...h Year of Service

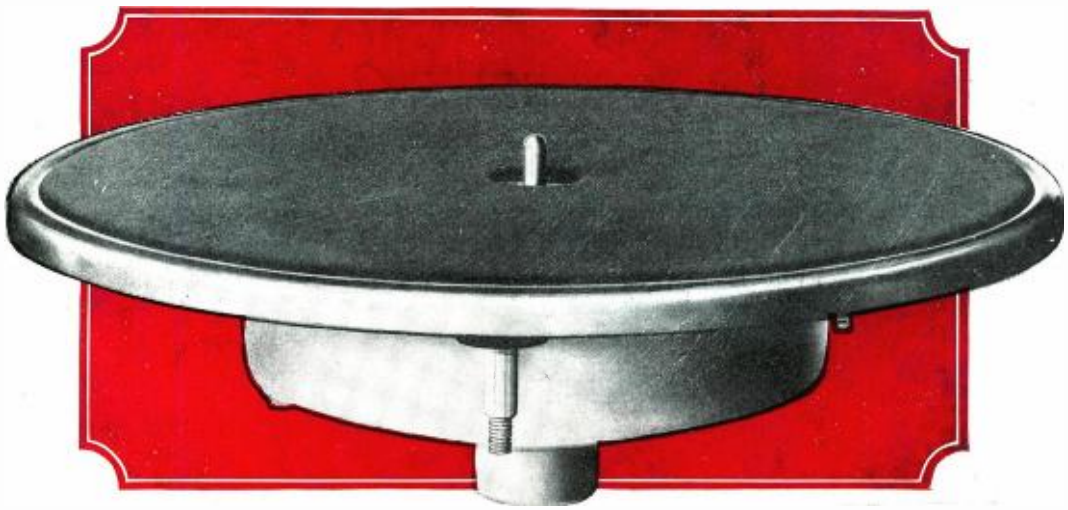
...ADIO ...INEERING

Vol. X AUGUST, 1930 No. 8

IN THIS ISSUE

Sold only by subscription
$2.00 per year

The Journal of the Radio Industry



Are Performance—and Price Important to You?

PERFECT pitch reproduction—a far simpler construction, and permanent lubrication are some of the features that combine to give a new kind of performance.

Bent records, voltage fluctuations and other irregularities do not prevent the Hammond Motor from reproducing accurate pitch because they do not affect its speed. There are fewer parts . . . no mechanical governor . . . no noise. It is the ideal phonograph motor, and the price is far below what you would expect.

We would be glad to send you Bulletin "F" which explains in detail—or better—let us send you a sample motor and testing instructions and determine for yourself in your own laboratory that it will out-perform the motor you are now using.

Mail the coupon below for immediate action.

The Hammond Clock Company
2915 N. Western Avenue, Chicago, Illinois

Gentlemen:

☐ Send me sample phonograph motor and testing instructions
☐ Send me Bulletin "F"

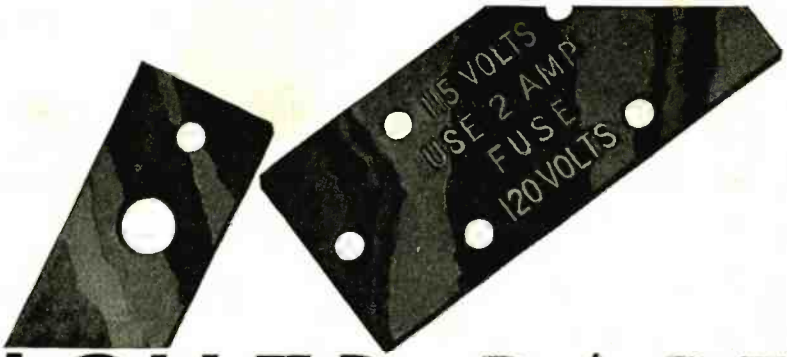
Name_____

Address_____

(RE8)

HAMMOND

Hammond Phonograph Motors are manufactured exclusively by The Hammond Clock Company under Hammond patents and applications. For sale only to manufacturers of phonographs and radio-phonograph combinations.



PUNCHED PARTS » *in Quantity*

FORMICA is equipped for rapid and prompt production of punched insulating parts in quantity. It has the largest manufacturing unit in the business for phenolic sheet—and a great amount and variety of machinery for its fabrication.

It has an organization specialized for 17 years on just one product. Such concentration is bound to produce results, and it has—a high quality product of unusual uniformity.

Send your blue-prints for estimates.

THE FORMICA INSULATION CO.
4626 Spring Grove Avenue
Cincinnati, O.

FORMICA

RADIO ENGINEERING

Reg. U. S. Patent Office

Member, Audit Bureau of Circulations

Western Editor ULMER G. TURNER

Editor DONALD MCNICOL

Associate Editor AUSTIN C. LESCARBOURA

Vol. X August, 1930 Number 8

Contents

Departments

Servicemen

Mr. H. G. Erstrom, executive vice-president, N. F. R. A., in a report to the Electric League, said:

"SERVICE represents a problem in every community where radios are sold. Servicemen have misrepresented themselves time and time again as knowing more about their subject than they ever dreamed of. It has been found in many cases, that the serviceman was not familiar with the set he was called upon to remedy, with the result that he "knocked" that merchandise and boosted another set which was not the same as the customer's, simply because he knew the inner workings of the recommended piece of merchandise. Dissatisfied customers were the result. The serviceman is the closest personal contact a radio dealer has with his prospect and he can not overlook any opportunity to provide his customer with more accurate, courteous service at the hands of a more accurate, courteous serviceman. A method of investigating servicemen is offered by our plan of examination and registration of servicemen. They are subdivided into classes A, B, and C, depending entirely upon education, experience, training and practical knowledge. This is an advantage to purchasers in that they are assured of securing the service to which they are entitled. It has advantage to the serviceman in that he is protecting his own chosen profession."

Published Monthly by

Bryan Davis Publishing Co., Inc.
52 Vanderbilt Ave.
New York City

Publishing
AVIATION ENGINEERING
RADIO ENGINEERING
PROJECTION ENGINEERING

Publication Office—North Broadway—Albany, New York
Chicago Office—333 N. Michigan Ave.—Charles H. Farrell, Mgr.
Cleveland Office—10515 Wilbur Avenue—James C. Munn, Mgr.
St. Louis Office—505 Star Building—F. J. Wright
Kansas City Office—306 Coca Cola Building—R. W. Mitchell
San Francisco Office—318 Kohl Bldg.—R. J. Birch
Los Angeles Office—846 S. Broadway—R. J. Birch

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.

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

ANACONDA
from mine to consumer
REG. U.S. PAT. OFF.

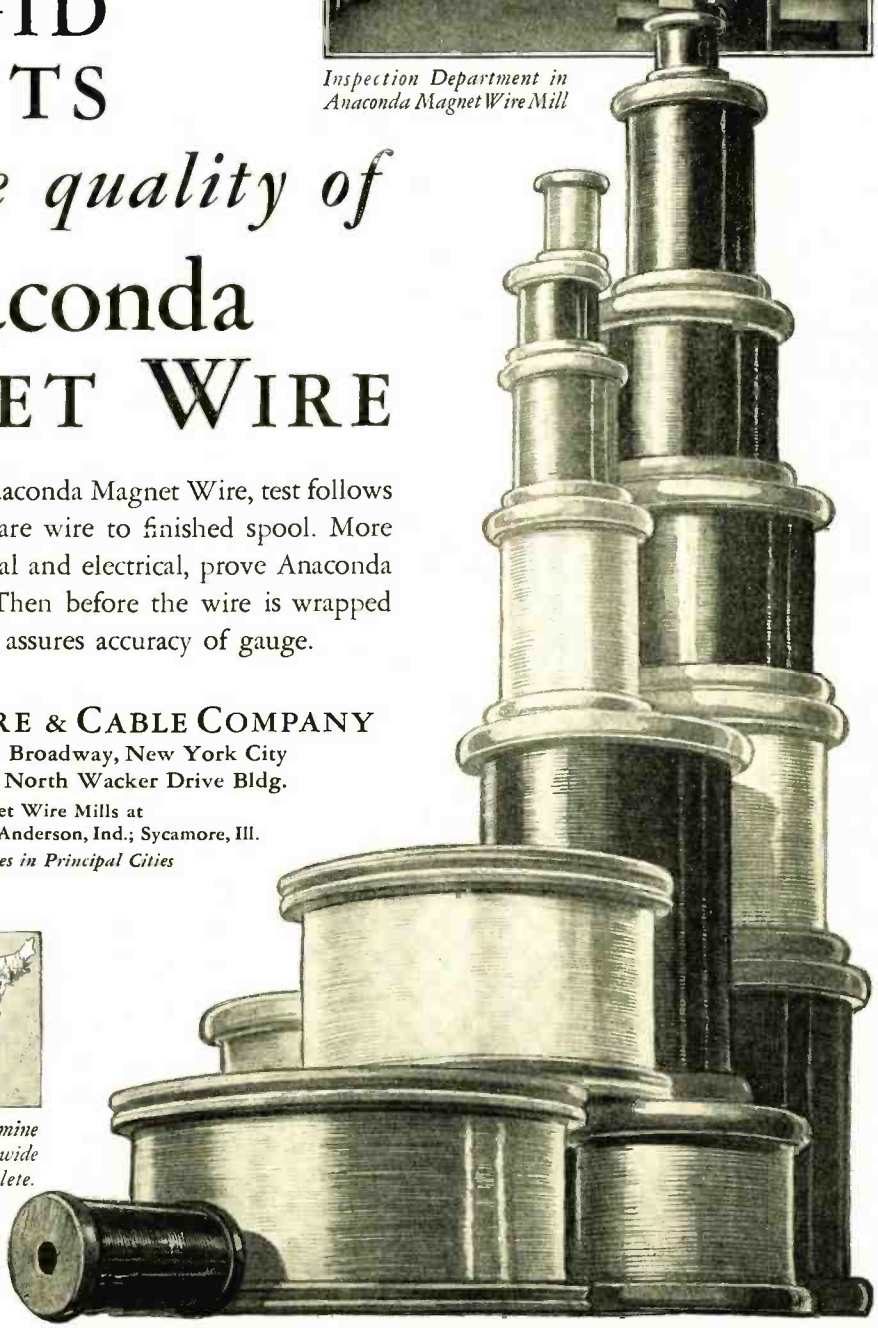
Inspection Department in Anaconda Magnet Wire Mill

RIGID TESTS *Prove the quality of* Anaconda MAGNET WIRE

In the manufacture of Anaconda Magnet Wire, test follows test continuously from bare wire to finished spool. More than a score, both physical and electrical, prove Anaconda the standard of quality. Then before the wire is wrapped for shipment, a final test assures accuracy of gauge.

ANACONDA WIRE & CABLE COMPANY
General Offices: 25 Broadway, New York City
Chicago Office: 20 North Wacker Drive Bldg.
Magnet Wire Mills at
Muskegon, Mich.; Anderson, Ind.; Sycamore, Ill.
Sales Offices in Principal Cities

Anaconda safeguards quality from mine to consumer — provides a nation-wide service, prompt, dependable, complete.



Editorial

August, 1930

DONALD McNICOL, *Editor.*

RECEIVER AND VACUUM TUBE PRODUCTION

PRODUCTION of radio accessories and radio receivers, in July got away to a good start. We say "good" advisedly. The start this year is, in its nature, a very healthy sign. Production this year has in most plants been entered upon with an improved understanding of the extent of the market and of market needs.

Through membership in the RMA the majority of the manufacturers have been enabled to get a fairly exact picture of the situation on a national scale. There is evidence that manufacturing executives have availed of the opportunity presented in conferences and at conventions to orient their production programs so as to have economically reasonable relationships to the programs of other established companies. This is not a credit only to the manufacturers' association. It is a credit also to the business sense of individual members of the association who have learned how best to profit from cooperative membership in the trade association.

Still another promising sign is the cooperative thought centered upon the sales situation by manufacturers of vacuum tubes and manufacturers of receivers. There is less inclination at present on the part of tube manufacturers to force upon receiver manufacturers refinements and innovations in tube design so soon as each little forward step is taken. Rather, there is a disposition to maintain uniformity in tube characteristics and tube performance.

The receiving set industry, as well as the public, are entitled to this sensible procedure. Orderly, economic procedure permits of consolidating every three or four years the small, accruing betterments into an identifiable improvement, worthy of wide publicity as a sales stimulant.

No one familiar with the past of set sales doubts that much of the resistance to sales of the higher priced sets has been due to the bogey "revolutionary invention to be announced soon."

There are in service today radio receivers which when transmission is good and atmospherics not troublesome, warrant the claim of an owner: "It couldn't be any better." Nevertheless, improvements will be made all along the chain from original source to output. The hope is that the bulk of the industry has learned the way to maintain industrial stability, while holding ajar the gate through which changes, alterations, betterments, or whatever is in store for the future, may come along in an orderly and an industrially economical manner.

▲

LET'S GO!

ONE manufacturer of radio receiving sets tells us that in July and August, this year, his factory will put twenty thousand new employees at work. This means production.

RADIO ENGINEERING in July received requests from eight other manufacturing plants for the names of competent laboratory and production engineers.

In one day in July, RADIO ENGINEERING answered sixteen letters from manufacturing establishments which called for information about stated raw products, radio parts and accessories.

Of course, at this time of year these activities may be looked for, but there have been some who have had the notion that there are in the country surplus stocks sufficient to take care of the 1930–1931 market needs. With the market requirements anticipated as closely as this is possible and with each manufacturer engaged in turning out what he has good reason to believe should be his share of the business, there is certain to be a fair share of prosperity for radio companies, radio engineers, mechanics, distributors and dealers.

▲

THE I.R.E. CONVENTION

THE convention of the Institute of Radio Engineers to be held in Toronto, Canada, August 18–21, promises to be a largely attended gathering of engineers, manufacturers and dealers. An interesting program of technical papers has been arranged and the social and entertainment features of the meet are unusually attractive. The time set for the Convention promises agreeable weather conditions in the Canadian city.

This Speaker assembly *now made faster and better*

. . . . Simply by replacing bolts and nuts with Self-tapping Screws

The Speaker Department of a prominent radio manufacturer found that it took too much time fastening the paper cones to the speaker shells. Bolts and nuts with lockwashers were being used for the purpose, and considerable fumbling occured in placing them. This defeated every attempt to obtain assembly speed.

In the assembly of the Receivers made by this concern, a similar problem was solved by using Hardened Self-tapping Sheet Metal Screws instead of machine screws. This led the Speaker Department to try these Screws for their fastening job. They proved to be ideal and were adopted, as only one simple operation is required to use these Screws—merely driving them in with a screw driver—the speed of assembly was greatly accelerated, with worthwhile savings in labor as well.

So satisfactory did the Self-tapping Screws prove on this cone assembly that they were also adopted to replace machine screws for fastening the transformer to the malleable-iron speaker pot. Costly and difficult tapping operations were here entirely eliminated by the simple change in fastening devices.

Many radio manufacturers find these unique Screws the easiest, speediest and most economical means of assembly. Test these screws for your work—see what they will do. A brief description of your assemblies bring proper samples for trial free.

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 material—holds better than a machine screw, even under vibration.

PARKER-KALON CORPORATION
Dept. L, 190–198 Varick Street, New York

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

PATENTED — APR. 1, 1919 — No. 1299232 — MAR. 28, 1922 — No. 1411164
AUG. 14, 1923 — No. 1465148 — FEB. 10, 1925 — No. 1526182 — OTHERS PENDING

THE SOURCE of SUPPLY for

high quality metals and alloys, refined especially for vacuum tube parts

MOLYBDENUM (99.95% pure)

An exceptionally high grade product, refined by exclusive Fansteel process which assures unusual purity and uniformity.

Moly "B"
Moly "X"

Two carefully compounded hardened Molybdenum Alloys, excellent for heaters, springs, hooks and support members, each possessed of special characteristics that make it best for certain purposes.

TANTALUM (99.9+% pure)

A superior metal of extremely low vapor pressure, great gas absorbing properties and ability to withstand high temperatures. Ideal for plates and grids.

"TAW" Metal

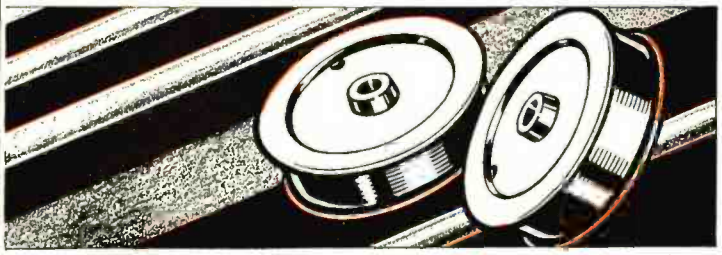
A new Tantalum Alloy of exceptional characteristics.

CAESIUM
RUBIDIUM

Pure metals and salts for photo-cells.

All Fansteel metals are made in the Fansteel plant, under strict laboratory control. Supplied in all standard commercial forms.

Write for full information and prices.



in ALL types of tubes IT PAYS to use FANSTEEL WIRE AND METALS

It's false economy to use cheap materials in a tube merely because the tube sells at a low price. For, with cheap materials, rejections run high—meaning losses of material, labor and overhead. Even worse, defects which crop out in performance may mean heavy losses in reputation and good will.

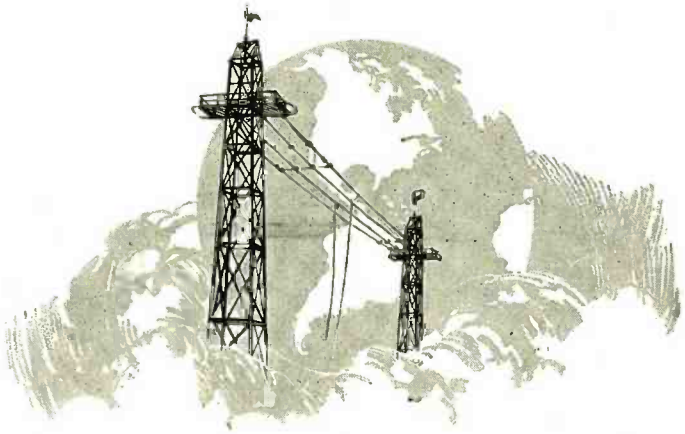
Fansteel Tantalum is absolutely the *best metal obtainable** for grids, plates and support members. It forms and welds easily, it holds its form under high temperatures, it requires no elaborate treatment, is easily de-gassed, and will absorb gases liberated by other metals.

While Tantalum may cost a little more, the difference is more than saved in lowered rejections and elimination of treating operations. Longer life and improved performance make its use even in low price tubes, a distinct asset.

*Let us *prove* this to you. Write today for samples of Tantalum—better still, ask for an engineer to call.

Fansteel wire doesn't get "mixed" in stock. Carton and Bakelite spool both plainly labeled

FANSTEEL PRODUCTS COMPANY, INC.
North Chicago, Illinois



Towers in the AIR

THE invention of the audion tube by Lee DeForest in 1906, made the household use of radio practical. Today the radio tower so commonly seen is representative of a truly towering industry. And yet they tell us that radio is still in its infancy.

To Scovill these "towers in the air" have a special significance—for Scovill proudly cherishes the thought that even before 1906 its contributions were welcomed by radio engineers. Scovill radio products—particularly condensers—have played an important part in the successive steps of radio's development.

Today Scovill radio condensers are admittedly the industry's standard of quality. Manufacturers of the finest radio sets use them—and we are sure they will continue to use them, for Scovill quality and Scovill service are of the sort that build good-will.

SCOVILL

Established 1802

MANUFACTURING COMPANY

· WATERBURY · · CONNECTICUT ·

Boston
Atlanta
Chicago
Providence

Cleveland
Los Angeles
New York

Detroit
San Francisco
Philadelphia

Cincinnati

In Europe—
The Hague, Holland

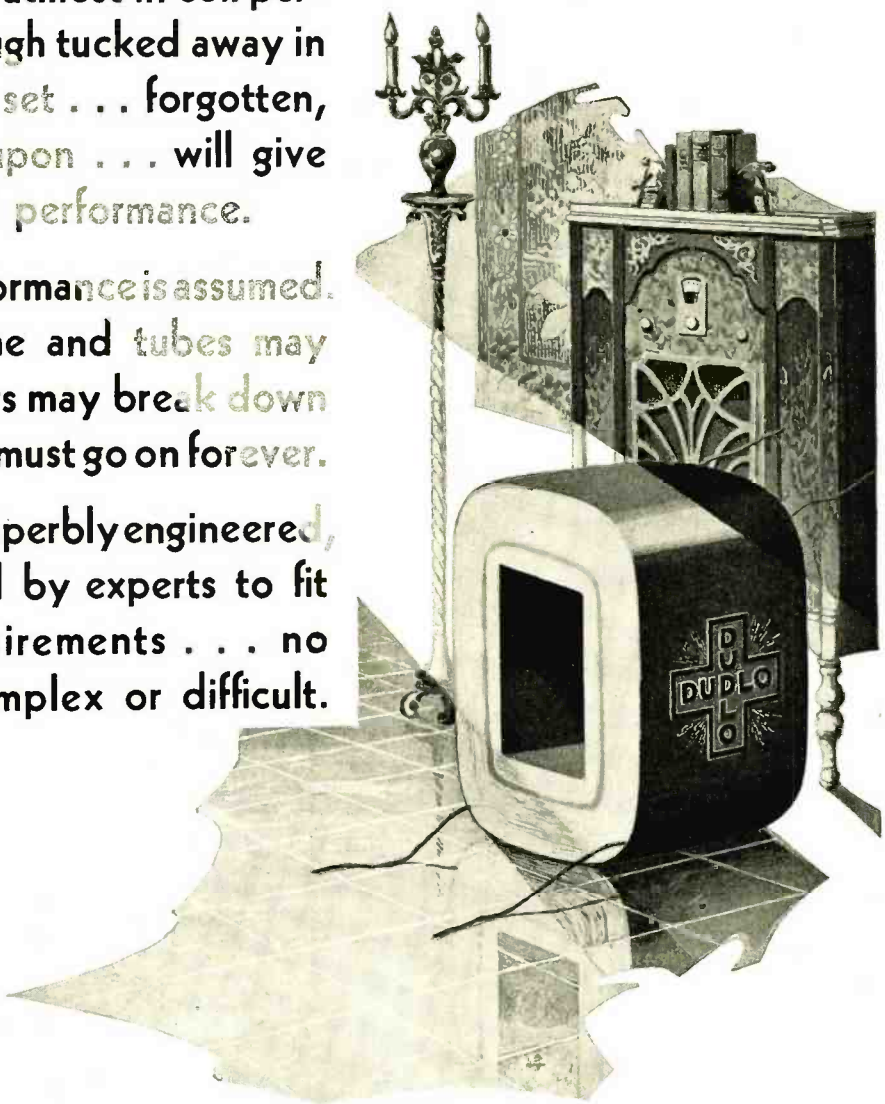
The coil's the thing!

In every hook-up an ideal coil is specified for each function in the set.

Each Dudlo coil is backed by its reputation as the utmost in coil perfection, and though tucked away in the chassis of a set . . . forgotten, yet depended upon . . . will give years of faithful performance.

Continuous performance is assumed. Tubes may come and tubes may go . . . condensers may break down . . . but the coils must go on forever.

Dudlo coils are superbly engineered, and constructed by experts to fit individual requirements . . . no matter how complex or difficult.



FORT WAYNE PLANT FORT WAYNE, INDIANA

GENERAL CABLE CORPORATION

EXECUTIVE OFFICES: 420 LEXINGTON AVENUE, NEW YORK • OFFICES IN PRINCIPAL CITIES

"ROUND ROBIN"

$1.

Group Subscription Rate

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

Note: Under the requirements of the Audit Bureau of Circulations each subscriber is required to fill in his name and classification in his own handwriting. Will you, please?

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 ..... State .....
Town .....
Classification .....

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

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

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

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

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

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

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

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

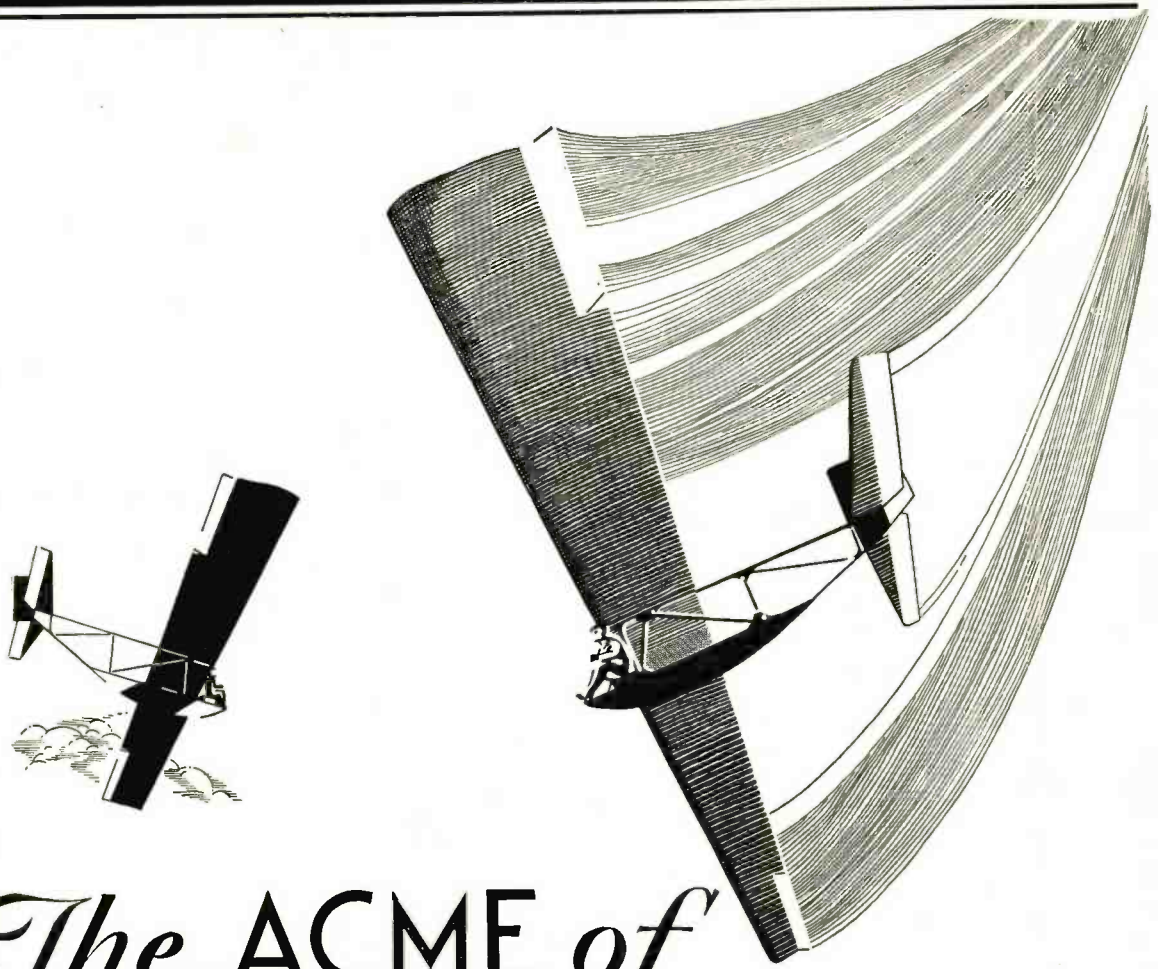
(M) Manufacturer
(Please check "M" if you are an executive, purchasing agent, production manager, service manager, plant superintendent or foreman.)

