Tenth Year of Service

RADIO ENGINEERING

Vol. X MAY, 1930 No. 5

IN THIS ISSUE

Sold only by subscription
$2.00 per year

The Journal of the Radio Industry

The "Synthetic" Age

THE true value to you, and *usefulness,* of ANY material, is not what it is,—*before* you are using it. Its *true* value depends on:

What it will do . . . . . **FOR** you.
What you can do . . . . . **TO** it.
What you can do . . . . **WITH** it.

In the STONE age, the advance in civilization was not in the Stone itself. It was in what people did WITH it, and TO it, and what it did FOR them.

In the IRON age,—our own rapid advances in civilization, and in standards of living, have been not merely from the fact that Iron *existed,*—but from what it does FOR us; what we have learned we can do TO it; and what we can do WITH it.

In the "SYNTHETIC" age, — the age of synthetic materials which we are entering now, exactly the same is true; it is conceded that the most important of the Synthetic Materials are the CELLULOSE GROUP, developments in which have been led by VULCANIZED FIBRE—the material of a million uses.

This company made the first Vulcanized Fibre in America, and for more than fifty years has led in scientific advancements which, starting from that crude first product fifty-seven years ago, have developed into the many different types of vulcanized fibre and phenolite which we now make,—perfected for the various requirements of Engineering and Industry.

Actually NEW materials, in terms of "What they will do FOR you; what you can do TO them; and WITH them."

* * *

In all Industry, there is now a new awakening to the fact that too often the *REAL* drag on profits, and on success in competition, is the using of *WRONG MATERIAL.*

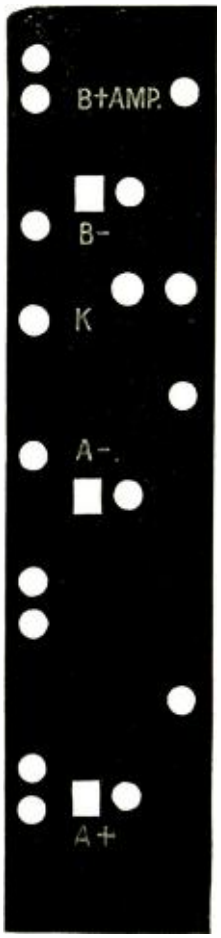
In all the *New Thoroughness* there is the one indispensable factor,—the question—*Are you Thinking IN THE RIGHT MATERIAL?*

NVF

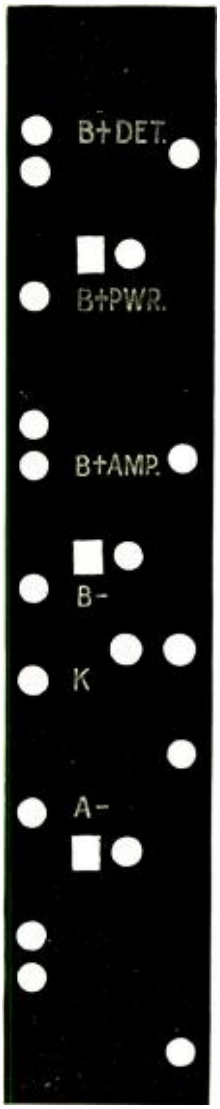
Write for Fact-Sheets of Industry, No. 1,—practical knowledge which hitherto has not been readily accessible—Mailed FREE to any worker or executive. Limited edition—Write NOW. State work you do, your company's product or business, and whether request is for self. Address Librarian (Dept.Q-4) National Vulcanized Fibre Company, Wilmington, Delaware, U.S.A.

NATIONAL VULCANIZED FIBRE COMPANY

Makers of "Peerless" insulation; Special Phenolites; "righter" Bakelites; many kinds of Vulcanized Fibre; Material Handling equipment etc . . .
Serving America's industries from smallest to greatest.



INSULATION THAT HAS THE ENGINEERS' *Confidence!*



FOR 17 years the phenolic laminated insulation produced by the Formica Insulation Company has had the confidence of the leading American engineers and production men.

The largest equipment in this field, and a large and competent organization is concentrated on the problems of producing just this one material, and that specialization has been resultful.

Formica is available in sheets, tubes and rods, and in every variety of part that can be machined from those forms. Send in your blue prints for estimates.

THE FORMICA INSULATION COMPANY
4638 SPRING GROVE AVE., CINCINNATI, OHIO

FORMICA

RADIO ENGINEERING

Reg. U. S. Patent Office

Member, Audit Bureau of Circulations

Western Editor EVANS E. PLUMMER | *Editor* DONALD McNICOL | *Associate Editor* AUSTIN C. LESCARBOURA

Vol. X | May, 1930 | Number 5

Contents

Departments

But It Will Not Happen Again

SOME time ago the editor of RADIO ENGINEERING asked the editor of the largest engineering periodical in the world what particular problem caused him the greatest concern.

The answer was: "Getting the subscribers to take the wrapper off the journal when it reaches them."

With many technical and industrial journals this is a real problem. Fundamentally, it is the character of the monthly contents of the magazine that determines whether or not subscribers are eager to rip off the wrapper to get at the contents.

It is a healthy situation when those who subscribe for a technical journal do so because they need and desire the sort of information published regularly therein. This refers to editorial text matter and to advertisements.

In this respect RADIO ENGINEERING is having very little difficulty. In fact when a subscriber's copy is lost in the mails we are promptly apprised of the loss. Owing to a shift of our printing establishment in April to new and larger quarters, the April issue of RADIO ENGINEERING was delayed one week in getting into the mails.

Ye editor may be perverse, but it was good to read the unending inquiries asking when the issue would be out.

Publishing
AVIATION ENGINEERING
RADIO ENGINEERING
PROJECTION ENGINEERING

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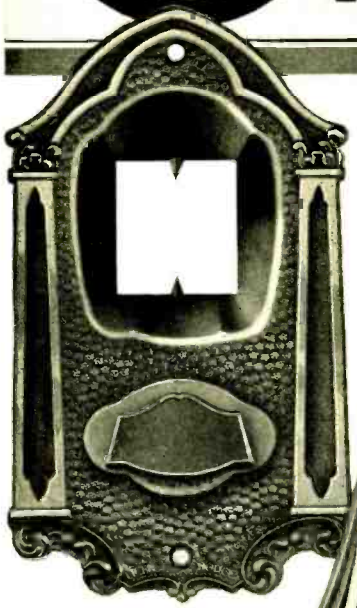
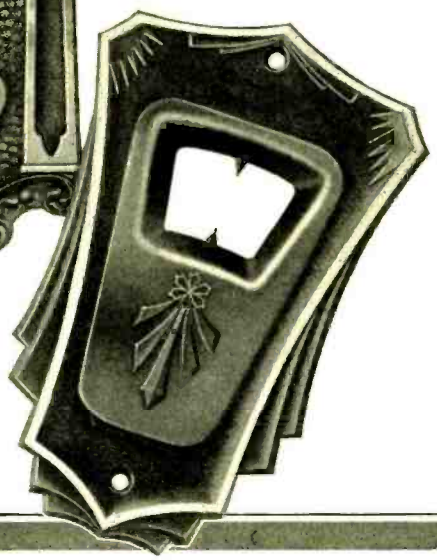
COIN EMBOSSED :: ETCHED

DIALS AND CONTROL PLATES

CROWE





Radio engineers are invited to write for suggestions, and a copy of our descriptive Bulletin No. 30.

Your logical source of supply for designs that are original and distinctive . . . for practical assistance on engineering details . . . for die work of superior excellence . . . for assurance of mechanical accuracy and convenient assembly . . . for prompt service and dependable deliveries.

. . . . . Just now we have some new developments in rotary disc dials which it will pay you to investigate.

. . . . . Our engineers are conversant with changing trends and prepared to make valuable suggestions.

We will exhibit at the RMA Show, at Atlantic City, June 2–6.

CROWE NAME PLATE & MANUFACTURING CO., 1749 Grace Street, CHICAGO

EDITORIAL

May, 1930

THE RADIO MARKET

RADIO receivers have yet to find their way into about sixty per cent of American homes. According to figures compiled by the National Chamber of Commerce, out of every one hundred families, fifteen are supplied with up-to-date "electric" sets, using socket power direct; twenty-two are supplied with battery-operated sets, and sixty-three are getting along somehow without radios.

These figures are impressive as pointing to the unsold radio market.

One radio sales organization presents a formula by means of which any radio dealer may learn the extent of his tributary market. The country over the average family consists of 4½ persons. A dealer who has his store in a town of 20,000 population may know that there are 4,444 families domiciled in houses, apartments and flats in his town.

If the Chamber of Commerce's tabulation is correct this particular center has 1,894 homes radio equipped and 2,550 homes without radios. Naturally, a varying proportion of the 63 per cent of homes without radios are not promising avenues for sales. Some persons have little or no desire to own a radio; some are surfeited by the radio next door, and some cannot afford a set and decline to buy one on the instalment plan.

In furnishing American homes with all of the conveniences desired by the people, radio is on the list somewhere between the electric iron and the iceless refrigerator.

▲

THE MANUFACTURER AND SERVICING

MANUFACTURERS of broadcast receivers are not all in agreement on the subject of servicing. Some manufacturers have from the beginning endeavored to sponsor all reasonable service on their sold receivers. Others have held to the opinion that servicing can never be anything but a nuisance to the manufacturer who attempts to maintain an organization directly in contact with servicing staffs.

The situation as it exists in most localities is that where well equipped and intelligently staffed independent radio service organizations are available they are doing a thriving business on any and all makes of receivers, and to the satisfaction of the customer.

The manufacturers who have conscientiously endeavored to maintain or aid dealer service agencies have no doubt been well repaid in the service satisfaction acknowledged by users of their receivers. But, all have for years observed that in the automobile business the Ford Service Station in a given community does not by any means do all of the Ford repair work. Many an independent garage has through the courtesy and efficiency of its personnel scooped not only the Ford but the Packard repairs of the town.

Some observers express their opinions that the bulk of radio servicing will be done as the bulk of automobile servicing is done—the first 30 or 90 days by the dealer and after that by whoever goes after the business.

With this, presumably the manufacturer will have no complaint.

▲

THE R.M.A.

ASSOCIATIONS, such as the R.M.A., have come to be something more than were the aggregations of leaders in particular industries who, years ago, foregathered in conclave for mutual profit.

The early business or trade "Conferences" were either of a Council of War order, or in the nature of celebrations—dependent, respectively, upon the exigencies of the times, and the bounty of the late harvest.

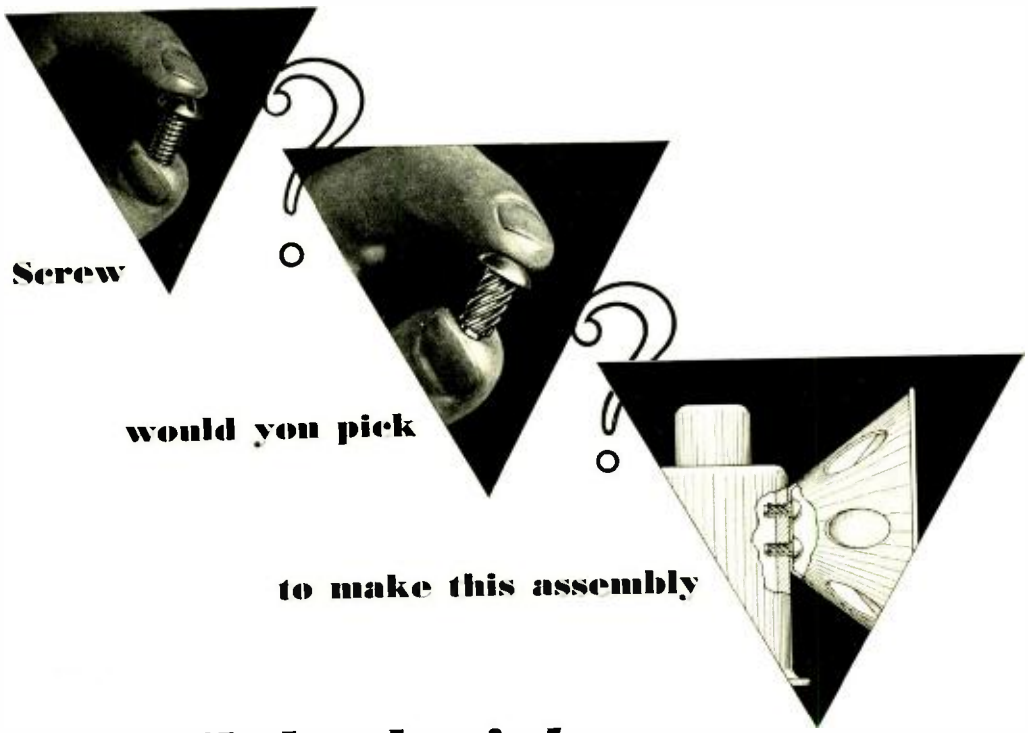
In the way of trade conventions, gatherings of radio manufacturers obviously are of an origin so recent that there is little in the way of recorded history to live down.

One of the outstanding characteristics of the present-day business executive is that he clearly understands that attendance at a trade show or a convention imposes upon him responsibilities which may not be evaded without direct personal loss.

Modern trade shows and conventions of several days duration cost a lot of money. Those who are privileged to be present should first dispose of the serious business in hand; should make copious memoranda of items of information picked up; should procure the answers to questions noted during weeks ahead of the convention; should seek opportunity personally to meet other manufacturers or their representatives.

In the case of the R.M.A. trade show these matters are aside from the big job of showing to advantage the products of the radio factories.

DONALD McNICOL, *Editor.*



Both will do the job...

but One saves 50% in labor

This simple assembly—fastening a speaker shell to a malleable iron pot—proves that it pays to pick screws carefully.

To make this assembly with machine screws requires costly and troublesome tapping that consumes much time and labor. To make it with Hardened Metallic Drive Screws only half the time and labor is necessary. And the fastenings are just as secure.

Many radio manufacturers try Hardened Metallic Drive Screws first, when an assembly requires a permanent fastening to iron, brass, aluminum, steel, Bakelite, etc. Experience has shown them that no other means of making fastenings is so easy, speedy and cheap.

You merely hammer this unique Screw into a drilled or formed hole. It cuts its own thread in the material . . . makes a better fastening than a machine screw—a fastening that will not loosen under vibration and severe service.

If any of your fastenings can be made with these Screws you can save time, labor and money. Check up on your assemblies. Send a brief description of any for which these Screws may be suitable. We will furnish proper samples for a test.

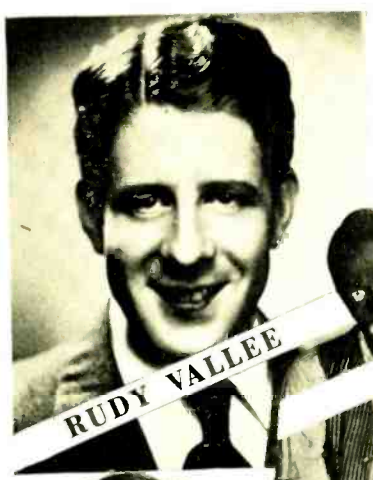
PARKER-KALON CORPORATION
Dept. L, 190-198 Varick St., New York, N. Y.

Canadian Distributors: Ontario: Aikenhead Hardware, Ltd., Toronto. Quebec: Caverhill, Learmont & Co., Ltd., Montreal. Nova Scotia: A. M. Bell & Co., Ltd., Halifax.

PARKER-KALON
TRADE MARK
HARDENED METALLIC
REG U S PAT OFF
DRIVE SCREWS
PAT. JAN. 29, 1924-NO. 1482151-OTHERS PENDING

These Screws Eliminate Tapping

They cut their own thread, like a tap, as they are hammered into a drilled or formed hole. They hold better than machine screws.



RUDY VALLEE

AMOS 'N ANDY

JOLLY BILL & JANE

LET THESE FAMOUS STARS BOOST YOUR RADIO SALES

HERE'S THE MOST SENSATIONAL IDEA IN THE HISTORY OF RADIO SELLING!

... How would you like to have *Rudy Vallee,* the Vagabond Lover, pulling the women buyers into your store?

And just imagine *Olive Shea* inviting the men prospects to come in and talk over that new set with you!

Listen, men! How would you like *Amos 'n Andy* plugging for you? And *Graham McNamee* ... the *Smith Brothers* ... *Vincent Lopez* ... beloved by millions of radio fans—drawing 'em into your place!

Men, this will happen in hundreds of radio stores throughout the United States this summer!...Demand the facts at the National Union booth and at the 10th floor rendezvous at the Ritz Carlton Hotel—Radio Show Week in Atlantic City.

And don't miss this year's Special National Union Radio Tube entertainment! Pst-t!

NATIONAL UNION RADIO CORPORATION
400 MADISON AVENUE, NEW YORK CITY, NEW YORK

OLIVE SHEA

GRAHAM McNAMEE

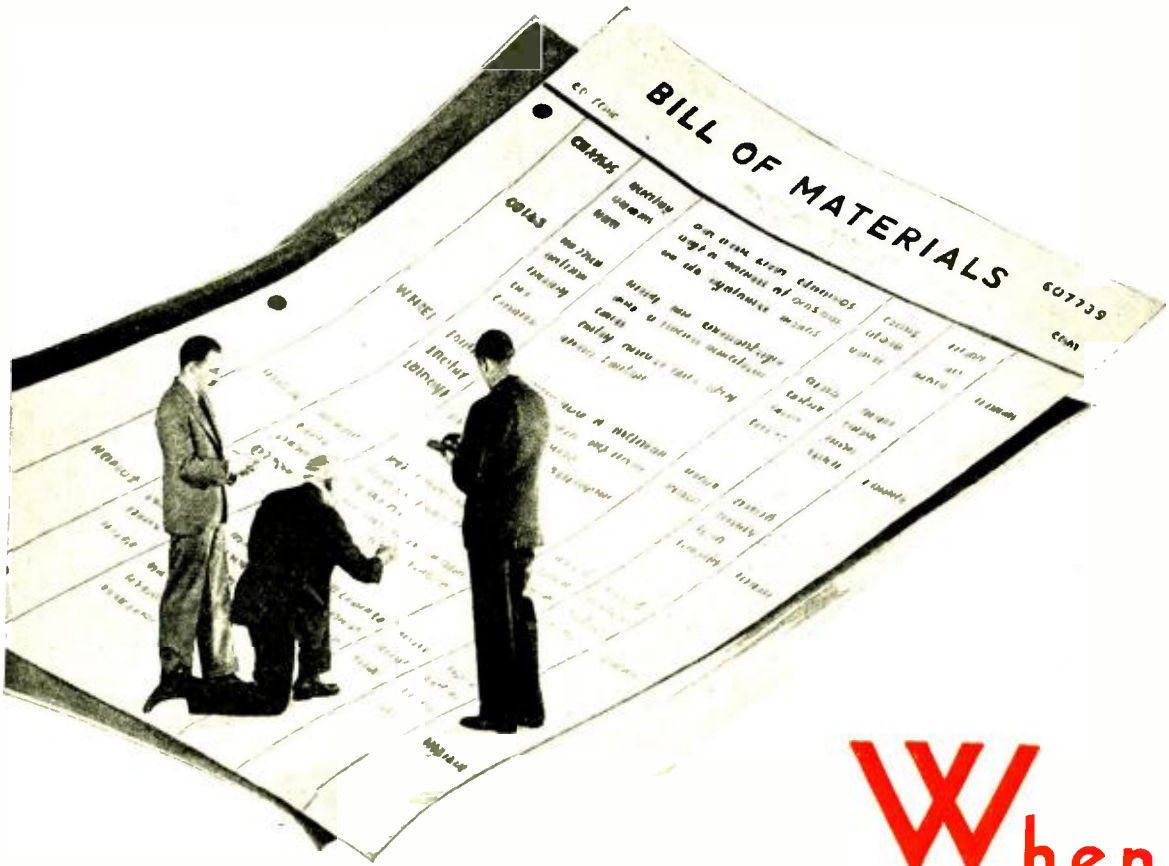
MEMO!

Yes! At the Show, I *must* remember to ask National Union about that "Radio Star" Idea!

SMITH BROTHERS

CLAIRE CARTER

MACY & SMALLE



When production costs must be cut . . .

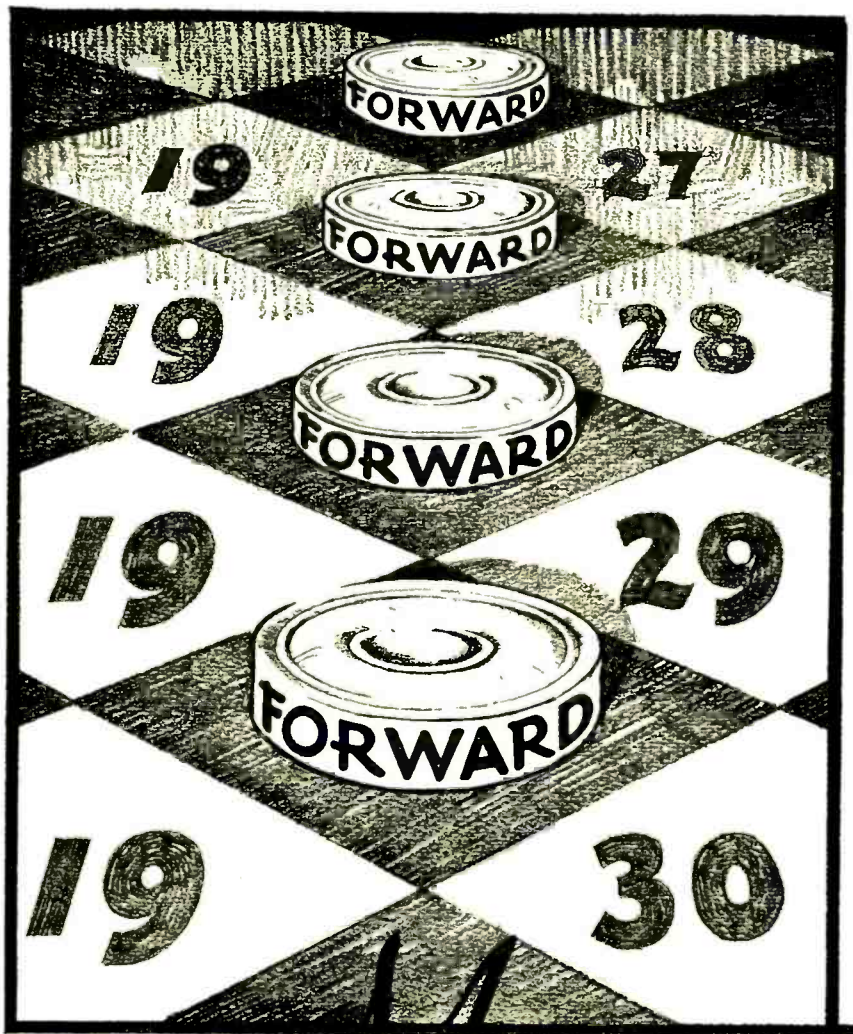
Dudlo's highly specialized engineers are most helpful. Their recommendations lead to important savings on magnet wire wound coils or to equally important economies in the handling of Dudlo Magnet Wire.

Dudlo's self-imposed high standard of quality insures the durability of your finished product . . . *at lowest cost.*

Engineering and manufacturing thoroughness make Dudlo the preferred source of supply for Coils and Magnet Wire.

DUDLO MANUFACTURING COMPANY DIVISION
OF
GENERAL CABLE CORPORATION

FORT WAYNE, INDIANA, U. S. A.



Moving on!

CONTINUED leadership is assured for Jensen Speakers. All of Peter L. Jensen's twenty years of research and nearly as many years of manufacturing experience will be built into the new model Jensen Speakers to be announced shortly.

