Tenth Year of Service

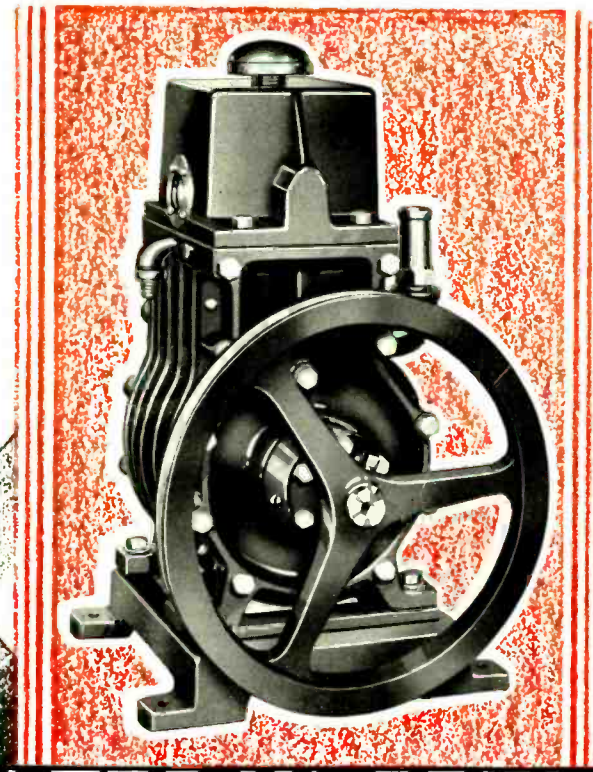
RADIO ENGINEERING

Vol. X NOVEMBER, 1930 No. 11

IN THIS ISSUE

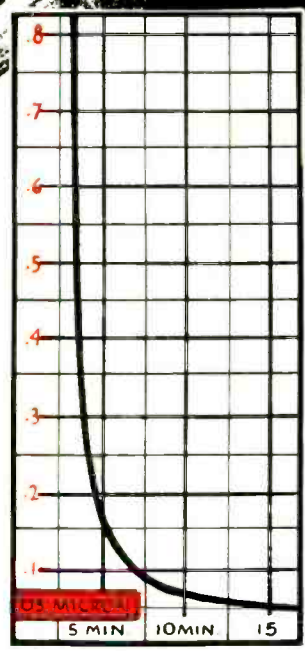
Sold only by subscription
$2.00 per year

The Journal of the Radio Industry



The Cenco Hypervac high speed high vacuum pump

A STRAIGHT LINE *to* LOWER PRESSURE *in radio tubes*



The exhaust curve of the Cenco Hypervac pump is a straight line, almost parallel along the time axis from atmospheric pressure into the tenths micron pressure region. In terms of pressure, a straight vertical path to lower pressures than before. In terms of time—a complete exhaust job from roughing to finishing in a few seconds.

Only by exhausting extremely large volumes can the time factor be actually measured in minutes to supply the curve at the left—where the finishing end of the Hypervac straight line exhaust curve cleans up a twenty-two liter volume.

Applied to common tube and line volumes, the Cenco Hypervac pump offers instant recovery on high speed machines and a cleaner exhaustion in every tube produced.

Address inquiries to the Central Scientific Company, 460 East Ohio Street, Chicago, Illinois.

CENTRAL SCIENTIFIC COMPANY

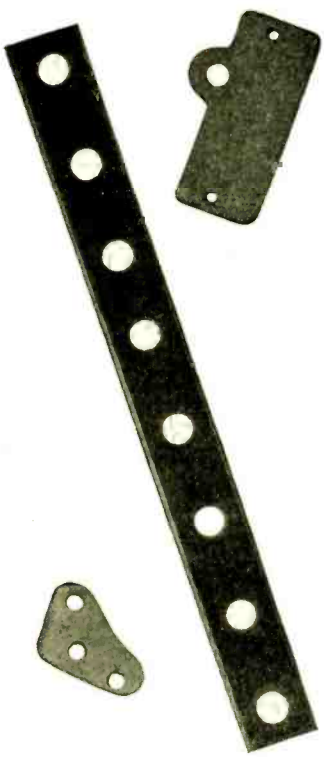
CENCO HIGH VACUUM PUMPS

Hyvac Megavac Super Cenco vac Rotovac Hypervac

NEW YORK - BOSTON - CHICAGO - TORONTO - LOS ANGELES

ELECTRICAL PARTS

promptly and accurately»



FORMICA for electrical uses is made in every variety required for insulating purposes in devices of all kinds.

