Tenth Year of Service

RADIO ENGINEERING

Vol. X JANUARY, 1930 No. 1

IN THIS ISSUE

Sold only by subscription
$2.00 per year

The Journal of the Radio Industry

Sweeping Through All Industries

New Thinking—New Awakening—New Alertness
New Seizing of Advantages

A Tidal Wave

FIRST of the FACT-SHEETS OF INDUSTRY; Equipment; Standards of Living; Costs; Materials; Methods; Savings; Profits; etc.,—now in preparation; will be ready soon.

Employe
Owner
President
Executive

This invitation is to You. Read it now. Accept it today.

SEND NOW for full CONTENTS OUTLINE of these new Fact-Sheets. Do not wait. Edition is limited. No obligation. Costs nothing whatever.

* *

Facts that will open your eyes. Many of them may startle you. Possibilities in some of them will make you sit up. A wave of new thinking is sweeping through all American industry. You know it; you have felt it. New weighing of opportunities; new awakening,—to new and advantageous possibilities.

* *

As a business man you want to be on the wave, not under it. We are here offering you some of the FACTS that are causing it.

Are you an EMPLOYE ?

Do you work for any company that buys or uses equipment? Or makes equipment for other companies? Or makes or handles any product that is used by Consumers?

Are you a straight thinker? Thinking for your company, as well as for yourself?

These Facts affect you directly or indirectly. You can't escape them. They affect your company; your work; your own interests. You owe it to yourself to get them. And to realize all they mean to you.

* *

We do not care what your position is; or whether you write "officially" for your company, or "personally" for yourself. The Full CONTENTS OUTLINE of these Industrial Fact-Sheets is yours for the asking. (Please state work you do; company; what it makes, or kind of service it deals in). These are Facts that if seized rightly may be of inestimable importance in your own work, advancement and prosperity.

* *

There is no question about it. This tidal wave of new thinking has force behind it. It is getting somewhere.

Are you a PRESIDENT ?

Or OWNER? Or an EXECUTIVE of such a concern? You owe it to yourself to have these Facts,—all of them. And to get this Full OUTLINE OF CONTENTS at once.

Here are Facts that connect directly to matters you are earnestly thinking about right now;—operations,—cost-reductions,—safety in competition,—design development,—betterments,—volume,—profits,—prosperity.

* *

Send for the OUTLINE OF CONTENTS. Do it today. There is no charge; no obligation.

A Letter or Card. Or Write on Margin:

Fact-Sheets of Industry; Dept X-1
N. V. F. Co., Wilmington, Del.

Please send me OUTLINE OF CONTENTS, without charge or obligation. - - My Name - - My Address - - Company - - Product or Business - - My Position or Kind of Work, or Department. - - [Please State whether writing Officially for Company, or Personally for self.]

The publication of this, the first of the Fact-Sheets of Industry, is the start of a plan which, when at full growth, will supply freely to thinking workers in ALL levels of industry, practical knowledge which hitherto has not been readily accessible; facts from many other industries which may stimulate their own productive thinking; and which, though they affect practically every business, every department and every worker, are usually known only in part and only by a limited group of specialists in each industry.

As a movement in line with national measures for further improvement of business conditions and of the circuit of producing, earning, consuming, equipping, etc.;—and as the initial step in this democratizing of inter-industry knowledge (which, under present conditions, is more needed by thinking workers, and can yield more important results than ever before);—all expenses of issuing the first of the Fact-Sheets of Industry are being borne by The National Vulcanized Fibre Company and its various divisions and associated industries.

NVF

NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON, DELAWARE, U. S. A.

FOR 16 YEARS

A LEADING SOURCE OF LAMINATED INSULATION

FOR 16 years . . . practically since the industry began . . Formica has been a source of supply for laminated insulation for many of the leading technical organizations in the United States.

During all of that time the Formica organization has been concentrated on just one product and the Formica laboratory has been working steadily to improve that product.

This exceptional concentration has resulted in a product and a service that is unusually satisfactory . . . and that has continued so for many years.

Send your blue prints for quotations on punched parts

THE FORMICA INSULATION COMPANY

4638 Spring Grove Avenue Cincinnati, Ohio

RADIO ENGINEERING

Reg. U. S. Patent Office

Member, Audit Bureau of Circulations

Editor
M. L. MUHLEMAN

Western Editor
EVANS E. PLUMMER

Advisory Editor
DONALD MCNICOL

Associate Editor
AUSTIN C. LESCARBOURA

Vol. X **January 1930** **Number 1**

Contents

Departments

Unit of Hum Power

THE conventional electrical standards —the volt, ohm and ampere—are familiar terms to both layman and engineer. The frequency of an incoming radio impulse, or its wavelength in meters, amplification constant and plate potentials are terms of everyday usage, though a few years ago they were practically unknown. But the a-c. receiver brings a new factor into engineering and everyday life—the hum of the electricity generated in the distant power house.

A-c. hum is a serious consideration in the design of modern radio receivers, and, in producing a satisfactory receiver, it must be reduced to a minimum. George Lewis, Vice President of the Arcturus Radio Tube Company of Newark, New Jersey, suggests as a unit of hum power the "b," giving due credit to that hymenopterous insect whose sound is most universally recognized as "hum."

The "b," according to the recommendation of Mr. Lewis, would designate hum energy in the electrical output of a receiver having the power of .000001 watt—or one micro or millionth watt. Hum energy of a magnitude of one quarter "b" or one fourth millionth of a watt can just be discerned by the average ear. As the response of the ear to sound is logarithmic, four times this energy, or one "b" is quite negligible but may be taken as the maximum hum content allowable in a really first class receiver.

According to scientific confirmation, the designation by Mr. Lewis of one microwatt of hum energy as a "b." is quite logical, as it roughly approximates the power generated by the average bee in humming. However, the sound produced by this amount of electrical energy is not as loud as a bee's hum due to the inefficiency of even a high grade dynamic loudspeaker.

Published Monthly by

Bryan Davis Publishing Co., Inc.

Publishing
AVIATION ENGINEERING
RADIO ENGINEERING
PROJECTION ENGINEERING

Publication Office—Lyon Block—Albany, N. Y.
Chicago Office—333 No. Michigan Ave.—Charles Farrell—Mgr.
Cleveland Office—10,515 Wilbur Ave.—James Munn—Mgr.
San Francisco Office—318 Kohl Bldg. } Cupit and Birch—Mgrs.
Los Angeles Office—846 So. Broadway }

Bryan S. Davis, *President*
James A. Walker, *Secretary*
E. M. Bacon, *Advertising Manager*

Entered as second class matter at the post office at Albany, N. Y., January 9, 1925, under the act of March 3, 1879.

52 Vanderbilt Ave.
New York City

Yearly subscription rate $2.00 in U. S. and Canada; $3.00 in foreign countries.

EDITORIAL

January, 1930

WRITTEN BY THE INDUSTRY

THE radio industry has enrolled in the national movement initiated by President Hoover to remedy and stimulate business conditions. Meeting recently at Briarcliff Lodge, New York, coincident with the Board of Directors of the Radio Manufacturers' Association, a large group of radio producers held a conference along the lines of those urged by President Hoover. Encouraging reports regarding the present and future of the radio industry were presented.

The meeting of the radio manufacturers was in open session and presided over by Mr. H. B. Richmond of Cambridge, Mass., President of the Radio Manufacturers' Association. Addresses were made by O. H. Caldwell of New York, former Federal Radio Commissioner; Frank D. Scott of Washington, legislative counsel of the Radio Manufacturers' Association, who represented the organization at the conference December 5 under the auspices of the U. S. Chamber of Commerce, and others.

President Richmond urged the radio manufacturers to do everything in their power "to carry out the broad principles outlined in these conferences" inaugurated by President Hoover. "As long as the nation's purchasing power is unimpaired," President Richmond said, "there is no need of fear in the radio industry. Its condition," he said, "is improving, although there was a recession both practical and psychological resulting from the stock market decline.

"The present general situation is unique in that over-production, which means unpaid-for merchandise, is in the hands of the consumer," said President Richmond. "We have both unpaid-for merchandise in the hands of the consumer and in our distributors' or our own warehouses as well. We also have a potential production much larger than current demand, causing part-time operation of plants.

"Conditions now are much improved," President Richmond said, "and the industry can look forward with confidence to the business of 1930."

Mr. Caldwell said that the situation was generally favorable and much improved over a few weeks ago. While there has been over-production, Mr. Caldwell said, at the same time this is radio's biggest year.

"The increase in radio business of dealers is reported to be forty per cent this year over 1928," said Mr. Caldwell. "It is the best year for dealers. The great middle classes have not been affected by the stock crash. Two homes in every street right now offer opportunity for the sales of radio sets.

"Prospects for 1930 will at least be equal to those of 1929."

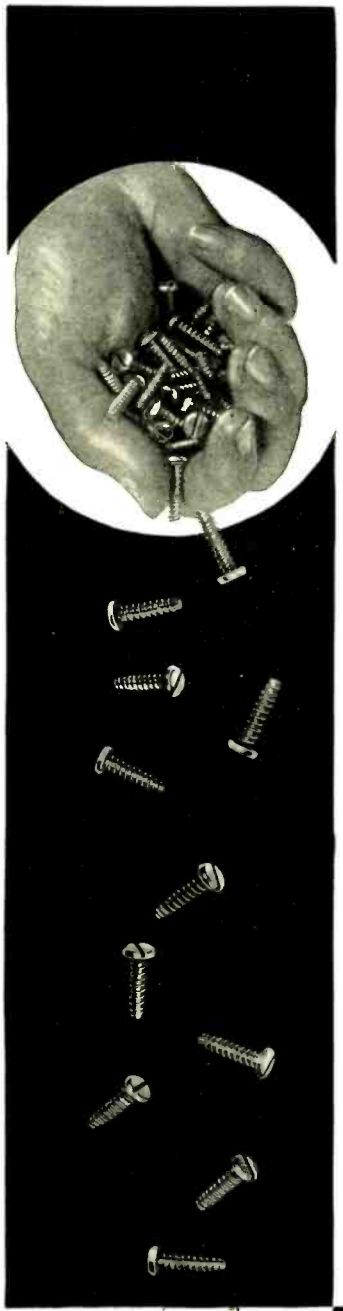
Mr. Scott gave a report regarding the conference December 5 at Washington, and many other manufacturers gave encouraging views regarding the radio future.

The manufacturers' conference was a special meeting under the auspices of the Radio Manufacturers' Association to give the manufacturers an opportunity to discuss the problems now specially before the radio industry.

The Board of Directors of the RMA, in separate meetings, also took action on many important industry problems. A comprehensive plan to secure reliable and frequent reports on production and radio stocks, and general industry statistics which have been lacking in the past, was presented by the RMA Statistics Committee and adopted by the Board.

Increased work of the Credit Committee also led the RMA Board to increase its staff to handle the credit situation. A detailed report regarding the Credit Committee's operation was presented by Mr. Leslie F. Muter of Chicago, Chairman.

Major H. H. Frost of New York, Chairman of the Merchandising Committee of the Association, presented, and the Board adopted, plans to enlarge the merchandising service afforded to RMA members.



THIS HANDFUL of SCREWS

. . . eliminates 44 tapping operations on each PHILCO Radio

All along the assembly line at the plant of the Philadelphia Storage Battery Co., wise production heads have reduced cost and trouble to a minimum in the assembly of Philco Radio receivers and speakers. Tapping was one of the principal difficulties but it was quickly and effectively eliminated by the Philco Engineers.

How? . . . Simply by replacing machine screws with Hardened Self-tapping Sheet Metal Screws. Forty-four of these unique Screws abolished 44 tapping operations on each Philco Radio. In addition they effected a saving in time and labor of over $16,000 in a year.

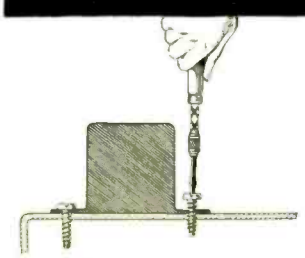
The many applications for which Philco use Self-tapping Screws include: Fastening padding, power, by-pass and neutralizer condensers; condenser braces; power chokes; power and push-pull transformers; volume control shields; shield plates; wire clamps and other parts to be securely attached to the chassis.

You, too, can use Self-tapping Screws profitably. Tell us what you want to fasten—we'll send samples for test. No obligation.

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

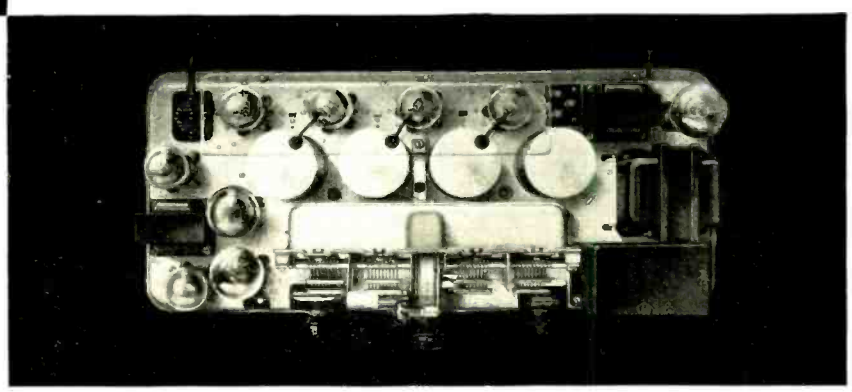
PARKER-KALON
HARDENED TYPE Z SELF-TAPPING
Sheet Metal Screws

PATENTED
APR. 1, 1918 - No. 1,299,232 — MAR. 20, 1923 - No. 1,411,184
AUG. 14, 1923 - No. 1,465,148 — FEB. 10, 1925 - No. 1,526,182
OTHERS PENDING



These Screws Tap their own Thread

Simply turn a Self-tapping Screw into a drilled or pierced hole. It taps its own thread in the metal—holds better than a machine screw—even under vibration.



can meet your specifications for molded insulation and stamped metal products— and give prompt delivery

THE Monowatt Electric Corporation has purchased the New England Metal Products Company and the Connecticut Molded Products Corporation, both of Meriden, Connecticut. The consolidation of these two factories has made possible one of the few completely integrated plants which produce molded insulation parts, metal stampings, and eyelets for the assembly of moldings and stampings. Not only do we produce both, but we combine them into finished parts for you if you desire.

You write the specifications either for molded insulations, or metal stampings, or a combination of the two. Our engineers become your engineers until your requirements are met. Then our factories become your factories, to insure the faithful carrying out of your requirements in the actual moldings and stampings.

Our large stock of standard molds is always available to you, and our facilities for making molds enable us to carry out special jobs both effectively and promptly. The same holds true of our metal stamping facilities.

You are invited to avail yourself of this highly technical service, in order to obtain the parts best adapted to your use, at the most economical cost.

THE MONOWATT ELECTRIC CORPORATION

21 WEST 40TH STREET, NEW YORK, N. Y.
427 WEST RANDOLPH STREET, CHICAGO

Factories: Bridgeport and Meriden, Conn. *Sales Offices:* New York and Chicago

MONOWATT *for greatest value*

GILBY FILAMENT WIRE AND SELVAGE MESH *for BETTER TUBES!*

GILBY SELVAGE MESH a comparatively late development has taken the field by storm. The solid, even edges simplify welding and this screen material in which the mesh is interlocked is rigid and rugged beyond belief. It may be supplied accurately within .005 plus or minus as specified. Its use will cut production shrinkage and lend a more finished appearance to your product. *One customer says "So far as we are concerned this Gilby Selvage Mesh represents the difference between producing 224's and not producing them."* This Selvage Mesh has proven itself so valuable that it is being widely imitated. In fairness to all concerned we give notice that our rights will be vigorously defended. Patent applications fully cover both the material itself and the tube of which it is a part.

Gilby Filament Wire—A tube is no better than its filament. There is no filament better than Gilby. Gilby Filament Wire has long been recognized as the Superior Product. Its uniformity, accuracy and long life is readily testified to by tube manufacturers.

We would appreciate inquiries and an opportunity to co-operate with your staff. Samples of Filament Wire and Selvage Mesh on request. Resistance and Ballast Wires, too!

GILBY WIRE COMPANY

Wilbur B. Driver, President

NEWARK, NEW JERSEY

John C. Campbell,
President

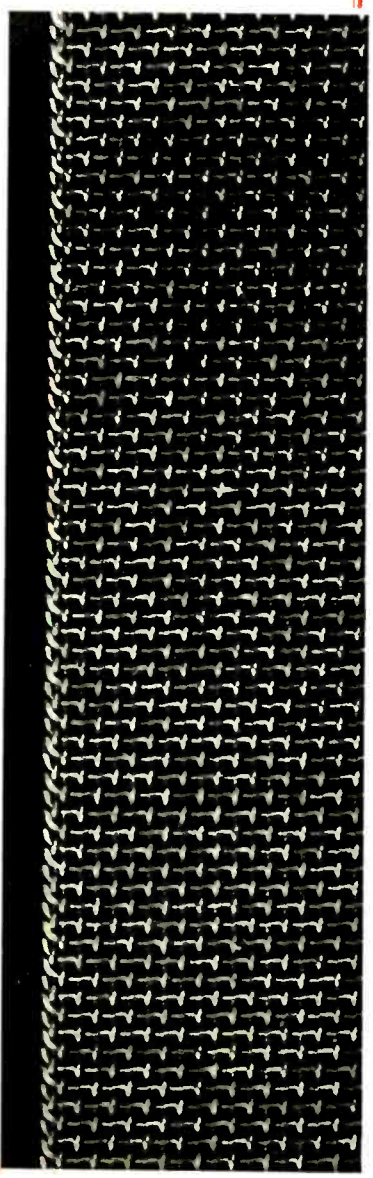
No advance in price!

Our contribution to President Hoover's program.

''In keeping with the spirit of the times we have NOT advanced the price of Newark ''SEALEDGED'' (Trade Mark) Grid Screen one cent. We are furnishing the material to manufacturers of radio tubes at the same price per square foot as formerly charged for raw cut cloth. Therefore the customer is paying no advance to obtain this improvement. This is our contribution to the maintenance of American business prosperity.''

JOHN C. CAMPBELL
President

This, below, is a photomicrograph which shows clearly how neatly and perfectly "SEALEDGED" (Trade Mark) is made.



Not only do you obtain a real price bargain in "SEALEDGED" — it is unquestionably the simplest and most effective solution of the grid screen problem. Absolutely uniform tube characteristics assured. No possibility of unraveling. No unevenness of the edges. A remarkably smooth and even finish all over. No jamming in the guides. Every wire bent in exactly the same way with amazing perfection. No dropping out of wires. No rejections due to poor wire cloth.

Ask for sample. Write a letter or use the coupon below.

Newark Wire Cloth Company
351-365 Verona Ave. Newark, N. J.

NEWARK WIRE CLOTH CO., 351-365 Verona Ave., Newark, N. J.
Please send me a sample of Newark "SEALEDGED" Grid Screen.

Name ..... Firm .....

Street ..... City ..... State .....

Ask the service man, he knows

"The De Forest radio tube surpasses every known make,"
—says Joel J. Michaels,
Executive Chairman, Citizens' Radio Committee.

This is one of many unsolicited letters we have received from service men the country over.

New York City
Oct. 1, 1929

De Forest Radio Co.
Jersey City, N. J.

Gentlemen:

I have kept a record of service calls during the past four years, and almost every conceivable type of radio set has come under my observation.

Sixty-five per cent of the entire troubles lay entirely to faulty tubes.

Of the entire quantity of tubes found defective, less than five per cent were De Forest Audions, and I have certainly found in my travels around the New York section, carloads of De Forest tubes giving splendid service and many of them bearing the earmarks of long service.

I prefer to recommend to my clients your vacuum tubes, because they are designed and constructed by scientists who know their business, whose background and experience antidates every existing vacuum tube manufacturer, and whose researches and improvements are widely copied and considered standard. The De Forest tube, in my judgment surpasses every known make, for performance, efficiency, mechanical construction and general all-around service.

I can testify to the fact that some of the World's D.X. records were obtained after De Forest tubes were substituted for others whose manufacturers claimed unbelievable performance.

When better vacuum tubes are made, De Forest will make them.

Respectfully,
Joel J. Michaels
Executive Chairman, Citizens Radio Commit

Radio Service Engineer,

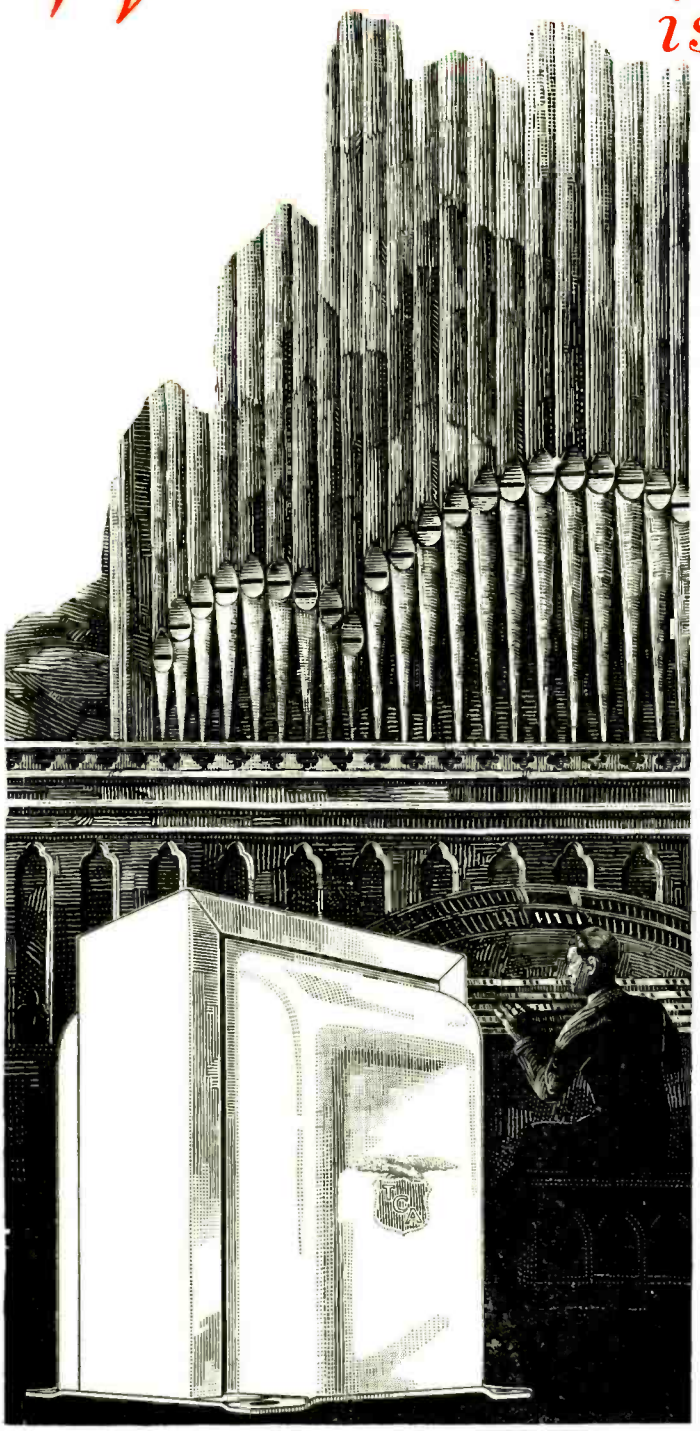
de Forest AUDIONS

DE FOREST RADIO CO.
PASSAIC, NEW JERSEY

Branch Offices Located in

Boston, New York, Philadelphia, Atlanta, Pittsburgh, Chicago, Minneapolis, St. Louis, Kansas City, Denver, Los Angeles, Seattle, Detroit, Dallas, Cleveland

When real **TONE-RICHNESS** *is required*



TRANSFORMER amplification is by all odds, and for many reasons, the favorite. True in tone over the full musical range, inexpensive, trouble-free, and enjoying the full confidence of a discerning public.

Transformers make the set.

The design and construction of transformers determine the quality of reception.

With the co-operation of the T·C·A engineering staff, you can be sure of the highest attainable results.

Complete manufacture and controlled quantity production have made T·C·A the favorite on the nation's finest sets. Audios . . Power-transformers . . Chokes . . Power Packs . . Dynamic Speakers.

TRANSFORMER CORPORATION OF AMERICA

2301-2319 SOUTH KEELER AVENUE

CHICAGO, ILLINOIS

Volume Control INSURANCE!

FAULTY vacuum tubes lead in the causes for costly servicing. And faulty volume controls are a close second. Of course there is some excuse for vacuum tubes; they are not all uniform; the radio public too often insist on questionable "bargain" tubes; and they wear out. But there is no excuse for an integral part of the radio assembly, such as the volume control.

Can you afford to produce radio assemblies without volume control insurance? Can you risk consumer, dealer and jobber good will? Can you willingly assume the cost of servicing out in the field? If so, you are a poor prospect for Volume Control Insurance. You will not be interested in what follows. But if you are concerned about these things, then you need Volume Control Insurance.

And here it is:

Use only those volume controls designed by specialists, who know the many problems of making reliable adjustable resistances. Those specialists realize that a reliable device is more than just a winding, a movable contact and terminals. They test each volume control separately for noise tolerance. They subject samples to continuous wear tests, hour after hour, day after day, month after month, and study the wear on the wire with powerful microscopes. They select resistance wire that will not oxidize, change resistance value, stretch. All of which spells the—

Wire-Wound Volume Control CLAROSTAT

Switch Type

which provides *triple insurance against trouble.* First, the winding, of special wire, cannot slip, shift or change resistance value. Second, both winding and contact are encased in bakelite shell with metal end plate, keeping out all dust, dirt or moisture. Thirdly, a smooth, positive, long-life contact member is employed, without causing noticeable wear on even the finest wire.

Please do not confuse this device with carbon paper, graphited fibre, or other devices the current-handling capacity of which is usually insufficient for continuous, present-day radio circuit use. Do not confuse it with other wire-wound devices, usually avoided because of the disagreeable grating, grinding sounds made during adjustment. The Wire-Wound Volume Control Clarostat turns with a smooth, velvety, really delightful motion. And it is as silent as the Sphinx, even in the most critical, high-gain circuits.

Duo Type

Best of all, the Wire-Wound Volume Control is made to meet your exact needs. Special winding machines, designed and built by our engineering staff, enable us to wind our bakelite strips with anywhere from 8 to 600 turns per lineal inch of length, and with resistance values up to 50,000 ohms. The strip may be tapered at any portion of its length. The winding may be variably spaced. Different sizes of wire may be employed throughout the winding. Therefore, we can supply a volume control to match any resistance curve you may desire.

The Wire-Wound Volume Control Clarostat is available in the single unit, with switch; in the single unit, without switch; and in the duo or tandem type, with each resistance unit electrically insulated if desired, and adjusted by a single knob.

And don't overlook another important insurance policy, while dealing with safe production—the Line Ballast Clarostat, which provides ideal and uniform operating conditions for your radio assemblies, irrespective of fluctuating line voltages.

WRITE *for technical data regarding the Wire-Wound Volume Control Clarostat and the Line Ballast Clarostat. If you are a radio manufacturer or an engineer engaged in the design and production of radio equipment, send your specifications and we shall gladly submit samples for your inspection and test.*

Clarostat Manufacturing Company, Inc.

Specialists in Fixed, Variable and Automatic Resistors

MEMBER RMA

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

Remember—there's a CLAROSTAT for Every Purpose

INCA

INCA — *Name derived from the Inca Indians, the original copper workers of early American history — emblematic of the best in the copper wire industry.*

In appreciation

Geo. A. Jacobs, Pres. of Inca, Says:

The response of the trade to the initial output of INCA products has been most pleasing. The substantial character of this response is further indicated by the immediate building of a factory addition trebling our plant capacity. We recognize in the universal satisfaction which is greeting INCA products a genuine tribute to the craftsmanship and engineering which make for exacting production of enameled, insulated wire and windings. We would be unmindful of the occasion if we did not express sincere appreciation of this good will and pledge the continuance of our complete facilities, in greater measure than ever before, in producing a dependable source of copper wire supply for the success of the electrical, automotive and radio industries.

George A. Jacobs

INCA

INCA MANUFACTURING CORPORATION

Copper Wire Products :-: *Fort Wayne, Indiana*

EASTERN OFFICE
Newark, New Jersey — Industrial Office Building

WESTERN REPRESENTATIVE
A. S. Lindstrom, 274 Brannan St. — San Francisco, Calif.

IMPRESSIONS *and* EXPRESSIONS

By

AUSTIN C. LESCARBOURA

The Mad Rush

As these lines are being written, in the middle of December, 1929, we might borrow those classic words, "All Quiet on the Western Front," with regard to the radio industry at large. At least that is the situation regarding production. Nevertheless, behind the lines there appears plenty of action preparatory to new advances. Overhead is being chopped down on all sides. Facilities are being concentrated. Excessive space is being discarded. Costly offices are being closed up as the staffs are brought to the factory where cheaper rents obtain. And everyone is more or less marking time.

Meanwhile, the industry is in a splendid shape for real profitable business. Parts manufacturers are on their tiptoes, with equipment and supplies ready to go to work. Set manufacturers have prepared for the most economical production ever. Inventories, while still high, are being rapidly reduced during the holiday season. Everything looks good, but—

Next year is another year. Ostensibly, everyone is going to get going on new production at the same time. There is going to be a frantic rush of work. And that is going to mean costly overtime and rush orders, which may somewhat offset the economies otherwise effected. Perhaps it might be well for the individual manufacturer here and there not to wait to the last minute. Let's go!

Tube Tolerances

Servicemen assure us that tubes are not what they used to be. Perhaps so. Perhaps not. We don't know.