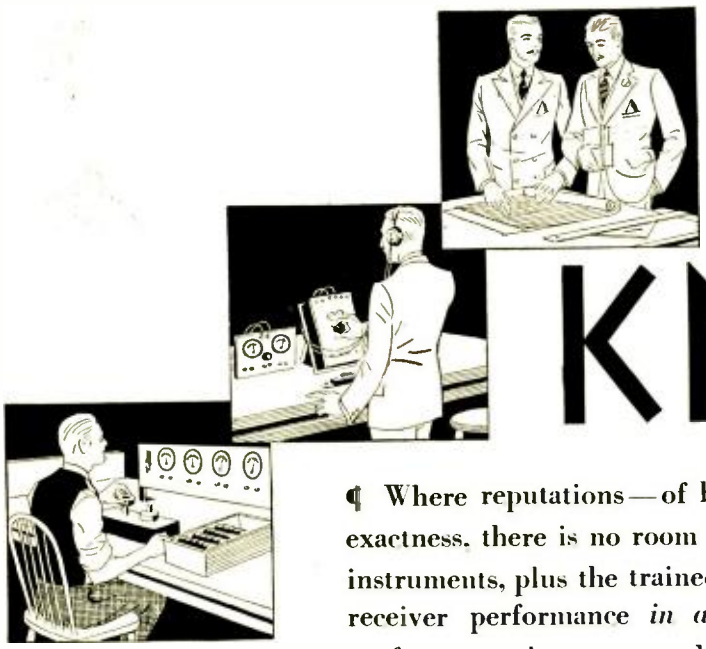
At the June trade show more manufacturers than ever before will show their sets Jensen Speaker equipped. These sets will have an assured advantage in tone *color, quality* and *sensitivity.*

Watch for these new Jensen Speakers which will be the industry's standard for 1930 and 1931.

Jensen
ELECTRO-DYNAMIC SPEAKERS

JENSEN RADIO MANUFACTURING COMPANY
6601 South Laramie Ave., Chicago, Illinois

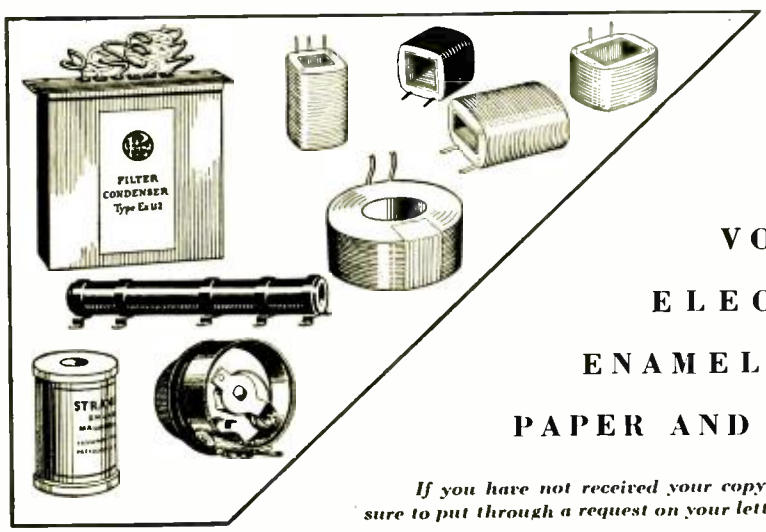
radio engineers do not guess—



THEY KNOW

¶ Where reputations—of both products and men—depend on exactness, there is no room for guesswork. ¶ Modern measuring instruments, plus the trained scientific mind, determine radio receiver performance *in advance*. The certainty of this performance is guaranteed by the use of tested and proven parts. ¶ Polymet Products have been approved by the engineering laboratories of practically all leading receiver manufacturers. Over 80% of them use Polymet Products in their production — — —

which is possibly the best proof that "Polymet Engineers do not guess:—*they know*, too!"



RESISTORS

TRANSFORMERS

VOLUME CONTROLS

ELECTRICAL COILS

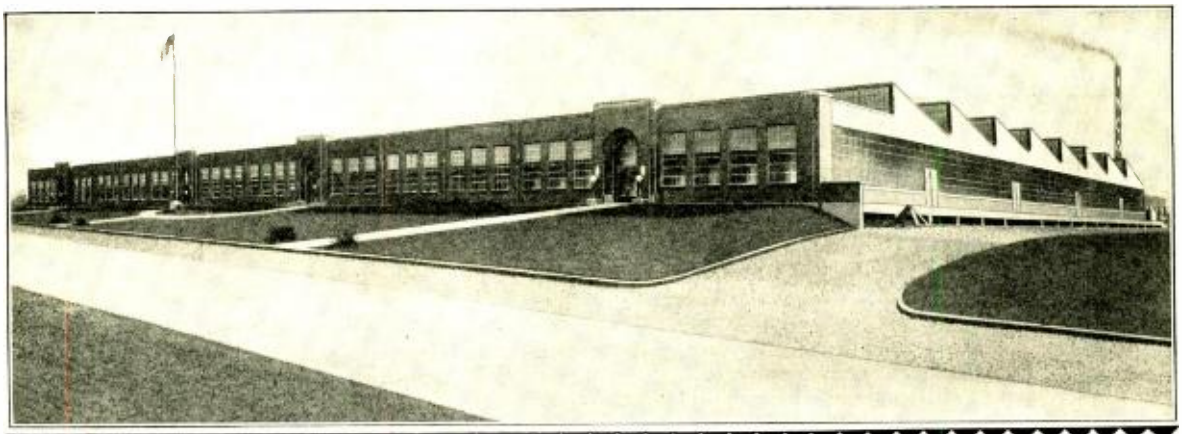
ENAMELED MAGNET WIRE

PAPER AND MICA CONDENSERS

If you have not received your copy of the "Polymet Engineering Manual," be sure to put through a request on your letterhead and one will be dispatched at once.

POLYMET MANUFACTURING CORP., 839-C East 134th St., New York City

Polymet Products



Another forward step in the PROGRESS OF INCA

THE INCA Manufacturing Corporation of Fort Wayne, Ind., is pleased to announce affiliation as a division of the National Electric Products Corporation of Pittsburgh and New York. The completion of this arrangement constitutes the latest advance in Inca's steady program of development and brings to this industry a direct source of copper.

The new arrangement means added efficiency in supplying promptly the demands of the magnet wire trade and still further contributes to Inca's matchless facilities of manufacturing. There is no change in offices, personnel, management or policy. George A. Jacobs, president of Inca, also becomes vice-president of National Electric Products Corporation.

INCA
symbolic of the best in the copper wire industry

Inca engineers will be pleased to confer with you on any of your magnet wire and coil problems

INCA MANUFACTURING CORPORATION

Copper Wire Products *Fort Wayne, Indiana*

EASTERN OFFICE: Newark, New Jersey — — Industrial Office Building
WESTERN REPRESENTATIVE: A. S. Lindstrom, 274 Brannan Street, San Francisco, California

Division of NATIONAL ELECTRIC PRODUCTS CORPORATION

INSURE THOSE A.C. SETS!

No matter how well you may design, manufacture and service those A.C. radio sets, remember, you are forever *gambling* with one uncertain and perhaps unfriendly factor—LINE VOLTAGE.

Of course you have come to take the so-called "110-volt" supply for granted. Of course the electric light and power companies hasten to assure you that they maintain line voltages constant. Of course you have provided your sets with adjustable taps for "high" and "low" line voltages. Of course no one has complained—as yet.

But nevertheless, radio consumers are now complaining to your dealers. They are going to complain to you. Tube manufacturers are complaining because of excessive replacement claims. And you are going to complain too, when you are called upon to make good on broken-down power packs, let alone the loss of good will and future sales.

Why gamble? You can insure against radio dissatisfaction. Stop gambling with questionable line voltage. Play safe. Until now this meant the installation of a line voltage regulator in the radio set itself. Sets out in the market could not be protected satisfactorily. But now you can protect your outstanding sets quite as well as the sets now being designed. And here's the answer—the greatest of all radio satisfaction and good-will insurance policies—

Automatic Line Voltage Regulator CLAROSTAT

An accessory—not a built-in device. May be attached instantly, without tools, without skill or experience. Simply insert prongs of usual attachment plug into slots of this device. Insert prongs of this device into slots of usual screw plug or convenience outlet. The *Automatic* Voltage Regulator Clarostat is now part of the circuit. The installation is complete. Your radio set is assured of uniform and proper working voltage, irrespective of line voltage conditions. And you are covered by radio satisfaction insurance.

It's *AUTOMATIC.* Not just a plain fixed resistance, which fails to compensate for reduced line voltage. This device provides a greater or less resistance between electric light line and radio set, compensating *automatically* and accurately for line voltage variations. When line voltage is high, the resistance is likewise high, causing necessary voltage drop for safeguarding radio set. When voltage is normal or subnormal, resistance is slight, causing small voltage drop. The usual fixed resistance, contrariwise, remains fixed, and when the line voltage drops, it chokes the radio set as indicated by loss of sensitivity, volume and tone quality.

If you are a MANUFACTURER

—recommend the *Automatic* Line Voltage Regulator Clarostat for your sets now in the hands of the trade and the public. Avoid kicks. Avoid power pack replacements. Avoid loss of good will. Avoid loss of dealers and distributors. And for those sets now going into production, make doubly sure by having them equipped with the Clarostat Line Voltage Ballast as a built-in feature.

If you are a SERVICE MAN

—be sure to install the *Automatic* Line Voltage Regulator Clarostat, for every set you install or service. Play safe. Don't gamble with your clientele. Avoid criticism of your work. And incidentally, make a profitable sale with this accessory, and pile up future sales.

WRITE for data regarding the *Automatic* Line Voltage Regulator Clarostat. Mention the type of set you wish to insure against line voltage dangers, and we shall gladly recommend the proper accessory or built-in equipment. And while you are at it, ask for our general data on resistances of all kinds—fixed, adjustable and automatic—resistances for every conceivable need.

Member R.M.A.

CLAROSTAT MANUFACTURING COMPANY, Inc.

Specialists in Aids to Better Radio

282 North Sixth Street : : Brooklyn, N. Y.

The "Little GIANT"

HERE'S the real "surprise package" of the radio industry. The new, perfected Sprague electrolytic condenser—with the exclusive one-piece, rolled-edge anode—concentrating 8 MFD capacity into a space of only 1⅜" diameter and 5" long.

Individual socket mounting makes it instantly adaptable to any circuit. Protected vent integral with top prevents all liquid leakage. And because there isn't a soldered or welded joint anywhere—the Sprague gives you in *practical* performance the maximum of efficiency.

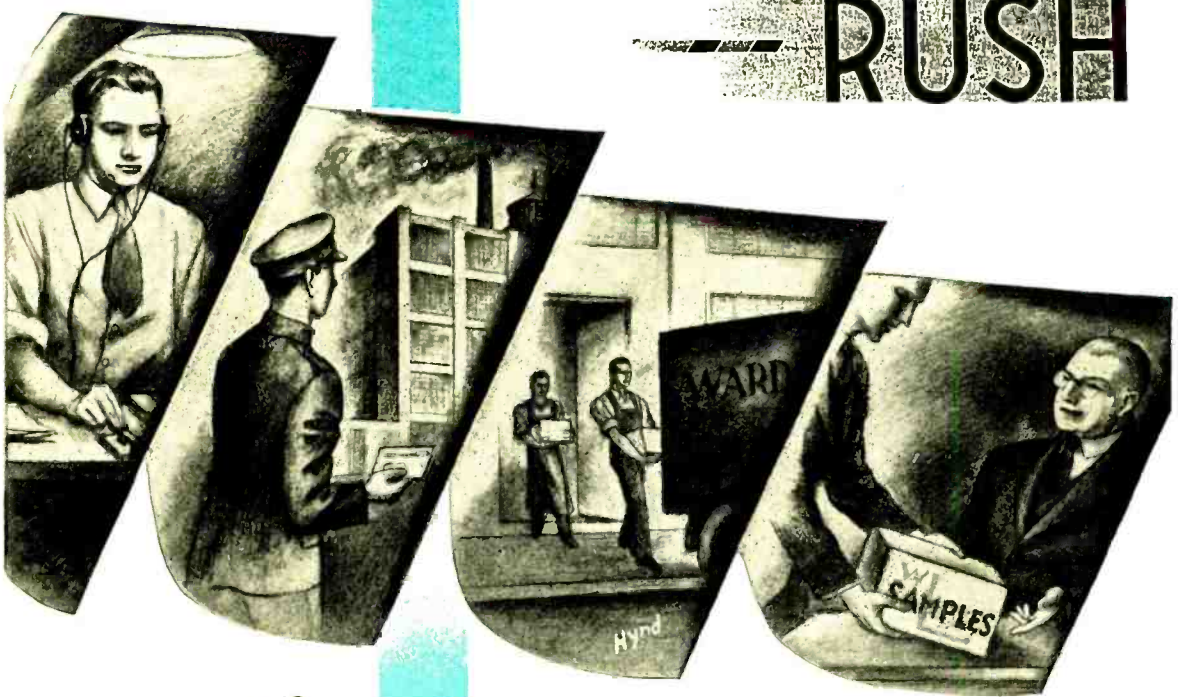
Radio set designers, builders and service men are invited to write for descriptive literature, and diagrams of tested circuits embodying Sprague Condensers for exceptional results.

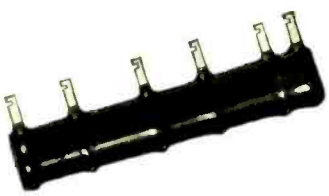
SPRAGUE SPECIALTIES CO.

Executive Offices & Laboratories: Quincy, Mass.
Factories: North Adams, Mass.

SPRAGUE
Electrolytic CONDENSER

WL SAMPLES—RUSH





Vitrohm Resistors may be had with various types of terminals. The tab-type terminal illustrated is a favorite for all applications. Vitrohm Resistors can be furnished with any desired number of tab terminals.

WARD LEONARD ELECTRIC CO.

31 South Street
Mount Vernon, N. Y.

Resistor Specialists for More Than Thirty-Nine Years

WHEN resistor samples of special design are needed in a hurry, bear in mind that Ward Leonard maintains a Customers' Service Department to supply you with FORTY-EIGHT HOUR service. The sole purpose of this department is to handle special orders, for it is not connected in any way with regular production.

Your written or telegraphed specification for samples is given immediate attention by a staff of Ward Leonard experts who are free to concentrate upon your order. In two working days, the samples are designed, produced and shipped to you.

What is true of the Customers' Service Department is also true of the Production Department, where your order for any of the wide variety of Ward Leonard products* will receive attention just as prompt and efficient. Speed of delivery is up to you. We meet our customers' needs.

*Vitrohm (vitreous enamelled) Resistors and Rheostats . . . . A. C. Voltage Regulators . . . . Theatre Dimmers . . . . A. C. and D. C. Motor Starters and Controllers . . . . Slide Wire Rheostats . . . . Arc and Spotlight Rheostats and Ballasts . . . . Mobile Color Lighting Equipment . . . . Adaptorons . . . . D. C. Battery Charging Equipment . . . . Circuit Breakers.

IMPRESSIONS and EXPRESSIONS

By

AUSTIN C. LESCARBOURA

Dry-Battery Receivers

SOME mighty fine research and engineering work is being conducted by a dry-battery manufacturer along the lines of a successful dry-battery receiver. Starting at the loudspeaker end and working back through the audio, detector, and radio-frequency circuits, this manufacturer's engineers have developed some experimental designs which are most promising. Ample volume is being obtained with dry-battery operation, together with excellent tone, while the battery life has been stretched to the point where it is economical and practical.

All of which must be welcome news to the rural home still out of reach of the electric power systems. While there may be a superabundance of radio sets offered for the metropolitan a-c. markets, the rural home is still seeking the convenience of a dry-battery radio set that will provide volume, quality, convenience and economy somewhat on a par with the sets of the city folks.

▲

A Twenty-Fifth Anniversary

NEXT year will be the silver anniversary of a great invention—the audion or three-element vacuum tube of Dr. Lee DeForest. It was in 1906 that this radio pioneer patented his grid or third element, thereby laying the foundation for our entire radio art as we know it today. Also, his audion has made possible the transcontinental telephone. the carrier-current signaling system, the talking pictures, television, the electrical phonograph, the practical photoelectric cell and other applications too numerous to mention.

Let's bear this event in mind—the silver anniversary of an invention that has done more to change the course of civilization and to speed up its tempo than any other single invention. It is to be hoped that the world at large will see fit to recognize the anniversary of this great invention, which outranks even the electric lamp in importance.

▲

—Including Phonograph

WHY more radio sets do not include the phonograph features, we do not know. At this time when it is about as easy to pry money out of the public as it is to work a Scotchman for a drink, a phonograph and radio combination at a reasonable price should prove highly attractive, especially during the summer months when radio may not go as well. That is the beauty of the usual phonograph and radio combination: if the atmosphere is bad, the family can turn to phonograph records. Also, most of the popular radio artists may be obtained on records.

Of course if radio set manufacturers insist on considering the additional cost of the phonograph feature on the basis of one to four in the list price, then this feature is out of the question. But if it is looked upon as a sales promotional expense, with very little increase in the list price over the actual cost of the phonograph feature, then the industry has something to shout about and to help pry the public loose from some of its hoarded cash.

▲

Side Lines

THE day of side lines seems to be dawning for the radio industry. Heretofore content to engage solely in radio products, many organizations are now turning to other fields as side lines, realizing full well the dangers of over-production, which must be avoided at all costs this year.

We hear that one of the outstanding radio set manufacturers is going to introduce an electric refrigerator selling for less than $100. Splendid! If true, it means that that manufacturing organization, already famous for its remarkable enterprise, will once more score a huge success. Another radio manufacturer has already introduced something unique by way of a refrigerator. Several set manufacturers have turned to public-address systems and amplifiers, and are doing well, although there seems to be a threatened over-production in this field. The industrial applications of the photoelectric cell are receiving no little attention.

All of which constitutes that much-sought silver lining in what has been a rather dark cloud of late. The tremendous production capacity of this industry of ours must be put to uses other than flooding the limited market with a superabundance of products dumped at profitless prices. with the seasonable chaos.

▲

Hard-Boiled Dealers

WHAT a hard-boiled lot of dealers we are facing this year! Those of the dealers who have come through the valley of liquidation in that last mad charge, are doing some careful picking of lines and manufacturers this season. Those manufacturers who dumped their sets, broke their promises, and left the dealers to their own devices in "getting out from under," are finding it mighty hard indeed to secure the proper representation this season.

Several manufacturing companies are going out with really sound merchandising plans. They are offering fair protection to dealers, which after all, is the greatest thing the dealers seek. They are giving dealers a chance to make a reasonable profit. They are helping the dealer solve his trade-in and local advertising problems. They are helping the dealer with his servicing problems. They are giving the dealer a financing plan such as he never had before. They are insisting upon the dealer making a legitimate profit. Such manufacturers are setting a pace that is bound to tell throughout the industry.

Gentlemen, the banquet is at an end. From now on it is a case of getting down from the table and joining hands with the little fellows on the floor, who insist on faring as well as the manufacturers. And they seem to have gained the upper hand at last. So let's all get together at last, so that everyone may make some money.

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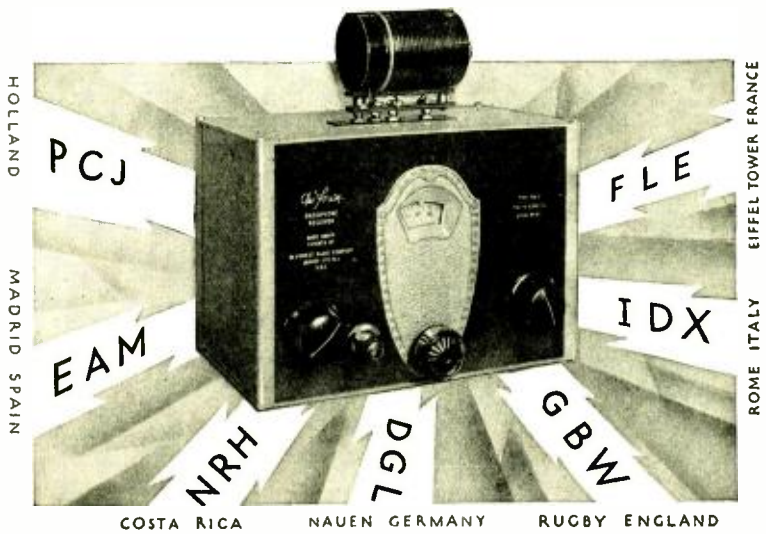

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Battery Requirements. Operates either from dry cells using Audions 422A and 499 or from 6-volt storage battery using Audions 422 and 401A. For loud speaker operation either Audions 420, 412A or 471B may be inserted in the last audio stage. Two 45-volt "B" batteries furnish the plate power.

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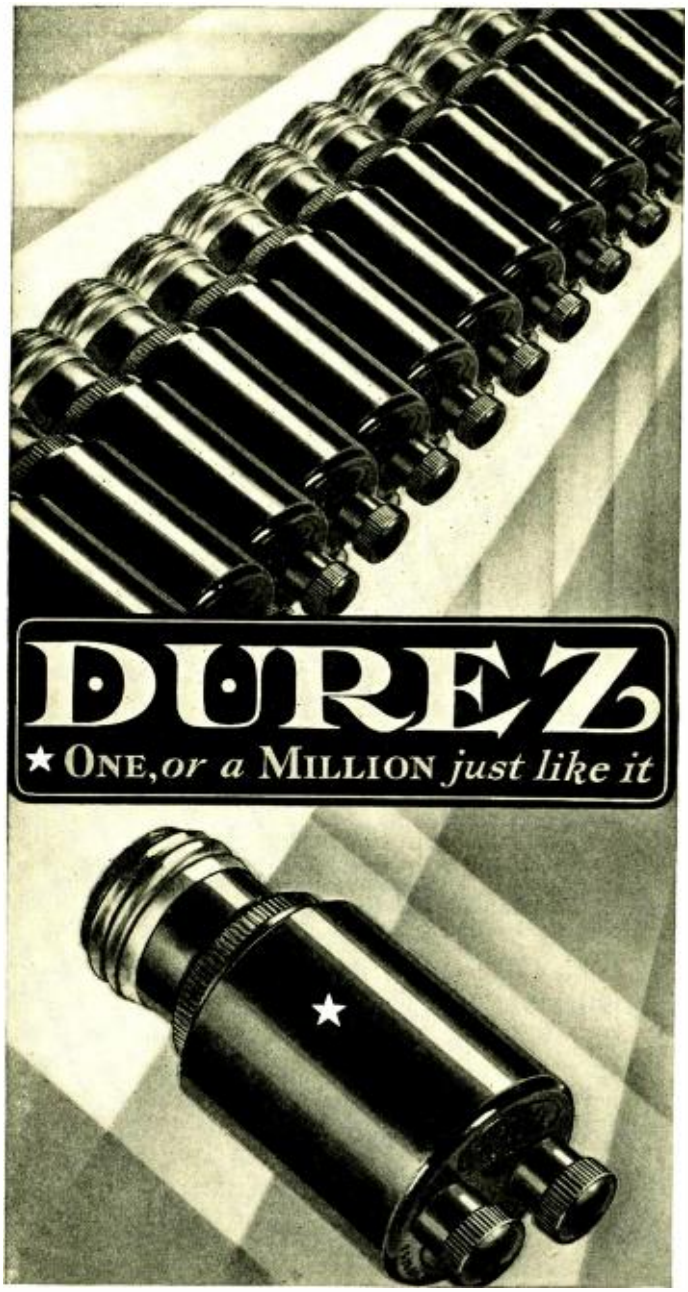

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Properties of Modulated Signals and Modulation Devices

An Engineering Presentation of the Fundamental Methods of Modulation by Means of Vacuum Tubes.

By Ralph P. Glover *

Foreword: Perhaps no single phase of present-day radio engineering is as important as the subject of modulation. Everywhere along the complex circuit from microphone to loudspeaker, we are directly or indirectly concerned with this process. The broadcast engineer depends on modulation not only for program transmission itself, but for the actual extent of the service area. The receiver engineer must provide means for demodulating signals in order to make the program available to the listener. Both must cope with innumerable technical problems in order that the loudspeaker may supply a reasonably accurate reproduction of what is taking place in the studio. As a background for these complex operations, we find a wide variety of engineering development work taking place, much of which is concerned with the generation, measurement and use of modulated radio-frequency oscillations. Despite all of this, many radio engineers have only a superficial conception of the processes and consequences of modulation and demodulation. This is, no doubt, partially due to the fact that the fundamental literature on the subject has been spasmodic and scattered. It is the purpose of this series of papers to present a general survey of the existing information on modulation and its measurement, and, it is hoped, to shed some additional light on this most interesting technical problem.—Author.