(E) Engineer

(T) Technician.

(S) Service Man

Note: If you do not belong in the above classifications, please write in your occupation or vocation.

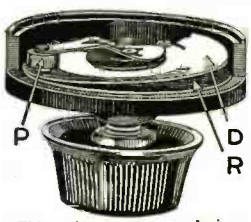


The ACME *of smooth performance*

CATAPULTED silently into the air, the glider taking advantage of every tiny air current, soars noiselessly and gracefully up and down the air valleys at the touch of the control sticks. It's the acme of smooth performance.

The modern radio receiver, if it is CENTRALAB equipped, figuratively speaking, rides the ether waves smoothly and noiselessly.

For real adventure in radio reception insist on CENTRALAB volume control equipment.



This shows the exclusive rocking disc construction of Centralab volume control. "R" is the resistance. Contact disc "D" has only a rocking action on the resistance. Pressure arm "P" together with shaft and bushing is fully insulated.

Centralab

CENTRAL RADIO LABORATORIES

Dept. 212 B, 16 Keefe Ave. Milwaukee, Wis.

NATIONAL UNION TUBES WIN

7 OUT OF 8 FIRSTS IN IMPARTIAL TESTS!

DR. RALPH E. MYERS, the scientist, brought his staff of 15 engineers from Westinghouse to produce National Union tubes—the finest in his great career, laboratory tests prove. To increase your tube sales feature the National Union line.

FAMOUS LABORATORY PROVES NATIONAL UNION'S SUPERIORITY

How Tests Were Made: Random samples of National Union tubes—the new ones designed and produced by Dr. Myers and his brilliant staff—were taken from stock. Just run-of-mine samples, understand. Retail stores supplied leading competitors' tubes. Then Electrical Testing Laboratories, New York, tested each type for static characteristics, ionization current, filament emission, plate voltage—plate current characteristics of type 280 rectifier tubes, and filament or cathode temperatures.

What They Found: National Union's 224's, for instance, averaged highest in *mutual conductance*, low in interelectrode capacity . . . proving they cannot be surpassed for selectivity, sensibility, distance reception. The 280 demonstrated the *long life* we claimed for it. National Union's 112A, 171A, and 245 tubes averaged higher than other brands for tone and volume. Only one type of our tubes graded second, and it stood high on the list.

The full Electrical Testing Laboratories' report will be shown you in confidence by the National Union representative. If you sell tubes, see it without fail.

Such quality is bound to command confidence.

Such quality commands CONFIDENCE

NEW YORK, July 20.—Another report by an impartial laboratory has come in . . . Again National Union tubes demonstrate their outstanding quality—by performance.

Today the Electrical Testing Laboratories, East End Avenue and 80th Street, scientific consultants to the country's leading electrical manufacturers, announced the findings of recent tests, *totally unprejudiced*. The National Union tubes when compared to the largest selling tube in America proved in impartial tests to be thoroughbreds at least equal in quality to their competitors'.

Every tube leaving our plants today is 100% electrically perfect, because of "double test" system unique in the industry, perfected by Dr. Myers and his distinguished National Union staff. You can sell the National Union tubes with 100% confidence.

The credit goes without question to Dr. Ralph E. Myers and his incomparable National Union engineering staff.

For years this famous group made tubes for Westinghouse. Dr. Myers was responsible in all for nearly one billion R. C. A. and Cunningham tubes.

But this National Union tube is his masterpiece! His greatest triumph!

Ask the National Union jobber today about these remarkable new tubes. Investigate our new 6-fact profit plan. At least try these tubes in your own home. Find out what winning thoroughbreds they are. Then sell them with assurance to your customers . . . They are real money earners for dealers. Ask for the proof.

Here are *Profits* for You

National Union is today America's premier brand of tubes. The quality is unquestioned, the sales policies are firm and fair to all, the banking sponsorship assures stability and strength. National Union is a brand that the jobber and dealer can sell with confidence and pride. Write or wire today for complete information to the General Offices, 400 Madison Avenue, New York City.

In 7 scientific studies out of 8 National Union tubes proved their brilliant efficiency. Here is definite illustration that the new National Union tubes give richer tone, finer selectivity, longer life! The E. T. L. report reveals that these remarkable new tubes have a *Mutual Conductance* (i. e., proof of quality) equal to or better than any other quality tubes on the market. All of our tubes proved to be far above the average.

The Tubes We Needed

Says U. S. Radio . . . "We have now shipped your tubes as standard equipment with Apex sets for more than four months and have in that time distributed well over 200,000 of your tubes with our receivers . . . Our service calls have been less than ever before in our experience . . . "—J. Clarke Coit, President, United States Radio and Television Corporation, leading set manufacturers.

NATIONAL UNION RADIO CORPORATION
400 MADISON AVENUE · NEW YORK CITY

IMPRESSIONS *and* EXPRESSIONS

By

AUSTIN C. LESCARBOURA

Tone-Plus Broadcasting

THE race between transmission and reception continues in broadcasting circles. Several leading broadcasters have been remodelling their transmitting stations of late not so much for the purpose of increasing power as to improve tone quality. Many more have signified their intention of improving tone quality. At the receiving end we are becoming more and more aware of this steady improvement in broadcast transmission, particularly by way of remarkable depth and mellowness in certain types of programs. All of which means that radio set designers and manufacturers must provide the highest type of audio amplifier and loudspeaker in keeping pace with the transmitted signals.

▲

More Super-Heterodynes

OUT of the blue sky comes the announcement that the RCA has finally made the superheterodyne patents available to its licensees. Heretofore kept exclusively for the RCA and associated brands of receivers, the superheterodyne circuit now has an opportunity of competing side by side with the tuned radio-frequency circuit. Furthermore, the engineers of many companies may now have an opportunity of seeing what they can do with this peer of circuits.

It is our modest opinion that the superheterodyne is going to make new strides as the result of its availability to many manufacturers. It is a circuit of many possibilities. While it is true that the tuned radio-frequency circuit has been developed to a remarkable degree, because it was the only satisfactory circuit available to set manufacturers under the former license agreement, the superheterodyne circuit has certain inherent advantages which place it ahead of any other. And now with many heads at work on how to apply this circuit to the best possible uses, we may be sure of a superheterodyne era in broadcast reception.

▲

Mantle-Piece Radio

THOSE chaps out on the Pacific Coast have stolen a march on the East and Middle-West radio manufacturers, by introducing the compact, self-contained, attractive mantle-piece radio sets which are meeting with much favor in the West. What is more, they are showing us how to introduce the second and even third radio set in the average home, at a time when many of us thought the radio market was approaching saturation.

As we understand the situation, the idea of the mantle-piece radio set is quite similar to that of the small second car in the average family of comfortable circumstance. The second car is small, inexpensive to operate, and good enough to do the routine work about the village or town, thus preserving the large car for longer trips and for carrying the entire family and guests. Likewise with the mantle-piece radio set; instead of having all the power, tone quality, sensitivity and selectivity that may be required of the main radio set, it has just enough to tune in local stations and provide entertainment in the small room. Therefore, it can be built at a very low and attractive figure.

They are clever out California way, when it comes to big things in small packages. Compact bungalows, built-in beds, handy buffets, kitchenettes—all those things originate out in sunny California, where space is apparently at a premium. The mantle-piece radio is certainly another clever suggestion which comes at an opportune time.

▲

Johnny On The Spot

PECULIAR times we are passing through. The other day a well-known parts manufacturer told us that no substantial orders were being placed for parts by set manufacturers. A few orders are trickling through, but only for a few hundred pieces at a time. Furthermore, the orders are being scattered around, since price and quality don't mean much for these sample orders. Whoever happens to be on the spot at the right time, gets these small orders. It is a Johnny-on-the-spot market.

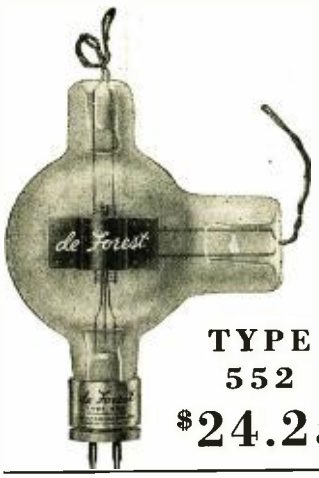
However, things will happen by October 1st at the latest. It will then be a case of either getting into production, or going out of business for good, for the season is now many months behind the production schedules of previous years. And when real production gets under way prices and quality will once more be taken into consideration. Meanwhile, the policy of some manufacturers to discontinue their advertising and slacken up their selling efforts is to be deplored. At this very moment, no doubt, set manufacturers are doing some tall figuring on how to get the best value for their orders to be placed in the next few months. The industry is going to do the shrewdest buying of its career. And unless the product is kept before the buyers, there will be little consideration when the time arrives for the handing out of orders.

▲

Profitable Alterations

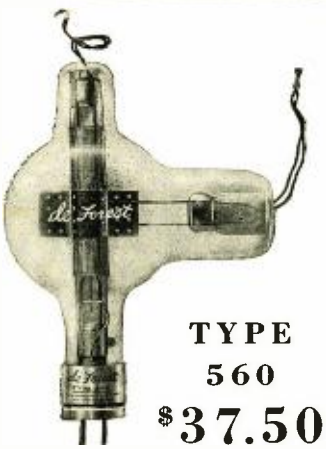
HERE and there we come across set manufacturers who have made some profitable alterations in their old models, thereby making them salable at attractive prices. One manufacturer, faced with the competition of others on a certain type of set which could no longer command the original price, very wisely went to work and included a phonograph feature at a cost of some twenty-five dollars per set, and succeeded in selling the entire stock at the original price, after all. The twenty-five dollars per set simply staved off a grand dumping party, which would have hurt this particular manufacturer far beyond words because he has never indulged in dumping.

We are told that there are hundreds of thousands of sets now seeking buyers, and yet the manufacturers of those sets have already come out with other models of a more advanced design including screen-grid tubes. Perhaps a little remodeling might help those sets already made and seeking buyers. Perhaps during these dull months those sets might be remodelled into screen-grid sets. That should not be such a difficult job. And the sets would then be brought up to date. Or again, there might be some slight change or addition to those sets.



TYPE 552 $24.25

Two 75-watters designed primarily for operation on 3 to 30 megacycles



TYPE 560 $37.50

THESE two de Forest 75-watters may be used as oscillators and radio frequency power amplifiers. They are particularly suited for stable r. f. amplification at either low or high frequencies.

In operating on very high frequencies leakage due to insufficient or improper insulation, and inter-electrode capacity, are factors that unless properly controlled will result in failures when operating within this band of frequencies—3 to 30 megacycles—especially on the upper band. In these de Forest transmitting Audions the construction reduces inter-electrode capacity to a minimum, and the high quality and scientific placement of the insulation reduces high frequency current leakage to the lowest possible point.

In the Type 560 75-watter, the extremely low control grid to plate capacity, which is inherent, makes neutralizing unnecessary—this is taken care of by the internal shielding.

For further information
consult your local dealer or address

DE FOREST RADIO COMPANY
PASSAIC NEW JERSEY

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

Export Department: 304 E. 45th Street, New York City, N. Y., U. S. A.

These are net prices on de Forest Transmitting Tubes

510-15 Watt Oscillator	$ 9.00
503A-50 Watt Oscillator and R. F. Power Amplifier	30.00
511-50 Watt Oscillator, A. F. Amplifier, Modulator or R. F. Power Amplifier	30.00
545-50 Watt A. F. Amplifier and Modulator	33.75
552-75 Watt Oscillator and R. F. Amplifier	24.25
504A-250 Watt Oscillator, Modulator or R. F. Power Amplifier	105.00
504-A Heavy duty 250 Watt oscillator or R. F. Power Amplifier, tungsten filament	105.00
500-500 Watt Special Oscillator	97.50
520B-5000 Watt Oscillator, R. F. Amplifier and modulator, water cooled	187.50
565-7½ Watt Screen Grid R. F. Amplifier	16.50
560-75 Watt Screen Grid R. F. Amplifier	37.50
561-500 Watt Screen Grid R. F. Amplifier	292.50
566-Half wave hot cathode, mercury vapor rectifier	9.00
572-Half wave hot cathode, mercury vapor rectifier	22.50

de Forest (AUDIONS) RECEIVING AND TRANSMITTING TUBES

TEXTOLITE LAMINATED

Preserves the original tuning regardless of the weather

RIGHT on the premises of Uncle Sam, the whims of weather vary between seasons (and between localities) from arctic frigidity to tropical humidity. ¶ In every season and atmosphere, radio listeners expect uniform performance from their radio sets. Where the insulation used is Textolite, the original precise tuning of radio sets is preserved through dry and cold, and hot and humid weather. General Electric research developed this material, which is so slightly affected by changes in humidity that it possesses a practically constant power-factor. ¶ Besides the radio-frequency grade, there are available many other grades of Textolite for the needs of radio manufacturers. ¶ The eastern and western fabricators of Textolite are equipped to furnish advice or specifications regarding your problems. There is also a Textolite specialist in your nearby G-E sales office.

General Fabricating Co.
165 Greenwich St.
New York City

Electrical Insulation Corp.
308 W. Washington St.
Chicago, Ill.

Join us in the General Electric program, broadcast every Saturday evening on a nation-wide N.B.C. network

885-47

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

RADIO ENGINEERING

Production, Administration, Engineering, Servicing

August, 1930

Fifth Annual and First International Convention of the Institute of Radio Engineers

THE fifth annual convention of the Institute of Radio Engineers is to be held in Toronto, Ont., Canada, August 18-21, 1930. A very excellent program has been prepared and in addition to the technical papers which have been arranged, a number of trips to radio organizations in and around Toronto have been scheduled. Special sight-seeing trips have been planned for the ladies who will find much of interest to them.

The convention headquarters will be at the King Edward Hotel.

Prior to August 14th, information regarding any features of the convention may be obtained from Institute Headquarters. During the convention there will be members of all committees on hand at convention headquarters, mezzanine floor, King Edward Hotel.

An information table with members of the Fellowship, Membership and Ladies Committees will be open from 9 a. m. to 10 p. m., during the convention. The committee members at this table will be glad to answer any questions. Special trips may be arranged either of a technical or a special nature. Street guides will be available.

For those desiring to arrive by plane, Toronto is well equipped with landing fields and there is a regular service between Toronto and Buffalo, N. Y. Further information may be obtained by writing to convention headquarters, attention A. M. Patience, chairman.

Special Attractions

The entire mezzanine floor of the King Edward Hotel has been set aside for a "Component Parts Show." Each exhibit will have a competent engineer in charge, capable of discussing his products with the engineer-delegate who is interested in them. This will be an opportune time for manufacturers of parts and all engineers in the industry to get together to discuss parts available for next year's chassis.

Another feature of special interest to engineers employed in the industry, is the joint meeting of the Institute of Radio Engineers and the Engineering Division of the Radio Manufacturers Association scheduled for 9:30 a. m., Wednesday, August 20th. For this meeting a number of very instructive papers dealing with manufacturing problems have been prepared.

DR. LEE DEFOREST
President I. R. E.

Members of the Fellowship Committee who will be on hand at all times at the information table will be glad to arrange a trip through the University of Toronto building, whose laboratories have so notably contributed to the advancement of science on this continent.

On Friday, August 22, the day following the convention, the Canadian National Exhibition opens for the fifty-second consecutive year. This is the greatest permanent achievement of its kind in the world. Its grounds cover three hundred and fifty acres, and represent, including buildings, almost twenty million dollars. It attracts annually over two million people from the four corners of the world. We would suggest that you take your vacation at this time so that you may be able to stay over for this great event.

Committee on Sections Meeting

A meeting of the Committee on Sections, at which it is hoped representatives of all sections of the Institute will be present, will be held at the Engineers Club on Tuesday, August 19 at 6 p. m. This meeting will give the many sections of the Institute an opportunity to be represented at a meeting of the committee on sections and will provide a means whereby the sections may exchange opinions and ideas as to methods of operation. A thorough treatment of the subject of sections and their operations will be in order and section representatives are requested to come prepared to discuss the many angles of the question.

Reduced Railroad Rates for Convention

The railroads have granted re-

duced rates for the round-trip to the convention and when purchasing tickets, the reduced return rate voucher must be requested. (No vouchers are issued on round-trip tickets.) This voucher must be validated at the registration desk at the convention and when presented to the ticket agent, will entitle the purchaser to one-half fare on the return trip to the original starting point.

Convention Committee: A. M. Patience, chairman; R. A. Hackbusch, Martin Hodsoll, J. M. Leslie, A. B. Oxley, Mrs. A. M. Patience, H. W. Price, C. L. Richardson, K. S. Van Dyke.

Registration and Arrangements: C. L. Richardson, chairman; R. A. Cline, R. W. Irwin, S. Gibbons, R. W. Northover, C. N. Smith, R. V. C. Smith.

Exhibition Committee: Martin Hodsoll, chairman; Virgil M. Graham and I. G. Maloff.

Ladies Committee: Mrs. A. M. Patience, chairman; Mrs. J. B. Byers, Mrs. R. A. Hackbusch, Mrs. Leech, Mrs. J. M. Leslie, Mrs. Noakes, Mrs. J. B. Parsons, Mrs. C. L. Richardson, Mrs. A. H. K. Russell.

Membership and Fellowship Committee: H. W. Price, chairman; B. deF. Bayly, R. B. Chamberlain, W. F. Choat, A. B. Cooper, C. P. Edwards, L. C. F. Horle, R. F. McDonough, A. H. K. Russell, J. G. Smith, all section chairmen.

Publicity Committee: R. A. Hackbusch, chairman; W. G. H. Finch, vice-chairman; W. H. Betty, C. E. Butterfield, O. E. Dunlap, Fred Ehlert, R. D. Heinl, Lloyd Jacquet, J. F. J. Maher, Donald McNicol and U. B. Ross.

Editor of News Sheet: Frank Dowsett.

Technical Papers Committee: K. S. Van Dyke, chairman; H. M. Turner, and William Wilson.

Trips Committee: J. M. Leslie, chairman; J. B. Byers, F. A. Gaby, D. Hepburn, H. E. Mott, J. B. Parsons, L. M. Price.

Banquet and Entertainment: A. B. Oxley, chairman; F. P. Guthrie, L. L. Wright, H. E. S. Hamilton.

G. W. PICKARD, President I. R. E., 1913.

Some I. R. E. History

The Institute came into existence at about the same time that the enlarged utility of the audion was disclosed—the year 1912. Previous to its formation there were two radio societies in existence: The Society of Wireless Telegraph Engineers, on January 1, 1907, had a membership of eleven and on January 1, 1912, forty-three. The Wireless Institute, on January 1, 1909, had fourteen members and on January 1, 1912, twenty-seven.

These two societies combined to form the Institute of Radio Engineers, with a total of fifty members, in 1912. By January 1, 1916, the membership had grown to 984. During the war years, until 1919, the membership was about one thousand paid members.

Prior to 1924 the Institute was mainly an organization of engineers in New York and vicinity. This, notwithstanding there was a Section in Boston and one in Washington, and that engineers in all parts of the world were members.

In the years prior to 1924, the main accomplishment of the Institute was the production of the Quarterly PROCEEDINGS—very ably edited by Dr. A. N. Goldsmith, and the periodical reports of the Standardization Committee.

It was in 1924, during President Morecroft's term that the first steps were taken to transform the Institute into a widely useful professional society. The committees were strengthened and committee chairmen were looked to to attain objectives.

President J. H. Dellinger took office at the beginning of 1925 and he planned many needed changes in methods of Institute operation and management, with the result that within the year considerable improvement had been made.

In 1926, Donald McNicol, who had been vice-president, became president. Mr. McNicol had been a member of the Board of Directors since 1919. Under his administration the reforms begun by Dr. Dellinger were carried forward. In that year the PROCEED-

Left: J. H. MORECROFT, President I. R. E. 1924.

Right: J. H. DELLINGER, President I. R. E., 1925.

INGS were gotten out bi-monthly. Large savings were effected in Institute costs; larger headquarters offices were procured and various technical and administrative committees were speeded up in activity. At the end of 1926 the Institute had about 5,000 paid members; additional Sections had been organized, and the services to members had been so extended that it became economical to employ a permanent, paid secretary. Increased income and economical management resulted in a healthy financial condition.

President Ralph Bown, who took office in 1927 carried forward the reorganization policies established during the two previous years, with the result that since that time the Institute has had a steady growth under the succeeding presidents: A. Hoyt Taylor, A. N. Goldsmith and Lee De Forest, and its usefulness and influence have increased in a degree highly gratifying to those who in volunteer fashion devoted years to building up the society.

The Toronto Section was formed in 1925, since which time it has been one of the most successful Sections of the Institute.

▲

BAD BUSINESS?

Maybe It's a Blessing To the Tube Industry

*By E. A. Tracy**

NOW and then, about once or twice a year, I wish heartily that I owned an influential paper. A paper like RADIO ENGINEERING, for example. Because if I owned such a paper I'd write some strong editorials that ache to be written. Here's my idea of an editorial right at present:

Bad business? We've been weltering in a slump? Well, gentlemen, suppose for the sake of argument that the radio industry on the whole lost money during the twelve months just past. What of it?

And then in my editorial I'd say: Maybe it's been a blessing to the business!

For, consider the tube end of it. Nineteen thirty has merely been the great radio tube industry's test by fire. What survives are the reputable, strong companies inspired with the quality ideal. What disappears are the weak fly-by-night tube makers—the fellows with more optimism than mutual conductance in their systems. Yes, 1930 will surely show which are the permanents in the radio tube field, which are to be trusted by dealers and public, which are doomed.

Thus, the tube manufacturer (and the set manufacturer, too!) with a good product designed and made on a scientific basis . . . has nothing to fear! He'll pass the 1930 test all right.

Thirty million families or persons in this land are radio fans! Does it seem reasonable that they will abandon what has become for them an impelling daily habit—an endless source of news, entertainment, education—because of depression? No. Quite the contrary. The blacker the outlook the more they would turn to their radios to forget. That is human nature.

Half the country today is either needing first sets, or replacements. And tubes! Those tubes which are finest, those which serve best—must surely know profitable sale in the next twelve months. Quality was the story in 1929, when the public paid $172,500,000 for 69,000,000 tubes. Quality *must* be the story from now on—because the public is not in the old economic mood for reckless replacements. It is buying the good things. Because they endure, because they pay in the long run. It was predicted in January that 1930 tube sales would

E. A. TRACY

rise to 84,000,000, of which 51,000,000 were replacements, and 33,000,000 the tubes put in as initial equipment on 4,500,000 sets. I doubt if we reach such figures.

But of this I am sure. The number of tube makers must inevitably dwindle. The old boom days are past. They ended last fall, impressively. 1930 is house-cleaning year. The "depression" is an economic boon to the tube industry. The surviving manufacturers—and they will get fat and prosper on the fruits of 1931's revival—will be held to rigid quality specifications. By precept—after seeing what happened in 1930 to the cheap, hit-or-miss tube makers. By popular request—from a public educated to demand the best by the far-sighted leaders of the industry.

*First Vice-President, National Union Radio Corporation

HARRY J. NICHOLS

HARRY J. NICHOLS, CHIEF ENGINEER OF GENERAL MOTORS RADIO

R. J. Emmert, president and general manager of General Motors Radio Corp., Dayton, O., announces the appointment of Harry J. Nichols as chief engineer.

Coming from the Westinghouse Electric & Manufacturing Company, where he was in charge of the radio engineering department at Chicopee Falls, Mass., Mr. Nichols has had long experience in the radio and engineering field, particularly in the development of radio broadcasting equipment.

A former Naval Academy man, Mr. Nichols returned to the service during the World War and saw duty at sea as an ordnance officer. At the close of the war he resigned his commission and was attached to the Bureau of Ordnance at Washington, where he organized the Ordnance Research Department.

After graduation from George Washington University Mr. Nichols entered the service of the Westinghouse Company, where, as a student engineer, he was associated with Mr. Emmert, who has now called him to head the engineering department of General Motors Radio.