But we do know that tubes are being subjected to greater strain than ever before. First, in working voltages. Higher applied voltages certainly place a severe strain on tubes, especially when compared with the lower applied voltages of former days. Secondly, in constant operating time. It is estimated that the average socket-power radio set today operates five hours per day, as compared to three hours a couple of years ago, and an hour or less five years ago. Obviously, tubes are subjected to more wear and tear in a shorter space of time.

Nevertheless, it is our personal belief that the tolerances on some tubes have been materially widened, resulting in poorer average tubes. The public has gained the benefit by way of lower list prices, but we sincerely believe that the radio industry has lost something by way of high-grade average tubes and minimum servicing.

Television —in 1930

The year 1930 should see the commercial advent of television. Based on what we are permitted to see and what we are not permitted to see, it seems that the young art is ready for commercial exploitation even if in relatively crude form.

There are two distinct shades of opinion regarding the commercialization of radio television, or radiovision. One believes that the young art should be developed to perfection in the laboratory, before inviting the public to invest its money in radiovision equipment. The other believes that radiovision should be developed in the great laboratory of everyday use, with the public taking active part just as it did in sound broadcasting.

At any rate, 1930 should see the making or breaking of the radiovision idea. Talk should give way to demonstration. Accomplishment should replace promise. Radiovision should become commonplace. The home should replace the laboratory. Will it be so?

The Poor —80!

If there is one beast of burden in the present-day radio situation, it is the —80-type full-wave rectifier tube, which is employed in the vast majority of socket-power receivers. Originally intended for a moderate power socket-power radio set, with a single —71-type power tube, this rectifier has been harnessed to the latest sets employing two —45-type power tubes in push-pull arrangement. From an output voltage not much in excess of 200 volts, the rectifier has been pushed to an output sometimes as high as 350 volts. Even the huge —50-type power tube has been placed on the shoulders of the —80 rectifier, in some sets.

Servicemen have long complained of the failure of the —80-type rectifier to stand the gaff. Fortunately, tube manufacturers have been strengthening the —80-type rectifier steadily, and today they are making tubes that stand up well. However, there is still much room for improvement. The —80 rectifier remains the beast of burden of present-day radio technique.

Time Switches

No handier feature could be included in the already handy radio sets than the time switch. Indeed, it is surprising that no standard radio set has yet appeared with a time switch as an integral feature. In view of the radio habits of the average American family, tuning in this or that morning program as an inspiration for the new day, as well as going to bed at night with the radio left turned on so as to be lulled to sound sleep, an automatic switching feature is a positive necessity.

It is our best belief that the time switch will be featured in some of the 1930 sets. And if we have made a wrong guess, then we believe that the set designers are even poorer guessers than we are, for they are overlooking a most important feature that will help sell new sets to those already owning old sets.

Crowe Announces *NEW AIDS* for Radio Engineers in 1930

Rotary Dial and Escutcheon, Type 30

THE Crowe company is more than a mere purchasing source for etched and embossed metal products. We maintain an engineering staff, alert to changing trends in radio construction and design, fully qualified along technical lines, and will be glad to cooperate with you in devising

Escutcheons
Dials
Station-Finding
and Control Devices
Drums and
Scales

for your forthcoming models. You are invited to avail yourself of this service. Put your problems up to us by mail, or ask for representative to confer with you.

Among our recent developments is the rotary disc dial, pictured above, consisting of thumb-controlled rotating dial, and handsomely finished bronze face plate or escutcheon, complete in one assembly.

Our Bulletin No. 30

which will shortly be ready for mailing, describes our full line of products and contains a wealth of practical suggestions for the radio engineer. It is replete with illustrations, and will evidence our ability to render invaluable aid in the designing and manufacture of escutcheons and parts for your new lines.

Write for Your Copy Today!

Crowe Name Plate & Mfg. Co.

1750 Grace Street - - - CHICAGO

Steel Drum, Type 29

This packing slip found in every Dudlo shipping case carries the clock number of the final inspector . . . it places the definite responsibility for the accuracy and perfection of the contents of each case.

Definite Responsibility

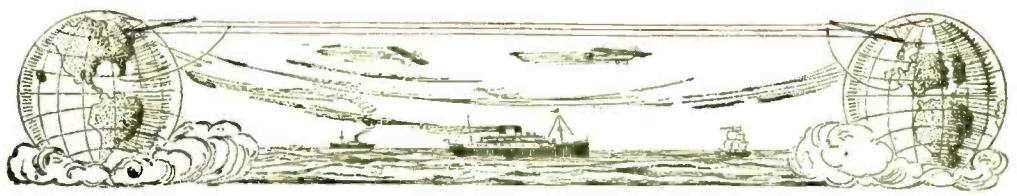
Dudlo inspection is a definite protection to every user of Dudlo products. Final inspection and packing are *one operation* . . . for the inspectors themselves pack the cases as the coils are passed. No other hands touch them after your packing slip is signed, and the inspector is directly responsible for every coil passed.

Only the most experienced and competent employees are promoted to the inspection department, and their positions depend on their accuracy and dependability.

Dudlo coils *must meet your* specifications

DUDLO

DUDLO MANUFACTURING COMPANY, FORT WAYNE, INDIANA
Division of General Cable Corporation



Sensitivity Measurements and Performance Tests on Radio Receivers in Production†

A Discussion of the Test Methods Used in Building the Victor Radio Sets

*By N. E. Wunderlich and W. R. Dohan**

WHEN quantity production of radio receivers began, it was soon found that quantity production methods were equally necessary in receiver testing. Operational tests depending upon the operator's judgment were found to be incompatible with high speed production, and high quality of the product. It is a great economic waste to place defective parts in any assembly, and to avoid this, a comprehensive testing procedure for all parts is necessary. Although this field presents many facts of interest, the limitation of space confines the field of this paper to sensitivity and performance tests of the completed receivers.

The three principal performance characteristics of a receiver are: fidelity, selectivity and sensitivity. The fidelity and selectivity are chiefly functions of the design, and if the normal sensitivity is obtained, the selectivity will be close to type. The fidelity is further checked by gain runs on the audio amplifiers.

In the search for a suitable quantity production test, the natural development was along the lines of laboratory procedure. It seemed desirable, if possible, to use the standard procedure for receiver testing adopted by the Institute of Radio Engineers. Obviously, it is not necessary to actually measure the sensitivity in microvolts per meter of each receiver shipped by the manufacturer, but it is highly desirable to know that every receiver shipped has a sensitivity equal to or better than an arbitrary standard set by the manufacturer.

Testing Systems

There are many systems which can be used for receiver testing, but they may be divided into two general classes—those employing local generation of the test frequencies, and those employing centralized generation and a transmission line of some description to each test position. Figs. 1 and 2 show outlines of the system elements for each class.

A third class might be mentioned in which the sensitivity of the receiver

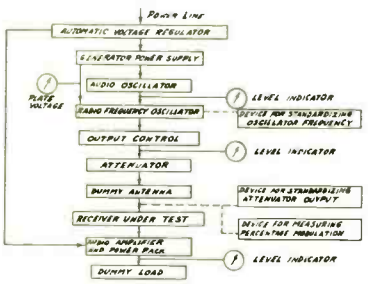


Fig. 1. Local generation system of receiver testing.

under test is compared to a standard receiver by switching the antenna. It is open to the objection that the signal input is not constant from minute to minute, and that the standard does not remain at the same sensitivity level. It may be regarded as a link between the plain operational test and the measurement system to be described.

Centralized generation systems may attenuate to the desired signal level at the generator, or at each test position, depending on the performance desired, as indicated in Fig. 2. For accurate measurement of each set, attenuation must be local but a single passing mark may readily be set by a central attenuator.

Using local attenuation, the transmission line may be used to feed the grid of a coupling tube placed at each position. The power level in the line may then be kept quite low and the radiation will, therefore, be small. This system has the disadvantage of introducing an additional variable element, the amplification obtained from the coupling tube and thus rendering the calibration of the test position less permanent.

If it is desired to align the sets at the test position, the attenuation must, of course, be under the control of the testing operator. The problems connected with this system are much more difficult as the transmission lines must operate at a very high level in order to have sufficient voltage available for alignment purposes.

The problems of local generation and attenuation are principally those of keeping the frequency and output of all generators the same. The problem of frequency is especially important if the generator is used for alignment as well as testing. It may be solved by using a centralized source of high frequency for synchronizing purposes, or as a standard against which to match the generator frequency by the method of zero beat. The use of a portable reference standard is much more practical, however, and avoids entirely the transmission line problem. In this connection, the oscillator must have a reasonable frequency stability so that, once set, it will operate very close to the correct frequency for a considerable period.

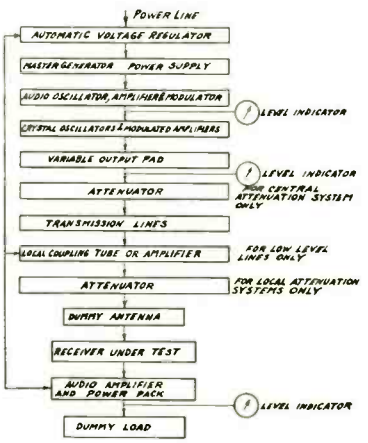


Fig. 2. Generalized central generation system of receiver testing.

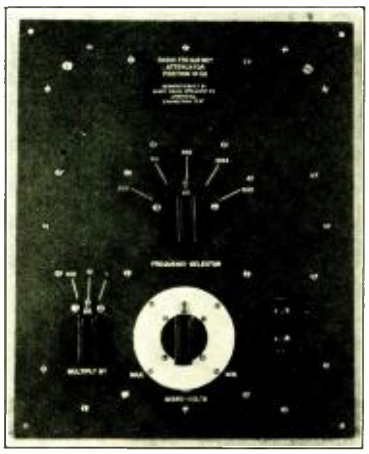
† *Delivered before the Radio Club of America, November 13, 1929.*

* *Engineering Dept., Audio Vision Appliance Co., Camden, N. J.*

The use of individual generator frequency stability by means of crystal oscillators would be an ideal solution but the cost would be very high for the necessary crystals.

The question of standardization of the attenuator output is, of course, present in both systems, but the centralized system gives the advantage that all test positions vary alike, so that once a calibration of the test position is made, it remains accurate as long as the master generator gives the correct output voltage.

The most direct method of calibrating an attenuator is by comparison with a portable signal generator whose output and percentage of modulation may be accurately determined and then maintained constant. The radio receiver then operates as a voltmeter, and the calibration is independent of line voltage, tubes, receiver constants, tuning, etc. The main objection is the amount of time necessary to calibrate a position. This objection is entirely overcome if the calibration is semi-permanent as in a central generation-local attenuation system.



Panel view of one of the radio-frequency attenuators.

Alternative methods are those using a radio receiver carried from position to position. These methods may be divided into two classes, those using a standard production receiver and those using a special receiver of some kind. In the construction of these special receivers the number of tuned circuits is usually reduced, and an excessive amount of audio amplification is often used in an effort to reduce changes in the overall amplification due to regeneration in the radio-frequency amplifier. A particularly interesting example of this tendency is a set consisting of but one tuned circuit of very low resistance, and a bias vacuum tube voltmeter. The tuned circuit gives a gain of about one hundred times, so that a voltmeter which would indicate one volt could be used to measure

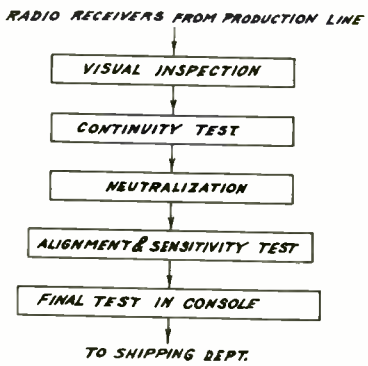


Fig. 3. Receiver inspection and test system.

10,000 microvolts. The device can be used to check the attenuators on one of the higher multiplier taps. All of the special, or standard set methods are open to the objection that the amplification varies with line voltage, time, humidity, temperature, rough handling, and many other variables, but the calibration checks may be carried out much faster and with less interruption to production.

A-F. Output Tests

Measurement of the audio-frequency power output of the receiver is quite simple, but some methods have considerable advantage over others. The vacuum tube voltmeter at once suggests itself. It is especially desirable for systems combining alignment and test because a grid leak and condenser voltmeter may be built to saturate at a certain level and thus protect itself against overload. The disadvantage of changing calibration, as the tube ages, or the operating voltages change, and the relative complexity compared to other systems, have restricted its use.

The thermal meter is a practical solution where test only is contemplated, but a thermal instrument is not rugged enough when alignment is combined with the test operation.

Rectifier systems of some sort are usually very rugged and hold calibrations for quite some time. Contact rectifiers are superior to crystals as the calibration is more permanent. Full-wave rectifiers are to be preferred, and if the type ordinarily supplied for trickle charging is used, it can hardly be injured by the maximum output of the receiver. The d-c. meters used to read the rectified current withstand a tremendous overload, so that the combination is a very rugged one, suitable for aligning and testing, and with reasonable permanency of calibration.

Contact rectifiers for metering purposes have recently been made available commercially, and a complete meter containing a miniature rectifier has also been placed on the market. Both devices have proved satisfactory as output meters.

In the particular system to be described, as shown in Fig. 3 the receivers from the production line pass through visual and continuity tests and then to the neutralizing operators. The continuity panels present nothing of special interest, but several points in the neutralizing technique deserve mention. By laboratory test, it was determined that the receiver possessed the best sensitivity characteristic when the neutralizing condenser in the first three stages was set to a certain value, and that in the fourth stage to a slightly lower value. The method of neutralizing is the ordinary procedure of applying a voltage to the input of the receiver and adjusting the neutralizing condenser of one stage which contains a dummy tube until minimum output is obtained. The departure from the standard practice consists in the use of two dummy tubes adjusted to different values. A dummy of lower capacity, painted red for identification is used to neutralize the last stage and in this manner, the sets are rendered more stable than those neutralized with the higher capacity dummies in all stages. In addition, the sensitivity characteristic is improved as previously mentioned. From the neutralizing positions, the sets pass to the alignment and sensitivity measurement operations.

Alignment Operation

Two methods are at present in use for the alignment operation and sensitivity test; one using local generation

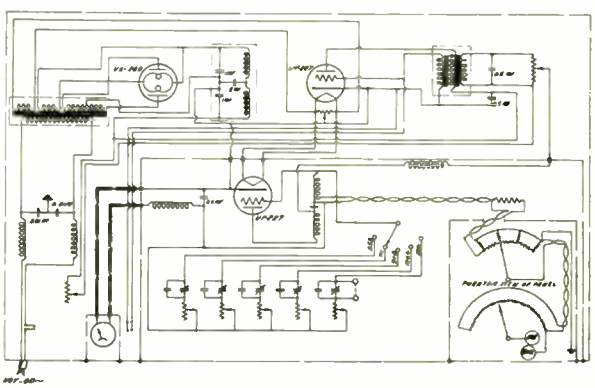
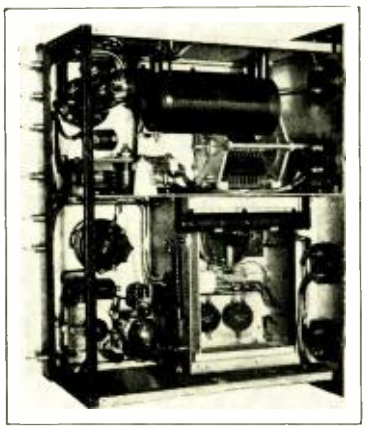


Fig. 4. Wiring diagram of radio-frequency test set.

which has been operating for some time, and a newer installation using central generation and local attenuation. The local generation system will be described first.

Alignment required outputs in the order of 10,000 to 100,000 microvolts from the attenuators for the preliminary stages of the process, as no



Top view of one section of the master generator.

steps were taken to pre-align the condensers. The passing mark was less than 100 microvolts, and therefore, satisfactory attenuation over a 1,000 to 1 range was required. It was desired to align and test at five frequencies—these were 553 kc., 711 kc., 948 kc., 1,264 kc., and 1501 kc. They are harmonics of 79 kc., so that a single 79 kc. crystal may be used for frequency standardization.

Referring to Fig. 4, the signal generators used, consist of an r-f. oscillator, with the voltage for the attenuator tapped off a few turns from the low potential end of the grid coil. A tap switch connects any one of five semi-fixed condensers across the inductance for tuning purposes. In series or in parallel with the tuning condensers, are variable resistors used to adjust the oscillation amplitude, so that the attenuator output is held constant for each of the five frequencies. The general construction is quite similar to a laboratory generator.

The attenuator is a ladder type structure with multiplying ratios of 1, 10, 100 and 1,000, and a tapped slide wire which gives 100 microvolts in 10 microvolt steps. The resistor units are very small and wound on thin mica cards, reducing the inductance error to a minimum, and the entire attenuator is shielded from the oscillator to prevent direct pickup in the leads. A dummy antenna of standard constants is connected in series with the high terminal of the attenuator output.

A grid current meter is used to indicate the oscillation amplitude. The oscillator grid current is approximately proportional to the oscillation current at any frequency, so five different settings are required for the five frequencies. A standard set calibrated against a master generator is used to check the output of the attenuator. In this manner, the output of all generators may be kept the same.

A 400-cycle audio oscillator supplies the modulation voltage which is applied in series with the r-f. oscillator plate voltage. Since the oscillator plate current is changing from zero to twice the average value, the peak voltage required for 30% modulation will be approximately 30% of the d-c. plate voltage. This has been checked with a peak voltmeter and found to be close enough for practical work.

The attenuator is separately shielded, and the attenuator and radio-frequency oscillator are enclosed in another shield. The entire assembly is mounted in a wooden cabinet lined with copper which makes contact with the metal front panel, forming a complete shield around the whole unit. The 110 volt a-c. line contains a filter to keep the leakage from this source low.

Forty-five of these units have been operating successfully for seven months. The total time lost because of generator breakdown to date was only 300 man-hours, or 5% of total man-hours expended. This illustrates one of the great advantages of the system— a breakdown only involves one unit and the defective unit may be readily removed to the maintenance shop where repairing can be done with maximum speed and efficiency.

The system also possesses great flexibility, as the entire test department may be moved overnight to a new location, or slightly rearranged at any time to suit conditions.

Central Generation and Local Attenuation

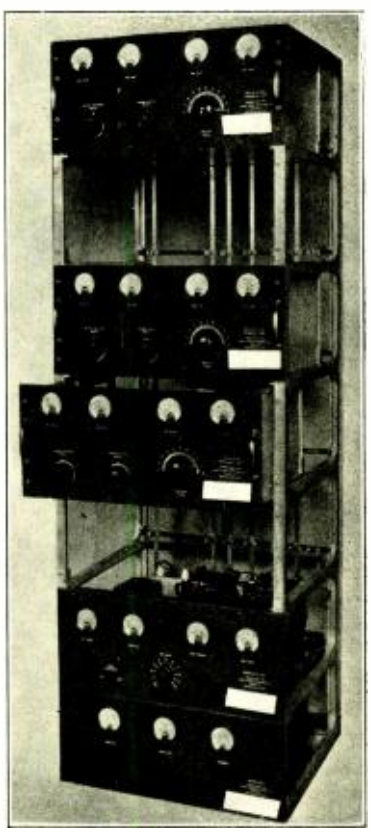
Central generation and local attenuation is the second system in use. Again the combination of test and alignment necessitated the choice of local attenuation. Referring again to Fig. 2, the attenuator at the generator is omitted and the lines are operated at a high level, eliminating the coupling tube. The five test frequencies were the same as those used in the local generator system. This system presents problems which are more interesting than the local generation system, especially the transmission lines used for conducting the five frequencies to the test positions.

The master generator logically comes first. In view of the future expansion in the number of test positions, a power output of about 10 watts was specified. UV-203A tubes were picked as being very rugged and reliable, but they necessitated the use of a high-voltage power supply. For standardization purposes, UV-203A tubes were used for both modulators and amplifiers.

The generator itself is built in six sections, five of which are detachable units built-in drawer form with plug-in connections at the rear. Referring to the circuit diagram, Fig. 5, each of the five units consists of a UX-210 crystal oscillator feeding a UV-203A amplifier. The amplifiers are fed with modulated plate voltage supplied from the sixth unit.

The crystal oscillator has two crystal holders in a constant temperature compartment, with a switch to connect either in the circuit, thus insuring continuous operation. A coupling coil of the required number of turns is located at the ground potential region of the plate coil, and the output is taken from this coil, using a balanced-to-ground circuit. The five frequency units are practically identical except for differences in circuit constants. The output may be controlled by slightly detuning either the crystal oscillator plate circuit, or the amplifier plate circuit. The current flowing in these circuits as well as the plate current of each tube is indicated by meters on each unit panel.

The bank of modulator tubes is located in the power supply section. Four UV-203A tubes function to modulate the five r-f. amplifiers, and by proper adjustments, the percentage



Master oscillator with two of the drawers removed.

of modulation is maintained approximately equal for all the frequencies. The modulator grids are fed from a step-up transformer working from a 200-ohm primary. A 400-ohm potentiometer serves to control the input to the primary. Grid and plate meters for the modulators, as well as a current transformer and thermal meter for reading directly the a-c. component of the plate current supplied to the amplifiers, are mounted on the power supply panel. The thermal meter is used to set the modulation to the correct value as determined by measurement of the modulation percentage with a peak voltmeter.

The complete generator has a double set of shielding, but due to ventilating requirements and physical limitations, the shields are not depended upon as electrical shielding. The entire generator is enclosed in a double wall copper screen booth about eight feet square. A transformer provided with an electrostatic shield between the windings, keeps the radio frequency from leaking out through the power line. The booth is provided with the usual "ice chest doors" used on measurement booths, and is practically leak-proof. A ventilating fan outside the booth draws the hot air out through a large pipe fitted with four screens, as the booth screening offers too much resistance to the passage of air.

At the rear of the master oscillator are located copper terminal boxes for the transmission lines. Each box contains an "H"-type attenuation pad with a ground at the center of the shunt arm. The arms of the side nearest the generator are made variable to control the output over small ranges. A short cable leads from each terminal box and connects with the proper frequency unit. There is no connection between the generator frame and the transmission line shielding or the booth walls, as this was found to increase the leakage.

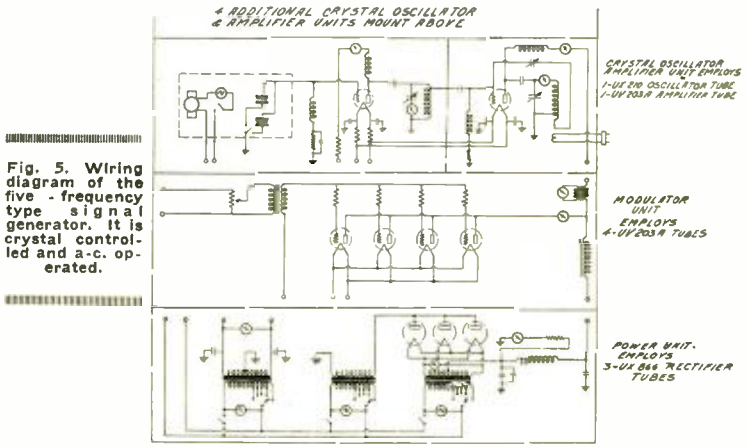


Fig. 5. Wiring diagram of the five - frequency type signal generator. It is crystal controlled and a-c. operated.

At the junction of the transmission line proper, with the "H" pad are pin-jack terminals for measuring the line potential. A suitable thermocouple and balanced multiplier resistances are bridged across the line, and the d-c. voltage of the couple taken off through chokes to a microammeter on the control panel. The two arms of the pad are controlled simultaneously to preserve the balance to ground by means of an insulated shaft. This control is adjusted until the reading of the microammeter indicates that the required voltage exists across the line.

The Transmission Lines

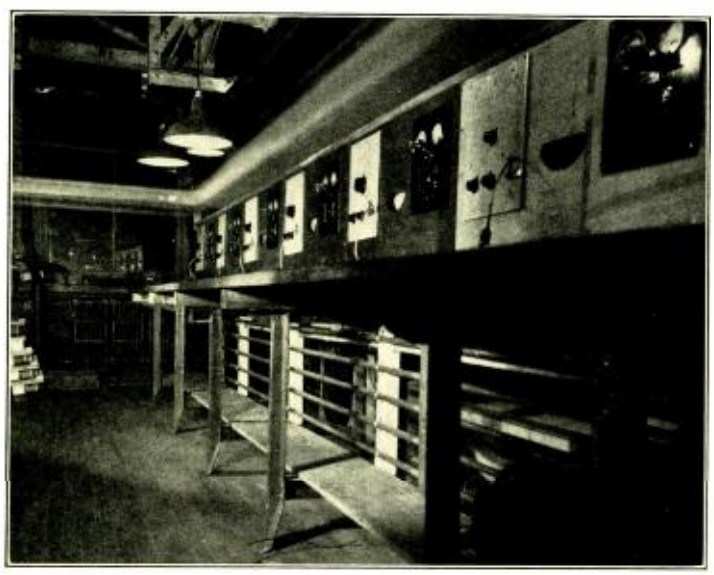
The transmission lines are perhaps the most unusual part of the system. A total of sixty attenuators, each of ninety ohms impedance, was indicated as the probable maximum load. Since a balanced-to-ground system was to be employed, this is equivalent to thirty loads of 180 ohms each, as one side of each attenuator is grounded and the other terminal connected to one side of the transmission lines. This is equivalent to a 6-ohm load on the main feeder line.

By referring to Fig. 6, the general location of the lines may be seen. The chief problems involved were the design of the main feeders to transmit, with small attenuation, a distance of about thiry feet at an impedance of 6 ohms, and the design of branch feeders in which the voltage change along the lines was small enough to be compensated for by the attenuator adjustments. The radiation and stray leakage from the transmission lines had to be below the level of normal interference in order not to interfere with the testing operations. In addition, the system had to be designed so that operation of one attenuator did not affect the operation of any other unit.

The radiation problem was to be disposed of, at least theoretically, by using the balanced-to-ground system, thus eliminating ground current, and shielding the line in a copper pipe which was used as the ground. The conductors were to be placed very close together, or twisted so that their combined field at points distant from the system would theoretically be zero.

At first, the use of twisted pair was tried, both plain and loaded with shunt capacity, but the loop inductance was found to be too high to even approach the 6-ohm impedance required, and the radio-frequency resistance was found to be excessive. Twisted pair has a characteristic impedance of about 130 ohms and loading with shunt condenser appears to be impractical. The loop inductance is about half a microhenry per foot, which would require a tremendous shunt capacity and loading at about two-foot intervals to obtain the required impedance.

It was recognized at once that some totally different type of construction



Showing the location of the transmission lines underneath one of the production test benches.

was necessary, not only to reduce the resistance, but to lower the characteristic impedance as well. Considering the approximate expression for the characteristic impedance of a line

$$Z_K = \sqrt{\frac{L}{C}}$$

it can be seen at once that the inductance must be reduced and the capacity increased to lower the line impedance. Obviously, the logical method of decreasing the loop inductance is to place the conductors in closer juxtaposition. This simultaneously increases the capacity and further decreases the impedance.

At this point, the use of two flat strip conductors giving a continuous loading suggested itself and a sample line was constructed, using six-thousandths paper as dielectric and half-

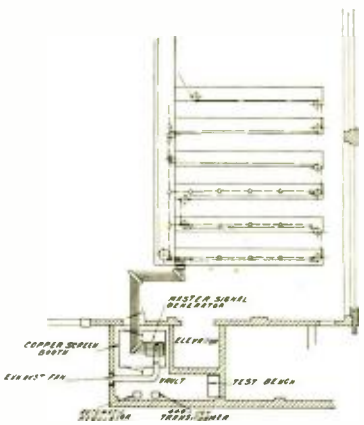


Fig. 6. General plan of the receiver testing department.

inch by twenty thousandths strips as conductors. The whole assembly was securely taped together. A preliminary series of measurements at 1264 kc. showed promise; the impedance having been reduced to about 9 ohms.

The inductance was, of course, too small to be measured with any of the usual laboratory equipment and the capacity was approximately 660 micro-microfarads per foot. The impedance was determined by working the line into various resistances, and noting the ratio of input to output voltages. For loads of less resistance than the line impedance, the output voltage is the lower; for loads of a higher value than the line impedance, the voltage is highest at the load, due to standing waves. The load resistance giving unity ratio is then approximately equal to the line impedance.

Paper obviously being an unsuitable material and the use of mica tape considered undesirable because of the necessity of "fishing" the finished line through the shielding pipes, varnished cambric was tried as an insulating medium. Measurements were made to determine the approximate magnitude of the dielectric loss to be excepted. A ten-foot section of line was included in a tuned circuit of known resistance, and the added resistance determined by the resistance variation method. The added resistance was 4.6 ohms; the series resistance of this line was negligible (calculation have placed it as about 0.01 ohm for the whole ten-foot length.) This is equivalent to a shunt resistance of approximately 4,750 ohms per foot, and at a one-volt line level with 400 feet of line in use, would give less than 0.1 watt power loss for the whole system.

Mathematical Treatment

The placing of the two conductors with the current sheets parallel is known to give a very favorable ratio of high-frequency to direct-current resistance. The ratio calculated for this particular line at 1,500 kc. was 1.72 which gives a radio-frequency resistance of 0.00223 ohm per foot.

The loop inductance of two parallel strips is given by the formula

$$L = 0.004\ D \left[\frac{d^2}{b^2} \log d + 1/2\left(1 - \frac{d^2}{b^2}\right) \log (b^2 + d^2) + 2\,\frac{d}{b}\,\tan^{-1}\frac{b}{d} - \log b\right]$$

microhenrys

where D = length of one strip in centimeters;
b = width of one strip is centimeters;
d = distance between strips in centimeters.