Historical Background

IT is an obvious statement, but literally true, that any serious consideration of the operation of modulation devices and of the properties of modulated waves, involves a review of the whole history of the telephone art, particularly those branches dealing with radio and carrier currents. At the risk of odious repetition of what is undoubtedly familiar to most readers, let us review generally the development of signaling by means of modulated continuous waves.

The art of radio communication, after passing slowly through the damped wave or spark stage, finally reached the point where continuous oscillation generators were a practical success. It had long been recognized that, were some such form of generator available, speech transmission might be accomplished by voice modulation. The development of the arc transmitter and the various forms of high-frequency alternators was, therefore, promptly followed by the application of this principle. The actual arrangement of these devices for radio telephone transmission is now of historical interest only. This was due primarily to the fact that the arc and alternator were soon outclassed by the electron tube as a continuous oscillation generator, and that the modulation methods themselves were inefficient and unkind to the ear.

The true starting point of modern high quality radio telephone and wire transmission may therefore be said to coincide with the development of practical electron or vacuum tubes. It is well to point out that radio telephone and wire telephone transmission engineering are merely specialized branches of electrical transmission engineering, and that development in one of these fields often finds immediate application in the other. Hence the radio engineer frequently finds himself profiting by the experiences of the telephone engineer.

Amplitude Modulation

In order that speech, music or other form of intelligence may be faithfully transmitted by means of modulated signals, it is necessary that the form of the final signaling wave closely resemble that of the signal itself. In the case of human speech or music, a large range of amplitudes having components widely distributed over the whole audible frequency band must be dealt with.[1] Thus the microphone voltage for the vowel sound "ä," having a form similar to that of Fig. 1 (a), would produce a modulated signal as shown in 1 (b), provided ideal apparatus were employed in the process.

An examination of Fig. 1 (b) shows that at any instant, or over any very small interval of time, we are dealing with a more or less complex waveform rather than one which follows a simple trigonometric law. The difficulty of applying any kind of analysis to a transient signal of this sort is readily apparent. Fortunately, we have open to us a much simpler alternative, and one which is no less valid than actual analysis of the complex function itself, were that possible. Precisely stated, we may form definite conclusions, both in regard to the effects on associated apparatus and as to the properties of the transient itself, regardless of its form, by purely steady-state considerations.

This is a long recognized principle of mathematics, and is based on the extension of Fourier's Series to non-periodic or non-recurrent waves.[2, 3] Space will not permit proof of this theorem beyond one simple illustration of this principle in regard to recurrent or repeating voltages.

Suppose that the e.m.f. of an arbitrary generator has a waveform as indicated in Fig. 2 (a). It can be shown that this complex wave is reducible to the sum of two sine waves, one of which is of double frequency. This fact may be verified by adding the corresponding ordinates of 2 (b) and 2 (c). Since this is true, we may replace our original generator by two fictitious generators whose e.m.f's. correspond in phase and amplitude to those of the corresponding harmonic components. This substitution is indicated in 2 (d) and 2 (e), and, viewed from the load, no difference whatever could be distinguished. We have established, for this particular case, that a complex wave may be resolved into harmonic sine components. In general, there will be an infinite number of these sine terms or components, although in Fig. 2, all but the first two terms are zero.

R. V. L. Hartley has shown, by analogous reasoning (with properly applied boundary conditions) that all the essential properties of any arbitrary signal may be investigated, provided the behavior of the system is known for sustained single frequencies.[2]

This general principle has, in fact, been applied to studies of the properties of static by Carson and others with enlightening results.

Having established the validity of analysis employing single, constant-frequency modulation, let us examine a signal of this type.

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* *Radio Engineer, The Crosley Radio Corporation.*

[1] *Speech and Hearing, Fletcher.*

[2] *"Relation of Carrier and Side-Bands in Radio Transmission," R. V. L. Hartley, Proceedings I.R.E., February 1923; p. 34.*

[3] *"Theory of Thermionic Vacuum Tube Circuits," Peters, Ed. 1; p. 121.*

Per Cent. Modulation

Referring to Fig. 3, it will be noticed that the wave envelope, indicated by the dotted line, is of sine form and varies symmetrically above and below the mean amplitude E_o. This mean amplitude may be thought of as the equivalent peak value of the corresponding unmodulated wave. The amount of increase in peak value of the modulated wave above the mean amplitude is therefore a measure of the extent to which the wave has been modulated. Following the nomenclature of Fig. 3, this may be stated mathematically by the expression

$$E_{max} = E_o + mE_o \quad (1)$$

or

$$E_{min} = E_o - mE_o \quad (2)$$

which may be restated as

$$m = \frac{\frac{1}{2}(E_{max} - E_{min})}{E_o} \quad (3)$$

The instantaneous e.m.f. can be expressed as

$$e = E_o (1 + m \sin \alpha t) \sin \omega t \quad (4)$$

The use of sine terms is consistent with the conditions illustrated at the time $t = 0$.

The coefficient m is variously called the modulation factor, ratio, coefficient or depth of modulation. Its valne varies from zero for no modulation, to unity for complete modulation, and is commonly expressed in per cent. Hence

$$\text{Per cent Modulation} = 100\,m$$

(The reader should note that values of m, calculated from either (1) or (2) above, will give misleading results if E_o is incorrectly determined, or if the envelope variation is not symmetrical about E_o. For these reasons it is preferable to use the form as given in (3). This expression corresponds to the definition of "percentage modulation" as given in the current Standard Definitions of Terms of the Institute of Radio Engineers. Various methods of determining m will be treated later.

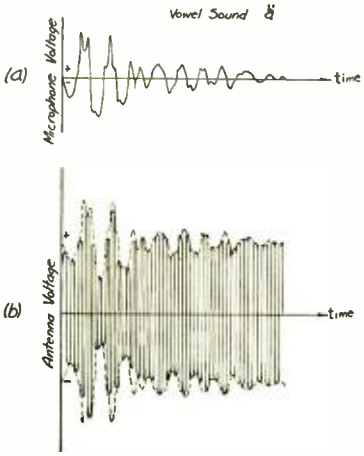

Fig. 1. (a) Typical form of microphone output. (b) Resulting modulated wave.

100 Per Cent Modulation

Consideration of the foregoing shows that theoretically m may be increased to unity (100% modulation) without disturbing the sine form of the wave envelope. Furthermore, this is the condition for maximum peak voltage of the sine-modulated wave for any particular value of E_o and is a limiting factor in broadcast operation. As a result, a corresponding peak signal level at the input to the modulator must be determined for any given transmitter. The peak program level is then kept just below this limit by proper studio control. We would consequently expect variations in per cent. modulation, ranging from zero when the microphone is idle, to 100% during the loudest passages, in the case of transmission from a broadcast station capable of complete modulation and operating without distortion.[4]

The peak factor,[5] or ratio of maximum to average amplitudes for average English speech, is given as approximately 5. This would indicate that on speech transmission, the average modulation for such a station would be about 20%. However, in the actual case, any such estimate is little more than an enlightened guess, since the average is heavily influenced by the policy of station operation with regard to the amount of distortion tolerated on peaks, the type of program, the microphone technique of the artist, and the diligence of the control-room operator.

Present-day interest in 100% modulation centers around the fact that such an installation permits a higher average modulation to be maintained or represents a more effective utilization of the available oscillation power than would otherwise be the case.

Devices for Producing Amplitude Modulation

An examination of Fig. 3 immediately suggests that modulation might be accomplished by varying the resistance of a circuit carrying the high-frequency current at an audible frequency rate. It is a matter of history that similar or equivalent methods were utilized on the early arc and alternator radio telephones. Due to the inherently poor characteristics of carbon microphones, which were used as the variable resistance elements, only small amplitude variations were produced by this direct process and transmission was, therefore, relatively ineffective and of decidedly poor quality. Nevertheless, the concept of amplitude modulation by variable resistance characteristic is exceedingly useful and, if properly applied, is a great aid in the interpretation of the functioning of vacuum-tube modulation devices.

This has been pointed out by Van der Bijl[6] and is based on theoretical investigations of the properties of three-electrode tubes by Miller[7] and Carson.[8] Due to the exclusive use of the vacuum tube in present-day radio telephony, only this type of modulation device will be discussed.

Grid Circuit Modulation

There are two general and fundamental methods of modulation with three-electrode vacuum tubes, namely, grid circuit modulation and plate circuit modulation. Both of these methods will be briefly reviewed.

Suppose, as in Fig. 4 (a), that we supply the grid circuit of the vacuum tube with both radio- and audio-frequency voltages. In accordance with the present method of treatment, the modulating low-frequency voltage is assumed to be sinusoidal and of single frequency. Fig. 4 (b) represents the grid voltage-plate current characteristic in the region of the operating point, which has been appropriately fixed by the use of batteries. Since the radio frequency f_1 is much greater than the modulation frequency f_2, we may adopt the view that the low-frequency generator acts in conjunction with the steady grid-bias potential and provides a relatively slow-shifting operating point about which the higher frequency e.m.f. oscillates rapidly. The grid voltage at various instants is shown in Fig. 4 (c), and corresponding instantaneous plate currents in Fig. 4 (d). The resulting plate current may be resolved into two components, a low-frequency component, and a high-frequency component of varying amplitude. Since the load impedance Z is commonly a tuned circuit adjusted for resonance at the higher frequency, only this component appears in the useful output and the resulting voltage is similar to Fig. 4 (e). This corresponds to our typical amplitude-modulated wave of Fig. 3. The foregoing description constitutes a brief physical picture of the functioning of the grid modulator. However, the same conclusions may be reached methematically in more specific fashion, thus providing quantitative information which is of much practical use to the engineer. The derivation will not be given in detail. For a complete exposition with detailed proof, the reader is urged to consult those portions of the bibliography dealing with vacuum tube theory.

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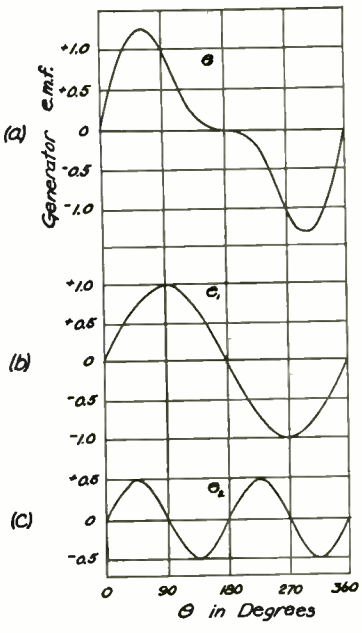
[4] *"Power and Current in Modulation," Carl Dreher, "Radio Broadcast" May,* 1929, *p.* 36.

[5] *Sacia, Bell System Technical Journal,* 4, 627; *October,* 1925.

[6] *"The Thermionic Vacuum Tube," Van der Bijl, first ed., p.* 322.

[7] *Proceedings I.R.E., June,* 1918.

[8] *The Equivalent Circuit of the Vaccum Tube Modulator," J. R. Carson. Proceedings I.R.E., June,* 1921—*Also April,* 1919, *p.* 187.



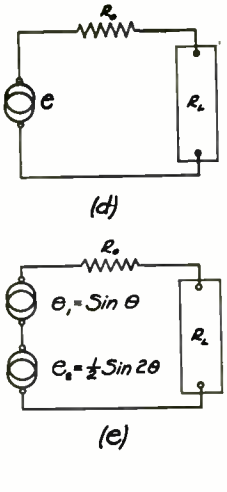


Fig. 2. Harmonic resolution of a complex wave.

From the curve Fig. 4 (b), it is evident that the instantaneous plate circuit is a function of grid voltage for any particular steady plate potential. Or

$$i_p = f\ (e_g) \qquad (1)$$

This may be expanded into a power series of the form

$$i_p = a_1\ e_g + a_2 e_g^2 + \ldots + a_n\ e_g^n \qquad (2)$$

The degree of approximation to the actual operating portion of the curve depends on the number of terms taken, becoming closer as more terms are added. For all practical purposes, the first two terms are sufficient. Hence

$$i_p = a_1\ e_g + a_2 e_g^2 \qquad (3)$$

where a_1 and a_2 are constants involving parameters of the tube taken at the operating point. From 4 (a) the grid voltage is

$$e_g = E_1 \sin \omega t + E_2 \sin \alpha t \qquad (4)$$

Substituting (4) in (3) we obtain

$$i_p = a_1 E_1 \sin\ \omega t\ +\ a_1 E_2 \sin\ \alpha t\ +\ a_2 E_1^2 \sin^2 \omega t\ +\ 2\ a_2 E_1 E_2\ (\sin\ \omega t)\ (\sin\ \alpha t) + a_2 E_2^2 \sin^2 \alpha t \qquad (5)$$

As was explained before, in all practical cases the load impedance is of such nature that only the first and fourth terms are present in the useful output. Hence (5) reduces to

$$i_p = a_1 E_1 \sin \omega t\ +\ 2 a_2 E_1 E_2\ (\sin\ \omega t \sin \alpha t) \qquad (6)$$

The first term of (6) represents currents of radio frequency only, while the second involves both radio and audio frequencies. The appearance of such a wave would be similar to that illustrated in Fig. 3. The importance of the second term of (6) will be discussed later.

Grid modulation has one important limitation which must not be overstepped if distortionless operation is to be obtained. For correct operation, the plate current variations must have exactly the same form as the grid voltage variations, which is another way of saying that the mutual conductance of the tube must be a linear function of the grid voltage. This can be shown as follows:

Differentiating (3) with respect to e_g we obtain

$$\frac{di_p}{de_g} = a_1 + 2\,a_2\,e_g = g_m \qquad (7)$$

Evidently the mutual conductance is a linear function of grid voltage provided (3) represents the operating portion of the characteristic curve with reasonable accuracy. It has been found that this is the case over a very small portion of the curve. We may conclude then, that both the high- and low-frequency voltages applied to the grid must be small, and that the tube must operate over a parabolic or square law portion of the characteristic if faithful modulation is to be obtained.

It is interesting to note that by restating (7) we may add to our conception of modulator functioning by variable resistance characteristic. Substituting

$$\frac{\mu}{r_p} \text{ for } g_m \text{ in (7)}$$

$$\frac{\mu}{r_p} = a_1 + 2a_2 e_g \qquad (8)$$

μ may be considered constant under the given conditions. Hence (8) can be expressed by an equation of the form

$$\frac{1}{r_p} = k_1 + k_2 e_g \qquad (9)$$

where k_1 and k_2 are constants.

Consequently we may picture the grid modulator as a device whose plate resistance, within certain definite limits, is an inverse linear function of the impressed grid potential.

Plate Modulation

While grid modulation depends for its effectiveness on operation over a curved characteristic, plate modulation is accomplished by utilizing the linear relationship between plate voltage and high frequency currents in an oscillating vacuum tube. This relationship is shown in Fig. 5 (b) and is linear over a rather wide range of plate voltage. If we insert a low-frequency sine wave generator in series with the plate battery E_B, as in Fig. 5 (a), the resulting plate voltage will vary sinusoidally above and below the battery value. The amplitude of the tank circuit current will contain these same variations, as indicated in Fig. 5 (d), thus producing the modulated high frequency current of Fig. 5 (e).

Mathematically, we may arrive at the same conclusions in the following simple manner.

The amplitude (or peak value) of the high-frequency tank circuit current depends upon the effective resistance of the oscillating circuit and upon the plate voltage. Let this amplitude be I_1 for a plate voltage of $E_p = E_B$. Or

$I_1 = k\,E_p$ (1) where k is the slope of the tank current amplitude-plate voltage line. Expressing the tank current as a function of time

$$i_1 = I_1 \sin \omega t \qquad (2)$$

Substituting (1) in (2)

$$i_1 = k\,E_p \sin \omega t \qquad (3)$$

If we introduce a low-frequency sinusoidal voltage e_s in the plate circuit, then

$$E_p = E_B + e_s = E_B + E_s \sin \alpha t \qquad (4)$$

Substituting (4) in (3)

$$i_1 = k\,E_B \sin\ \omega t + k\,E_s \sin\ \omega t\ (\sin\ \alpha t) \qquad (5)$$

This expression is similar to equation (6) obtained for grid modulation.

Many other circuit arrangements have been developed for producing plate modulation. In many cases separate tubes are used for oscillators and modulators. The separate modulator then performs the function of oscillator plate voltage variation.

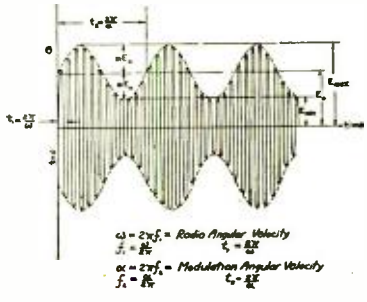


Fig. 3. Generalized sinusoidally modulated wave.

The Sideband Theory

The reader should realize that all of the foregoing analyses have dealt with the purely physical view of the operation of modulation devices. The mathematics used has been merely a sort of shorthand description of the physical phenomenon under examination. However, it is possible to obtain an entirely different theory of modulation by purely mathematical manipulation of equations which have been developed in this paper. The resulting theory of the composition of a modulated wave is known as the sideband theory and has been in existence for about ten years.[9][12]

In spite of this fact, some controversy still exists between those who are satisfied with the bare facts of amplitude modulation and the rest who prefer the amplitude theory expanded into components of carrier and sidebands.

For the benefit of those who are not familiar with the expansion, it will be given in some detail. Using the nomenclature of Fig. 3, we may express the instantaneous voltage of the modulated wave by the expression

$$e = E_o (1 + m \sin \alpha t) \sin \omega t = E_o (\sin \omega t + m \sin \alpha t \sin \omega t \quad (1)$$

or

$$e = E_o (\sin \omega t + \frac{m}{2} \sin \alpha t \sin \omega t + \frac{m}{2} \sin \alpha t \sin \omega t) \quad (2)$$

Adding and subtracting $\frac{m}{2} \cos \alpha t \cos \omega t$ to the bracketed terms and rearranging

$$e = E_o (\sin \omega t - \frac{m}{2} \cos \alpha t \cos \omega t + \frac{m}{2} \sin \alpha t \sin \omega t + \frac{m}{2} \cos \alpha t \cos \omega t + \frac{m}{2} \sin \alpha t \sin \omega t)$$

$$= E_o \left[\sin \omega t - \frac{m}{2} (\cos \alpha t \cos \omega t - \sin \alpha t \sin \omega t) + \frac{m}{2} (\cos \alpha t \cos \omega t + \sin \alpha t \sin \omega t)\right] \quad (3)$$

Remembering that

$\cos (A + B) = \cos A \cos B - \sin A \sin B$ and

$\cos (A - B) = \cos A \cos B + \sin A \sin B$, then

$$e = E_o \left[\sin \omega t - \frac{m}{2} \cos (\omega + \alpha) t + \frac{m}{2} \cos (\omega - \alpha) t\right] \quad (4)$$

or

$$e = E_o \left[\sin 2\pi f_1 t - \frac{m}{2} \cos 2\pi (f_1 + f_2) t + \frac{m}{2} \cos 2\pi (f_1 - f_2) t\right] \quad (5)$$

Referring to terms within the brackets, the first represents the carrier, the second the upper or superior sideband, and the third the lower or interior sideband.

Let us consider the significance of equation (5). Instead of a wave of constant frequency with varying amplitude, our modulated signal now appears in the form of three components on three different frequencies.[10] The amplitude, frequencies and characteristics of the carrier and sidebands are given below in tabular form, as deduced from (5).

Component	Frequency	Amplitude	Characteristic
1. Carrier	f_1	E_o	Amplitude constant
2. Upper side band	$f_1 + f_2$	$\frac{mE_o}{2}$	Amplitude is a function of modulation coefficient.
3. Lower side band	$f_1 - f_2$	$\frac{mE_o}{2}$	Amplitude is a function of modulation coefficient.

The carrier is of constant amplitude and consequently plays no part in the transmission of intelligence. The sidebands both vary in amplitude and hence are considered as the intelligence-bearing components. An immediate inference from the tabulated data above is that transmission by modulated signals requires a band or channel of frequencies whose width is twice the frequency of the modulation. For these reasons, various devices have been invented whereby either sideband may be suppressed with consequent reduction in the width of channel required for transmission to one-half.[11]

While the derivation was based on the generalized modulated signal of Fig. 3, inspection will show that the same carrier and sideband components are obtained by simple trigonometry from the final equations for grid circuit modulation and plate circuit modulation obtained before.

Amplitude Modulation vs. Sideband Theory

Despite the fact that the sideband theory has long been known and its application widely demonstrated, there remains an unwarranted amount of misunderstanding and confusion in the minds of many engineers in regard to its true significance and relation to the varying amplitude conception. It is not unusual to find a person who is quite at home with the one view, and utterly at sea with the other. With this in mind, the following conclusions are offered. (Detailed proof is impossible here for obvious reasons.)

1. Amplitude modulation corresponds to our purely physical interpre-

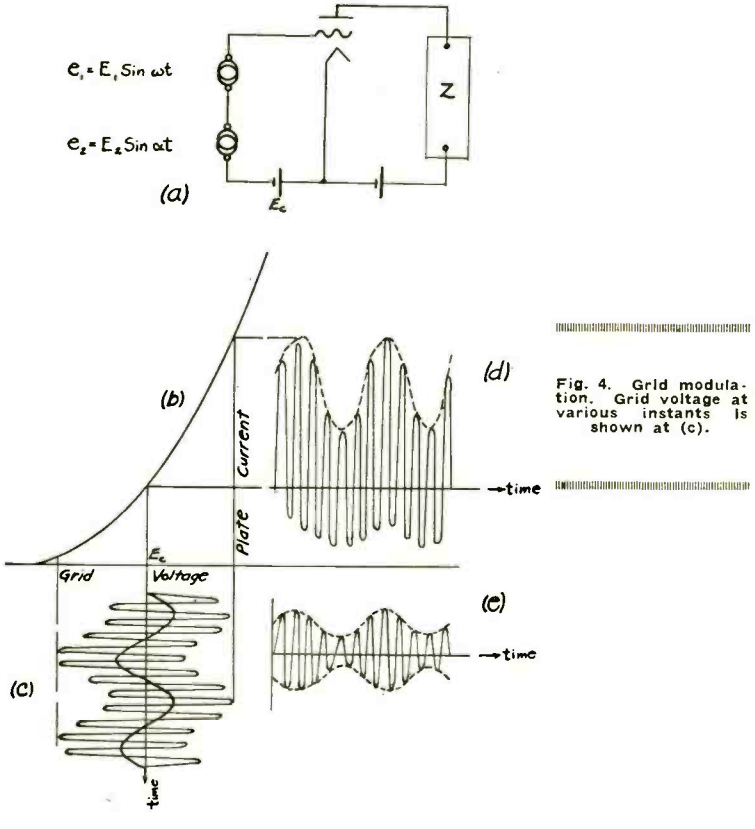


Fig. 4. Grid modulation. Grid voltage at various instants is shown at (c).

[9] *Carrier Current Telephony and Telegraphy, Colpitts and Blackwell. Trans. A.I.E.E., Volume 40, 1921, page 205.*

[10] *The term "frequency" is used in its ordinary sense, i.e., as the reciprocal of the time for one complete period.*

[11] *Production of Single Sideband for Transatlantic Telephony," R. A. Heising, Proceedings I.R.E., June, 1925; p. 291.*

tation of the operation of ordinary modulation devices. Any consideration of the mechanism of modulation leads first and foremost to the varying amplitude viewpoint. This has been demonstrated in the discussion of grid and plate modulation.

2. Amplitude modulation corresponds to the characteristics of a modulated wave as determined from actual measurements. The peak and minimum amplitudes are very easily determined.

3. Since no mathematical operations other than simple trigonometry are involved in going from the varying amplitude expression to the sideband expression, the operations are reversible. Interpreted physically, if we could generate the carrier and sidebands separately and mix them in proper amplitude and phase, the components would combine or "beat" to produce an amplitude modulated wave Hence the conception or carrier and sidebands may be considered a tool for the interpretation of the properties of an amplitude modulated wave.

4. Any phenomenon which is explainable on the basis of carrier and sidebands is also explainable on the basis of varying amplitude.[12] It so happens that in some cases one view is more convenient to use than the other. This is illustrated by the fact that the sideband conception is valuable when the wave is acted upon by filters for reducing the width of channel required for transmission, but the varying amplitude interpretation is most convenient when considering the physical operation of modulation devices, the functioning of detectors, and in general, measurement work.