▲

ELECTRICAL EXPORTS INCREASE

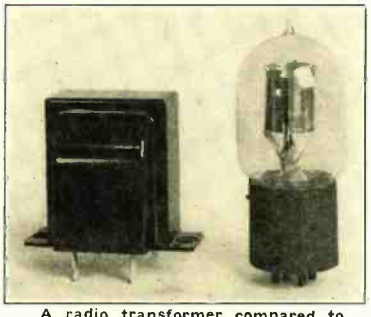
For the first four months of 1930, electrical exports exceeded the total for the same period of 1929 by 7.8 per cent.

For April, 1930 exports were $11,453,561 against $13,029,910 for March, 1929 and $12,194,998 for April, 1929. For the four months ending April 30, 1930 exports were $48,624,515 as against $47,756,667 for the same period of 1929.

Imports during April amounted to $168,860.

Development of Electrical Sheet Steel for Radio Uses

Research Carried on by Mills Has Made Possible Modern Magnetic Materials



A radio transformer compared to ordinary radio tube.

FOR most uses of sheet steel in radio work, one grade of iron or steel sheets, black or uncoated, looks like any of the hundreds of others on the market. There are many uses for iron and steel sheets, and even though they look alike, under the skin all are different, and each grade is designed to meet certain requirements. The manufacture and production of sheet steel for magnetic purposes has been a very interesting development. The cooperation of certain manufacturers with the users of electrical sheets and a study of the problems and application of these thin sheets, used for magnetic parts of motors, generators and transformers, as well as many other important parts of modern radio equipment, has been the means of developing special grades having certain characteristics which make them entirely different from the sheets used for other purposes.

Magnetic Materials for Radio Uses

As nearly every piece of electrical apparatus has a magnetic circuit (that is, requires a magnetic material), much investigational work has been carried on to determine the best quality of steel available for the devices used in the transmission and reproduction of sound.

The electrical manufacturer is constantly on the lookout for steel of improved magnetic properties, and with this in mind The American Rolling Mill Company, having established the necessary organization and equipment for the development of quality steel, has done much pioneer work to bring the magnetic sheets to the high quality known today.

Years of work were required before manufacturers were able to produce sheet steel for magnetic purposes that would meet present-day requirements. Following the discovery of the characteristics of silicon steel by Sir Robert A. Hadfield, the company was able to cooperate with one of the large electrical manufacturing organizations to carry on development work of this kind. It was in 1903 that the actual work on the improvement of sheets for magnetic purposes was begun.

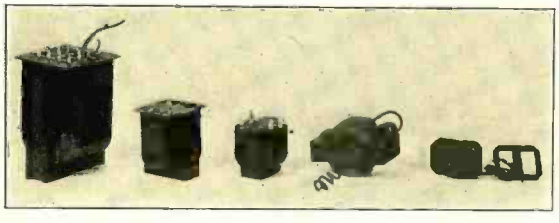
This development of electrical sheet steel has continued through the years. A decided improvement in the quality of the sheets has been made. In fact, the quality was improved to such an extent by 1905 that the actual improvement in the losses in the steel used in electrical machines was more than 50 per cent. Today it is possible because of knowledge acquired through these years to produce sheets to meet the specific requirements of the modern radio.

An interesting comparison of the development of the transformer, which is indicative of the progress in the electrical sheet steel field, from 1831 to the present, has been brought out by the Moloney Electrical Company of St. Louis, Mo.

There has also been considerable development in smaller types of transformers, choke coils, and other equipment for use in radio work. Fig. 1 shows a few types of radio transformers and choke coils, as well as a small punching from an ARMCO sheet.

Special Problems Solved

The manufacturer responsible for important developments and improvements in the manufacture of electrical sheet steel has completed a special organization and setup to cooperate with radio manufacturers and builders as well as makers of other electrical machinery. They anticipate and help solve special problems in several ways:



A few radio transformers, choke coils and punchings made of electrical sheets.

First, through the proper plant organization; second, through the proper plant equipment; third, by having complete testing equipment and a special organization for making the required tests; fourth, by having a technical organization continually studying magnetic problems; fifth, by research, development, and the preparation of material for improved magnetic characteristics.

Standards have been set up which have been approved by the American Society of Testing Materials, and in many cases special specifications are issued by the customer, so that there is always a standard by which magnetic characteristics may be measured or compared.

The world's largest producer of special analysis steel sheets, at its Zanesville, Ohio, plant, has established a magnetic testing laboratory, organization and equipment, so that every lot is thoroughly tested and recorded before shipment is made. The customer is also informed as to the quality and tests of the sheets furnished on the respective orders.

The development of a product of this kind, especially during the period when radio equipment and methods are being constantly improved, and subject to radical changes, depends on many factors, and only through careful selection and handling from the raw material to the finished sheet is a manufacturer able to furnish uniform quality. Constant study of the problems as well as research made on the preliminary work, is necessary before the sheet steel for radios can be produced in large quantities for commercial purposes.

▲

BOOK REVIEW

PRACTICAL RADIO CONSTRUCTION AND REPAIRING—By J. A. Moyer and John F. Wostrel, 354 pages, illustrated—McGraw-Hill Book Company, New York, 1930.

This is the second edition of a handbook brought out in 1927. The new edition contains much practical radio information, of use to engineers and servicemen. The price of the book is $2.50.

Automobile Radio Receivers†

Detail Account of a Satisfactory Automobile Radio Receiver, Including Antenna System, Audio- and Radio-Frequency Elements.

*By Arthur V. Nichol**

IT is the purpose of this paper to discuss the special considerations involved in the design of automobile radio broadcast receivers. A brief history of the development of radio reception in motor-cars will also be reviewed.

Possibly all radio men are a little queer, or just miss being normal, but ever since a crystal detector made its appearance and I daresay, a bit before, some of us have attempted reception and transmission from vehicles. We couldn't get enough of radio, pardon me—"wireless," at home and much effort was expended toward the portable receiver so we could carry it with us. Most of these early attempts were purely portable sets. By the time tubes came into general use, and the waves between two hundred and six hundred meters became something more than the amateurs' playground, some very good portable receivers had been constructed. About 1922 several of these receivers had been installed and operated in automobiles, but they were essentially portable receivers, which the automobile receiver of today distinctly is not.

It remained for Wm. M. Heina to definitely design an installation which was so constructed as to make it a part of the automobile rather than an accessory, a mobile, rather than a portable receiver. This was in 1925. Since then much development has been done, until today it is possible to enjoy approximately the same reception in your motor car as you do in your home.

Auto-radio therefore is not an overnight development as would appear from some of the current newspaper and trade journal articles. It has had its laboratory stages, and emerges much as other radio developments, a dependable product properly engineered and designed to perform under those conditions encountered in the automobile.

To more fully bring out the highly specialized receiver necessary for motor car operation we may follow its developments:

The first sets were usually operated on separate batteries, rather than from the car battery. Their batteries were carried wherever convenient; in all probability in the rear where the acid from the storage "A" could conveniently spill and ruin the floor mat. The antenna consisted either of a loop; an erection similar to a small fence around the car roof, or a series of wires strung about the car which gave it much the appearance of a full rigged ship. A speaker was seldom present but if one was used it usually occupied as much room as the set. Owing to motor interference, operation was not possible while driving except on signals of high level.

One by one these crudities of early design were overcome. Today the plate supply batteries are housed in a watertight compartment under the floor. The antenna is concealed in the roof, between the deck material and the head lining. The speaker has assumed much smaller dimensions and is now mounted under the cowl. "A" power is supplied by the car battery and all that remains to be seen of the radio receiver is a dial and switch on the instrument board, as much a part of the car as the speedometer.

For clarity let us divide a typical installation into its various components. We have:

1. The antenna system.
2. The radio-frequency system.
3. The audio-frequency system and reproducer.
4. Means for overcoming the interference from the electrical systems of the car.

The Antenna System

The importance of antenna system design cannot be too highly stressed. Extensive tests on various types, sizes and constructions have definitely pointed to the superiority of the large area screen antenna over all others, with the horizontally coiled loop as a second choice. The effective height is woefully low which means that a receiver of high gain is necessary. The capacity of the antenna should therefore be made as high as possible. In cars using poultry wire as a support for the deck material this netting may be insulated and makes an excellent antenna.

Many automobile manufacturers are insulating this poultry wire from the car by a spacer built into the roof construction. A lead wire is brought down the right front post to facilitate installation. Measurements of these antennas show, for sedan models, a capacity of about 200 μ μf. and a resistance of about 1.5 ohms at 1,000 kc. The inductance is negligible. This capacity compares favorably with that of a good broadcast antenna, but the effective height averages but .4 meter. In cars having a slat roof, the antenna may consist of copper window screen tacked against the under side of the bows and concealed by the head lining. In factory installations this copper screen is placed between the slats and the deck material. The characteristics of this type are much the same as those of the poultry wire antenna, but as they are necessarily smaller in area they show no improvement in reception.

In roadsters and touring cars a flexible wire is woven into a horizontal loop supported by cloth which is stitched to the pads which support the top material at each side. A lining of the same material as the top is stretched beneath to conceal it from view. In such an installation, the top may be folded back as the lead wire is brought down the rear of the top and along the body sill to the cowl. The set may be operated with the top up or down, although better reception is of course had with the top up. This antenna is about 75 per cent. as efficient as the screen, but because of the smaller masses of metal about it, its effective height is greater than that of the screen. These two factors tend to offset one another, and a very successful installation can therefore be made even in a roadster. A touring car antenna often is superior to that possible in a sedan.

Many unusual types have been tried, such as using a capacity to earth, the use of insulated bumpers, trunk racks and so forth. Probably one of the most interesting was an insulated plate fastened beneath each running board. Shielded leads were run from these plates to the receiver. The antenna transformer primary was grounded at the exact center. The idea was that spark radiation from the ignition system would be picked up equally by these two plates and being in phase across the antenna coil would cancel out. The signal, however, being slightly out of phase would induce a potential in the secondary. It was far from successful from an elimination standpoint, but was a rather good antenna. However, it was directional and therefore discarded.

Wire, tinsel tapes or small loops mounted inside the car do not prove satisfactory because of the shielding effect from the metal parts of the body. These antennas necessitate receivers of too high a gain to be practical and their advantage from an installation angle is slight.

We find, therefore, that the best antenna is one which combines the highest possible capacity with the greatest effective height, or in other words

---

†*Presented before the Radio Club of America, April 9th, 1930.*

**Asst. Chief Engineer, Automobile Radio Corp.*

maximum spacing from metal parts of the body.

The Radio-Frequency Amplifier

Cars today show the effects of standardization to a marked degree. The space available and its location however is subject to wide variation. The receiver must be mounted in an accessible position. It must be easily installed and must not in any way interfere with service or replacement of any parts or accessories already installed in the automobile. Careful consideration shows the space most readily available to be under the cowl between the instrument board and the engine partition. This position has the added advantage of allowing direct control of the tuning elements without the necessity of flexible shafts, gears or rods, and therefore materially reduces the installation expense.

The receiver may conveniently be broken into two units, one containing the radio-frequency amplifier, detector and tuning control and the other containing the audio amplifier, voltage regulator and output system. These units can be interconnected by a flexible shielded cable enabling the audio unit to be mounted in the most practical position. This further simplifies installation.

As the antenna is necessarily rather inefficient it is necessary that the receiver have high sensitivity. Owing to the fact that the receiver will be used in congested areas where many large and powerful broadcast stations are in operation, the selectivity must be about equal to that of a home receiver. The smaller and less efficient antenna somewhat simplifies this but the increased gain still makes selectivity a factor.

Our choice of circuits is limited. High amplification with selectivity calls for a multiplicity of tuned circuits. In properly designed circuits using the 201-A tube, it has been found possible to obtain voltage amplifications as high as 15 per stage. These tubes have the advantage of low filament consumption, comparative freedom from microphonic noise and a high degree of uniformity even when different makes of tubes are compared. This is of considerable advantage from a service angle. Three of these tubes working into a 112-A detector give ample sensitivity for all ordinary conditions of reception.

We have not found it possible to utilize the screen-grid tube to advantage in such radio-frequency amplifiers. This is due to several causes. At least three tuned stages are necessary for good selectivity. With screen-grid tubes the gain per stage is several times that obtained with the 201-A type, hence we reach the practical limit of amplification without having a sufficient number of tuned stages to give a proper degree of selectivity. By practical limit of amplification, we mean that limit imposed by raising the background noise level to a point where it becomes objectionable and interferes with reception. There is no permanent advantage in increasing sensitivity beyond this point. If we do, it merely means we shall have to operate the receiver with the gain control at a point considerably below maximum. There are times, of course, under exceptional conditions such as exist in the country during the fall and winter, when the background noise level is low enough to allow full gain, but under normal conditions it is rarely possible to increase the sensitivity beyond 20 microvolts per meter and obtain satisfactory reception.

We can, with three 201-A type tubes obtain a sensitivity better than 5 microvolts per meter. This sensitivity could be obtained with 2 type 224 tubes, but with 201-A's we have the added advantage of another tuned stage which increases selectivity to such a marked degree that it warrants the additional space required. The production cost is about equal, as the screen-grid amplifier requires careful shielding and more expensive construction in order to withstand the mechanical abuse to which the receiver is subjected.

Low filament consumption is necessary as the additional load of the receiver on the car battery must be kept at a minimum. The 222 and 199 type tubes, while possessing desirable filament characteristics, are mechanically weak and are microphonic. The 224 type requires a high filament current and even when operated in series parallel this current is sufficient to endanger the proper operation of the car battery system.

We may therefore consider it good practice to utilize 201-A tubes as radio-frequency amplifiers. The best method of using these tubes is in a tuned neutralized amplifier.

As the receiver is to be operated when the engine is running it is necessary to compensate for voltage variations of the battery when under charge. To offset this difficulty it is advisable to adjust the minimum possible filament potential to such a value as will keep the tubes in saturation at all times. A negative grid bias of high value should be used to prevent deactivation of the tube filaments when operating at such excessive potential as may be developed by a gassing battery.

Some ripple from the generator commutator may enter through the detector filament but as the 112-A type tube has an oxide filament of high thermal lag this is of no consequence. A tube having an X L filament may cause considerable trouble at this point.

The Audio-Frequency System and Reproducer

The audio system may be one of two general classes—transformer or resistance coupled.

The selection of the type most adaptable to automobile radio will be governed by the available space, total output, type of tubes and battery requirements.

Space being at a premium the plate supply must be limited to 180 volts with provision for operation on 135 volts if necessary. Resistance coupling would be satisfactory if 180 volts could be used in all installations but space for batteries is not available in some instances. It would of course be necessary to use a tube of the 240 type in the first audio. These tubes are a possible source of trouble as they are not as uniform as the 201-A and are mechanically weaker. There are, however, some very good arguments which could be advanced in favor of resistance couplings were it not for the battery limitations.

The transformer coupled amplifier has the advantage of higher gain, adaptability to various plate potentials and the use of more rugged tubes.

Working back from the output tube we find that a 171-A will operate at 180 volts plate with a grid swing of 28 volts r.m.s. A 2-1 coupling transformer reduces this to 14 volts from the first audio tube. Therefore a 201-A operated at 90 volts plate and 4.5 volts bias will perform excellently in this position. Accepting 5 as the available amplification from this tube the input becomes 2.8 volts and a transformer of the same ratio; 2—1, means a detector output of 1.5 volts.

The amplifier thus has a gain of approximately 80. It is not advisable to increase the gain beyond this point, for, while the response is increased on weak signals, shadow effects are increased owing to the square law response of the detector. These shadows are caused by reflection and shielding from buildings, railroad bridges, etc., and may become very troublesome if the audio gain is of high value. A volume control tube might be used, but if operated by the carrier, or a function of the carrier, would necessitate visual tuning. This is of course a disadvantage as it further complicates the receiver, makes installation more difficult and is distracting to the car operator.

In the foregoing amplifier the power tube is allowed to overload first. While this condition is not generally desirable it becomes almost a necessity in automobile receivers. The wide variation of conditions under which the receiver must operate necessitates high gain and sufficient audio amplification must be incorporated to maintain output levels between plus 10 and plus 20 dbs. Due to road, traffic and engine conditions the average noise level in the car apparently lies between plus 6 and plus 10 decibels and the signal must be sufficient to blanket this. However, owing to the confined space of the car body audio intensity should be low enough to prevent uncomfortable overload.

The reproducer used must naturally be as efficient as possible as the power available is limited.

Speakers may be divided into two classes: magnetic and dynamic. The magnetic speaker is much better suited for car installation because of its light weight, smaller size and the fact that it can be made dust tight.

The importance of complete protection from dust cannot be over-emphasized. The amount of iron and steel particles contained in ordinary road dust is very high, sometimes as high as 12 per cent., and as a large amount of this dust is tracked into the car, it floats about, is gathered by the magnetic field of the speaker and consequently ruins its operation.

The small space available is a considerable handicap, but because of the acoustics of the car body surprisingly good results may be obtained. The absorption of the higher audio frequencies by the upholstery of the car tends to offset the lack of adequate baffle and the results are very pleasing. The speaker is usually mounted against the engine partition high enough to allow foot room and as a result the cavity resonance of the location further reinforces the middle and low register. It is not possible to cut a hole in the engine partition and utilize this as a baffle for in modern car construction this partition is heavily padded to absorb engine noise, and the aperture filled by the speaker would admit this noise to the decided discomfort of the operator.

The dynamic speaker, while being slightly more sensitive, and possessing better fidelity has the disadvantage of additional current consumption for energizing the field. Automotive engineers desire that the total current consumption be kept as low as possible and the addition of this speaker field current, which is often greater than that drawn by the receiver, offers a decided objection. Low field consumption could be had but the manufacturing difficulties attending such construction would not warrant the design.

A brief description of a receiver designed with these considerations in view is of interest.

Description of a Representative Receiver

The radio-frequency unit consists of a steel chassis measuring about 8 inches x 10 inches on which the components of the r-f. amplifier and detector circuits are mounted. This chassis is secured in a drawn steel box immediately behind the instrument board. The box consists of two similar sections separating on the center line of the condenser shaft thus allowing access to the unit by the removal of a single knurled screw which releases the cover section. The entire chassis may be removed by loosening four retaining screws. As the chassis are completely interchangeable the replacement of a defective unit is but a matter of a few minutes, in fact the change can be made in much less time than it takes to change the car battery, and is as simple. The circuits of the r-f. amplifier and detector are conventional. Particular attention had to be paid to the elimination of possible modulation due to vibration. For this reason the variable condenser is designed to permit maximum rigidity of both rotor and stator plates.

The tuned circuits are brought to resonance by means of inductor discs which move coaxially with the r-f. transformers, rather than with the conventional trimming condensers, as condensers may vibrate and introduce modulation. The condensers used to neutralize the capacity coupling of the tubes take the form of plungers which are rigidly supported on the chassis, the opposite plate being a sleeve moulded into the body of the condenser. The wiring is extremely short and direct and therefore further reduces the chance of modulation from small changes in capacity or coupling.

As previously stated a "C" bias on all tubes is necessary to prevent deactivation of the tube filaments and to render the performance of the receiver independent of the polarity of the filament supply. To accomplish this the filament end of the r-f. transformer secondary must be at "C" potential. It must, however, be at chassis potential to the r-f. currents in the circuit. To accomplish this a 1/4 mf. condenser is placed between these points, effectively in the tuned circuit. To prevent possible coupling and eliminate the possibility of damage from defective tubes, short circuits, etc., protective resistors are inserted in both plate and "C" leads. These resistors are, of course, heavily by-passed. By thus isolating each circuit much higher gain may be incorporated without serious trouble from stray coupling such as usually exists when common feeders are used for these circuits.

A conventional grid detector is used. Additional capacity must be introduced to compensate for the absence of reflected capacity in the detector stage. A small piece of braid over the detector grid lead supplies this.

Tuning is accomplished by a single control extending through the instrument board. To facilitate installation the control shaft is a hollow tube, and the gain control is mounted on the rear of the condenser and articulated by means of a small knob in the center of the tuning dial. Switch leads for controlling the filaments enter through a grommet secured when the cover is placed in position.

The audio chassis is approximately 5 inches x 10 inches. In addition to the tubes, sockets and transformers it carries an output filter and an iron core reactor. The filaments are fed through this reactor. It thus serves a double purpose; that of filtering any ripple which may be present in the filament circuit; and in addition, offers a convenient method of adjusting the filament potential to the correct value.

Knockout slots are provided in the box for the interconnecting cables. As there are four knockouts, any two of which may be used, this box may be mounted in any convenient position. The cover is held in position in the same manner as that of the r-f. box. The interconnecting cables terminate at each end in connecting blocks, carrying plug and jack connectors which provide a rapid and foolproof means of connecting the units.

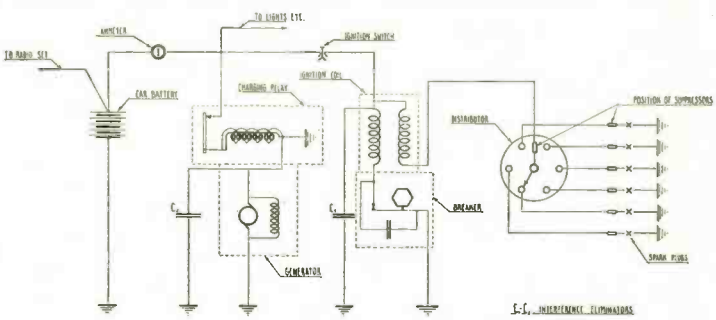
These connecting blocks slip into the rectangular knockouts provided in both boxes and are held firmly in position when the covers are in place. This method has proven very satisfactory and trouble from faulty hook-up is almost unknown. The battery cable, which connects the audio chassis with the box containing the B and C batteries is usually run under the floor boards and is connected to the battery box by means of a water-tight coupling. Either lead cable or a special waterproof housing is used.

Particular attention must be given to making the battery box water-tight. A small amount of moisture may cause bad leakage and run down batteries. Special moulded case waterproof batteries have been developed for this type of service, and their use is recommended wherever possible. The battery box is usually mounted so that the cover fits flush with the car floor thereby making the batteries readily accessible for test and replacement.

Tests conducted over the past four years show the standard V30D type most economical and suitable for automobile installation, where the total plate current drain is twenty milliamperes or less. Under these conditions and with normal use a good make of battery will give approximately four months service, and it is not exceptional to exceed this.

Elimination of Interference Caused by the Electrical Systems of the Car

Motor and ignition noise was by far



ELECTRICAL SYSTEM OF A CAR

Figure 1.

the most important obstacle to overcome. This type of interference is present to a varying extent in all cars, and some means of successfully eliminating its effect upon reception had to be found. In 1927, A. A. Leonard, working on the problem, made several important discoveries which led to a practical system of eliminating this trouble. Briefly, his findings were these: The high tension ignition wires of an engine may be considered as miniature antennas, grounded at the spark-plug end and oscillating at a frequency dependent upon their distributed inductance and capacity, practically determined by their length. The passage of the spark at the plug excites these miniature antennas and as their radiation efficiency is extremely high a considerable amount of power is radiated. Owing to the high radiation resistance damping in these circuits is also high and the energy thus radiated in highly damped trains impacts the antenna. The resultant interference is similar to that experienced by broadcast receivers from 600-meter spark transmitters of high decrement. In the car, however, the interfering damped train from the ignition system has a frequency lying between 10 and 60 megacycles, in some cases higher. Also, coupling is much closer. Shielding was tried but it had the serious disadvantage of materially curtailing the efficiency of the ignition system, besides being costly and inconvenient to install. Mr. Leonard then conceived the idea of destroying the oscillatory character of the currents in the ignition wires. This proved very successful. It can readily be seen that a resistance of sufficiently high value introduced into the oscillatory circuit will render it aperiodic. In other words, the value of $\frac{R}{2L}$ is increased to be equal to or greater than $\frac{1}{\sqrt{LC}}$. This is a condition in which oscillation is impossible, and the current becomes a single pulse. This in no way affects the efficiency of the ignition system, and may even improve it by materially reducing the time constant of the ignition coil.

Gasoline vapor under compression behaves somewhat like dynamite, and must be exploded by impact from the rupture of the gap at the plug, rather than by the heat of the arc after the rupture has taken place.

It therefore follows that the introduction of resistance, even in the order of several hundred thousand ohms, in series with the theoretically infinite resistance of the gap before rupture, will have no effect. It will however rapidly dissipate the energy fed to the circuit by the coil after the rupture has occurred, thus dissipating this energy as heat rather than radiating it at radio frequencies.

In practice it is customary to introduce a resistance of approximately 25,000 ohms directly at the plug. This value is higher than is necessary to satisfy the equation of $\frac{R}{2L}$ being equal to or greater than $\frac{1}{\sqrt{LC}}$, but as there is some aging effect in the resistors, it is considered good practice to use a higher value than actually necessary. Incidentally, two well-known manufacturers of carbon resistances have developed a special type of resistor which is suitable for use in ignition circuits. The ordinary carbon resistor is unsatisfactory for this use, as its value may decrease very rapidly under high potential discharges. A thorough life test under actual operating conditions should be given a resistor intended for this use.

We now have a circuit in which the damping factor is raised to a point preventing oscillation. However, in a car the wires directly associated with the plugs are not the only source of trouble. These wires terminate at the distributor, which is in reality a rotary switch. The center arm of the distributor is fed from the high tension terminal of the coil. This arm is separated from the various contacts by a definite gap, and this gap is important, being placed there for a particular purpose. If a plug is fouled, owing to carbon deposits, the resistance of the gap at the plug can no longer be considered infinite, but assumes a high value, generally several megohms. The high potential current induced in the coil secondary would leak off across this resistance rather than rupture the gap at the plug. The purpose of this distributor gap, then, is to permit the secondary current to exist at fairly high potential before passage to the spark-plug, thus insuring a spark even though the plug be partially shorted by the resistance due to fouling. We therefore must insert a resistance in series with the lead to the distributor brush in order to destroy such oscillation as may occur in this lead.

