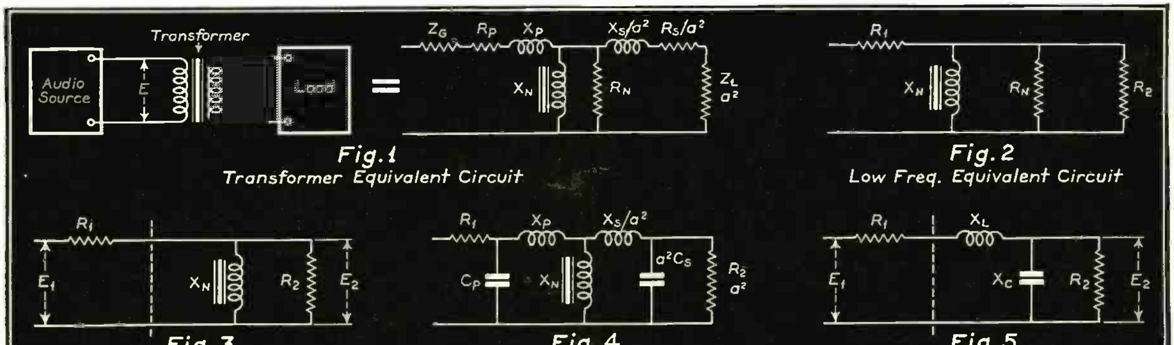


Fig. 1 — Transformer Equivalent Circuit

Fig. 2 — Low Freq. Equivalent Circuit

Fig. 3 — Simplified Low Freq. Circuit

Fig. 4 — High Freq. Equivalent Circuit

Fig. 5 — Simplified High Freq. Circuit

- SYMBOLS -

a = Ratio of sec. to pri. turns
C_P = Pri. winding capacitance
C_S = Sec. winding capacitance
C_T = $C_P + a^2C_S$
f = Any audio frequency
F = Resonance frequency of X_L and X_C
R_P = Pri. winding resistance
R_S = Sec. winding resistance
R_N = Pri. no load (core loss) equivalent resistance
X_N = Pri. no load low freq. reactance
X_P = Pri. leakage reactance
X_S = Sec. leakage reactance
X_L = $X_P + X_S/a^2$
X_C = Total capacity reactance = $1/2\pi f C_T$
Z_G = Source impedance
Z_L = Load impedance

AUDIO AMFLIFIERS

ty reactance to tube plate resistance at the frequency F. An inspection of these curves shows that if $\frac{X_c}{R_1}$ has certain values at frequency F, the audio-frequency characteristic will be relatively flat up to frequencies approaching F. In particular, we note the good performance of the value $\frac{X_c}{R_1} = 0.8$.

We may now set down the conditions that prevail in an amplifier having good audio response; the reactance of the transformer primary winding is high enough at the lowest audio frequency to keep the characteristic flat as indicated by the right-hand portion of Fig. 6; at the same time, the winding capacity reactance is such a value at the resonance frequency F that the response is kept nearly uniform up to frequency F, or this frequency is sufficiently higher than the highest audio frequency that the curve does not droop, no matter what the value X_c has at frequency F.

The question arises: are good audio response curves a sufficient guarantee of high fidelity, or is it possible to have good response according to the curves, but at the same time bad distortion because of changes in amplifier load impedance?

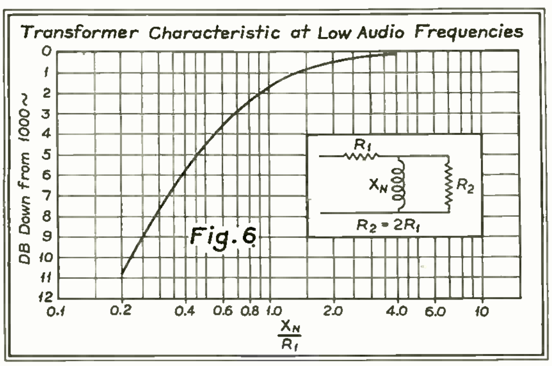
In an attempt to answer this question, the equivalent primary impedance of the load will be considered, apart from the tube impedance. Referring to Figs. 3 and 5, this is the impedance to the right of the dotted line. It is the load impedance referred to the transformer primary, and we shall designate it simply as load impedance. Figs. 8 and 9 show the respective load impedance curves at the low and high audio frequencies. Fig. 8 shows the change in load impedance from its 1000-cycle value R_2 as the frequency is lowered. It should be observed that the abscissas are necessarily $\frac{X_N}{R_2}$, instead of $\frac{X_N}{R_1}$ as in Fig. 6 and this difference should be kept in mind when comparing the two curves.

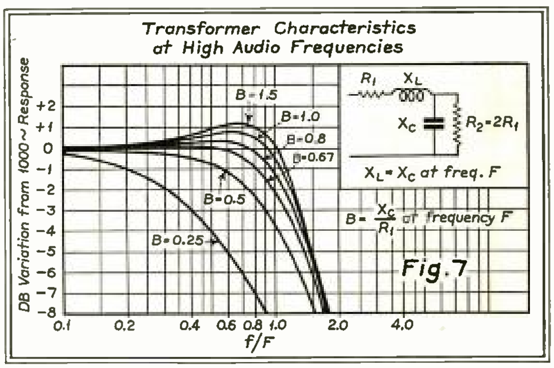
Likewise, in Fig. 9 the factor D is $\frac{X_c}{R_2}$ in place of $B = \frac{X_c}{R_1}$ as in Fig. 7. It will be seen that the impedance varies widely from its 1000-cycle value, especially at lower values of D.

From Figs. 8 and 9, we are able to compare the change in impedance with the frequency characteristics of the previous curves. We see from Fig. 6 that if the transformer characteristic is allowed to fall off 1.0 db at the lowest frequency, the corresponding value of $\frac{X_N}{R_1}$ is 1.3. This means that $\frac{X_N}{R_2}$ is 0.65. Looking for the corresponding load impedance in Fig. 8, we see that it is only 0.55 of its 1000-cycle value. Likewise, for 0.5 db droop of the frequency characteristic, the load impedance falls to 0.7 of R_2; while for a closer impedance match of 0.9 R_2, the frequency characteristic falls off only 0.1 db. It is thus apparent that considerable load impedance variation occurs even with comparatively flat frequency characteristics.

Turning to the high audio frequencies, we find still greater divergences. Suppose, for example, that the transformer has been designed so that $\frac{X_c}{R_1}$ is 0.8 at F (that is, $B = 0.8$ in Fig. 7). Suppose further, that the highest audio frequency at which the amplifier operates is 0.75F. The amplifier then has a nearly flat characteristic, with a slight rise near its upper limit of frequency. Turning to Fig. 9, we must choose the curve corresponding to $B = 0.8$. Since $R_2 = 2R_1$, the curve is that marked $D = 0.4$, from which we discover that at 0.75F the load impedance has dropped to 25 per cent of R_2, an extremely poor match for the tube.

It might be objected that since 0.75F is the upper frequency limit, the harmonics resulting from the low value of load impedance would not be transmitted, and no harm would be done. But if we look up the frequency 0.375F, whose second harmonic *would* be transmitted, we see that the load impedance is only $0.63R_2$. Between 0.375F and 0.75F (over half of the amplifier frequency





range) the load impedance gradually drops from $0.63R_2$ to $0.25R_2$. Thus considerable distortion over a wide frequency range results.

To give some idea how much distortion these low load impedances produce, a series of loads were plotted on typical plate characteristics: 100 per cent, 70 per cent, and 50 per cent of the recommended value of twice the plate resistance. Results are tabulated below:

Load	*Percent Second Harmonic*	*Percent Third Harmonic*
100% U.P.O. Value	3	1.2
70% U.P.O. Value	9.8	3.6
50% U.P.O. Value	19.1	5.85

The excessive last figure for the second harmonic means a waveform departing materially from sinusoidal, and although it affects the peak voltage amplitude more than the rms value, a droop results at the low impedance points of the frequency characteristic in addition to that shown by Figs. 6 and 7. This effect is slight compared to the diminution of load impedance, however, and it is no indication of the amount of distortion present.

An obvious deduction from the curves is that the practice of compensating for drooping frequency characteristics by external equalizers leaves uncorrected the distortion of poorly-designed power stages. Such deficiencies may be eliminated by specifying limits to the variation of amplifier primary equivalent load impedance as a basis of performance, instead of or in addition to frequency response. For amplifiers operating into loads of twice the tube plate resistance, it is desirable to design the transformer so that the load is within a few per cent of the proper value to avoid distortion. Flat characteristics are then automatically assured. The reverse, however, is by no means true.

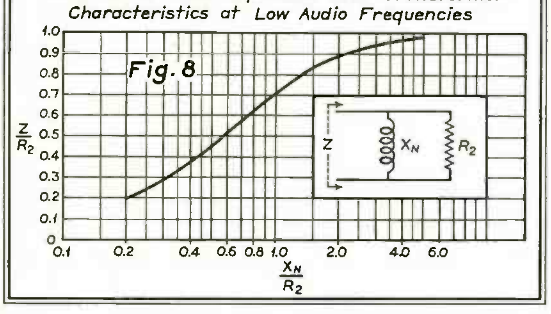
The phase angle introduced by the transformer makes little difference in the distortion at or near the load $R_2 = 2R_1$. When the load impedance decreases, however, the phase angle is likely to increase the harmonic content to a still greater degree.