By tabulating the values of the various terms for the range of ratios of $\frac{d}{b}$ which are of interest, it can easily be seen that the first term becomes very small and negative in sign; and between $\frac{d}{b}$ ratios of 0.05 to 0.01, becomes only about 2% of the third term. The second term in this range differs from the last term (log b) by less than one per cent. Therefore, we may write approximately

$$L = 0.004\ D \left[2\,\frac{d}{b}\,\tan^{-1}\frac{b}{d}\right] \times 0.98 \text{ microhenrys}$$

but the value of $\tan^{-1}\frac{b}{d}$ approaches the value 1.57 radians very slowly as the value of the tangent approaches infinity, so we may write for ratios of $\frac{d}{b}$ less than 0.05.

$$L = 0.0123\ D_{cm} \times \frac{d}{b} \text{ microhenrys}$$

The inductance, therefore, is approximately proportional to the distance between strips.

For the capacity between strips, we may write approximately, neglecting edge effect,

$$C = \frac{K \times S}{4\pi d} \quad \frac{10^{-5}}{9} \text{ microfarads}$$

where S = the area of one side of one strip in square centimeters;
d = the distance between strips in centimeters;
K = dielectric constant of insulating strip;
let b = width of one strip in centimeters;
D = length of one strip in centimeters.

Then

$$C = \frac{K \times b \times D}{36\pi d} \times 10^{-5} \text{ microfarads.}$$

Substituting these values of L and C in the approximate formula for the line impedance

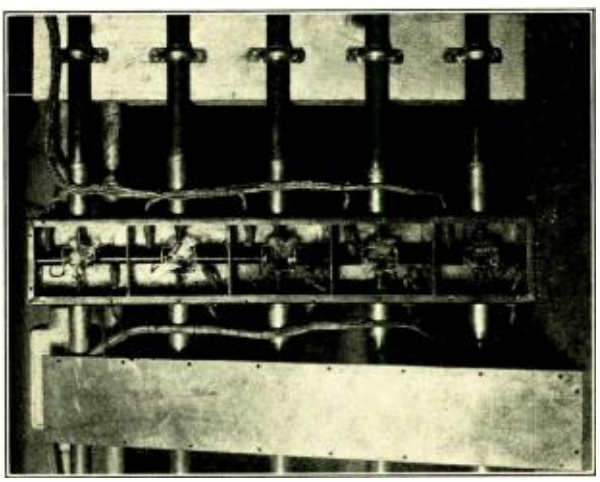
$$Z_K = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.0123\ D \times d}{\frac{K \times b \times D \times b}{36\pi d}}} \times 10^{-5}$$

And

$$Z_K = \frac{d}{b}\sqrt{\frac{1.4 \times 10^5}{K}}$$

The impedance also is thus seen to be an approximately linear function of the spacing of the strips for ratios of $\frac{d}{b}$ less than 0.05.

Applying these formulas to an actual line where b was ½-inch and d was ten-thousandths varnished cambric with a dielectric constant of about 3.4 at high frequencies, the inductance



View of the coupling arrangement for the transmission lines.

was found to be 0.0075 microhenrys per foot, the capacity 0.000456 microfarads per foot, and the approximate impedance 4.1 ohms.

Using the more accurate formula, taking into account the series resistance and shunt conductance, we have

$$Z_K = \sqrt{\frac{R + j\omega L}{G + j\omega L}}$$

where R = 0.00223 ohm per foot;
G = 0.00021 ohm per foot.
gives an impedance of 5.32 ohms. The actual impedance of the line is even higher than this figure in practice because it is impossible to bind the two strips tightly enough together to approximate the thickness of the varnished cambric dielectric.

The propagation constant is

$$P = \sqrt{(R + j\omega L)(G + J\omega C)}$$

$$P = \sqrt{.000123 \angle 178° 45'}$$

$$P = .01109 \angle 89° 22'$$

$$P = A + jB = 0.0001208 + j0.01108$$

The attenuation constant is

A = 0.0001288 napiers per foot.
= 0.001119 db. per foot.
Or approximately 6 db. mile.

A line of this character thus fulfills the requirement of efficient transmission, and since the current sheets are so close together, the radiation is a minimum.

Voltage Distribution

The second requirement of equality of voltage at the various points of attachment of the attenuators would require a line with different impedance for each section between loads to approximate the condition. For constructional reasons, this was ruled out, and all sections of the line were constructed with the same spacing after a preliminary test at 1264 kc. had shown that distributed loads, on an open circuited 6-ohm line 37 feet long (approximately the length of each branch feeder) gave a voltage rise of only about 30%, which could readily be compensated by the attenuator adjustments. By shunting about 10 ohms across the open end, a very uniform voltage distribution can be obtained.

The actual voltage distribution on one of the branch feeders with the attenuators connected, is tabulated below in terms of percentage of the initial voltage.

	Length from Origin				
	0	73"	146"	219"	292"
Frequency	*Percent of Initial Voltage*				
553 kc..	100	100.4	101.8	102.6	102.9
711 kc..	100	100.8	103.3	104.2	104.5
948 kc..	100	105.3	110.5	113.0	114.0
1264 kc..	100	113.8	122.4	128.6	129.3
1501 kc..	100	115.8	129.0	136.8	138.4

It will be noticed that at the higher frequencies, a voltage rise is occuring. This is due to the fact that the branch line is not properly terminated, and a standing wave exists.

The lines are thus seen to fulfill the requirements, and at the same time, keep within the practical limits of construction.

The one-half inch lines with varnished cambric tape insulation were placed inside of ¾" round copper pipes. The line then took a position approximately on a diameter of the pipe so that the capacity to ground was small. The pipes were connected by suitable junction boxes as it was difficult and undesirable to "fish" the strips around corners. The entire piping system was securely bonded together by making the junction boxes common to the five frequencies, and using internal partitions to divide the boxes into five compartments. All pipes were "sweated" into the boxes and the covers securely screwed in place so that a completely shielded system was obtained.

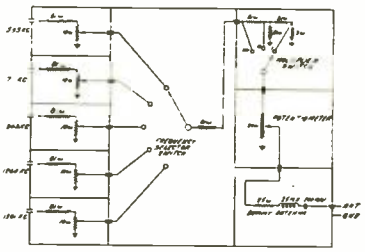


Fig. 7. Radio-frequency attenuator and dummy antenna.

The attenuators are connected in pairs across the line with the junction grounded. Five shielded leads are brought from each junction box to a connection box at the rear of each attenuator, which contain terminals for the attachment of the attenuator leads. This construction permits rapid replacement of the attenuator unit should it become defective. The connecting leads have a characteristic impedance of about 100 ohms so that the attenuator impedance of 90 ohms is a good match.

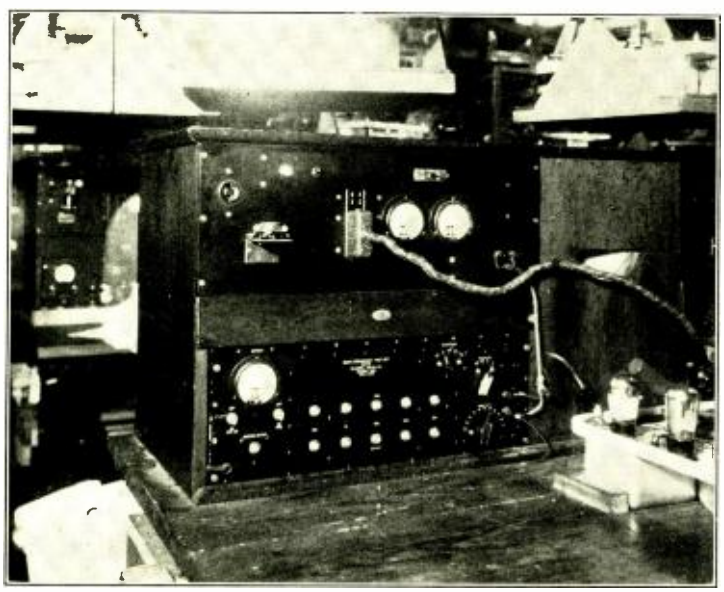
The Attenuator Unit

The attenuator unit consists of an aluminum casting divided internally into nine compartments. Five of these compartments contain the input sections of the attenuator for the five test frequencies. Referring to the circuit diagram of Fig. 7, these sections consist of 81-ohm resistors in series with 10-ohm potentiometers. The sliding arms of the potentiometers connect to the taps of a frequency-selector switch in a sixth compartment. The potentiometers are adjusted with a screw driver through holes at the rear of the attenuator to give the desired input to the selector switch contacts. The holes are covered by sliding tabs to keep the shielding as complete as possible.

The contact arm of the frequency-selector switch is joined through an 81-ohm resistor to the final attenuation network. The sections just described serve as "buffer" sections to reduce the effect on the line voltage of placing the multiplier switch on the 100 times tap.

The multiplier is located in the seventh compartment, and consists of a network of an 81-ohm and a 10-ohm resistor to give the 10 times tap, and another network of 81-ohm and 9-ohm resistor to give the unity tap. The contact arm of the multiplier switch connects to one side of a 20-ohm potentiometer mounted in the eighth compartment, which is used as the final slide wire, giving a fine adjustment.

In the ninth compartment, the dummy antenna is located. A double shielded panel is used with guide bushings for the control shafts. All control shafts are broken by insulated couplings, eliminating any tendency for the controls to become "hot." Due



A close-up view of the five-frequency, crystal controlled, signal generator.

to the complete shielding, leakage from the attenuator is extremely small. The switches have "ball clicks" as well as marks engraved on the front panel, as this has been found to speed up the testing operation. A celluloid dial is used for the potentiometer, and the necessary passing marks are made with ink, allowing a change, if necessary, at a later period.

Test Connections

Since the receiver to be tested with both the foregoing systems was one distinct unit, and the power pack and audio amplifier another; one power pack was installed permanently at each test position, and the receiver plugged into a connecting female plug on the testing panel. This panel also contains a detector plate-current meter, and the direct-current milliammeter measuring the current from a contact rectifier used as an output level indicator. A switch is available for connecting either the speaker or output voltmeter and dummy load in circuit. A UY-227 socket is mounted on the panel and connected to the amplifier which operates continuously. This device keeps the heater of the detector tube hot and avoids delay.

The line voltage for the entire testing system is maintained constant with an automatic induction regulator, and very little trouble is experienced from this source, as all loads are continuously in circuit. Any change in the primary current due to removing a radio set from the power pack circuit is quite small.

Tubes are the chief variable element remaining. All tubes are checked at least twice daily, and in addition, compensation for tubes below the average is made by changing the passing mark slightly. The spot check on sensitivity is constantly maintained in the test cage, and the Engineering Laboratory tests a number of samples daily, so that a close control of the product is possible.

At present, twenty positions are in service and the system is operating very satisfactorily. The leakage is of the same order of magnitude as that from a laboratory signal generator, and the testing operation has been speeded up slightly. The great advantage of frequency stability and the smaller number of checks required on the test position are noteworthy features of the system.

References

K. S. Johnson — *Transmission Circuits for Telephonic Communication.* Chapter XII (New York,— 1927).

Bureau of Standards — *Circular No.* 74 (2nd edition) page 302 (March, 1924).

Rosa & Grover — *Bureau of Standards Scientific Paper No.* 169 (3rd edition) page 156 (December, 1916).

GLYPTAL LACQUERS

*By Lawrence E. Barringer**

NOT long ago, phthalic anhydride was a chemical rarity, produced from naphthalene, and quoted at five dollars a pound. Today it is an important heavy organic chemical used in the manufacture of dyestuffs and selling at less than 20 cents a pound. This chemical has been combined with glycerine, a by-product of the soap industry, to produce a synthetic resin. Although compounds of glycerine and resin-forming acids had been studied by chemists during the latter half of the nineteenth century, no commercially useful compounds of this class had been made before the General Electric research laboratories developed alkyd resins. Various phthalic anhydride or alkyd resins are now being manufactured under the trade name "Glyptal."

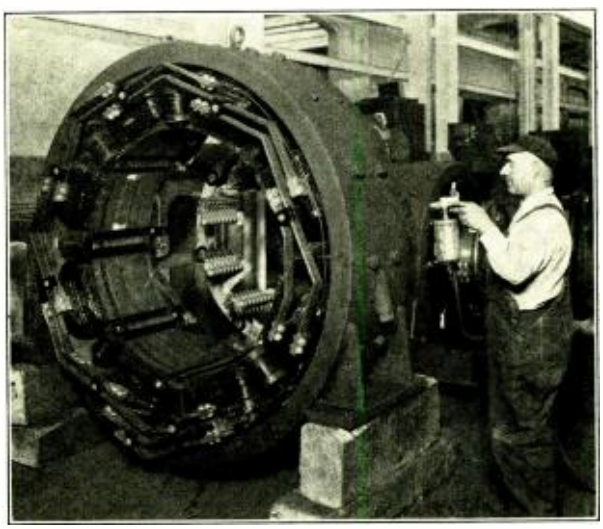
Glyptal in modified forms is finding many uses.[1] In its flexible form its most important function is as the base of finishing and protecting materials such as paints, varnishes, lacquers, etc.

A detailed description of the study and tests which ultimately led to the development of Glyptal lacquers will not be attempted at this time. Consideration will be given only to the qualities which intensive research proved to be inherent in these remarkable coverings.

Glyptal lacquers are resistant to all mineral oils, and, when baked, to their fractions—gasoline, kerosene, etc. They also resist weak acids and alkalies. They withstand temperatures in excess of 600 deg. F. and have a higher dielectric strength than many commonly used paints.

They are superior as finishing coatings for any surface; and are particularly suitable for covering surfaces that are ordinarily difficult to coat, such as aluminum and galvanized iron, because tenacious adhesion is one of their outstanding properties. The finish which they produce is smooth, easily cleaned, and durable because it is usually resistant to abrasion.

Up to the present time they have been produced in the following colors: aluminum, blue, brown, green, gray, black, and red.



Factory application of Glyptal Lacquer on the frame of a d-c machine.

Methods of Application

All the Glyptal lacquers have basically the same general characteristics and may be applied by spraying, brushing, or dipping. They air-dry, dust-free in 30 min., may be handled in 2 hr., and set hard in 8 to 10 hr. The drying time is greatly accelerated by heat. Baking improves the coatings and somewhat prolongs their good qualities where this treatment is convenient.

The aluminum Glyptal lacquer is particularly resistant to heat. In fact, tests show that temperatures as high as 600 deg. F. produce practically no discoloration in the finish, for which reason it will prove unusually serviceable as a coating for metal parts that are exposed to high temperatures.

In the electrical field of applications, the red lacquer finds effective use in connection with the manufacture and maintenance of both direct-current and alternating-current apparatus and also of storage-battery equipment.

The blue, brown, green, gray, and black Glyptal lacquers are intended primarily for finishing purposes, although they may also be used for many of the same applications for which the red lacquer is most suitable. As coatings for manufactured articles, especially those of metal, experience has shown that they afford worthwhile economies.

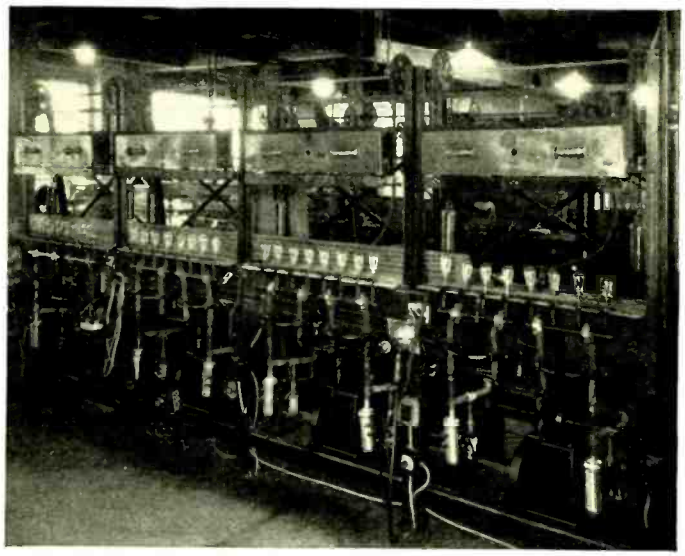
* *Engineer of Insulations, General Electric Co.*

[1] *A number of these uses, particularly that as a cement in built-up mica insulation, were described in the articles, "A Revolutionary Development in Mica Insulation," by L. E. Barringer, Nov., 1926, p. 757, and "Glyptal Mica Moves Ahead—Now the Flexible Form," Oct., 1929, p. 530, both in the* GENERAL ELECTRIC REVIEW.

HIGH VACUUM

The Problems Attached to the Production and Maintenance of High Vacuum in Radio Tubes

*By H. V. Cadwell**



Four hand stations shown in operation in the plant of the Gold Seal Manufacturing Co. This also shows the arrangement and connection of vacuum pumps employed.

AS IN the case of many laboratory developments that have become commercial articles, the radio tube is accepted by the purchaser as a commonplace portion of his set that causes it to function, never realizing the immense amount of research, study and effort that was put forth in its development. The radio tube is truly a remarkable device, since its function is to utilize and control extremely small entities. These entities are known to the physicist as electrons. They are smaller than the smallest subdivision of an element, which still retains the characteristics of the element and is known as a molecule. They are smaller than the component parts of a molecule, known as an atom. They are the satellites that rotate about the nucleus of the atom.

The atom can be aptly described as being a very minute solar system with the nucleus or center consisting of a unit charge of positive electricity. This minute positive charge can be compared with the sun in our solar system. About this nucleus of positive electricity groups of negative electrons circulate in a manner similar to the planets of the solar system. When the atom is in the neutral or normal condition there are just enough negative electrons to equal and neutralize the positive charge of the nucleus.

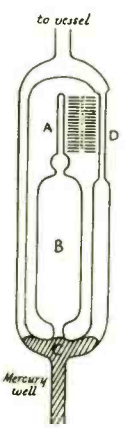


Fig. 2. Details of the McLeod gauge, described in the text.

Mass of a Free Negative Electron

To further emphasize the small magnitudes associated with the negative and positive electrons, some of the calculated values can be given. Thompson gives the mass of the free negative electron as 9.01×10^{-28} grams, or decimal 27 ciphers 9 grams. This value is 1/1845th of the mass of a single hydrogen atom. The positive nucleus is exceedingly small with a radius of but 1/2000th of that of a free negative electron. Yet it is upon these small bodies that the radio tube depends for its proper performance. It is certainly an achievement to produce radio tubes in mass production with the degree of precision that is required and still sell them at the current prices.

In a metallic conductor there are free electrons unattached to atoms and their motions, which take place in all directions, determine by their kinetic energy the temperature of the conductor. If the temperature of the conductor is raised sufficiently, the electrons acquire such velocities that some are projected beyond the attractive range of the positive charges remaining on the conductor and sail off into space. This escape of negative electrons increases rapidly with temperature and constitutes what is known as the "thermionic current" from the heated body.

In the exhausted radio tube the heated filament or cathode heater gives off the emission producing the thermionic current and the plate surrounding it receives a negative charge until a state of equilibrium is reached, where the negative charge of the plate is strong enough to repel the oncoming negative electrons, which accumulate about the source of emission to form a "space charge," which prevents further electronic emission at that temperature. The coated hot cathodes are a development of the art to provide electronic emission in quantity at a lower temperature than would be possible from the heated filament alone and as a result of the low temperature heating of the filament, longer life and as a more stable emission is imparted to the radio tube.

Thermionic Current

When the plate of the tube is made positive with respect to the filament by applying a potential difference to these two parts, electrons are urged from the filament to the plate and a continuous thermionic current flows within the tube. This thermionic current depends upon many factors, the most important from the standpoint of the tube manufacturer being (1) the nature of the surrounding gas, (2) the pressure of the gas, and (3) the gases occluded in parts of the tube. When the potential difference between filament and plate is large the kinetic energy of the negative electrons reaches such a value that the gaseous molecules remaining in the space are ionized from the impact of the electrons which collide with them. The ionized gas molecules are charged positively as the impact has destroyed the equilibrium of the neutral gas atom by jarring off one or more negative electrons which go to the plate increasing the thermionic current. The positively charged gas atom is attracted toward the filament by virtue of its unlike charge and there neutralizes the space charge of negative electrons, which also increases the thermionic current. When ionization has commenced great irregularities are introduced in the thermionic current.

The outstanding problem in the manufacture of radio tubes is, therefore, the elimination of gases, free and occluded in the glass walls and metal parts, which may be liberated during the life of the tube. To obtain a stable emission during a life of the tube of approximately 1000 hours, the pressure of the gas in the finished tube must be considerably less than .00001 millimeters of mercury pressure.

Gas Pressures

Gas pressures are customarily measured by the height of a column of mercury which they will support. The gas pressure at the surface is balanced by the mercury column above this surface and is equal to the prod-

* *Central Scientific Company.*

uct of height and density of the column. Standard atmospheric pressure is the pressure which will support a column of mercury 760 millimeters high at sea level at 0 degrees Centigrade. Since the density of mercury at 0°C. is 13.595 grams per cubic centimeter, one standard atmosphere is equal in pressure to 13.595x76, or 1033.2 grams per square centimeter. Applying to very low pressures the common units are millimeters of mercury or thousandths of a millimeter of mercury, which unit is called a micron. A millimeter of mercury pressure is 1/760th of an atmosphere and a micron of mercury pressure of 1/1000th of a millimeter of mercury pressure and is often written as 10^{-3} mm. An inch of mercury pressure is the same as 25.4 millimeters of mercury pressure. To measure such small pressures as one micron accurately, special gauges must be employed.

The gauge used as a fundamental instrument for measuring such small pressures as one micron is the McLeod gauge (see Fig 1). It should always be used for testing the efficiency of pumps and for any measurements involving standardization of assemblies or calibration of other measuring devices. The principle of operation of the McLeod gauge will be clear by reference to Fig. 2. The total volume of B and A represent a certain volume of the gas at the pressure to be measured. When mercury is forced up to the point C, this volume of gas remaining in bulb B is trapped and is compressed into the smaller volume of the capillary tube A. The ratio of these two volumes determines the ratio in which the actual pressure is magnified for measurement. This magnification is from 500 to 50,000 times depending upon the proportions of the instrument. The pressure on the balancing mercury column D is so small that it can be considered zero. By adjusting the level in D to zero on the scale, the difference in level between A and D represents the pressure in the vessel being measured, multiplied by the magnification factor or volume ratio. A direct reading scale in microns absolute mercury pressure can thus be computed and fitted to the instrument. The McLeod gauge requires the same attention to the elimination of adsorbed gas and moisture as other parts of a vacuum system.

Vacuum System

The vacuum system employed in the manufacture of radio tubes was originally very simple, consisting of the exhausting pumps and manifold to which the tubes were attached. With the proper selection of materials and correct dimensions for the manifold and the employment of the most efficient vacuum pumps, the manufacturer was bound to produce a high-vacuum radio tube, if he followed standard practice of high-vacuum technique, which required adequate time for pumping, application of sufficient heat to the walls of the tube and electrodes to drive off occluded gases, and finishing his work with an efficient chemical cleanup or getter. This method of manufacture is sure but slow, as it is an intermittent process.

Mass production is based upon a continuous flow of the product from receiving room to shipping room and continuous exhausting is one step in such a scheme in radio tube production. The unfortunate situation existed at the time the radio tube demand overwhelmed the manufacturers with the advent of regular broadcast programs. that all the automatic or continuous exhausting machines available were designed for the incandescent lamp industry. Since the incandescent lamp, especially the gas-filled lamp. does not require the high degree of exhaustion that is necessary in the radio tube, many of the rules of high vacuum practice were violated to obtain convenience or economy in the design of the automatic exhaust machines for incandescent lamps. However, since these automatic machines were all that were available and the demand for radio tubes had to be met, these machines were modified in each tube plant as well as time would permit to enable them to make radio tubes continuously. Undoubtedly, an automatic exhaust machine will eventually be built, based upon sound principles of high-vacuum technique, which will enable the manufacturer to produce quantities of tubes continuously in the minimum time per tube with small losses due to imperfect vacuum. Until that time arrives the best that can be done is to modify the existing automatic exhausting machines to conform as closely as possible to approved high-vacuum technique.

Fig. 1. Illustration of a typical McLeod gauge.

Design Modifications

These modifications should first take into consideration the proper materials for constructing the connecting vacuum lines. Such materials should be chosen with careful regard to their characteristics for absorbing and holding gases which are later released as the vacuum increases in the line. An all-glass or metal vacuum line, being simpler is preferable to one made up of several different materials. Where glass is used a hard glass should be selected in preference to a soft glass as the softer glasses have the property of adsorbing and absorbing greater quantities of gas and moisture. If metal tubing is used to construct the vacuum line, it should be thoroughly cleaned and subjected to an extended heating in hydrogen to eliminate the absorbed gases. Metal tubes are also likely to be porous, especially at bends. Such tubes should, therefore, be coated with some material that will seal them against leakage through their walls. A thick coat of baked Japan is suitable. Rubber tubing connections invariably cause some leakage into the system, but it is impossible to entirely avoid them. In making rubber tubing connections other than at the ports themselves, the two ends of the glass or metal tubes must be brought together. The rubber tubing must be excellent quality with high pure gum content. It should have as thick a wall as can be mechanically accommodated, should fit snugly and extend several inches each way from the joint. The finished rubber connection should then be painted with a good grade of heavy-bodied mineral oil.

Any part of the vacuum line or system on being exposed to the atmosphere acquires a surface film of gas and vapor very quickly. It is important, therefore, to keep the line always protected from the atmosphere after it has once been conditioned. When initially set up the entire vacuum system should be well flamed and pumped out for a considerable period of time before being put in operation. The combined factors of moisture, absorbed gases, traces of grease, etc., necessitate a certain aging process of any new system before good results can be expected. Each system should, therefore, be so designed as to protect itself after it has once been thoroughly

outgassed. For this purpose some provision must be made for closing off the vacuum system just below each outlet or port when the ports are unoccupied. These points should be kept closed even when the system is not under exhaustion. While these factors influence the time required for exhaustion of the product there are other factors of equal or greater importance.

Rate of Pressure Reduction

Rate of pressure reduction is determined by the pressure difference which can be maintained between the pump and the product being exhausted. This depends on: (1) the speed of the pump; (2) rate of leakage into the exhausting system through connections, etc.; (3) rate of evolution of gas from the glass walls and metal parts of the article under exhaustion; and (4) the form of the system with particular reference to the diameter and length of all connecting tubes.

Particularly in the last stages of pumping the length and bore of communicating tubes become of great importance. In a simple system consisting of bulb, connecting tube and pump, rate of removal of gas from the bulb through the pump is approximately in inverse proportion to the length of the connecting tube and directly proportional to the cube of the diameter of the connecting tube. For example, if the length of the connecting tube is reduced to half and the diameter held the same, the rate of exhaustion is doubled and the gas is removed in half the time originally required. Also if the diameter of the

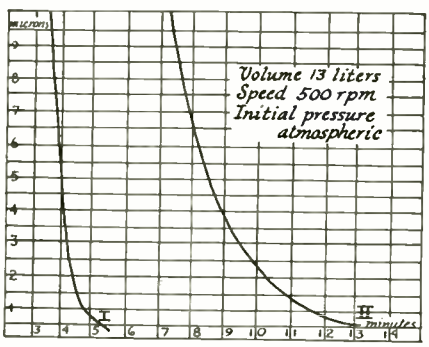


Fig. 3. Curves showing magnitude of pressure lag with two different diameters of connecting tubing.

connecting tube is doubled and the length is held the same the rate of exhaustion is eight times as fast and the gas is removed in one-eighth of the original time required. From this rule it is obvious that all connections must be kept as large in diameter as possible. To fully realize the advantages of a high-speed pump a diameter of ¾-inch is regarded as a practical minimum for the connecting tubing.

Not only does a small connecting tube reduce the speed of exhaustion but it may actually be the factor which determines the final pressure in the bulb at a value higher than the pressure attained by the pump. At any point in the process of pumping there exists an equilibrium between rate of removal of the gas from the bulb and the combined rate of leakage into the connecting tubing and evolution of gases from the walls and metal parts of the bulb being exhausted. A restricted connecting tube thus greatly delays pressure equalization between the article being exhausted and the pump and so prevents exhaustion to the limiting pressure of the pump in any reasonable length of time. The stem of the tube is the "bottle neck" which sets a limit to the minimum time in which a tube can be exhausted to any desired low pressure. This is true regardless of the vacuum maintained by the pump and would still be true if that vacuum were perfect.

A numerical estimate of the actual magnitude of this pressure lag which can be created by small diameter connecting tubing is readily obtained by reference to Fig. 3. These two curves represent identical conditions with the single exception of the diameter of the connecting tubing. A system consisting of a McLeod gauge and a 13-liter glass vessel were in each case connected directly with the pump by a glass tube 20 cm. (8") long. Curve No. 1 was obtained using a connecting tube 15.4 mm. inside diameter and Curve No. 2 with a connecting tube 7 mm. inside diameter. The pump speed was 500 r.p.m. and exhaustion started at atmospheric pressure. The horizontal scale reads in minutes required to reach the pressures indicated on the vertical scale which is in microns or one-thousandths of a millimeter absolute mercury pressure.

Removal of Free Gas

The removal of the free gas within a tube is not the most important operation in producing an extremely high and permanent vacuum, as efficient pumping equipment will do this quickly, provided the connecting tubes are of proper materials and of suitable dimensions. It is of much greater importance to remove the gases absorbed in and adsorbed on the glass and metal parts of the tube. To remove such closely held gases so as to prevent their diffusion into the evacuated tube after it has been put into use requires the employment of a series of operations that will facilitate the release of these gases during the pumping operation. A preliminary step of heating the metal parts in a vacuum or hydrogen furnace before they are assembled assists in reducing the quantity of gases held by these parts, but a certain amount of gases are readsorbed before the tube finally reaches the exhaust operation.