Some question may arise as to the actual efficiency of operation of these resistors as oscillation suppressors. Some rather simple but interesting tests may be described which show definitely their action.

Suppose we introduce a neon tube of low internal capacity into a high tension lead. We know that the glow will occur only on the positive plate of the tube. Without the resistor in the circuit the glow will definitely show on both plates, although one will be considerably brighter than the other, owing to the damping. Upon introducing the resistor, however, the glow will be confined to one plate only and there will be no indication of reversal of potential which must accompany oscillation. This method is extremely sensitive, as neon lamps are available which will glow brilliantly at potentials as low as 120 volts. This is about 1 per cent. of the possible potential developed by the coil. It may also be noted that the resistance of the neon tube is very high until ionization occurs, consequently the development of oscillation is unhindered by introduction of resistance by the tube.

The cathode ray tube also presents an admirable method of determination although its associated circuits render it more cumbersome. For determination of oscillation the tube may be capacitively coupled to the high tension wire by means of a small piece of foil, or even by the lead wire itself. Owing to the high potentials which may be induced between the control plates by possible resonance of the lead wires with the high-frequency oscillation in the circuit under observation, the tube should be protected by shunt resistances to prevent arcing. It is almost impossible to introduce a time axis owing to the ultra high frequencies at which oscillations occur, and the usefulness is limited to determination of oscillation, and measurement of peak potentials.

A tube voltmeter may be used in much the same manner. It will be necessary to operate the coil at such polarity that the reversal of secondary current will supply positive potential to the grid. The spark frequency must also be increased to at least 50 per second, otherwise this method will produce negative results. The cathode ray tube is by far the most sensitive and has the advantage of calibration. which is not possible with either of the other methods as the neon tube is insensitive to less than its ionization voltage, and in calibrating the tube voltmeter, the frequency of the spark and form factor of the wave must be taken into consideration.

With the elimination of the high tension circuit interference the major source of trouble is overcome. However, electrical interference may still be present, caused by various elements of the low tension circuit. The primary of the ignition coil; the automobile fraternities' name for the induction coil, still causes trouble owing to the oscillatory nature of the break at the timing points. When the points are open this circuit contains the primary of the induction coil in series with a condenser of about .2 to .4 mf. The purpose of this condenser is to absorb the potential developed across the primary of the induction coil by the rapid collapse of the field in the coil when the points are opened thus preventing an arc which would fuse the contacts rendering them inoperative. This potential however is rapidly changing in value as the flux becomes less, and in a very short time the potential across the coil terminals falls below that impressed upon the condenser. The condenser then discharges through the coil, not only reducing the flux to zero, but actually causing a reversal of potential, hence a reversal of flux in the primary of the coil. This is of course an oscillatory condition which may go through several complete cycles. Its frequency, disregarding for the sake of clarity the secondary coil, is determined by the inductance of the coil primary, the capacity of the condenser, and the resistance of the cir-

cuit. The resistance is high, owing to the copper losses of both secondary and primary. Iron losses must also be considered. The frequency is rather low, seldom higher than 2500 cycles, but can readily couple to the audio system of the receiver. To a great extent this is overcome by providing a short path for these oscillations to flow through. A condenser of 1 to 2 mf. capacity is connected between the battery side of the coil and ground. This is termed a drainage condenser. It also prevents any radio frequency which may be developed at the breaker points from travelling back through the primary wiring of the car to the radio set. A small choke coil might be interposed in this lead but care must be taken to see that it does not affect the ignition operation at high speeds. It is not practical to do this on 8-cylinder or high-speed engines as resonant conditions may be obtained which might do considerable damage to the coil, points, and condenser.

Noise from the generator is seldom very noticeable. A condenser connected directly across the brushes will clear up any but the most perverse ripples. If this is insufficient the generator must need attention. Dirty commutation or open bars are definitely noticeable in the radio receiver, and the set serves as an excellent check on generator operation.

In conclusion the writer wishes to thank the Chrysler Motors Engineering Department and the engineering department of Dodge Bros., Inc., for the suggestions and assistance they have rendered in the development of automobile radio; the Allen Bradley Company, Inc., and the Erie Resistor Corporation for development of resistors suitable for use in ignition circuits; the Sterling Mfg. Co., Inc., and Mr. Geo. Eltz, Jr. for reproducer development; also members of the engineering and service departments of the Automobile Radio Corporation and the Willard Storage Battery Co., for data used in compiling this paper.

Rating of Broadcast Receivers

Selectivity, Sensitivity and Fidelity of Radiophone Reception may be determined with Reasonable Accuracy.

By Darrell B. Green

UNTIL recently, prospective buyers of radio receivers have been forced to rely upon their own general impressions of the grade of performance of a receiving set. After hearing one set at one time and another set at another time and under different conditions, it is practically impossible for even a trained musician to make an intelligent comparison. A good salesman, an attractive cabinet and a reasonable price are usually final deciding factors.

The radio public will welcome a step that has been taken by the Institute of Radio Engineers to eliminate guesswork in the selection of a receiver.

A committee appointed by this organization has outlined a standard method of testing set performance. There are three tests made; a selectivity test, a sensitivity test and a fidelity (tone quality) test. It is not easy to judge one of these qualities unless actual laboratory tests are made. For instance, a receiver is popularly supposed to be selective when a turn of the dial from one division to the next brings in one or more stations. However, the size of the dial and the condensers can easily be such as to do this mechanically without affecting the electrical property of selectivity. The real test of selectivity is to see whether a station to which the receiver is not tuned interferes with the tuned station.

Selectivity

In the laboratory test of selectivity, a modulated radio frequency signal from a calibrated oscillator is impressed upon the receiver tuned to the signal and the output is measured by an audio-frequency voltmeter in place of the usual speaker. The frequency of the signal is then changed by 10 kilocycle steps while the set is left tuned to the first point. The output, of course, drops because of being out of tune but the input signal strength is increased until the same output voltage is obtained, as at first. The input signal strength is then plotted against frequency and a curve is obtained showing how strong a signal (off tune) must be to give the same output strength as the signal to which the set is tuned. Three curves are usually plotted at 600, 1000, and 1400 kilocycles.

The committee makes no suggestion for a numerical rating of selectivity, but the suggestion has been made by others that a set be rated as 100 per cent. selective if a station 20 kilocycles on either side of resonance has to be 100 times as strong as the station to which the set is tuned, to be heard with the same volume.

Sensitivity

Sensitivity means how faint or distant a station the set will bring in. For the sensitivity test, the same procedure described above is used except that the set is retuned to each frequency step and the power input adjusted to give a standard output. A set is 100 per cent. sensitive when an input field strength of one microvolt per meter will produce 50 milliwatts output throughout the broadcast range of frequencies. Field input strength plotted against frequency comprises the sensitivity curve. Three curves are plotted for this test, one at each of the above radio frequencies.

Fidelity

Fidelity or quality means freedom from distortion. With a constant input strength the set should equally amplify all voice and music frequencies. For the fidelity test, the audio modulation is varied from 60 cycles to 5000 cycles (approximately the musical range) and the output is measured. To reproduce faithfully all musical tones and rate 100 per cent. this test should show a flat curve (equal amplification) throughout the audio-frequency band. Three radio frequencies are used.

In order that comparisons may be made between measurements made in different laboratories, the committee has prescribed standard conditions governing the above tests. The radio-frequency input must be modulated 30 per cent. by an audio-frequency of 400 cycles. A standard output from the receiver of 50 milliwatts is maintained. An artificial antenna of 20 microhenrys, 200 micromicrofarads and 25 ohms resistance is used on the receiver.

Radio laboratories are testing sets and publishing their performance curves. Set purchasers should study these curves and choose the kind of set desired. All sets are more selective at low frequencies. This is usually due to the fact that the radio tuning condensers are shunted with the grid input resistances and dielectric losses appearing as resistances. These may be considered as equivalent series resistance $R_s = \frac{X^2}{R_{sh}}$ Where R_s is the equivalent series resistance and R_{sh} is the actual shunt resistance. It will be seen that as the condenser capacity is decreased (at high frequencies) the

(*Continued on page* 39)

* *Paper presented at Ohio University Branch, A. I. E. E.*

The Parting of The Ways

An Incomplete Analysis of the Radio Production and Merchandising Situation

By Austin C. Lescarboura, Associate Editor
Mem. A.I.E.E., Mem. I.R.E.

LAST fall the market broke, both stock and radio. The vagrant radio industry, until then riding the wave of popularity that made possible the running of a huge industry with but little fundamental knowledge of markets, production methods or other information found valuable by other industries, had need of checking up on itself. In the intervening months, this has been done. The books have been balanced. House has been cleaned. Now, what to do in this clean house? We seek the answer to this question.

Breaking the question into its components, we meet such subjects, old time acquaintances all, as production schedules, conditions anticipated for the coming season, the curtailment of radio production and the substitution of other lines, estimates of probable radio markets and the determination by each concern of its share of the business. We also run against the problems of production and merchandising changes as well as miscellaneous—a word used rarely outside of expense accounts—suggestions for the betterment of the radio industry.

The radio manufacturers are in production. That *is* news. One or two parts manufacturers tell us their machinery is hungry for raw material, but manufacturers of sets seem to be overstocked. On the whole, however, it seems as though the wheels of the radio industry are moving. "They are grinding slowly, but they grind exceedingly small." Timidity is holding back production. Seemingly, the industry has learned its lesson. Diogenes might search most diligently, not with an old lantern, but with a powerful arc light, and not come across the manufacturer who is piling up an inventory. Warehouses are not going to make money from the radio industry this year. A healthy sign, that. Still production in some instances is by no means slow. The Central Radio Corporation, which organization makes sockets exclusively for manufactures, reports great activity. Morris Metcalf, vice-president and treasurer of American Bosch Magneto, acting as mouthpiece of that company, claims that Bosch is "doing everything possible to extend the manufacturing and buying season" in the belief that "business not done in June and July is never fully made up later in the season." Equally true of the ice skate industry.

Seasonalism a Detriment

The manufacturers are agreed that for the most part seasonalism in the radio industry is a detriment that must be overcome. In the production end it means a steady, slow production in place of alternative periods of overtime and shut-down. In the merchandising field it means educating the public to the purchase of radio sets as musical instruments instead of as Christmas presents "From Dad to the Family."

Soothsaying, fortune telling and predicting are great sport. Even the great and the near great of the radio industry must take time out to glance ahead. To such questions as "Are you making a worthy product?" all the answers would be the same. But when it comes to predicting the coming radio season, we discover that "hope springs eternal in the human breast" in spite of all, but that pessimists and conservatives have at last found their way into the industry. One of the foremost radio manufacturers seemingly without a twinkle in his eye or his tongue in his cheek, admits that 1929 was the company's best season, and on top of that says that the company expects, not hopes, mind you, but expects to exceed 1929. Europeans are right when they say that America is a nation of optimists!

1930 Season May Lag

But not so very right, either. For another organization predicts only a fair season, anticipating a business exceeding that of 1928, but not quite equalling that of last year. One manufacturer thinks that the season will start rather late this year, but by the end will approximate if not equal that of 1929. One concern estimates about 60 to 65 per cent of the business transacted last year. And then, resorting to the Socratic method, the question of determining the radio market was answered by asking us to foretell the general business conditions of the year. We regret our inability to aid in this respect. If a knowledge of general conditions would lead to an accurate appraisal of the radio market, and if we could know the general conditions, we would close our editor's desk and endorse huge checks given us by radio manufacturers in payment for imparting to them our precious information.

Alack and alas, it cannot be. Of course, if business is good this fall, which would require a decided change, radio would pick up. The last quarter of 1929 was none too good, what with one thing and another. A general revival of busines combined with more reliable merchandising methods within the radio industry might lead to a year comparable with 1929.

A few of the manufacturers have availed themselves of the little information obtainable from reliable sources concerning estimates of the probable radio market for the coming season, on the basis of which they determine their share of the total market. A short time ago, in a survey covering the vacuum tube industry, we found that most of the manufacturers were firmly convinced that they were going to produce anywhere from 500,000 to 5,000,000 tubes for the year. And since the estimated total output of these same manufacturers was placed at about 75,000,000 and there are about 80 tube manufacturers, it was evident that something was wrong somewhere.

Gauging the Market

In the case of the radio industry proper, concerns claim to be determining their share of the total market, but on what bases and with what accuracy and what that share will be, none will say. One concern, dealing in parts, produces chiefly on the specific orders from set manufacturers. Sales estimates serve for lines sold directly to the dealer. The Zenith Radio Corporation controls its production in such a manner that surplus of distress stock cannot be created. This company claims never to have been loaded with stock. Other manufacturers, not so fortunate, might do well to consult with Zenith and learn its secret formula for keeping down its waistband and maintaining a trim and healthy figure. But wait, they hint at the system themselves. "We have never permitted our jobbers or dealers to overload. We believe in conservative production."

All those who vote according to Zenith? The motion is carried. But

like prohibition, too many radio manufacturers vote for sane production and no forcing of merchandise on dealers, and then turn around and load everybody up, including themselves. But conditions are righting themselves. It might have been said before, but aside from a few foolish manufacturers it can scarcely be said any longer, that their eyes are bigger than their stomachs. However, we should like to know the bases on which estimates of the market are made. It seems to us impossible to gauge the radio field accurately without a more certain knowledge of general business trends, in this most variable of years. As one manufacturer asks, "How can radio maintain its rising curve in the face of a decline in nearly all other industries?" Well, we shall see, we shall see.

Some of the good folks who so patiently sat down to write us about their activities hold to the rule that it is bad business to swap horses in the middle of the stream. These will stick by radio. The question is, will radio stick by them? These concerns are manufacturing radio equipment exclusively. Others,, perhaps a bit afraid, perhaps with a view to utilizing some of their machinery, space and labor for other lines instead of having it lay idle or over-producing in radio, have turned to other fields. Radio, bell ringing, ignition and sign transformers are attracting the attention of one firm. Other companies always have been engaged in manufacturing aside from radio, such as Bosch and Atwater Kent. One concern is adding relays to its line, another is going in for refrigeration, still another is considering additional lines, but with no curtailment in radio production. They are almost always very sure to emphasize that "without curtailment of radio," for fear of giving any impression other than that radio was never more on the up and up.

Production methods seem to have been fairly well standardized. That is but natural, since the history of radio until the dark ages of November, 1929, was one to demand mass production. There are hints of production changes, vague and non-committal. But for the most part, the changes are in using the present methods more efficiently. Such phrases as "economizing by merchandising wherever possible," "improving to lower manufacturing costs," "nothing radical," "cheapening in every possible way," "more efficient methods," and "flexibility" give an excellent idea of how production is meeting the problem of getting more pleasant monetary tunes from radio.

The Big Surprise

And now for the big surprise. We thought that the question concerning changes in the merchandising methods employed by the radio industry would bring an avalanche of opinions as to what is wrong with the radio industry, what can be done to correct it, more money for the manufacturer, jobber, dealer, consumer, quicker turnovers, fewer turn-ins, credit, exclusive territories, service, discounts, department store dumping and the like. And what do we get? A wide expanse of monotonous desert marked, "No particular changes in merchandising methods."

We were astounded. For months now we have listened to the wailings and the moanings of radio manufacturers anent the subjects of cut-throat competition, price-cutting and the like. We know that many manufacturers have apologized profusely to their jobbers and dealers, promising never, never again so long as they lived to behave in so shameless a manner as they had in the past. We know for a fact that pressure has been brought to bear leading to certain drastic changes in merchandising policies. We know that improvements in the radio industry this year are to be chiefly in the merchandising end. And yet, when we give the manufacturers an opportunity to speak about these changes they decline the invitation.

Cortlandt Street!

What is the matter? Are they afraid others may steal their world-beater plans? Have they decided that now that the crash is a few months past they can resume their old tricks? Perhaps all the talk of reforms has gone for naught. Or is the silence on the merchandising front due to a misgiving lest by mentioning improved plans the manufacturers will imply imperfect plans in the past? No such implications are needed. The inventories of last winter and Cortlandt Street speak for themselves.

But since we must be accurate before all else, we can report no excursions into new merchandising channels as a result of our survey, much as we may have spoken of them before and will again as a result of information gleaned elsewhere. One concern plans to make more by working harder. That is a good idea. Another is selling to jobbers whereas they had formerly sold direct to dealers. And that is all, aside from the opinion of Mr. Metcalf of Bosch to the effect that "what the industry needs is what most other industries have, namely, reliable statistics tabulated and distributed frequently enough to indicate the trend of radio affairs. So long as a number of important manufacturers frankly ignore such basic facts, we will have the same troubles as we have had in the past." And that is that.

Not a mention of the new merchandising plan to be instituted by General Motors Radio, nothing about exclusive territories, nothing about qualifications for dealers, the retention of a trained service personnel, nothing about not selling to department stores and other takers of distress merchandise, nothing of the basis on which sales will be made, mechanical features, tone quality, beauty of cabinet and the like, nothing about the obsolescence problem. We were amazed. We still are amazed. We stand with open mouth, gaping. Excuse us for a moment.

Rushing about for miscellaneous suggestions with which to break the silence in merchandising circles, we find one opinion to the effect that the radio industry must wait for improvement until the general business conditions of the country improve. This shows radio still to be in the class of luxuries, or products not vital or even very desirious where times are the least hard. In which case we would suggest an educational campaign leading to the conception by the general public of a radio receiver as a standard adjunct to the home, such as rugs, chairs, lights, ice box and the like.

Another company is waiting for the country to "return to the economic conditions existing in early 1929." On the surface, this would appear most desirable. But when we realize that it was those very conditions that led to the recession of business a few months later, let us look elsewhere for aid. It would be nice to have spring of 1929 back again, without its resultant fall. Unfortunately we must answer with a resounding "No" the question, if spring is here, can fall be far behind?

One opinion is to the effect that the radio industry is dependent on general business conditions, and should gauge production accordingly. Also that the industry will only be stabilized when the consumer pays a fair price for what he receives. But one cannot blame the consumer for purchasing at the cheapest possible price. The consumer is never to be blamed for buying in the most favorable markets. And after all, the consumer has stood by the radio industry remarkably well, buying every few months for years, while the industry was changing so drastically and sets became obsolete almost as quickly as milk sours. No, the public cannot be blamed. The same company that makes the remark about the public paying a fair price adds, "continuous unloading is not only unprofitable to the radio industry, it disarranges the buying psychology." And it does infinitely more than that, too. Not only does it cause people to wait for the sales they know are coming; it makes list price meaningless, causes unduly fast obsolescence and a consequent distrust for the industry as a whole.

One very startling suggestion is for greater consumer demand. Yes, but how, asks the industry? The Central Radio Corporation suggests that production be based on accurate inventories of distributors' and dealers' stocks, taken at least monthly. This in the opinion of that concern, should stop wholesale dumping.

The Patent Situation

Another company desires to see the patent control and licensing situation

(*Concluded on page 35*)

The Strange Story of Resistance

WHEN Georg Simon Ohm announced the law that the current flowing in an electric circuit is, in amperes, equal to the applied potential in volts divided by the unit resistance of the entire circuit, the calculation was intended to disclose what was possible in the way of useful electric current taking into consideration the presence of unavoidable resistance.

To have a metallic conducting circuit was necessary in order to convey electric current from one point to another. The longer the circuit of a given size of wire the greater would be the resistance and the less the current strength from a given source of current.

In the early telegraphs it was an axiom that for good working of lines the resistance of the electromagnets of the terminal relays should be equivalent to the resistance of the external wire circuit between stations. Thus, a line having a resistance of 1,000 ohms was equipped with relays having each a resistance of 1,000 ohms.

The fact that there was virtue in resistance first made its practical appearance in the operation of submarine cables in which artificial lines were employed, and in land line duplex operation where artificial lines made up of resistance coils were employed to simulate electrically the resistance characteristics of the actual line wires.

In the high resistance astatic galvanometers introduced in the 60's of the past century the windings were of fine copper wire, silk covered. In the tangent galvanometers of about the same period copper windings also were used. In the shunt, high resistance windings used on these galvanometers cotton covered German silver wire was used. The coils having 10, 100, and 1,000 ohms resistance. These coils were wound on hard rubber bobbins.

In the early telegraph service when gravity batteries were employed there was no occasion for the employment of resistance coils in series with batteries of 200 up to 300 volts, or higher, as the internal resistance of the cells provided all the protection necessary.

Enter the Wound Resistor

When dynamo machines were first employed in the 80's of the past century there was presented an immediate need for resistance coils to be placed in series with each line wire connected by bus to the generator, due to the negligible resistance in the dynamo winding.

These resistance coils were wound on tin cylinders about two inches in diameter and about six inches long. The wire was iron-nickel; about 30 per cent German silver, cotton covered and shellacked.

At the same time the rheostats employed in duplex and quadruplex telegraphs had resistance windings of 30 per cent German silver wound on wood bobbins boiled in beeswax and with a layer of waxed paper next to the wood core.

About the year 1900 resistance coils appeared with the wire baked in various forms of lava.

Constantan

About 1900, or a year or two earlier, "Constantan" wire appeared. It was 18 per cent nickel, silver and copper. Ten years earlier, about 1890, Dr. Edward Weston engaged in research in resistance alloys, producing a material which later on was placed on the market under the name of Isabellen-Hutte.

In the following years an investigation of the whole range of nickel-copper alloys was carried on by Basse and Selve, in Germany, who published data dealing with the characteristics of alloys. Constantan was an outcome of these investigations. The name was given to it because of its relatively constant resistance regardless of temperature variations. The same material was marketed in America under the name of Ia-Ia.

About 1895 Fried Krupp Company in Essen, Germany, placed on the market a nickel alloy containing 25 to 30 per cent of nickel and marketed it under the name of Kruppin. This material was the development of an alloy made for armorplate and it made available the highest specific resistance that has ever been known commercially in a wire. This material, however, rusted readily and was not reliable because of its tendency to crystallize for no particular reason, especially in the finer sizes. It proved, however, to be a very valuable alloy for many places where high resistance was required in a small space. It was used extensively for enclosed arc lamps and for rheostats.

The maker of electric heating apparatus then had at his command, only two possible alloys, namely, Constantan and Kruppin and the result was that very few heating appliances could be made because of the short life of the resistance alloys that were then available. Copies of this Kruppin wire were soon made in this country and were marketed under the names of Tico, Climax and other trade names.

It was not until after the outbreak of the war that the copper nickel alloys, similar to Constantan were produced in this country as it was generally supposed that makers here did not have enough ability and experience to make them. When it became necessary to either make the alloy here or go without it, it did not take long for our makers to produce successfully in quantity. This material was sold under the name of "Advance" and is being marketed by the Gilby Wire Company under the name of Cupron.

In 1907, A. L. Marsh patented an alloy of nickel and chromium which proved to be such a substantial advance in quality over anything that was then obtainable that it has put the resistance wire business on a very firm basis. This alloy, now known as chromel, nichrome and tophet is so reliable and will stand such extreme temperatures that thoroughly first-class heating appliances can be produced from it. Its specific resistance is higher than any other material known in wire form.

It has been a long time now since any substantial advances have been made in alloys for electric resistance purposes. There is an insistent demand for material giving substantially higher specific resistances up to perhaps 1000 ohms per circular mill foot and also material which can be operated at temperatures beyond 2000 degrees Fahrenheit which is the present limit for nickel chromium alloys that are now available.

Much effort has been exerted to produce these materials but up to this time, nothing substantially better has been placed on the market.

The Gilby Wire Company of Newark, N. J., under the direction of Wilbur B. Driver, has been doing a large amount of experimental investigation on these problems. Resistance material with a resistance of approximately 1000 ohms per circular mil foot will very likely soon be announced. Mr. Driver has been closely identified with the development of resistance wire for more than thirty years.

A Remote Control Tuning Unit for the Modern Radio Receiver

Description of Balanced Bridge Method of Tuning From a Distance

By N. Bishop *

A SURVEY of the field of remote control devices for radio receivers allows one to classify the important ones under five general types.

1. Selection of a limited number of stations by pressing a button, or turning a switch to a position indicating the desired station. By this operation a small motor circuit is opened either by a contact actuating a relay or a wiper reaching a slot in some sort of commutator. In general, these systems require one wire in the cable for each desired station plus additional control wires.

2. Tuning the receiver by ear, and by a switch on the control panel, which allows the motor to be started, stopped, or reversed.

3. Systems which operate on the principle that if a carrier of sufficient strength is received it will actuate a vacuum tube-relay combination so as to stop the motor. By depressing a button, the relay contacts are momentarily shorted out, and the motor runs until the next carrier is tuned in.

4. Systems using the equivalent of two synchronous generators with their armatures connected together.

5. So called step by step systems in which a motor with a toothed armature is made to rotate in steps by shifting the field current to successive field coils by rotating a small switch.

* *Radio Engineer, Harvey Hubbell, Inc., Bridgeport, Conn.*

Requirements for Remote Control

After gathering as much data as possible, the following requirements were arbitrarily set up for the operational characteristics of a satisfactory system.

1. The person operating the system must have no more operations to perform than if he were tuning the receiver itself.
   a. Turning set on and off.
   b. Selecting desired channel.
   c. Setting volume to desired level.
2. The accuracy of the system must be such that the receiver will perform as well when controlled remotely, as when the dial position is set at the receiver itself.
3. A minimum number of wires between and receiver and the control box.
4. The system must be rugged and capable of maintaining its accuracy without attention over extended periods of time.

Work on this problem, in which the author has been engaged, was started in October, 1929, and specifications for the production of the elements of the system are now being prepared.

Principle of Operation

In general the system depends upon the principle of the balanced resistance bridge for its operation. As is well known there have been various attempts made to solve this general problem, one of which[1] uses three relays and operates on d-c. only. Referring to the simplified schematic Fig. 1, R_1 and R_2 are similar potentiometers, wire wound, well insulated, and capable of sufficient dissipation to allow them to be connected across the 110-volt a-c. supply circuit without undue heating. R_1 is mounted concentrically to the condenser shaft on which is mounted the rotating arm and which is driven by the small induction motor through a reduction gear.