In voltage amplifiers, having load resistances of more than twice the plate resistance, the change in load impedance produces less distortion. For example, if the load is an open grid, the load impedance change causes negligible distortion.

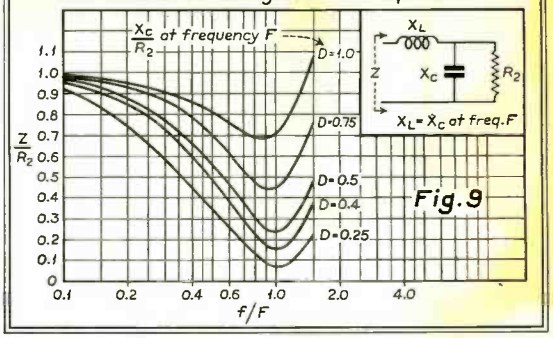
These considerations also apply to resistance-coupled amplifiers, in so far as they exhibit frequency characteristics with regard to voltage and impedance.

The same general conclusions may be drawn for Class A push-pull amplifiers as were deduced in the preceding section for single-side Class A amplifiers. This is true with the exception that the second harmonic components appearing in the amplifier output are due to unlike tubes, rather than to low impedance distortion.

The internal tube resistance of a Class B amplifier



Variation of Load Impedance with Transformer Characteristics at Low Audio Frequencies



Variation of Load Impedance with Transformer Characteristics at High Audio Frequencies

varies so much with operating conditions, such as the amount of signal voltage on the grids, power output and plate voltage, that it is difficult to draw curves similar to Fig. 7 for Class B operation. If the tubes are loaded lightly, the plate current may rise at the higher frequencies; if loaded heavily, the output voltage falls off. Qualitatively, the characteristic curves may be expected to follow the same general trend as for Class A amplifiers.

Usually we may expect a greater decline in Class B amplifier characteristic curves than that evidenced by Class A amplifiers, because the effect of tube resistance is greater. Carrying this effect to the limit, we may assume that the resistance is so great that the current into the load cannot increase as the load impedance decreases. Hence, the characteristic curve falls off proportionately with the load impedance curves, Figs. 8 and 9. Flat characteristic curves are, therefore, a closer index of undistorted output in Class B amplifiers. In a lightly-loaded amplifier, the frequency characteristic stays flat at higher frequencies, but the plate current rises in proportion as it does so and distortion may develop before the frequency response falls off.

This discussion leads to the additional conclusion that the mode of tube operation has a decided effect upon amplifier frequency characteristics. Tubes having greater internal resistance than one-half the load resistance require better transformers to effect good frequency characteristics.

A few safeguards may now be suggested to direct amplifier design to the attainment of true high fidelity:

(1) Theoretical or actual frequency response curves, made with power sources other than the vacuum tubes for which they are intended, should not be accepted as performance data for the transformers of power stages.

(2) All amplifier stages should have uniformly flat response, and the indiscriminate use of equalizers to compensate for poor response should be avoided.

(3) In order to eliminate distortion, the value of equivalent primary load impedance of each power stage transformer should be kept within close limits.

(4) A further suggestion lies in the method of checking this impedance value. Since the phase angle of a transformer is low where the load impedance is close to the proper value, a simple test of primary voltage and current over the required frequency range would determine the quality of an amplifier transformer.

The recent developments of inverse feedback and pi-filter configurations do not diminish the importance of the salient points of this article; on the contrary, these considerations indicate to what extent such measures are necessary, in a given amplifier, to obtain good audio quality.

USING THE R-F CHARTS

THE DESIGN of band-pass radio-frequency circuits was materially simplified by the publication, in RADIO ENGINEERING for December, 1936, of a series of charts based upon certain equations first given in *Electronics* in 1930. Earlier, there were some equations published in *Wireless World;* these purported to show the band width passed by capacity coupled circuits of the type employed by Stromberg-Carlson and called by that company the Bi-resonator.

The information in both of the references noted above was such that a great amount of computation was necessary in order to arrive at the desired values of circuit constants. This, of course, is only to be expected by the engineer engaged in circuit design; it is, certainly, not a valid reason for any failure to use these circuits commercially. Such failure is undoubtedly due to the increased cost which would result.

However, as has been pointed out by RADIO ENGINEERING in many editorials, the time must eventually come when the standards of high-fidelity reception will demand that serious attention be given to the use of band-pass circuits not only in the intermediate-frequency amplifier, but in the pre-selector stages as well. It is interesting to note at this point that most of the inquiries which have come as a result of the publication of the design charts, have been from the engineers in foreign countries; it is with the thought of supplying a group answer to many of these inquiries that this resume is prepared.

The figure numbers to which frequent reference will be made in what follows, are those appearing on pages 14, 15 and 16 of the December 1936 issue of this publication; they are also reproduced herewith, although much reduced in size.

It will be seen, from the equation appearing on Fig. 1, that we shall have need of three quantities to start the solution of a problem involving band-pass circuits; these are, the effective resistance of one coil which is designated as R_n (theoretically, R_n should include the effective resistance of the condenser which tunes each circuit, but it is felt that with present-day high-quality insulation, condensers with negligible r-f losses can be obtained; in any event, the Q of the coils is so likely to exceed greatly that of the condensers that the latter may be, for all practical purposes, neglected); the value of the inductance of one coil, L; and the frequency separation or, in other words, the band width which is f_s.

Consider briefly the schematic also shown on Fig. 1. The two condensers not identified by any letters are those which with the large coils tune the circuit to the desired frequency. It should be kept in mind that what we have here is two circuits coupled together by means of C_m and the negative mutual inductance —M. That is, C_m and —M constitute a common reactance through which two tuned circuits are coupled. Incidentally, it will be found that when C_m and —M are determined from the charts, their frequency of resonance will be entirely outside the working range of the coupled circuits; the reason why this should be so will be at once apparent when it is remembered that at resonance the reactive terms cancel leaving the resistance as the only component of the circuit impedance.

It will be seen that the two tuning condensers of the schematic under discussion are effectively in series with C_m. This might result, under certain conditions, where C_m was small enough, in a decrease in capacity of the tuning con-