Manufacturers who do their own fabricating may get the characteristics they require in Formica sheet.

Those who buy fabricated parts may have them in quantity accurately shaped very promptly, for Formica has one of the largest installations of fabricating machinery in the industry.

For seventeen years leading American technical organizations have depended on Formica as a source of supply for these materials.

Send your blue prints for quotations.

THE FORMICA INSULATION COMPANY
4638 Spring Grove Avenue
Cincinnati, Ohio

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 | November, 1930 | Number 11

Contents

Departments

13 Million Radio Sets In Use in United States

RADIO receiving sets in use in the United States on July 1 have been estimated by the Department of Commerce at 13,478,600.

New York, with 1,752,000, had the largest number. California was second with 1,470,000 sets, or more than the total of several States which exceed her in population. Other State totals were: Illinois, 1,060,000; Pennsylvania, 977,000; Ohio, 845,000; Massachusetts, 656,000; Michigan, 627,000, and New Jersey, 453,000.

In 1929 the number of receivers sold totaled about four and one-half million, equipped with about thirty-two million tubes. In addition, in 1929, there were about thirty-eight million tubes sold separately over the counter.

The distribution of receivers over the entire country has been ascertained to be: New England States, 9.5 per cent; Middle Atlantic States, 26.8 per cent; East North Central States, 23.64 per cent; West North Central States, 11.06 per cent; South Atlantic States, 6.15 per cent; East South Central States, 2.47 per cent; West South Central States, 4.76 per cent; Mountain States, 2.94 per cent, and Pacific States, 8.06 per cent.

These percentages were made up from sales records made in the two years 1928–1929.

The present wide demand for midget sets, and the variation as to locality of general employment, may this year cause changes in these group percentages.

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.

Editorial

November, 1930

A SUCCESSFUL CONFERENCE

RADIO manufacturers have one industry's share of economic difficulties, and until the bulk of these are ironed out, there is sound reason for cooperative determination to avoid incurring others.

If there is doubt in the minds of the industry's members that much can be accomplished through cooperative deliberation, this may be dispelled by recalling the conference of March, 1930, in New York, participated in by receiver manufacturers' representatives and the tube manufacturers. That conference dealt fairly and openly with the subject of the Pentode tube. While nothing was suggested that would interfere with laboratory development of this type of tube, it was made generally plain that a stampede toward the wide use of the tube would add little or nothing to the consumer's dollar's worth, but would destroy the market for thoroughly serviceable merchandise already manufactured and stocked.

This conference, called by the R. M. A., served a sensible purpose.

▲

SELECTIVITY

ON one hand manufacturers of radio receivers like to believe that the sets their engineers have designed and which their sales people are selling are as selective as the advertisements claim they are. On the other hand it is interesting to note the mass protests of set owners when a broadcasting company announces that it proposes to install a "high power" transmitting station within 10 miles of considerable numbers of listeners' homes.

The cry goes forth "all other stations will be blanketed," one indication of which is that broadcast listeners still demand variety and are willing to explore far afield for it.

In the search for a slogan that might serve as a destroyer of sales resistance why not, "The non-blanket receiver: any station, any time?"

▲

UNIVERSAL WIRELESS

IN informed radio circles there is frequent comment anent the probable future use of the excellent radio telegraph stations erected and equipped by the Universal Wireless Corporation. Several station units of this system were completed by the end of the year 1929. Typical of the others are the stations at Scobeyville, N. J., and Plainfield, Illinois.