The application of adequate heat to the tube for a sufficient period of the total exhaust time will release a considerable portion of the adsorbed and absorbed gases from the tube parts. This is accomplished through the use of a gas oven, which should be capable of heating the tubes to a temperature only slightly below their collapsing temperature under atmospheric pressure. This temperature is somewhere between 400 degrees and 500 degrees C. for the usual glasses employed in the manufacture of the radio tube shells. When the tube has reached a temperature of between 200 and 300 degrees C. there will be a rapid evolution of the adsorbed moisture and gases and later as the tube is heated to the maximum temperature given above there is an increasing evolution of the absorbed gases from the tube parts, which will continue for as long as a half an hour. For this reason it has been suggested that a considerable quantity of the absorbed gases may be removed from the glass parts, principally the shells of the tubes, by giving them a preliminary baking of about an hour in a vacuum furnace operated at a temperature near their softening point before they are sealed to the press or stem parts.

As the vacuum increases in the tube under exhaustion the metal parts are more or less insulated from the external heat being applied by the oven to the shell of the tubes. It is, therefore, necessary to heat these parts either through internal bombarding or by induction from a high-frequency induction coil placed over the tube. Either of these methods will heat the metal parts to redness, which will release the major portion of the gases they contain provided the pumping system is rapid enough to remove the gases before they can be reabsorbed by the metal when the source of heat is removed.

In specially designed systems, after long and arduous treatment of the materials in both the tube and vacuum system, it is possible to attain an ultimate vacuum in the vicinity of 10^{-9} (1/100,000,000) millimeters of mercury pressure, through the use of mercury vapor or molecular pumps backed by efficient preliminary pumps. This low pressure would be impossible to attain commercially, if other agents than pumps were not used, but fortunately chemical cleanups or getters can be relied upon to assist in reducing the pressure in the tube under manufacture to the ultimate desirable pressure of 10^{-5} mm. mercury pressure.

The getters also continue to function after the tube is sealed off and will absorb the residual gases that diffuse from the walls of the tube and metal parts provided the amount released is not too large. It is usual practice to age or season the tubes before the final testing which permits the getter to improve the tubes properly exhausted, but poorly exhausted tubes are beyond saving by the getter.

Types of Vacuum Pumps

There are two principal types of vacuum pumps which have practical

value in manufacturing processes at present; the oil sealed rotary pump and the mercury vapor pump. A third type holds promise of considerable value owing to its great capacity, high ultimate vacuum and the fact that it does not employ liquids with their attendant vapors in its operation. This is the molecular pump of which no commercially practical design is as yet available. Recent research on the designs of pumps based on the molecular principle indicates that the former undesirable features can be eliminated. When such a pump becomes available exhausting problems may be greatly simplified. Full discussions of the theory and various designs of these three types of pumps will be found in most of the tests on vacuum procedure.

In the past the mercury vapor pump was extensively used for lamp and tube exhaustion because: (1) theoretically it has no lower pressure limit, and (2) its speed of exhaustion is very high. Mercury vapor pumps require backing pumps in series to reduce their internal pressure and maintain it below a critical value. As backing or fore pumps rotary oil pumps are universal.

The advantage of the low pressure limit of mercury vapor pumps is of less importance than their high speed of exhaustion in manufacture. While they are capable under laboratory conditions of exhausting to pressures such as 10^{-7} mm., limited time for each operation, considerations of mechanical convenience, etc., prevent an attainment of anything like this vacuum in the factory. The later development of increased efficiency in rotary oil pumps assures pressures of from 1/10th to 10 microns directly without mercury vapor pumps, this figure varying greatly with the type and capacity of the oil pump. On the other hand, the mercury diffusion pump of simple type can, with proper backing, attain a speed of approximately 100 liters per minute. No single rotary oil pump is available which will give this speed independently in the desirable vicinity of 1 micron. In the design of oil pumps too great a displacement frequently limits the final vacuum and conversely, so that a truly high vacuum pump must be limited as to its rate of exhaustion. There is a growing tendency to eliminate mercury vapor pumps from both hand and machine stations by selecting rotary oil pumps giving the best final vacuum and connecting several of these in parallel when greater speed is necessary. Parallel connection of similar pumps gives a final vacuum equal to that of a single pump and multiplies the single pump speed by the number of pumps connected. This practice greatly simplifies an installation and reduces its operating cost.

"Roughing Pumps"

In automatic machines where rotary oil pumps are used almost exclusively, it is frequent practice to connect the first pumping stages of the present type of machine to "roughing pumps." The "roughing pump" has a large free air capacity, but gives only a pressure reduction in the vicinity of 10 to 50 microns. It is supposed that this arrangement shortens the total pumping time required for each tube. The effectiveness of this measure is questionable from several standpoints. In order that heating by baking and high-frequency induction may be most effective in eliminating gas it must be carried on at a pressure of only a few microns. The longer this period of heating at low pressure, the better is the final vacuum. It is probably better to apply the high vacuum to the early stages as well as the last, increasing the pumping speed on the first stages, if it proves necessary, by multiple parallel connection of high-vacuum pumps of the same type as are used on the last stages.

On hand stations also, several well-known manufacturers have already discarded mercury vapor pumps in favor of efficient oil pumps giving a vacuum of about 1/10th micron. They find that adequate baking and discharge action, properly timed bombardment, and a "getter" of good capacity, produce the hardest tubes possible when combined with pumping to a pressure of about 1 micron.

When such a plan is adopted it is necessary to select rotary oil pumps carefully. The limiting end pressure of the best rotary oil pump is about 1/10th micron. They should be selected to give this actual vacuum on the basis of direct McLeod guage measurement, and checked carefully during operation with the McLeod guage.

Speed of Oil Pump

There is an optimum speed of rotation for an oil pump above which it is impossible to assure the best vacuum. Final vacuum should be made the first consideration and the actual pumping capacity of each single unit of second importance. Pumps at present available producing pressures of 1/10th micron have as their practical limiting speed per unit about 50 to 60 liters per minute.

In general, backing one good compound oil pump by another is without material advantage, where such pumps produce 1/10th micron of pressure singly, and represents a waste of floor space and power. Nothing is gained either in better vacuum or greater capacity, except in the case of roughly constructed pumps subject to excessive leakage. Wherever the capacity of good oil pumps requires increasing, parallel connection should be employed. However, parallel connection of pumps will not materially shorten the time of attaining extremely low pressures unless due consideration is given to the other limiting factors tending to extend the time of pumping.

Limiting Factor

The limiting factor of the greatest importance is caused by small diameter connecting tubes in the vacuum system. It is, therefore, quite important that the diameters of all connecting tubes be increased when additional pumps are attached to the system.

A unit of three high-vacuum pumps especially designed for use with automatic exhaust machines.

CONDENSERS AND HEAT

TOO little thought is given to the matter of temperature in the handling of condensers, according to Harry W. Houck, Chief Engineer of the Dubilier Condenser Corporation. This authority on condensers warns us that condensers, when placed in radio power units, should not be exposed to high temperature due to the radiated heat of tubes or resistors in the immediate vicinity. The condensers should be protected from heat by partitions if possible, and the tubes and resistors should be provided with proper ventilation. At any rate, paper condensers should not be heated beyond 110 deg. F. The leakage mounts rapidly with increase in temperature, and the leakage, in turn, reduces the resistance and therefore passes more current through the condenser.

Tests recently conducted in the Dubilier research laboratories serve to throw considerable light on this matter of heat in the performance of condensers. In a direct comparison between condensers heated to normal room temperature, and condensers heated to 125 deg. F., over a period of eighteen hours so as to make certain that the condensers were heated throughout their mass and not just externally, the condensers heated to the higher temperature withstood a 20 per cent higher breakdown voltage. This might seem contrary to expectations and would indicate, on its face, that condensers were benefited by heating. However, such performance is no indication of life, and subsequent life tests have shown that a condenser heated above room temperature has its life shortened materially.

Public-Address and Centralized Radio Systems

III. Line Level and Mixer Circuits

By E. W. D'Arcy

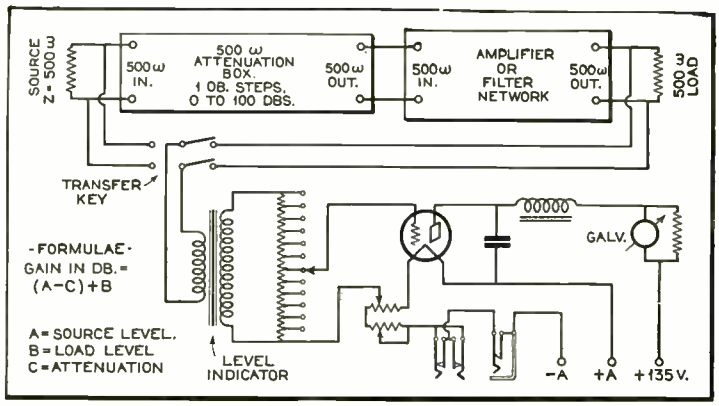


Fig. 10. Level indicator that can be used in measuring amplifier efficiency.

Level-Indicating Devices

THIS subject is possibly not very thoroughly understood by a majority of readers in this magazine so before proceeding with further articles on public-address equipment I thought it would be advisable to devote a certain limited amount of space to the discussion of accessory operating equipment used in broadcasting stations and practically every place where speech input equipment is used.

Maintaining Line Level in Broadcasting

Possibly the most widely-used field of level indicators is pertaining to maintaining a pre-determined line level in broadcasting stations. In broadcasting, as you probably are quite familiar with, the vast majority of programs are transmitted to the broadcasting transmitter itself via telephone lines. As it is impossible in the majority of instances to regulate the line level directly at the transmitter and very much preferable to have some means of regulation in the studio where the program originates, a level indicator is necessary. In other words, merely a peak voltmeter to determine that the peak of modulation efficiency shall not be exceeded.

It might possibly be of still further assistance in the understanding of the subject to realize that a pair of telephone wires will only carry a certain specified peak of voltage without induction troubles making themselves evident with associated lines in the same cable. Another additional requirement is that the line level itself being transmitted over wires must have a high enough value to make any associated line noise fall in the background and therefore not be objectionable from the entertainment point of view. The telephone company therefore has established two standards of measurement, one of them is based on what they call transmission level and the other is based on volume level. Both of these levels are in logarithmic proportion and the definition decibel is used to define relative values of loudness in proportion to their established zero level. As an example, zero level as defined by the telephone company, pertaining to their volume level, would consist of a current of 1 3/10 milliamperes flowing through a load of 500 ohms. This being their established zero level all other currents are arbitrarially defined as being so many decibels below or above this pre-determined zero level.

Constant Level in Recording

The same necessity for reliable means of maintaining constant level is found in recording for talking motion pictures. It can be quite readily understood that only a given amount of energy can be recorded on the record groove, due to the width of the groove and if this volume level is exceeded, over-cutting is the result. Further discussion of this particular phase will be taken later on as we are at the present time merely confining ourselves to the uses of level indicators themselves.

Line Equalizer Adjustment

In matching lines to obtain a flat frequency response curve it is found quite necessary to have some type of calibrated signal strength measuring device to check lines under equalization. All telephone lines used for transmitting speech frequencies require quite extensive equalizing networks to make up for the shunting effect of the capacity between conductors and this consequent attenuation of higher frequencies. It is customary practice, therefore, to make use of level-indicating devices at both the terminal point of the telephone line and its other end, thus enabling the establishment of standard line level at different frequencies. The one making the test and taking readings of the level indicator located at the sub-station under test can phone back his readings of line level for different frequencies and these can be plotted on graph-paper and pads designed to equalize this shunting effect.

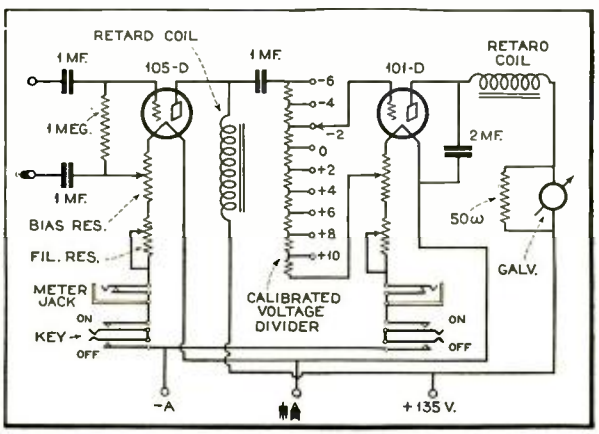


Fig. 11. Vacuum tube voltmeter suitable for measurement of audio voltages.

Amplifier Gain Measurement

Standard level indicators can also be used in measuring amplifier efficiency. The circuit for this is shown in Fig. 10. More detailed information on this subject will be included in the latter part of this series.

Design and Construction

There are several different types of level indicators used in broadcasting stations at the present time. The relative efficiency of any one type over another is more or less dependent upon the personal belief of the engineer who installs them. We will, therefore, confine ourselves to the description of three types in current use at the present time.

A primary requirement for any level indicator is that in itself it will consume as little current as possible and merely serve as an indicator of the peak voltage at any given instant. If close adherence is made to this basic principle accurate results can be obtained. However, operating expediency seems to demand some departure from this rule.

A circuit diagram of a level indicator which doesn't consume current is displayed in Fig. 11. This indicator has its maximum voltage limit, however, due to the over-loading of the first amplifier tube as the diagram shows. It merely constitutes a vacuum-tube voltmeter with one stage of impedance-coupled amplification preceding it and a calibrated potential divider which is used in the grid circuit of the vacuum-tube voltmeter to obtain arbitrary values of line level.

The input impedance of this particular level indicator can be practically ignored and its consumption of power is so small as to be inconsequent. However, it is dependent upon the characteristics of the first coupling tube for its accuracy and repeated calibration of this device is quite necessary for different tubes; therefore, its use is limited more or less to the laboratory.

Circuit diagram Fig. 12 shows a type of level indicator produced by the Western Electric Company for use with their equipment and, as can be seen from the diagram, merely constitutes a vacuum-tube voltmeter, a potentiometer and a tapped input transformer. This device is designed to operate on 500-ohm telephone circuits and when used in this manner is very practical. Possibly the only difficulty to be encountered with in this tapped type input transformer level indicator is that the input impedance varies slightly with positions on the transformer taps due to the shunting effect of the potential divider. However, the resistance of the divider is made high enough so this in itself falls out of our consideration. Very little further explanation is required on this device.

Fig. 13. Panel view of a typical level indicator.

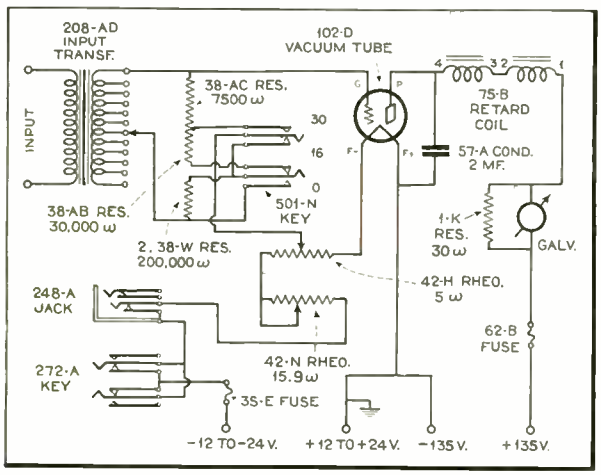


Fig. 12. Circuit diagram of the Western Electric Co. level indicator.

Fig. 13 shows another type level indicator panel. The circuit diagram for this type is shown in Fig. 14. The same method of obtaining grid bias is used as with the level indicator previously described, the basic difference being that the input impedance is kept constant for any given setting of the level indicator potentiometer. This system, therefore, in the author's opinion, has a certain amount of superiority over the type previously described.

Program Mixer Circuits

One of the most vital parts of any speech input amplifier and possibly one of the least understood is the system used for mixing various incoming signals, regulating the volume and combining them before feeding them to the amplifier. In broadcast terminology we simply refer to this equipment as mixer equipment. It is the purpose of the ensuing discussion on this subject to call the attention of the reader to several types in current use and point out a few of the difficulties and causes of frequency distortion occurring in a large percentage of this type of equipment now in use. The best way to analyze this type of equipment is by first discussing independently the several different types of volume controls possible to use. With this purpose in mind we will discuss the diagram shown as Fig. 15. This circuit is possibly the most universally used of all types of volume controls at the present time and also is probably the

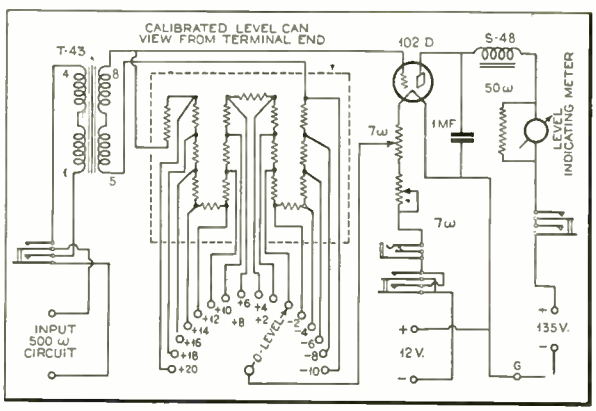


Fig. 14. Circuit diagram of the Jenkins & Adair level indicator, a panel view of which is shown in Fig. 13.

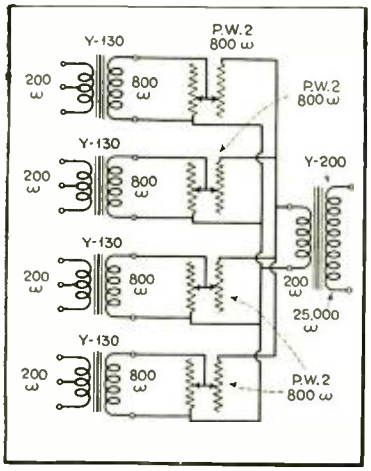


Fig. 17-A. Parallel constant output impedance mixer.

worst that could be used. As shown by the diagram, the potential divider is connected across the load with the center arm connected to one side of the source. In this system for any given degree the attenuation, both the input and output impedances vary greatly and it is impossible to accurately design equipment to work in and out of this type of volume control.

As can be seen by the curves shown the impedance looking into volume or mixer control from the load varies from 176 ohms to 1,000 ohms. This variation is instantaneous with any variation of the center arm feeding from the source. As can quite readily be seen it is a problem to decide what impedance should be used in determining the load impedance as any one impedance is almost as bad as another. So far as distortion goes in this particular leg it possibly can be ignored, due to the fact that the higher frequencies will not be greatly attenuated.

Now, considering the impedance looking into the mixer control from the source; we see that it varies between 300 ohms and zero depending upon the setting of the attenuator. At the higher degrees of attenuation a considerable loss of higher frequencies is noticed and this alone would render this system very impracticable as a volume control. The ideal impedance drawn across the 200-ohm line is that of the representative T-type pad and is the most practical system of volume control if made sufficiently flexible.

Typical Mixer Circuits

Now we shall analyze the typical mixer circuits displayed in Fig. 16. Fig. 16-A represents a type mixer that is widely used in broadcasting stations and as can be determined by our previous discussion, an analysis of the circuit in Fig. 15 shows that it would be impossible to calculate the impedance of these circuits, as we have the variation shown by the graph taking place for each individual manipulation of the mixer control and since the load varies to this great extent it is easily noticeable that it is practically impossible to make any determination of the best impedance match. Of course, in operating these controls during a program, when one circuit's gain is raised, all of the rest will have a proportionate decrease in gain. This is a very impractical type of mixer, and in modern equipment is steadily being replaced by much more efficient and well-designed mixers.

In Fig. 16-B is shown the same potential divider type mixer, only these mixers are connected in series. This arrangement has some points of superiority over the circuits shown in Fig. 16-A as there is very little likelihood of a short circuit on any one of the mixer positions. Therefore, it is not as bad as the parallel type. However there is room for improvement in this type due to the variation of impedance with each individual manipulation of the mixer gain control.

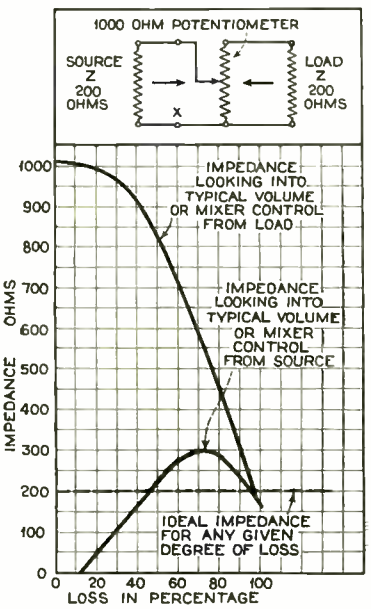


Fig. 15. Impedance curve of typical mixer.

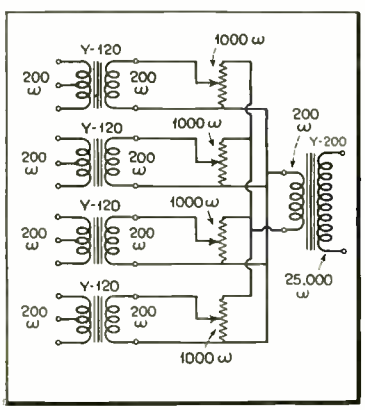


Fig. 16-A. Parallel potential divider type mixer.

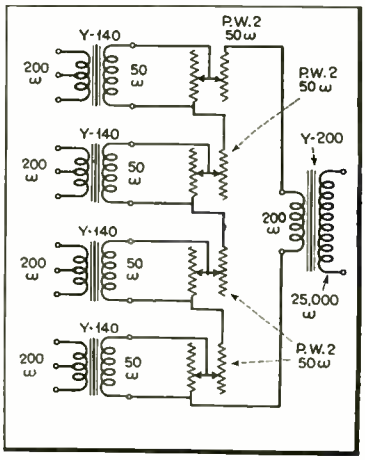


Fig. 17-B. Series constant output impedance mixer.

Constant Impedance Type Mixer

In Fig. 17-A a circuit is shown of a more or less constant impedance type mixer that has been used in the best equipment made in the past. The compensation resistance which is gauged directly to the potential divider and operates simultaneously, maintains the output impedance of any mixer circuit constant for any given attenuation setting. This system has been used quite extensively in the high-class speech equipment and there is no doubt as to its superiority over the types previously mentioned. However, we still have a variation of from 200 ohms to zero of the input impedance of this type of mixer control. This causes considerable distortion.

In Fig. 17-B is displayed a series-type constant output impedance mixer control. This system is very much preferable to the one shown in Fig. 17-A, due to the fact that the output impedance of the bank can be closely matched to the input impedance of the amplifier. This type is largely used at the present time in motion-picture studios and where excellent results are in demand.

(*To be continued*)

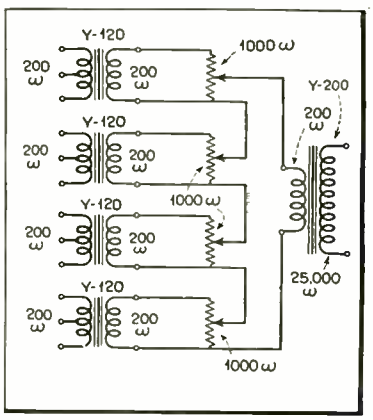


Fig. 16-B. Series potential divider type mixer.

THE NEW YEAR

Official Statements by Leading Executives Indicate Radio Prosperity for the New Year

1930 RADIO PROSPECTS

By H. B. Richmond
President, RMA

MEASURED in terms of radio sets placed in homes, 1929 was decidedly a better year than was 1928. The radio industry experienced some difficulties due to a too ambitious manufacturing program, but this condition is being readjusted rapidly, so that we enter 1930 with a well coordinated plan of

H. B. RICHMOND
President, RMA

engineering development, manufacturing, and merchandising. In the long run, the healthier the condition of any industry, the greater the value in purchases obtained by the consumers of the products of that industry.

A radio set is of little value without good broadcast programs. These programs are dependent on two factors, the equipment of the broadcast stations, and the quality of the material broadcast. Congress has just passed an act providing for the appointment of a chief engineer and for two assistant engineers to assist the Federal Radio Commission in studying the technical aspects of broadcasting, that they may make such regulations as will provide better reception in every radio-equipped home. The physical equipment of the stations themselves has been improved materially during 1929, and a large amount of improvement construction is now under way. Certainly 1930 starts off most auspiciously in regard to better broadcasting.

Better Programs

As to the quality of the programs themselves there can be little question. There was a constant improvement during 1929, and now the presidents of the two great chains announce several more millions of dollars will be spent in 1930 than were spent in 1929 for better talent. 1929 saw some criticism in the ratio of advertising talk to entertainment in sponsored programs. The advertisers are finding that too large a ratio brings ill-will instead of good-will, so that this unfortunate practice is being corrected. We expect a real improvement in the advertising-entertainment ratio for 1930.

The Federal Radio Commission has continued to suspend its order limiting chain broadcasting. It is hoped that such a procedure will continue in 1930. It is inevitable that our best programs must originate in our larger cities. Each year shows an improvement in the design of radio receivers. A similar advance occurs each year in automobiles. These improvements are gradual, not startling. Circuit improvements, new tubes, and speaker advances have been a part of each year's accomplishments. We will see them in 1930. The one thing in this regard that the industry must guard against is too ambitious claims. Too many advertisers have used terms to indicate that the changes due to improvements were revolutionary instead of the natural advance of a growing art. Thanks to the activities of the Better Business Bureaus, a curb has been put on this type of advertising.

Would you buy an automobile in 1930 that did not represent some improvement over one of the same period in 1929? Of course not! Do you expect the car you purchased in 1929 to be made worthless by the advertising of the automobile manufacturers in 1930? Of course not! This identical reasoning is applicable to the radio industry. A survey of the new tubes, speakers, and circuits under development proves the truth of this statement.

More Sets in the Home

1930 will see a rapid extension of a most natural trend that developed in 1929, namely, the requirement of more than one radio set in the home. When Dad wants to listen to the business reports, Mother wants dinner dance music, and the children, the bed-time stories. No longer is a single radio in the living room all that is required. The children have their own set; Dad has one in his den; perhaps there is one in the maid's quarters; all in addition to the console model Mother chose for the living room, fully as much because of its furniture value as for its radio qualities.

Radio has become a vital part of our daily existence.

RADIO WILL CONTINUE AT HIGH LEVELS IN 1930

By Major H. H. Frost
Chairman, Merchandising Committee, RMA

THE retail radio trade need have no fears concerning either volume or profits for 1930. No matter what may evolve from the present manufacturing situation, the public will continue to buy radio receiving sets and the retail trade will continue to sell them.

1929 can be looked upon not only as an unusual year in many respects, but it was unusually good. The first nine months established new record-breaking radio totals which will make 1929, when the entire year's operations are totalled, one of the best if not the best year, radio has ever had.

The radio trade can look forward with every confidence that the momentum gained in 1929 and the public interest which has been stimulated in radio will continue at high levels in 1930.

While 1930 may not exceed the record-breaking volume of 1929, there is

MAJOR H. H. FROST
Chairman, Merchandising Committee, RMA

every reason to believe that there will be fewer manufacturers and fewer dealers and this will guarantee that those who remain and do a sound and sane merchandising job will profit to a greater extent than has been possible in the past.

NO BASIS FOR PESSIMISM

By Ernense Kauer
President, CeCo Mfg. Co.

WHAT of 1930, is a question that comes frequently to men engaged in radio business enterprises. It would have come anyhow at this time, but the query is more insistent since the business recession which was so marked by events reflected in trade among securities listed with the larger stock exchanges of the country.

There is no reason to exhibit undue optimism but neither is there any basis for pessimism. It is true that the radio industry experienced a severe slump in the last part of 1929, normally expected to be the best in the year. I daresay there will not be any considerable activity in the early part of 1930. However, when that is said, I believe the worst part of the picture has been faced. Doubtless, a large amount of anticipated profits have not materialized. I do believe, however, that they are only delayed; that within this new year they will be realized.

It must be remembered that the radio industry has had slumps before without impending the industry's march of progress. In none of the industry's previous experiences, however, was there anywhere near such a state of stabilization as obtained in the trail of the period from October to December. Leading members of the industry had to tighten their belts and curtail activities, but in few instances were any of them put to difficulty. Inventories had been too carefully watched.

I think it accurate to say that most leading concerns in the radio industry had a profitable year even if profits were considerably below expectations. The curtailment that did ensue was not an unnatural development following the Autumn of 1928. No doubt the caution engendered by the experience of 1929 will find its reaction in helpful trade in 1930.

This is sure. The radio manufacturing division is in a magnificent state of technical development. There is little excess of merchandise in warehouses or on dealers' shelves. The industry starts with a clean slate in 1930, and with economies in merchandising and distribution, which are being brought forward continually, this new year should be a profitable one.

ERNEST KAUER
President, CeCo Mfg. Co.

GROWING PAINS

By Fred G. Carson
Vice-Pres., Colonial Radio Corp.

WHAT has gone or what is coming, is no mystery to those who have felt the pulse of the radio industry. The verdict of the merchandising doctor is "Growing Pains" a condition that forebodes the last stages of adolescence and the approach of real maturity. This condition is as normal in the life and growth of an industry as it is in an individual.

The setting for the radio industry's entrance upon its period of maturity is a happy one.

The recent analyses made by Roger W. Babson now point to an upward trend in general business prosperity. The industrial expansion launched by President Hoover and enthusiastically endorsed by the country's leading executives will play a big part in helping to dispel any trace of depression that may be lingering in the public mind. Continued good wages, and in many cases increased wages, are providing the consumer with sufficient funds to meet his obligations. The radio industry, which depends to a great extent upon installment buying, should experience a healthy reaction because of these activities.