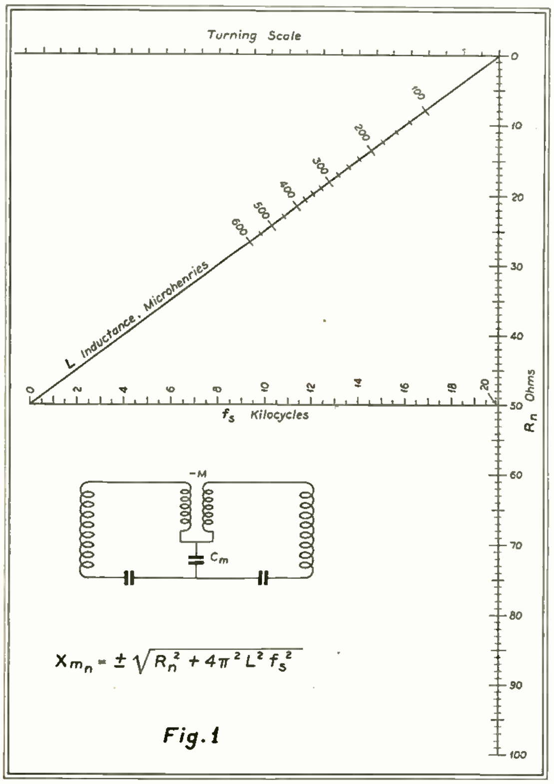


Fig. 1

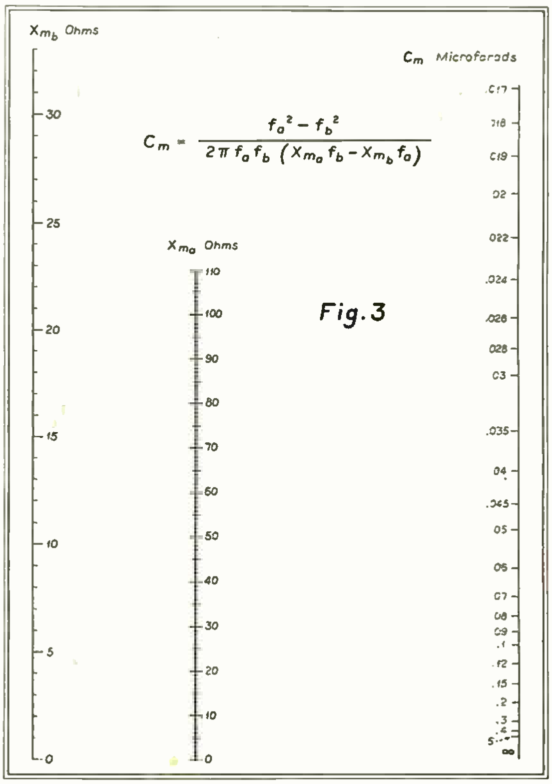


Fig. 3

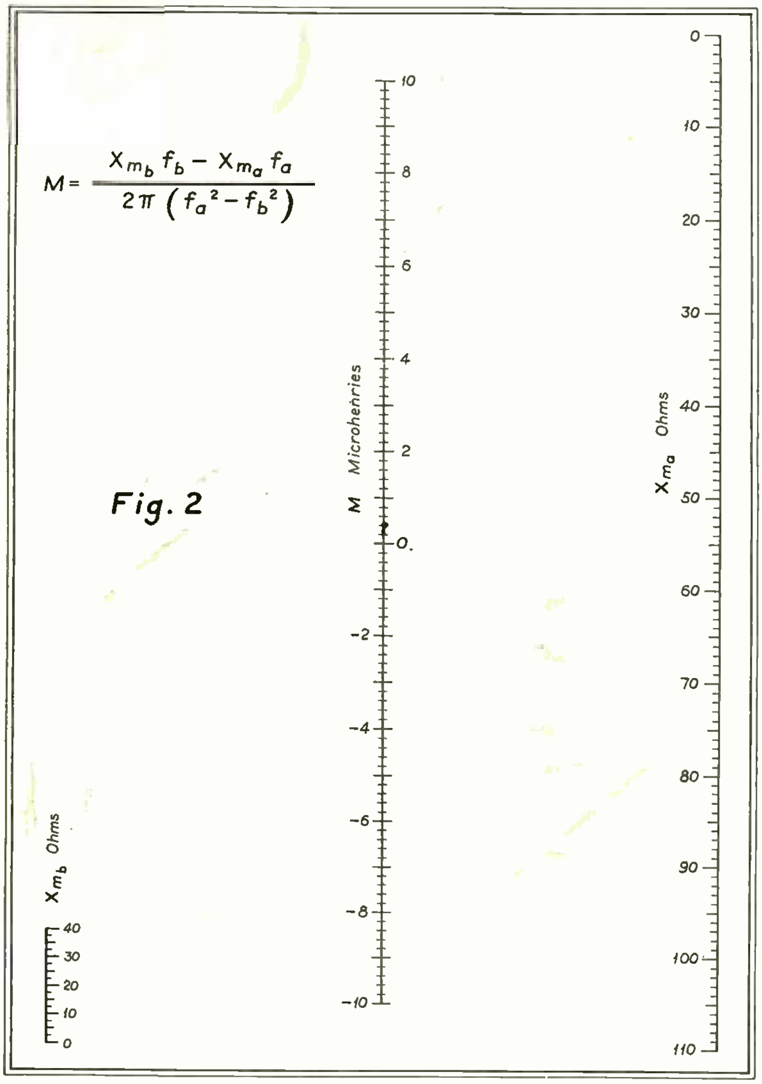


Fig. 2

densers sufficiently great to make it impossible to cover the desired frequency range. For this reason it will be advisable to make a trial calculation to determine if the conventional variable condenser—with a maximum of 350 to 365 mmfd—will be large enough when used in series with whatever value C_m appears to be assuming. If not, variable condensers with a maximum of 440 mmfd or thereabout should be substituted.

The effective resistance of the coils is best determined by measurement, employing any of the accepted methods. It is, of course, apparent that the effective resistance must be known at two frequencies at least. These may be the marginal frequencies of the particular band over which it is proposed to use the system. In the case of the regular broadcast band, these frequencies will obviously be 540 and 1,500 kilocycles; however, if the frequencies above 1,500 kc, which at present are assigned to high-fidelity broadcast stations, are to be covered along with the regular broadcast band, it will be best to consider 1,600 kilocycles—or even somewhat higher—as the upper limit.

We are now prepared to enter upon an actual problem. which we will state as follows: Given, coils of 240 microhenrys inductance; variable condensers of 365 mmfd maximum capacity. We are to determine the values of C_m and —M for a constant band width of 15,000 cycles over the range of 540 to 1,750 kilocycles. (It should be noted that in the preparation of the charts, these two marginal frequencies were selected because of the fact that many present-day receivers, and presumably those of future design, cover the so-called high-fidelity stations as well as some of the amateur band along with standard broadcasts, all on the same coils.)

The first step is to find the effective resistance of the coils at or near the marginal frequencies. By actual measurement, our coils are found to have, at 540 kilocycles, an effective resistance of 7.4 ohms, while at 1,700 kilocycles, the resistance is 25.8 ohms.

We start with the chart of Fig. 1. On the scale marked "f_s kilocycles" locate the point 15, corresponding to the frequency separation in kilocycles, or band width, desired. Connect this point with 240 on the scale "L, inductance, microhenrys." Continue the line to the "turning scale" at the top of the chart. From the point where the line intersects the turning scale, run a line to the scale "R_n Ohms" at the point 7.4. Now, *measure the length* of this latter line, i.e., the one joining the point on the "turning scale" with the point 7.4 on the "R_n Ohms" scale. On the "R_n Ohms" scale, this *measured length*, starting from the top, of course, gives the function Xm_n. In our problem, this measured line proves to be 2.25 inches (5.7 cm) in length. This distance, 2.25 inches, measured along the "R_n Ohms" scale indicates a value of 25 for Xm_n. In other words, this Xm_n is the value of mutual reactance which, at a frequency of 540 kilocycles will, with a circuit resistance of 7.4 ohms, give a band width of 15,000 cycles.

Exactly the same procedure is followed using the value of 25.8 ohms for R_n; this will give Xm_n for 1,700 kilocycles. As before, we connect 15 kilocycles with 240 microhenrys, on the appropriate scales; connect the point of intersection on the turning scale—thus far, of course, the procedure is identical with that in the first step—with the point 25.8 on the "R_n Ohms" scale. Measuring the resulting line, we find that it is 3.1875 inches (8.2 cm) in length. This distance, measured along the "R_n Ohms" scale gives the value of 35 for Xm_n at 1,700 kilocycles.

For the sake of clarity, these two values of Xm have been designated Xm_a, which is the value of Xm at 1,700 kilocycles, and Xm_b is the value of Xm at 540 kilocycles.

We are now ready to obtain the value of the negative mutual inductance, —M, which will, in combination with C_m, give the 15,000 cycle band over the entire range from 540 to 1,700 kilocycles. It will be seen that the chart of Fig. 2 consists of three vertical scales. On the left is a scale for Xm_b and on the extreme right is a scale for Xm_a. The center scale, marked "M Microhenrys" is the one on which the answer will be found.

The procedure is quite simple. On the Xm_a scale we find the point 35 and on the Xm_b scale the point 25. Joining these two points with a straight line, we

(*Continued on page 31*)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Each radio tube socket shown here satisfactorily met a particular need. The most widely diversified line of sockets and plugs in America is offered by "Cinch." Thirty three different types of contacts! Each component part skillfully designed and produced to give maximum performance. *Foolproof* radio tube sockets, with positive constant contact on all prongs, assembling ease, soldering accessibility, *promptly delivered*, "Cinch" radio tube sockets have been adopted by leading set manufacturers.
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Design . . Notes And

110-A program amplifier is equipepd with automatic volume limiter.

A STEP TOWARD VOLUME COMPRESSION

THE WESTERN ELECTRIC COMPANY has introduced to the broadcasting industry a device which will enable stations to double their effective signal level without raising their input power or increasing their licensed carrier power.

In the past it has been necessary for the control operator to watch his modulation meter continuously, ever attempting to anticipate its sometimes erratic fluctuations and never daring to remove his fingers from the gain control knob. Now he can devote more attention to other monitoring problems, resting assured that the new program amplifier will automatically prevent over-modulation.

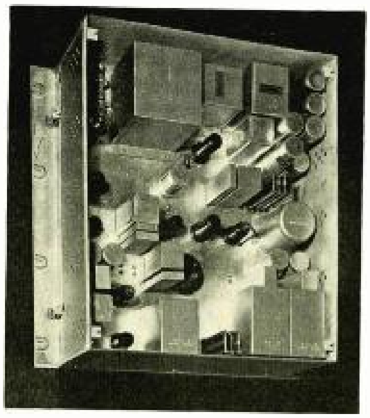
The program amplifier incorporates a circuit which normally amplifies the program to a predetermined level. However, when the input increases above a preselected level, the speech or music energy operates a volume control network in such a manner that the amplification is reduced, thus automatically compensating for the excessive rise. The result is that the product at the output of the amplifier is held within the desired limit, and the device may be easily adjusted so that program peaks will rarely cause modulation of the transmitter in excess of 100 percent.

The basis of this device is a variable loss network inserted in the program circuit and so designed that its loss is directly controlled by the instantaneous program level. As long as the level remains within a predetermined limit the loss inserted is small and fixed, but as the program level rises above the preselected value, the loss inserted becomes increasingly great. Therefore, although the level at the input to the amplifier may rise, the level at its output will taper off above some preselected point, according to the way the automatic monitor has been adjusted. For example, it may be adjusted so that when the transmitter is being modulated 80 percent and another 2 db output will cause 100 percent modulation, 5 db rise at the input will actually be required to accomplish this 2 db rise at the output. Thus it will be seen that with this device the transmitter may be normally modulated 3 db above the level which has been considered safe with manual monitoring, and the effective coverage of the transmitter will be correspondingly increased.

Whenever peaks exceed some preselected level, a light flashes so that the operator may know just when and how often these peaks occur. If these peaks occur too frequently, it is an indication that the general level of modulation is too high and the operator is thus advised that a readjustment is necessary.

Because of this new boon to broadcasters, the personnel of the stations and the listening public alike will benefit through the more satisfactory performance that will result from its introduction.