An engineering inspection of these stations shows them to be well-designed, and thoroughly equipped to handle large volumes of message traffic in inter-city service. As modern radio plants they are far in advance of various of the older stations operated by other services—naturally so, as several of the stations now handling radio message traffic are, in many particulars, obsolete.

The Universal Company apparently made good in its agreement to have these stations ready for service in 1930. In future developments and disclosures it will be interesting to learn the reasons for restraining the company from proceeding to operate on the short wave channels originally allocated to this service.

▲

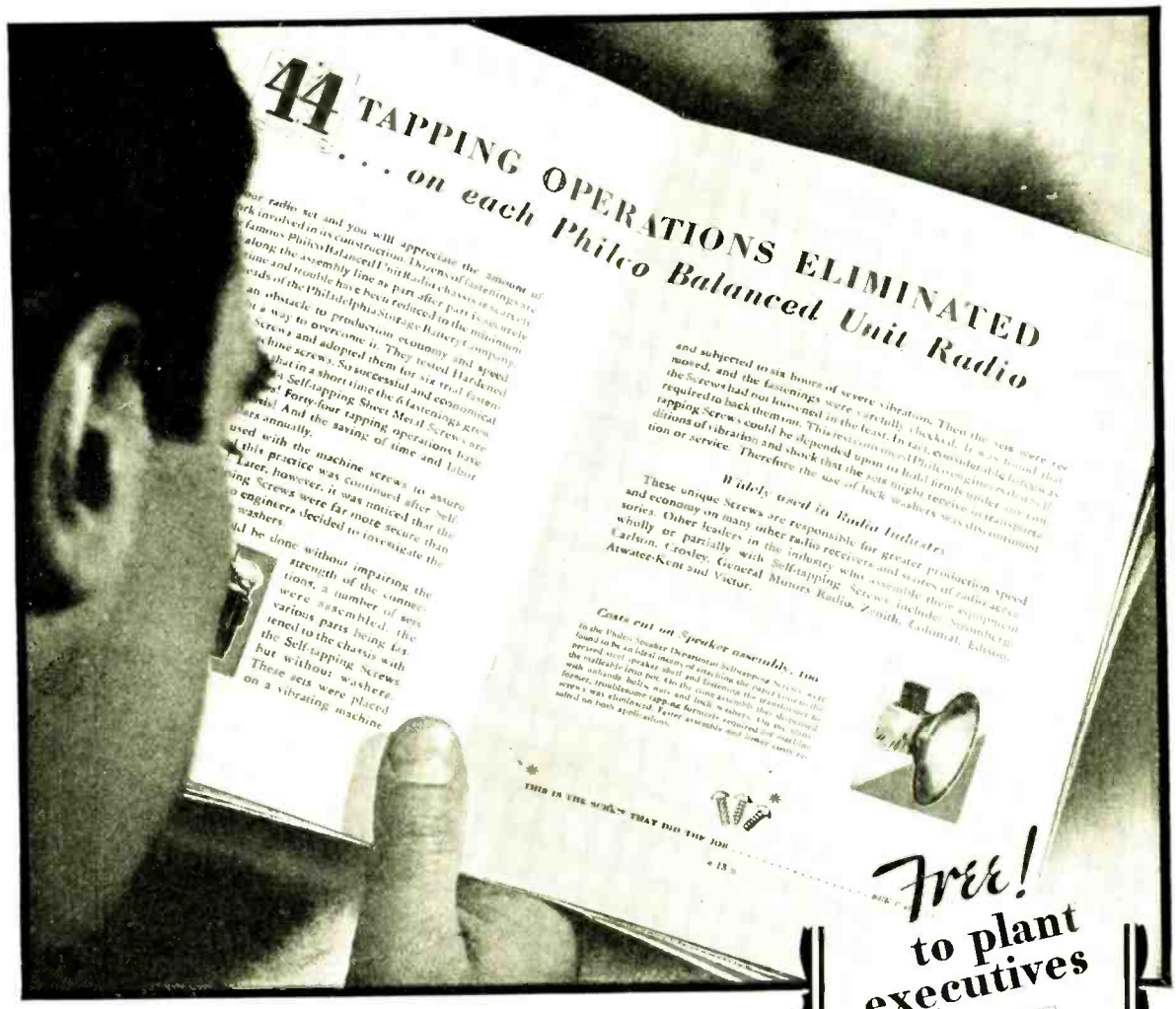
THE MEASURE OF HUMAN PROGRESS

AT the Toronto convention of the Institute of Radio Engineers, Colonel Lee, vice-president of the Institute, in an address stated that he believed the time would come when history will not be written in terms of wars, tariffs and treaties, but rather in terms of scientific advance.