At the beginning of this upward trend in business there is every indication that the radio industry will throw off the awkwardness which has been characteristic of its adolescent growth, and will develop gracefully along stable, scientific lines.

How has the recent development of the radio industry affected the individual manufacturer?

The answer is simple: Those firms who have watched the signs and have guided themselves accordingly will be in a stronger position in 1930 than they have ever been. Expansion on the part of the manufacturer, as consumer demand indicated, was a healthy development and will gather strength and momentum in 1930. Any other basis of expansion will be disastrous.

NO RADICAL CHANGES

By Powel Crosley, Jr.
Pres., Crosley Radio Corp.

WITH the coming of each new year, it has become the custom to ask radio manufacturers to forecast the development in radio for the next year.

It is difficult to anticipate radical change or improvement. First we saw the crystal detector sets; then came the vacuum tube with storage batteries

POWEL CROSLEY, Jr.
Pres., Crosley Radio Corp.

or dry cells, which held the center of the stage for several years.

In 1927 came the completely revolutionary change to the a-c. tube sets which would operate direct off of the electric light current. The past year has seen what has been pronounced to be the greatest development of all in radio—the screen-grid tube and its application to circuits in radio receiving sets. Perhaps the development of the moving coil type of speaker should be mentioned, for it has greatly improved radio reception in the past two years.

Concentration on Manufacturing Costs

There now seems to be nothing radically new and different on the horizon. It now appears that radio set manufacturers face no radical changes for some time to come. The development of the modern screen-grid tube receiver with moving coil speaker leaves little to be desired in the way of further improvement. The radio manufacturer can now concentrate his efforts on the perfection of detail and reduction in manufacturing cost while the radio public can be assured that a modern set purchased today should give satisfactory performance for years to come.

TUBE REPLACEMENTS

By Fred D. Williams
Manager, Radio Tube Division, National Carbon Co.

THE year 1929 witnessed a remarkable expansion of the radio receiving business because of the cumulative requirements of receiver purchasers of previous years. The sale of tubes is today a major factor in the volume of radio retail sales and is destined to account for an ever-increasing proportion of the expenditures of the public's radio dollar.

These radical changes impose new and greater responsibilities, both upon the radio tube manufacturers who make them and upon the dealers who sell them. A high standard of uniformity is being attained by leaders among tube makers, with a consequent increase in consumer confidence and satisfaction. But we have only begun to educate the consumer to the fact that his tubes require occasional renewal.

In order to obtain the fullest advantage of the magnificent programs available to the listener and to enjoy the full beauties of reproduction of which the modern radio set is capable, radio tubes should be replaced at regular intervals according to the number of hours the receiver is used. Replacement of oil in a motor-car is a comparable example.

Only if high quality tubes of uniform electrical characteristics and of rigid mechanical construction are used to replace worn-out tubes, are the full capabilities and measure of service attainable from modern radio reception secured. I venture to state that fully two-thirds of the receivers now in service are being powered by tubes so deficient in emission that only a fraction of the volume and quality of which they are capable is being enjoyed by their owners.

TUBE REFINEMENTS

By George Lewis
Vice Pres., Arcturus Radio Tube Co.

RADIO reception today is well-nigh perfect. The frequency characteristics of a good receiver are practically the same as those of our better broadcasting transmitters. Listening to a really fine program on one of the high-grade receivers now available at very reasonable prices, one wonders just what can be done to make things better. However, guided by past experience, we appreciate that perfection is never actually attained, and that progress must continually be made. In 1930, such will probably be in the matter of mechanical and electrical refinements—slight variations in standard designs that will mean dollars in the pockets of the consumer through a reduction in service calls. In our branch of the industry, we are endeavoring to make tubes just a little bit better than our past product—through structural improvements and greater facilities for quick and accurate testing. Though we are told that today we make a very efficient tube, our research department and our laboratories are working night and day in exhaustive development work. If we can make a tube a little stronger than before, with a closer tolerance to electrical standards, perhaps just a fraction better vacuum with the pumping time cut only a few seconds, these almost insignificant achievements will have an accumulative effect that will actually be noted in the consumer's pocket-book.

The only possible radical development anticipated by engineers lies in the design of circuits employing the pentode and the improvement of this

GEORGE LEWIS
Vice Pres., Arcturus Radio Tube Co.

tube itself. Should any set manufacturer find this tube of economic value, Arcturus is ready to make it for him.

Remove control devices, making it possible for the operator to adjust his receiver from a distant point at comfort, will undoubtedly be developed to the point where they can be incorporated in medium priced sets.

PRODUCTION CONTROL

By Edgar H. Felix
Radio Consultant, NEMA

ECONOMISTS, discussing the effect of reduced security prices upon general business, have been almost unanimous in classing radio receivers as luxury goods, one of the few major lines to be adversely affected by the business situation. But the widespread distribution of radio products in every class of American family supports the belief, held by the radio industry, that only general unemployment is likely to affect seriously the demand for its products. Therefore, the effective measures tending to relieve apprehension on this score should bring about resumption of normal buying.

Latest Survey

The quarterly surveys made by the Department of Commerce through the cooperation of the Radio Division of the Association have been extremely helpful in making possible accurate analysis of the radio situation. The latest survey comprised figures from 15.6 per cent of the retail trade, a percentage sufficiently large, according to the standards established by experienced economists and statisticians, to give an accurate reflection of nation-wide conditions. The most recent survey covers the period from July to September inclusive, and therefore makes possible analysis of the situation free of any influence of stock market conditions.

From these figures we learn the average gross sales per dealer during the quarter was $3,445, as compared with $3,031 for the same quarter last year, an increase of 13.6 per cent. The number of retail outlets rose from 31,573 to 39,929, a gain of 26.5 per cent. Retail sales rose from $95,834,887 for July, August and September, 1928, to $137,759,064 for the same quarter of 1929, a gain of 43.7 per cent. With such substantial gains in late summer retail sales, during a quarter which ordinarily accounts for but 21 per cent of retail sales, dealers were naturally optimistic. This attitude is reflected by the fact that, on October 1, 336,339 sets were reported on order by dealers.

The average number of a-c. sets in the hands of each dealer on October 1, 1928 was 8.6 or a total of 277,752 for the entire trade. That stock jumped to 14.2 per dealer, or a total of 568,865 sets on October 1, 1929, neglecting the few thousand battery sets included. It is obvious, therefore, that even prior to stock market breaks, the dealer was already carrying a substantial inventory load. If all the sets on order are added to this stock, the retail stocks of a-c. sets by the middle of October may have reached a total of 905,204 sets.

It must be remembered, however, that the fourth quarter of the year, then beginning, is the biggest from the retail standpoint. In usual years, approximately 40 per cent of the year's total business is done in that quarter. To equal last year's retail sales figures requires that only 42 per cent of the business anticipated on the basis of the sales of the first nine months of the year be actually achieved by radio dealers. During the fourth quarter of 1928, radio dealers disposed of 1,055,299 a-c. receivers. The number of a-c. receivers in stock and on order on October 1, 1929 amounted to about 90 per cent of this figure. Naturally, dealers, observing their stock on hand

rising from an average of 8.6 sets to 14.2 sets on October 1, this year over last, curtailed their buying and, when the market break took place, virtually ceased buying.

Drop in Sales

The result has been increased manufacturers' stocks. Well-managed companies, particularly those with small organizations, were quick to respond to conditions and promptly reduced production. Others hoped to stimulate sales by price reductions. The major producers, during the last year, have substantially increased their production facilities, anticipating tremendously increased retail sales. The production facilities of the industry are ample to make twice as many sets as were actually sold last year. It is apparent that there was warning, as early as October 1, that supply is far in excess of demand and that dealer stocks, despite increased sales, were growing at an alarming rate.

Manufacturers are unable to adjust their production figures to the retail situation without a knowledge of the production situation in the entire industry. Furthermore, to be useful such production figures must be gathered frequently and promptly so that they may be of value in guiding manufacturers as to their production policies.

Naturally, there is hesitation among the leaders of the industry to confide their production schedules to anyone, lest they become public property. But this danger is negligible as compared with the advantages of securing a monthly compilation of sets produced or placed in trade by manufacturers. Twenty-four of the forty-five branches of the electrical industry represented in the National Electrical Manufacturers' Association submit their production figures to the Association, in order that the *total* production for each branch of the industry may be available for the guidance of the industry. To be of value in the radio industry, production compilations must include all of the major quality producers and a sufficient number of the smaller companies to be fully representative.

If one of the results of the present reduced operations of radio manufacturers is to teach a lesson of the advantages of permitting a compilation of monthly production figures, a thing which has been urged by this association for years, it will, in the long run, prove one of the most profitable seasons in the industry's history.

Future Prospects

As to the prospects of the immediate future, the retail situation, while unusual, is not alarming. First, the receivers in stock are up-to-date merchandise; second, dealers promptly curtailed purchasing before their best sales season got away. Consequently, the liquidation process is likely to be orderly. It is already stimulated by price reductions. The liquidation necessary to restore dealer buying is a reasonable achievement for this season of the year. Stocks of a-c. sets on January 1, 1929, were reported as 266,617. If we subtract that from the number on hand and the number on order on October 1, 1929, i. e. 905,204, it leaves a figure of 638,587 sets to be disposed of in the three best months of the year. Furthermore, there were cancellations of orders reported as standing on October 1, 1929, which further reduces the number to be disposed of to reach the inventory figures of January 1, 1929. Considering that, last year, 1,055,299 a-c. receivers were sold during October, November and December, while demand was running 43.7 per cent above last year a few weeks before the stock market break, liquidation of overstock by the retail trade, the first essential to liquidation of manufacturers' stock, is a very promising prospect.

However, we are not upon a stable basis until production is as well regulated as the dealer is adjusting purchases to inventory conditions. Unless measures are taken by the industry to compile gross production figures at regular intervals, the possibility of over-production is always present. If resumption of dealer buying and liquidation of manufacturers' stocks restores production to full capacity, the groundwork is laid for another period of over-production.

BETTER TUBES

By Harry H. Steinle
Vice Pres., Triad Mfg. Co

ADVANCE predictions for the the radio industry in 1930 center aroond further refinements in mechanical construction.

The screen-grid tube will develop even greater possibilities. I am confident that tubes will continue to play an increasingly important part in the future development of the radio art. For, after all, the most expensive radio set on the market is totally lacking in entertainment and intrinsic worth if it lacks tubes possessing the highest quality. Tubes are the vital points in a radio set whether it be electric or battery operated.

Tube manufacturers whose sole purpose is to produce merchandise of the highest engineering and mechanical efficiency will find ready markets. It is significant that battery-operated sets which incorporate screen-grid tubes are rapidly gaining in favor in rural districts.

So with city and rural demands for tubes steadily increasing the 1930 season looms bright for the better class of radio tube manufacturers.

Suggests Reserve Tubes

The practical plan followed by the automobile owner of having a spare tire and tube might well be adopted by the radio set owner.

In my travels I have observed scores of cases where an otherwise delightful radio programme was spoiled by reason of the fact that one of the tubes in the set ceased to function. The family and friends of the set owner were considerably disturbed when the finest efforts of Mme. Kola Tura were lost as the offending tube flickered and went dead.

With no extra tubes on hand and the average sources of supply closed on Sundays, holidays and late at night, it is needless to state that the moral should be obvious. By having a spare tube or two on hand the set owner safeguards himself against eventualities. Even the finest tubes will "flicker out" at a time when anything else would be more desirable.

RADIO PROGRESS

By Ray H. Manson
Chief Engineer, Stromberg-Carlson Tel. Mfg. Co.

THE past year has been one of great radio progress in both broadcasting improvements and refinements in radio receivers. Of course, there has been a great improvement in broadcast programs but in addition to this many other improvements were made on the engineering side of broadcasting. Many of the stations presenting good programs increased their power and their signal modulation which brings them more consistently to the receivers of a greatly extended audience with better quality. Improved microphones and amplifiers have improved tone quality of broadcast signals. During the year a large number of stations have been equipped with crystal oscillators for keeping them steadily on their assigned frequency. Chain networks have also expanded during the year, bringing metropolitan programs to a greatly extended audience.

Correspondingly great improvements have been made in radio reception apparatus. Radio sets produced during 1929 are more sensitive and more selective and give a better tone quality than last year's sets. The increased sensitiveness and more selectivity of this year's products is due in some cases to screen-grid tubes in radio-frequency circuits designed especially to take full advantage of their possibilities. One such advantage is linear power detection which is particularly adapted to taking advantage of the higher signal modulation of modern stations. Another improvement of the current year was automatic volume control with visual tuning to enable the operator to see when he was accurately tuned to the station desired. With a receiver so equipped all local stations and distant stations sound about alike in volume.

With such improvements as these in broadcast transmission and reception, the reason for the 25 to 40 per cent increase in radio business during 1929 is readily apparent and on can expect equal or greater progress in 1930.

Aircraft Radio

A Description of Both Radio Receiving and Transmitting Apparatus for the Large Multi-Motored Planes as Well as the Small Planes

By C. W. Thomas

TWO-WAY communication between ground and plane is only necessary when the airline is charted over water or uninhabited country. When this is the case it is essential that transmitting equipment be carried on the ship together with an operator skilled in its operation. Undoubtedly legislation will soon be enacted compelling large passenger carrying planes to do so. Freight planes or small private pleasure craft need only be equipped with receiving sets capable of securing the government radio beacons and weather reports. It may be said here, however, that unless the above mentioned beacons are adjusted to more nearly the same frequency assignment instead of being scattered all over the allotted band, severe confusion will be experienced by any but skilled operators of aircraft receivers. It has been the writer's experience that

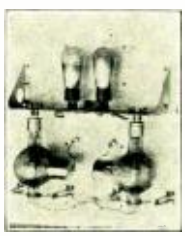


Fig. 1. A transmitter with a power output of two hundred watts.

it is not only possible but highly desirable to have beacons, such as those marking the transcontinental airline, set on the same frequency.

Receiving and Transmitting Apparatus

Realizing that the common tendency is to criticize existing equipment without providing a better substitute, the author will describe both receiving and transmitting apparatus for the large multi-motored planes as well as the small pleasure ship. This equipment, as will be noticed, gives a maximum of power with a minimum of adjustments, attention and weight.

Fig. 2. Antenna reel recently used by the Army Signal Corps.

Experience with existing apparatus has shown that failure is due to high voltage breakdown, not only in the windings of the generators, but also in the cables from the machine to the transmitter. In the apparatus about to be described this has been overcome by using an alternating-current generator of low voltage which feeds a pair of transformers on the transmitter thus making the high-voltage leads only a few inches long and confining them to the circuits in which they are used.

Potentials of 1000 volts as used in most transmitters are constantly breaking down insulation and making the equipment inoperative, while the author successfully handles 5000 volts without trouble. This naturally leads to the use of larger transmitting tubes and a consequently greater power output.

Another source of trouble is secondary equipment such as relays, circuit breakers, and filament batteries. In order to keep down weight most generators of high voltage are designed to give intermittent service. This being the case they are bound to give trouble when operated by inexperienced personnel and under conditions as severe as those met in aircraft operation. These generators are driven either by self-regulating propellers, battery-driven motors, or by being coupled to the plane's engine itself. The first has the advanrage of light weight but if not designed properly will add enough weight due to head resistance to offset this good point. Its disadvantage is that of being inoperative in the case of a forced landing when it is most needed. The second has the advantage of being available either on the ground or in the air but places a prohibitive load on the ship's battery which is usually taxed to capacity with other loads. The last is most desirable from a practical point of view because it may be so mounted on the engine that it is enclosed in the cowling and offers no head resistance. Its disadvantage is that in case of motor trouble either in

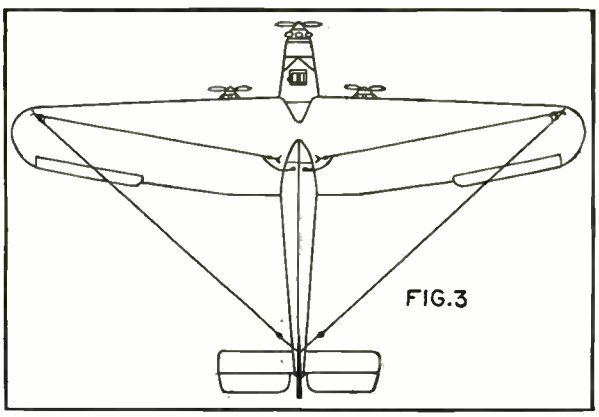


Fig. 3. A horizontal doublet antenna which, due to the size of the airplane, is easily tuned.

the air or on the ground it becomes inoperative. However this may be eliminated by designing the generator to deliver two voltages, one to operate the radio transmitter and the other to charge the ship's battery. This latter winding could then be driven by the battery as a motor in the case of trouble, and produce the voltage required by the radio transmitter. Machines of this type are being experimented with by several manufacturers, and should be available soon.

Radio Transmitters

Without doubt the greatest source of trouble with present-day equipment is not due to inherent faults of apparatus but rather to the belief of airline managers that co-pilots or mechanics are capable of maintaining communication with anything as sensitive to care, as a radio transmitter. Unless the apparatus is designed to be extremely rugged and to operate automatically it is impossible to get along without an exceptionally capable operator.

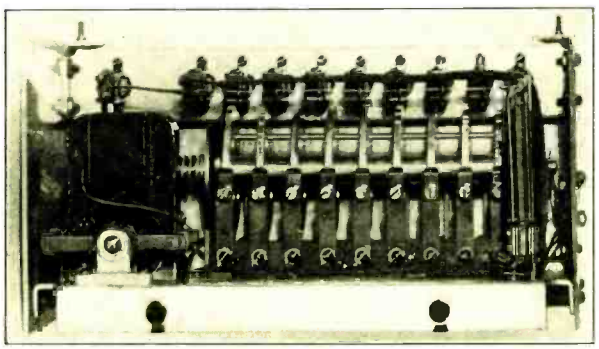


Fig. 5. Interior of the automatic radio transmitter unit. A ship's location, name and number can be sent to its base by merely pushing a button.

Fig. 1 shows a transmitter, designed by the author, the conservative power output of which is two hundred watts and complete including power supply, and antenna; it weighs but eighty-four pounds.

To maintain a constant frequency an oscillator-amplifier arrangement is used with a high ratio of capacity to inductance in the tank circuit. Two 7.5 watt tubes are used as oscillators in a self-rectified circuit, the plates of which are fed from 500-volt taps on the transformer. The Colpitts type of circuit was chosen because of its ready adaptability to interchangeable inductances. Due to the small amount of circulating radio-frequency current they may be wound with small wire, thus reducing the weight. Three small variable condensers are shunted across the tank not only to permit of a remotely controlled wave change device but also to allow the transmitter to be tuned and locked while the plane is on the ground.

The high end of the medium frequency assignment was chosen in order to permit using a fixed antenna on the plane. This antenna somewhat limits the amount of useful radiated energy as compared with the trailing wire, but its advantages more than offset those of the latter type.

Use of the longer waves require a trailing wire with a large amount of inductance as loading in the output circuit. This not only dissipates more than half the useful energy but also raises the potential at the fairlead enough in most cases, to break down the insulation.

Of prime importance is the fact that the whole transmitting system may be tuned and inspected while the ship is in the hangar, and regardless of personnel this adjustment will be maintained in flight. With the present type of equipment adjustments or inspection by the government supervisor means nothing because of the fact that these adjustments are only marked and recorded and not preselected and locked. Then, too, the antenna has to be reeled in after each flight and due to the fact that it is part of a tuned circuit it is seldom indeed that inexperienced personnel ever get it in resonance with the amplifier circuit. Not only does this result in the reduction of power output but, due to the necessity for adjusting the driver when a wave change is made in flight, the ground station is apt to miss a call on account of the ships being off wave.

It is not an uncommon thing to lose a trailing wire aerial due to the poor design of the reels available. The trouble is usually found in the locking

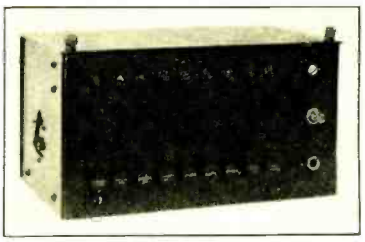


Fig. 4. Panel view of the automatic radio transmitter.

device which is always of the friction type. Fig. 2 shows a reel recently made use of by the Army Signal Corps which was designed for a receiving aerial but could be used for transmitting by making the casting of micarta instead of aluminum as shown, or by using one wavelength and cutting the antenna to the proper length for resonance. In this case the wire may be let out the full length and by inserting a short piece of rawhide between it and the reel the latter will not be energized during transmission. The reel illustrated is self-locking and should the pilot have to release the knob while letting out the aerial the spring latch in the handle will engage with the ratchet and prevent the wire from running out. The fairlead shown has a bell fitted to its end into which the weight is drawn. This prevents the weight from swinging or twisting loose from the wire. The weight has a spring through its center which permits it to be drawn up tightly against the bell and held by the teeth of the ratchet on the reel.

But to get back to the transmitter, the oscillator as shown has two inductances, one for tuning in the operating band 2750 to 2250 kilocycles (109 to 133 meters) and the other for the international distress wave, 500 kilocycles (600 meters). The power amplifier uses two 100-watt tubes, connected back to back with their plates fed with a series connection from the 2500-volt taps on the transformer. These tubes are of the screened plate type and the screen is fed from the 500-volt tap which supplies the oscillator plates.

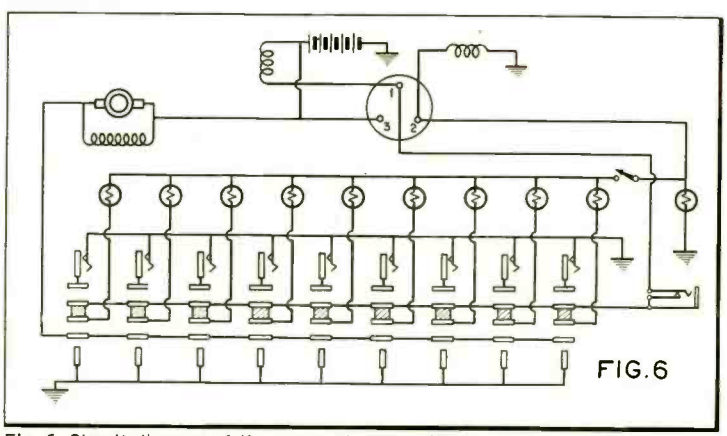


Fig. 6. Circuit diagram of the automatic transmitter unit shown in Figs. 4 and 5

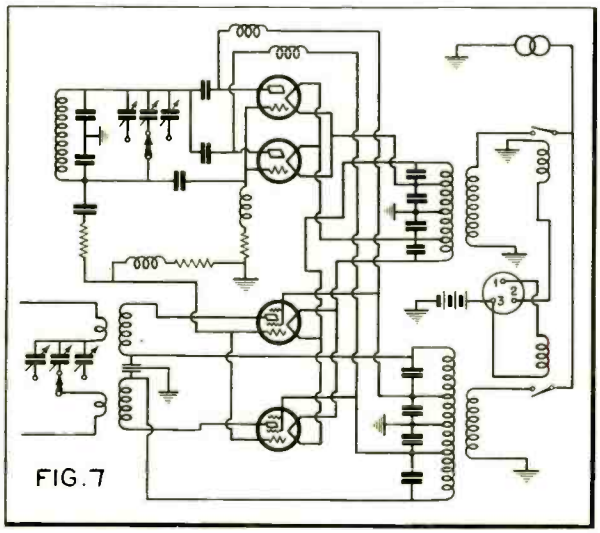


Fig. 7. Only three wires are required to connect the automatic unit to the transmitter, the circuit of which is shown here.

The amplifier plate circuit is untuned and power is fed to the antenna through two reactance coils, one in each plate lead. Being untuned the reactance coils may be wound with small wire only large enough to handle the plate current of the tubes. This again effects a great saving in weight and reduces the tuning controls by three.

The antenna, Fig. 3, used by the author, was a horizontal doublet which, due to the size of the plane was easily tuned, with a few turns for coupling, to one-half the fundamental of the lowest working frequency, i. e. 2750 kilocycles (133 meters). In tuning the antenna circuit use is again made of three small 100 mmf. variable locking condensers which preselect the wave by means of a switch which is common to that used in the oscillator circuit. This then is the only variable that need be adjusted in flight and then only when it is necessary to change wave. Either of the first two waves may be selected from the cockpit of the plane by remote control but to use the distress marine wave the oscillator and amplifier inductances must be changed. The transmitter, being adapted to remote control may be placed in the wing of the ship, thus making room for another passenger in the cabin.

The power supply for this equipment is a standard 200-volt, 400-cycle ½ kw. generator which supplies a plate and filament transformer mounted on the back of the transmitter. Use of the filament transformer takes the load which is ordinarily placed on the plane's battery.

So far in this description all chance of failure due to the human element has been removed and now all that is necessary is to key the set with the characters of the telegraph code. It is regrettable but nevertheless true that in all cases where radio transmission was attempted in any of the world's spectacular airplane flights the failure to get through was due entirely to faulty operating.

Automatic Transmitters

There is little if any information in the possession of a pilot, while in flight, that needs to be transmitted to the ground. From the standpoint of a safety factor the transmitter need only be operated in the case of a forced landing and then not until the ship has landed. Prove this last statement to yourself by trying to imagine a pilot with a microphone held to his lips calling "mayday" (maider) or trying to send out an intelligent SOS, while looking for a spot on which to set his ship. It just isn't done. The only solution to a problem of this kind, where an operator is not carried as part of the crew, is an automatic transmitter. Figs. 4, 5 and 6 show a machine of this kind for planes flying over regularly charted airlines. Its weight is but seven pounds and by merely pushing a button any inexperienced person in the plane is able to send back not only the ship's position but its name or number and the condition of the weather. Another button informs the ground station when a forced landing is being made.

The construction of this little device is very simple, consisting of a series of code discs mounted on a common shaft and driven by a miniature motor which secures its power from the ship's battery. There are nine discs used in the instrument shown but any number may be added to accommodate any particular run. In order to simplify its construction as much as possible many pilots were consulted as to the information which they deemed necessary to transmit to the ground station or dispatcher. Instead of a long report of the weather condition it has been summarized into three possible conditions, i.e., good, bad, and impossible. If the weather is good the plane is able to fly with ease; if bad some difficulty is encountered; if impossible the ship is forced down.

Approximately fifty miles apart are located emergency landing fields and there are code discs for reporting the passing of these fields. Before a ship leaves on a run the pilot knows what the general weather conditions are over the run due to the facilities provided by the vast network of landlines constantly sending this information into the dispatcher's office. After he

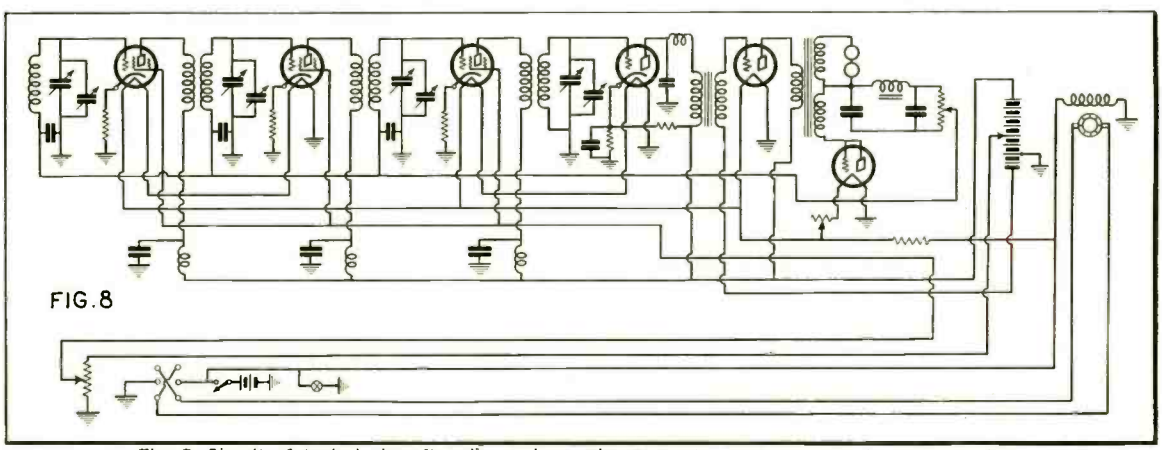


Fig. 8. Circuit of typical aircraft radio receiver, using a-c. tubes with filaments in series-parallel.

leaves he is only interested in any change which may occur enroute, to endanger his landing at the destination. This information is sent to him on regular fifteen minute schedules by the ground radiophone station and is acknowledged by him by pushing a button which sends back the information. "Plane No. 8 message received OK." This method not only relieves the pilot of the necessity of calling the ground station but assures the ground station operator of receiving an intelligible code signal. The ground station repeats the message, of course, until an acknowledgment is received. When the ship passes over the first emergency field he pushes the button corresponding to this passing point and the number of the ship and the name of the field is sent to the dispatcher; if no other signal is received it is understood that the weather at this point is good, but if the weather is bad the pilot pushes another button which sends back this information. Naturally the time the ship passed this point is the time the signal is received and by keeping a "plane sheet" somewhat as a railroad dispatcher keeps a "train sheet," not only the position but the approximate speed of the ship may be seen at a glance. If at the next field the report is again bad and this report is soon followed by the signal "forced down" it is natural to assume that the weather was impossible at this point. By consulting his sheet the dispatcher is able to tell within a mile just where the ship went down if it happened to be between landing fields. The "forced down" disc then does double duty, reporting impossible weather, and a forced landing due to other causes. These other causes are transmitted to the dispatcher by telephone by the pilot after landing.