(*It is felt that this device, even with the limited degree of program-level compression which it affords, is certainly a step in the direction of completely automatic control which, in turn, is prerequisite to the satisfactory operation of expanders in the receiver circuits. It is obvious, of course, that primarily the device is to prevent over-modulation and the compression resulting from its operation is sufficient only to meet this objective.—Editor.*)



Rear view of 110-A amplifier with cover renewed.

ANOTHER TUBE NUMBERING SYSTEM

A SIMPLE TUBE number which gives directly the principal characteristics of the tube to which it is assigned, and one that will absorb new types as they are brought out is sorely needed. An ideal numbering system is one which would show the purpose, electrical and physical characteristics, the cathode voltage and type, the socket required, and any peculiarities of the tube described, yet would not lead to an inordinate number of digits in the tube number.

The system proposed here satisfies most, but not all of these conditions. Physical construction, and electrical characteristics of certain special types are omitted. The system uses a letter to designate the purpose of the tube, a number to indicate cathode voltage and type, and a number to indicate base type, as suggested in the March issue of RADIO ENGINEERING. The 16 fundamental classes are:

A Power-amplifier triode
B Beam-power amplifier
D Diode detector
G Dual grid a-f amplifier (tetrode)
H High-mu a-f amplifier
L Low-mu a-f amplifier
M Mixer or converter
(N) Mixer, like 6L7, if warranted
P Pentode a-f amplifier
Q Screen-grid r-f amplifier
R Remote cut-off r-f pentode
S Sharp cut-off r-f pentode
T Twin tube
U Designation of high-vacuum rectifier
V Designation of vapor-type rectifier
X Half-wave rectifier
Y Full-wave rectifier
Z Voltage-doubling rectifier
E Cathode-ray indicator type (tuning indicator).

As far as possible, the letters were chosen as abbreviations or suggestions of the type tube they represent. The beam-power amplifier was given a separate symbol because of the unique and important characteristics of the tube. The symbols G, N and Z are not absolutely necessary, but they serve to distinguish more clearly the tube types they represent. U and V are not used directly to designate tubes, but are used after X, Y or Z to show the type of rectifier.

Another designation of cathode voltages is suggested, which also distinguishes between heater and direct filament types in addition to giving the voltage ranges. It is as follows:

COMMENT . . *Production*

0 2-volt heater type
1 2-volt filament
2 2.5-volt heater
3 2.5-volt filament
4 5-volt heater
5 5-volt filament
6 6.3-volt heater
7 7.5-volt filament
8 12-volt heater
9 25-volt heater.

Note that in this classification, all heater type tubes are even numbered, while all filament types are odd numbered with the exception of Fig. 9, which represents 25-volt heater type. The classification takes care of all tubes except the WD-11, WX-12, V99, 20, 22, 26 and the 30-volt 48. Of these, none is of importance except possibly the 48. Such peculiar cathodes as those of the 82 and 15, as well as the difference between the metal tube rectifiers 5W4 and 5Z4 are distinguished by this system.

The actual tube number consists first of the letter representing the primary purpose of the tube, then, for dual purpose, multi-unit, or rectifier tubes, a second letter to represent the second purpose or to modify the characteristic; next the cathode type number, then a number giving the number of prongs on the base, or for the octal base, the number 8 at all times, irrespective of the number of prongs used. If there is more than one tube that would have the same number throughout, then a serial number would be added to distinguish the various tubes. To illustrate, take the 41, 42 and 89, all tubes of essentially the same character. Under the proposed system, they would be called P66, P662 and P663 respectively. The P showing that they are pentode audio amplifiers, the first 6 indicating a 6.3-volt heater type cathode, the second 6 giving the number of prongs on the base, and the 2 and 3 showing that these particular tubes were the second and third of that particular character.

The 6B7, a duplex-diode pentode, is a good illustration of the application of the numbering to a multi-unit tube: the corresponding symbol for it is DP67, the corresponding metal counterpart DP68, and the 2-volt filament type, DP16. A low-mu triode-pentode would be called an LP67 (the 6F7), while a high-mu twin-triode such as the 6N7 would be a TH68.

Tubes corresponding to the more familiar rectifiers would be named as follows: The present type 80, a YU54; the 83, a YV54; the 5Z3, a YU542; the 83-v, a YU44; the 82, a YV34, and the 1-v, an XU64.

The 6A8 and 6L7 present a difficulty in naming which is possible of three solutions: The 6L7 can be given a double characteristic, such as is done in the March RADIO ENGINEERING; a separate letter can be assigned to it, or it can be classed as a second tube with characteristics similar to the 6A8. The difficulty with giving it a double characteristic is that one who is not familiar with the tube might interpret the number to mean that the tube was a multi-unit tube with a sharp and a remote cut-off unit in the same envelope. There is no such tube at present, but there is a possibility that one will be made. The argument against giving it a separate letter is that it makes one more letter to remember, and makes a class with only one tube in it. If more tubes like it are to be made, it may be well to make it a separate class. Against classing it as a second type 6A8, is the fact that it has characteristics that give it a wider scope of usefulness than the 6A8. The proposed numbers for these tubes are M68 for the 6A8, and M682 or N68 for the 6L7.

With this system of numbering, about three-fourths of the tubes require four digits, two require five, and the rest use three, based on tube types in the new RCA receiving tube manual. One tube requiring the five digits is the DH262 (2A6), to distinguish it from the DH26 or 75. Both of these tubes are 2.5-volt duplex-diode high-mu triodes.

By placing the distinguishing letter of the tube first, it is possible to arrange the tubes in practically alphabetical order of performance, so facilitating the selection of a tube of desired characteristics from a chart or manual.

No provision can be made in the system for the type 48 tube unless a letter is assigned to designate its cathode construction. The necessity for such a procedure depends on whether such tubes are to be continued.

G. H. Gill
UNIV. OF CALIFORNIA

United Air Lines' "Flying Laboratory."

Inside the cabin of the "Flying Laboratory."

FLYING LABORATORY

EQUIPPED WITH SEVERAL unique inventions designed to eliminate rain and snow static that occasionally interferes with two-way short-wave aircraft radio reception, the "flying laboratory" of United Air Lines is making a series of far-reaching tests which may unlock the problem of static suppression. Four special anti-static antennas are installed on the twin-engined airliner. They include the football-shaped device mounted on top of the plane's nose, the "ring-in-the-nose" type projecting from the nose, and a rotatable ring under the belly of the ship. The fourth type is installed inside the plane. Thin shafts projecting downward from the nose and from the side are "lightning rods" designed to discharge static collected by the metal skin of the transport.

While the flying laboratory speeds along at three miles a minute, technicians record the effectiveness of several new types of anti-static aircraft radio antenna. Upholstered chairs of the big airliner have been replaced by a test stand with recording devices with which the engineers check their success in their battle against rain and snow static which occasionally interferes with plane-ground radio communication.

RMA NEWS

RMA EMPLOYMENT SURVEYS

In an exchange of information on employment conditions, the RMA has just concluded two separate surveys, for receiving set and parts manufacturers, through an RMA questionnaire distributed May 4. A large number of manufacturers in both the set and parts fields participated and average employment rate figures in various employee classifications were secured. The final summaries were distributed to the participating companies, as authorized recently by the RMA Board of Directors.

APRIL EXCISE TAXES

Internal Revenue Bureau collections of the federal five percent excise tax on radio and phonograph apparatus in April, 1937, were $331,618.50, an increase of three percent over the collections of $321,006.84 in April, 1936. April excise taxes on mechanical refrigerators were $1,023,973.58, compared with $1,045,929.90 in April, 1936.

FEBRUARY LABOR INDICES

Marked curtailment during February in radio industry production was due "primarily to seasonal slackening of activities," according to the February report of the U. S. Bureau of Labor Statistics. There was a decrease of 8.8 percent in February radio employment following a decrease of 7.8 percent during the previous month of January. However, the February employment was 5.3 percent above that of February, 1936, and the February employment index figure was 170.6 percent compared with 186.8 percent during the previous month of January.

Radio factory payrolls last February declined 14.9 percent from the previous month, but were 13.9 percent above February, 1936. The February index figure on payrolls was 124.2 compared with 145.4 during the previous month of January.

Average weekly earnings last February of radio factory employees were reported at $19.11, a decrease of 6.7 percent from the January average of $20.38, but the February average earnings were 8.1 percent above February, 1936. The February, 1937, national average weekly earnings of all manufacturing industries was $24.73, while the national average of all durable goods manufacturing establishments was $27.54, both increased about 3 percent above January.

Average hours worked per week in radio factories last February were 34.1 hours, a decrease of 6.1 percent from the January average of 36.3 hours, but were 5 percent above February, 1936. The national average work hours of all manufacturing industries during February was 40.4 hours, an increase of 2.1 percent over January, and the national average work hours of all durable goods manufacturing industries in February 41.6 hours, an increase of 2.6 percent over the previous month of January.

Average hourly earnings last February of radio factory employees was 56 cents, a decrease of only .6 percent from the January average of 56.2 cents, and February hourly earnings were 3.3 percent higher than February, 1936. The national average hourly earnings of all manufacturing industries in February, 1937, was 60.2 cents, while the national average of all durable goods manufacturing industries was 65.1 cents, an increase of 1.2 percent over January earnings.