R_2 is mounted in a remote control box, and the moving arm position is indicated by a suitable dial. The relay shown consists of a field winding, an armature winding, and a single pole double throw contact arrangement with a neutral position. Assuming the position of R_1 to be identical with R_2, if R_2 is moved to a new position, the circuit will be unbalanced, and current will flow through the circuit including the relay armature. The phase

[1] *Patent No.* 1738262.

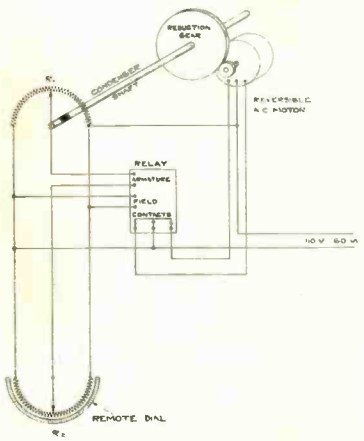
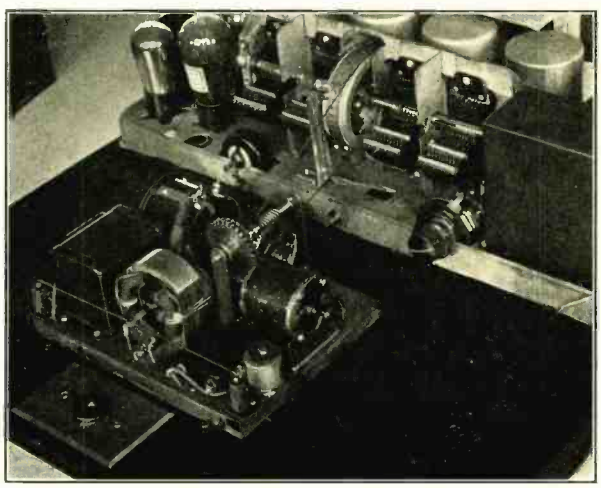


Fig. 1. Schematic of remote tuning circuit.



Right—
Fig. 2. Close-up of control mechanism showing relay, induction motor, reduction gear, resistance unit, anti-spark condensers, etc.

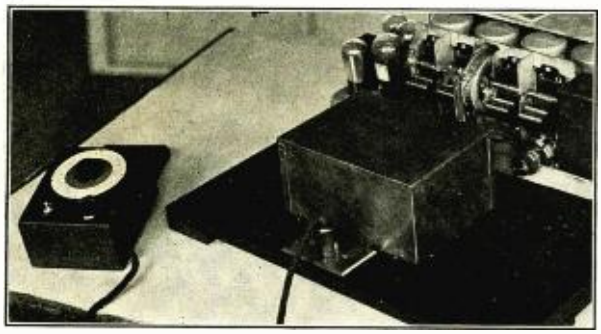


Fig. 3. Remote tuning system as applied experimentally to a Philco Model 95 chassis. Tuning unit shown at left.

and magnitude of this current depends upon the direction from the balance position that R_2 is rotated, and how far it is rotated. If R_2 is rotated in such a direction as to make the armature current in phase with the relay field current, the relay will close up the motor circuit so as to make the motor turn the arm of R_1 towards the new balance point as determined by the new setting on R_2. If the displacement of R_2 is in the opposite direction, the relay armature and field currents will be 180° out of phase, and the relay closes up on the other side, causing the motor to turn in the opposite direction. The motor turns the condenser shaft until the arm on R_1 reaches the new balance point which in turn causes the relay to return to neutral, and the motor stops. Should the motor, due to its rotational inertia, carry the arm on R_1 past the balance point, the relay immediately reverses it, and the balance is automatically restored.

The Relay

In the above paragraph is given a brief and qualitative outline of the principle of operation of the balanced bridge remote tuner. The development of this device from an idea to a commercial product required that we first develop a relay having the desired sensitivity, and capable of controlling a small 110-volt induction motor without any possibility of contact trouble due to sticking or burning. This relay must operate on a 60-cycle 110-volt supply, and must be rugged.

The relay sensitivity, and the characteristics of the potentiometer are intimately connected. To simplify matters a start was made with the potentiometer. The dissipation capability of the potentiometers was limited by considerations of size of the remote control unit, and the necessity of limiting its temperature to a few degrees above room temperature. A resistance of 900 ohms would dissipate 13½ watts when connected across the 110-volt circuit. This dissipation could be easily taken care of in this control unit, and the size of the resistor necessary would not prevent making the unit compact. To save space, and increase the number of turns on the resistance unit, a potentiometer having the resistance distributed around 300° of the control shaft was used. This requires, as is shown in the experimental setup, a further reduction between the drive shaft and the condenser shaft.

Assuming a linear relation to exist between the angular displacement of the control shaft, and the frequency, for the broadcast band, the following relation holds:

$$\frac{950 \text{ K. C.}}{300^\circ} = 3.17 \text{ K.C./degree}$$

It was considered advisable to make the system accurate to plus or minus 2 K.C., so as to preclude the possibility of distortion by improper tuning which is possible with some of the more modern sets having multi-section bandpass tuning arrangements. This means that the system must be accurate within

$$\frac{2 \times 300^\circ}{950 \text{ K. C.}} = .63^\circ \text{ or roughly 1 part in 500.}$$

Assuming the line voltage equals 110, the relay must operate from neutral to one side or the other when a voltage of .22 or more is applied to the armature. This value of voltage assumes no drop in the potentiometer arms due to the armature current. Actually the relay is called upon to operate on somewhat less than .22 volts due to this drop.

Several types of commercially available a-c. relays were tried without success, and it was soon evident that the system would be impractical unless we could develop a sensitive, rugged, 3 position alternating-current relay. After considerable experimental work, a scheme was finally evolved which brought the system from the realm of an idea to a commercial practicability. In general the relay amounts to a frame and pole arrangement similar to a small a-c. motor on which are wound the field coils. Between the poles the armature is suspended on knife edge bearings. Attached to the armature shaft is a cross arm which carries the common contacts. Relay action is secured by rotary action of the arm which turns in a direction dependent upon the phase relation of the armature and field currents. The sensitivity of this relay combined with the bridge elements mentioned in the last paragraph, is well within the arbitrary limits set up before the work was started.

The limits of accuracy of such a system are entirely at the discretion of the manufacturer. Certain factors must be considered when considering sensitivity and they are as follows:

1. The sensitivity of the relay must not be greater than the potential difference existing between 2 turns on the potentiometer or the system will never balance; that is, the motor will continue to run through the approximate balance position and reverse.

2. Unless the motor stops instantaneously when the circuit is opened, it may, if the sensitivity is too great, carry the potentiometer past the balance point, and do the same on the reverse motion, which would also cause instability. This difficulty does not exist in practice as there is used an electric brake on the motor; or a motor having a small armature.

The illustration, Fig. 2 shows the system applied to a standard Philco Model 95 chassis. There are seven wires connecting the remote control unit to the receiver assembly, three of which are used in the volume control circuit, which in this case consists of controlling the input to the power amplifier. This method is effective in this receiver because automatic volume control prevents overloading of the previous stages, and the impedance of the volume control circuit in the cable is low enough not to be seriously affected by inductive pickup or to cause a loss of high frequencies due to the capacity of the cable.

Application

The system is flexible in its possible applications. It may be used as one control unit permanently connected to a chassis in a console or several units may be wired in different rooms of a house with the receiver installed in the cellar or attic. If this be the case the 110-volt house wiring acts as two of the necessary interconnecting wires and only one additional pair of wires is necessary for tuning, and turning the set on and off. Control could be shifted from room to room by a simple selector switch conveniently located, or one control unit can be provided with a plug, and receptacles can be distributed at convenient places throughout the house. This would prevent two persons from attempting to tune the receiver at the same time from different rooms. If the system is to be wired into a house, it would be advisable to have separate speakers for different rooms with individual volume controls for each speaker. If the push button station selector type of remote control is desired, this system lends itself readily to such a scheme. The only change necessary is in the control box which, instead of having a dial mounted on the moving arm of the potentiometer, would have a number of switches one side of which would be connected together and the other side of each switch making contact with the potentiometer through an adjustable con-

(Continued on page 39)

The Essential Factors in the Design of Receivers and Amplifier Systems*

THE modern radio receiver has become a precision product, built under the most exacting conditions prescribed by skilled engineers. It is no longer a heterogeneous combination of parts, wired together to conform to some trick circuit. A desired overall performance is obtained by combining a number of elements, each of which contributes its quota to the final result or overall performance. The complete design represents the results of intensive laboratory investigations.

In the logical design of a receiver there are several interesting and instructive investigations of the fundamentals of receiver design which one may explore without a laboratory full of expensive instruments. All that is required is a pencil, some paper and an understanding of how radio receivers operate. With these simple tools it is possible to work out the general design of receivers.

Surprising as it may seem, in working out the design of a receiver we must put the cart before the horse. The place to start the design is at the loudspeaker, the tail end of the set, and work towards the antenna. A moment's consideration will indicate why this is so. The loudspeaker represents the direct point of contact between the listener and the broadcasting studio. The final function of every radio receiver is to supply the listener with music of good quality and of proper volume. Quality is a characteristic that depends largely on the use of good apparatus in the receiver and operating the tubes under conditions to produce the least possible distortion.

Volume depends upon the overall amplification of the receiver and the power handling capacity of the power tubes and loudspeaker. In working out a receiver circuit we start with the one definite thing—the output from the loudspeaker. The output from the loudspeaker and its sensitivity determine how much power is required to drive it and knowing this we can decide the kind and number of power tubes we must use. Having determined this point we then proceed to figure how much audio-frequency voltage must be supplied to the power tubes to obtain maximum output. We then work back through the audio amplifier gradually increasing the overall amplification until the input voltage to the amplifier is about equal to the audio-frequency output voltage we can expect to get from the detector. Knowing the audio-frequency voltage required from the detector we can calculate the modulated radio-frequency voltage we must apply to the detector input to get the required audio-frequency output. The r-f. input to the detector determines how much r-f. voltage must be supplied by the last tube of the r-f. amplifier. We then work back through the r-f. amplifier until the input voltage required is sufficiently small to give the receiver the desired sensitivity. This very briefly is the manner in which the design should progress. In order to work out a design by such a method the following major facts must be determined:

Unit	*Data Required*
Loudspeaker:	Efficiency Impedance Power handling capacity
Power tubes:	Type, number and method of connection; Maximum undistorted output; a-c. input required for maximum output; a-c plate resistance.
Audio amplifier:	Maximum a-c. output required; Audio voltage available at input; Gain required; Type of amplifier—transformer, resistance or impedance coupled; Plate voltage available; Type of tubes.
Detector:	Sensitivity; Maximum audio output; R-F. input required; Type of tube
Amplifier: radio frequency	Required r-f. output voltage; Sensitivity required; Available input voltage; Selectivity required.
Antenna circuit:	Effective height of antenna; Type — indoor, outdoor or loop.

The preceding tabulation serves to indicate once again that the design of one section of a receiver depends to some extent upon the characteristics of the other parts of the set. For example, the audio amplifier design cannot be completed without a knowledge of the characteristics of the power tubes and the audio output voltage from the detector. The r-f. amplifier design hinges around the voltage required to operate the detector and the voltage available from the antenna circuit. It will also depend upon the selectivity requirements for this will determine the number of tuned circuits required.

We can state in the form of a problem the material which will be covered in the remainder of this article and the other articles to follow in this series.

Problem

A receiver is to be able to supply sufficient output from a loudspeaker for good reproduction, without any danger of overloading. The loudspeaker is 2 per cent efficient. The overall sensitivity of the set is to be 10 microvolts per meter. Determine the following data:

1. Type and number of power tubes required.
2. Overall audio-frequency gain and number of stages required, using either transformer or resistance coupling.
3. Output voltage from different types of detectors and modulated r-f. input to the detector required to give this output.
4. Output voltage required from r-f. amplifier and overall gain required to give a sensitivity of 10 microvolts per meter. Number of r-f. stages and gain per stage required if four tuned circuits are to be used. Same data for three tuned circuits.
5. Plate voltage and plate current required for the operation of the various tubes. Tabulation of all voltages and currents required from the B power unit.
6. Calculation of all resistance values for filtering and C bias.
7. Drawing of complete circuit of receiver.

For the data on which to base our discussion we will make use of the laboratory work on detectors and amplifiers which has been described in

---

* *Prepared for the Research Worker, published by the Aerovox Wireless Corporation.*

technical publications by various engineers. The remainder will be devoted to a determination of the first point, the amount of power required from the power tubes.

The amount of power required will depend upon the efficiency of the loudspeaker and the amount of acoustical (sound) energy the loudspeaker must create in the room in which it is being operated. This power must be produced without overloading the power tubes, for if this occurs serious distortion will result. In determining the characteristics necessary to prevent overloading we must assume certain values, but we can get a good idea of what the requirements are. We must base our calculations on the most difficult conditions. The most trying test is given to a receiver when it is required to reproduce an orchestra program, for here the range in volume is very great and the fortissimo passages very loud.

An Average Case

Suppose, to take an average case, orchestra music is being broadcast and that the ratio of power between the pianissimo and fortissimo passages is a million to one, corresponding to a range of 60 db. Because of the characteristics of the lines used to pick up broadcast programs it is necessary to cut down this range to about 40 db. ten thousand to one, so as to keep the weak passages above the line noise and to prevent the loud passages from overloading the amplifiers. Let us assume that this ratio of ten thousand to one is maintained throughout the broadcast and receiving systems, which would be true if there was no overloading at any point.

Now we have to decide how much power is required to satisfactorily reproduce the softest passages. A relative idea of the amount of acoustical power required can be obtained from the fact that the average power of normal speech is about ten microwatts. We can therefore assume that the minimum power required from the loudspeaker can be about three microwatts.

If we assume that the energy associated with the pianissimo is to be three microwatts, then the energy during the fortissimo passages will be ten thousand times as great, or 30,000 microwatts, which is the same as 0.03 watts. To have a factor of safety we will double this so that the maximum acoustical power required from the loudspeaker will be 0.06 watts. Now the problem states that the loudspeaker efficiency is 2 per cent. Therefore, the power input to the loudspeaker during the loudest passages will be

$$\text{Power into loudspeaker} = \frac{\text{Output power}}{\text{Efficiency}} = \frac{0.06}{0.02} = 3 \text{ watts}$$

Therefore the power tube must be able to supply three watts of undistorted power. Now let us list the various types of tubes and determine which type should be used. The list is given below:

Type of Tube	*Plate Voltage*	*Grid Voltage*	*Undistorted Output in Watts*
112-A	135	9	0.12
371-A	180	40	0.7
345	250	32	1.6
310	400	31	1.3
350	450	84	4.5

From this table it is evident that no single tube except the 350 will supply sufficient power and it hardly seems advisable to use this tube for the high plate voltage it requires would make the receiver very expensive to construct. We will therefore have to use two tubes in push-pull to obtain the required power. A single 345 tube delivers 1.6 watts and two of them in push-pull will supply at least 3.2 watts. A single 371-A is rated at 0.7 watts, so two in push-pull give about 1.4 watts. It appears therefore that the arrangement which will most satisfactorily supply the required power consists of two type 345 tubes in push-pull and this is the arrangement we should use. We have therefore determined the first important point in this process of designing a receiver. We have learned how to calculate how much power is required assuming a certain loudspeaker efficiency and how to pick and choose from several possible tube combinations the arrangement meeting the requirements most satisfactorily.

This treatment of the problem cannot be considered exact, but it has served our purpose. It was necessary to assume an average value for the power associated with the pianissimo passages and this assumption determines the maximum power required. But the preceding discussion has shown how to calculate such things and has served also to indicate why power tubes must be used.

Audio Amplifiers

We may now consider the factors that affect the design of the circuits between the grid of the power tube and the plate circuit of the detector tube. Although herein special emphasis is placed on the design of radio receiver circuits, the data given below is applicable to all types of audio amplifiers, whether they are used as part of a radio receiver, public-address system or as part of a talking movie installation.

Before beginning a detailed discussion of the subject we would like to point out that we are considering an audio amplifier to consist of all the apparatus from the source of audio-frequency voltage up to the grid circuit of the power tubes. This is perhaps somewhat unusual since many think of the power tubes as part of the audio amplifier. If we do this, however, we are grouping under one name two groups of apparatus with entirely different functions. All of the apparatus up to the grid circuits of the power tubes functions as a voltage amplifier, whereas the power tubes are designed to supply power rather than voltage. For this reason the factors that influence the choice of the power tubes are altogether different from the factors that affect the design of the circuits preceding the power tubes. It seems advisable therefore to differentiate between these two parts of the circuit, and it was for this reason that the first part of this article presented the considerations that determine what power tubes should be used.

Amplifier Design

The design of an audio amplifier depends upon a number of factors of which the most important are:

(1) The maximum a-c. output voltage required. This is determined by the type, number and arrangement of the power tubes.

(2) The upper and lower limits of frequency which must be uniformly amplified.

(3) The maximum amplification required. This is determined by the maximum required output voltage and upon the available input voltage.

(4) The available plate voltage. Whether a resistance or a transformer-coupled amplifier is used may depend somewhat on this factor.

In normal circuits the maximum a-c. voltage which can be impressed on the grid of a power tube without producing distortion, will be equal in peak value to the d-c. bias on the tube. For example if a particular tube requires a bias of —40 volts then the maximum a-c. voltage that the tube can handle without overloading will be a voltage whose peak value is 40 volts. The peak value of an a-c. voltage is equal to 1.4 times the effective voltage. If two such tubes were connected in parallel the maximum a-c. voltage would be the same. If two such tubes were connected in push-pull they could handle, without overloading, twice as much voltage. That is, the total voltage from grid to grid could be 80 volts peak. If we wish to consider that the push-pull arrangement permits us to somewhat overload the tubes without producing serious distortion, then the maximum permissible a-c. voltage on the grids will be somewhat greater. If for example we consider that two tubes in push-pull can safely supply say three times the output of a single tube then the maximum permissible a-c. voltage becomes about 25 per cent greater or, in this case, 100 volts peak. From this discussion we can obtain the following working rules. The maximum a-c. peak voltage which a power tube circuit can handle is:

(a) Equal to the d-c. bias on the grid, for a single tube, or for two or more tubes in parallel

(b) Equal to twice the bias on the

grid, for two tubes in push-pull

(c) Equal to 2.5 times the d-c. bias on the grid, if two tubes are connected in push-pull and some overloading is considered permissible.

These maximum permissible voltages represent the a-c. voltages which must be impressed on the power tubes —in a transformer-coupled amplifier they are the voltages across the secondary of the last audio transformer. In the case of a resistance-coupled amplifier they are the voltages across the grid leak connected in the power tube circuit. With these rules and a knowledge of the d-c. bias required by various tubes together with data on the circuit arrangement of the power tubes it is possible to quickly and accurately determine the maximum a-c. voltages required.

Gain Required

The overall voltage amplification or "gain" required in an amplifier is determined by the maximum a-c. output voltage required and the a-c. voltage available at the input of the amplifier. If we need 100 volts peak at the output and the available input voltage has a value of 2 volts peak then the gain required is 50, since if 2 volts are amplified 50 times we will get the required 100 volts. Stating this as a simple formula we have

$$\text{Gain required} = \frac{\text{Maximum output voltage required}}{\text{Available input voltage}}$$

Now let us see how we can calculate the gain of an amplifier. First let us consider the transformer-coupled circuit. The gain of a transformer-coupled amplifier is due to two things —the voltage step-up that occurs in the tube and the voltage step-up that takes place in the transformers. The total gain will be a product of all these individual gains. For example, if an amplifier consists of a tube giving an effective amplification of 7, and two transformers each with a turns ratio of 4, then the total gain will be

$$\text{Total gain} = 7 \times 4 \times 4 = 112$$

Now, assume a definite problem and work through the solution. Suppose two type 245 tubes are to be used in push-pull with 250 volts on the plates and a bias of —50 volts. Sufficient voltage is available to operate them at a slight overload (condition C). The input voltage is one volt peak. The amplifier is to be transformer coupled. Determine the repaired gain, the transformer turns ratio required, and the voltages at which the tubes should be operated. Heater type 227 a-c. tubes are to be used.

The maximum voltage output required will be

$$\text{Peak voltage output required} = 50 \times 2.5 = 125 \text{ volts peak}$$

The gain required will be

$$\text{Gain} = \frac{125}{1}$$

From a table of tube characteristics we can determine that a 227 tube has an amplification constant of 8. The actual amplification of the tube in a circuit can be assumed to be about 90 per cent of its amplification constant. So we can figure that from a 227 tube we can obtain a gain of about 7.2 (8×0.9). Suppose we use an input push-pull transformer to couple the 227 to the 254 tubes and that the turns ratio of this transformer can be 4.5. Then from the tube and this transformer the gain will be

$$4.5 \times 7 = 31.5$$

Since the overall gain required is 125 the turns ratio of the first transformer can be

$$\frac{125}{31.5} = 3.97$$

and in practice we could use a transformer with a ratio of 4.

If we preferred to use a ratio of 3 for the first transformer then the first transformer and the tube would give a gain of

$$3 \times 7 = 21$$

and to get a total gain of 125, the input push-pull transformer should have a turns ratio of

$$\frac{125}{21} = 5.95$$

Suppose we use the first arrangement, i. e. input push-pull transformer ratio of 4.5 and the first transformer with a ratio of 4. The circuit that results is given in Fig. 1. Now what d-c. plate voltage and bias should be used on the 227?

The peak a-c. voltage across T_2 is 125 volts. Since this transformer has a ratio of 4.5 the voltage across the primary is $\frac{125}{4.5} = 28$ volts peak, approximately. Since the effective amplification of the tube is 7 the voltage across the grid circuit of the tube is

$$\frac{28}{7} = 4 \text{ volts peak}$$

Now the peak value of the signal voltage on the grid of an amplifier should never exceed the d-c. bias on the tube. If it does, the tube draws grid current, and distortion is produced. Therefore in this case the bias on the 227 tube should be at least 4 volts and preferably somewhat more to prevent any possibility of overload. Referring to a chart of tube characteristics we find that this type of tube with —6 volts on the grid takes 90 volts on the plate and these two voltages are very satisfactory for use in this case. Since the amplifier is to be a-c. operated bias voltage should be obtained from a fixed resistor placed in the cathode circuit. The value of this resistance is equal to the bias required divided by the plate current in amperes. In this case the plate current is 3.5 ma. (0.0035 amperes) and the C bias resistance should therefore be 6 divided by 0.0035 which gives 1700 ohms.

Now consider the case of the resistance-coupled amplifier. Suppose a single 245 type tube is to be used for the power tubes and the preceding tubes are to be type 240. The input voltage available is one-half volt, peak. Work out the design of the amplifier.

The voltage amplification obtained from a tube in a resistance-coupled amplifier is approximately equal to

$$\text{Amplification constant of the tube} \times \frac{\text{Load resistance}}{\text{Load resistance} + \text{plate resistance of tube}}$$

The recommended plate resistor for use with the 240 tube is 250,000 ohms (0.25 megohms) and from a table of tube characteristics we determine that the a-c. plate resistance of this type of tube is 150,000 ohms and the amplification constant is 30. Therefore the approximate amplification obtained from the tube is

$$30 \times \frac{250{,}000}{250{,}000 + 150{,}000} = 18.8$$

Since the bias required on the 245 type tube is 50 volts, the peak a-c. voltage across the grid circuit must be 50 volts. Therefore the voltage on the grid of the preceding high-mu tube must be

$$\frac{50}{18.8} = 2.66 \text{ volts peak}$$

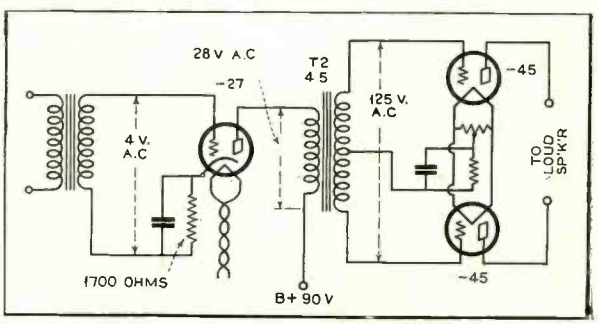


Fig. 1. Push-Pull Amplifier.

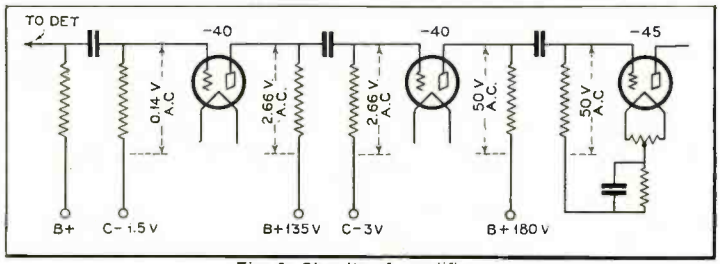


Fig. 2. Circuits of amplifier.

This means that a signal with a peak value of 2.66 volts impressed on the grid of this tube would supply the required 50 volts at the power tube. But the voltage available to operate the amplifier is only 0.5 volts. We may therefore add another stage. Adding a stage will give a total gain of 18.8 times 18.8 or 354. The gain required is

$$\frac{50}{0.5} = 100$$

and two stages therefore will give more gain than required—this is not any great disadvantage, however, for it simply eliminates any possibility of overloading and makes it possible to operate with somewhat reduced input voltage. Now, what voltages are required on the tubes?