If the ship is flying over water or uninhabited territory it has no business doing so without a skilled telegraph operator aboard. The important thing about the "forced landing" disc is that when once depressed the button locks into position and keeps repeating the message until released while the others make one revolution and stop automatically. This relieves the pilot of any further responsibility and he may spend all his time in landing the ship properly.

Three small wires as shown in the transmitter diagram, Fig. 7, is all that is required to connect the automatic device to the equipment.

Receiving Equipment

The question of receiving equipment has been worked out rather successfully and that shown in Fig. 8 makes use of three '24 type tubes as radio-frequency amplifiers, a '27 type detector, a '12A for audio amplification and a 199 type for automatic volume control. The indirect heater type tubes were chosen not only due to their more rugged filament construction but also for their ability to filter out extraneous noises which get through to the set from the ship's power supply. A fixed resistor in the filament line reduces the ship's 12 volts to 5 volts; this is fed to the first two tubes in a series connection as are the next two and the last tube is placed across the line.

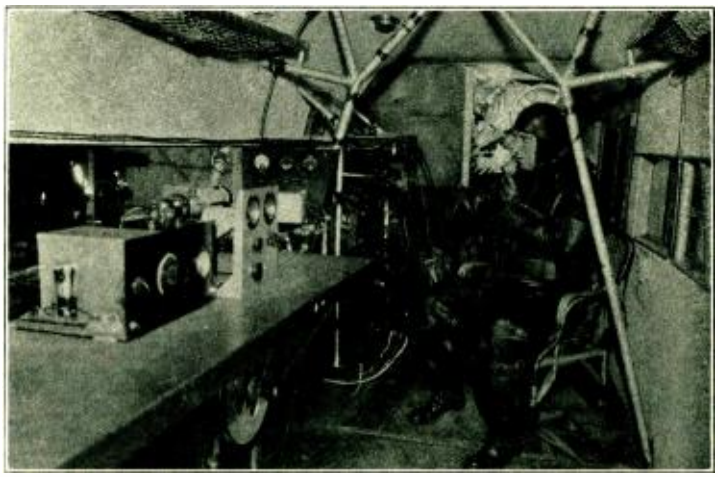


Fig. 9. The world's first flying laboratory operated by the U. S. Signal Corps.

Experience has proven the need for an automatic volume control. When flying a beacon course the signal keeps getting louder as the plane approaches the transmitter, and this makes it necessary for the pilot to keep reaching for the volume control in order to reduce the signal strength. If the weather is very bad there are so many other things to occupy his attention that he forgets the radio signal until it near deafens him. To overcome this difficulty use is made of a 199 type tube as is shown in Fig. 8. The current drain on the "B" battery is so low that use is made of the special aircraft battery designed and sold by the French Battery Company as their number 5963. This small block weighs but eight pounds and delivers a total of 135 volts being tapped at 45 and has an extra 9 volts tapped at 1½ and 3 for grid bias. Nine volts are applied to the grid of the '12A tube and the battery and receiver is built into one complete unit.

Due to the crowded condition of most cockpits it is essential that the receiver be designed for remote control. This is not only essential but desirable from a standpoint of efficiency. In using a vertical pole antenna as used by the T.A.T., it may be placed well back on the fuselage of the ship and the receiver mounted directly beneath. This places the whole unit near the outer edge of the interfering electrical field produced by the spark plugs and engine generator. The reduction in noise level is so pronounced that this equipment may be operated with incomplete high-tension shielding, that is, open spark plugs and connecting wires, provided the wires are beneath a good motor cowl. This placing of the apparatus is not new by any means but the remote control devices used on the receivers that have come to the writer's attention have not only weighed as much as the receiver but have had a decided spring and backlash to them.

This necessitated the design of something not only better but much lighter. The method used by the author is not only cheaper but it has the advantage of ease of control and definite adjustment indication. A small motor is used to drive the condensers in either direction and the reduction gears produce enough friction to cause the rotation to cease as soon as the current is off. This means then that all the pilot has to do is to operate a small reversing switch in the cockpit and watch the indicator which may be placed on the instrument panel. The indicator is attached to a double acting piston which slides up and down a cyclinder connected in series with a hydraulic circuit which is operated by another set of miniature pistons connected to the condenser shaft by a rack and pinion. The receiver is then connected to the indicator by two small copper tubes containing a mixture of castor oil and alcohol. Three small wires constitute the control for the driving motor, the volume, and the filaments. Expansion and contraction of the fluid is taken care of by a zero adjustment on the indicator. Its appearance on the panel somewhat resembles the red indicating device of a modern motor-car gasoline gauge.

Fig. 9 shows the world's first flying laboratory operated by the U. S. Signal Corps at Dayton, Ohio.

Most of the information on present-day aerial communication had its birth in this well-equipped plane. Due to military secrecy this fact is not generally known, but commercial aircraft communication with slight modification, is merely following the trail blazed by these well-informed pioneers in this work.

HERALDING

THE NEW LEADER IN REPRODUCTION

Amplifiers by an acknowledged leader in the audio field are indispensable where better quality, greater power output, or both, are required. Thordarson power amplifiers meet these requirements, combining all the features of design gathered by years of research and experience in Thordarson laboratories.

Special Features:

1. Fidelity—These amplifiers incorporate the best of Thordarson audio transformers, properly designed to give uniform amplification over the useful audio range.

2. Output—Maximum undistorted output 4650 milliwatts.

3. Amplification—Voltage amplification of 275.

4. No Hum—Hum has been reduced to absolute minimum.

5. Design—The work of many months by Thordarson engineers backed by years of experience.

6. Adaptability—Ingenious means for applying this amplifier to any problem in sound reproduction.

7. Simplicity—Self-contained, no outside terminals.

8. Safety—Completely fused and equipped with automatic safety switch.

9. Workmanship—In keeping with Thordarson products.

10. Attractive Appearance—Finished in gold lacquer.

11. Guarantee—Liberal 90-day guarantee.

12. License—Licensed by Radio Corporation, Bell Telephone, General Electric, Westinghouse and Thordarson.

13. Price—$89.50.

DISTRIBUTORS

Boston, Mass.
Woodrow Radio Co.
166 Prospect Street
Cambridge, Mass.

Chicago, Ill.
Newark Electric Co.
226 W. Madison St.

Chicago, Ill.
Chicago Radio Apparatus Co.
415 S. Dearborn St.

Cleveland, Ohio
M & M Co.
500 Prospect Avenue

Dayton, Ohio
Burns Radio Co.
12-20 Jefferson St.

New York City, N. Y.
Graymore Radio Corporation
142 Liberty St.

THORDARSON
POWER AMPLIFIERS

DISTRIBUTORS

Philadelphia, Pa.
M & H Sporting Goods Co.
512 Market St.

Pittsburgh, Pa.
Camerradio
430 Wood Street

Minneapolis, Minn.
Findley Electric Co.
111 S. 6th St.

Minneapolis, Minn.
Jalleco Mfg. Co.
229 E. Hennepin Ave.

Seattle, Wash.
Wedel Co.
520 2nd Avenue

St. Louis, Mo.
Van Ashe Radio Co.
210 N. 10th St.

St. Paul, Minn.
Pioneer Electric Co.
137 E. Fifth St.

THORDARSON ELECTRIC MFG. CO., Huron, Kingsbury and Larrabee Sts., Chicago, Ill.

The Trend of Invention

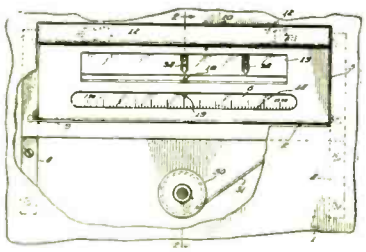
By RICHARDS & GEIER

PATENT AND TRADE MARK ATTORNEYS 274 MADISON AVE NEW YORK CITY

RADIO LOGGING AND INDICATING DEVICE

Daniel Schwartz, of Chicago, Illinois. U. S. Patent No. 1.734,694. (Issued November 5, 1929.)

THE main objects of this invention are to provide an improved logging and indicating device for radio receiving sets, to provide improved markers in a device of this kind for appropriately indicating settings for receiving from various broadcasting stations respectively, to provide an improved front cover for a logging device to provide means on such cover for projecting indirect light upon the indicia of the device, to provide an instrument of this kind which may be conveniently installed

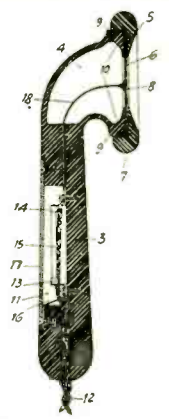


in a radio cabinet of standard construction and which is accessible from the exterior of the cabinet for permitting adjustment of the markers, and to provide improved actuation mechanism for moving an indicator and lamp in correspondence with the movements of the tuning apparatus of a radio.

APPARATUS FOR AMPLIFYING LOW-FREQUENCY SPEECH CURRENTS OF RADIO RECEIVERS

Gustav Eichhorn, of Zurich, Switzerland. U. S. Patent No. 1,735,267. (Issued November 12, 1929.)

This invention relates to wireless telephony employing valve-receivers and in particular to a receiving device which has the distinguishing feature that a portion of the phone-circuit is adapted to be applied to the ear of the user, or to a part of the head near the ear and another portion is to be brought into contact with some other part, say the hand of the user, so that the body of the user is included in the anode circuit with one pole of a tube- or valve-radio-receiver connected by a connect-



ing lead to the human body, and the other pole connected by a connecting lead to an exciting element which is held against the head or near the ear, so that a polarity is prevented and the skin or supple part of the face in the immediate neighborhood of the ear are forced by an electrostatic effect to set up oscillations which are not transferred to the ear-drum but direct to the inner organs of hearing.

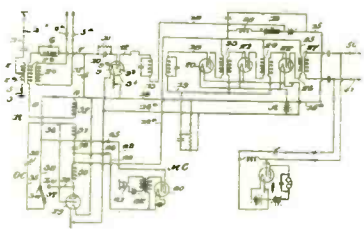
Free books on patent and trade-mark law can be obtained by our readers upon request to Radio Engineering or direct to Richards & Geier. Copies of the patents described on this page may be obtained through the above-mentioned firm of patent attorneys.

FREQUENCY CONTROL FOR RADIO DISTRIBUTING SYSTEMS

Edward E. Clement, of Washington, District of Columbia, Assignor to Edward F. Colladay, of Washington, District of Columbia. U. S Patent No. 1, 730,407. (Issued October 8, 1929.)

This invention relates to radio broadcasting systems, and especially to those designed for regional distribution.

In a radio telephone system of broadcast distribution, a central station and a plurality of subscribers' stations interconnected by individual line wires, a source of modulated high-frequency radio waves at the central station, an oscillator also at the central station tuned with relation to said high-frequency modulated waves so as to produce a relatively

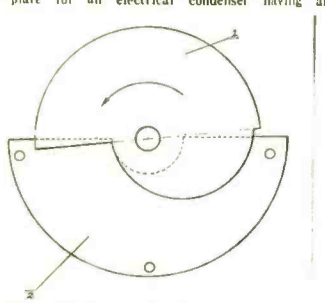


low-frequency beat wave, above the limit of audition, means to transmit said beat waves carrying the original modulations, over individual line wires to the subscribers' stations, and means at each subscribers' station controlled entirely by the subscriber for detecting said waves and rendering the modulations thereon audible to the subscriber.

ELECTRICAL CONDENSER

John M. Miller, of Washington, District of Columbia. U. S. Patent No. 1,724,499. (Issued August 13. 1929.)

An object of this invention is to provide a movable plate for an electrical condenser having an

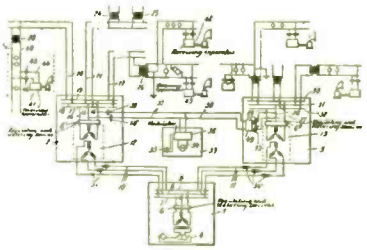


arc which subtends an angle of more than 180 degrees at the center of rotation.

HIGH FREQUENCY BROADCASTING OVER POWER LINES

Robert D. Duncan, Jr., of East Orange, New Jersey, Assignor to Wired Radio, Inc., of New York, N. Y., a Corporation of Delaware. U. S. Patent No. 1,730,412. (Issued Oct. 8, 1929.)

A high-frequency broadcasting system comprising an electric power distribution network including a central power generating station, a plurality of substations connected to said central station, and branch distribution circuits extending from said substations to power consumers' installations, a high-frequency broadcasting central station, a plurality of high-frequency carrier current transmission lines extending from said broadcasting station to different substations, said transmission lines being connected

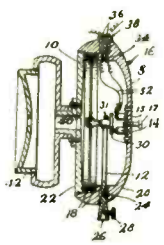


at said substations to said branch distribution circuits for impressing modulated high-frequency current upon said branch distribution circuits, means for preventing undesired oscillations between said central station and said substations and high-frequency signal receiving devices at a plurality of said consumers' installations.

SOUND SYSTEM

Harry Harold Thompson, of Kansas City, Missouri, Assignor to Radio Corporation of America, of New York, N. Y., a Corporation of Delaware. U. S. Patent No. 1,735,095. (Issued November 12, 1929.)

This invention relates to a new and useful combination of coacting elements for transmitting, receiving and translating radio waves, and the invention consists generally of a phonograph, or a phonograph cabinet, a radio apparatus associated with

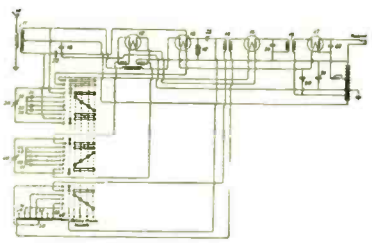


said phonograph, or cabinet, and a device in circuit with said radio apparatus and which may be applied to a telephone or a phonograph to transmit or receive and amplify the vibrations of the radio apparatus or the vibrations produced by a record placed in operative relation to the needle of the phonograph.

RADIORECEIVER

William H. T. Holden, of Brooklyn, New York, Assignor to American Telephone and Telegraph Company, a Corporation of New York, U. S. Patent No. 1.726,622. (Issued September 3, 1929.)

This invention relates to radio receivers, and con-



sists in certain improvements applicable to the radio receiving apparatus now in general use.

MERSHON
ELECTROLYTIC
CONDENSER

DISTRIBUTORS

Here's your golden opportunity to make real money with the Mershon Line. The first time a distributing proposition has ever been available. Wire us for full details at once.

ENGINEERED into your circuit or built into your set - the MERSHON Electrolytic Condenser modernizes its construction and insures its efficiency.

It saves weight, space, cost, trouble and replacements! It gives you capacity far beyond your fondest dreams!

For instance, 72 microfarads in 32 cubic inches.

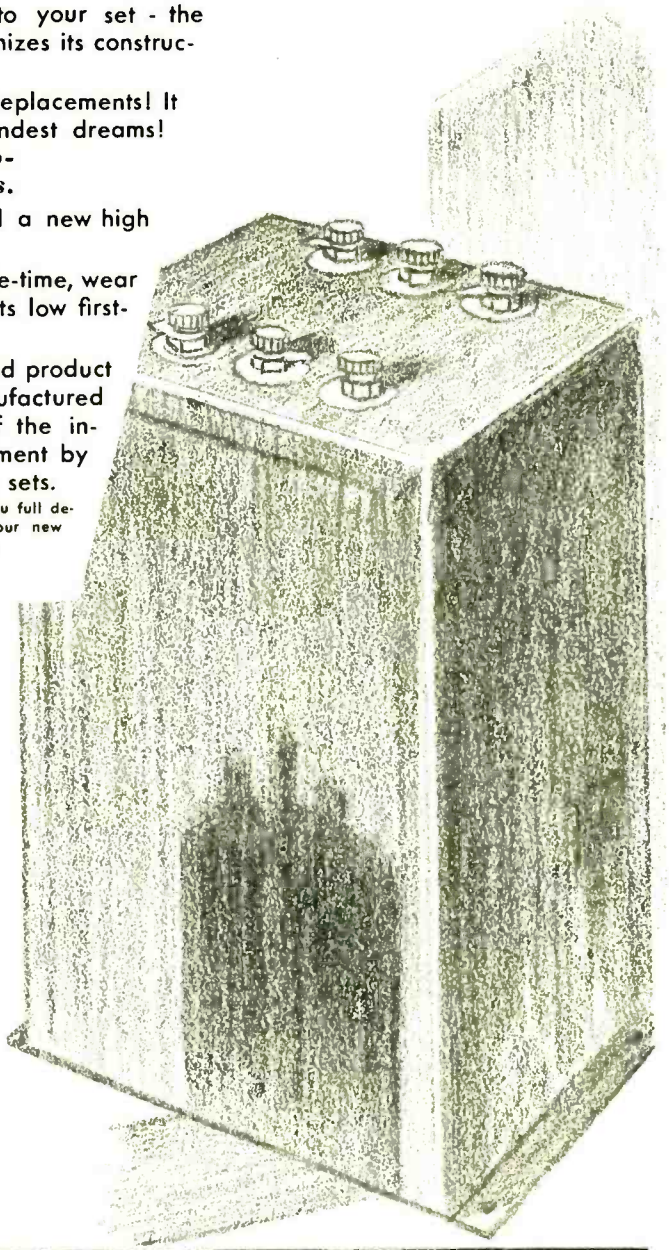
It gives you a new low hum-level; and a new high standard of tone quality!

And because it's self-healing, it gives life-time, wear proof, trouble-free service that makes its low first-cost its last cost as well.

Not an experiment - but the perfected product of years of scientific research, manufactured by one of the pioneer companies of the industry - and used as standard equipment by 29 leading manufacturers of radio sets.

Our Engineering Department will be glad to give you full details of the proper MERSHON installation for your new circuit or set. Just address — Mershon Divisian

THE AMRAD CORPORATION
Medford Hillside, Mass.



SELF-HEALING

NEWS OF THE INDUSTRY

RMA TRADE SHOW

A TOTAL of 85,000 square feet of space will be available to exhibitors in the 1930 RMA Trade Show for display and demonstration purposes, it was disclosed by J. B. Hawley, Chairman of the Show Committee, in a report to the Board of Directors of the Radio Manufacturers Association at Briarcliff, New York, December 7th.

The 1930 Trade Show is scheduled to be held the week of June 2nd in the large, new municipal auditorium at Atlantic City, New Jersey.

Of the 85,000 square feet available for the show, there are 45,000 square feet (exclusive of aisles) available for display booths. 40,000 square feet are available on the same floor for demonstration booths which will be made as nearly sound-proof as possible. There is room for 200 demonstration booths of 200 square feet each.

This is the first time at either the Trade Show or the RMA public shows in New York and Chicago, that it has been possible to arrange for demonstration rooms on the same floor and immediately adjacent to the display booths, and it is expected that a much more satisfactory show from every standpoint will result.

The 45,000 square feet available for display purposes is 50 per cent larger than the actual floor space available at the three hotels which housed the 1929 show where only 30,000 square feet of space was available at the Stevens, Blackstone and Congress Hotels put together.

The new and enlarged facilities available at the Atlantic City auditorium will make it possible for manufacturers to present their products to the trade more adequately and more advantageously than has been possible in the three previous shows.

Chairman Hawley reported to the Board that it was the opinion of the Show Committee that not only would the 1930 show surpass previous trade shows in attendance and results achieved, but that visitors and exhibitors alike will find the 1930 show a vast improvement in business transacted and general satisfaction.

"The Show Committee felt," he stated, "that all important jobbers and dealers who constitute the industry's major buying power would attend the show no matter where held and that the east coast location would draw a large number of the smaller eastern dealers who have never gone to Chicago."

Applications for show space will be issued January 1st and the lists will close February 15th, so that RMA members who desire to exhibit must have their applications in before the middle of January.

It was also announced that the hotels in Atlantic City have agreed to establish the same rates for rooms as prevailed in the same week of June, 1928, 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.

RADIO OWNERS AND SALES RECORDS TO BE TAKEN

In addition to a census of radio receiving set owners in the United States, the 1930 federal census will include the first complete government record ever made of radio sales, according to a statement by the Radio Manufacturers Association.

The radio census of 1930 is being made at the direct request of the Radio Manufacturers Association, first, to secure data on the market for radio products, second, to ascertain accurately the radio audience and for radio advertising data, and third, to secure more accurate figures on the 1929 sales of radio products.

The question, "Have you a radio set in your home?" will be asked in the government census of all heads of families. This will give data on radio population with accurate detail by states and counties, as well as nationally. It will be of assistance to the Federal Radio Commission, to broadcasting interests, and also to radio advertisers, giving the coverage of broadcasters.

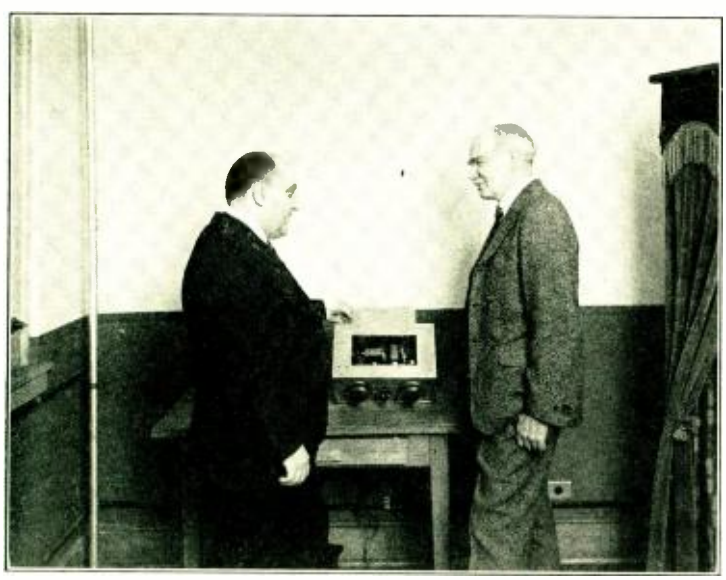
The cooperation of radio owners in making the government census complete is being urged. The information cannot be made the subject of either congressional or state taxation. This assurance has come from the Department of Commerce and Census Bureau officials. The possibility of taxation of radio receiving set owners has blocked previous attempts to take an owners census. The census law has a specific provision that the data and information secured in 1930 cannot be used for taxation purposes. Efforts in Congress in the past to have a radio owners census taken and also through the Post Office Department have been opposed because of the possibility of taxation of receiving set owners, which is opposed by radio industry interests.

The radio owners census also will give the manufacturers reliable data regarding potential markets in various states and communities. It will show the districts where radio is not extensively used as yet.

Last August when the federal authorities began work on plans for the 1930 census, the question of having the government take a radio owner census was broached to Secretary Lamont of the Department of Commerce by Bond Geddes, Executive Vice-President of the Radio Manufacturers Association. The movement was supported and assisted by broadcasting interests and also by officials of the Department of Commerce, including Mr. T. Marshall Jones, Chief of the Bureau of Electrical Equipment. Recently the negotiations for the radio census were concluded in Washington with Census Bureau officials by Mr. William Alley, Merchandising Manager for the Radio Manufacturers Association, and Mr. Frank D. Scott, its Washington legislative counsel.

In addition to the radio owners census, the Radio Manufacturers Association also arranged for a census to be taken of radio sales in 1929. This will be divided to show the value of receiving sets sold in 1929 and also other radio products, including tubes, loudspeakers, etc. This data will be secured from radio dealers. In the past only a limited number of dealers have reported to the Department of Commerce, and the new census is the first ever taken by the Census Bureau regarding radio sales.

In the census of receiving set owners no attempt will be made to ascertain the type or variety of the radio sets owned, as between battery or tube sets, or the degree of obsolescence, but the census is expected to be of great value both to broadcasting and manufacturing interests as a means of determining the radio listening population, as well as radio markets.



Dr. Lee DeForest (right) and Louis Gerard Pacent, pioneers in the radio field, who were nominated recently as President of the Institute of Radio Engineers and the Radio Club of America, respectively, are seen discussing a new development in super short-wave receivers. Dr. DeForest and Mr. Pacent have been friends for 23 years.

RMA ATTEMPTS TO RELIEVE CREDIT RESTRICTION

Efforts are being made by the Radio Manufacturers Association, through the industrial conferences initiated in Washington by President Hoover and otherwise, to prevent undue restriction of credits for radio and other time paper. Large finance companies and other financial interests handling radio and other time paper are reported to have restricted discounts recently, placing an additional burden on the sales of radio and other products sold on time payments.

Following appeals to RMA officials from radio jobbers and dealers, steps were taken, in connection with the Hoover industrial conferences, to bring the credit situation before the industrial leaders. Initial results were secured through Julius Barnes, Chairman of the United States Chamber of Commerce. Just before the recent industrial conference of this organization in Washington Chairman Barnes was sent the following telegram by President H. B. Richmond of the Radio Manufacturers Association:

"Situation regarding credit restriction on installment purchases affects radio and many industries. While some economists feel that present situation has been caused through over-production because of excess unpaid-for merchandise in hands of consumer and this condition possible through liberal extension of installment credit, we feel that sudden curtailment of such credit now being made by commercial credit organizations would be severe blow. Undue credit restriction for installment merchandise purchases will also increase unemployment because of curtailing purchases. We suggest that your conference Thursday give serious consideration to plans preventing abrupt curtailment of installment credit and believe subject requires action by your conference and other official authorities."

At the Washington conference Chairman Barnes responded by calling the attention of the large gathering of industrial leaders to this credit situation and the problem was referred to one of the working committees appointed by the conference to develop remedial action in the future. The Radio Manufacturers Association was represented at the conference by its Washington legislative counsel, Mr. Frank D. Scott, under appointment of President Richmond of the RMA.

DE FOREST EXECUTIVE OFFICES MOVE TO PASSAIC

According to the announcement of James W. Garside, President, the executive offices of the DeForest Radio Company have been moved from the Jersey City plant to the main plant at Passaic, N. J. Inasmuch as the bulk of DeForest Audions are now produced at the Passaic plant, it was decided some time ago to concentrate the main stock and shipping facilities at that point, followed by the executive offices so as to provide closer cooperation and supervision. New and larger quarters than those outgrown in the Jersey City plant have now been provided for the executive offices at Passaic.

TRIAD PRODUCTION SHOWS INCREASE

Production is on the increase in the new plant of the Triad Manufacturing Company, makers of Triad tubes, at Pawtucket, R. I., according to George Coby, president of the company in a recent interview. More than 600 employees are now on the payroll of the company bending every effort to supply the demand for Triad tubes from its jobbers and dealers throughout the country.

Increased floor space and mechanical facilities have been added in order to take care of orders which have been accumulating at the Pawtucket plant. Trade reactions from the New York, Chicago, Boston, Philadelphia and other radio shows throughout the country proved highly encouraging, according to Mr. Coby.

CECO RESEARCH DIVISION

Ernest Kauer, president of CeCo Manufacturing Co., Providence, R. I., has announced that work is starting immediately on the new research equipment installation which will take up an entire floor of the new four-story building immediately adjacent to the mammoth tube-production plant. An expenditure of $200,000 is scheduled.

"We are going a step beyond any research hitherto followed by any radio enterprise which strictly limits its production activities to tube-manufacture," Mr. Kauer said. "We not only intend to develop new tube capabilities; we also will apply them.

"Until now, tube research has been satisfied to find new possibilities in tubes and then stop short, leaving their application in circuits to receiving-set engineers. This has caused a division of energy in reaching a result.

"In our new research department, which will be completed before next Spring, we will not only conduct research for the improvement of tubes, but will also work out efficient circuits for their use."

Anticipating the question, Mr. Kauer stated that CeCo had no intention of going into the set manufacturing business.

"We simply want to aid in the most efficient use of radio tubes. There is too much lost motion, lost time, now spent between the newest tube development and its adaptation in radio sets. We want to help overcome this. By developing circuits which will immediately use the product of our research department, radio progress will be aided greatly. Such plans will be turned over to the set manufacturers for the best use they can make of them."

ESCO INCREASES PLANT SPACE

The Electric Specialty Company of Stamford, Connecticut, is increasing its manufacturing capacity approximately 40% by the erection of a two-story steel and brick addition to its plant in Stamford.

Their business has been a substantial and conservative growth every year since the organization of the company in 1913. Sales for 1929 will exceed those of their best year, 1928, by about 40%.

ESCO products are used extensively the world over; particularly has their name become famous as manufacturers of motor generators, dynamotors, converters, and aeroplane generators for radio transmission and reception, and as manufacturers of small synchronous motors. Their work is confined largely to the development of special applications, and ESCO is always glad to render such engineering service and advice as may be possible with their engineering staff. The officers of the Company are: J. M. Wright, President; M. L. Bickart, Treasurer; D. G. Shepherd, General Manager.

NEW CALLITE PLANT

The Callite Products Company recently started production in their new plant at 540 – 39th Street, Union City, N. J. This new plant is an expansion of their present plant at 547 – 39th Street, Union City and was purchased by the Callite Products Co. several months ago to take care of their rapidly expanding business in "Caltung" filament, molybdenum and their other special wire products for the radio tube and incandescent lamp industries.

These increased facilities include additional equipment for their modern molybdenum refining and wire drawing departments, cathode assembly department and departments for the manufacture of hooks, welds, cut wires and other radio tube parts.

Most of the departments in the new building are now under production and the Callite Products Co. expect, with these new facilities, they will have plant capacity to meet the demands of their customers for the present.

New plant of the Callite Products Co., at Union City, N. J.

METRIC MEASURES BEFORE CONGRESS

Declaring that adoption of the metric weights and measures by the United States will be urged energetically during the new session of Congress, Hon. Fred A. Britten of Illinois has introduced metric legislation in the House of Representatives.