MARCH EXPORTS INCREASED 17%

Radio exports in March, 1937, increased 17 percent, according to the current report of the U. S. Bureau of Foreign and Domestic Commerce, despite a decrease in receiving set exports, but with large increases in tubes and parts. Total exports last March were $2,608,360, compared with $2,229,717 in March, 1936. The radio export increase for the first quarter of 1937 was 24.1 percent.

Receiving set exports last March numbered 50,955 valued at $1,306,115, compared with 58,595 valued at $1,330,100 in March, 1936.

Tube exports last March numbered 1,002,800 valued at $417,836, an increase over 928,827 tubes valued at $382,930 in March, 1936.

Exports of parts and components in March, 1937, totaled $601,938, compared with March, 1936, exports of $403,198.

There were 37,929 loud speakers valued at $75,641 exported in March, 1937, compared with 17,705 speakers valued at $35,050 in March, 1936, and exports last March of transmitting apparatus totaled $206,830 compared with $78,439 in March, 1936.

For the first quarter of 1937, total radio exports were $7,568,319, against $6,098,083 in the first three months of 1936. This included 164,914 sets valued at $4,211,765 in the 1937 first quarter, against 150,929 sets valued at $3,719,044 in the first quarter of 1936.

Tube exports in the first 1937 quarter totaled 2,526,284 valued at $1,067,022 compared with 1,955,961 tubes valued at $836,490 in the similar period of 1936.

Exports of parts and components in the 1937 first quarter totaled $1,626,684 compared with $1,029,659 in the first quarter of 1936.

Loud speaker exports during the first 1937 quarter were 88,890 valued at $187,529, against 45,331 valued at $93,482 in the first quarter of 1936.

Transmitting apparatus exported during the first 1937 quarter were $475,319, against $419,408 in the similar period last year.

BROADCASTERS MEET JUNE 20

The annual convention of the National Association of Broadcasters will be held June 20-23 at the Sherman Hotel in Chicago. Many promotion, advertising, copyright and operation problems are on the broadcasters' program as arranged by Managing Director James W. Baldwin.

CANADIAN SALES

March sales of Canadian manufacturers, according to information to RMA from Canadian RMA, totaled 13,257 sets valued at $1,119,698, compared with 8,978 sets valued at $824,511 in March, 1936. Of the March, 1937, Canadian sales 8,598 were a-c sets valued at $849,830; 1,433 battery sets valued at $90,014, and 3,226 automobile sets valued at $179,854.

For the first quarter of 1937 Canadian sales reported were 36,172 sets valued at $3,187,137, compared with 31,703 sets valued at $2,942,425 in the comparable quarter last year.

ENGINEERING MEETINGS

Ten RMA engineering committees held meetings at the Pennsylvania Hotel during the 25th Anniversary Convention of the Institute of Radio Engineers. In addition to a meeting of the Committee on Broadcast Receivers, of which Mr. E. T. Dickey is chairman, there were meetings of the Board of Editors of the "RMA Engineer" under Chairman L. C. F. Horle, and many meetings of sub-committees working on parts and tube standardization.

NEW YORK SHOW POSTPONED

Announcement has been made of postponement until next year of the proposed National Electrical and Radio Exposition scheduled next September in the Grand Central Palace, New York. Sometime ago the RMA Board of Directors adopted resolutions against exhibitions in shows on the ground that they were not in the interest of the industry.

EXPORT NOTES

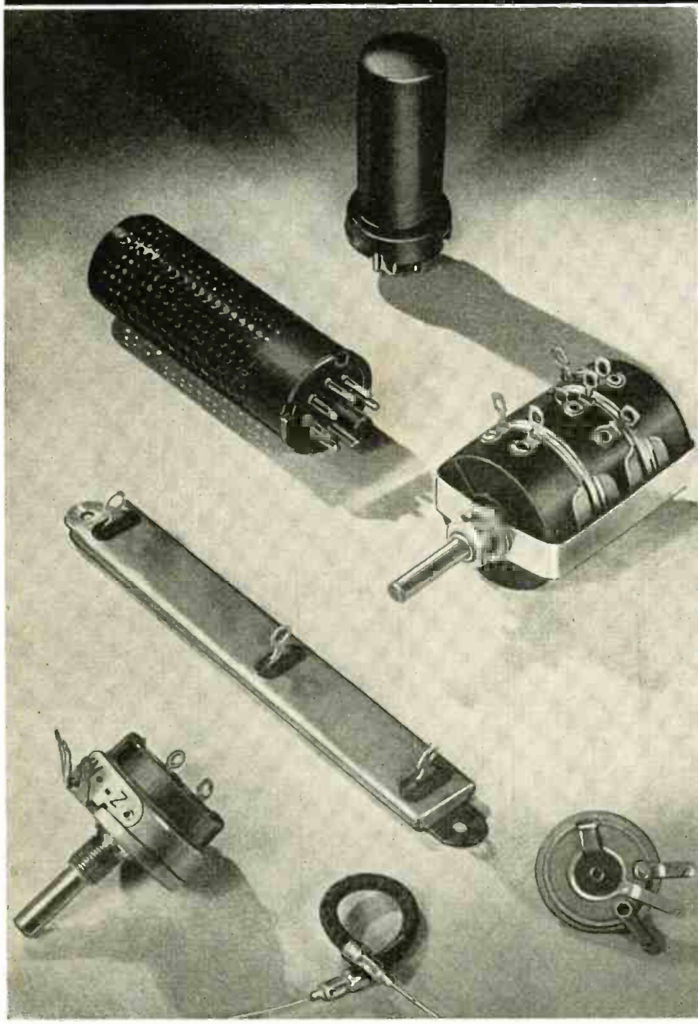
Czechoslovakia—Another reciprocal trade agreement, with Czechoslovakia, is being negotiated by the State Department, and Chairman S. T. Thompson of the RMA Export Committee has made arrangements to urge inclusion of concessions for radio.

Bolivia—Import prohibitions against radio sets valued under $50 have been removed in Bolivia by an export decree, according to advices to the U. S. Bureau of Foreign and Domestic Commerce. Prohibitions against imported radios worth over $50 remain in effect.

Argentina—Argentine and the Netherlands have signed a commercial agreement, according to advices to the U. S. Bureau of Foreign and Domestic Commerce, providing for reduction of the Argentine duty on Dutch radio sets, certain component parts and amplifying apparatus and other commodities. The trade treaty was negotiated by a Dutch trade mission and is subject to ratification by the Netherlands Government.

Brazil—The Vivacqua Irmaos S. A. of Rua Jer Monteiro No. 32, Victoria, State of Espirito Santo, Brazil, a branch of a Rio de Janeiro importing house, has written the RMA requesting exclusive agency for American radio manufacturers in the State of Espirito Santo. Catalogs and correspondence from American manufacturers interested in the territory of the State of Espirito Santo are requested.

Let CLAROSTAT *Solve* YOUR RESISTANCE PROBLEM



THE Clarostat organization does just one job: it makes resistors and resistance devices—nothing else. It plays no favorite type or types. That is why you can depend on getting precisely that type best suited to your particular assembly.

■ *Adjustable Resistors*

Potentiometers and rheostats. Wire-wound or composition-element. Dual and triple units for T-pad, L-pad and mixer constant-impedance controls, etc. With or without power switches. Any taper. Also constant impedance output (25 watt) attenuators for P-A systems, Handy hum controls. Etc. Etc.

■ *Fixed Resistors*

Inexpensive flexible resistors with braided covering. Wire-wound plug-in resistors for line-dropping and voltage-divider networks. Center-tapped strips. Metal-clad strip resistors, including NEW Molded-Seal Type.

■ *Ballast Resistors*

In perforated metal casings and in metal tube styles, for voltage regulation.

Loose - Leaf DATA covering every type of resistor in general use, available on request. Write on your business letterhead. Meanwhile, submit your resistance problems for engineering aid and quotations.

CLAROSTAT *Manufacturing Co. Inc.*
285-287 NORTH SIXTH STREET
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News Of The Industry

TRANSDUCER CORP. MOVES FACTORY

G. M. Giannini, President of the Transducer Corporation, announced from executive headquarters in Radio City, New York, that demand for his company's microphones and inter-office communication systems has necessitated a 700 percent increase in factory space. The Transducer factory which had been located at 22 West 48th Street, has moved to larger quarters at 455 West 45th Street.

In charge of activities at the new address are F. L. Lester, Production Engineer, and Ben Eisenberg, Test & Design Engineer. Serving in the capacity of Design Consultant is Richard W. Carlisle, well known throughout radio engineering circles, and a former member of the staff of Westinghouse and RCA.

— RE —

RADIO EQUIPMENT PROTECTION

How tubes, transformers, condensers and other equipment may be safeguarded is the subject of an interesting folder just issued by Heinemann Electric Co., Trenton, N. J. "Radio Equipment Protection" describes the Re-Cirk-It combination switch and circuit breaker, available in ratings from 50 milliamperes up to 35 amperes, and in instantaneous trip and time-delay action for various kinds of loads. A copy will be sent on request.

— RE —

CHINA APPOINTS ARCTURUS TECHNICAL ADVISOR

Officials of the National Government of China and executives of the Arcturus Radio Tube Company, Newark, New Jersey, concluded a contract recently naming that company as official technical advisors and counsellors to assist the Republic in its radio tube manufacturing program.