From a table of tube characteristics we find that two conditions of operation for these tubes are suggested. They are

Battery voltage	C bias
135	—1.5
180	—3.0

With the aid of the amplifier circuit which is given in Fig. 2, we may work out which of the above two conditions of operation should be used. Here the peak voltage across the power tube is 50 volts and in working out the problem calculation showed that this required 2.66 volts across the grid of the preceding tube. Since the bias must always be equal to or greater than the peak signal voltage it will be necessary to operate this tube with 180 volts on the plate and a —3 volt bias. The peak voltage across the grid of the first tube will be

$$\frac{2.66}{18.8} = 0.14 \text{ volts}$$

and this tube can therefore be operated with a bias of —1.5 and 135 volts on the plate.

Suppose in the above problem that there was no way to reduce the input voltage below 0.5 volts. With this voltage impressed on the amplifier the peak voltage across the grid of the power tube would be

$$\text{Input Voltage} \times \text{Gain of Amplifier}$$

$$0.5 \times 354 — 177 \text{ volts peak}$$

and the power tube would be sadly overloaded. If the input voltage must be 0.5 volts and the maximum output 50 volts then the amplifier gain must be

$$\frac{50}{0.5} = 100$$

If we use two type 240 tubes this means that the gain per tube must be 10 since two tubes each with a gain of 10 will give a total gain of 100. What value of plate resistor will give a gain of 10? We can determine this from the formula previously given. Substituting the desired gain of 10 in this formula we have

$$10 = \frac{\text{Load resistance}}{\text{Load resistance} + 150{,}000} \times 30$$

and solving for the load resistance we obtain a value of 75,000 ohms to obtain a gain per tube of 10.

The preceding discussion has, we hope, helped to indicate how to calculate the gain of amplifiers and determine the correct operating voltages.

THE PARTING OF THE WAYS

(*Concluded from page 29*)

cleared up, thereby bringing up a subject on which we could write a book, which many might read and few act upon. So we will desist. Holding the prices up is another suggestion. In this connection, congratulations to the Edison Radio. The Zenith Radio Corporation would like to see the opportunists, gamblers and racketeers banished from the field, the use of sane production methods, no over-production or distress merchandise. Heaven at last! But we must be good boys to get there.

One concern deems it a good policy to sell radio on an entertainment basis rather than on an engineering basis, with all its talk about technical advances "just around the corner." Surely, radio as entertainment would tend to de-seasonalize the industry, since entertainment is the monopoly of no one season, while engineering features, particularly when manifested in yearly models, tends to making radio seasonal in the extreme.

Interpreting these opinions in one sentence, it might be said that the radio industry could best be improved, in the opinion of certain manufacturers, if an educational campaign based on radio as entertainment could be fostered, tending to de-seasonalize radio and increase demand, this demand to be tabulated and sales estimates made, on a basis of which production could be regulated to prohibit over-production and distress merchandise, the radio sets to be merchandised through legitimate channels by intelligent and sincere concerns.

Utopia is in sight. But we still need a ladder to climb there.

▲

CIVIL SERVICE EXAMINATIONS

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

Senior radio engineer, $4,600 a year.
Radio engineer, $3,800 a year.
Assistant radio engineer, $2,600 a year.

Applications for senior radio engineer, radio engineer and assistant radio engineer must be on file with the Civil Service Commission at Washington, D. C., not later than August 27, 1930.

The examinations are to fill vacancies occurring in the Departmental Service and in the field.

The entrance salaries are $4,600 a year for senior radio engineer; $3,800 a year for radio engineer, and $2,600 a year for assistant radio engineer. 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 education, 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 custom house in any city.

▲

CHURCHES BROADCAST

The list of American broadcast licensed stations issued by the Federal Radio Commission on June 2, shows stations operated by twenty-nine churches including religious institutions.

The Electrolytic Condenser

By John Dunsheath

Introduction

ELECTROLYTIC condensers are based on the so-called "valve action" of certain metals, when used as the positive electrode in an electrolytic cell. There are various metals exhibiting this property of which, however, only aluminum (and to some extent tantalum) have been used so far with commercial success.

It has been known since the earliest experiments of Wheatstone in 1853, that aluminum exhibits such valve-action, i. e., when constituting a positive electrode (anode) of an electrolytic cell, and current is passed through the cell, the aluminum does not dissolve in the electrolyte as do most of the metals, but instead is covered with a hard insoluble film which affords a high resistance to the flow of current, able to withstand high voltages. The process of passing current through the cell is called the formation voltage. However, if the flow of current is reversed and the aluminum made a negative electrode (cathode), the film offers practically no resistance to the passage of the current.

The phenomenon, above described, remained for a long time only of academic interest because aluminum was not commercially available.

In the early part of the twentieth century, this valve action became the object of intensive investigations, the most important of which were those of Guntherschulze and his co-workers in Germany. The result was the development of electrolytic cells for lightning arresters, rectifiers and condensers based on this phenomenon.

The results of Guntherschulze's researches indicated that the purity of the material was of great importance in obtaining good electrolytic condensers, as he found that impurities in general gave undesirable results as far as the continuity of the film structure was concerned. In a similar way his work indicated that increase in forming-temperature improved the structure of the film.

Improvement in purifying materials, in the technique of the forming process and in construction details have made it possible to obtain the present high-grade product.

When electrolytic condensers are used in connection with rectified direct current for smoothing out ripples—which is one of their most common uses—only one of the electrodes (anode) is of aluminum. The other electrode is of a non-film forming metal, for instance copper, and the copper may form the can of the cell.

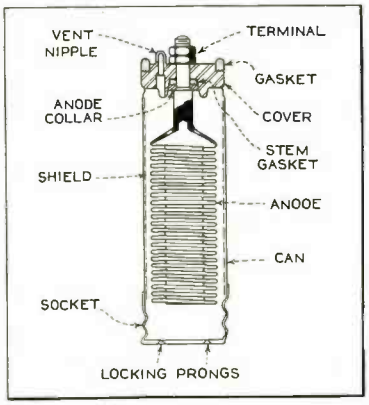


Fig. 1. Construction of the Elec-rolyytic condenset

The electrolyte of the cell is in the form of an aqueous solution, for instance, a solution of borax and boric acid. The film acts as the dielectric whereby the aluminum is the positive and the electrolyte the negative plate of the condenser.

The forming time, choice of electrolyte, as well as other factors, determine the thickness of the film. For a certain electrolyte and forming process, the breakdown voltage, i. e., the voltage which the films can withstand is directly proportional to the thickness of the film. On the other hand, the capacity of the cell is inversely proportioned to the thickness of the film.

From the above, it appears that within certain limits, it is possible to design a cell of any given capacity and breakdown voltage.

Due to the minute thickness of the film, large capacities can be obtained with relatively small areas and small cost. For instance, electrolytic condensers for filter purposes having a breakdown voltage of 450 volts can be produced at a price less than half of the equivalent cost of paper condensers.

Mechanical Construction

The construction of the condenser will appear from Fig. 1.

Inserted in a copper can, which forms the negative electrode of the condenser, is a helical corrugated aluminum tube, which forms the positive electrode.

The can is filled to a level near to its top with a suitable electrolyte.

The anode is supported by a hard rubber cover whereby the stem of the anode protrudes through a suitable hole of the cover and is threaded to receive terminal anodes.

To prevent leakage around the anode stem there is provided a rubber stem gasket. The cover is also provided with a soft rubber check valve B forming an integral part thereof. This check valve is provided with a needle hole which permits the escape of gases, but does not permit dust to enter the can, nor liquid to escape.

The gasket around which the rim of the can is crimped, provides for air-tight sealing of the cell.

As a rule, there is also provided a perforated shield of insulating material between the anode and the can to prevent accidental contact between same.

For convenient mounting, the lower part of the can is threaded and fits in a corresponding threaded base or socket, which can be mounted in any convenient way in an upright position.

Anode

The one-piece helical tube anode is an important recent development overcoming several drawbacks in previous anode construction. It has been found advisable to construct the anode, where it emerges from the electrolyte, as a narrow, solid stem.

That part of the anode which is immersed in the electrolyte has to have as much surface as possible so as to obtain a large capacity. In the past this has been done by making the anode of two parts, the immersed part consisting of crimped or rolled aluminum foils, the other part being a stem to which the foils are secured by riveting or welding. However, adjacent to the joining points of these two-piece anodes, seams, cracks and crevices are formed which prevent proper formation of the film at these places. This causes a considerable increase in the leakage current and may cause the short-circuiting of the condenser.

Furthermore, such crimped or rolled electrodes have sharp edges of great ex-

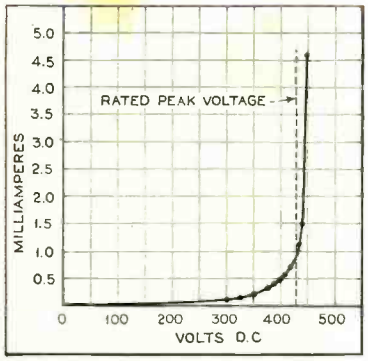


Fig. 2. Variation of leakage current with voltage.

tension. The film formation on such edges is unreliable and discharge is likely to occur from same.

It seemed highly desirable to obtain an anode made from one piece comprising a solid stem extending from the electrolyte and having a part of large surface area immersed in the electrolyte, and at the same time designed to reduce the edges or sharp points to a minimum. To produce such an anode, a great number of difficulties connected with the working of aluminum had to be surmounted and development of radically new manufacturing process and machinery was required. The result was the single piece helically corrugated tubular anode shown in Fig. 1. Besides incorporating the advantages above pointed out, this anode also has the advantage of negligible self-inductance which is important if the condensers are used at high frequencies.

Purity of Materials

Aluminum of the highest purity available is used and this aluminum is subjected to a further treatment to improve the surface for the purpose of film formation.

In a similar way, the copper can which serves as the negative electrode is made from pure electrolytic copper, which is further subjected to electrochemical treatment.

The electrolyte is subjected to repeated refining processes, to eliminate all impurities and is further subjected before its use to highly sensitive analytical tests to detect and prevent the presence of impurities.

Operating Characteristics

In Fig. 1, the standard eight microfarad condenser is shown. This condenser is manufactured as a rule for a 440 to 450 volt breakdown voltage. The operating characteristics, outlined below, relate primarily to such condensers, although in general they apply equally well to other electrolytic condensers.

In referring to the leakage current in the following discussion, this current is taken for the whole condenser, thus for eight microfarads. The leakage current per microfarad is one-eighth of these values.

The standard condenser is formed so as to have a breakdown voltage of 534 to 450 volts d-c. It is therefore recommended to operate this unit at a peak voltage not exceeding 430 volts d-c. making allowance for line voltage variations as well for the peaks of existing alternating ripple voltages superimposed on the applied d-c. voltage. In speaking of breakdown voltage in connection with electrolytic condensers, it is, of course, to be kept in mind that the term breakdown here is only a relative term, and is taken to be a voltage at which the condenser begins to pass a leakage current. This is not the same in the case of the paper condensers where, when the breakdown is reached, the condenser becomes shorted and is permanently destroyed.

In Fig. 2, which gives the values of the leakage current in varying voltages, it will appear that with a condenser operated at 430 volts the leakage current increases only slightly with the applied voltage. If, however, the voltage much exceeds 430 volts the leakage current rises very sharply. If the voltage then drops, the leakage current drops also very sharply and is again given by the curve; thus the curve represents a reversible process when the condenser is subjected either to abnormal voltage conditions or returned to its normal operating condition.

This phenomenon is generally referred to as "self-healing" and gives an important advantage to electrolytic condensers over paper wherein the application of excessive voltage causes a breakdown which punctures the condenser and thus destroys it.

For the above reason and because of the fact that the breakdown-voltage of electrolytic condensers runs much more uniform than that of paper condensers it is permissible to employ electrolytic condensers at much nearer their breakdown voltage than can be done with paper condensers.

Life

Since neither the anode nor the cathode is consumed in the operation, the life of the condenser is determined by the amount of water in the electrolyte, which is decomposed by the passage of the leakage current.

In view of the small leakage current of the condensers, the amount of water leaving in the form of gas through the vent is so minute that if condensers would operate continuously at the highest permissible voltage and at highest permissible ambient temperature, it would require more than twelve years continuous operation before sufficient water would have evaporated to cause any detectable decrease in the capacity of the condensers.

Influence of Temperature and Frequency on Capacity

In regard to the influence of temperature it appears that the capacity reaches a maximum at 130 degrees Fahrenheit and at this temperature the power factor reaches a minimum. The decrease in power factor is due to a decrease in resistance and this in turn results from the increased solubility of salts in the electrolyte at this higher temperature and the higher mobility of the ions in the electrolyte.

Since, in a radio set, the usual temperature is around 110 to 115 degrees Fahrenheit, the condenser is operating at a point near its best operating characteristics.

While the condenser freezes at a temperature of 16° F. such freezing does not cause injury to the condenser because when heated up it will again show the same characteristics as before.

Influence of Temperature on Leakage Current

A rise in temperature increases the leakage current. Such increase is proportionately less than that of impregnated paper condensers. Up to 140° F. the leakage current increases proportionately with the temperature, approximately doubling for a 70° Fahrenheit rise. For temperatures from 140° to close to boiling point, the leakage current increases approximately as a logarithmic function of the temperature. Close to boiling point, the leakage current is quite high.

Due to the low leakage current of the condensers at normal room temperature, these condensers can be safely operated up to temperatures found in commercial radio receivers.

This first hand description of the electrolytic condenser was gathered in the laboratories of the Sprague Specialties Company, North Adams, Mass.

▲

PROGRAMS FROM EUROPE

There will be much general interest throughout the coming Fall and Winter in music and talks broadcast from other countries. During the present month (August) eight programs from the British Isles are to be relayed to American listeners by the National Broadcasting Company.

▲

THE NEW METALS

NIROSTA: can be machined, welded, spun, drawn and polished. It is acid and heat resistant; does not warp, dent or tarnish; polishes quickly with a rag.

CARBALOY: tungsten, carbon and cobalt. Is exceeded in hardness only by the diamond..

BORIUM, Stellite, Widia, Straus metal and Carbaloy although of great hardness are not steels.

REMOTE CONTROL

(*Continued from page* 32)

tact. Pressing a button for a desired station would first release any previous contact set up and then set a new balance position. Such a system would have two distinct advantages over existing push button schemes:

1. Changes in the setting for a given station can be made in the remote control box by a simple adjustment of the contact position corresponding to that station.

2. Any number of buttons can be provided with no increase in the number of wires in the cable.

Meeting the Requirements

Summarizing the operational characteristics of the tuning system described in this article in the same order as the requirements are discussed in the second paragraph; the system in its present form:

1. Requires no different or additional procedure to operate the set remotely than to operate it directly.

2. Is accurate in excess of 1 part in 900, which is better than the plus or minus 2 K.C. limit mentioned previously.

3. Uses but four wires between the set and the control box for tuning and turning set on and off, two of which may be the 110-volt house wiring. The number of additional wires for volume control depends on type used, usually two or three.

4. Is capable of maintaining its accuracy over an extended period of time, as there is nothing to change it except brush wear which is negligible. It will stand the same amount of rough usage that the receiver will, without harm.

5. And is sufficiently quiet to allow using it with a receiver of high sensitivity when tuning in distant stations.

▲

RATING OF BROADCAST RECEIVERS

(*Continued from page* 27)

equivalent series resistance increases, which causes broad tuning.

Nearly all sets are more sensitive at high frequencies. A set that is highly selective is likely to give poor quality because of clipping of sidebands. Since music frequencies occupy about 5000 cycles on either side of resonance, the ideal resonance curve would be flat-topped and 10 kilocycles wide. Band-pass tuners are an effort to approximate this kind of tuning.

Finally it should be noted that the above tests do not cover speaker performance. The receiver may pass the above tests and yet give poor quality because of a speaker that discriminates against certain frequencies.

To properly test a speaker, a sound intensity measuring instrument is needed whose sensitivity is not affected by frequency. Unfortunately no satisfactory device has been developed to do this. The Rayleigh disk and the Webster phonometer have been used but both of these are affected by frequency changes. At present, the most satisfactory device seems to be a condenser microphone feeding an amplifier whose output can be metered. Procedure has not become standard for testing speakers.

▲

KDKA TO USE NEW 200 KW. TUBES

Success of the new transmitting station of KDKA, which is being built near Saxonburg, Pa., will depend largely upon innovations in broadcast set design which have been developed by the radio engineering and research departments of the Westinghouse Electric and Manufacturing Company.

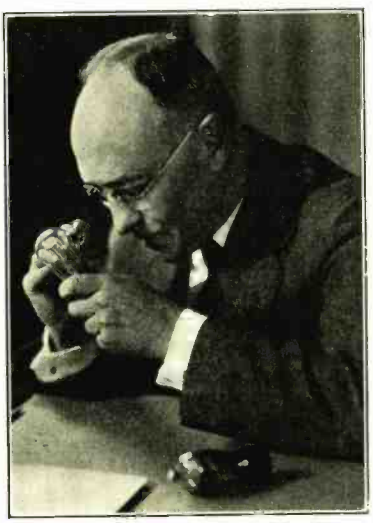
Of these innovations, one of the most important is the new 200-kilowatt tube, AW-220, which will be used. This tube, is not merely an enlarged edition of a smaller tube, but is thoroughly engineered as a tube of larger size and of a distinctly novel design.

▲

DR. RALPH E. MYERS

Dr. Myers, vice-president in charge of engineering and manufacture, National Union Radio Corporation was at one time professor of courses in electro-chemical engineering at Pennsylvania State College. For his scientific studies he was given a Ph.D. by the University of Pennsylvania. He is fifty years old and at the height of his career.

Dr. Myers is a member of the American Institute of Chemical Engineers, the American Institute of Electrical Engineers and other scientific societies. He is chairman of the national sectional committee for the standardization of rolled threads, for screw shells, for electric sockets and lamp bases. He is chairman also of the advisory committee on lamp holders and bases of the national committee of the International Electro-Technical Commission.



DR. RALPH E. MYERS

WORLD'S SMALLEST SYNCHRONOUS MOTOR

What is believed to be the world's smallest synchronous electric motor is shown by C. E. Skinner, assistant director of engineering for the Westinghouse Electric and Manufacturing Company. About the size of a hickory nut, it runs on ordinary house current. Its rating is approximately one-half cricket power.

This motor is used in delicate devices which require a constant speed with very little power.

▲

RMA TO ESTABLISH CENTRAL PATENT BUREAU

An important step toward solution of the patent troubles in the radio industry has been taken by the Radio Manufacturers Association. Establishment of a central patent bureau to collect and disseminate complete information on radio patents was ordered by the RMA Board of Directors at their mid-summer meeting July 30th at Niagara Falls, Ont. The new patent department will be in the New York offices in charge of a competent radio patent attorney.

An extensive library on radio patents, foreign as well as domestic, will be developed in the RMA patent department. It will collect, digest and index all radio patents and publications and all information regarding patent litigation. Files of many important manufacturers who are members of the RMA will be centralized in the RMA patent department which will advise manufacturing members of radio suits and decisions, applications for and issuance of radio patents.

NATIONAL RADIO WEEK

National Radio Week, September 22 to 28, 1930, will be held during the same period as the Radio World's Fair in New York.

Recording and Regulating Transmitting Frequencies

Department of Commerce's Monitor Station in Nebraska Will Soon Begin Systematic Check of all Transmitters. KDKA, Pittsburgh, Sticks Closely to Assignment.

A STEP toward keeping world control of the air lanes in this country is seen in the near completion of the million dollar radio monitor plant being erected at Grand Island, Nebraska, by the radio division of the United States Department of Commerce. This receiving station, which is scheduled to open September first, next, will be the most complete in existence. The receiving units will be two hundred times more sensitive than the average home set, with ample capacity to pick up broadcasts from any spot on the globe. The monitor station will therefore be able to keep tab on the 20,000 sending stations now operating in various parts of the world and others as they are established, and to police against interference and misuse of wavelengths and power.

The equipment of the new station is in advance of present-day needs, foreseeing widespread use of television as well as greater developments in amateur and international broadcast and communication from ships at sea. A fifty-acre tract of land is necessary for the plant and the miles of antennas which stretch in all directions supported by numerous poles. In addition to the executive force, a crew of thirty radio engineers will be required from the start.

In designing and building the station, the Department has taken every precaution to protect and safeguard the station and prevent interference of whatsoever nature. The main building which will house the equipment and receivers is 85 feet long, 75 feet wide and two stories in height. In designing the building, the aim has been to simplify the maintenance of uniform temperature at all times. To this end, the masonry walls were insulated with a flexible insulation made of a wool-like blanket placed between two layers of strong creped kraft paper. The bulk of this insulator is 92 per cent dead air space—dead air space according to science being the most effective heat insulator known next to a perfect vacuum. The interior walls are plastered on a comparatively light-weight insulating board of the new wood type made entirely from soft northern woods. Wire communication lines of which there are twenty-two running into the station have been installed under ground and a further protective measure against interference was the placing of copper screen in the walls and over the windows.

The Power Plant

The power unit which consists of three Diesel engines furnishing 75 kilowatts of power is housed in an auxiliary building. All power supplies are to be filtered and shielded. The standards and receivers in the new station will receive their power from storage batteries which in turn are charged by means of small motor-generators. Each receiver is housed in a shielded booth.

International Service

The Department of Commerce hopes that the new plant will be the means of straightening out some of the congestion which now exists in the broadcasting world. Operating internationally through the Berne Bureau of Switzerland, the services of the station will be available to all authorities. Construction work is under the direction of S. W. Edwards who is also supervisor of radio for the Detroit District. Benjamin Wolfe, formerly of San Francisco is the superintendent of the station.

Grand Island was selected for the location of this giant plant because it is virtually the geographical center of the country and because topographical and soil conditions are ideal for the operation of such a station.

KDKA Tests Its Radio Frequency With Piezo Crystal

One of the most troublesome things in the realm of radio broadcasting is the station that does not remain exactly on its assigned frequency. Those that do not do so cause trouble to broadcasters assigned to nearby channels. Listeners are acquainted with the reception conditions which can be caused by a "wobbling" station.

A check over the records of Station KDKA, Pittsburgh, during the past three years shows that the pioneer station has had an average daily deviation of only plus or minus 51 parts in a million. The Federal Radio Commission limit is plus or minus 500 cycles in a million, so that the KDKA variation is ten times better than the requirement.

This measurement of KDKA's frequency is taken daily by R. C. Hitchcock, member of the research department of the Westinghouse Electric and Manufacturing Company. Mr. Hitchcock is a specialist in the work and also in vacuum tube research. He is especially noted for his most recent development, an organ which uses vacuum tubes instead of pipes.

KDKA's radio frequency is checked daily at the research laboratory by a simple method which is very similar to that used in tuning musical instruments, Mr. Hitchcock explains. His discussion of the theme is as follows:

"When two mandolin strings are only slightly out of tune, alternate loud and soft tones, sometimes called "waxing and waning" tones are heard. These alternate loud and soft sensations are called beats, and are due to the difference in the frequencies of the two strings. If one is tuned to the A above middle C it vibrates 435 times a second. If the second string is slightly sharp, and vibrates, say 437 times a second, the waxing and waning occurs at the *difference* frequency, 437 minus, 435 or twice a second. The beat frequency is said to be two per second.

Audible beats are used to good advantage in measuring two radio frequencies which are close together. To measure KDKA at its assigned 980 kc., a radio-frequency oscillator of 982 kc. gives an audible beat of 2 kc., approximately the pitch of the third B above middle C. By measuring the "whistle" or "beat" between KDKA and three standard oscillators com-

pared with the standards of the United States Bureau of Standards, KDKA's frequency can be accurately determined.

Illustration of Frequency Bands

Suppose a five foot bookshelf to be filled with magazines. If each page represents 50 cycles per second, and the pages are two thousandths of an inch thick, the shelf would contain 30,000 pages. Assuming an average of 100 pages per month, this would contain copies of the magazine for twenty-five years. The present broadcast band of 550 to 1500 kilocycles per second would include the pages numbered from 11,000 to 30,000. Dividing up the band into ten kilocycle divisions means assigning 200 pages to a station.

The Federal Radio Commission has specified that the absolute value of the assigned radio frequency must be within 500 cycles per second of the correct absolute value. This corresponds to plus and minus 10 pages; the station must be kept at its proper position in the bookshelf within 10 pages.

KDKA has been assigned 980 kilocycles per second, corresponding to page 19,600 on the hypothetical magazine collection; and if the Commission's requirements are to be followed, KDKA should be kept between pages 19,590 and 19,610. The variation mentioned above, 51 parts in a million, means that from day to day, KDKA varies a maximum of one page from its mean position.

Modern Die Casting

*By J. B. Nealey**

THE three most important methods of casting molten metals into various shapes are sand, permanent mold and pressure die casting. Each has its field of application, separate and distinct from the others, but the lines of demarkation between these fields overlap more or less. With the cost of dies ranging from $500 to $3000 each the employment of the pressure die casting method is confined to volume production of identical pieces. Speed of production and die life are greatly influenced by the character of the alloy used, as witnessed by the fact that more than a million "shots" are possible with a zinc base alloy while only about 350,000 are practical with an aluminum base alloy. Brass and bronze, due to the rapid breaking down of the dies, are not yet being commercially die cast.

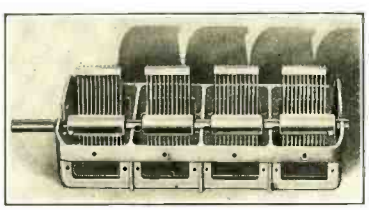
Dies are made from special alloy steel carefully heat treated. Their life is limited by the pressure and temperature under which they are operated. The pressures used in die casting range from 400 to 600 pounds per sq. in. while the casting temperatures are as follows:—the zinc alloys at 750-900° F. and the aluminum alloys at 1350-1500° F. while the tin and lead base alloys are cast at 400-500° F.