Alternative resolutions have been presented by the metric champion. One resolution provides for a survey and report by the United States Secretary of Commerce on world standardization, with a view to general use of metric weights and measures by this country. The other resolution calls for adoption of the metric units in merchandising throughout the United States after a transition period of five years.

A nationwide campaign for metric legislation has been launched. The Metric Association held its annual convention in Des Moines, Iowa, on December 30th. Merchants, manufacturers, agriculturists, educators, engineers and scientists gathered to perfect plans to bring the United States onto the metric basis in 1930.

Metric advocates throughout the United States are petitioning the Secretary of Commerce, urging that he accord favorable consideration to the world metric standards. More than 300 chambers of commerce are endorsing the advance, besides scores of influential national organizations, including the National Wholesale Grocers Association, All-America Standards Council, American Chemical Society, National Wholesale Druggists Association, National Canners Association, American Institute of Architects, National Congress of Mothers and Parent-Teacher Associations, National Federation of Women's Clubs, Institute of Radio Engineers and the National Research Council.

The States of Illinois, California, Tennessee, North Dakota and Utah are among those which through their legislatures have petitioned Congress to adopt the metric standards for general use in the United States.

NFRA CONVENTION

THE 4th Annual Convention of the National Federation of Radio Associations will be held at the Statler Hotel, Cleveland, Ohio, February 10 and 11, 1930. At this time radio distributors and retailers and all of those engaged in the radio industry will be welcomed for a joint discussion of their mutual problems. The Board of Directors and officers of the Association wish to extend a cordial invitation to every one to be present at this meeting.

The Convention will be of particular interest to the radio retailers in that many of the retailers most vital problems will be discussed by authorities on the subject. That this Convention will be a "down to facts" meeting is a foregone conclusion. Radio wholesalers of national prominence as well as radio retailers of similar prominence will be in attendance at this meeting. Policies will be outlined for the operation of retailers and wholesalers organizations for the coming year. It behooves every wide-awake radio tradesman to be present at this meeting and secure all of the facts and information possible in order to help him conduct his business in a more successful manner during the coming year.

MONOWATT ELECTRIC CORP.

The Monowatt Electric Corporation now includes the plants and business of the former Connecticut Molded Products Corporation and the New England Metal Products Company, both of Meriden, Conn., in addition to its factory at Bridgeport. This means ownership, operation and control of a metal stamping plant and a plant which specializes in the manufacture of molded insulation parts. This consolidation cuts overhead and increases production efficiency. The Monowatt Electric Corporation is prepared to cooperate with manufacturers who require metal stampings molded insulation products or an assembly of the two. The company maintains offices in New York and Chicago.

UNITED STATES CIVIL SERVICE EXAMINATIONS

The United States Civil Service Commission announces the following open competitive examinations:

SENIOR RADIO ELECTRICIAN, $2,000 TO $2,500 A YEAR

RADIO ELECTRICIAN, $1,800 TO $2,100 A YEAR

JUNIOR RADIO OPERATOR (AIRWAYS), $1,620 TO $1,920 A YEAR

Applications for senior radio electrician, radio electrician, and junior radio operator (airways) must be on file with the Civil Service Commission at Washington, D. C., not later than January 29.

The examinations are to fill vacancies in the Airways Division of the Lighthouse Service, Department of Commerce, and in positions requiring similar qualifications.

The entrance salaries range from $2,000 to $2,500 a year for senior radio electrician, $1,800 to $2,100 a year for radio electrician, and $1,620 to $1,920 a year for junior radio operator (airways). Higher-salaried positions are filled through promotion.

Competitors will not be required to report for examination at any place, but will be rated on their training, experience, and fitness.

Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or from the Secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

"TEN YEARS YOUNG"

Mr. Joseph L. Ray, President of the Radio-Victor Corporation, has contributed a Foreward to the interesting booklet entitled "Ten Years Young," just published by the Radio Distributing Corporation, New Jersey Distributors of RCA products, in commemoration of their tenth anniversary.

Highlights in the history of the radio industry during the past decade are recorded in this attractively illustrated brochure, which was prepared by Miss Ruth E. Meyer of the Goldsmith Company, Newark, N. J. It also includes a valuable chronology of important milestones in radio progress, beginning with Marconi's discovery and patent in 1896 and mentioning major events in the radio industry up to the present time. This is the first chronology of its kind.

The Radio Distributing Corporation was a pioneer in radio merchandising in New Jersey, and the first to distribute RCA products exclusively. The organization has enjoyed extraordinary growth during its ten years of existence, and today its distribution service covers the state through the co-ordinated facilities of three branches, located at Newark, Asbury Park and Trenton. The officials of Radisco, as the firm is known to the trade, are Max H. Krich, President, Paul R. Krich, Vice-President, and Harry Krich, Treasurer.

Copies of the booklet may be obtained upon request from the Radio Distributing Corporation, 558 Broad St., Newark.

FIVE-DAY WEEK ADOPTED BY WARD LEONARD

Believing that the fundamental stability and expansion of business are unaffected by the recent stock market drop, Ward Leonard Electric Co., Mount Vernon, N. Y. one of the oldest electrical manufacturers in the East, announced through its President, Leonard Kebler, that effective immediately the company will operate on a five-day week. The 800 employees of the concern are to receive the same wages formerly paid for the forty-eight hour, six-day working week. The adoption of the five-day week has been under consideration for three months, Mr. Kebler said, and so firmly convinced are executives of the company of generally satisfactory business during the coming year, that it was decided to make the shorter week effective at once.

RCA-VICTOR APPOINTMENTS

Mr. E. E. Shumaker, president of the RCA-Victor Company, Inc., which began operations January 1, 1930, has announced the appointment of Major I. E. Lambert as vice-president and general counsel, and of Mr. E. C. Grimley as treasurer and comptroller of the new company.

Major Lambert at present heads the legal department of the Radio-Victor Corporation of America which will be absorbed by the new and larger company, and was previously assistant general attorney of the Radio Corporation of America for over five years.

G. J. HALLAN JOINS DE FOREST

G. J. Hallan has been appointed General Sales Manager of the DeForest Radio Company of Jersey City, N. J. Mr. Hallan has resigned as Radio Merchandise Manager of the Associated Merchandising Corporation of New York City. Prior to that connection, he was Field Sales Manager of C. D. Black & Company of New York City, and General Sales Manager of the Merchandise Division of Sperry & Hutchinson Company of New York.

CECO PROMOTES N. O. WILLIAMS

N. O. Williams, Chief Engineer of the CeCo Manufacturing Company, of Providence, has been made Works Manager, according to an announcement by Ernest Kauer, president of the company. Mr. Williams is also a vice-president of Ceco.

CLORE JOINS U. S. ELECTRICAL TOOL

Announcement is now being made by The United States Electrical Tool Company, Cincinnati, of the appointment of Ralph H. Clore as new general sales manager. He succeeds George M. Lawrence who, after a number of years as branch manager and general sales manager resigned to become vice-president of the General Radial Drill Company, also of Cincinnati.

Mr. Clore is well qualified for this new position, having had actual production experience, and having served as branch sales manager for this company for the past several years. He is thoroughly acquainted with the portable electric tool and machine fields.

In the Swiss Alps—Above the Clouds—
The Voice of PAM

PAM 16, Price $125.00

brings the news of the far-away world to chalet hotels. PAM brings music that echoes and re-echoes across deep chasms and moon-tipped glaciers . . PAM transfers the sophisticated entertainment of the world's capitals to mountain solitudes . . .

For all winter sports . . . skating to music on moon-lit lakes . . . skiing . . . tobogganing . . . PAM is used for announcing events as well as amplifying music from radio or phonograph.

PAMs faithfully amplify any sound from a microphone, phonograph, or radio set, to a volume which can be regulated for the largest or the smallest indoor or outdoor audience.

And PAMs are the heart of an installation comprising radio set, phonograph pick-up, wiring for each room, and loud speakers that should be in every hotel, school, church, auditorium, arena, skating rink, theatre and dance hall.

Are you making handsome profits from such installations right now?

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations, and many new PAM Amplifiers, will be sent upon receipt of 10 cents in stamps to cover postage. When writing ask for Bulletin No. RE 8.

Samson Electric Co.

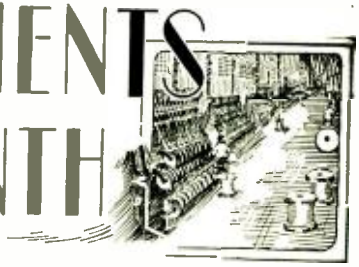
MANUFACTURERS SINCE 1882

MEMBER R.M.A.

Main Office:
Canton, Mass.

Factories: Canton and
Watertown, Mass.

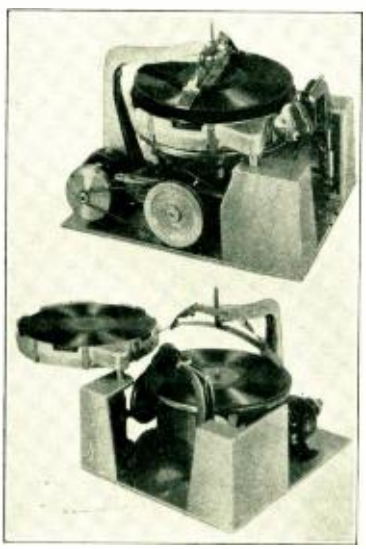
NEW DEVELOPMENTS OF THE MONTH



THE KRASBERG "MUSICPHONE"

The "Musicphone" is a unique, automatic machine or playing and changing talking-machine records. It s made by the Krasberg Tool & Mfg. Co., of Chicago, its designers.

While primarily designed for those manufacturers making special automatic console machines, it has found popularity in other fields. One of these is in music stores where an automatic machine has long been needed for changing and repeating demonstration records all day long.



The "Musicphone," shown in the record changing and playing position.

Essentially, the Musicphone consists of a turntable and electromagnetic pickup for playing standard 10-in. discs. At its completion, a record is picked up and gently clamped into a special ring holder. Another record is dropped onto the turntable, the machine again started and the pickup unit returned to playing position and lowered onto the record. The complete change requires but 15 seconds.

Sturdily built, the mechanism is driven by oversize motors. Each, the turntable and record changing mechanism, is geared to a 1/50th horsepower motor. The turntable speed is continuously adjustable by a governor, running between 78 and 80 r. p.m.

When the last record of a lot has been played the entire group will be repeated if the machine is left going.

GRAYBAR CRYSTAL CONTROL UNITS

Crystal control for 500-watt broadcasting stations has been made available by the Graybar Electric Company through a new oscillator unit, just developed by the Bell Telephone Laboratories.

Extraordinary improvement in the broadcasting efficiency of stations of this low power, of which there are approximately 70 in this country, is possible through the use of crystal control, heretofore unavailable, according to A. J. Eaves, head of the Research Products Sales Department of the Graybar organization. He points out—since there are more 500-watt stations in existence than those of any other type—that the new oscillator unit is expected to materially enhance the reception enjoyment of millions of radio listeners.

Stabilizing of a set frequency, one of the most difficult problems of broadcasting science, is an important feature of crystal control, through the oscillator unit. Mr. Eaves declares. The temperature control of the quartz oscillator and the circuit arrangement of the new unit are such that the frequency may be readily maintained within 50 cycles or less of its designated value, he states.

While this new type of crystal control, designated as the D-90684 oscillator unit, was primarily designed to convert the Western Electric 1-A and 1-B transmitters into crystal control of frequency, it also may be applied to any transmitter requiring not more than 30 watts of carrier frequency input. The frequency range of the equipment is from 550 to 1500 kc., according to the announcement.

The circuit consists of a crystal controlled oscillator, followed by three stages of amplification. The circuit, which is arranged for connection to external sources of filament and plate supplies, is mounted on a relay rack, on which is also an interchangeable panel. On this latter panel is mounted suitable equipment for connecting the heater circuit of the crystal chamber to either alternating- or direct-current supply as ordered.

When furnished with equipment for alternating current, either 220 or 110 volts may be used from a single phase of 25-60 cycle supply. When furnished with equipment for direct current, either 220 or 110 volt supply may be used.

Many of the outstanding broadcasting stations now employ the crystal control type of oscillator units. Among these are the 50,000-watt Western Electric stations of WLW, Cincinnati, and of WABC, New York—the latter now being completed for use about February of 1930.

STEVENS PORTABLE A-C. AND BATTERY PHONOGRAPH

The Stevens Manufacturing Corporation of Newark, N. J., announces the production of a new portable electric phonograph that incorporates several novel features. The portable is enclosed in a black leather carrying case and resembles in size and appearance the conventional portable phonograph. The assembly is driven by the Stevens silent motor with step-down transformer and rectifier operating directly from the usual a-c. lighting lines.

A phonograph sound box and arm delivers the music to a built-in hartex or laminated cloth horn which utilizes the angle of the carrying case cover as a sound reflector.

An original feature of the new phonograph is the incorporation of a small battery compartment. When the portable is used in a boat or on a picnic, where no a-c. is available, a small switch disconnects the a-c. rectifier and substitutes the battery source. There is no provision for manual winding as it need never be resorted to. An expanding leaf in the cover of the carrying case makes it possible to carry a moderate quantity of records in the phonograph itself.

THE STEVENS-SIBLEY ELECTRIC PHONOGRAPH MOTOR

The Stevens-Sibley electric phonograph motor is unique in that it is non-sparking and has no gears or springs. It runs smoothly and quietly without objectionable hum. The drive is against the outer rim of the turntable, which insures even, balanced movement. It has a speed adjustment, giving all speeds required for correct or modified reproduction. There are no exposed parts, all elements being enclosed in a substantial cast metal housing which is dust- and moisture-proof. The motor requires no attention whatever, not even lubrication. The non-sparking feature makes this motor particularly desirable for use with electric pickups for the electrical reproduction of records.

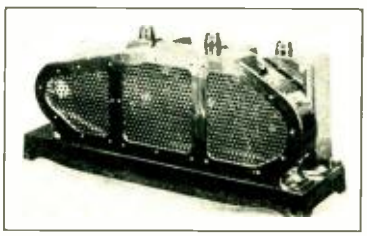
The motor is designed to operate on direct current furnished either by standard dry cells, or on stepped-down and rectified alternating-current supply. The current drain is so low that long life is assured from a set of dry cells, or again from the dry disc rectifier when operating on a-c. socket power.

The Stevens Manufacturing Corporation of Newark, N. J., manufactures not only the Stevens-Sibley motor, which is employed in several a-c. and battery portable phonographs, but also the die cast and balanced turntable and motor bracket, making a most convenient unit.

HIGH VACUUM PUMPING UNIT FOR AUTOMATIC EXHAUSTING MACHINES

The Central Scientific Company, of Chicago, has met the demand for a compact pumping unit for the production of high vacuum on the present types of automatic exhausting machines, used in quantity production of radio tubes, by mounting the well-known Cenco Megavac pumps, three to a unit, which they designate as the Cenco Megavac Triple Unit Pump.

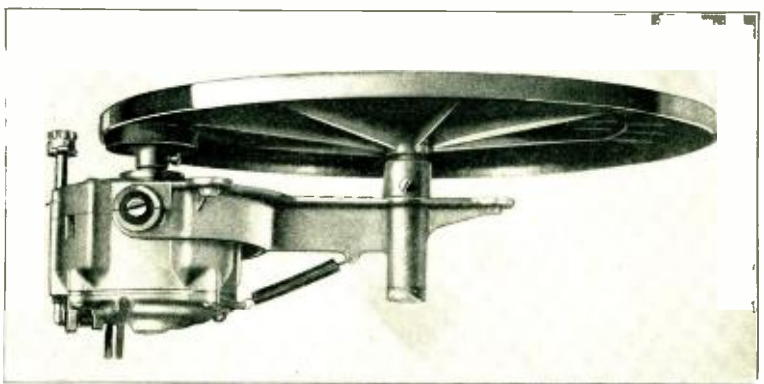
The Cenco Megavac Triple Unit pump consists of three Cenco Megavac pumps, mounted on a cast iron



The Cenco Megavac Triple Unit Pump.

base, 15x42 inches over-all, with a one horsepower motor driving the pumps by means of silent, molded rubber V-belts. Ball-bearing idler pulleys are also provided to permit easy adjustment of the belt tension.

The Cenco Megavac pumps, used on the Triple Unit mounting, are all laboratory tested and must attain a vacuum better than 1/10th micron on a test system equipped with a McLeod gauge before they are released.



The Stevens-Sibley electric phonograph motor, with turntable.

The manufacturers recommend that the usual connecting tubes from the sliding valve of the automatic exhausting machine to the pumps be replaced with connecting tubes of not less than 5/8" internal diameter, as the rate of evacuation to pressures of one micron or less is largely dependent upon the diameter of the connecting tube and its length. Experimental data upon the rate of exhaustion at these low pressures shows that the rate of flow of gases through tubes is proportional to the cube of the diameter of the tube divided by its length. Therefore, when the diameter of the connecting tube is doubled, and the length is not changed, the rate is increased by eight times. In using large diameter connecting tubes from the pump to the sliding valve, the tubes must be drawn or swedged down on one end to permit the connection to be made with the sliding valve.

When large diameter connecting tubes are used, six Cenco Megavac Triple Unit pumps will be adequate, without other pumping equipment, to exhaust any type of radio tube on a 21 head automatic exhaust machine.

JENKINS & ADAIR VARIABLE ATTENUATOR

Jenkins & Adair, 3333 Belmont Ave., Chicago, Ill., are offering a new variable attenuator, an accurate instrument designed for broadcast, recording and laboratory measurement. This apparatus consists of a rotating switch mechanism in conjunction with a group of H-type resistance networks. The range is from 0 to 20 db. in steps of 2db. The device is made in two types; the GA-200 for 200-ohm audio circuits, and GA-500 for 500-ohm audio circuits.

Jenkins & Adair Variable Attenuator.

While a simple voltage dividing device, such as a potentiometer, is suitable for controlling volume in a circuit containing a voltage component only, it always produces distortion of the frequency characteristic in a circuit containing both voltage and current components. The only convenient method of avoiding such distortion is to introduce into such a circuit an H-type resistance network, long familiar in telephone practice and often referred to as a "line pad".

The accompanying illustration shows the back of an attenuator with cover removed. The rugged detent mechanism may be seen, and the sixty contact points which are connected to as many accurate resistance units. The instrument is dustproof and of very heavy construction. The broadcaster will find these attenuators most useful at the terminus of remote control pairs, and in the input circuits from mixing panels. The recorder will find similar uses. They are valuable wherever it is desirable to introduce a known loss in an audio circuit, and where absence of distortion is essential.

NEW JEFFERSON TUBE CHECKER

A new and simplified tube checker for a-c. tubes, has just been perfected by the Jefferson Electric Company, 1500 South Laflin Street, Chicago, after several years of experimentation and research. With only two readings, it is possible to determine the condition of all popular makes of a-c. tubes.

The test is extremely simple. Place the tube in the proper socket and note the reading. Then press the small button and note the second reading. The difference between the two readings indicates accurately the amplification and the mutual conductance of the tube. The greater the difference in readings the greater the amplification.

Each tester is furnished with complete instructions including a scale which will enable the user to determine whether the tube is good, fair, or poor. By other indications, it is possible to know whether the plate and grid are shorted, whether the plate is open, and whether the filament is open or shorted. The initial reading is an indication of the filament emission and plate resistance. The tester consists of six sockets, one each for the -26, -27, -24, -45, -71A and -80 type tubes, a milliammeter, a push button, and the connection for testing screen-grid tubes.

The Jefferson a-c. Tube Checker will sell to the dealer at $13.50 net.

New Jefferson Tube Checker.

PIERCE-AIRO MARKETING BATTERY CHASSIS

Pierce-Airo, Inc., manufacturers of the "Pierce-Airo A-C. Chassis," announce the introduction of a screen-grid battery chassis for which they report a considerable demand.

This battery chassis has three stages of radio-frequency including one stage of screen-grid amplification. It has an illuminated drum dial, compartment for "B" and "C" batteries, and is of rugged steel construction. The tubes required are one -22 screen-grid and five -12-A power tubes. The manufacturers, Pierce-Airo, Inc., 117 Fourth Avenue, New York City, will quote a price for the chassis alone and also for a metal cabinet model.

NEW INSULINE NOISE ELIMINATOR

The Insuline Corporation of America announces the development of an improved light duty noise eliminator, for all-electric radio receivers, known as the New Model Filtervolt, Jr.

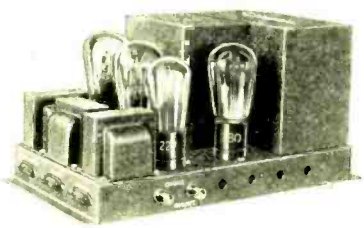
The new Filtervolt, Jr., while retaining all the points of superiority of the original model, has been improved in a number of important respects. A recently developed filter system, operating on an entirely new principle of resonance, permits the use of much smaller condensers and chokes. This makes it possible to incorporate greatly increased noise eliminating properties in the same compact space.

The Filtervolt, Jr., is particularly adapted for use in eliminating the more common disturbances from household appliances, such as vacuum cleaners, sewing machines, electric fans, electric heating pads, the switching "on" and "off" of electric lights, electric toasters, floor polishers, drink mixers, dial telephones and all appliances using small motors of one-sixteenth horsepower or less.

NEW "THOMAS" POWER AMPLIFIER

The Thomas Engineering & Manufacturing Co., of St. Charles, Ill., makers of wound condensers, have started production on a power amplifier which is very compact yet having a very high output.

The new Thomas amplifier is only 14 inches long, 7⅝ inches wide and 7¼ inches high and is entirely a-c. operated. The amplifier uses an -80 type rectifier, a -27 tube in the first audio stage, or a -26 tube, depending upon which type of amplifier is ordered, and two -45 tubes in push-pull in the power stage.



New "Thomas" a-f. amplifier.

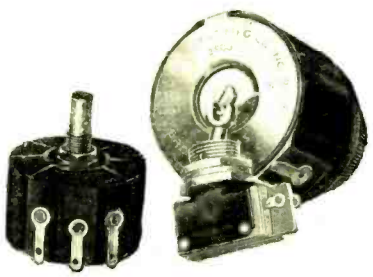
It is stated that the manufacturers model will furnish 65 to 70 mils for the field of a d-c. dynamic speaker and that the amplifier can be used with speakers with or without an input transformer.

The manufacturers state that they are in a position to meet any production that might be demanded of them.

NEW CLAROSTAT VOLUME CONTROL

Because of the installation of unique winding equipment designed and constructed by its engineering staff, the Clarostat Mfg. Co., Inc., of Brooklyn, N. Y., is now in position to offer wire-wound volume controls matched to any resistance curve. The bakelite strip employed in the volume control clarostat may be tapered in any portion, the spacing of the turns may be varied, and different sizes of wire may be incorporated in the same winding, in meeting special requirements.

Mechanically, the new wire-wound volume control clarostat comprises a bakelite casing with metal end plate, providing ample protection against tinkering, dust, dirt and moisture. A special form of contact provides smooth operation. Absolute contact at all times provides silent operation, even in the most critical radio circuits. Each device is tested for a rigid minimum noise tolerance before it is shipped. There is no appreciable wear on the winding, even when using the finest gauge wire for high resistance values. The device is available in any resistance range up to 50,000 ohms, and to match any resistance curve. It is a one-hole mounting job, provided with three soldering tabs, for handy installation.



Clarostat volume control with and without power switch.

CLAROSTAT VOLUME CONTROL WITH POWER SWITCH

As a further contribution towards simplifying the broadcast radio set panel, a combination volume control and power switch is now offered by the Clarostat Mfg. Co., Inc., of Brooklyn, N. Y. This device comprises the standard wire-wound volume control Clarostat, with an extension pin on the shaft to trip a toggle power switch, mounted at the rear of the assembly. In this way, one knob serves the double function of turning the radio set on and off, and adjusting the volume to any desired degree. A bakelite case with metal end cap protects the winding and contact member from mechanical injury quite as well as dirt, dust and moisture. The device turns with a smooth, velvety action, without introducing noise even in the most critical radio circuit. The winding can be tapered so as to match any resistance curve, and in any value up to 50,000 ohms. The knob turns 300 degrees as a volume control, plus 40 degrees to turn the power switch off and on.

NEW AMRAD SET

A new radio receiver, to be known as the "Minuet," has been added to its 1929 Bel Canto series, it is announced by the Amrad Corporation of Medford Hillside, Mass. The new set will retail for $158.00.

The new "Minuet" is a console of fine walnut and lace wood. It uses eight tubes, including three screen-grid tubes and two -45 tubes in push-pull; the Mershon Condenser, an extra-heavy chassis, and a nine-inch electric speaker mounted on a baffle board.

H. J. L. AMPLIFIERS

Two compact amplifiers are announced by the H. J. L. Laboratories of Chicago. The two sizes are standard and require a space of but 11¼"x7½"x6¾".

The most powerful, Model 250, employs a type '50 output tube and will deliver a 4.7-watt undistorted output to a properly designed speaker system. Its over-all gain is 62 decibels at 1,000 cycles. Its current consumption at 110 volts is 65 watts and the shipping weight 20 pounds. This model was designed for theatre or other large coverage use.

The smaller Model 245 utilizes a '45 tube in the output stage. Its rated output is 1.7 watts. Over-all gain is 57 decibels at 1,000 cycles, current consumption 40 watts at 110 volts and shipping weight 15 pounds.

Both models have a pre-amplifier stage consisting of a '24 type tube used as a resistance-coupled space-charge amplifier. Plate supply comes from a built-in '81 rectifier and associated filter. Binding posts allow a 2,500-ohm dynamic speaker field coil to be used as a filter choke.

Each model should be worked out of a 100,000 ohm impedance and into a 4,000-ohm speaker circuit. In order to obtain full rated output an input of .25 volt is necessary.

One of the new H. J. L. a-f amplifiers.

Televocal
Quality Tubes

The Televocal Screen Grid Tube AC 224 is a triumph of economic engineering. To *Set Manufacturers* it offers a tube that is long-lived and built to stand any strain. A long series of factory inspections and tests insure uniformity in quality and performance. To the *Consumer* it offers greater sensitivity and selectivity, more volume and fidelity of tone and quicker heating. To the *Dealer* it offers a tremendous, popular demand for this revolutionary achievement and insures customer satisfaction.

Prepare against a possible shortage by ordering now.

Televocal Tubes are made in all standard types.

National Union Radio Corporation

No. AC 224 Screen Grid

Televocal Division Dep't C2 400 Madison Ave. New York City

NOW D-C TUBES *by* ARCTURUS

There's an ARCTURUS *Radio Tube for Every Popular Set*

A-C Tubes

127 Detector Amplifier
124 A-C Screen Grid
126 Amplifier
145 Power Amplifier
150 Power Amplifier
071 Power Amplifier
180 Full Wave Rectifier
181 Half Wave Rectifier

D-C Tubes

012-A Power Amplifier and Detector Amplifier
101-A Detector Amplifier
099 Detector Amplifier
122 D-C Screen Grid
071-A Power Amplifier

Built to the Same High Standards That Made Possible Arcturus A-C Superiority

YOU know what the name Arcturus means on a radio tube! Quick action, quiet performance, long life. This kind of service has made Arcturus Tubes famous throughout the radio industry...a symbol of dependable tube performance wherever A-C sets are manufactured.

Now Arcturus announces *Direct-Current* Tubes, measuring up to Arcturus quality standards in every respect.

Radio engineers and set manufacturers who have standardized on Arcturus A-C Tubes for test and experimental purposes can use Arcturus D-C Tubes with the same confidence. For uniformly good operation of any a. c. or d. c. set use Arcturus Tubes.

ARCTURUS
RADIO TUBE
COMPANY
Newark, N. J.

ARCTURUS
LONG LIFE
RADIO TUBES

"HiQ-30"

Custom-Built From

WORLD FAMOUS PARTS

UST like adding two and two to get four —the result is inevitable when you combine a most efficient circuit with parts the whole radio world respects.

The "HiQ-30" *Band-Filter* Radio is Hammarlund-designed and Hammarlund-built. That's all the insurance of quality anyone needs. It is available as a complete kit or you may purchase any of its units separately for experimentation.

Write Dept. RE1 for Information

HAMMARLUND MANUFACTURING CO.
424-438 W. 33rd St., New York, N. Y.

For Better Radio
Hammarlund
PRECISION
PRODUCTS

M&W Co. 1876

LACQUERS ENAMELS

Speaker Cement No. 54

A Permanent, Quick-Setting, Light Colored M & W Cement for hand or machine application on Cone Seams, Edges, Apex or Leather.

Adopted by many manufacturers because it is an *Improvement.*

Our Consulting and Advisory Service, based upon Specialized Experience in the Radio Industry, will help you.

Your inquiry is invited.

Maas & Waldstein Company

Executive Offices and Plant, 438 Riverside Ave., Newark, N. J.

Chicago Office and Warehouse 1115 W. Washington Blvd.

Los Angeles Office and Warehouse 1214 Venice Blvd.

LYNCH Resistors

Complete line of Resistors for every resistance need. Guaranteed accurate, permanent, noiseless, popular. The name Lynch is your assurance of Quality, Service, Dependability and Reasonable prices.

LYNCH DYNOHMIC Resistors

Capacities range from 250 ohms to 10 megohms. ½, 1 and 2 watt types. The resistance element is based on the famous metallized principle which has proved its superiority where accuracy and uniformity are of paramount importance. The molded end caps insure positive mechanical and electrical contact. The tinned copper pigtails are molded into the caps—not soldered or strapped thereto.—proof against noise caused by faulty construction. List prices range from 50c for ½ watt types to 85c for 2 watt types.