In preparation of this program, Kyi-Tsing Chu, former chief engineer of the Radio Administration, Ministry of Communications of the National Government of China, and associates representing the National Resources Commission visited various radio tube factories during the few months they have been in the United States. Final decision, selecting Arcturus as its source of engineering information was then made.

MALLORY ACQUIRES ELECTRAD

P. R. Mallory & Co., Inc., Indianapolis, announce the purchase of the assets, good will, trade-marks, patents and patent rights of Electrad, Inc., New York City. L. A. de Rosa, Chief Engineer, and other key employees of Electrad, Inc., will join the Mallory organization. Plant and offices will be moved to Indianapolis.

— RE —

AMPHENOL CATALOG

A new radio parts catalog has been announced by the American Phenolic Corp., 500 South Throop Street, Chicago, Ill. Completely revised since the previous issue, the catalog contains data on new connectors, cable accessories, etc., as well as complete listings of sockets, plugs, connectors and associated equipment. Copies will be furnished on request.

— RE —

PLASTIC MOLDING

A booklet, The Story of Plastic Molding, has been announced by the Chicago Molded Products Corp., 2145-53 Walnut Street, Chicago, Ill. Because of the many important uses of plastics in the radio industry, the booklet should be of interest to many. It contains descriptions of various molding materials and their properties, hints on design, and a complete listing of parts available from stock molds. Copies may be obtained by writing to the company on business letterhead.

— RE —

MODERN PLASTICS COMPETITION

To exemplify the improvement in industrial equipment and scientific apparatus during the past year through the use of plastics materials, *Modern Plastics* magazine announces that it is accepting entries for the Second Annual Modern Plastics Competition.

A skillfully designed plastic trophy, the first of its kind ever used, is offered to designers, engineers, architects, materials manufacturers, mold makers, and concerns sponsoring plastic applications to their products, with first, second and third honors to be awarded in the industrial and scientific classifications. The contest closes on September 15th, and there are no fees or charges involved.

Chinese government officials visit the Arcturus plant.

RAILWAY EXPRESS APPOINTMENTS

Several changes among operating officials in certain sections are announced by Railway Express Agency.

E. H. Stevens has been appointed general superintendent of transportation Central departments, headquarters Chicago, succeeding J. G. Ruble, retired after more than fifty years of service.

J. C. North has been named superintendent of the Southwestern Kansas division, with headquarters at Wichita, Kansas, succeeding E. H. Stevens.

E. M. Graham, superintendent of the Montana division, with headquarters Spokane, Wash., vice J. C. North.

C. I. Fitzgerald assumes the post of superintendent of the Washington-Alaska-Yukon division at Seattle. Mr. Fitzgerald was formerly general agent in Denver. He succeeds Mr. Graham.

John R. Marra has been appointed superintendent of the Buffalo-Erie division in the Empire State department, headquarters Buffalo, N. Y. Mr. Marra was formerly chief clerk to the president in New York. He succeeds F. F. LaRowe, who recently retired after a career of over half a century in the express service.

— RE —

MOSS JOINS SOLAR

Arthur Moss, well known throughout the radio industry, has recently resigned as president of Electrad, Inc., with which company he has been associated since 1923. As is announced elsewhere on this page, the control of Electrad, Inc., has passed to new interests.

As of June 1st, Mr. Moss becomes sales manager of Solar Manufacturing Corporation, New York City, manufacturers of condenser products, and Wickham Harter, who has been in charge of sales of that company since its organization, has been promoted to the position of general sales manager.

Mr. Moss for many years has been actively connected with the Radio Manufacturers' Association, representing on its Board of Directors the interests of the parts and accessory manufacturers in the radio industry.

— RE —

MAGNAVOX BULLETIN

The Magnavox Company, Fort Wayne, Indiana, has issued a bulletin in which are listed the complete specifications of this company's line of dynamic speakers. This bulletin will be mailed to those requesting it.

— RE —

ISOLANTITE BULLETIN

Bulletin 103, Isolantite Stand-Off Insulators, has just been issued by Isolantite, Inc., 233 Broadway, New York City. Copies may be obtained by writing to the company at the address given.

— RE —

VIBRATION STUDY

Copies of a circular bearing the above title will be furnished to those requesting it from the Sundt Engineering Co., 4238 Lincoln Avenue, Chicago, Ill.

BELIEVE IT OR NOT

WITH APOLOGIES

UTC's leadership in transformer design is substantiated by the fact that some of the largest commercial organizations turn to UTC with their special transformer problems. Some of the more interesting units recently made by UTC for such organizations are almost in the "Believe It or Not" class.

1

One organization* required a 60,000 AMP. transformer in a space approximately seven inch cube. Every other supplier contacted said "Impossible."

UTC MADE IT.

2

One of the important elements in the "U. S. Safety in the Air" program involved a special filter for use on planes. The excessive weight of this filter made the system impractical.

UTC, however, reduced the weight from over thirty pounds to 3¼ POUNDS.

3

The use of high carrier frequencies for special communication service made necessary high power amplifier equipment for test service.

UTC designed the amplifier equipment for one organization* and supplied the audio transformers for service up to 100,000 CYCLES.

4

Hum pickup on portable amplifiers and pre-amplifiers was the bugaboo of one communications organization.†

They are now buying UTC because, as their Engineering Department stated, "We wouldn't have believed it possible if we hadn't actually made complete laboratory tests." The input transformers supplied to this organization weigh only eighteen ounces, have a frequency characteristic uniform from 30 to 14,000 cycles, and a hum pickup 90 DB lower than similar units of standard construction.

5

A special carrier frequency problem encountered by one company,** required a high power, air-cooled, audio transformer with 30,000 VOLTS insulation and frequency response good up to 150,000 CYCLES.

A unique transformer winding licked this problem.

6

A complete group of speech input and remote pickup amplifiers manufactured by one company,¶ were not usable due to high hum level.

UTC suggested the use of the LS-10X (tri-alloy shield) input transformer, which eliminated the problem completely.

7

One of America's foremost radio comedians wanted to imitate the voice of America's foremost news announcer on his program.

The UTC 4 B sound effects filter made the job perfect.

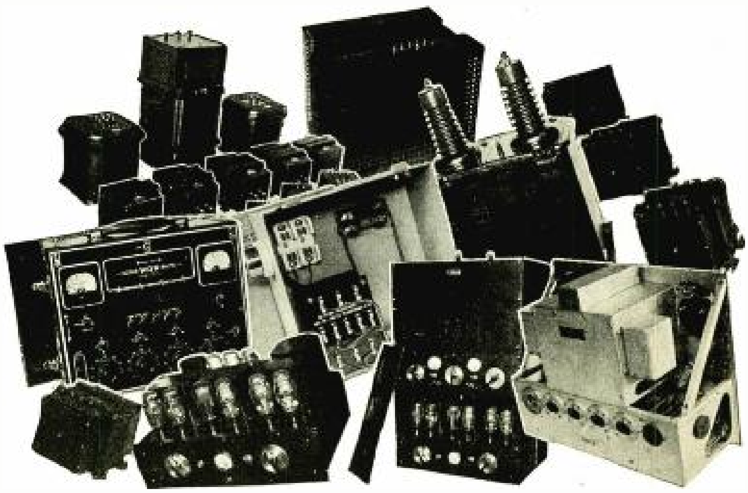
TO OUR KNOWLEDGE

* The largest research organization in the world.

† Largest radio receiver organization in the world.

** Largest radio communications company in the world.

¶ Largest electrical manufacturer in the world.



UNITED TRANSFORMER CORP.

72 SPRING STREET • NEW YORK, N. Y.

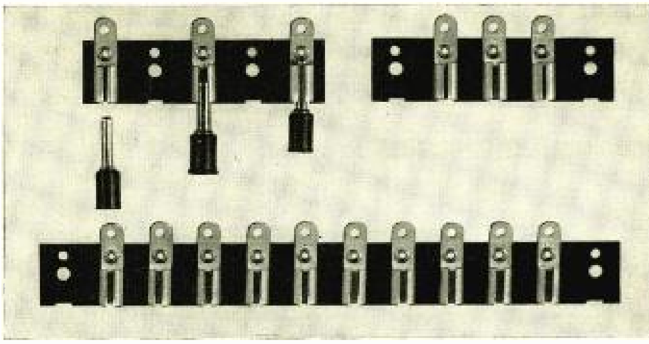
EXPORT DIVISION: 100 VARICK STREET NEW YORK, N.Y. CABLES: "ARLAB"

New Products

WESTON TUBE CHECKER

A radio tube checker said to be of unusual operating flexibility, designed as a "matched companion unit" for the Weston 772, 20,000 ohm-per-volt analyzer, has just been introduced by the Weston Electrical Instrument Corporation, Newark, N. J. Equipped with a large rectangular indicating meter "stepped up" from a two-color metal panel, this Model 773 tube checker is equally striking in appearance and convenient in use. If desired, the two test units may be purchased in a single combination carrying case designed for the purpose. Or, as an individual piece of equipment, the tube checker is available with carrying case or special counter mounting.

— RE —



The Cinch terminal strip.