The principal alloys are zinc base and aluminum base alloys. The first consists of 4 per cent aluminum, 3 per cent copper, 0.1 per cent magnesium and the balance zinc. This alloy in test bars has shown a tensile strength of 47,300 lbs. per sq. in., with a Brinell hardness of 83.

A typical aluminum base alloy contains ½ per cent silicon, 4 per cent nickel, 4 per cent copper and the balance aluminum. However, the silicon content of this alloy is varied up to 10 per cent to obtain various combinations of physical requirements. The aluminum alloys range from 25,000 to 35,000 lbs. in tensile strength, are very light in weight and while they cannot be plated commercially they take a high polish. Plating difficulties are due to the fact that an oxide forms the instant air strikes an aluminum alloy. A great deal of research work is being done to overcome this difficulty and it is reported from one quarter, that the problem has been solved, in an experimental way. Zinc alloys are readily plated.

Tin and lead base alloys are also made up and used. They range from the cheaper antimonial lead alloys on up to the high speed, tin babbitts. Due to the lower melting points these can be cast with greater accuracy than can the alloys previously described. As tin and lead will contaminate zinc and aluminum alloys, separate melting pots are always used.

In the plant of the Allied Die Casting Corp., Long Island City, N. Y., the die casting machines are arranged along the windows and consist of three sizes, the large and small hand operated type and the large hydraulically operated type. This latter machine has a four bar die carriage operated with a horizontal hydraulic cylinder. The furnace is of heavy steel, brick lined and fired with two gas burners. A cast iron oval pot of 2500 cu. in. capacity sets in the furnace and a gooseneck is partially submerged in the molten alloy in the pot. Another gas burner plays on the exposed part of this gooseneck.



A die-cast 4-gang radio condenser.

* *American Gas Association.*

PSYCHOLOGY PLAYS PART IN RADIO RECEPTION

*By Ray H. Manson**

THE term "color blindness" is a familiar one. The term "tone blindness" is not so familiar. And yet the human ear, like the eye, has its distinct limitations. The noise of city life has compelled us to be less sensitive to sounds for the sake of our nerves. We must ignore most of the noise in order to be comfortable, and this is impairing the function of hearing, we are told by psychologists and physicians. Then also, the ear has its limitations of responsiveness to pitch. Persons with unusually keen ears can hear tones as high pitched as 10,000 cycles, while others can hardly perceive tones higher than 5,000 cycles.

Such limitations of the hearing faculty make radio reception a matter of psychology as well as of acoustics. The early types of reproducers or loudspeakers were not acoustically capable of accurately reproducing low notes. When such a note was played in the broadcasting studio, it was reproduced not as a tone of the same frequency but as a harmonic of this tone. Such tones sound "tinny" and the listener becomes mentally fatigued without knowing the exact reason why. His mind unconsciously "manufactures" from the harmonic the fundamental tone it represents. Since the lower notes are not received, the music is high pitched and prolonged listening to it is tiresome, although here again the listener may not be conscious of the reason.

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

The Trend of Invention

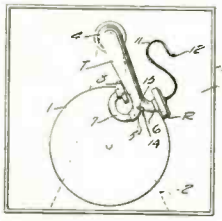
By RICHARDS & GEIER

PATENT AND TRADE MARK ATTORNEYS 274 MADISON AVE NEW YORK CITY

SOUND-AMPLIFYING APPARATUS

Adolph A. Thomas, of New York, N. Y. Assignor to Radio Corporation of America, of New York, N. Y., a Corporation of Deleware. U. S. Patent No. 1,758,986. (Issued May 20, 1930)

This invention relates generally to loudspeakers and is particularly applicable where the amplifying horn of a phonograph is used as a loudspeaker for a radio set, especially where the phonograph and radio set are in the same cabinet. The object



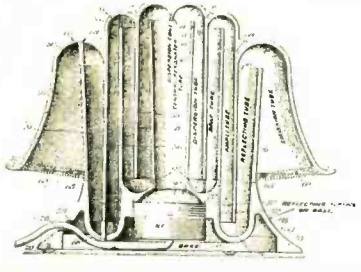
of the invention is to provide a new and improved tonearm to which a telephone receiver may be attached above the top board of the phonograph without removal of the phonograph sound box and independently thereof.

▲

ACOUSTIC AMPLIFIER

Harry E. Hall, of St. Charles, Illinois, Assignor to Freeman and Sweet, of Chicago, Illinois, a Copartnership composed of Hadley F. Freeman and Donald H. Sweet. U. S. Patent No. 1,759,614. (Issued May 20, 1930)

This invention relates to delivering large volumes of sound from a source having sufficient energy for such delivery, but being itself of insufficient magni-



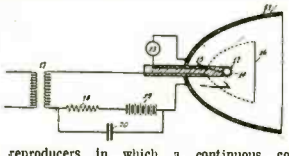
tude to act on sufficient volumes of air. While the inventor has illustrated the invention as applied to a horn or a loudspeaker unit for radio work, it will be obvious that the principles of the invention are applicable in a large number of other instances.

▲

SOUND REPRODUCER

Irving Wolff, of New York, N. Y. Assignor to Radio Corporation of America, a Corporation of Delaware, U. S. Patent No. 1,758,993. (Issued May 20, 1930)

This invention relates to an inertialess type of sound reproducers. More particularly it relates to



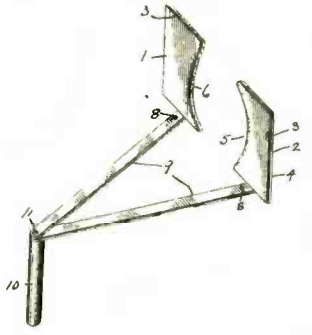
sound reproducers in which a continuous corona discharge is provided, the discharge being modulated by a sound modulated current such as is obtained from a radio receiver.

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.

ACOUSTIC DEVICE

Max Kaplick, of New York, N. Y. U. S. Patent No. 1,757,966. (Issued May 13, 1930.)

This invention relates to acoustical devices and has for its primary object the provision of a device for use by singers or other persons to permit the user to receive aurally the sounds produced in singing or talking so that the user will hear his own voice in a



manner corresponding closely to that in which other persons hear the rendition of vocal pieces.

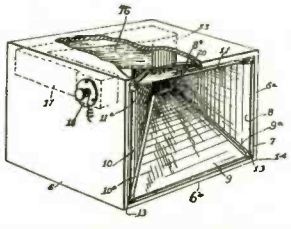
The device is particularly adapted to eliminate the direct transmission of sounds from the mouth to the ear of the user, and so the user can modify the quality of the tones or diction which he produces, in such a way as to render the same in the manner most desirable for audition.

▲

SOUND AMPLIFIER

Theophilus G. Williams, of Morristown, New Jersey. U. S. Patent No. 1,760,892. (Issued June 3, 1930)

This invention relates to means to amplify and propagate sound waves, particularly waves of the character transmitted by a diaphragm actuated by undulations induced in an electric current, as in a sound reproducing device, and particularly adapted for use in connection with radio receiving apparatus,



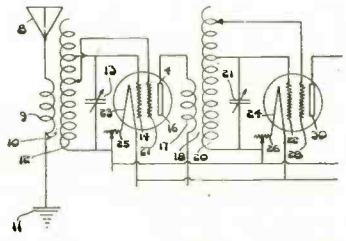
and it is the object of the invention to provide a sound amplifier of this character, which is novel, compact and cheap in structure, and highly efficient in propagating and magnifying the sound waves of dominant and undertones.

▲

RADIOCIRCUITS

Guy S. Cornish, of Cincinnati, Ohio, Assignor to the Cincinnati Patent Engineering Company, of Cincinnati, Ohio, a Corporation of Ohio. U. S. Patent No. 1,759,937. (Issued May 27, 1930)

An object of the invention is to produce a circuit in which the use of a tube having more than one grid element will bring about results such as the reception of radio signals with less static and



local interference and at the same time with a greater degree of strength and clarity than has heretofore been possible without a corresponding increase in the strength of such objectionable interference as is usually experienced.

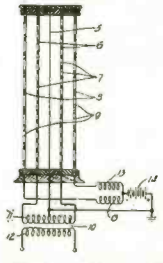
▲

ACOUSTIC DEVICE

Ralph V. L. Hartley, of South Orange, New Jersey, Assignor to Bell Telephone Laboratories, Incorporated, of New York, N. Y., a Corporation of New York. U. S. Patent No. 1,762,981 (Issued June 10, 1930)

This invention relates to acoustic devices and particularly to an electrostatically operated device.

An object of this invention is to radiate sound



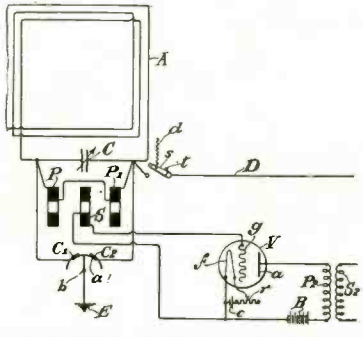
energy with substantially uniform efficiency over at least a large portion of the frequency range employed in speech and music.

▲

RADIO COMPASS

Frederick A. Kolster, of Palo Alto, California, Assignor to Federal Telegraph Company, of San Francisco, California, a Corporation of California. U. S. Patent No. 1,759,119. (Issued May 20, 1930)

This invention relates to radio compasses or kindred receiving apparatus having a directional characteristic and utilizable for interference prevention,



and particularly for determining the bearing and sense of direction of a radio beacon or other radio transmitter.

NEWS OF THE INDUSTRY

NATIONAL UNION NAMES HUTCHINS SALES MANAGER

E. A. Tracy, vice-president of National Union Radio Corporation, the merger of five independent tube plants in which RCA has a financial interest, has announced the appointment of Henry A. Hutchins, Jr., merchandising expert, as sales manager. Mr. Hutchins has a conspicuous record in large volume sales of radio tubes. He is known personally by jobbers and dealers in nearly every state in the Union.

"With a man of Mr. Hutchins' calibre," Mr. Tracy said, National Union has a sales spokesman capable of winning the trade's approval and confidence. He will be in complete charge of our extensive sales organization.

▲

VULCANIZED FIBRE AND LEATHEROID

The National Vulcanized Fibre Co., of Wilmington, Del., has purchased the leatheroid and vulcanized fibre business of the Rogers Fibre Co., of Boston, Mass., and Kennebunk, Maine.

The Rogers Fibre Co. has long been identified in the fibre industry as manufacturers of trucks, cans and boxes and of a certain type of fish paper. Their trade name "Leatheroid" is well known throughout the industry.

Mr. Leon B. Rogers has joined the N. V. F. organization.

▲

NEW HOTEL INSTALLS CENTRALIZED RADIO

The Manhattan Towers, New York's newest uptown hotel, located at Broadway between 74th and 75th Streets, is being equipped with a powerizer centralized radio system, for both the church which occupies the building to a height of several stories and for the 1500 rooms of the hotel proper.

Three 50-watt powerizers will amplify the sound for all parts of the building. The officiating clergyman's voice will be heard by his entire congregation. The manager and other officials of the hotel will be able to speak to employees throughout the establishment, and the occupants of all the rooms, each of which is equipped with a radio receiver, will be able to tune in on any of three programs. The three-channel systems being installed will permit one guest to listen to one station, another to a second, and still another to a third, with no interference whatever. Perhaps a guest will desire to listen to the orchestra playing in the grill. That wish may be granted without the necessity of going to the grill.

In short, the powerizer centralized radio system, such as is being installed in the Manhattan Towers, and many other hotels, schools, ships, libraries, hospitals and public buildings, is the answer to many sound amplification and transmission problems. The day is near at hand when such systems will be considered standard equipment.

▲

COTTERILL JOINS SOUND STUDIOS

The increasing demand for its services in the preparation, presentation and recording of broadcast programs is necessitating a rapid and healthy expansion in the facilities and personnel of Sound Studios of New York, Inc.

The holder of a license granted by Western Electric Company for the recording of broadcast programs, this organization is not only presenting such features as Palmolive, Ovaltine, Seiberling Singers and Chase and Sanborn, but also recording programs for spot broadcasting.

Norton Cotterill, well-known in the sales promotion field, has recently joined Sound Studios of New York in a sales capacity. Formerly assistant market analyst for Frigidaire, then connected with the General Motors Acceptance Corporation on domestic credit, dealer contact and sales convention work, Mr. Cotterill brings to his present position a wealth of information and experience to aid the progressive radio sponsor in selecting his markets and tying his radio programs in with dealer aids and other merchandising plans.

▲

INVENTOR OF SELF-TAPPING SCREWS AWARDED CERTIFICATE OF MERIT BY FRANKLIN INSTITUTE

Heyman Rosenberg, vice-president of the Parker-Kalon Corporation of New York, was among the distinguished scientists and engineers to be honored by the Franklin Institute of Philadelphia at the Medal Meeting held by the Institute on May 21.

Mr. Rosenberg, was awarded the Institute's Certificate of Merit for his development of Parker-Kalon hardened self-tapping screws, which have contributed greatly to the fabrication of metal products of every description.

His first achievement along these lines took the form of a self-tapping sheet metal screw that overcame the difficulties previously encountered in joining and making fastenings to light gauges of sheet metal. This unique screw, so threaded and hardened as to make it capable of cutting a thread in sheet metal, like a tap does in iron or steel, as it is screwed in, was such an outstanding improvement in fastening devices that its extensive adoption by the metal working industries followed quickly.

Having produced an easier, quicker and cheaper means of making light gauge sheet metal assemblies, the inventor's thoughts turned to the problem of making fastenings to solid sections of material, such as iron, brass and aluminum castings, steel, Bakelite, etc.; where the tapping of holes, with its breakage of taps, upkeep of tapping machinery, etc., is often a factor in the cost of the article. After a good deal of research and experiment, Mr. Rosenberg devised and patented the screw, now generally known as a hardened metallic drive screw. This screw has a spiral form of hardened thread, which cuts or forms a corresponding female thread in the material as it is hammered in or otherwise driven in. The troublesome and expensive tapping operation, which the inventor set out to eliminate, has thus been dispensed with. Because of the savings in time and labor that these screws bring about, they are today being used by thousands of manufacturers in the assembly of hundreds of articles made from the materials mentioned.

As the original design of sheet metal screw was suitable only for use in light gauges of metal and as the hardened metallic drive screw could be used only where a permanent fastening was desired, due to the fact that once driven in this screw could not readily be removed, there still existed a need for a similar device which could be used in heavy gauges of sheet steel; and also one suitable for making fastenings to solid sections of material and which could be removed and reinserted when necessary. This presented quite a difficult problem but Mr. Rosenberg's inventive genius created an improved form of his original self-tapping sheet metal screw, which has fully met these requirements.

His latest achievement in fastening devices is the screwnail, combining the driving qualities of a nail and the holding qualities of a screw. This device was designed to give a more secure means of fastening sheet metal to wood and has been accepted with enthusiasm in all trades where sheet metal to wood fastenings have to be made.

▲

NEW BULLETIN ON LATHE ATTACHMENTS

Bulletin No. 77, just published by the South Bend Lathe Works, is something entirely new in lathe publications. This 20-page, letter-size booklet is devoted exclusively to description and illustration of the many attachments used with New Model South Bend Lathes.

The bulletin shows how the lathe is easily converted into a milling machine; a keyway cutting tool; a precision grinder; a jig boring and spacing tool; a gear cutter; and—for manufacturing purposes—into a turret lathe.

It fully describes handwheel and lever types of draw-in collet chuck; a wide variety of split collets for making small precision parts; step chucks; spindle nose collet chucks, drill chucks, universal geared scroll chucks, and others, together with full directions for their selection. There is also a taper attachment for use on milling cutters, reamers, taps, and hobs; and a speed reducer for relieving and for providing the extremely low spindle speeds required in making single or multiple long-pitch screws and spiral-groove rods. The bulletin shows double tool slides; a thread indicator; a micrometer carriage stop; collapsible taps and self-closing dies for cutting external and internal threads; a hand-lever tailstock; transposing gears for cutting International standard metric screw threads; and a large number of small lathe tools and accessories. With each description there is valuable information regarding the use and purpose of the attachment.

The new bulletin seems to justify the names, "universal machine" and "lathe of attachments," as the New Model South Bend Lathe is known in many manufacturing plants, tool rooms, automotive service shops, and engineering laboratories.

Free copies of the bulletin are ready for mailing to those who write the factory at South Bend, Indiana.

ANNOUNCES CHANGE IN NAME

Blaw-Knox International Corporation succeeds Milliken Bros.-Blaw Knox Corp., New York, as the international trade division of the Blaw-Knox Company. This change is in name only, necessitated by expansion of operation over a wider field. The personnel of the company and management remains the same. The scope of the Blaw-Knox International Corporation, with its affiliated companies, extends to every part of the world.

Blaw-Knox International Corporation gives a complete export service to all users of their products which include: radio towers, steel buildings, steel bins, weighing batchers, inundators, central concrete mixing and proportioning plants, grating, water-cooled accessories for high-temperature furnaces, air preheaters, rolls, steel castings, alloy steel castings and steel mill machinery.

The affiliated and subsidiary companies of the Blaw Knox Company are: Union Steel Castings Co., Pittsburgh, Pa.; Pittsburgh Rolls Corporation, Pittsburgh, Pa.; National Alloy Steel Co., Pittsburgh, Pa.; Lewis Foundry & Machine Co., Pittsburgh, Pa.; Blaw-Knox Construction Co., Pittsburgh, Pa.; Blaw-Knox, Limited, London, England: Milliken Brothers, Limited, London, England; Compagnie Francaise Blaw-Knox, Paris, France; Compagnia Italiana Forme Acciaio, Milano, Italy; and Blaw-Knox, G.m.b.H., Dusseldorf, Germany.

▲

TRIAD

Vernon K. Wilson, assistant sales manager of the Triad Mfg., Co., Pawtucket, R. I., has returned from an extensive visit in the west where he met with great success in furthering the sale of Triad products.

G. N. Noel is in charge of Triad sales in San Francisco, and R. J. Noel is in charge of South California territory. E. R. Fallon is Boston representative of Triad.

▲

ENLARGE GREBE FACTORY

To provide the additional factory space which had to be secured to take care of the increased production necessities of A. H. Grebe & Co., Inc., the offices in the Richmond Hill plant have been moved from the second floor to the top. Production activities are now concentrated on four floors, with the warehouse facilities located in the Bush Terminal in Brooklyn. Even storeroom space at Richmond Hill is now being utilized for administration and production personnel.

▲

RESISTANCE UNITS

The Ohmite Manufacturing Company, 636 North Albany Avenue, Chicago, Ill., has issued a new catalog of resistance units. There are illustrated six different terminal types in more than thirty different sizes and each size can be furnished in a range of resistance from a fraction of an ohm to as high as 250,000 ohms. Tapped units are shown and the variety and possible combinations of such units are practically infinite. A page is devoted to simple yet effective mounting brackets which are being used more and more by manufacturers of radio equipment.

▲

WESTINGHOUSE ADVANCES R. L. DAVIS

R. L. Davis, engineer in charge of radio development at the East Pittsburgh plant of the Westinghouse Electric and Manufacturing Company, has been named manager of the radio engineering department of the Westinghouse Chicopee Falls, Mass., plant.

V. E. Trouant has been appointed to the radio engineering position at East Pittsburgh made vacant by the transfer of Mr. Davis. As manager of the radio engineering department at Chicopee Falls, Mr. Davis will succeed H. J. Nichols, who has resigned. In his new position Mr. Davis will report to the director of engineering at East Pittsburgh. D. G. Little will continue as chief engineer of the radio engineering department. Announcement of the changes was made by R. S. Feicht, director of engineering.

▲

CROSLEY TO MAKE AMRAD RADIO SETS

The Crosley Radio Corporation has taken over the receiving set manufacturing business of the Amrad Corporation, together with the exclusive right to use the name Amrad in producing and marketing radio receiving sets.

The set engineering staff of Amrad, headed by Fred Johnston has been moved to Cincinnati as a division of the Crosley Engineering Department.

Little things like this help make your set a headliner

by George Lewis, Vice-President, Arcturus Radio Tube Company

DAILY dramas are being staged in the stores of your local dealers. Your set plays the leading role. The audience is made up of the Joneses or Smiths or Browns who are going to buy a radio, and like all audiences they're in a critical mood.

Snap the switch—let's go!

Your set, equipped with Arcturus Tubes, brings in the program in 7 seconds. No annoying 40-50 second wait, while live prospects fidget.

The music is clear, true, and free from hum; sure to be satisfying.

Another Arcturus feature—long life—keeps up the good first impression. Critical engineers know that sets equipped with Arcturus Tubes require minimum servicing.

In these three ways Arcturus Tubes help make sure of a perfect performance every time your set is in the spotlight. Each point is important, for a slight edge over competition often swings the sale your way. When you use Arcturus Blue Tubes for standard equipment, you're liable to get the kind of demonstrations that make your dividends grow.

ARCTURUS RADIO TUBE COMPANY
Newark, N. J.

ARCTURUS

Quick Acting

RADIO TUBES

DEPENDABLE!

EVEREADY RAYTHEON TUBES FOR TALKING PICTURES, TELEVISION AND ALL INDUSTRIAL PURPOSES

THESE tubes have a firmly established position in the fields of talking pictures, television and industrial usage.

The Eveready Raytheon Foto-Cell is a long-life tube for talking pictures and television. It is also finding new industrial uses every day, such as paper testing, color matching, automatic counting, control of illumination and many others. It comes in several standard types, or can be made to specification.

The Eveready Raytheon Kino-Lamp, for television reception, has uniform glow over the entire plate, and its reproductive qualities are perfect without the need of mirrors or ground glass.

Write, if you are interested in talking pictures, television or Foto-Cell applications of any kind. *Free*—Eveready Raytheon Technical Bulletin No. 1, dealing with the Kino-Lamp, and No. 2, covering the Foto-Cell.

★ ★ ★

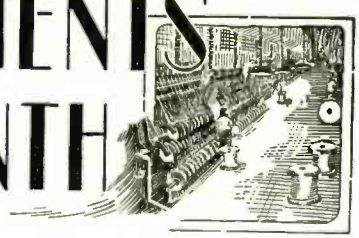
The Eveready Hour, radio's oldest commercial feature, is broadcast every Tuesday evening at nine (New York time) from WEAF over a nation-wide N. B. C. network of 30 stations.

NATIONAL CARBON COMPANY, INC.
General Offices: New York, N. Y.
Branches: Chicago Kansas City New York San Francisco
Unit of Union Carbide UCC *and Carbon Corporation*

EVEREADY RAYTHEON

Trade-marks

NEW DEVELOPMENTS OF THE MONTH



NEW CALLITE INSULATOR

The engineering and research laboratory of the Callite Products Company, Union City, N. J. has developed a high refractory insulator that has some unusual qualities for use as cathode insulators, and other applications for radio tubes and neon signs. These insulators are made in a wide variety of shapes and sizes to meet the many applications of insulating material in the electronic industry.

This insulating material is of a special composition, free from occluded gasses, with a very high insulating quality, high fusing point, and has no interaction with tungsten or tungsten-molybdenum alloy heater wires at elevated temperatures.

The Callite Products Company have made exhaustive tests on this insulating material during the past year and reports from the radio tube manufacturers who are using this new material, show that it is a superior product.

REPLACEMENT TRANSFORMERS

The Dongan Electric Manufacturing Company, 2987 Franklin Street, Detroit, Mich., have in stock transformers for replacement purposes specially de-

signed with open type mounting and lug terminals for ease of assembly. These are for radio receiver and power pack purposes.

RESISTANCE-COUPLED AMPLIFIER UNITS FOR ALL PURPOSES

Supplementing its engineering developments in the loudspeaker field, aiming at the most realistic rendition possible, the engineering staff of the Stevens Manufacturing Corporation, Newark, N. J., has now developed a line of unique resistance-coupled amplifiers.

The new resistance-coupled amplifiers are available in several types, ranging from a simple three-tube chassis with single -45 type power tube, to a most elaborate unit with two -45 type power tubes in push-pull, preceded by two screen-grid tubes and a single three-element tube, including meters and controls if desired. The units are compactly designed, with self-contained power pack, for ready incorporation in any radio set, console or cabinet. For radio or electrical phonograph manufacturers desiring the exceptional tone quality, the Stevens organization now offers an unique line of resistance-coupled amplifiers precisely matched to its speakers including the latest design of burtex or fabric diaphragm.

TUBES FOR COIL WINDING

Many styles and sizes of machine-made paper tubing are manufactured by The Paper Tube Company, 1718 N. Damen Ave., Chicago, for coil winding. This new tubing presents many features of great interest to the radio and electrical industries. Because it is made by machine, it is more accurate than hand-made cores. It runs close to dimensions and may be had in any desired wall thickness. It is available in many shapes—square, oblong, hexagonal, triangular, rectangular, square or oblong with rounded corners—and in sizes ranging from ⅜-inch to 2¾-inch I. D.

The tubing is built up layer by layer with each lamination securely cemented to the next. It is spiral wrapped in a diagonal or criss-cross manner to give the side walls greater strength. The paper or fibre stock used is manufactured according to the most rigid specifications under a process during which magnetic extractors remove mineral and metallic matter. Neither the paper nor the cementing materials contain any mineral or acids which might affect the smallest enameled wire.

ACCURATE RESISTORS

The wire-wound resistors manufactured by the Shallcross Manufacturing Co., 700 Parker Ave., Col-

lingdale, Pa., carry the trade name Super Akra-ohm. These are made to tolerances of 1% to 0.1 of 1%.

MANUFACTURING MACHINES

The F. J. Stokes Machine Company, 5850 Tabor Road, Olney, P. O., Philadelphia, Pa., are marketing standard equipment for the electrical and chemical industries, including automatic preforming presses, porcelain compressing machines, resistance disc compressors, motor brush compressors, wire drying tanks, vacuum impregnating apparatus, vacuum pumps, etc.