In this connection, let us consider the effect of a highly selective circuit on the fidelity of a modern broadcast receiver. It is well known that the fidelity of a receiver is better at the high frequency end of the broadcast band. This is usually explained by reasoning that, since the receiver has better selectivity at the low frequency end of the band, the sideband frequencies suffer more attenuation for low carrier frequencies than for high carrier frequencies.

This explanation is convenient, but explanation based on amplitude variation[12, 13] is no less convenient and perhaps corresponds more closely to actual physical behavior.

In considering the overall selectivity of a receiver, we may generally think in terms of the properties of one set of tuned circuits since the selectivity depends upon the number of tuned circuits and the properties of the individual circuits. If an alternating e.m.f. is suddenly impressed in one of the circuits, the currrent will decrease at a rate which depends on the circuit resistance and reactance. This may be expressed in terms of decrement. Low decrement, in general corresponds to high selectivity and low circuit resistance. Hence, in a highly selective circuit. the current will decrease slowly. It is a fundamental conception that the variations

[12] *Correspondence from A. B. Howe, Exp. Wireless and W. E., February, 1929; p. 95.*
[13] *"Principles of Radio Communication," Morecroft, 2nd ed.; p. 780.*

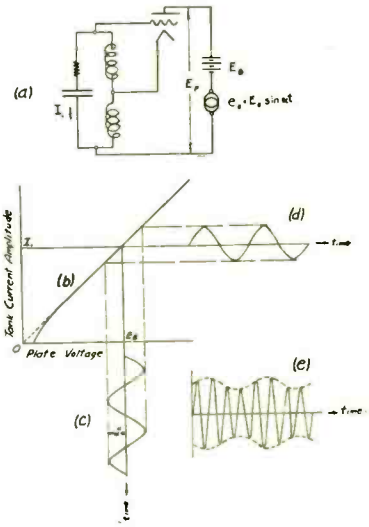


Fig. 5. Plate modulation.

in high-frequency current in the tuned circuits of the receiver must follow the variations of the impressed signal closely for distortionless or faithful reception. High modulation frequencies cause rapid variations in the signal amplitude.

We may conclude, then. that discrimination against high modulation frequencies is the result of the fact that the tuned circuit is not capable of reproducing efficiently amplitude variations at a rapid rate.

(To be Continued)

PSYCHOLOGY OF PRICE MAKING

PSYCHOLOGY seems to play an important part in our attitude toward our problems of cost. We insist on close and reliable figures of production costs and the use of those figures to bring about the most efficient and economical operation of our factories. When it comes, however. to our distribution department we have an altogether different point of view. That point of view is controlled by our attitude toward the exigencies of price making. We are compelled (or think we are) to establish prices after consideration of competitors' prices, that is. to make the price "what the market will bear." Accordingly, our common practice seems to be, first, to determine our manufacturing cost as carefully as we can and then to add to that cost whatever margin can be included to allow for the sales and general expenses and the company's profits. If, for example, article "A" is in a highly competitive field, we may add 10 per cent to the manufacturing cost to allow for selling and general expenses and profits. Article "B" is a little more favored and we add 20 per cent. Article "C" is a popular specialty and it will stand 30 per cent.

At this point it is pertinent to inquire into the objectives in accounting for marketing costs. A few of these objectives are as follows:

(a) To effect economies in individual items of marketing cost. Such control is brought about through the use of a budget.

(b) To establish sales prices (or effect control of profits) through a knowledge of marketing costs of individual products.

(c) To supervise the profitableness of sales methods, sales territories, and possibly of individual salesmen.

These are a few of the proper objectives in accounting for marketing costs. —*Thomas W. Howard, in NEMA News*

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KNOWN PHONOGRAPH RECORD BEST FOR SPEAKER TEST

Just how good is this particular loudspeaker? Sucb a question often confronts the radio engineer or the radio dealer. The answer is generally obtained by connecting the speaker with a radio set, listening to a few bars of music, and drawing a hasty conclusion. While this procedure may do for the radio enthusiast about to buy a single speaker, it is hardly safe practice for a set manufacturer placing an order for a thousand or one hundred thousand speakers, and incidentally involving the very future of his company by way of public acceptance.

The best method of determining loudspeaker performance and comparing loudspeakers, states Clifford E. Stevens, chief engineer of the Stevens Mfg. Corp., Newark, N. J., and an authority on loudspeaker design, is to employ a phonograph record and good pickup. The record should be one with which the tester is fully familiar, so that he knows precisely how much or how little of the musical values of that particular selection he has heard in the past. It then becomes a relatively simple matter to draw conclusions as to the performance of any speaker.

Modern Radio Tube Manufacture

Factory Main Steps in Tube Making

By Foster Clark *

THE manufacture of a radio tube entails many operations of considerable complexity and requires the exercise of great care at all times to ensure the production of a high grade article. Automatic machinery and gas heat have made it possible to turn out quality tubes in large quantities with but a small percentage of spoilage or rejection.

The same general procedure is followed in the making of all standard types of tubes; therefore, in following the process, we shall confine ourselves principally to the new screen-grid tube, type —24, as this tube is being widely used in the newer radio receivers and has a few additional operations involved in its manufacture differing from those employed in the making of the ordinary filament-type tube.

The first step in the process consists in the making of the "flare," which is the part of the tube through which the connecting wires pass from the evacuated interior to the base in the completed product. This is made from four-foot lengths of glass tubing, having a wall thickness of thirty- to forty-thousandths of an inch. These lengths of tubing are placed in the flaring machine, which consists of a rotary table with eight gripping arms for the eight positions of the flaring operation. The first two positions are for the preheating of the glass by means of small fish-tail gas torches, which are so adjusted as to heat the bottom portion of the length of tubing with increasing intensity. At the third position a rotating monel-metal butterfly gradually rises inside the tube so that the strongly heated glass is pressed out uniformly at the bottom in a taper or flare. Four torches play a strong flame against the tubing during this operation so that the glass will be sufficiently malleable to shape easily. The next position allows the flared portion to cool before it is placed on the gauge in the fifth position. The tube is gripped firmly after being gauged and is heated with increasing intensity in the next two positions at the point where it is to be cut. In the eighth position a rotating cutter drops down as the tube swings into place, then rises inside it to the indicated height, where it cuts the glass. The cut section, known as the "flare," drops down a slide as the table rotates to the first preheating position again. This complete operation takes about fifty seconds.

After inspection, the flare goes to the stem machine, which is also of the rotating table type with eight positions. Three of these machines are shown in the right background of Fig. 1. The first two positions are for loading, where the "welds," consisting of nickel-copper wire of various lengths coated with borax, are placed in slots in a special vertical chuck. The flare is slipped over these welds with its flared end uppermost and a small glass exhausting tube, is dropped in the center of this assembly to a point about three-eighths of an inch above the bottom of the flare. The flare is now gripped by metallic holders and the entire assembly rotated to the third position between two soft flame torches which play on the flare at the point where the pinch is to be made. In the next position three torches play on each side of the flare, beginning the melt. The pinch is made in position five by two metallic pincers, intense heat being applied by means of five sharp flame torches on each side. The sides of the flare are pressed together by the pincers and the borax flux on the welds melts, thus fusing the flare and welds together with an airtight seal. In the sixth position, with three torches heating the pinch, the exhausting tube comes under a small air jet, which blows a small hole through one side of the pinch. It is through this small hole that the bulb assembly is evacuated in a later operation. The last two positions are for annealing by means of soft flame torches. This complete stemming operation requires one minute.

This stem assembly is removed by the operator and placed in the stem annealer, which consists of a narrow inclined chamber four feet in length, heated by small gas burners. The temperature of this chamber decreases toward the discharge end and is controlled within close limits by the adjustable burners. The stems move by gravity as the operator places a new stem in the annealer; each stem, upon reaching the discharge end, is inspected and placed in a container. Fifteen minutes is the average annealing time.

The annealed stem assembly now goes to the stem formers, where the welds or lead wires are bent into the proper form to fit the parts which are to be mounted thereon. The stem formers are mechanically operated and consist of matching dies which bend the various wires to shape.

After inspection, the formed stem goes to one of the assembly benches, some of which are shown in Fig. 1, at which point the various internal parts such as the plate, grids, and filament are mounted upon it. These parts vary so widely with the different types of tubes that the description of the process will be confined to the screen-grid tube.

The stem for one of these tubes is taken up by the operator and a cylindrical plate of strip nickel is mounted on two of the lead wires and welded to them by means of a small electric welder. Next the cathode is inserted in the center of the plate and welded to its respective terminals. The cathode itself is a hairpin-shaped tungsten wire or filament enclosed in a nickel sleeve from which it is electrically separated by a solid insulating compound. The nickel sleeve is coated

Fig. 1. Assembly benches where formed stem has plate, grid and filament attached.

* *Industrial Department, Detroit City Gas Co.*

with a special oxide of strontium and calcium.

The screen-grid assembly is now mounted on the two remaining support wires of the stem assembly and welded to them in the same manner as the plate was welded. This assembly consists of three main parts; an outer nickel mesh cylinder closed at the top except for a small opening through which the top of the cathode and the inner grid supports project; an inner grid of fine molybdenum wire in coil form; and a third grid next to the cathode, known as the control grid, also made of molybdenum wire.

Fig. 2 Sealing-in machine in right foreground.

Completion of Assembly

Following this operation, the control grid lead wire is welded to the top connection of the control grid. At the same time the "getter cup" is welded to one of the main grid supports; this is merely a short nickel wire at the end of which is a small nickel cup containing a tiny piece of magnesium ribbon. This complete assembly, now known as the "mount," is tested for short circuits.

From the testing board the mount is transferred to the sealing-in machine, shown in the right foreground of Fig. 2. Here the mount is placed on a rotating support known as the sealing head, the bulb placed over it, and heat applied both to the injunction of the flare and bulb and to the small tube through which the control grid lead wire now passes. The sealing head, constantly rotating, is moved into increasing heat zones until at the fourth position the glass begins to soften as sharp flame torches play on the two selected points. At position five the tube surrounding the control grid lead wire is sealed off and the flare junction is being formed. In the next position the top of the bulb is annealed by a single soft flame torch, while the flare and bulb are fused together and the bottom of the bulb cut off by action of eight sharp flame torches playing on this point. At the seventh position this bulb assembly, as it is now called, is removed from the machine, inspected, and placed in a tray. This operation requires about seventy seconds for completion.

Now follows what is probably the most spectacular and particular operation of all those involved in the manufacture of a radio tube, the exhausting process.

The bulb assembly from the sealing-in machine is placed on a support in the exhauster in such a manner that the exhausting tube, mentioned previously, fits into a piece of rubber tubing connected by a glass trap to a valve from the exhausting line. As the exhauster rotates from one position to another, the glass trap and valve coincide with a port on the stationary central unit of the exhauster leading to the exhausting pumps; thus the bulb is continually exhausted in every position. The bulb assembly moves first through a small gas-heated oven, where it is baked at a temperature of 950 deg. Fahr. for a period of approximately three and one-half minutes. Upon emerging from the oven the tube is subjected to high frequency electrical bombardment by a current induced in the metallic parts by means of an external electric coil, which drops down around the bulb. By means of this electrical bombardment and the heat developed therefrom the gases present in the glass and metallic parts of the tube are set free and burned out. A fourth coil then drops around the tube at the level of the getter cup, the heat flashing the magnesium in the cup, thus burning out any gas yet remaining and forming a silvery coating inside the tube. In the next position two small fishtail torches move into place on either side of the exhausting tube and seal this off. The entire cycle through the exhauster is about seven minutes. One of these machines is shown in the left center of Fig. 2.

Each exhauster is connected to a battery of eighteen rotary vacuum pumps, shown partly at the lower left of Fig. 2, which continue to pump the bulb until the exhausting tube is finally sealed off. High quality tubes are usually exhausted to a pressure of one micron, or one one-millionth of a millimeter.

The tube is now "based." The base is made of bakelite, with a ring of bakelite cement around the inside, and contains a number of hollow pins fastened to the bottom, one pin for each wire. The lead wires of the tubes are straightened with tweezers and the base fitted on in such a way that a wire protrudes through each hollow pin, care being taken that each wire is inserted in the proper pin. The screen-grid tube has five lead wires at the base in addition to the control grid lead at the top. The tube then passes through a rotary gas-fired oven held at 140 deg. Fahr., which hardens the bakelite cement and fastens the tube firmly to the base. The tube is kept in the oven for ten minutes.

Gas Does Important Work

Following the basing operation, the wires are cut off flush with the ends of the pins and the latter are pressed on a small pad of acid flux, then dipped in a shallow pan of solder, heated by a small gas burner.

A small nickel cap, having a small hole in the center, is now slipped over the control grid lead wire and secured to the top of the tube by means of bakelite cement. The tube is baked in a small gas-fired oven for a few minutes to harden the cement, then the wire is cut off flush with the top of the cap and a drop of solder placed at this point, thus forming the top contact point.

Next the tube is "aged" for twenty minutes on a special board containing one hundred sockets, each connected to a lamp for indicating voltage. Current is applied to all the contact points and any gas still remaining in the tube is "aged out" through absorption by the magnesium vapor previously released inside the tube from the getter cup.

After aging, each tube is placed on a testing board, where it is tested for short circuits. cathode activity, normal plate current, and gas by extremely delicate instruments. If the tube shows a current of more than one micro-ampere in the grid circuit it is sent to the recovery department.

The tube base is now branded with the manufacturer's name and the type of tube. This is done by inserting the tube in a metal sleeve and rolling it over the gas-heated brander.

Finally, each tube is cleaned with very fine pumice, wrapped in a corrugated holder, placed in an individual carton, and packaged in a shipping container.

Gas and air are both supplied at three pounds per square inch pressure to the various production machines and are mixed at each point of application by means of a special mixing tee. This makes it possible to obtain any type of flame and any degree of heat desired at each point. The flexibility and adaptability of gas heat make it indispensable to this process, where the requirements vary from low temperature annealing to a sharp glass melting flame in the same operation.

The Farm Market for Radio Receivers

Demand Growing for Information Services

By S. R. Winters

THE Kansas farmer who graciously relayed radio entertainment along a barbed-wire fence for the pleasure of his neighbors may have been the forerunner of an era when radio programs will travel along wires to farm homes extensively. Dipping into the future, Morse Salisbury, chief of the radio service, United States Department of Agriculture, foresees the possible use of so-called "wired radio" as an avenue for conveying agricultural information and entertainment into rural homes. Wired radio appears on the horizon as a probable competitor of space radio, with the first installation of physical equipment and studios at Cleveland, Ohio.

While the Kansas farmer shared his radio programs with neighbors by associating his elaborate rndio equipment with the barbed-wire fence and it was only necessary for them to tap this wire for music or speech, the plan to broadcast over wires is not so simple nor so inexpensive. This contemplated new radio service presupposes that the farm home is already served with electric power from central stations. Unlike the prevailing method of broadcasting music and speech through space, the radio waves radiating in all directions, the so-called "wired radio" or "wired wireless" implies that a radio program is transmitted over an electric power line—or, more accurately speaking, the radio wave travels in close proximity to the wire—and if this line enters a farm home the radio program may be picked up by receiving sets designed for the purpose. These receivers, if present plans are pursued, would be supplied farmers like telephones, on a monthly rental basis.

And it is this cost system—the necessary charge of so-much a month for the rental of the receivers or a fee to reimburse the distributors of radio programs over wires, that handicaps "wired radio" in its competition with space broadcasting. Farmers owning receiving sets and with the world within their reach—through chain broadcasting — and without listening fees, will doubtless hesitate to utilize commercial wired radio, with its necessary levy for operating expenses and reasonable profits. However, the advocates of wired radio to its freedom from the congestion of broadcasting stations that afflicts "space radio" and a like immunity from static and fading when radio entertainment travels along wires instead of through the ether. "This development," declares the radio service of the Department of Agriculture, in referring to wired radio, "holds for the future, when most farm homes will be served with electric power from central stntions, a new radio outlet for agricultural information. For the present it means that wired-wireless interests, if they attempt to compete with space radio broadcasters, must supply service programs for the housewife and for 'town farmers.' The Department of Agriculture will be interested in both phases."

Anticipating an expansion of the present policy of popular broadcasting stations to sandwich phonograph records between advertisements of the air, Mr. Salisbury seeks to embrace a similar opportunity for spreading the gospel of better farming. While small broadcasting stations have long resorted to the use of phonograph records as a coated sugar-pill to lure advertisers, Mr. Salisbury refers especially to that more significant and less objectionable procedure of phonograph-record continuities for feature advertising broadcasts over chains or groups of stations. In this instance, the continuous story and its advertising are impinged on the wax of a phonograph record or on the celluloid of a sound-film strip. "The Department of Agriculture," advises Mr. Salisbury, "should be prepared to employ this method of releasing from many stations realistic broadcasts by agri cultural authorities."

These folks aren't fooling while they listen-in

It is trite, but nevertheless a fact that broadcasting recognizes no boundary lines—State, national, or even international. Almost nightly, as we finger the dials of our receiving sets we are aware that the boundary line between Canada and the United States dissolves as radio waves refuse to recognize artificial limitations. This very factor may inflict its penalties as well as offer its advantages of being a nullifier of the handicap of distance. Of this problem—the breaking down of State boundary lines—Mr. Salisbury warns, what may be meat for one State may be poison for another. This makes it all the more necessary that State and Federal information broadcasting be correlated, points out Mr. Salisbury. This is one of the reasons, he informs us, for proposing to agricultural and home-economic extension services of the several States a system of releasing cooperative Federal, State, farm, and home programs through cooperating broadcasting stations in each State.

"The development of farm and home fact-broadcasting during the coming year, will involve many problems of correlation. Vexing situations are likely to arise in connection with the working out of the cooperative manuscript services. Radio knows no boundary lines. Hence delicate matters of release of information by the States through radio stations which, although located in one State, serve an audience in several States, may conceivably arise. However, no insurmountable difficulties in this connection have arisen through the operation of the 19 land-grants college stations now broadcasting, and such as do arise through expanding farm and home broadcasting, through cooperation with commercials, can undoubtedly be overcome."

Mr. Salisbury is hopeful of beneficial results in present efforts to enlarge the sphere of radio in the role of educator. "Within the coming months," we are told by the chief of the radio service, "the survey of the national committee on radio and education, appointed by Secretary Wilbur of the Department

of Interior on May 24, 1929, will undoubtedly develop valuable facts. This committee will deal not only with the elementary and high-school field and the college and university field, but with the field of informal adult education and extension—the field in which the Department of Agriculture's radio service is particularly interested. The national committee's report will be formulated in 1930. Meanwhile the radio service is making an effort to secure from representative farm listeners their stand on current developments in agricultural extension and general information broadcasting. Another year will see a much firmer basis for developing the use of this new public service agency for the benefit of the farm and the home."

By way of review of the significant trends and developments in broadcasting, during 1929, as they relate to rural life, Mr. Salisbury gives the following conclusions:

"From the chaos of conjecture and experiment in the early years of the radio industry and the broadcasting art, a pattern of certainty and the settled outline of a new business and social institution rapidly emerged during the fiscal year 1929.

"All observers, within and without the radio industry, agree that the widespread use of broadcast programs by the political parties during the Presidential campaign of 1928 firmly fixed the place of radio as a factor in forming public opinion. This fact has had significant influence both in the program-making of the broadcasters and in the attitude of the leaders of American thought and action toward radio.

"It has made the broadcasters turn their attention to ways and means of meeting their opportunity and obligation to carry on educational and information service.

"The recognition of radio's service in getting facts and opinions to the listening public naturally has increased the desire of persons who have facts or opinions to set forth to obtain broadcasting time.

"Another highly significant development of the year was the definite rating of commercial stations—as distinguished from stations not operated for profit or commercial 'good-will' purposes—in preferred positions by the complete reallocation of frequency assignment made effective November 11, 1928, by the Federal Radio Commission. In this reallocation only two stations not operated by business interests were placed on cleared channels, and each of them must share time on the channel with another station.

"Persons interested in agricultural broadcasting will pay particular attention to the status of the land-grant college stations, as to assignments of frequency and of broadcasting time. Only one land-grant college station was placed upon a cleared channel. It divides time with a commercial station on the same channel. Of the remainder all were assigned regional channels.

"The overwhelming preponderance of commercial stations in the preferred assignments under the reallocation plainly indicates that the ability of such stations, backed by ample resources, to provide programs appealing to all interests will probably keep them in the forefront of the broadcasting picture. Their position naturally carries with it a responsibility to see that the public interest is served. They accept the obligation to supply not only commercially sponsored advertising programs of entertainment but also sustaining programs of information, education, and inspiration.

"Because of the small personnel available and the necessity for working that personnel at top speed in order to get out the programs, the radio service did not during the past year undertake any survey of the status of agricultural broadcasting. Such a survey is greatly needed in order to provide a basis for organizing information services to use this new agency of communication effectively. Such surveys as were made during the year by agencies outside of the Department of Agriculture indicated that the farm audience is fairly well reached by the present technic of agricultural broadcasting. For example, the survey made by the National Broadcasting Company, and issued under date of January 1, 1929, included the following findings in regard to the efficiency of present general information farm broadcasting and the listening habits and preferences of the rural radio audience:

"Farm families listen more than city and town families during the daylight hours, especially between 12 noon and 2 p. m.

"Preferences for most of the different types of programs are practically the same on the part of farm, town, and city families. There are significant differences, however, with respect to several types of programs—semi-classical and classical music and grand opera are preferred less by farm and small-town families than by city families, whereas religious services, crops and market reports, and children's programs are preferred more by farm families than by city families.

"Nearly three-fourths of the farm families enjoy talks on agricultural subjects. The exact percentage is 72.12. Of the small-town families, 31.44 per cent, of the families in medium-sized cities, 23.45 per cent, and of the families in large cities. 10.19 per cent, likewise reported that they enjoy agricultural talks.

"A smaller, more specialized study made by the Pennsylvania Department of Agriculture and published on November 1, 1928, is summarized as follows:

"Of 352 farm radio owners: 231 have 5 or 6 tube sets.

"315 have loudspeakers.

"270 make a special effort to tune in on special farm programs. (It will be noticed that this percentage, 76.7, tallies fairly closely with the National Broadcasting Company's survey percentage of 72.12.)

"199 said they depended upon the radio market reports in buying and selling.

"274 replied that radio weather reports helped them in planning their farm work.

"330 were sure their families would not be satisfied without a radio.

"220 believed that the radio is helping to keep young people interested in farm life.

"During 1928 the Extension Service of the Department of Agriculture made three studies of the effectiveness of extension work in influencing rural people which took radio broadcasts into account as an extension agency.

"In a Rhode Island study involving 379 farms and farm homes it was found that 63 per cent were equipped with radio receiving sets. No practices, however, were reported as being adopted because of information obtained by radio. In Vermilion County, Ill., 304 farm and home records were obtained. In this area 40 per cent of the homes had radio receivers, and 0.1 per cent of the improved practices reported as being adopted were credited to this agency. In a Michigan study involving Jackson County in the lower peninsula and Menominee County in the upper peninsula, 451 records were obtained. Twenty-two per cent of the farms had receiving sets, and 2 per cent of all the practices reported as being adopted were credited to this agency.

"Extension executives of the department, after analyzing fragmentary data on the cost and influence of radio, stated that while no conclusion can yet be reached, the indication is that the radio will compare well with published news services in influencing the adoption of improved practices by farmers and home-makers."

By way of retrospect, a summary of progress of radio's contribution to farm life during 1929 would include the following projects either initiated or sponsored by the radio service of the Department of Agriculture: Inauguration of daily broadcasts through a network of the National Broadcasting Company; arrangement of two nation-wide broadcasts from the same company's net work; a resume of the annual agricultural outlook report, in January, 1929; a program from the 4-H club camp in Washington, D. C., in the course of which Mrs. Herbert Hoover delivered a message to the youth of the nation; the number of broadcasting stations using the syndicate manuscript service increased slightly, the total being 152; and the response from the radio audience listening to these agricultural broadcast services exceeded 80,000 pieces of mail.