HAMMARLUND PRODUCES NEW TRANSFORMER

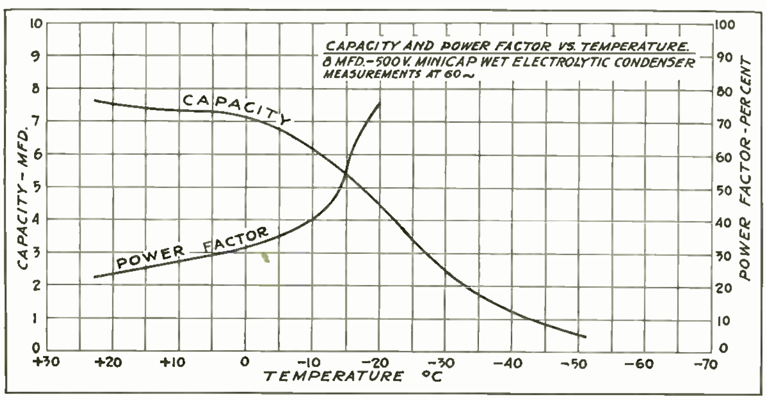
A new group of iron core i-f transformers are now being made by the Hammarlund Manufacturing Company, Inc., 424 West 33rd St., New York City.

These new transformers are said to provide high gain per stage together with extremely sharp selectivity. Specially developed finely powdered high permeability magnesium alloy, rust proof and non-corrosive, is used for the core. This core is claimed to afford a great increase in inductance. thus permitting a reduction in the number of winding turns and consequently greatly reducing eddy current losses. These transformers may be used with all tubes normally used in i-f amplifiers. They are illustrated and further described in the Hammarlund catalog available free of charge.

— RE —

SOLAR MINICAP

Solar Manufacturing Corporation, 599 Broadway, New York City, announces "Minicap," a new, ultra-compact, non-freezing wet electrolytic capacitor. Ranges up to 8 mfd. at 500 volts peak and 38 mfd. at 100 volts peak are furnished in a can only 1" diameter by 1 15/16" high. This represents a reduction in size of 85% from older wet electrolytic practice. Temperatures as low as —20° Centigrade are said to find the Minicap still in practical operative condition.



SPACE SAVING TERMINAL STRIP

Cinch is now offering a new improved terminal strip, designed for the set with limited space. It is a most efficient speaker terminal strip with a tenacious grip. Contacts are made of highly resilient metal treated by a Cinch exclusive method, especially for easy soldering. Will not turn or distort under any continuous abuse; secured to dialectric strip end with three point support. Will not take a "set," no tension loss. Strips may be had with from one to ten terminals with mounting centers of ½" spacing. It is said to be absolutely new in its major features. It was developed by engineers of The Cinch Manufacturing Corporation, 2335 W. Van Buren Street, Chicago, Illinois.

— RE —

PLUG-IN INSTRUMENTS

New, low-cost, detachable instruments for general industrial use whose sockets may be cut into the conduit run feeding a motor or grouped in standard metal boxes to constitute a panel assembly, are announced by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Sockets can be installed at low cost in all circuits feeding electrical loads in industrial plants and processes where it would be helpful to know consumption and performance characteristics, even if only occasionally. Direct advantages of the plug-in instrument for industrial use include, (1) socket provides its own switchboard eliminating costly panels, wiring and mounting details, (2) various instruments can be plugged in the same socket to obtain volts, amperes, watts, power factor, kilowatt hours, etc., and (3) sockets can be installed and sealed off providing convenient outlets for future installation of instruments or making connections for portable analyzers for periodic testing.

— RE —

CAL-FON SYSTEM

The Cal-Fon produced by the Universal Microphone Co., Inglewood, Cal., as an inter-communicating 'phone with any number of stations, in June was started in production in a model specially adapted for automobile trailers. It will be the conventional handset but will be designed for wall use. The device will be fitted with a spring ring clip similar to those used on shipboard with the addition of a wall bracket. The Cal-Fon itself will be available for trailer installation, but the 'phone in the automobile itself will have no box. Switch will be in the handle. A buzzer, bell or light can be attached for signal purpose.

— RE —

AIR CELL RESISTOR

"Everready" "Air Cell" Resistor, an inexpensive device which converts to "Air Cell" operation radio receivers originally designed to be powered by 2-volt storage batteries, has been placed on the market by National Carbon Co. This flexible resistor, five and a half inches long, has only to be connected to either terminal of the "Air Cell" battery for the radio owner to begin enjoying the advantages of "Air Cell" reception. Resistors are made in five different values, to match the current drains of different makes and models of receivers.

— RE —

RCA TUBES

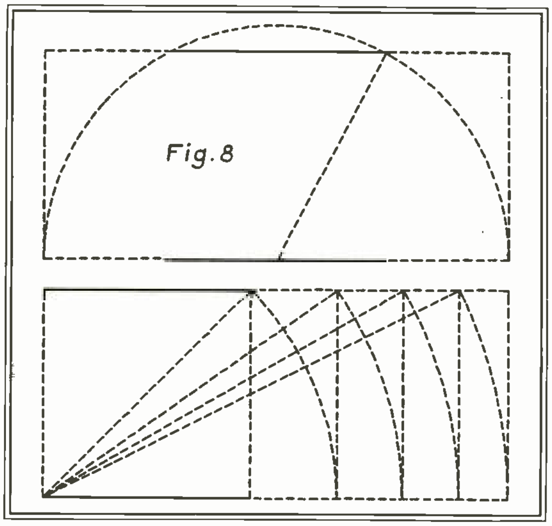
Recent additions to the Radiotron line include: 6D8-G, pentagrid converter; 6L5-G, detector amplifier triode; 6N5, tuning indicator; 6S7-G, triple-grid, super-control amplifier; and 6T7-G, duplex diode high-mu triode.

Complete information on these types may be obtained from RCA Mfg. Co., Inc., Radiotron Division, Harrison, N. J.

DYNAMIC SYMMETRY

(Continued from page 6)

true in this root, the length of the diagonal being 1.618 times the unit side. Here again the sides are incommensurable in length but commensurate in area. Root 4 again becomes commensurate in line as well as in area and as shown in Fig. 5 consists of two unit squares.



By similar methods we can construct Root Figures of any denomination. All of these rectangles are considered to be strong dominant shapes based on good proportion. Each of these roots was originated from the unit square and constructed outside of its confines. It is also possible to build the same proportionate figures within the square as shown in Fig. 6.

This is done by drawing an arc from any corner of the square and intersecting this arc with a diagonal. If a perpendicular is dropped from this point, the enclosed figure is in Root 2. As shown in the diagram, all roots can be constructed within as well as outside of the unit square.

There is one more fundamental shape of major importance to Dynamic Symmetry, christened with the exotic name of "The Whirling Square." The geometry of its construction is explained in Fig. 7. If the arc is continued through 180 degrees as in Fig. 8, we produce a Root 5 overall and two overlapping Whirling Squares. This close relation between Root 5 and the Whirling Squares will be utilized in later construction.

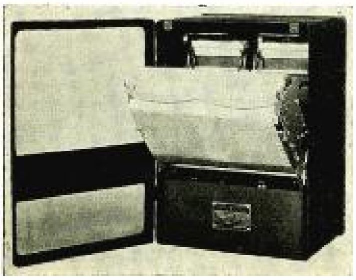
Those that have waded through the explanation to this point are no doubt interested in just how and where these various figures can be applied to design. The clippings taken at random from engineering pamphlets illustrate the extensive use of Dynamic Symmetry in radio today. From name-plates to complicated chassis lay-outs, the engineer will find that these fundamental figures are given consideration both by the manufacturer and the set designer. It is an interesting as well as instructive pastime to take a pair of dividers and go over some of the well known products on the market today and see for yourself the extensive applications of even these fundamental shapes. True, Dynamic Symmetry is concerned with far more than just a boundary line in good proportion, but the art of determining and being able to produce such simple areas is the first step in utilizing this new science.

(To be continued)

HIGH-VACUUM 2-INCH CATHODE-RAY TUBE

A new 2-inch high-vacuum cathode-ray tube with four electrostatic deflection plates, two common, is announced by Allen B. DuMont Laboratories, Inc., Upper Montclair, N. J. Known as Type 24-XH, this tube measures 7⅝ inches overall in length. A large octal base is used. The heater voltage ac or dc is 6.3, making this tube interchangeable with the 913. From 300 to 600 volts may be applied on the second anode. Providing four times the area of the 1-inch tube, Type 24-XH offers a practical tube for all routine operations where economy and compactness are essential.

— RE —



G-E DOUBLE PHOTOELECTRIC RECORDER

A photoelectric instrument which will record simultaneously on one chart, two electrical quantities as low as one microampere, full scale, and representing a power consumption of but 0.000000001 watt from the measured circuit, has just been placed on the market by the General Electric Company. It is designated the double photoelectric recorder.

The double photoelectric recorder can be applied wherever simultaneous readings are desired. In some cases this immediately cuts testing time in half and in others it aids materially in discovering unusual relations between two variable electrical quantities. This recorder is the outgrowth of the original photoelectric recorder which has become familiar to electrical and mechanical engineers, physicists, and others, including physicians, and scientific crime-detection specialists.