THE KONVERTER

Because there is a good potential demand for a-c. sets where 32, 110 or 220 volt direct current is available, the Kato Engineering Company, Mankato, Minn., are offering a new and complete line of Konverters for all d-c. voltages.

Small 32 volt d-c. to 110 volt a-c. Konverters are featured, as well as small 110 volt d-c. to a-c. Konverters, but various sizes can be obtained up to 5000 watts.

Due to the principle employed in building a Konverter, together with advanced engineering features, current consumption is very low. Low power consumption is desirable for farm light plant service as its stored-up power is limited.

All Konverters work equally well on high or low wavelengths. They are carefully filtered so that a smooth supply of a-c. operates any standard radio set. As the inverted converter is the principle used, no transformer is necessary, making the unit very simple and efficient.

THE FOTO-VOICE

Stoner and Heath, Inc. of 122 Greenwich St., New York City, announce their new console type 33-1/3 r.p.m. turntable unit driven by a synchronous motor.

Due to the increased popularity of electrically transcribed radio programs it has been necessary to develop a special turntable unit which will produce in every respect the fidelity and purity of the actual and original recording and in the Foto-Voice units this result has been secured and demonstrated by actual use in broadcast station work.

CONDENSER TESTER

A condenser tester especially designed for radio uses has been brought out by the Electric Heat Con-

trol Company, Cleveland, Ohio. It measures capacities from 1/10 to 8 microfarads.

NEW CONDENSER

A new design variable condenser has been added to the Precise Products complete line. This condenser is made in multiples from a single to a 5-gang of .00035 and .0005 capacity. Specifications of the condensers are as follows:

The ⅜ inch shaft supporting the rotor assemblies is contained in a ball-bearing race. The stator assemblies are individually supported using insulation known as "Victron." The stator and rotor blades are of 1/32 inch hard sheet aluminum spaced .130 inch centers. The contour of the rotor is such that 40 per cent gives a 10 kilocycle separation. The other 60 per cent gives a 2 meter separation. Complete shielding of all parts is accomplished by housing the condenser in a steel case which is cadmium plated. The split blade rotor is also an added feature to this design. A contact wiper for each individual rotor assembly is arranged for a ground connection. The minimum capacity of the .00035 is 19½ mmf. and for the .0005 23 mmf.

DRY ELECTROLYTIC CONDENSERS

A new type of dry electrolytic condenser for comparatively high voltage filter work has been announced by the Aerovox Wireless Corporation, 70 Washington Street, Brooklyn, New York.

These new dry electrolytic condensers have a maximum peak voltage rating of 500 volts d-c. and have the very desirable self-healing characteristic which

makes them proof against momentary high voltage surges. This characteristic gives the condenser very long life without danger of crippling the power unit due to breakdowns.

The filtering action per microfarad of this type of condenser is equivalent to that of paper condensers of similar capacity ratings, but the sizes of the units are much smaller than for equivalent capacities and voltage ratings of paper condensers. They may be had in all peak voltage ratings up to 500 volts d-c.

They are dry, compact, surge-proof and low in cost.

DUO TYPE VOLUME CONTROL

In meeting the requirements of radio assemblies calling for the simultaneous control of two circuits, the Clarostat Mfg. Co., Inc., Brooklyn, N. Y., now announces the Duo Type wire-wound volume control clarostat. This device is made up of two standard volume control units, with tapered windings if so desired to match any resistance curve. The units are mounted in tandem, so as to operate with a single knob. Each resistance unit may be arranged for any resistance and may be electrically insulated from the other. A power switch can also be included in the assembly, so as to turn the power on and off by means of the single volume control knob. Due to the unique winding and contact member of the volume control clarostat, the knob of the duo type turns with a smooth, velvety action, and without noise even in the most critical radio circuits.

NEW HOOKUP WIRE

The Cornish Wire Company, 30 Church Street, New York, has introduced a new hookup wire, with a high voltage breakdown. The wire is marketed under the trade name Paralac.

DAYRAD TEST PANEL

The Most Complete Test Panel For Shop Use.

Fully equipped with instruments for making every radio test and adjustment. Tube Checker, Radio Set Analyzer, Oscillator. Simultaneous readings on 3 meters. Complete series of external meter ranges. No complicated inter-connections. D.C. Volt Meter Ranges, all 2500 ohms per volt.

The engineering has all been done behind the panel. This means quick work, utility, thoroughness.

Made in two types.
Type HB — $179.00. Net to dealer.
Type HB-180 includes 175-180 kilocycle fixed frequency oscillator. $195.00. Net to dealer.

Write for more complete information.

THE RADIO PRODUCTS CO.

Dept. E. — 5th & Norwood — Dayton, Ohio.

Largest Exclusive Manufacturers of Coils in the U. S.

BOLD STATEMENTS THAT EASTON COILS PROVE

[1]

THERE are no finer coils made anywhere today than EASTON Coils.

[2]

There are no more economical coils—quality and perfect, enduring performance considered—than EASTON Coils.

[3]

There is no organization better able to make Coils to your exact specifications than is EASTON with its long-experienced staff of Engineering and Manufacturing Experts.

Send your specifications to EASTON. All information and data furnished to our Engineering and Data Department will be held in strict confidence. Samples and quotations promptly furnished.

EASTON COIL COMPANY
EASTON, PA.
P. O. Box 237

Largest Exclusive Manufacturers of Coils in the U. S.

FOR YOUR "B" POWER UNIT, USE THE ORIGINAL "B-H" FOR POWERFUL, SUSTAINED D. C.

IF YOU use a "B" eliminator, try the original gaseous rectifying tube—the Eveready Raytheon B-H—and note the tremendous improvement. Instead of a filament, it uses ionized helium gas—which supplies millions upon millions of electrons a second, steadily, efficiently, reliably, through a long life of service.

The Eveready Raytheon B-H is *standard* in more than a hundred makes of "B" eliminator units. In fact, most "B" eliminators are *designed for* the famous B-H gaseous rectifying tube.

Note to experimenters: If you require a dependable source of powerful D. C., you will find the Eveready Raytheon B-H adaptable to many purposes.

★ ★ ★

The Eveready Hour, radio's oldest commercial feature, is broadcast every Tuesday evening at nine (New York time) from WEAF over a nation-wide N. B. C. network of 30 stations.

Type B-H
125 m. a.
at 300 volts

EVEREADY RAYTHEON

Trade-marks

NATIONAL CARBON COMPANY, Inc.
General Offices:
New York, N. Y.
Branches:
Chicago Kansas City
New York San Francisco

UCC

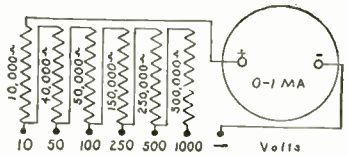
Unit of Union Carbide and Carbon Corporation

Super Akra-Ohm

wire Super AKRA-OHM *wound*

Resistors

accurately wound and calibrated with precision to insure an accuracy of 1%, are especially adapted and highly recommended for use in properly controlling the complex and complicated circuits required in the radio, audio, visio and industrial applications of the electron tube and photo-electric cells. They are also valuable for Laboratory Standards, High Voltage Regulators, Telephone Equipment, Grid and Plate Resistors, etc.



Bulletin 100-M completely describes with many charts and diagrams the many uses for Super Akra-Ohm Resistors.

Send for your copy today. Let us know your resistor specifications and we will quote you on the proper type required for your work.

ALWAYS Super AKRA-OHM ACCURATE

Shallcross Mfg. Company
ELECTRICAL SPECIALTIES
700 PARKER AVENUE
Collingdale, Pa.
(NEAR PHILADELPHIA)

Accurate NON-INDUCTIVE WIRE WOUND RESISTORS

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 62.

ALUMINUM:
Aluminum Co. of America
Fairmont Aluminum Co.

ALUMINUM, SHEET:
Fairmont Aluminum Co.

AMMETERS:
General Electric Co.
General Radio Co.
Weston Elec. Instrument Corp.

AMPLIFIERS, POWER:
General Radio Co.
Samson Elec. Co.

ANTENNAE, LAMP SOCKET:
Dubilier Condenser Corp.

ARRESTERS, LIGHTNING:
Cornish Wire Co.

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

BASES, VACUUM TUBE:
(See Tube Parts)

BENCHES, STEEL WORK:
Angle Steel Stool Co.

BINDING POSTS:
General Radio Co.

BOXES, STEEL:
Angle Steel Stool Co.

BRACKETS, ANGLE:
Scovill Mfg. Co.

BRASS:
Scovill Mfg. Co.

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

BUSSES, STEEL:
Angle Steel Stool Co.

BUTTS:
Scovill Mfg. Co.

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

CABINETS, STEEL:
Angle Steel Stool Co.

CASTINGS:
Fairmont Aluminum Co.

CELLS, PHOTOELECTRIC:
National Carbon Co., Inc.

CEMENT, LOUD SPEAKER:
Maas & Waldstein Co.

CENTRALIZED RADIO SYSTEMS:
Samson Elec. Co.

CHAIRS, STEEL, FACTORY AND OFFICE:
Angle Steel Stool Co.

CHASSES:
Aluminum Co. of America
Metal Specialty Co.

CHOKES, AUDIO FREQUENCY:
American Transformer Co.
General Radio Co.
Meissner Mfg. Co.
Polymet Mfg. Co.
Thordarson Elec. Mfg. Co.
Transformer Co. of Amer.

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

CHOKES, POWER:
American Transformer Co.
Concourse Electric Co., Inc.
Dongan Elec. Mfg. Co.
General Radio Co.
Meissner Mfg. Co.
Polymet Mfg. Corp.
Transformer Corp. of Amer.

CLAMPS, GROUND:
Clarostat Mfg. Co.
Fahnestock Electric Co.
Scovill Mfg. Co.

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

CLOTH, WIRE:
(See Wire Cloth)

COIL FORMS:
General Radio Co.

COIL WINDING:
Acme Elec. & Mfg. Co.
Concourse Electric Co.
Dudlo Mfg. Co
Easton Coil Company
Inca Mfg. Co
Meissner Mfg. Co.
Polymet Mfg. Corp.

COILS, CHOKE:
Acme Elec. & Mfg. Co.
Concourse Electric Co.
Dudlo Mfg. Co
Easton Coil Company
Polymet Mfg. Corp.
Westinghouse Elec. & Mfg. Co

COILS, IMPEDANCE:
Dudlo Mfg. Co
Easton Coil Company
Polymet Mfg. Corp.

COILS, INDUCTANCE:
Cardwell, Allen D. Mfg. Co.
Easton Coil Company
General Radio Co.
Hammarlund Mfg. Co.
Inca Mfg. Co.
Meissner Mfg. Co.

COILS, MAGNET:
Acme Wire Co.
Dudlo Mfg. Co.
Easton Coil Company
Inca Mfg. Co.
Meissner Mfg. Co.
Polymet Mfg. Corp.

COILS, SHORT WAVE:
Easton Coil Company
General Radio Co.
Hammarlund Mfg. Co.

COILS, TRANSFORMER:
Acme Wire Co.
Dudlo Mfg. Co
Easton Coil Company
Meissner Mfg. Co.
Polymet Mfg. Corp.

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

CONDENSERS, BY-PASS:
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Concourse Elec. Co., Inc.
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Igrad Condenser & Mfg. Co., Inc.
Polymet Mfg. Corp.
Potter Co., The
Sprague Specialties Co.

CONDENSERS, ELECTROLYTIC:
Aerovox Wireless Corp.
Amrad Corporation
Condenser Corp. of America
Polymet Mfg. Co.
Sprague Specialties Co.

CONDENSERS, FILTER:
Aerovox Wireless Corpn.
Amrad Co.
Concourse Electric Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Corp.
Igrad Condenser & Mfg. Co., Inc.
Kingston Products Corp.
Polymet Mfg. Corp.
Potter Co., The
Sprague Specialties Co.

CONDENSERS, FIXED:
Aerovox Wireless Corpn.
Amrad Corporation
Concourse Elec. Co., Inc.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Polymet Mfg. Corp.
Potter Co., The
Sprague Specialties Co.

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

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

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

CONDENSERS, VARIABLE TRANSMITTING:
Cardwell, Allen D. Mfg. Co.
Concourse Electric Co.
DeJur-Amsco. Corp.
General Radio Co.
Hammarlund Mfg. Co.
Jenkins & Adair, Inc.

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

CONNECTORS:
Cornish Wire Co.
Scovill Mfg. Co.

CONTAINERS, BATTERY BOX:
George F. Mitchell & Sons Co.

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

CONTROLS, VOLUME:
Central Radio Laboratories
Clarostat Co.
Ferranti, Inc.
Polymet Mfg. Corp.
Superior Resistor Co.

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

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

COPPER:
Scovill Mfg. Co.

CORDS, EXTENSION:
Anaconda Wire & Cable Co.
Cornish Wire Co.
Polymet Mfg. Co.

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

CUSHIONS, SPEAKERS:
Western Felt Co.

DESKS, STEEL, OFFICE AND FACTORY:
Angle Steel Stool 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:
Thomas & Skinner Steel Products Co.
Willor Mfg. Corp.

DRAWERS, STEEL, BENCH:
Angle Steel Stool Co.

DRYER-IMPREGNATORS:
F. J. Stokes Machine Co.

DYNAMOTORS:
Electric Specialty Co.

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

EXPORT:
Ad. Auriema, Inc.

FADERS:
Clarostat Mfg. Co.

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:
Amperite Corp.
Polymet Mfg. Corp.

FLEXIBLE SHAFTING
S. S. White Dental Mfg. Co.

FOIL:
Aluminum Co. of America

GALVANOMETERS:
General Electric Co.
General Radio Co.
Westinghouse Elec. & Mfg. Co.

GENERATORS:
Electric Specialty Co.
Janette Mfg. Co.

GETTER MATERIAL:
(See Tube Parts)

GRAPHITE
Acheson Oildag. Co.

GRID LEAKS:
(See Resistances, Fixed)

HANDLING EQUIPMENT:
Nat'l. Vulcanized Fibre Co.

HINGES:
Fahnestock Elec. Co.
Scovill Mfg. Co.

HORNS:
Amplion Co. of Amer.

INDUCTANCES, TRANSMITTING:
General Radio Co.
Jenkins & Adair, Inc.

INSTRUMENTS, ELECTRICAL:
General Electric Co.
Westinghouse Elec. & Mfg. 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.
National Vulcanized Fibre Co.
Synthane Corp.
Westinghouse Elec. & Mfg. Co.

INSULATION, REFRACTORY:
The Stupakoff Labs.

JACKS:
General Radio Co.

KITS, TESTING:
(See Testing Kits)

LABORATORIES, TESTING:
Electrical Testing Labs.

LACQUER, WOOD:
Maas & Waldstein Co.

LACQUER, METAL:
Maas & Waldstein Co.

LACQUER, ENAMEL:
Maas & Waldstein Co.

LAMINATIONS:
Lamination Stamping Co.
Thomas & Skinner Steel Products Co.
Willor Mfg. Corp.

LAMPS, MINIATURE:
National Carbon Co., Inc.

LAMPS, PANEL:
National Carbon Co., Inc.

LEAD-INS:
Clarostat Mfg. Co.
Electrad, Inc.

LOCK WASHERS:
Shakeproof Lock Washer Co
Thompson-Bremer & Co.

LUBRICANTS, RADIO:
Acheson Oildag Co.

LUGS:
Scovill Mfg. Co.
Shakeproof Lock Washer Co.
F. R. Zierick Mfg. Works

MACHINE TENDERS, STEEL, SHOP:
Angle Steel Stool Co.

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

MACHINES, SPECIAL
Willor Mfg. Corp.
F. J. Stokes Machine Co.

MAGNESIA, TUBES:
The Stupakoff Labs.

MAGNESIUM:
Aluminum Co. of America.

MAGNETS:
Thomas & Skinner Steel Products Co.

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

METERS:
General Electric Co.
Weston Elec. Instr. Co.

MICROPHONES:
Amplion Co. of America
Electro-Acoustic Prod. Co.
General Industries Corp.
Jenkins & Adair, Inc.
Universal Microphone Co.

MOLDING MATERIALS
(See Insulation, Moulded)

MOTORS:
Electric Specialty Co.

MOTOR-GENERATORS:
Electric Specialty Co.

MOUNTINGS, RESISTANCE:
Polymet Mfg. Corp.

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

NICKEL SILVER:
Gilby Wire Co.
Phosphor Bronze Smelting Co.
Riverside Metal Co., The

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

OSCILLOGRAPH:
General Radio Co.

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.
Scovill Mfg. Co.

PANS, STEEL, LATHE CHIP:
Angle Steel Stool Co.

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

PHONOGRAPH MOTORS:
The Hammond Clock Co.

PHOSPHOR BRONZE:
Baltimore Brass Co.
Phosphor Bronze Smelting Co.
Riverside Metal Co.

PHOTOELECTRIC CELLS:
(See Cells)

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

PLATES, OUTLET:
Howard B. Jones

PLUGS, ATTACHMENT:
General Radio Co.
Howard B. Jones
Polymet Mfg. Corp.

PORCELAIN TUBING:
Isolantite Co.
The Stupakoff Labs.

POTENTIOMETERS:
Clarostat Mfg. Co.
Central Radio Laboratories
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories

POWER UNITS, A-:
Thordarson Electric Co.

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

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

POWER UNITS, PARTS FOR:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Polymet Mfg. Corp.
Thordarson Electric Mfg. Co.
Transformer Co. of Amer.

PRESSED METAL PARTS:

PUBLIC ADDRESS SYSTEMS:
Amplion Corp. of America
Samson Elec. Co.

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.
George F. Mitchell & Sons Co.
Scovill Mfg. Co.
Soreng Manegold Co.

PUNCHINGS, BAKELITE:
Electrical Insulation Corp.

RECEPTACLES, WALL:
Scovill Mfg. Co.

REFRACTORY SPECIALTIES:
The Stupakoff Labs.

REGULATORS, VOLTAGE:
Amperite Corp.
Central Radio Laboratories
Clarostat Co.
DeJur-Amsco Co.
Polymet Mfg. Corp.
Soreng Manegold Co.
Ward Leonard Elec. Co.

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

RESISTANCES, FIXED:
Aerovox Wireless Corp.
Central Radio Laboratories
Clarostat Mfg. Co.
The Daven Corp.
DeJur-Amsco
Frost, Herbert H.
General Electric Co.
Hardwick, Hindle Inc.
International Resistance Co.
Polymet Mfg. Corp.
Superior Resistor Corp.
The S. S. White Dental Mfg. Co.
Ward Leonard Elec. Co.

RESISTANCES, VARIABLE:
Central Radio Laboratories
Clarostat Mfg. Co.
DeJur-Amsco Corp.
Frost, Herbert H., Inc.
General Electric Co.
Hardwick, Hindle, Inc.
International Resistance Co.
Polymet Mfg. Corp.
Shallcross Mfg. Co.
Ward Leonard Elec. Co.

RESISTANCE WIRE:
(See Wire, Resistance)

RHEOSTATS:
Central Radio Laboratories
Clarostat Mfg. Co.
Frost, Herbert H.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories
Westinghouse Elec. & Mfg. Co.

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

SCREWS, HARDENED SELF-TAPPING:
Parker-Kalon Corp.

SCREWS, DRIVE, HARDENED METALLIC:
Parker-Kalon Corp.

SEALING COMPOUNDS
Candy & Co.
Cochrane Chemical Company

SHEET METAL PARTS:
George F. Mitchell & Sons Co.

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

SHORT WAVE APPARATUS:
Cardwell, Allen D., Co.
De Forrest Radio Corp.
General Radio Co.
Hammarlund Mfg. Co., Inc.

SOCKETS, TUBE:
Central Radio Corp.
Electrical Insulation Corp.
Frost, Herbert H.
General Radio Co.
Howard B. Jones
Soreng Manegold Co.

SOLDER:
Kester Solder Co.

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.

STAMPINGS, METAL:
Aluminum Co. of America
George F. Mitchell & Sons Co.
Radio Products Corp.
Scovill Mfg. Co.
Thomas & Skinner Steel Prod. Co.

STEPS, STEEL:
Angle Steel Stool Co.

STOOLS, STEEL, FACTORY AND SHOP:
Angle Steel Stool Co.

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

SWITCHES:
Polymet Mfg. Co.
Soreng Manegold Co.

TABLES, STEEL WORK:
Angle Steel Stool Co.

TAPE, COIL:
Johnson and Johnson

TAPE, INDUSTRIAL:
Johnson and Johnson

TAPE, LOUD SPEAKER:
Johnson and Johnson

TELEVISION PARTS:
Clarostat Co., Inc.
Shallcross Mfg. Co.

TERMINALS, SOLDER, SCREWS, SPADE;
Howard B. Jones

TESTERS, B-ELIMINATOR:
General Radio Co.

TESTERS, TUBE:
General Radio Co.
Radio Products Co.
Weston Elec. Inst. Co.

TESTING INSTRUMENTS:
General Electric Co.
General Radio Co.
Radio Products Co.
Westinghouse Elec. & Mfg. Co.
Weston Elec. Instrument Corp.

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

TESTING LABORATORIES:
Electrical Testing Labs.

TIN COATED METAL:
Baltimore Brass Co.

TOOLS:
Willor Mfg. Corp.

TRANSFORMERS, AUDIO:
Acme Elec. & Mfg Co.
American Transformer Co.
Concourse Electric Co., Inc.
Dongan Elec. Mfg. Co.
General Radio Co.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, B-POWER UNIT:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Kingston Products Corp.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, BROADCAST STATION:
Jenkins & Adair, Inc.
Samson Electric Co.

TRANSFORMER CASES, METAL:
Metal Specialty Co.

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

TRANSFORMERS, OUTPUT:
Dongan Elec. Mfg. Co.
General Radio Co.
Samson Elec. Co.
Thordarson Electric Mfg. Co.
Transformer Corp. of America

TRANSFORMERS, POWER:
Acme Elec. & Mfg. Co.
American Transformer Co.
Concourse Electric Co., Inc.
Dongan Elec. Mfg. Co.
General Radio Co.
Kingston Products Corp.
Polymet Mfg. Co.
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.

TRUCK, STEEL:
Angle Steel Stool Co.

TUBE MACHINERY:
See (Machinery, Tube.)

TUBE, PACKING:
Holed-Tite Packing, Inc.

TUBE PARTS:
Acheson Oildag Co.
American Electro Metal Corp.
Buffalo Wire Works Co., Inc.
Callite Products Co., Inc.
Cambridge Wire Cloth Co.
Cleveland Wire Cloth & Mfg. Co.
The Engineering Co.
Fansteel Products Co., Inc.
General Plastics, Inc.
Gilby Wire Co.
Goat Radio Tube Parts Inc.
Newark Plate Labs.
Juno Fasteners, Inc.
Lepel High Freq. Labs.
Radio Products Corp.
The Stupakoff Labs.
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.
National Carbon Co., Inc.
National Union Radio Corp.

TUBES, RECTIFIER:
Arcturus Radio Co.
Cable Radio Tube Co.
De Forest Radio Co.
National Carbon Co., Inc.
National-Union Radio Corp.

TUBES, SCREEN GRID:
Arcturus Radio Co.
Cable Radio Tube Co.
De Forest Radio Co.
National Carbon Co., Inc.
National Union Radio Corp.

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

TUBING, COIL:
Paper Tube Co.

TUBING, NICKEL:
Gilby Wire Company
National-Harris Wire Co.

TUBING, PAPER — SPECIAL WRAPPED:
Paper Tube Co.

TUBING, PAPER & FIBRE:
Paper Tube Co.

TUBING, REFRACTORY:
Henry L. Crowley & Co., Inc.
Isolantite Co.
Stupakoff Labs, Inc.

TUBING, VARNISHED:
Alpha Wire Corp.

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

VARNISH:
Maas & Waldstein Co.

VOLTAGE REGULATORS:
(See Regulators)

VOLTMETERS, A. C.:
General Electric Co.
General Radio Co.
Weston Elec. Instrument Corp.

VOLTMETERS, D. C.:
General Electric Co.
General Radio 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.
Cochrane Chemical Company

WAXES, INSULATING:
Candy and Co.
Cochrane Chemical Company

WAXES, SEALING:
Candy and Co.
Cochrane Chemical Co.

WIRE, ANTENNA:
Alpha Wire Corp.
Anaconda Wire & Cable Co.
Cornish Wire Co.
Dudlo Mfg. Corp.
National Vulcanized Fibre Co.
Roebling, J. A., Sons Co.

WIRE BALLAST:
National-Harris Wire Co.

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

WIRE CLOTH:
Buffalo Wire Works Co., Inc.
Cambridge Wire Cloth Co.
Cleveland Wire Cloth & Mfg. Co.
Gilby Wire Co.

WIRE, COTTON COVERED:
Anaconda Wire & Cable Co.
Alpha Wire Corp.
Dudlo Mfg. Corp.
Gilby Wire Co.
Polymet Mfg. Corp.
Roebling, J. A., Sons Co.

WIRE, ENAMELED COPPER:
Alpha Wire Corp.
Anaconda Wire & Cable Co.
Cornish Wire Co.
Dudlo Mfg. Corp.
Polymet Mfg. Corp.
Roebling, J. A., Sons Co.

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

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

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

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

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

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

WIRE, RESISTANCE
Alloy Metal Wire Co.
Anaconda Wire & Cable Co.
Fansteel Products Co., Inc.
Gilby Wire Co.
National-Harris Wire Co.

WIRE, SILK COVERED:
Alpha Wire Corp.
Anaconda Wire & Cable Co.
Cornish Wire Co.
Gilby Wire Co.
Radio Wire Corp.
Roebling, J. A., Sons Co.

WIRE, SPAGHETTI:
Alpha Wire Corp.
Cornish Wire Co.

WIRE, TANTALUM:
Fansteel Products Co., Inc.

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

ZINC:
St. Joseph Lead Co.

INDEX OF ADVERTISERS