R.M.A. Trade Show Will Break All Records

PROGRAM FOR RMA TRADE SHOW ASSURES WEEK OF MANY ACTIVITIES

THE TIME..... Week of June 2nd, 1930
THE PLACE..... New Municipal Auditorium, Atlantic City, New Jersey
THE EVENT..... Fourth Annual Radio Trade Show of the Radio Manufacturers Association
THE REASON... See the latest of everything in radio
Will everybody be there? *Right!*

IN size, attendance and entertainment features, the annual convention and trade show of the Radio Manufacturers Association at Atlantic City, June 2-6, next, will break all records, according to information now available. Reservations for the exhibit space in the mammoth $15,000,000 auditorium on the Atlantic City boardwalk now exceed all past records of successful RMA trade shows. Advance hotel reservations also are in excess of former years, the entire space in large beach hotels being engaged in one or two instances.

Reduced railroad fares, the Association announces, also have been granted by all railroad lines. One and one-half fares for the round trip, on the certificate plan, have been arranged for the RMA gathering. Special trains to Atlantic City are now being arranged from New England, New York, Chicago, St. Louis, Cincinnati, Detroit, Minneapolis, St. Paul, Dallas in the southwest, Los Angeles, San Francisco and the Pacific northwest, and also from New Orleans, Atlanta and other southern points.

The unusual vacation and entertainment advantages of Atlantic City, are apparently going to be taxed to their utmost for the entertainment of the radio throng during the RMA week of June 2d. Official as well as other entertainment programs are now being made for Atlantic City in June, and bathing, golf, sailing and other entertainments in full swing are expected to be added attractions to the radio week events.

In addition to the convention and business meetings of the RMA, extensive programs for discussion of many industry problems also are being prepared by the National Federation of Radio Associations and the Radio Wholesalers Association. On Tuesday, June 3d, the Institute of Radio Engineers will hold a special session. There will also be meetings of the newspaper Radio Editors Association and the newly organized Radio Press Association.

For the exhibition of the latest art in modern radio products, the vast auditorium at Atlantic City will have about 200 exhibitors of receiving sets, tubes.

Jess B. Hawley, show committee chairman, and G. Clayton Irwin, Jr., trade show manager, are still receiving space reservations and assignments to exhibitors are being made.

Plans for the convention features and annual RMA banquet, the latter on Wednesday night, June 4th, are also being made by B. G. Erskine of Emporium, Pa., chairman of the RMA convention committee. One of the largest banquets ever held in the United States is assured, in the great ballroom of the auditorium. Unique entertainment features at the banquet and also during radio week are being arranged by Chairman Erskine.

For the special train service to Atlantic City and convenience of the radio dealers and jobbers attending the RMA events, cooperation is being given by officers and others of the National Federation of Radio Associations and the Radio Wholesalers Association.

Jess B. Hawley of St. Charles, Ill., chairman of the show committee, and Ben G. Erskine of Emporium, Pa., chairman of the convention committee, both were enthusiastic over prospects for the June conclave of the radio industry, and their plans were approved by the board of directors.

Eastern Dealers Will Benefit by Proximity of Trade Show

For the first time, radio dealers and jobbers along the Atlantic seaboard will have an opportunity to attend the annual trade show of the Radio Manufacturers Association conveniently and economically. And, if advance interest in the show can be considered a criterion, Eastern dealers will flock to Atlantic City in multitudes the week of June 2nd.

Reports reaching the Chicago office of the RMA indicate also that the radio trade of the Middle West is not going to neglect this opportunity to visit the "playground of the World" and the radio trade exposition at the same time. Special trains from a large number of southern and middle west cities are already being arranged and Atlantic City hotels are reporting an unusually large number of reservations.

Boardwalk hotels declare that the largest proportion of their advance reservations are coming from the central and south central states. This is taken by RMA officials to indicate that the great majority of middle west dealers who attended the show at Chicago in years past are now planning to follow the show to Atlantic City.

With this middle west attendance already indicated and with the assurance of the attendance of thousands of eastern dealers who have never been to a trade show, the RMA is confident that the Atlantic City show will attract equal or possibly larger attendance than the record of 32,000 established last year.

One Headquarters

In contrast to last year's show at Chicago, where three hotels several blocks apart were required to house all the displays, this year's show at Atlantic City will be housed under one roof. In fact, all the activities in connection with the trade show and convention will be housed under the one magnificent roof of the $15,000,000 Auditorium.

The show itself will also be a greater drawing card this year than it has been. A number of highly important interests are embarking upon programs of receiving set production and merchandising for the first time this year and their products will make their debut at the show.

Dealers and jobbers will also be keenly interested in the newest products of the new and older manufacturers as well, whose latest output will be initially presented to the trade at Atlantic City. While nothing revolutionary is expected, it is known that most manufacturers have several innovations ready for initial exhibition at the trade show.

Trade conditions this year are so unusual that an unprecedented amount of interest is being taken in the show. The trade wants to know what companies have survived, what companies are financially the soundest and what new types of receivers, cabinets, cir-

cuits, tubes and other products will be brought out for next season's market. The week of June 2nd will answer all these questions.

All the hotels in Atlantic City have agreed to establish the same rates for rooms as prevailed in the same week of June, 1928, the RMA discloses, so that trade show visitors will be safeguarded against any rise in the rates of hotel accommodations during the show. The hotels have also agreed to permit no one but RMA members to secure demonstration space in any of the hotels, thus insuring again that the trade show will be of the fullest benefit to RMA members exclusively.

Railroads have also declared their intention to provide half fare tickets on the return trip for all RMA Trade Show visitors. Special trains from the four corners of the country are also now in the process of making up.

Invitations to the trade will be mailed early in May. Admission to the show will be by invitation only, which are issued free of charge by writing the Radio Manufacturers Association, 32 W. Randolph Street, Chicago, Illinois.

Entertainment

Each day during the week of June 2nd there will be constant and varied entertainments for the industry guests. There will be luncheons, dinners, theatre parties, as well as the premier event, the annual RMA banquet. The banquet will be held on Wednesday evening, June 4th, in the great ballroom of the Atlantic City Auditorium, which seats 5,000 persons, assuring the largest RMA banquet ever held and probably the largest ever held in the United States. Last year the RMA banquet broke all records for affairs of this kind, with more than 2300 guests, and even these accommodations were insufficient. The great ballroom in the Atlantic City Auditorium is expected to hold between three and four thousand guests, when the curtain rises on the night of June 4th.

With all these activities planned the 1930 RMA trade show and convention is expected to become an outstanding milestone in radio history.

Saltzman to Speak

General Charles McK. Saltzman, chairman of the Federal Radio Commission, has consented to deliver the principal address, it is announced by H. B. Richmond, president of the Radio Manufacturers Association.

A summary of the many activities planned for show week indicates that visitors to the show and convention will not find time lagging on their hands. The festivities will open promptly Monday morning, June 2nd, at 10:00 o'clock with registration of visitors.

At one o'clock Monday afternoon the trade show will open its doors and the serious business of the week will begin. Dealers and jobbers will then have their first glimpse of the new 1930–31 lines and manufacturers will form the first new-season contacts with the trade.

N. F. R. A. and R. W. A. Meetings

A number of business sessions in connection with the various conventions scheduled for show week will also be held Monday. At 10:00 a. m. the RMA board of directors will convene, at 11:00 a. m. the first open meeting of the week will be held by the National Federation of Radio Associations to which all show visitors are invited. This will take place in room twelve of the auditorium, boardwalk entrance. The rest of the day will be taken up with the trade show and committee meetings of the RMA, the Federated and the Radio Wholesalers' Association.

Tuesday, June 3, will be more or less the engineer's day, as the Institute of Radio Engineers will have both morning and afternoon sessions. Dr. Lee De Forest, president of the I.R.E., will preside. The trade show hours on Tuesday will be from 1:00 p. m. to 10:00 p. m.

On Wednesday, the first membership meeting of the Radio Manufacturers Association will take place at 10:00 a. m., at which General Saltzman will speak. President Richmond of the RMA will preside. Dr. Hugh P. Baker, trade association manager of the U. S. Chamber of Commerce at Washington, D. C., will be the only other speaker.

Also, on Wednesday morning, an open meeting of the Radio Wholesalers' Association will be held with Harry Alter, president, presiding. At 10:30 a. m., the board of directors of the National Association of Broadcasters will meet. At 2:00 p. m. the Radio Press Association will convene with President H. H. Corey in the chair. Sessions of the Radio Writers Association also are to be scheduled.

At 5:00 p. m. sharp on Wednesday, the trade show and all display rooms will close to make room for the big whoopee event of the week—the annual RMA banquet! This will begin at 7:00 o'clock in the grand ballroom of the Auditorium, one of the largest banquet halls in the world. Advance demand for tickets insures that its 3,000 seating capacity will be taxed to the limit. An unusual entertainment, in the form of a miniature musical revue of nationally celebrated stars will feature the banquet. This is being arranged by B. G. Erskine of Emporium, Pennsylvania, chairman of the convention committee.

On Thursday morning at 10:00 o'clock the final membership meeting and election of officers of the RMA is scheduled. Committee reports for the year will be made and new officers and directors elected. The Radio Press Association will meet again at 2:00 p. m. and the trade show will be open from 1:00 p. m. to 10:00 p. m.

Friday, will be "clean-up day," with the show opening at 1:00 o'clock. The feature of the day will be the customary joint luncheon of the board of directors of the RMA, the N.F.R.A., the Radio Wholesalers' Association, the National Association of Broadcasters, and this year for the first time, the directors of the Institute of Radio Engineers will also attend.

Six o'clock Friday afternoon will witness the end of the fourth annual show and will bring to a close what is expected to be one of the busiest and most significant weeks the radio industry has ever experienced.

Final word from Jess B. Hawley, chairman of the RMA show committee, indicates that not only will the show be a complete sellout so far as floor space and number of exhibitors is concerned, but that the attendance will compare with and possibly exceed last year's record of 32,000.

G. Clayton Irwin, Jr., show manager, also reports that all details of the show are being perfected and that it will be the largest and most beautiful trade show the RMA has ever had. He reports complete satisfaction with the facilities of the Atlantic City auditorium and believes that exhibitors and visitors alike will be thoroughly satisfied with the arrangemets. Mr. Irwin also says that new applications for space are being received daily, and what to do with additional exhibitors will soon present a very serious problem which the show committee will have to solve.

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FEDERAL RADIO COMMISSION

The make-up of the personnel of the Federal Radio Commission, as recommended for reappointment. is: Ira E. Robinson, two years; Eugene O. Sykes, three years; W. D. L. Starbuck, four years; Harold A. Lafont, five years, and Major General C. McK. Saltzman, six years.

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R. S. M. A

The Radio Service Manager's Association, 324 West 42nd Street, New York, has issued No. 4, Volume 1, of the periodical "The Radio Service Man." John S. Dunham is president of the association and G. C. Kirchhoff, editor and business manager.

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MORE WORK FOR WAVELENGTHS

There is a general belief abroad that radio communication is decidedly limited by the present channels available within the wavelength bands at our disposal.

Based on previous practice, we would be rapidly approaching the saturation point of radio possibilities, states J. E. Smith, President of the National Radio Institute, Washington, D. C., but recent developments indicate the same multiplexing or multiplying of existing radio channels as took place in wire communications. One inter-city radio communication system is working on a scheme of five communication circuits for each short-wave channel. Another communication company is thinking in terms of radio telephone and radio telegraph circuits for each short-wave channel. With multiplex radio in the near future we may multiply our existing radio possibilities many times.

Coil Corrosion*

Electrolytic Effect Causes Electromagnet Difficulties

By E. L. Fisher

IN COMMON with most development work the evolution of our electromagnetic apparatus has been attended by numerous associated problems requiring the expenditure of considerable time and effort in their solution. Some of these solutions are yet to be fully attained, the complete answer being progressively realized through increase in the general store of engineering knowledge.

One of the problems besetting the use of electromagnetic apparatus has been corrosion of the wire winding. This trouble appears in operation in the failure of apparatus to function due to the winding having become open-circuited as a result of chemical or electrochemical attack at some point of imperfect protection by the insulating materials.

Failures due to this action, with a few exceptions, are confined to coils wound with enameled wire of 34 gauge or smaller, enamel insulation being particularly liable to corrosive attack because of the presence of occasional minute holes in its surface, at which points corrosive action appears to concentrate.

In the early investigations of coil corrosion it was usually found that this activity became serious only in the presence of a uni-directional potential between two or more windings or between a winding and the iron core. The activity was therefore seen to be mainly electrolytic in character. The electrolyte necessary to the promotion of this action was chiefly moisture from the atmosphere which penetrated the outer insulating materials, taking certain of their impurities into solution.

The severity of the corrosive action being, therefore, controllable to a large extent through improvement in the insulating materials, the history of our wound apparatus design, and especially of relay coils, abounds with records of experimental tests and resultant changes in coil insulation and structure. In fact, in the case of the present-day relay, few of the insulating materials present in the original development of these coils are found.

Improvements have included changes from untreated to impregnated manila papers and thence to varnished and impregnated Kraft papers (high grade chemical wood paper made by the sulphate process); from cotton fibre spoolheads, which contained objectionable chlorides, to phenol fibre; and from coil coverings, containing a starch loading pastè which rapidly promoted corrosion in the presence of moisture, to a shellacked serving of dyed cotton thread.

As the corrosive action is electrolytic, a solution of the problem has also been sought by means of a high degree of moisture exclusion from the coil structure. During the early development of the flat type relay, coils were vacuum-impregnated with a special moisture-proofing compound developed for the purpose. Although this treatment improved the resistance of the coils to corrosion, the comparatively low melting point (140° F.) of the wax used became the cause of added difficulties in the field due to leaking of the impregnating compound from the coil onto the operating structure and other apparatus. This led to the discontinuance of the general practice of impregnating and to the readoption of a dry coil using improved insulating papers.

As the use of extremely fine gauges of enameled wire became increasingly desirable from a standpoint of electrical efficiency, further improvement in the corrosion-resisting characteristics of wound apparatus was sought. Because the advantages to be realized through the use of finer gauges of wire are especially attractive with relay coils, these again become the subject of experimental investigations intended to improve their moisture-resisting properties.

These investigations have dealt with moisture-proofing attained by surrounding the structure with a surface seal which is highly impervious to moisture rather than by completely impregnating the coil with a high-melting-point moisture-proof compound. Efforts along this line that have shown promise have mainly included tests on the use of a single wrapping of a highly moisture-proofed insulator between the coil winding and the cotton serving.

In actual practice this general type of protection is applied in a somewhat different manner, as illustrated in the covering recently standardized for relay coils. It consists of the replacement of the present covering of shellacked cotton thread by a serving of cellulose acetate silk. This covering is applied directly over the winding in the form of a number of threads, as is usually done with the cotton serving, and a skin is then formed over the entire surface by subjecting the covering to a fine spray of acetone which softens the outer layer and allows it to solidify subsequently into a continuous film that is highly impervious to moisture. This covering also provides a seal at the spoolheads by adhesion to a spool-head washer composed of a special cellulose cement which is cheaper than the red rope-paper washers as well as an improvement from a corrosion standpoint.

The last mentioned development represents the most efficient means of corrosion prevention now incorporated in the manufacture of wound apparatus (with the possible exception of the comparatively expensive practice of potting the coils in a metal case) in that it permits, with less corrosion hazard, the use of enameled wire several gauges finer than could be used in older impregnated coils.

A fairly satisfactory solution of the general problem of corrosion of the type of wound apparatus most commonly used appears to lie, therefore, in the use of surface coverings that are highly impervious to moisture, together with the continued use of properly restricted insulating materials which experience has shown to withstand the test of time.

* *Bell Laboratories Record.*

EXTREMES OF 1930

The engineer in this picture supports with his right hand an incandescent electric lamp of approximately 100,000 candle power, used in moving picture studio lighting. In his left hand he holds one of the smallest lamps developed up to the present time for operation on 110-volt commercial electric circuits. Both lamps were made by the General Electric Vapor Lamp Company, Hoboken, N. J.

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WHOSE TUBES AND WHOSE RECEIVERS WILL GET INTO THIS MARKET?

In an address before four thousand delegates at the National Music Supervisors' Conference at Chicago on March 26, Walter Damrosch, dean of American orchestra conductors, lauded the value of radio in extending appreciation of music. It will soon be possible, he said, for 27,000,000 school children to listen to symphony orchestras, including 10,000,000 rural school pupils.

The Radio Dealer Wakes Up

How the Evils of Radio Merchandising Are Being Wiped Out by New Manufacturing Interests Now Entering the Radio Arena

By Austin C. Lescarboura
Mem. I.R.E. Mem. A.I.EE.

THE discussion that follows may not be altogether pleasant. Some of us prefer to stuff our ears to the unpleasant truth. This discussion is not for them. But for those who prefer to know the truth and face the facts, on the theory that "forewarned is forearmed," there is much food for thought in what follows.

That the radio merchandising situation has been the joke of American business, goes without saying. In fact, the radio industry has "just growed and growed" like the famous Topsy, without particular rime or reason. It has the general atmosphere of a racket, despite the fact that it has taken its place among the leading industries of the nation. Production has been divorced from marketing, so that year after year a vast surplus has been disposed of at bargain prices. List prices have meant little or nothing in the radio industry, serving solely as the basis for bargaining. Discounts have meant little or nothing, since too many detours have been found whereby to circumvent the legitimate profits of jobber and dealer. Appointed with a lavish hand, each territory is overrun with jobbers frantically signing up every Tom, Dick and Harry that could raise the price of one or two sets and thereby be termed a dealer. The efforts of too many jobbers have been reflected in a super-abundance of dealers in every territory, with excessive competition among them for customers, resulting in a wild slashing of list prices and the giving away of legitimate retail profits. The abuse of legitimate business principles does not end here. The sales managers of many radio manufacturers, at the slightest signs of sales resistance, have dumped the remainder of the season's products as "distress merchandise" to the scavengers of the radio industry, who in turn have shouted the news from the housetops. Cortlandt Street prices are known the country over. Even in the most remote hamlet, these prices are learned by the buyers of radio sets, who flare back on their local dealers in righteous indignation at the higher prices charged by the local merchant for identical goods. Time purchase contracts are cancelled right and left, due to the possibility of purchasing a new set from a department store or a Cortlandt Street vender for a sum below the payments still remaining on the locally bought receiver. Meanwhile, the dealer must buy back the contract —and go broke, which is the general order of things today.

The Dealer Constitutes the Advance Guard

Why bring up these unpleasant facts? you may ask. Simply because many of us, particularly at the manufacturing end, are very much like the general staff officers back in the comfortable dugouts, miles behind the firing line. We are not immediately involved in the battles raging up front. And yet, if our battle front, represented by the retailers, should crumble, we may soon find ourselves in a sorry plight. No matter how big, how wealthy, how important we may feel as manufacturers, our very existence depends on those little radio dealers here and there who, in the final analysis, constitute our real business. Everything else is simply the superstructure of the radio industry.

The radio manufacturer may be interested to know of the conservative estimate that this spring 25 per cent of the existing radio dealers will go bankrupt. Already, the weaker radio dealers, particularly the part-time dealers such as barber shops, garages, hardware stores, sporting goods stores and so on, have passed out of the picture. The enormous drop in the number of radio dealers is materially reducing the outlets of the radio manufacturer, frankly a blessing in disguise. No one makes money in radio merchandising when there are too many dealers in a given community. Excessive selling makes for limited buying, and results in bargain prices with profits for no one.

Radio manufacturers during the past few months have, in some instances, run amuck as regards merchandising. The largest and soundest manufacturers have cut their list prices, increased their discounts, and engaged in a dumping party such as the industry has never seen before in its hectic career. Daily instances are at hand of large manufacturers offering dealers 10 per cent additional discount if they will buy sets immediately, followed by a second offer a few weeks later offering 25 per cent additional discount. Radio merchandise has reached the status of playing the market on margin. The radio dealer is no longer a business man: he has been reduced to a gambler.

More Dumping?

Further dumpings are anticipated at this writing. The sales managers of various large set manufacturers, anxious to clean the slate and start afresh with a new line, will undoubtedly sacrifice the balance of the past season's production. The public is enjoying radio bargains such as it has never enjoyed before. Many of the most conservative set manufacturers are engaged in dumping for the first time in their histories. As a result, years will be required to rebuild the prestige of some sets. Indeed, it would be far wiser, in the long run, were the surplus merchandise dumped into the sea—or sold abroad. If only the number of good brains in the industry matched the number of good sets!

Well, so much for the dark side. Destructive criticism is of value only to clear the ground for constructive criticism. Fortunately, the survival of the fittest dealers will bring the industry face to face with a handful of keen, capable, well-financed dealers, who will insist on being treated as business men and not as gamblers. Only the radio manufacturer who can meet such demands will have satisfactory merchandising outlets.

The problems of the radio industry are not so different from those of the automobile industry. Over-production and trade-ins, for example, are old problems to the automobile manufacturer. Time payments have long been the vogue. Weak dealers have handicapped the sale and reputations of some automobiles, but the better companies have selected and built up good sales representatives. Long ago, the automobile industry ceased giving away its legitimate profits, and established its list prices on a fairly firm foundation. As for list prices, they mean what they say. True, the dealer may make greater allowances on the trade-ins, but by so doing he is only signing away his legitimate profits and hastening his demise. The better automobile companies virtually run the dealer's business for him, auditing his books, aiding him with sales and servicing, and seeing that the dealer really makes money.

Automobiles and Radios

Just what does the automobile industry mean to the radio industry? Many things. It is the big brother of the radio industry. And now we may have ample opportunity of learning what it is all about, as the result of the entry of the General Motors Corporation into the radio field. At first, it was believed that this new factor would simply merchandise automobile radio sets and home sets through its automobile dealers. But that organization has too much merchandising

sense. It believes in "every shoemaker to his last." Automobile dealers will continue to concentrate on automobiles. Meanwhile, radio dealers will handle the General Motors radio products.

Now let us see just how General Motors intends to crow-bar its way into the overcrowded radio field at this late date. Throughout the country, that organization has sales representatives calling on radio dealers. The best dealer in each territory is selected for the proposed sales representation. Relatively few dealers are being appointed. In the Metropolitan New York territory every national radio set is sold by at least 2,500 dealers. General Motors will appoint only 100 dealers in the same territory—a 25 to 1 ratio! Instead of considering each little village as a separate entity, the dealer's district is based on the number of wired homes and the per capita wealth of the territory, thus protecting the dealer from a potential standpoint not only for the present but for a healthy, prosperous growth.

Some territories may comprise a number of small towns, others may be just a section of a city; but in every case the potential is accurately figured and the radio contract written accordingly.

There will be two classes of dealers, direct and associate. Associate dealers will be the smaller retailers in outlying territories, where the potential does not warrant a direct dealer operation. Associate dealers will be appointed by the direct dealers, under the supervision of the General Motors Radio Corporation's representative, supervising the territory.

Few, if any, distributors will be included in the merchandising plan of the General Motors Radio Corporation, due to the fact that the entire distribution will be handled through strategically located zone offices direct to the dealer.

In return for the potential protection which is provided, the General Motors Radio Corporation dealer will be permitted to handle only the General Motors Radio. In the larger cities, where the potential warrants, he will have to be a full-time General Motors radio dealer. In the smaller towns and cities where the potential does not warrant a full-time General Motors Radio operation, he may handle other products, of a non-radio nature. But from a radio standpoint he must cast his lot four-square with General Motors. No man can serve two masters.

Protection for the Dealer

The dealer is assured *protection*, which to him is most important. He knows positively that General Motors radio sets will not be dumped, that they will not be sold through department stores and other channels that go in for bargain prices, that the list prices really mean list prices. He knows that there will be no over-production of these products.

All production schedules are to be based on an accumulation of individual dealer projections 90 days in advance. As for trade-ins, a special fund, known as the used radio disposal fund, is established for each dealer, which allows a cash disposal fund each 90 days for disposing of trade-ins that have been accumulating during that quarter, but for which there is no resale value.

A dealer has no advertising expense, the company covering both national and local dealer advertising on a very comprehensive basis. The dealer will not operate on a discount basis. The products of the General Motors Radio Corporation will be sold to him at net prices and to the public on a list price basis. The differential between net and list, together with the advertising fund and used radio disposal fund, in addition to the many other advantages of the franchise, assure the dealer an ample margin of profit. The equivalent discount on the average sale will be approximately 43 per cent.