— RE —

CLAROSTAT PRECISION RESISTORS

For precise resistance values, such as in measuring equipment and critically balanced circuits, Clarostat Mfg. Co., Inc., Brooklyn, N. Y., is producing close-tolerance resistors to meet any specifications. Because of unique winding machines at the Clarostat plant, the strip type precision resistor can be produced at a relatively low cost, so that precision units need no longer be considered in the laboratory class, it is said.

Typical of such precision units are the strip resistors made for an instrument manufacturer. The accurately spaced wire is wound on bakelite strip. The winding, checked by the operator to come within the given tolerance, is treated with a protective lacquer. In some instances the finished winding is further protected by a special wrapping. Such resistors are a routine production matter in the Clarostat plant, and are turned out in large quantities and at a relatively low cost, with a 2% plus or minus tolerance, it is said.

NEW CINAUDAGRAPH SPEAKERS

The Cinaudagraph Corporation of Stamford, Connecticut, announces a new series of small speakers. Although the speaker diameters are only five inches, the units incorporate the polyfibrous cone material, the dust-proof voice coil and the magnet alloy, "Nipermag." There are two models, one of which is 5⅜ inches in outside diameter without mounting holes. This model is to be clamped into position and is designed for intercommunication systems and for header-type automobile installations. The other model is 5¾ inches in outside diameter with mounting holes and is designed for those applications where the six-inch speaker is found to be too large.

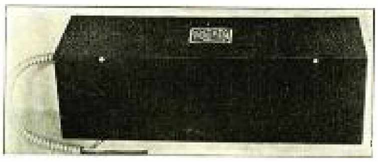
— RE —

TOBE POWER LINE FILTER

Providing 60 db. attenuation of frequencies between 200 kc and 30 mc, the new power line Filterette, Model TR25, isolates receiver and instrument test rooms from high frequency disturbances present on electric power circuits in factory and industrial areas.

Filterette TR25 is designed to operate on any 110 volt, single phase circuit and will handle 25 amperes without excessive heating or voltage drop.

For factories or laboratories desirous of filtering 220 volt or polyphase circuits, the Filterette Division of the Tobe Deutschmann Corp., Canton, Mass., is prepared to design and construct special Filterettes in any desired current carrying capacity.



— RE —

TRU-TAN MODEL B-16 PICKUP

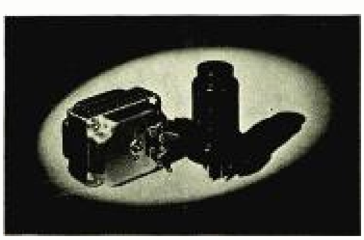
The engineers of the Astatic Microphone Laboratory, Inc., of Youngstown, Ohio, have released their new Tru-Tan Model B-16 Pickup.

This instrument introduces to the professional field the Astatic Offset Head Design, a refined form of the offset principle which is the European practice.

— RE —

MOTOR FOR REMOTE CONTROL

A new motor is being announced by the Utah Radio Products Co., designed especially for use in remote radio controls. It is a shaded pole induction motor, of the 3-wire brushless reversible type unusually compact but with a high torque for its size. It will be produced in three sizes of ¾-inch, ⅞-inch and 1-inch rotor diameter and can be made up for any voltage from 6 to 110 volts ac. With its compact construction and its freedom from radio interference due to the absence of brushes, this motor is said to be ideal for the purpose for which it was designed.



LEPEL OSCILLATORS

The model "E" oscillators, manufactured by the Lepel High Frequency Laboratories, Inc., 39 West 60th Street, New York City, are described in a bulletin, No. 403, just issued. The model "E-1" oscillator is designed for permanent mounting on automatic exhausts; the "E-2" is for hand use.

These oscillators are of the quenched-gap type, and are designed to be shock proof and ground free. They are used for gas indicators in tube manufacture, etc.

Complete information may be obtained from the manufacturer.

— RE —

VOCAGRAPH FEATURES "HUSHED-POWER"

New Vocagraph amplifiers and complete portable sound systems, just announced by the Electronic Design Corp., 164 N. May St., Chicago, Ill., feature a reproducing principle termed "Hushed-Power." It is claimed that this recent development makes possible an amplifier with far greater usable power output than can be achieved through former designs. In general, the principle of "Hushed-Power" employs an improved proportioning of stage gain which reduces tube loading and the possibility of distortion from overload. Another feature of this system is the reduction of internal noise and hum by means of improvements in transformation and filter circuits.

— RE —

PANEL INSTRUMENTS

A line of low-priced panel instruments with bridge type construction and soft iron pole-pieces has been announced by the Simpson Electric Company, 5216 Kinzie Street, Chicago. This type of construction, states the Simpson organization, has only been available in instruments selling at considerably higher prices. Increased initial accuracy and lasting accuracy over a period of years are the advantages claimed for this construction.

— RE —

MICROPHONE DESK STAND

The desk stand shown in the accompanying illustration has just been announced by the Amperite Company, 561 Broadway, New York City. By placing the microphone horizontally, the center of gravity is lowered, making the stand quite stable, and the leaf spring suspension acts as a shock absorber. The microphone can be rotated in practically any position, making it useful for pulpit, desk and footlight installations.

R-F CHARTS

(*Continued from page* 20)

find at the intersection of this line and the center scale, the value of —1.4 microhenrys for M.

In a similar manner, on the chart of Fig. 3, we locate our points of 35 and 25 for Xm_a and Xm_b, respectively. Joining them with a straight line, which is prolonged to intersect the "C_m Microfarads" scale, we run into what is apparently an incongruous result, i.e., our answer is off the scale—considerably so! However, it should be noticed that the lower end of the "C_m Microfarads" scale is at "infinity." This can be taken to mean that any value of C_m in excess of about 0.5 mfd will serve to make the circuit function properly. Actually, it might be better engineering to start all over again with coils of different inductance (but here caution must be exercised in that too radical a change in coil inductance will materially affect the frequency range over which the circuit is to operate) and which have not only different resistance, but *different rates of variation* of resistance with frequency. It might be well to point out here that the solution of the problem which we have just carried out, indicates quite clearly that the coils which were considered (bank-wound with Litz wire) are not ideally suited to this particular type of circuit. The situation is likewise indicative of the "cut-and-try" technique which is so essential to the actual engineering of a circuit. The final answer, with respect to the value of C_m, is unsatisfactory and it would be most desirable to, as mentioned above, start all over again with coils of radically different resistance characteristics in order to arrive at a solution which will not be in the form of "almost any value greater than"—which, after all, is not much of an answer.

In order to obtain coils with a negative mutual inductance, the most obvious method is again "cut-and-try." There is—so far as we can learn—no mathematical formula by which the design can be predicted. Some authorities whom we have consulted stated as follows: The best way to obtain the small values of negative mutual inductance which will obviously be required will be to wind a coil of two wires, side by side; that is, two wires held parallel and wound onto a form. Or, a solenoid wound bi-filar would be a logical method. In this event, it is felt that the mutual inductance will closely approximate the inductance of a single-layer solenoid of comparable dimensions. In the event the bi-filar winding is used, the closed end of the bi-filar winding connects to C_m; in the case of parallel wires wound onto a form, the "start" ends would connect to C_m.

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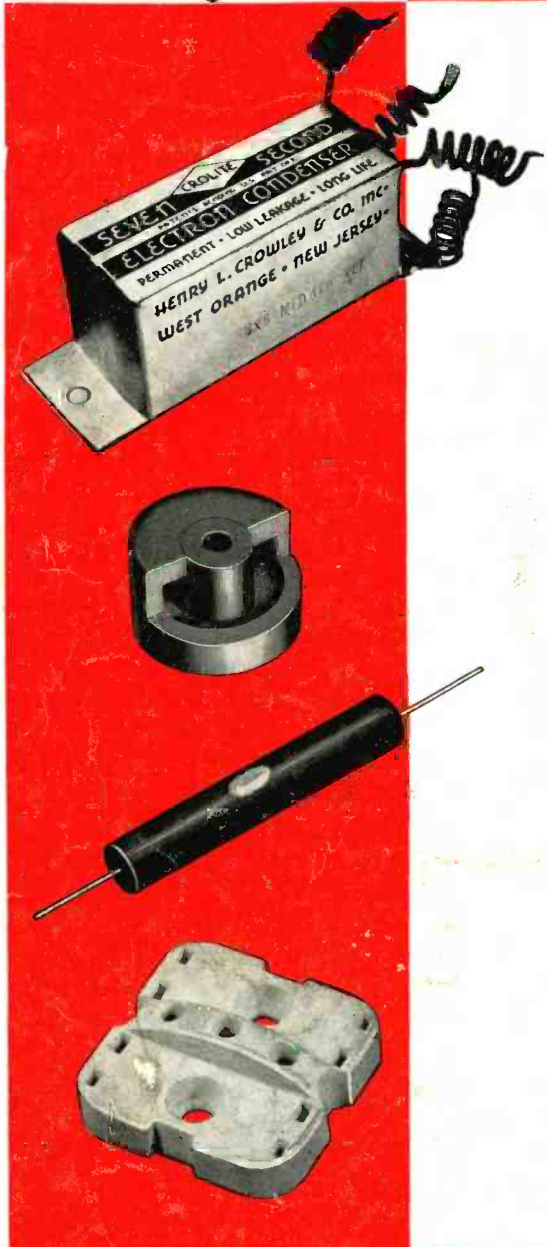

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