The thought is not new but the fact that it is occupying the minds of advanced thinkers in Europe at the present time is encouraging. In our own country, in the minds of many scientists and engineers dates of inventions or discoveries have come to have historical significance.

What well grounded engineer does not carry in mind as epochal dates, the following and many others: 1820, Oersted and magnetism; 1827, Ohm and the first laws of electricity; 1829, Henry and the electromagnet; 1831, Faraday and magneto electricity; 1835, Morse and the telegraph; 1858, the trans-Atlantic cable; 1876, Bell and Gray, the telephone; 1878, the Edison phonograph; 1881, the incandescent lamp; 1895, Marconi's early experiments; 1906, DeForest's audion?

Should the present "how to do it" age of engineering literature and of engineering instruction some day be broadened to include "How it came about" there would be industrial and individual gains of a desirable order. Intimate knowledge of how inventors work, of each forward step made by them and of their habits of thought, never have failed to inspire respect and admiration on the part of students.



"Every Man *concerned with production* should read it"

. . . says a prominent production engineer

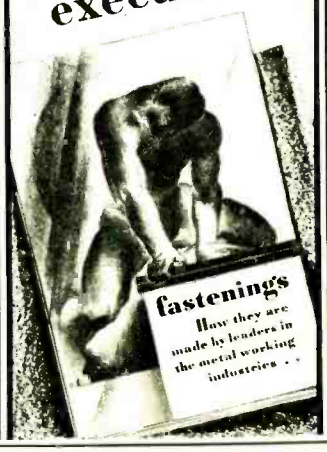
Any man concerned with the production of a product made wholly or partly of metal will find this new booklet, "Fastenings—How they are made by leaders in the metal working industries," most interesting reading. The chances are, too, that he will obtain from it information of considerable value to his own work.

This booklet contains accurate descriptions of the ways in which greater fastening economy has been attained on the Servel Refrigerator, Philco Radio, Hotpoint Range, Ford Trimotor Plane, Simmons Metal Furniture, Zenith-Detroit Carburetor and other well known products. All of the facts and figures given, were secured through fastening studies made by independent engineers in the plants of fourteen of the most prominent concerns in their respective fields.

"Fastenings" will be sent free of cost or obligation to any plant executive. It is only necessary to fill in the coupon and attach it to your letterhead.

PARKER-KALON *Hardened* Self-tapping Screws

Free! to plant executives



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

Send a free copy of "Fastenings" marked to the personal attention of:

Name and Title.....

Company.....

Street and City.....