Cartridge or Pigtail Type

LYNCH VERITAS Resistors

Cartridge or Pigtail Type

Made in four sizes with 2 watt, 5 watt and 10 watt ratings. Capacities range from 500 ohms to 10 megohms. The Lynch Veritas Resistors have the metallic resistive coating fused to the inside of the glass, and can run a great heat without change in value. Not affected by humidity—non-absorbent. It is as perfect a resistance as can be made. 85c list for 2 watt types, $1.00 list for 5 watt types, and $1.25 list for 10 watt types.

Lynch Products are:

- Approved by leading engineers.
- Endorsed by test and experimental laboratories.
- Employed by scientific apparatus and precision instrument makers.
- Selected by discriminating radio receiver manufacturers.

TUBADAPTA

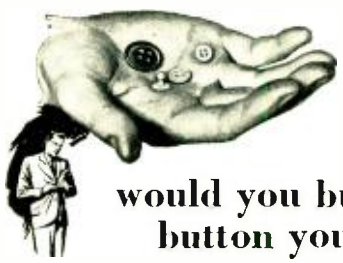
for ALL SETS
Improves TONE. Safeguards power tube. 4 models, to fit any radio set. List $2.50 each.

Write NOW for 4-page folder illustrating and describing our Complete Line, and 40-page book on Resistances.

LYNCH MANUFACTURING CO., INC.,
(formerly Arthur H. Lynch, Inc.)
1775 B'way New York, N. Y.

Manufacturers of
LYNCH RESISTORS, EQUALIZORS, SUPPRESSORS, MOUNTINGS, RESISTANCE-COUPLED KITS, *ETC.*

Which ?..



would you buy to button your coat?

There'd be no efficiency in a collar button or shirt button, would there? Similarly, there is little efficiency in a *RESISTOR* unless it is the right capacity, built to do the specific job.

Even a slight variation *in* specifications or *from* them can result in a marked loss of service.

We specialize in Resistors. Our stock models embrace a generous range of sizes, types, capacities and mountings. For special models—we usually can have finished samples on their way to you within 72 hours after your specifications reach us.

Our New Catalog

No. 429 is a veritable handbook of Resistor knowledge, Resistance Tables, suggestions and information. A request on your letterhead will bring your copy, post-haste.

RESISTORS

HARDWICK, HINDLE, Inc.

Sales: 122 Greenwich St., New York City

Factory: 215 Emmet St., Newark, N. J.

Buyers Directory of Materials and Apparatus

Readers interested in products not listed in these columns are invited to tell us of their wants, and we will inform the proper manufacturers. Address Readers' Information Bureau.

Addresses of companies listed below, can be found in their advertisement—see index on page 78

ADAPTERS:
Lynch, Arthur H., Inc.

ALUMINUM:
Aluminum Co. of America
National-Harris Wire Co.

AMMETERS:
Ferranti, Inc.
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Instrument Corp.

AMPLIFIERS, POWER:
Ferranti, Inc.
G. M. Laboratories, Inc.
General Amplifier Co.
General Radio Co.
H. J. L. Laboratories
Radio Receptor Co., Inc.
Samson Elec. Co.

ANTENNAE, LAMP SOCKET:
Dubilier Condenser Mfg. Co.
Electrad, Inc.

ARRESTERS, LIGHTNING:
Jewell Elec. Inst. Co.

BASES, SPEAKER:
American Felt Co.
Booth Felt Co.

BASES, VACUUM TUBE:
(See Tube Parts)

BATTERY COMPOUNDS:
Mitchell Rand Mfg. Co.

BEARINGS, RADIALL:
Chicago Gear Works

BENCHES, STEEL WORK:
Standard Pressed Steel Co.

BINDING POSTS:
General Radio Co.

BRACKETS, ANGLE:
Electrad, Inc.
Scovill Mfg. Co.

BRASS:
Baltimore Brass Co.
National-Harris Wire Co.
Scovill Mfg. Co.

BROADCAST STATION EQUIP'T:
Cardwell, Allen D., Mfg. Co.
Ferranti, Inc.
General Radio Co.
Jenkins & Adair, Inc.

BUTTS:
Scovill Mfg. Co.

CABINETS, METAL:
Aluminum Co. of America
Metal Specialty Co.

CELLS, PHOTOELECTRIC:
Burt, Robert C.
G. M. Laboratories, Inc.
National Carbon Co., Inc.

CEMENT, LOUD SPEAKER:
Maas & Waldstein Co.

CENTRALIZED RADIO SYSTEMS:
Ferranti, Inc.
Samson Elec. Co.

CHASSES
Aluminum Co. of America
Metal Specialty Co.

CHOKES, AUDIO FREQUENCY:
American Transformer Co.
Ferranti, Inc.
General Radio Co.
Jefferson Electric Co.
Thordarson Elec. Mfg. Co.
Transformer Co. of Amer.

CHOKES, RADIO FREQUENCY:
Cardwell, Allen D., Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co., Inc.
Samson Elec. Co.

CHOKES, B ELIMINATOR:
American Transformer Co.
Dongan Elec. Mfg. Co.
Ferranti, Inc.
General Radio Co.
Jefferson Electric Co.
Polymet Mfg. Corp.
Transformer Co. of Amer.

CLAMPS, GROUND:
Fahnestock Elec. Co.
Scovill Mfg. Co.

CLIPS, SPRING:
Electrad, Inc.
Fahnestock Elec. Co.
Scovill Mfg. Co.

COIL FORMS:
General Radio Co.

COIL WINDING:
Acme Wire Co.
Dudlo Mfg. Co.
Inca Mfg. Co
Meissner Mfg. Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, CHOKE:
Acme Wire Co.
Dudlo Mfg. Co.
Ferranti, Inc.
Jefferson Electric Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, IMPEDANCE:
Acme Wire Co.
Dudlo Mfg. Co.
Ferranti, Inc.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, INDUCTANCE:
Acme Wire Co.
Cardwell, Allen, D., Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
Inca Mfg. Co.
Rome Wire Co.

COILS, MAGNET:
Acme Wire Co.
Dudlo Mfg. Co.
Inca Mfg. Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, SHORT WAVE:
General Radio Co.
Hammarlund Mfg. Co.

COILS, TRANSFORMER:
Acme Wire Co.
Dudlo Mfg. Co.
Polymet Mfg. Corp.
Rome Wire Co.

CONDENSER PARTS:
Aluminum Co. of America
Ferranti, Inc.
Metal Specialty Co.
Scovill Mfg. Co.

CONDENSERS, BY-PASS:
Acme Wire Co.
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.
Fast, John E. & Co.
Ferranti, Inc.
Polymet Mfg. Corp.
Potter Co., The
Thomas Engineering & Mfg. Co.
Wireless Specialty Apparatus Co.

CONDENSERS, FILTER:
Acme Wire Co.
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Fast, John E. & Co.
Polymet Mfg. Corp.
Potter Co., The
Thomas Engineering & Mfg. Co.
Wireless Specialty Apparatus Co.

CONDENSERS, FIXED:
Acme Wire Co.
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.
Fast, John E., & Co.
Polymet Mfg. Corp.
Potter Co., The
Thomas Engineering & Mfg. Co.
Wireless Specialty Apparatus Co.

CONDENSERS, MIDGET:
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
Scovill Mfg. Co.
United Scientific Laboratories

CONDENSERS, MULTIPLE:
Cardwell, Allen D. Mfg. Co.
Hammarlund Mfg. Co.
Scovill Mfg. Co.
United Scientific Laboratories

CONDENSERS, NEUTRALIZING:
Hammarlnnd Mfg. Co., Inc.
Polymet Mfg. Corp.

CONDENSERS, VARIABLE TRANSMITTING:
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.

CONDENSERS, VARIABLE:
Cardwell, Allen D. Mfg. Co.
Frost, Herbert H., Inc.
General Radio Co.
Hammarlund Mfg. Co.
Scovill Mfg. Co.
United Scientific Laboratories

CONNECTORS:
Scovill Mfg. Co.

CONTROLS, CURRENT:
Allen Bradley Co.
Central Radio Laboratories
Polymet Mfg. Corp.
Shallcross Mfg. Co.

CONTROLS, VOLUME:
Allen Bradley Co.
Central Radio Laboratories
Clarostat Co.
Electrad, Inc.
Ferranti, Inc.
Polymet Mfg. Corp.
Radio Receptor Co., Inc.

CONVERTERS:
Cardwell, Allen D., Co.
Electric Specialty Co.

CONVERTERS, ROTARY:
Electric Specialty Co.
Janette Mfg. Co.

COPPER:
Baltimore Brass Co.
Scovill Mfg. Co.

CORD CONNECTORS:
Rodale Mfg. Co.

CORDS, EXTENSION:
Acme Wire Co.
Rodale Mfg. Co.

COUPLINGS, FLEXIBLE:
Chicago Gear Works
Hammarlund Mfg. Co., Inc.

CURRENT CONTROLS, AUTOMATIC:
Radiall Co.

CUSHIONS, SPEAKERS:
Western Felt Co.

DIALS:
Crowe Nameplate & Mfg. Co.
General Etching & Mfg. Co.
Hammarlund Mfg. Co.
Scovill Mfg. Co.
United Scientific Laboratories

DIALS, DRUM:
Hammarlund Mfg. Co.
United Scientific Laboratories

DIE-CASTINGS:
Allied Die-Casting Corp.

DIES:
Willor Mfg. Corp.

DYNAMOTORS:
Electric Specialty Co.

ESCUTCHEONS:
Crowe Nameplate & Mfg. Co.
General Etching & Mfg. Co.
Scovill Mfg. Co.

EXPORT:
Ad. Auriema, Inc.

FELT, ACOUSTICAL:
American Felt Co.
Booth Felt Co.
Western Felt Co.

FELT, PACKING:
American Felt Co.
Booth Felt Co.
Western Felt Co.

FILAMENTS:
(See Tube Parts)

FILAMENT CONTROLS, AUTOMATIC:
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Radiall Co.

FOIL, ALUMINUM:
Aluminum Co. of America

FRICTION TAPES:
Mitchell Rand Mfg. Co.

GALVANOMETERS:
Ferranti, Inc.
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.

GEARS:
Chicago Gear Works

GENERATORS:
Electric Specialty Co.
Janette Mfg. Co.

GETTER MATERIAL:
(See Tube Parts)

GRID LEAKS:
(See Resistances, Fixed)

HEADPHONES:
Amplion Co. of Amer.

HINGES:
Scovill Mfg. Co.

HORNS:
Amplion Co. of Amer.

INDUCTANCES, TRANSMITTING:
General Radio Co.

INSTRUMENTS, ELECTRICAL:
Ferranti, Inc.
General Electric Co.
Jewell Elec. Inst. Co.

INSULATION LAMINATED
Electrical Insulation Corp.
Formica Insulation Co.
General Electric Co.
National Vulcanized Fibre Co.
Synthane Corp.

INSULATION, MOULDED:
Bakelite Corp.
Formica Insulation Co.
General Electric Co.
General Plastics Co.
Monowatt Elec. Corp.
National Vulcanized Fibre Co.
Synthane Corp.

INSULATION, VARNISHED:
Acme Wire Co.
Mitchell Rand Mfg. Co.

JACKS:
Carter Radio Co.
Electrad, Inc.
General Radio Co.

KITS, TESTING:
(See Testing Kits)
General Radio Co.
Jewell Elec. Inst. Co.

LABORATORIES, TESTING:
Electrical Testing Labs.
Wireless Egert Engineering, Inc.

LACQUER, WOOD:
Maas & Waldstein Co.

LACQUER, METAL:
Maas & Waldstein Co.

LACQUER, ENAMEL:
Maas & Waldstein Co.

LAMINATIONS:
Lamination Stamping Co.
Willor Mfg. Corp.

LAMPS, MINIATURE:
National Carbon Co., Inc.

LAMPS, PANEL:
National Carbon Co., Inc.

LAMPS, SOUND RECORDING:
G. M. Laboratories, Inc.

LEAD-INS:
Electrad, Inc.

LOCK WASHERS:
Shakeproof Lock Washer Co

LUGS:
Scovill Mfg. Co.
Shakeproof Lock Washer Co.

MACHINERY, TUBE:
American Transformer Co.
Arrow Mfg. & Machine Co., Inc.
Engineering Co., The
Central Scientific Labs.
Eisler Electric Co.
Int'l Machinery Works, Inc.
Lepel High Frequency Labs.
Manhattan Electric Bargain House, Inc.

MACHINES, SPECIAL
Willor Mfg. Corp.

MAGNESIUM:
Aluminum Co. of America.

METAL RADIO PARTS:
The Metal Specialty Co.

METALS, RARE:
Fansteel Products Co., Inc.
American Electro Metal Corp.

METERS:
Ferranti, Inc.
General Electric Co.
Jewell Elec. Inst. Co.
Weston Elec. Instr. Co.

MICROPHONES:
Amplion Co. of America
Electro-Acoustic Prod. Co.
Jenkins & Adair, Inc.
Radio Receptor Co., Inc.
Universal Microphone Co.

MOLDING MATERIALS
(See Insulation, Moulded)

MOTORS:
Electric Specialty Co.

MOTOR-GENERATORS:
Electric Specialty Co.

MOUNTINGS, RESISTANCE:
Electrad, Inc.
Lynch Mfg. Co., Inc.
Polymet Mfg. Corp.

NAMEPLATES:
Crowe Nameplate & Mfg. Co.
General Etching & Mfg. Co.
Scovill Mfg. Co.

NICKLE SILVER:
National-Harris Wire Co.
Riverside Metal Co., The

NUTS:
Shakeproof Lock Washer Co.

OHMMETERS:
General Radio Co.
Weston Elec. Instru. Co.

OSCILLOGRAPH:
The Beltone Corp, Ltd.
General Radio Co.

OSCILLOSCOPE:
The Beltone Corp., Ltd.

PACKING PADS, CABINET:
American Felt Co.
Booth Felt Co.
Western Felt Co.

PACKING MATERIAL:
Holed-Tite Packing, Inc.

PANELS, COMPOSITION:
(See Insulation, Moulded)

PANELS, METAL:
Aluminum Co. of America
Metal Specialty Co.
Radio Receptor Co., Inc.
Scovill Mfg. Co.

PAPER, CONDENSER:
Dexter, C. H. & Sons, Inc.

PAPER, CONE SPEAKER:
Seymour Co.

PARTS, SCREW MACHINE:
Standard Pressed Steel Co.

PHONOGRAPH MOTORS:
(See Motors)

PHOSPHOR BRONZE:
Baltimore Brass Co.
National-Harris Wire Co.
Riverside Metal Co.

PHOTOELECTRIC CELLS:
(See Cells)

PICK-UPS, PHONOGRAPH:
Amplion Co. of Amer.
Electro-Acoustic Prod. Co.
Hardwick, Hindle, Inc.
Jensen Co.

PLATES, OUTLET:
Carter Radio Co.

PLUGS, ATTACHMENT:
Carter Radio Co.
General Radio Co.
Polymet Mfg. Corp.
Rodale Mfg. Co.

POTENTIOMETERS:
Allen-Bradley Co.
Central Radio Laboratories
Electrad, Inc.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories

POWER UNITS, A-:
Jefferson Electric Co.
Radio Receptor Co., Inc.

POWER UNITS, B-:
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Thordarson Electric Mfg. Co.

POWER UNITS, A-B-C:
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Thordarson Electric Mfg. Co.

POWER UNITS, PARTS FOR:
Acme Wire Co.
American Transformer Co.
Dongan Elec. Mfg. Co.
Ferranti, Inc.
General Radio Co.
Jefferson Electric Co.

Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Thordarson Electric Mfg. Co.
Transformer Co. of Amer.

PRESSED METAL PARTS:
The Metal Specialty Co.

PUBLIC ADDRESS SYSTEMS:
Radio Receptor Co., Inc.
Samson Elec. Co.

PULLEYS:
Chicago Gear Works

PUMPS, HIGH VACUUM:
Arrow Mfg. & Machine Co., Inc.
Central Scientific Co.
Eisler Elec. Corp.
Int'l Machine Works, Inc.

PUNCHINGS:
Aluminum Co. of America
The Metal Specialty Co.
Scovill Mfg. Co.

PUNCHINGS, BAKELITE:
Electrical Insulation Corp.

RECEPTACLES, WALL:
Carter Radio Co.
Rodale Mfg. Co.

RECORD CHANGERS:
Krasberg Tool & Mfg. Co.

REGULATORS, VOLTAGE:
Central Radio Laboratories
Clarostat Co.
DeJur-Amsco Co.
Polymet Mfg. Corp.
Radiall Co.

RELAYS:
Cardwell, Allen D., Mfg. Co.
Leach Relay Co.

REPRODUCERS, TALKING MOTION PICTURES:
The Beltone Corp., Ltd.

RESISTANCES, FIXED:
Aerovox Wireless Corp.
Allen-Bradley Co.
Central Radio Laboratories
Clarostat Mfg. Co.
DeJur-Amsco Co.
Electrad, Inc.
Electro-Motive Co.
Ferranti, Inc.
Frost, Herbert H.
General Electric Co.
Hardwick, Hindle Inc.
International Resistance Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.

RESISTANCES, VARIABLE:
Allen-Bradley Co.
Central Radio Laboratories
Clarostat Mfg. Co.
Electrad, Inc.
Frost, Herbert H.
General Electric Co.
Hardwick, Hindle, Inc.
International Resistance Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Shallcross Mfg. Co.

RHEOSTATS:
Allen-Bradley Co.
Central Radio Laboratories
Electrad, Inc.
Frost, Herbert H.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories

SCREW MACHINE PRODUCTS:
Aluminum Co. of America
National Vulcanized Fibre Co.
Scovill Mfg. Co.
Standard Pressed Steel Co.
Synthane Corp.

SCREWS, METAL DRIVE:
Parker-Kalon Corp.

SEALING COMPOUNDS:
Candy & Co.
Mitchell Rand Mfg. Co.

SHIELDING, METAL:
Aluminum Co. of America
Hammarlund Mfg. Co., Inc.

SHIELDS, TUBE:
Carter Radio Co.

SHORT WAVE APPARATUS:
Cardwell, Allen D., Co.
General Radio Co.
Hammarlund Mfg. Co., Inc.
Lynch, Arthur H., Inc.

SOCKETS, TUBE:
Frost, Herbert H.
General Radio Co.
Lynch, Arthur H., Inc.

SOLDER:
Amplion Corp. of Amer.
Kester Solder Co.
Jensen Radio Mfg. Co.
Oxford Radio Corp.
Rola Co., The

SPAGHETTI:
(See Wire, Spaghetti).

SPEAKER PARTS, METAL:
The Metal Specialty Co.

SPEAKERS:
Amplion Corp. of Amer.
Electro-Acoustic Prod. Co.
Jensen Radio Mfg. Co.
Potter Co., The
Rola Co., The
Transformer Co. of Amer.

SPROCKETS:
Chicago Gear Works

STAMPINGS, METAL:
Aluminum Co. of America
Metal Specialty Co.
Scovill Mfg. Co.

SUBPANELS:
Formica Ins. Co.
General Radio Co.
National Vulcanized Fibre Co.

SWITCHES:
Electrad, Inc.
Ferranti, Inc.
Rodale Mfg. Co.

SWITCHES, MERCURY:
G. M. Laboratories, Inc.

TABLES, STEEL WORK:
Angle Steel Stool Co.
Standard Pressed Steel Co.

TANTALUM:
Fansteel Products Co., Inc.

TAPES, FRICTION:
Mitchell Rand Mfg. Co.

TELEVISION PARTS:
Allen-Bradley Co.
Clarostat Co., Inc.
Lynch, Arthur H., Inc.
Shallcross Mfg. Co.

TESTERS, B-ELIMINATOR:
General Radio Co.
Jewell Electrical Inst. Co.

TESTERS, TUBE:
Ferranti, Inc.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Inst. Co.

TESTING INSTRUMENTS:
Ferranti, Inc.
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Radio Products Co.
Weston Elec. Instrument Corp.

TESTING KITS:
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Inst. Co.

TESTING LABORATORIES:
Electrical Testing Labs.

TIN COATED METAL:
Baltimore Brass Co.

TOOL STANDS:
Standard Pressed Steel Co.

TOOLS:
Willor Mfg. Corp.

TRANSFORMERS, AUDIO:
American Transformer Co.
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
Radio Receptor Co., Inc.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, B-POWER UNIT:
American Transformer Co.
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
Radio Receptor Co., Inc.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, BROADCAST STATION:
Ferranti, Inc.
Radio Receptor Co., Inc.
Samson Electric Co.

TRANSFORMER CASES, METAL:
Metal Specialty Co.

TRANSFORMERS, FILAMENT HEATING:
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, OUTPUT:
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
Radio Receptor Co., Inc.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, POWER:
American Transformer Co.
Dongan Elec. Mfg. Co.
Ferranti, Ltd.
General Radio Co.
Jefferson Electric Co.
Polymet Mfg. Co.
Radio Receptor Co., Inc.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, R. F., TUNED:
Cardwell, Allen D. Mfg. Co.
Hammarlund Mfg. Co., Inc.

TRANSFORMERS, STEP-DOWN:
Amplion Corp. of Amer.
Radio Receptor Co., Inc.

TUBE MACHINERY:
See (Machinery, Tube.)

TUBE, PACKING:
Holed-Tite Packing, Inc.

TUBE PARTS:
American Electro Metal Corp.
Callite Products Co., Inc.
Cleveland Wire Cloth & Mfg. Co
Engineering Co., The
Fansteel Products Co., Inc.
General Plastics, Inc.
Gilby Wire Co.
Goat Radio Tube Parts Inc.
Lepel High Freq. Labs.
Nat'l.-Harris Wire Co.
Newark Plate Laboratories
Newark Wire Cloth Company
Synthane Corp., Inc.
(See Parts, Tube.)

TUBE TESTERS:
(See Testers, Tube)

TUBES, A.C.:
Arcturus Radio Co.
Cable Radio Tube Co.
De Forest Radio Co.
Hyvac Radio Tube Co.
Marvin Radio Tube Corp.
National Carbon Co., Inc.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.
Triad Mfg. Co.

TUBES, RECTIFIER:
Arcturus Radio Co.
Cable Radio Tube Co.
De Forest Radio Co.
Hyvac Radio Tube Co.
National Carbon Co., Inc.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.
Triad Mfg. Co.

TUBES, SCREEN GRID:
Arcturus Radio Co.
Cable Radio Tube Co.
De Forest Radio Co.
Hyvac Radio Tube Co.
National Carbon Co., Inc.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.
Triad Mfg. Co.

TUBES, TELEVISION
See *(Cells, Photoelectric.)*

TUBING, NICKEL:
National-Harris Wire Co.

TUBING, REFRACTORY:
Stupakoff Labs, Inc.

TUBING, VARNISHED:
Alpha Wire Corp.
Mitchell Rand Mfg. Co.

UNITS, SPEAKER:
Amplion Corp.
Jensen Radio Mfg. Co.
Rola Co.
Wright DeCoster, Inc.

UNIVERSAL JOINTS:
Chicago Gear Works

VARNISH:
Maas & Waldstein Co.
Mitchell Rand Mfg. Co.

VOLTAGE REGULATORS:
(See Regulators)

VOLTMETERS, A. C.:
Ferranti, Inc.
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Instrument Corp.

VOLTMETERS, D. C.:
Ferranti, Inc.
General Electric Co.
General Radio Co.
Jewell Elec. Inst. Co.
Weston Elec. Instrument Corp.

WASHERS:
American Felt Co.
Aluminum Co. of America
Booth Felt Co.
Electrical Insulation Corp.
Scovill Mfg. Co.
Shakeproof Lock Washer Co.
Synthane Corp.
Western Felt Co.

WAXES, IMPREGNATING:
Candy and Co.
Mitchell Rand Mfg. Co.

WAXES, INSULATING:
Candy and Co.
Mitchell Rand Mfg. Co.

WAXES, SEALING:
Candy and Co.
Mitchell Rand Mfg. Co.

WIRE, ANTENNA:
Acme Wire Co.
Alpha Wire Corp.
Dudlo Mfg. Corp.
National Vulcanized Fibre Co.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE BALLAST:
National-Harris Wire Co.

WIRE, BARE & TINNED COPPER:
Alpha Wire Corp.
Dudlo Mfg. Corp.
Roebling, J. A., Sons, Co.
Rome Wire Co.
Spargo Wire Co.

WIRE, COTTON COVERED:
Acme Wire Co.
Alpha Wire Corp.
Dudlo Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, ENAMELED COPPER:
Acme Wire Co.
Alpha Wire Corp.
Dudlo Mfg. Corp.
Polymet Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, FILAMENT:
American Electro Metal Corp.
Callite Products Co., Inc.
Fansteel Products Co., Inc.
Gilby Wire Co.
National-Harris Wire Co.

WIRE, HOOK-UP:
Acme Wire Co.
Alpha Wire Corp.
Dudlo Mfg. Co.
Roebling, J. A., Sons, Co.
Rome Wire Co.

WIRE, LITZENDRAHT:
Dudlo Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, MAGNET:
Acme Wire Co.
Anaconda Wire & Cable Co.
Dudlo Mfg. Corp.
Inca Manufacturing Co.
Rome Wire Co.

WIRE, MOLYBDENUM:
American Electro Metal Corp.
Callite Products Co., Inc.
Fansteel Products Co., Inc.

WIRE, PIGTAIL:
Dudlo Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, RESISTANCE
Alloy Metal Wire Co.
Gilby Wire Co.
National-Harris Wire Co.

WIRE, SILK COVERED:
Acme Wire Co.
Alpha Wire Corp.
Radio Wire Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, SPAGHETTI:
Acme Wire Co
Alpha Wire Corp.
Mitchell Rand Mfg. Co.
Rome Wire Co.

WIRE, TINNED COPPER:
Alpha Wire Corp.
Dudlo Mfg. Corp.
Roebling, J. A., Sons, Co.
Rome Wire Co.

ZINC:
St. Joseph Lead Co.

INDEX OF ADVERTISERS

"ROUND ROBIN"

$1.

Group Subscription Rate

(The subscription rate for individual subscribers is $2.00 a year.)

To the attention of
CHIEF ENGINEERS
FACTORY EXECUTIVES
PRODUCTION MANAGERS

"RADIO ENGINEERING" should be interesting and helpful to your personnel. Your copy isn't always available to your assistants.

WHY NOT START THIS CIRCULATING AS A ROUND ROBIN?

BRYAN DAVIS PUBLISHING CO., Inc.,
52 Vanderbilt Ave., N. Y.

Kindly enter the following subscriptions to RADIO ENGINEERING at $1.00 a year.
(This subscription rate applies on 4 or more subscriptions)

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Name .....
Address .....
Town ..... State .....
Classification .....

Will you not cooperate with us by classifying subscriptions sent in as follows:

(M) Manufacturer
(Please check "M" if you are an executive, purchasing agent, production manager, service manager, plant superintendent or foreman.)

(E) Engineer
(T) Technician.
(S) Service Man
(D) Distributor or Dealer

WILLIAMS PRESS, INC., NEW YORK—ALBANY

Present business conditions offer positive proof. Set and Amplifier manufacturers who purchased their parts from outside sources saved thousands of dollars. A wire to the supplier held up production.

Manufacturers who built their own parts were forced to carry a huge inventory on parts as well as on sets.

The cycle has swung back in the automobile industry. One of the leaders, who formerly thought it good business to make all his parts in his own plants, has discontinued that practice and now contracts with outside manufacturers.

Transformers built by Dongan have the undivided attention of a 20 year old company highly specialized and organized in Transformer engineering and manufacturing. Those who use Dongan as a source are certain of securing the very latest in sound development, a consistently first-class product, and the very lowest production price.

Amplifier and Service Engineers

Here are the Season's Most Popular Items for 245 Tube Construction

No. 994—Power Amplifier Transformer $12.00
either No. 2189 Push Pull Output Transformer $12.00
with No. 2142 Push Pull Input Transformer 4.50
or No. 3107 Straight Output Transformer 12.00
with No. 2158 Audio Transformer 4.50

D-946—Standard Condenser Unit $22.50
No. 5554—Double Choke (use in Filter Circuit) ... $11.00
No. 2124—Transformer (Radio and Phonograph Amplification) ... 6.00

Check or Money Order will give you immediate delivery.

DONGAN ELECTRIC MANUFACTURING CO.
2991-3001 Franklin St., Detroit

Radio Tube Checker in a Bakelite Molded case. Made by The Radio Products Co., Dayton, Ohio.

A superior instrument case of *Bakelite Molded* at 50 per cent less cost

WOOD proved to be an unsatisfactory material for the case of the A. C. tube checker shown above. The finish was easily marred, and wood is always subject to warping and splitting. Through the use of Bakelite Molded the makers not only secured a more sturdy, compact and durable case, but obtained it at 50 per cent less cost.

The seamless Bakelite Molded case is formed in one press operation, with a smooth, hard, lustrous surface inside and out. It is far more attractive in appearance than a wood case, and provides greater protection for the sensitive instruments assembled within it. Another advantage is that the smooth Bakelite Molded surface does not scratch the finish of furniture upon which the case may be placed.

Bakelite Engineering Service. Intimate knowledge of thousands of varied applications of Bakelite Materials combined with eighteen years' experience in the development of phenol resinoids for radio uses provides a valuable background for cooperation offered by our engineers and research laboratories. Write for Booklet 38M, "Bakelite Molded."

BAKELITE CORPORATION

247 Park Avenue, New York, N. Y. Chicago Office: 635 W. 22nd Street

BAKELITE CORP. OF CANADA, LTD. 163 Dufferin St., Toronto, Ontario, Canada

BAKELITE

REGISTERED U. S. PAT. OFF.

THE MATERIAL OF A THOUSAND USES

"The registered Trade Mark and Symbol shown above may be used only on products made from materials manufactured by Bakelite Corporation. Under the capital "B" is the numerical sign for Infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products."