Servicing—the worst headache of radio merchandising—is receiving particular attention. All service work by the dealer must be charged for at flat rates. The General Motors service experts specify the equipment necessary, and the kind of men required. They establish the dealer's service department, and check up frequently on its work. In addition, the General Motors radio organization will maintain service depots conveniently located to all territories, to handle promptly the service jobs beyond the dealer's ability and equipment. All sets are guaranteed for ninety days, and all repairs and parts are to be paid for by the organization.

Finance Plan

Best of all is the finance plan. The General Motors Acceptance Corporation, which finances all General Motors automobile sales, is also to serve the radio dealers. Not only will this finance organization handle the dealer's paper or deferred payment contracts, but it will supply the necessary finances to the dealer. The General Motors radio organization demands immediate payment on all shipments of sets to dealers. But the G.M.A.C. advances the money to the dealer for such immediate payment, at the 6 per cent interest rate. The G.M.A.C. matches the dealer's investment 5 to 1. If a dealer has a $20,000 capital which is about the minimum required to swing the representation, the G.M.A.C. will advance $100,000 for the dealer's purchases of General Motors radio equipment.

A monthly financial and operating statement is secured from each dealer in order to make certain that he is operating on a safe and sane basis. The dealer must make money. His quota of sets is reasonable. In a territory of 15,000 wired homes for instance, the annual quota is set at approximately 600 sets. If the dealer's sales are not up to expectation, a General Motors radio sales expert is sent to the dealer and builds up the market. Likewise, with the selection of locations, arrangement of stores, suggestions for stock, servicing and so on. The dealer has behind him a highly skilled orgauization to build up his local success. Contrast this with the existing practice of loading the dealer up with radio sets, then dropping the price behind his back, and seeking additional competition for that dealer by appointing other dealers in his territory!

The General Motors organization, we firmly believe, is going to make a signal success of its radio venture. It will do more: it will awaken radio dealers to the realization that existing practices should be wiped out. Dealers will insist on similar square deals from other radio manufacturers, and only those in position to match the General Motors plan will have worthy merchandising outlets.

The radio merchandising situation is about to change. The present depression is a blessing in disguise. Radio manufacturers can no longer use the radio dealers as garbage cans. The dealer who remains on his fect after the present wild liquidation party, is a sound dealer. He is looking for sound manufacturers.

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TUBE REPLACEMENTS GIVE RECEIVER NEW LIFE

*By Ray H. Manson**

ALTHOUGH the average owner of a radio receiver is not interested in technical details of operation, he is interested in getting the best possible performance out of his set. The man who takes good care of his receiver realizes the value of giving it an annual overhaul, preferably in the spring to meet warm weather conditions.

The best of receivers will he all the better for a thorough servicing now and then, with tube replacements where necessary. A new set of tubes will often rejuvenate the old receiver to an incredible extent.

In the well-made receiver all parts except tubes are usually good for years of service. But tubes must be replaced just as electric lighting bulbs must be replaced. Due to constantly available power supply and to better programs. sets today are being used two or three times as long as they were several years ago and the only perceptible wear is upon the tubes.

One may think that because the tubes light in the receiver that they are in good condition. This is not so and their real condition can be ascertained best by the serviceman's tests. Depleted tubes not only injure tone quality but make the set insensitive and broaden the tuning.

*Chief Engineer Stromberg-Carlson Tel. Mfg. Co.

Electrochemical Power Pack Condensers

Aluminum Sheet and Gummed Fabric Product Is Non-Hydroscopic

By E. W. Lincoln

HIGH voltage condensers of low cost and small bulk, affording durable high capacity value and extremely low energy loss were described in RADIO ENGINEERING, October, 1928. It is stated that these condensers are effecting substantial savings in radio receiver filter circuits. Such condensers are readily substituted in standard filter circuits of amplifier units as new or replacement blocks and have a proven long operating life. Recent refinements in manufacturing control have improved the product to a high degree of uniformity.

Characteristic curves showing the extremely small leakage currents in 5- and 8-mf. size blocks are shown in Fig. 1. Thus, at a rated voltage of 350 volts, the leakage current per microfarad is only 0.06 milliampere, and at 700 volts, the leakage current per microfarad of the rated 700-volt block is only 0.1 milliampere. At normal operating voltages the leakages on such condensers is negligibly small. For example, if a 700-volt rated condenser of this type is used in a -45 tube power pack at a maximum voltage of 370 volts, the leakage per microfarad at such operating voltage is only 0.01 milliampere.

An idea of the advantageous reduction in bulk is shown by Fig. 2, where several overall canned measurements for large capacity blocks are given. These condensers can be mounted in any position and they neither freeze in Winter nor evaporate in Summer heat.

An outstanding advantage of the improved Edelman type condenser is its long shelf life, permitting use of the condenser at its normal voltage without any reforming operation, because the dielectric layer does not dissolve away with long standing, even after two years' time. The ruggedness of the positive plate film, which is a hard homogenous coating that does not flake off upon bending the plate, permits compact assemblies of any desired small shape and mounting position, and since each section is electrically shielded there is no leakage current across the choke coil to destroy part of the hum filtering as in the case of some wet type condensers.

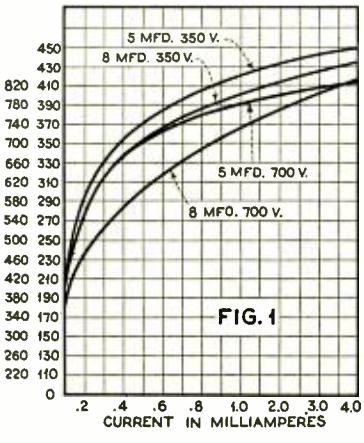
The condenser itself consists of a compact roll of aluminum sheets separated by a gummed fabric, wholly non-aqueous and prepared non-hydroscopically. The chemicals used are stable at more than twice the normal and highest likely operating temperatures, and breakdown does not occur even up to the high melting point of the supporting wax used for sealing the assembly. The effect of surges or overloads is merely to temporarily increase the leakage current and the structure readily dissipates such temporary loss in heat because of the high ratio of the metallic thermic volume used in the assembly compared to the small amount of chemical employed.

High Capacity

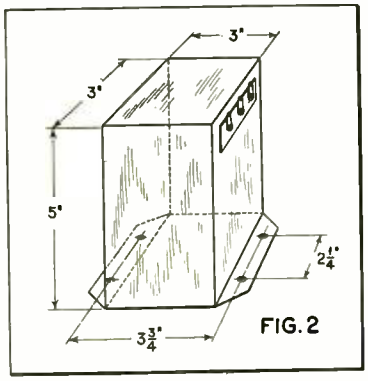
High capacity is attained by a permanizing process which gives an exceedingly thin dielectric layer at the junction of the positive electrode and the gum layer. A true oriented, molecular dimensioned, lattice structure comprises this surface on the prepared positive plate and the contact couple acts as a capacitance junction, conduction occuring only on the movement of electrons held freely at the molecular boundary.

Whereas a surge is apt to permanently break down a paper and foil type condenser it does no harm to the electrochemical condenser of this type. as the condenser merely returns to normal after absorbing the first shock, dissipating the heat caused thereby. Over a period of time, it has been observed that the leakage current tends to decrease with use of the condenser. Since the condenser is polarized, the common negative termina! must always be connected to negative, and the positive plate terminals always to positive potential. Owing to low cost of this type condenser it is not necessary to economize by skimping on capacity sizes used. This permits higher quality filtering, affording better quality of amplification. There is nothing to spill or leak out during shipment, nor to deteriorate during shelf life before the assembly reaches the ultimate user and consumer.

When these condensers are used in a-c. power packs operating amplifiers employing heater type tubes, the initial charging current time of the condenser is much less than the heating period of the vacuum tubes, but sufficient to protect the rectifier tube from excessive surge voltage. There is a definitely prolonged life of rectifier tubes of the -80 type when operated with these gum condensers, because the starting peak surges are reduced and absorbed by the condensers. There is however a total absence of excessive charging current.



Curves showing leakage.



Over-all measurements of container.

It is not feasible to list all of the many uses of such condensers in the electrical arts other than to mention that any desired shape, size, capacity, and voltage rating is readily available for any special purpose desired. Commercial sizes have been made ranging from ½ mf. up to 10,000 mfs. and for voltages up to 1000 volts. As may be observed from Fig. 1, the ratings of the manufacturer are conservative, affording a large engineering factor of safety. The manufacturer does not call the 350-volt condenser a 500-volt type because it will withstand 500 volts without breakdown, nor is the 700-volt condenser rated at 1000 volts because it will withstand a peak of 1000 volts. All ratings are well below minimum leakage ratings of normal operating temperature, allowing for temperature rise in service due to proximity of mounting to transformers, rectifiers, etc., which radiate heat to the condenser.

In testing such condensers the usual flash spark test applied to paper condensers is obviously valueless. The usual tests are simple and consist principally of a leakage current reading taking after a fixed interval of charging time, such as 15 seconds. It may be remarked that the manufactur-

(*Concluded on page 40*)

Public-Address and Centralized Radio Equipment

Directly Useful Information on This Timely Subject

By E. W. D'Arcy *

VI. Microphones

THE author shall confine himself in this article to types of microphones used commercially for public-address, talking pictures and broadcast work.

There is room for improvement in even the best microphones, and it is rather peculiar that instead of having several different principles used commercially, the field has been limited to resistance, and capacitative types.

Possibly an understanding of the limitations of present microphones can be had by considering that, for perfection, a microphone should possess no inertia, and should produce an output directly proportional to the air pressure applied.

This supposition has not been fulfilled practically, however, although there have been types developed which do not rely on any mechanical agency for transposition of sound energy to electrical energy.

The glow microphone is one example of a type which offers greater theoretical perfection compared with the stretched diaphragm type. Unfortunately, this type has been quite unreliable.

Research will, undoubtedly afford some basically new design of commercial microphone which will replace existing types with their non-linear characteristics.

Carbon Microphones

An illustration of a high quality microphone is shown in Fig. 28. This type is representative of the best carbon microphones as it is very well built mechanically and possesses excellent frequency response characteristics. The circuit for operation of this microphone is displayed in Fig. 29.

It is easily seen that as the diaphragm moves in either direction, the current through one side of the transformer will increase while the current through the reverse side will decrease. This effect contributes to the elimination of microphone hiss caused by the normal current flowing through the carbon as well as eliminating distortion caused by even harmonics. It also eliminates any effect of the microphone current upon the transformer, since the battery current flowing through the microphone transformer creates opposing magnetic fields and therefore is balanced out.

* *Chief Engineer D'Arcy Laboratories, Chicago, Ill.*

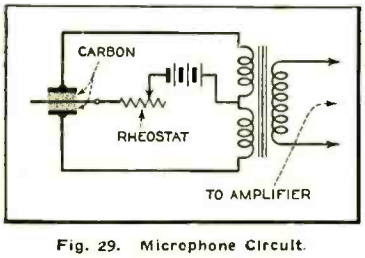


Fig. 29. Microphone Circuit.

Mechanical Construction

One of the most important factors in a successful microphone is that of the material used in the diaphragm. It must be of uniform thickness in order to avoid having resonant points when stretched. It must be sensitive to sound waves even when placed under extreme tension. It also must be rough enough to allow its being placed under sufficient tension to raise its natural period to the upper end of the used audible frequencies. Practice indicates that successful results can be obtained if the diaphragm is stretched to a natural period of 5,000 cycles.

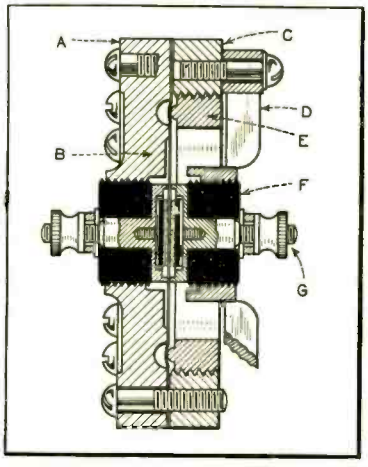


Fig. 28. Carbon microphone
A. Rear plate assembly.
B. Damping chamber.
C. Front ring.
D. Button support spider.
E. Diaphragm tension ring.
F. Rubber button bushing.
G. Carbon granule button assembly.

Copper aluminum alloys seem to possess the best requisites for diaphragm material when properly heat treated. Thickness of the diaphragm unstretched as a rule varies between one and two mils, depending upon the product of the manufacturer. The copper aluminum diaphragm is, by the best manufacturers, plated to insure a contact affected as little as possible by oxidation.

Damping Required for Good Response

If no damping were applied to the microphone diaphragm, considerable difficulty would be experienced due to the resonance points caused by stretching the diaphragm. Therefore, damping is applied by an enclosed air chamber between the back plate and diaphragm as well as by the carbon granules which are held under compression by the carbon containers.

Mechanical Construction

It can be seen that the physical dimensions of the supporting assembly have to be of considerable size to insure uniform response unaffected by mechanical resonance of any part of the microphone other than the diaphragm. For that reason the supporting rings, tension ring, and back plate are made of steel of sufficient mass both to insure rigidity and a very low natural period.

Effective Impedance of Carbon Microphones

The alternating-current impedance of a carbon microphone is not, as one would expect, its apparent talking resistance but rather the ratio of the power absorbed by it to the square of the current flowing through it. It is generally assumed that the a-c. resistance of a carbon microphone is 80 per cent of its apparent talking resistance.

Measurement of Effective A-C. Resistance

A reasonably accurate system of determining the a-c. resistance of a carbon microphone is shown in Fig. 30. The system operates on the supposition

that the carbon transmitter may be regarded as a source of constant e.m.f. acting in series with the impedance of the transmitter.

The operation is as follows: With the transmitter acted upon by a sustained source of sound and the decade resistance box (R) disconnected, the voltage is then measured across the terminals B and C. This evidently is one-half of the voltage developed by the carbon transmitter. Then with the voltmeter connected across A and C sufficient resistance is introduced by the decade box R to reduce the voltage, as indicated on the voltmeter, to its preceding value.

The value of R will then equal the a-c. resistance of the transmitter on the previous assumption that the transmitter is a source of constant e.m.f. acting through its a-c. resistance. The system is only accurate if the impedance of the retard coils and voltage-divider resistance are several times that of the transmitter resistance.

Correct Load Impedance

The input impedance of the transformer, under load, should at least equal the a-c. resistance of the microphone at the lowest frequency desired to pick up. Since reproduction is desired at as low a value as 16 cycles, it can be seen that a transformer for good frequency response must be of considerable size. As an example, one of the best transformers for use with a standard carbon microphone of approximately 100 ohms to the button, possesses an inductance of .95 henry with a resultant reactance, non-loaded, at 25 cycles, of 149 ohms. For best reproduction, an inductance of even higher value than this is desirable. As it can be seen, the reactance of an inductance of this value at 16 cycles would only be 95 ohms unloaded. The loaded transformer primary impedance would be considerably below this figure. It also must be noted in the design of transformers that since a carbon microphone is essentially pure resistance, it does not vary its impedance with frequency.

Condenser Microphones Theory

The basic theory of condenser microphones is very simple, and we will explain their operation with the assistance of the diagram shown in Fig. 31.

The condenser transmitter type 394 can be considered a very excellent condenser of small capacity. A resistance

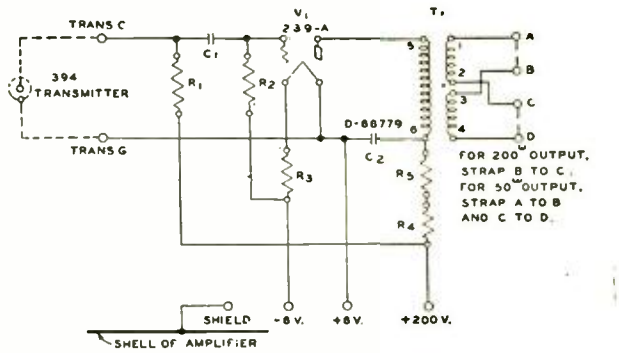


Fig. 31. Condenser transmitter, One stage of amplification.

(R_1), such as 10 megohms, is connected in series with it. The diaphragm of the condenser transmitter assumes a slightly convex surface upon application of the charging voltage. Sound waves, therefore, impinging on this surface cause the diaphragm to change position and vibrate in unison with the impinging sound waves. This varies the capacity of the condenser, thus changing the charging current fed to the condenser through the resistance R_1. This change in current through R_1 causes a varying voltage drop across R_1. The grid of V_1 is then connected so as to receive actuation from this voltage by means of the coupling condenser C_1 and the grid resistance R_2.

The condenser transmitter in output is approximately 24 decibels below a carbon transmitter, and the necessity for an additional stage of amplification is therefore quite evident. It is also quite obvious that in a high impedance circuit of the characteristics of this condenser transmitter and voltage drop resistor, a long coupling lead to its amplifier cannot be tolerated. This is due to the additional capacity introduced, with resultant decrease in the high-frequency response.

Construction and Theory of the Condenser Transmitter Unit

A detailed diagram illustrating the internal construction of a condenser transmitter is furnished by the Bell Telephone Laboratories and is displayed in Fig. 32. This particular type is illustrative of one of the best types of condenser transmitter and we shall use this illustration for the discussion of the construction of a condenser transmitter.

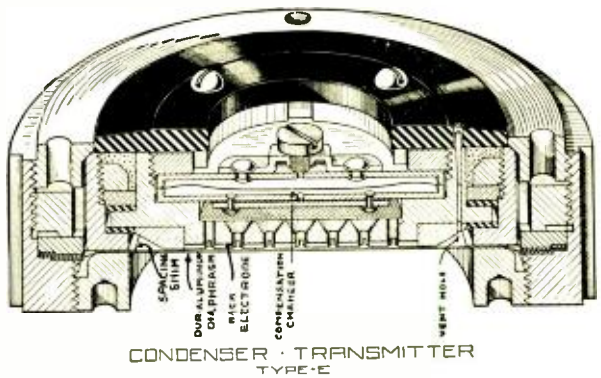


Fig. 32. Internal construction of transmitter, in detail.

Theory

The design of a condenser transmitter is a very much more complex undertaking than simply having two condenser plates separated from each other, one variable and the other fixed.

Possibly the best idea of the attention which must be observed for detail is afforded by examination of the back electrode displayed in the illustration, Fig. 32. If a simple electrode were constructed with no perforations in the back plate, a most disappointing performance would result.

In order to better understand the requirements for condenser transmitter

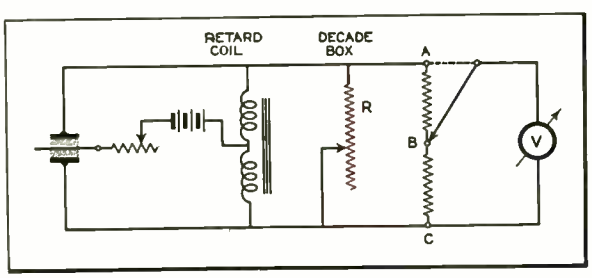


Fig. 30. Hookup for determining the a-c. resistance of a microphone circuit.

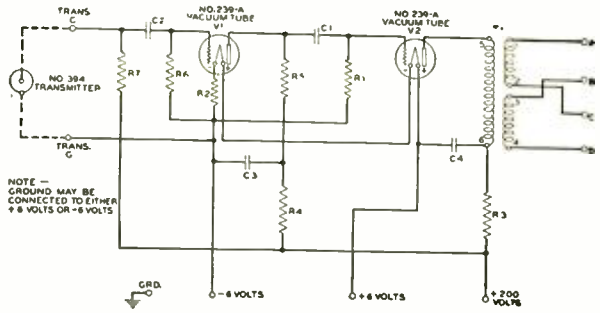


Fig. 33. Condenser transmitter. Two stages of amplification.

design, we may analyze the accoustical principles involved to some extent. To begin with, the diaphragm assumes under applied potential a paraboloid contour. Sound waves impinging upon the surface of this diaphragm cause it to vary between the outer limit of this paraboloidal curve and its uncharged normal position. If a plain electrode were used and the chamber between the diaphragm and electrode sealed to

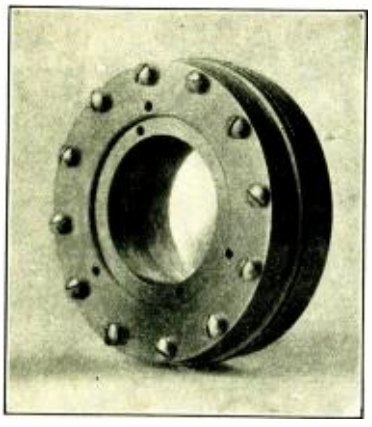


Fig. 34. Assembled microphone.

prevent moisture from short circuiting the transmitter a considerable difficulty would be experienced from two effects; namely, the barometric change in air pressure would not be compensated for, and therefore the microphone instead of being allowed to assume this paraboloidal contour at all times, would be entirely dependent upon the barometric pressure. Also, the damping applied to the diaphragm by the small space chamber located between the back electrode and diaphragm would not result in either a uniform lineal response curve or a flat frequency response.

It, therefore, is evident with these limitations in mind that the condenser transmitter in order to be practical must possess the following requisites:

A. The space between the diaphragm and back electrode must be as small as practicable in order to insure a high factor of variable capacitance.

B. The introduction of non-active capacity due to bulky electrode and frame construction should be as small as possible.

C. An extremely high leakage resistance is of great importance in order to secure quietness of operation.

D. A sealed and moistureless chamber is required in order to eliminate danger of the microphone sweating or forming moisture between the diaphragm and back plate under variant atmospheric conditions. As a rule, gas is introduced in the chamber instead of air, to eliminate this effect.

E. A flexible back to the sound chamber must be integrally built in the transmitter in order to equalize the pressure on the front and rear of the diaphragm.

F. The back electrode should be so constructed that the air damping compensates for the damping characteristics of the diaphragm and in this manner assure a flat frequency response curve.

These conditions are fulfilled very well in the microphones displayed in Figs. 32 and 34.

Condenser Transmitter Amplifier Construction

The amplifier of any condenser transmitter should be considered as an integral part of the transmitter, as a considerable amount of compensation for the transmitter response can be introduced by correct design of the amplifier which is built in the case.

The amplifier circuit shown in Fig. 31 is used in both microphones displayed in Figs. 32 and 34. By the constants of the condenser C, and the resistances R_1 and R_2, a wide variance in amplifier frequency characteristics can be obtained. This effect assists in obtaining excellent high-frequency response.

An amplifier is constructed for the microphone shown in Fig. 32, of two stages of amplification. This amplifier allows the operation of the microphone at considerable distances from the mixer panel and is used quite extensively in motion-picture work. The circuit for this amplifier is shown in Fig. 33.

The output impedance of the microphone amplifier generally is so arranged as to feed either into the mixer control circuit or into the 200-ohm facilities installed for carbon microphones. Considerable advantage is obtained by eliminating the repeat transformer generally used for carbon microphones and feeding the microphone

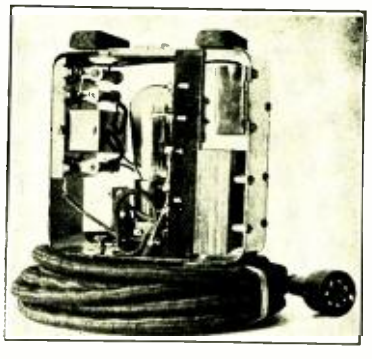


Fig. 36. Condenser amplifier.

output directly into the mixer control. This practice eliminates the phase distortion caused by the mixer transformer and therefore is the more preferable system.

Physical Construction of Microphone Cases

The photograph of a microphone shown in Fig. 35 is probably best known to readers since this is the type widely used in the more modern broadcasting stations and in talking picture work.

This particular type of condenser transmitter mounting is most practical for motion-picture work, as the suspension allows the microphone to be adjusted just outside the focus of the cameras without any great amount of difficulty.

The condenser amplifier shown in Fig. 36 affords an idea of a very excellent type of amplifier mounting as the amplifier is completely swung on sponge rubber, in this manner eliminating any microphonic noise which might be caused by tube vibration.

(*To be continued*)

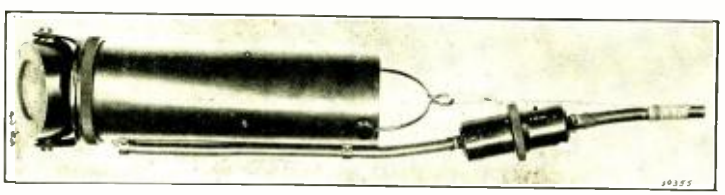


Fig. 35. Microphone used in talking picture work.