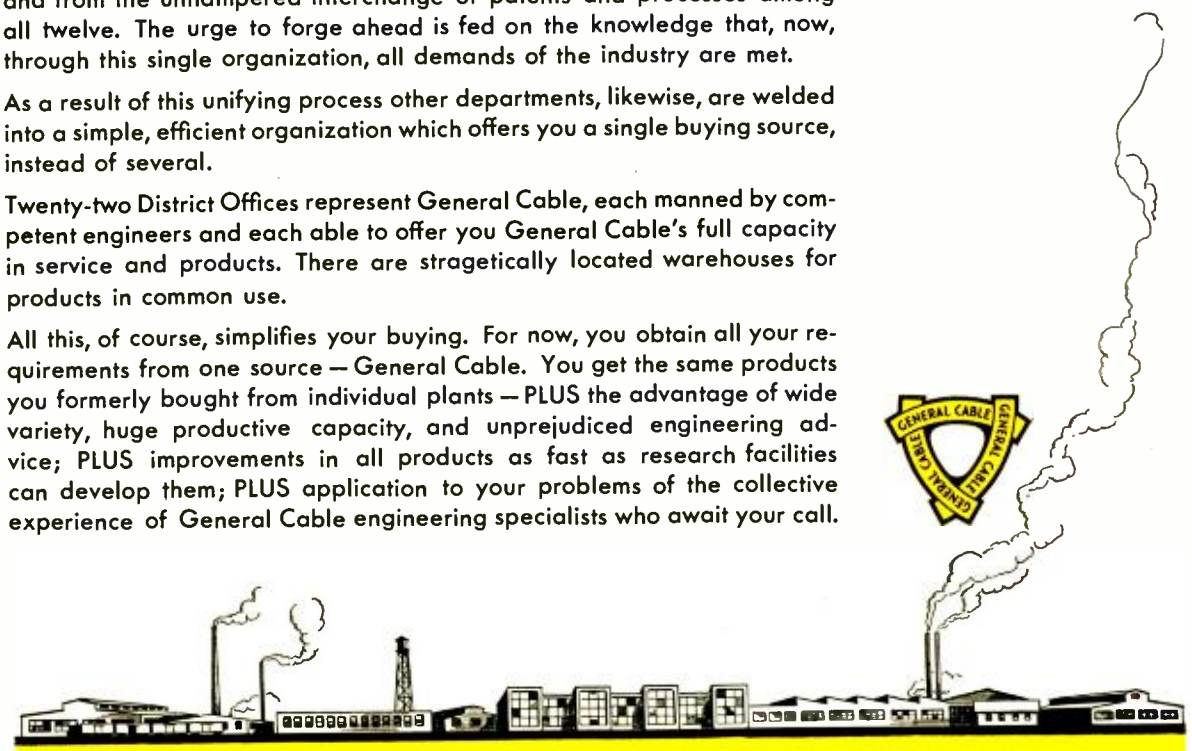
THE twelve wire and cable mills pooled to form General Cable had long been leaders — some famous for highest quality magnet wire; others for noteworthy developments in the manufacture of complex electrical coils; still others for distribution and transmission wires and cables — and so on through the gamut of kindred products. With a single trade mark to indicate the high standards to which all conform, these twelve plants, in effect, are one . . . modern, efficient and with obvious capacity to produce a great variety of wires, cables and accessories.

Under the single management of General Cable, productive capacity naturally thrives on the flexibility which comes from the unification of plants and from the unhampered interchange of patents and processes among all twelve. The urge to forge ahead is fed on the knowledge that, now, through this single organization, all demands of the industry are met.

As a result of this unifying process other departments, likewise, are welded into a simple, efficient organization which offers you a single buying source, instead of several.

Twenty-two District Offices represent General Cable, each manned by competent engineers and each able to offer you General Cable's full capacity in service and products. There are stragetically located warehouses for products in common use.

All this, of course, simplifies your buying. For now, you obtain all your requirements from one source — General Cable. You get the same products you formerly bought from individual plants — PLUS the advantage of wide variety, huge productive capacity, and unprejudiced engineering advice; PLUS improvements in all products as fast as research facilities can develop them; PLUS application to your problems of the collective experience of General Cable engineering specialists who await your call.



PLANTS

BALTIMORE Maryland
BAYONNE New Jersey
BUFFALO New York
DETROIT Michigan
EMERYVILLE California
FORT WAYNE Indiana
MOBILE Alabama
PAWTUCKET Rhode Island
PENNINGTON New Jersey
PERTH AMBOY New Jersey
ROME New York
ST. LOUIS Missouri

WAREHOUSES

BOSTON
BUFFALO
CHICAGO
CINCINNATI
CLEVELAND
DALLAS
DENVER
DETROIT
LOS ANGELES
MOBILE
NEW YORK
PORTLAND
SAN FRANCISCO
SEATTLE

CORPORATION

CROWE

RADIO PRODUCTS

The above drum and escutcheon has been designed especially for the exclusive use of the Echophane Radio and Manufacturing Company. Other designs for general use. (Illustration exact size.)