Is Your Factory Paying for Free Rides for Dead Wood?

One Company Makes a Discovery and Applies a Remedy

HOW closely does the average executive scrutinize his shipping department when he is on the trail of wasteful practices? That careful attention paid to this busy department will be well worthwhile is demonstrated by the experience of the Bryant Heater and Mfg. Company of Cleveland, Ohio. This firm found that it had been giving free rides to 75 tons of unnecessary wood in its shipping crates and boxes each year. When satisfactory shipping containers were found, freight costs were lowered and loss and damage claims eliminated.

Investigation Leads to New Forms of Containers

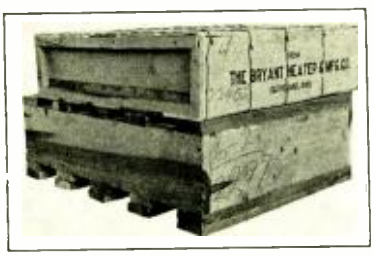
J. N. Schweikert, director of manufacturing for the Bryant Company, believed that there was room for improvement in the shipping department of his firm, but as modern business does not proceed on opinion, he decided to apply scientific fact-finding in order to ascertain if his suspicions were justified. He submitted various articles of Bryant merchandise, packed for shipment in the usual manner, to a laboratory that is equipped to test the strength and serviceability of packing containers. The loaded crates were dropped and rolled in a huge testing drum, simulating in a major way the drops, bumps, sliding and jars that merchandise receives in transit. In varied compression tests their strong points and their failures were measured by recording apparatus and the results of these tests, number of drops before failure or breakage of container, and the point of failure in the side, and edge and diagonal compression tests were checked by engineers with notebook in hand. The treatment given the containers was probably more severe than is encountered in the ordinary run of shipping but the purpose was to locate weaknesses.

When all of the data about the boxes and crates had become a matter of clinical record, the engineers analyzed it and designed new containers to overcome the weaknesses of the old ones, and it is noteworthy that at the same time new crates, while of greater strength, contained far less construction materials—25 to 40 per cent less, depending upon the character of the commodity for which they were designed. When these were ready they were packed with wares and subjected to the same tests that the original containers were put through. The comparative results, demonstrating the superior efficiency of the newly designed container, led the Bryant Company to adopt a new style of container known as the wirebound box.

CONVENTIONS

S.M.P.E.	Washington, D. C.,	May 5-8.
N.E.M.A.	Hot Springs, Va.,	May 18-23
R.M.A.	Atlantic City,	June 2-7
R.W.A.	Atlantic City,	June 2-7
N.F.R.A.	Atlantic City,	June 2-7

At the end of the first year when the cost department placed before Mr. Schweikert a detailed analysis of the results of this change in containers, he found that the company had made a saving amounting to more than $7,600 in packaging and transportation costs for that period. Mr. Schweikert noted the interesting fact that the purchases of the new type of crate during the year also came to the same total. In other words a dollar spent for individually designed containers saved a dollar that had leaked away in wasteful methods under the old system. The entire cost of the new crates had been repaid by the saving they effected, to say nothing of the virtual elimination



Two packing crates, one of them up to date, the other out of date.

of loss and damage claims, and the receipt of the shipment in A-1 condition by the consignees.

Several factors contributed to this remarkably worthwhile reduction in the cost of shipping the factory's finished products. The new crate has a lower first cost than those formerly used as the engineering principles of bridge building which are embodied in its design, save costly material at the same time providing ample strength where needed for the protection of the heavy metal units of the company's line. Another natural consequence of making a crate out of less material, is the saving in bulk. Five times as many of the new boxes can be stored in a given space as was possible before the adoption of this type of container, thus releasing valuable floor space for other purposes. The firm's packers are able to seal the new crates and boxes in less time than they could drive the nails required to close the old-style containers, as the use of hammer and nails is now practically eliminated. Even the company's first-aid man had a favorable word in regard to the lessened number of accidents to workers, formerly occasioned by saws, splinters, loose boards with nails, hammering, etc.

Large Saving in Weight

As a final checkup, a record was kept of the weight of each box and crate when it was dressed up and ready to go. There was a reduction in these weights that continued through the entire list of items shipped, as not one of the familiar articles weighed as much in its tailored container as when packed after the old-style method. A total excess baggage of more than 150,000 pounds had been trimmed away—more than 75 tons of waste lumber. The elimination of this unproductive, dead weight was in no way offset by any risk to the security of the company's shipments. Instead, the firm has the satisfaction of knowing that its merchandise, otherwise handled under the same conditions as before, is now reaching destinations without damage. Under the old system of packing, a certain number of claims had been accepted as unavoidable evils.

There is another item not listed in figures presented but by no means overlooked. The shipment conveyed a little more of the good-will that the company would like to send to each customer with his consignment. The customer receives his merchandise in a container that is easily and quickly opened and which has accorded its contents full protection while in transit.

Mr. Schweikert reports his findings with the thought that others may be giving profit-stealing free rides to dead wood. Economies such as those gained for the Bryant Company in a department usually considered far from the productive side of business, can be accomplished only through fact-finding — the scientific laboratory method which is the rule of business of today. They emphasize the triumph of research over guesswork and the rule of thumb method that all too frequently characterizes shipping department practices.

The June issue of RADIO ENGINEERING *will be the Big R.M.A. Show Number. Get your copy or you will not know what's in the wind.*

SIGHT-SOUND DEVICE IS PROMISED SOON

RADIO programs recorded on narrow strips of film much after the manner of the sound track of the talkies will, it is reported, be released soon to 119 stations in the United States and Canada.

The advisory board for the organization consists of Herman Halstead, vice-president of Paul Block, Inc.; Malcolm Straus, A. J. McCosker of WOR, W. S. Lemmon of WRNY, Donald Flamm of WMCA, Townsend Rice and Manning Wakefield.

The plan of action is explained as follows: The stations comprising the systems will be supplied with reels of sensitized film upon which complete programs ranging from fifteen minutes to one hour are recorded. These reels are sent out in advance to each station, where they may be broadcast at any specified hour in each city. By this method, it is pointed out, the same sponsored program may be broadcast in each city during the time best suited to it. The present plan calls for the preparation and release of forty features a week. WMCA is the New York city outlet for the system.

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ELECTROCHEMICAL POWER PACK CONDENSERS

(*Concluded from page* 35)

ing shrinkages for this type of condenser are extremely low and substantially negligible when chemical control is employed during the processing.

In these days when engineering production costs have to be closely figured, this new improved condenser, which is patented, affords savings in the manufacture of all apparatus requiring a high grade filter condenser. In some radio chassis power packs, for example, the savings have averaged as much as $1.00 per pack. These condensers are manufactured at the plant of the Potter Company, North Chicago, Illinois.

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1929 RADIO RECEIVER SALES HIGHER THAN 1928

AVERAGE value per dealer of radio equipment sales during 1929 to 10,455 dealers reporting to the Department of Commerce for the survey of stocks and sales is placed at $13,000, compared with $10,800 for 1928, and $11,750 for 1927, it was stated orally March 26 on behalf of the electrical equipment division, which is working in conjunction with the radio division of the National Electrical Manufacturers Association.

The dealers included in the 1929 survey, approximately one-fourth of all known dealers in the United States, reported an aggregate business of $135,845,635 for the year, compared with a total volume of business amounting to $70,877,517 reported by 6,569 dealers for 1928 and $90,785,050 for 7,737 dealers for 1927, it was stated.

Data showing the seasonal variations in the volume of business handled per dealer during the four quarters of 1929 are as follows: First quarter, 22.7 per cent; second quarter, 15.8 per cent; third quarter, 23.2 per cent, and fourth quarter, 38.3 per cent. It was pointed out that as 40 per cent is generally representative of the volume of business done during the final quarter of the year, last year's 38.3 per cent was almost normal despite the break in the stock market.

Aggregate sales of 862,599 electric sets and 35,197 battery sets were reported in the 1929 survey. The average number of sets sold by each dealer is given as 86, compared with an average of 68 for 1928 and 47 for 1927.

Sales of radio sets during the fourth quarter of 1929 by the dealers reporting numbered 403,932, valued at $59,248,585.

The average value of radio sets sold during 1929 was $151. Averages for the four quarters were as follows: First, $164.50; second, $164; third, $154, and fourth, $146.50.

—*United States Daily*

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EXECUTIVE COMMITTEE ON AERONAUTIC RADIO ORGANIZED

Under the chairmanship of Clarence M. Young, Assistant Secretary of Commerce for Aeronautics, an executive committee on aeronautic radio has been organized in the aeronautics branch, it was announced recently.

The committee, in addition to Mr. Young, is composed of the following officials of the aeronautics branch: F. C. Hingsburg, chief engineer, Airways Division: Dr. J. H. Dellinger, chief of the radio research section; Harry H. Blee, director of aeronautic development; and Gilbert G. Budwig, director of air regulation. Frederick R. Neely, chief of the aeronautic information division, is secretary of the committee.

This committee will augment the work of the executive board of the aeronautics branch which was created by Mr. Young shortly after his appointment as assistant secretary of commerce for aeronautics, and which is composed of the director of aeronautic development, Mr. Blee; the director of air regulation, Mr. Budwig; and the chief engineer of the airways division, Mr. Hingsburg. This board coordinates the work of the entire aeronautics branch and determines policies affecting all of its activities.

The function of the executive committee on aeronautic radio is to determine the policies of the aeronautic branch in matters pertaining to radio aids to air navigation and to the requirements of the air commerce regulations relative to radio equipment for aircraft and ground stations.

DE FOREST EXPERIMENTAL STATION INCREASES POWER

THE power of the DeForest experimental radio telephone station, W2XCD at Passaic, N. J., which has become familiar to many broadcast listeners who occasionally wander down to the bottom of their tuning dials, is being steadily increased. New equipment is being developed and installed for increased power and coverage. From 50 watts, the transmitter has been increased to 500 watts, and the power is now being further increased to the full 5,000 watts authorized by the license granted by the Federal Radio Commission.

The DeForest engineering staff has applied to the Federal Radio Commission for a 20-kilowatt television broadcasting license on approximately 2050 kilocycles. It is felt that with this power rating, satisfactory television signals can be provided over a wider area for the satisfactory development of practical television. Also, the De Forest organization has applied to the Commission for a further increase in power from 5 to 50 kilowatts, for the radio telephone experimental transmitter. Lastly, an application has been filed for a broadcasting license covering a 10-kilowatt transmitter on 830 kilocycles.

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2,512,000 FARMS WITH RADIOS

OUR farm population, alone, has more radio sets than any one of the foreign countries, is the report from The Farm Journal.

American farms now have 2,512,000 radios, while in all of England, or all of Germany, there are only 2,500,000 sets. France has only 1,250,000 sets. Japan has 550,000 and Argentina 530,000.

The American farm people are not only enjoying all of the entertainment features which the city people enjoy, the talks, news and various other features, but in addition their radios are helping farmers to make money.

Prompt market reports and weather reports are of vital importance to farmers, and the special farm educational features put out by the U. S. Department of Agriculture, the agricultural colleges and other organizations are helping farmers to increase their production while decreasing their costs.

The 600,000 farm boys and girls who belong to the 4-H Clubs are enjoying a special weekly program of club news, instruction and entertainment.

With all these special farm features available to farm families with radios, it is not surprising that the number is increasing by three-fourths of a million each year.

MR. ENGINEER—

ARE YOU FAMILIAR WITH THE PIONEER PUNCTURE PROOF FILTER CONDENSER?

The radio engineer, who considers his reputation of prime importance will assure himself that the receiver he designs this coming year will enhance his reputation next year.

He will insist upon including in the power-pack of his receiver, filter condensers that will not be injured by voltage surges.

As revealed by the purchases of leading radio receiver manufacturers, particularly since the advent of the all-electric receiver, the Amrad Mershon Electrolytic Filter Condenser has come forward in its field in a startling manner.

It has filled a definite need for filter condensers of comparatively low first cost and puncture-proof construction,—filter condensers that also act as safety valves to protect their associate equipment from surges.

The Amrad Mershon Electrolytic Condenser was first displayed at the Portland Radio Show, Portland, Maine, in September 1921. Its construction patents date back to December, 1911. Research and development have continued since then. Over three million of these units are in use today.

With such a background of experience in manufacture, and satisfaction in service, the Amrad Mershon Electrolytic Filter Condenser can be depended upon to live up to the rigid performance requirements of present-day receiver manufacture.

The Engineer engaged in the design, construction, or operation of radio receiver—or transmitter—equipment will be interested in our new booklet "Puncture Proof Filter Condensers."

The coupon, attached to your letter-head will bring you a complimentary copy.

MANUFACTURED BY THE AMRAD CORPORATION

THE AMRAD MERSHON FILTER CONDENSER WILL BE ON DISPLAY AT THE ATLANTIC CITY R. M. A. RADIO SHOW (June 2nd to 6th) AT BOOTH C-1

THE AMRAD CORPORATION
225 College Avenue
Medford Hillside, Mass.

THE AMRAD CORPORATION
225 College Avenue
Medford Hillside, Mass.

Gentlemen: At no obligation, please send me a complimentary copy of your booklet "Puncture Proof Filter Condensers."

Name .....
Address .....
City .....
State .....

The Trend of Invention

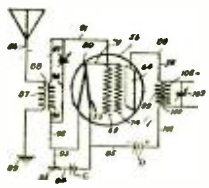
By RICHARDS & GEIER

PATENT AND TRADE MARK ATTORNEYS 274 MADISON AVE NEW YORK CITY

AUDION TUBE

Walter J. Albersheim, of New York, N. Y., Assignor to Radio Corporation of America, of New York, N. Y., a Corporation of Delaware. U. S. Patent No. 1,736,815. (Issued Nov. 26, 1929.)

This invention has for its object primarily to provide an audion tube designed to be employed in wireless electric or so-called radio systems for improving the quality of transmission, detection and amplification of the signal waves by diminishing the



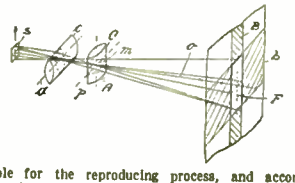
tendency to regeneration or feedback by capacitive conductance of the signals through the medium of a stabilizer provided within the tube for modifying the electrostatic field surrounding the steering or current input electrode of the device. The stabilizer having a fixed potential serves the purpose of overcoming oscillations which tend to cause whistling and noisy bowls in the signals passing through the tube.

▲

SOUND REPRODUCTION

Arnold Poulsen and Axel Carl Georg Petersen, of Copenhagen, Denmark. U. S. Patent No. 1,747,261. (Issued February 18, 1930.)

The present invention has for its object to render practicable the enlargement of a phonogram to a degree sufficiently high to fulfill the requirements, without difficulties being created thereby in respect to the manufacture of a linear light-sensitive cell



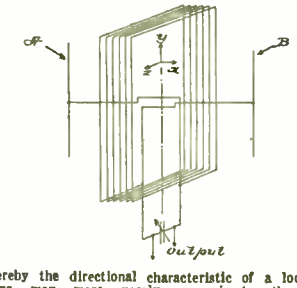
suitable for the reproducing process, and according to the invention the said object is to be attained by the formation on the said slit or light-sensitive cell of an image of the phonogram which is distorted on account of the unequal enlargement of the same in longitudinal and lateral direction.

▲

LOOP ANTENNA

Jackson H. Pressley, of Fort Monmouth, Oceanport, New Jersey. U. S. Patent No. 1,747,262. (Issued February 18, 1930.)

This invention relates to a novel improvement in coils, used as antenna in radio communication apparatus, and has for one of its objects to provide means



whereby the directional characteristic of a loop antenna may more nearly approximate the ideal "figure 8" diagram.

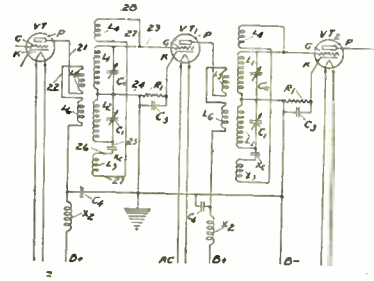
Free books on patent and trade-mark law can be obtained by our readers upon request to Radio Engineering or direct to Richards & Geier. Copies of the patents described on this page may be obtained through the above mentioned firm of patent attorneys.

RADIO APPARATUS

Anatol Gollos, of Chicago, Illinois. U. S. Patent No. 1,751,081. (Issued March 18, 1930.)

This invention relates to radio apparatus and relates particularly to such apparatus of the multiphase type.

The principal objects of the invention are to provide a new and novel radio-frequency amplifying circuit whereby more energy can be transferred from an electron valve to a succeeding electron valve than by present known circuits of which the inventor has



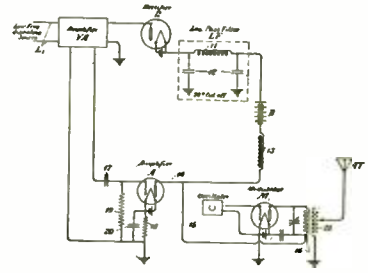
any knowledge, without in any way producing phase distortion or causing a loss of selectivity in the circuit; to provide a band-pass system within a predetermined band of frequencies whereby increased and undistorted potential will be impressed upon the input circuit of a succeeding electron valve; and to provide good selectivity and improved tone qualities.

▲

CARRIER-AMPLIFIER CONTROL IN RADIO SYSTEMS

Russell S. Ohl, of New York, N. Y., assignor to American Telephone and Telegraph Company, a Corporation of New York. U. S. Patent No. 1,744,836. (Issued January 28, 1930.)

This invention relates to signaling systems, and more particularly to arrangements in such systems for



controlling the amplitude of the carrier frequency thereof in accordance with the amplitude of low or voice frequency signals.

▲

ACOUSTICAL WAVE FILTER

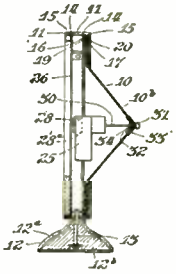
Harvey C. Hayes, of Washington, District of Columbia. U. S. Patent No. 1,751,035. (Issued March 18, 1930.)

The object of the invention is to eliminate static or strays in a radio receiving system and to amplify the pure signal received from the transmission station free from all extraneous noises.

LOUDSPEAKER

Frank J. Reichmann, of Chicago, Illinois. U. S. Patent No. 1,748,996. (Issued Mar. 4, 1930.)

The object of the present invention is the provision of a cone-type sound reproducer which in large measure



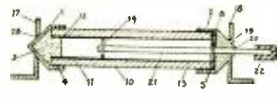
will be free from the undesirable tonal characteristics of the cone and which will faithfully reproduce sounds having widely divergent frequencies.

▲

ELECTRICAL RESISTANCE AND ART OF FORMING THE SAME

Harold Pender and John H. Mueller, of Philadelphia, Pennsylvania. U. S. Patent No. 1,739,256. (Issued December 10, 1929.)

This invention relates to electrical resistance media and devices and methods of production thereof.

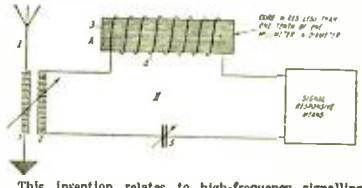


One of the objects of the invention is to provide a practical resistor characterized by certain desirable features in use.

▲

OSCILLATORY CIRCUITS

Alexander Meissner, of Berlin, Germany, Assignor to Gesellschaft Fur Drahtlose Telegraphie M. B. H. Hallesches, of Berlin, Germany. U. S. Patent No. 1,751,592. (Issued March 25, 1930.)

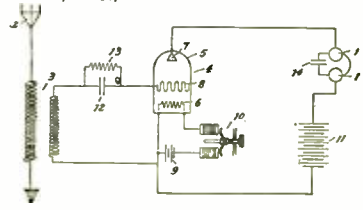


This invention relates to high-frequency signalling systems and more particularly to a new and useful inductance coil and system for using said coil.

▲

RADIO APPARATUS

Gustav O. Wilms, of Milwaukee, Wisconsin, Assignor, by Mesne Assignments, to the Reliance Company, of Milwaukee, Wisconsin, a Corporation of Wisconsin. U. S. Patent No. 1,737,903. (Issued December 3, 1929.)



An object of the invention is to obtain a smooth and regular variation in the action of electronic valves employed in radio apparatus.

NEWS OF THE INDUSTRY

TRANSFORMER CORPORATION ENTERS CONDENSER FIELD

Installation of $200 000 worth of equipment for the manufacture of a complete line of fixed condensers is now under way at the plant of the Transformer Corporation of America, Chicago, according to J. J. Kahn, director of sales. The line will include both by-pass and filter condensers of various types and capacities, for both a-c. and d-c. circuits and will meet practically all radio and general electrical requirements. Emphasis is to be placed on the electrical equipment phases of condenser manufacture.

Albert O. Hauser, for five years chief engineer for Tung-Sol Condensers, Inc., formerly Brown & Caine, Inc., Chicago condenser manufacturers, has been retained to supervise the construction of the new condenser plant and processes of manufacture as well as the development and performance of the products.

Approximately 34,000 square feet of the additional 60,000 square feet recently acquired by the Transformer Corporation of America for housing increased manufacturing facilities will be devoted to the newly created condenser division.

Mr. Kahn's announcement marks the departure of the organization into the new field of condensers, which are a highly critical component of electrical and radio circuits.

▲

LOEB APPOINTED POLYMET REPRESENTATIVE

Officials of the Polymet Manufacturing Corporation, at 829 E. 134th St., New York City, have announced the appointment of Mr. A. J. Loeb as sales representative for Northern Ohio and the state of Michigan, for all Polymet products. Mr. A. J. Loeb makes his office in Cleveland and may be addressed to his office at 3221 Carnegie Ave., Cleveland, Ohio.

▲

RECENT ADDITIONS TO THE ENGINEERING STAFF OF ELECTRAD

Mr. Harry H. Horning—Ten years' engineering and sales work with the Cutler Hammer Mfg. Co. of Milwaukee, and nine yeares as supervising engineer on development and design with the Philadelphia & Reading Coal and Iron Co. at Pottsville Pa. Mr. Horning's duties with Electrad will be in the nature of a special development and sales engineer combined. His services will be available to manufacturers in the general industrial and radio field.

Mr. E. J. Hughes—Twelve years with the Splitdorf Electrical Co. of Newark, N. J., as research engineer and general supervisor on development and production on resistors and condensers with the Brandes Products Corp. of Newark, N. J. Mr. Hughes' duties will be the development, research and production on vitreous enameled resistors as applied to the radio and electrical fields.

▲

TELEVISION ON PACIFIC COAST

Philo T. Farnsworth, of San Francisco, Calif., is director of research of Television Laboratories, 202 Greene Street, that city. The laboratories expect to have equipment ready for sale in the near future.

▲

INCA AND NATIONAL ELECTRIC PRODUCTS

Announcement is made of another step in the program of expansion of the Inca Manufacturing Corporation of Fort Wayne. This comes in the news of the affiliation of this company as a division of the National Electric Products Corporation, of Pittsburgh and New York. George A. Jacobs, president of Inca, becomes vice-president of National Electric. It is stated that the new arrangement brings to Inca a direct source of copper, adding greatly to its ability to supply promptly demands of customers for magnet wire and contributing much to its facilities of manufacturing. The management and personnel which founded and successfully launched the Inca industry will not be changed in any way. The officers remain: George A. Jacobs, president; W. C. Glass, vice-president; George W. Spindler, secretary-treasurer, and A. A. Connor, sales manager. The alliance with National Electric became effective April 1, 1930. The Inca Manufacturing Corporation manufactures enameled, insulated wire and windings, in the finer sizes.

▲

MACOMBER AGENCIES APPOINTED FACTORY REPRESENTATIVES FOR VOX RADIO TUBES

The Munder Electrical Company announces that the Macomber Agencies, 268 Market Street, San Francisco, and 50 Alice Street, Oakland, California, have been appointed factory representatives for the VOX radio tube on the Pacific coast.

RCA RADIOTRON COMPANY APPOINTS F. B. WANSELOW EASTERN SALES MANAGER

Ferdinand B. Wanselow, recently appointed eastern district sales manager for the RCA Radiotron Company, Harrison, N. J., is now located in New York City.

Mr. Wanselow's career in the radio industry is a long and successful one. He was just out of high school when we entered the war so he joined the navy where he studied radio as an operator. In the spring of 1918 he entered the Naval Academy at Annapolis.

Resigning his naval commission to go with the Radio Corporation of America, Mr. Wanselow spent his first few months in the radio business selling in a department store. Here, behind the counter, he gained invaluable experience by coming into personal contact with the customer. In 1925 he was given a territory covering from New York to Florida. He was then called to the New York district where he

FERDINAND B. WANSELOW

formed a highly successful authorized dealers' organization. Following this he was made assistant district sales manager for eastern territory. With the formation of the Radio-Victor Corporation he was advanced to assistant district manager, eastern district.

Mr. Wanselow now brings to the RCA Radiotron Company an extremely broad knowledge of the radio industry and of up-to-date merchandising methods which will be of great value to RCA Radiotron wholesalers and dealers.

▲

TRACEY HEADS NATIONAL UNION GROUP IN ATLANTIC CITY PILGRIMAGE

E. A. Tracey, vice-president in charge of sales of the National Union Radio Corporation, will be at the head of a large group of N. U. tube engineers, sales executives and demonstrators in the trek from New York to the Atlantic City radio show.

"The Atlantic City exhibition usually is just another beauty show," Mr. Tracey said. "But this one is different. This time it's the manufacturers who must bring forward their most advanced products and most attractive merchandising programs for the critical scrutiny of the judges—the dealers and jobbers.

"It's going to be at the radio show, I predict, that the dealers and jobbers are going to pick the 'beauties' in the radio set and tube lines—the radio world's 'Miss America' for 1930 and 1931," he added. "The dramatic and sometimes drastic events of the past season will be expressed at the June Trade Show in a careful weighing up of manufacturers by jobbers and dealers, who will look far beneath the surface before choosing their lines."

PAPER TUBES FOR RADIO

The Philadelphia Paper Tube Corporation, 2835 Ormes Street, Philadelphia, Penna., has acquired the business of the Superior Paper Tube Works. The corporation's manufactured output will be for radio uses, mainly, featuring treated paper tubes, secondary and speaker tubes and square and round tubes of all sizes.

George Wilkins is president of the corporation; Charles E. Wilkinson vice-president, and Mrs. Mary Wilkinson, secretary-treasurer.

▲

RADIO MARKET IN ARGENTINA

Ralph A. Sayres, well known in radio circles, is now in Buenos Aires, Argentina. Mr. Sayres reports a promising market in Argentina for radio receivers and other radio products.

▲

ALLOY METAL WIRE COMPANY FORGES TO FRONT

The manner in which the Alloy Metal Wire Company, Inc., has, in the brief space of five years, reached a commanding position in supplying the special wire and strip requirements of the electrical and radio industries, is largely due to the ability of its management to meet the challenge of these great trades to progressive development.

The increased demand for non-corrosive metal products, particularly in wire and strip, has been emphasized not alone from increased technical requirements in new creations of manufacture, but also to resist the chemical action of atmospheric conditions which, in recent years have become more than ever charged with fumes which attack the baser metals.

They also supply the radio industry—new screen-grid tube division—with wire used in the screen filaments and supports of the screen-grid tubes and the electrical manufacturers with incandescent lamp wire. Another of their interests is the supply of Monel metal wire for manufacturing rivets, nails and wire screen to meet non-corrosive requirements in withstanding the action of the elements and which is used to replace copper and iron where the corrosive action of salt air and atmosphere polluted with gaseous fumes turn copper green and cause iron to disintegrate from excessive rust.

Their Monel screen wire is largely used by filter manufacturers who employ it to replace cloth, and for filtering purposes in general in connection with the chemical industry.

The Alloy Metal Wire Company states that it was the first to produce radio tube filament wire on a production basis to specifications required by tube manufacturers. The pure nickel ribbon which the company manufactures is held to .001 tolerance in width and .0001 in thickness. This is used in the manufacturing of radio tubes.

▲

CORNISH WIRE COMPANY

The Cornish Wire Company, 30 Church Street, New York, manufacturers of Super Braidite hook-up wire, furnish a model "A" stripping machine for plant use in wiring operations.

▲

DRIVER-HARRIS COMPANY IN NEW LOCATION IN CHICAGO

The Driver-Harris Company has changed the location of its Chicago office from West Randolph Street to larger quarters at 1138-40 West Washington Blvd.

▲

NEW USE FOR TUBES

A special arrangement of radio and photoelectric apparatus has been designed by George Lewis, vacuum tube engineer and vice-president of the Arcturus Radio Tube Company, Newark, N. J., for use in all timed sporting events that, according to the claims of the inventor, provides an automatic and accurate photograph of the finish, an imperishable record of the time, and indisputable evidence as to place in close events. A light ray is focused across the track at the finish point on a special photoelectric device that acts as a relay the moment a figure—runner, horse or cyclist—passes across the line. The impulse caused by the fleeting shadow is amplified and within one thousandth of a second actuates a camera which takes a picture of the scene, including the dial of a stop-watch set in motion at the beginning of the race. In the case of races where fast contestants lap the slower ones, the device acts as an "electronic gate" or "tape," and can be held open by means of a switch, until the probable winner approaches the "line."

The apparatus functions unfailingly under all light conditions. It is light and portable, and is readily set up on any track.

WHY KEEP A PROSPECT WAITING 50 SECONDS?

by George Lewis, Vice-President Arcturus Radio Tube Company

INTERESTED buyers of radio sets deserve careful treatment. They don't like to wait. And the 30- to 60-second delay caused by the slow starting speed of many tubes often loses sales.

Happily, there is an easy way to avoid this wait—embarrassing to your dealers, irritating to their customers. Just see that your sets are equipped with Arcturus *Blue* Tubes . . . the tubes that bring in programs in 7 seconds by your watch.

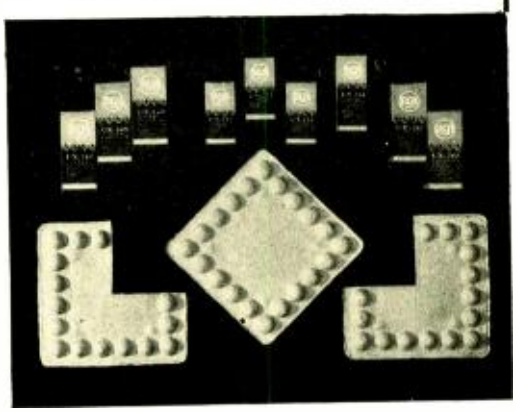
Arcturus Tubes have other features, too, that help sell sets and keep them sold after the sale is made. They are famous for clear, humless tone; and their dependability and long life mean minimum servicing.

Consumers judge a radio set by its tubes. Make sure *your* set has the added advantage that only Arcturus Tubes give.

ARCTURUS RADIO TUBE COMPANY
Newark, N. J.

ARCTURUS
Quick Acting
RADIO TUBES

HOLED-TITE INTERIOR PACKING FOR KITS OF 5 TO 12 TUBES



THIS IS EVERYTHING NEEDED TO PACK A 9 TUBE KIT ready to place into corrugated carton.

TUBE KITS Now Packed The Holed-Tite Way

Prevents breakage, costs less, requires smaller shipping carton, simplifies packing, *eliminates mussy excelsior.*

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TRADE MARK NEW YORK
Radio Tube Pads
Holed-Tite Packing Corp.
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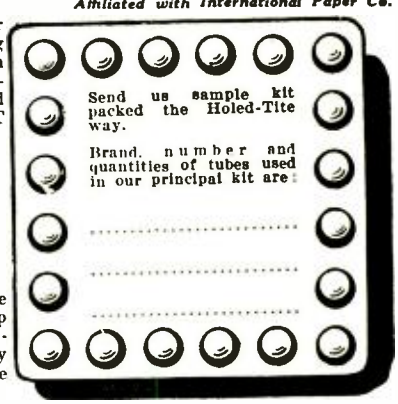
Affiliated with International Paper Co.

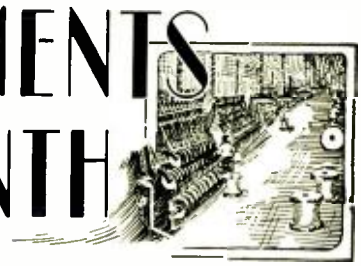
Simplify your kit packing problem. Pin coupon to letter-head and MAIL AT ONCE

"Protect the Heart of the Radio"

Holed-Tite moulded pulp pads are standard in use by most large tube manufacturers.



NEW DEVELOPMENTS OF THE MONTH



NEW RECEIVER BY PHILCO

Philco has added a new direct-current receiver to its line of radio receivers, it is announced by the manufacturer. The new set is known as Model 40.

The new model is an all-electric screen-grid radio for use on d-c. 95 to 135 volts. It has a circuit using in six tubes; three type -24 screen-grid tubes; one type -27 tube, and two type -71-A tubes. The tubes used are standard—the same as are used in the a-c. receiver. The two screen-grid radio-frequency tubes supply the set with a sensitivity which makes possible the tuning-in of many stations during the daytime. An increased number of broadcasting stations can be tuned in as compared to most a-c. receivers as the sensitivity is practically as great at the low-frequency end of the seale as it is at the high-frequency end. The uniform gain radio-frequency transformer design is largely responsible for this.

A screen-grid tube is used for the biased detector. It improves the sensitivity and will carry a very strong signal without overloading. The push-pull amplifier produces more volume than can be used in the home. To prevent distorted reception due to overloading of the tubes, the circuit is designed so that the detector tube chokes and reduces or cuts off the signal if the volume control is turned up too far on a nearby powerful station. After maximum undistorted volume has been reached, advancing the volume control reduces the volume or cuts off the signal entirely.

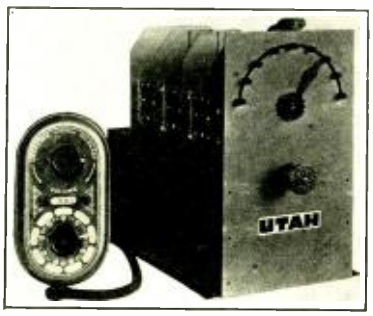
Excellent fidelity of tone is obtained by the non-overloading screen-grid detector, the resistance coupled first audio-frequency stage, the push-pull power stage and the Philco electrodynamic speaker.

▲

NEW TYPE OF FIELD COIL

A new type of field coil for dynamic speakers has just been produced and put on the market by the Inca Manufacturing Corporation of Fort Wayne. The new coil, known to the electrical industry as a choke, or impedance coil, represents new and novel improvements in the coil art. It is radically different from the conventional design in many ways. The fact that the coil can be furnished with or without external leads constitutes a notable departure. This is possible because of a unique and ingenious terminal arrangement, making the terminals instantly available but eliminating the necessity of the long external leads where not desired by the manufacturer. The insulating sheath, completely sealing the coil, creates a moisture and water-proof condition never before possible and affords mechanical and electrical protection to the winding. The coil supplies a basic need of the manufacturer, namely enameled wire, in coil form, without the spool. The coil is bound by two circumferential bands which not only contribute to the neatness and utility of the coil, but add greatly to its strength.

▲

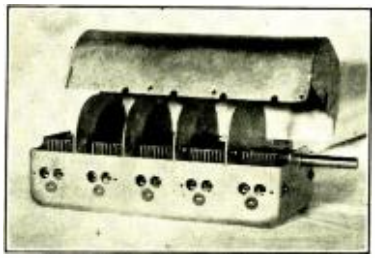


UTAH AUTOMATIC CONTROL

The above illustration shows a front view of the two units of the Utah automatic remote control device. At the left is the remote control switch box and at the right is the unadorned automatic selector attached to a chassis. The automatic selector occupies a space five and one-quarter inches in diameter and one inch deep above the base of the receiver, and three and a half inches in diameter and two and one-quarter inches below the base.

NEW VARIABLE CONDENSER

A new variable condenser is being offered the industry by Precise Products, Inc., Rochester, N. Y. It is of the completely shielded type, housed in a one-piece pressed steel tub of great rigidity, which with its intersecting partitions enclosed by a cover achieves complete shielding of the condenser units.



The rotors are carried on a ground steel ⅜-inch shaft mounted on ball bearings, each with its own wiper contact.

The plate design affords a minimum capacity, 21 mmf. and an almost straight-line tuning curve, resulting in exceptional separation between broadcast channels.

▲

QUINN REFILLABLE TUBE

The National Radio Tube Corporation, Cleveland, Ohio, announces a refillable (filament replacement) tube for radio and amplifier uses, on a-c. or d-c.

The heating element of this tube is contained in a hollow sleeve which extends upward through the grid structure. The heating element does not burn in the vacuum. The heating element may be renewed at a cost of 50 cents.

▲

UNITED SCIENTIFIC REPRESENTATIVES

United Scientific Laboratories, Inc., 113 Fourth Avenue, New York City, announce the appointment of two new representatives to handle their new type S. G. variable condenser—N. J. Clark & Company. 2885 E. Grand Boulevard, Detroit, Michigan; and Sigmund H. Cohen, 207 East 15th Street, Los Angeles, California.

▲

THREE NEW MODEL GANG CONDENSERS PRODUCED BY HAMMARLUND

Utilizing the many advancements incorporated in the famous "Battleship" multiple condenser and numerous others resulting from fourteen months of research, three new models of this type condenser, the outstanding features of which are light weight, yet extreme ruggedness, and compactness, known as the M type series, have just been brought out for set manufacturers by The Hammarlund Manufacturing Company, Inc., 424 West 33rd Street, New York City.

The light weight and compact features are made possible by the use of a specially developed aluminum frame and aluminum rotor and stator plates. This permits a huge saving in transportation charges, since it reduces greatly the total weight of the receiver. Also its compactness allows the construction of compact receivers to harmonize with the modern home setting.

Although a light-weight condenser, it is by no means a fragile product. With its reinforced, ribbed die-cast frame and rigid rotor and stator setting, it is an example of brute strength. To further this feature, a three-eighths inch shaft is used. The special setting also prevents the plates from vibrating, which causes the annoying microphonic effect.

Surface type wiping contacts of phosphor bronze with attendant low resistance, are connected to each rotor. This, coupled with the use of extremely low-loss Bakelite insulation throughout, with a power-factor of but 0.4 against 3.5 or more of the commercial grades of Bakelite stock, provides extreme efficiency, especially at the high frequencies, where absence of any resistance is so essential. Especially is the contact to each rotor valuable in screen-grid circuits.

The condenser is also adaptable to shielding either in individual stages or as a complete unit.

A MODERN, SIMPLE GROUND CLAMP

The Potter Company, 1950 Sheridan Road, North Chicago, has brought out an attractive, rust-resisting ground clamp, with copper ground wire lug and of vise grip construction. A standard package contains twenty-five clamps.

▲

NEW LARGE SWING LATHE IS ANNOUNCED

The 16-24-inch new model South Bend large swing lathe is designed for machining work of large diameter on which only light cuts are taken.

This lathe is a regular 16-inch lathe fitted with raising blocks to increase the swing from 16¼ inches to 24¼ inches over the bed. The raising blocks are firmly fitted under the headstock, tailstock and compound rest. The compound rest raising block is graduated on the base so that the tool can be fed to the work at any angle desired. It is fitted with automatic cross and longitudinal feeds and is especially built for the cutting of screw threads.

The 16-inch large swing lathe may be fitted with lathe chucks, drill chucks, and other attachments which make possible a great variety of work. It can also be supplied with countershaft drive or silent chain motor drive. It can be had in any length bed from six to twelve feet.

▲

A NEW ANTENNA

An antenna unit packaged as a ¼-inch wide roll of tape, has been introduced by The Samson Industries, 9 Rutger Street, St. Louis, Mo. A metallic conducting strip is backed by an adhesive tape which

may be erected as an indoor antenna, without nails, staples or other fasteners. The name of the new product is Stiktape.

▲

DAYRAD RADIO SET ANALYZER

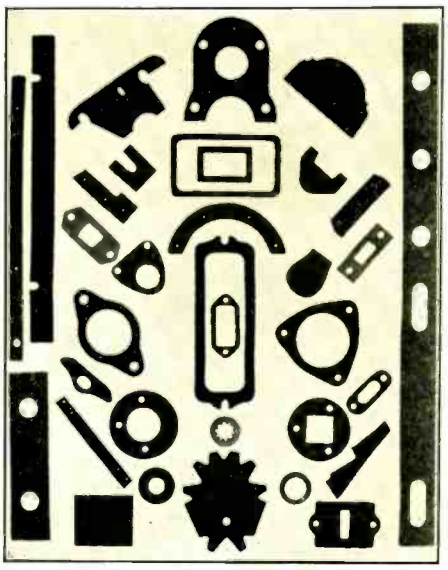
The "DayRad" radio set analyzer is one of the latest products of the Radio Products Company, Dayton, Ohio, manufacturers of "DayRad" radio service equipment.

This new instrument will indicate the true condition of the receiver so accurately that the operator will have no difficulty in locating the trouble.

Only one selector switch is used to connect meter ranges to points under test. Any d-c. meter reading may be reversed by means of a push button. No reading is obtained until button which operates desired meter is depressed. Both plates of type -80 rectifier tubes may be tested separately. Both UY and UX sockets are mounted on the panel, eliminating the use of adapters when inserting tubes. Rectified current may be tested in circuits using Raytheon tubes. Power pack secondary voltages may be read on the 800 volt a-c. range. A self-contained continuity test is provided. Resistance values may be read on the d-c meter. D-C ranges 0-20-100 mils. 0-20-100-200-600 volts. A-C ranges 0-4-8-160-800 volts. The carrying case is of bakelite.

New tests made necessary by modern service methods are provided for in addition to the usual functions of the analyzer.

VERSATILITY OF FELT



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Washers, wicks, gaskets and bases—all felt. You owe it to yourself to investigate the possibilities of this universal product.

Felt is daily solving hundreds of engineering and manufacturing problems. Avail yourself of the intelligent cooperation offered by the American Felt Company.

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A SENSIBLE SOLUTION TO RADIO PRODUCTION PROBLEMS

KINGSTON products have been successful in hundreds of thousands of radio receiving sets. Why not consult with our engineers?

Back of these experts is a corporation large enough to handle any production, regardless of size—and twenty-five years of experience in electrical manufacturing.

An opportunity to talk over your requirements of power transformers, filter condensers, filter reactors and other products is welcomed.

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KINGSTON
RADIO POWER EQUIPMENT
to manufacturers specifications

Dubilier Condensers

For Replacement in Receiving Sets, Eliminators, Speakers, Etc.

A fast-growing list, by the foremost manufacturer of radio-condensers. Built to give TEN YEARS, or more, of service.

LIST-PRICES, subject to regular dealers' and jobbers' discounts.

Atwater Kent		
Model 37 (Salvage allowance on chokes and case $2)	PL-2127	$15.00
Bremer-Tully		
Model 8-17	PL-672	12.00
8-20A & 8-21	PL-1216	15.00
B-Eliminator	PL-517	10.00
Columbia-Kolster		
Model 901	PL-455	17.50
C-6	PL-1039	4.75
C-4	PL-1054	7.50
920	PL-1557	6.50
961	PL-1147	17.50
980	PL-1142	17.50
980	PL-1156	6.00
Crosley		
By-Pass 1. 200v.	PL-1738	1.25
By-Pass .5 400v.	PL-1739	1.25
Erla		
Model W	PL-1121	10.50
J	PL-1194	13.50
A-2	PL-1315	9.50
224	PL-1642	9.25
224-By-Pass	PL-1602	1.65
224-By-Pass	PL-1635	.95
224-By-Pass	PL-1636	.85
224-By-Pass	PL-1337	1.00
Exide B-Elim	PL-411	7.75
Fada		
Model E	PL-999	9.00
Model D	PL-1245	8.50
Model M	PL-1465	6.75
Model K	PL-1506	9.75
A-Eliminator	PL-1132	4.50
Federal		
D, E, F, G, H,	PL-571	6.40
Ditto (Buffer)	PL-340	1.65
Farrand B-Elim	PL-121	9.00
Freed-Eisemann		
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6-H	PL-455	17.50
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R.C.A.		
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4th RMA Trade Show

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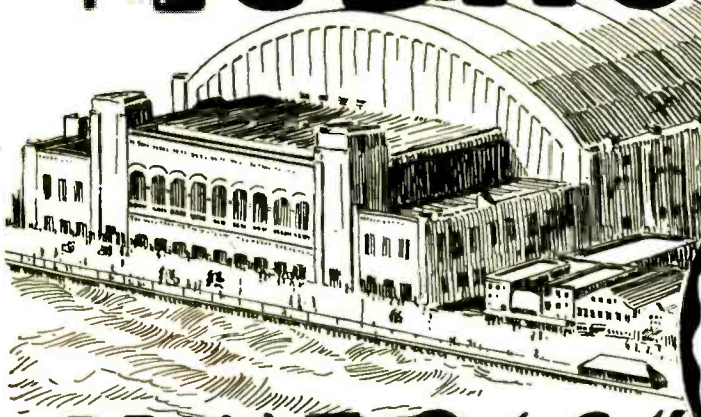

JUNE 2 to 6th

RADIO MANUFACTURERS ASSOCIATION — RMA

All indications are that the 4th Annual R. M. A. Trade Show to be held in Atlantic City June 2nd to 6th will be the largest as well as the most important Trade Show in the industry's history.

In addition to the latest receiving set models and accessories, which will be exhibited and demonstrated in the Atlantic City Auditorium, many important subjects of interest to everyone in the industry, from dealer to manufacturer, will be discussed.

During the same week as the Trade Show, the Sixth Annual R. M. A. Convention, the National Federation of Radio Associations, the Radio Wholesalers Association, and the Institute of Radio Engineers will convene in Atlantic City.

Atlantic City abounds in first class hotels. The visitors to the trade show can be assured that an average of $10.00 per day will well cover all expenses except transportation. For your information, we give the round trip railroad rates to Atlantic City from the principal cities.

Make your hotel reservations through the Atlantic City Convention Bureau, Atlantic City, N. J.

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Railroad Rates To
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Pittsburgh	$ 22.50
Cleveland	29.06
Toledo	34.83
Detroit	37.94
Columbus	32.28
Dayton	36.09
Cincinnati	38.75
Louisville	45.21
Indianapolis	42.03
Chicago	47.28
Milwaukee	51.87
St. Louis	55.32
Kansas City	70.38
Minneapolis	69.27
Omaha	74.18
Denver	103.20
Los Angeles	162.89
San Francisco	162.89
Portland & Seattle	163.10

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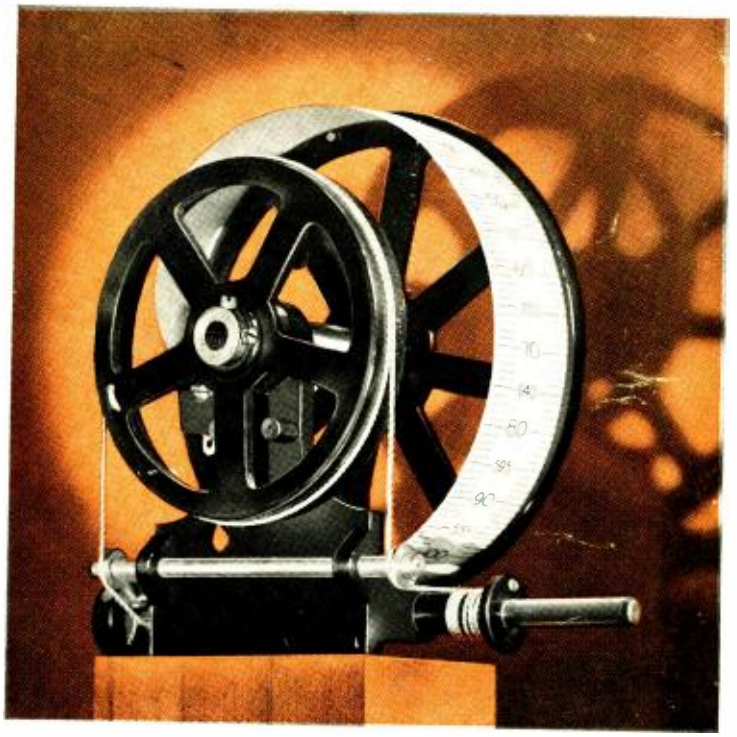

Drum dial unit of Bakelite Molded. Pioneer Radio Corp., Plano, Ill.

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