A well-varied line of tuning devices, dials, and escutcheons has been designed and executed by Crowe to meet every need of the radio set manufacturer.

A competent Engineering and Designing Department is constantly at work developing new tuning units and parts for the future requirements of the Industry.

Let Crowe co-operate with you in planning the tuning devices and escutcheons for your new models. . . . . Write for detailed information.

CROWE
NAME PLATE & MANUFACTURING CO.
1741 Grace Street .. Chicago

Above is the escutcheon designed and executed by Crowe exclusively for Silver-Marshall, Incorporated. (Shown exactly two-thirds actual size.)

REDUCE COSTS

WITH THE NEW

FANSTEEL

MOLYBDENUM WIRE

AND

DUCTILE "MOLY" ROD

HERE is a better Molybdenum! One that is really ductile, malleable and workable, even in large diameter rods! Less breakage less spoilage and shrinkage, simpler cleaning processes. Your rejections and your tube costs should go down. Refined by Fansteel from basic materials, especially for use in tubes, it is made remarkably pliable for such material, easily shaped and fastened, easily de-gassed and cleaned. You've never used Molybdenum like this! Offered at no increase in price. Send for samples! Ask also for samples and prices of other Fansteel Metals and Alloys you may be interested in—available in all commercial forms.

FANSTEEL PRODUCTS COMPANY, INC.

NORTH CHICAGO, ILLINOIS

TANTALUM · TUNGSTEN · MOLYBDENUM · CAESIUM · RUBIDIUM · ALLOYS

TYM·FLEX

Tympanum Flexum

A New
And Exclusive Feature of
Jensen Speakers

The Year's Most Important Contribution To the Radio Industry

TYM-FLEX is the name of a new diaphragm . . . or cone . . . destined to become synonymous with Jensen as a mark of distinct superiority on loud speakers.

Over three years ago, Peter L. Jensen foresaw that the next great forward step in dynamic speakers would be in the cone design and material.

The new TYM-FLEX Cone is the result of three years of intensive research and development on the part of Jensen engineers under his direction.

This new cone has many mechanical and acoustical advantages. It is moulded in one piece . . . no glued or matched joints. It is impervious to water or moisture. It is unaffected by the widest and most rapid changes in humidity. It is free from all rattle or mechanical vibration.

These distinct mechanical advantages are greatly overshadowed by this new cone's acoustical advantages. TYM-FLEX Cones, for the first time permit wide latitude for the incorporation of desired acoustical qualities in loud speaker diaphragms. Thus, in the skilled hands of Jensen engineers, TYM-FLEX Cones even improve the performance of Jensen Speakers . . . recognized standard of the radio industry. With the TYM-FLEX diaphragm a new performance heretofore considered unattainable is scientifically accomplished.

The industry's approval is attested by the endorsement of radio set manufacturers, more of whom use TYM-FLEX equipped Jensen Speakers than any other make.

Naturally TYM-FLEX Cones are an exclusive Jensen feature and available only in Jensen Electro-Dynamic Speakers.

Write for the new Jensen booklet, "The Story of the TYM-FLEX Cone" which tells of the dramatic development of this outstanding improvement in loud speaker design.

Jensen
ELECTRO-DYNAMIC SPEAKERS
Licensed under Lektophone Patents

JENSEN RADIO MANUFACTURING COMPANY, *6601 South Laramie Ave.*, CHICAGO, ILL.

ANOTHER *NEW* JENSEN SPEAKER

•

The trade and retail buyers are now demanding an electro-dynamic speaker with Automobile Radio Receivers. To satisfactorily meet this demand Jensen offers the new

Jensen
AUTO SPEAKER

A compact electro-dynamic speaker using a minimum of current from the storage battery. Designed to withstand road shock. Built into a rigid metal housing, with sturdy adjustable brackets for convenient and quick installation. . . List price, $16.50.

QUALITY AND UNIFORMITY

ARE WATCHWORDS IN THE PRODUCTION

OF EVEREADY RAYTHEON TUBES

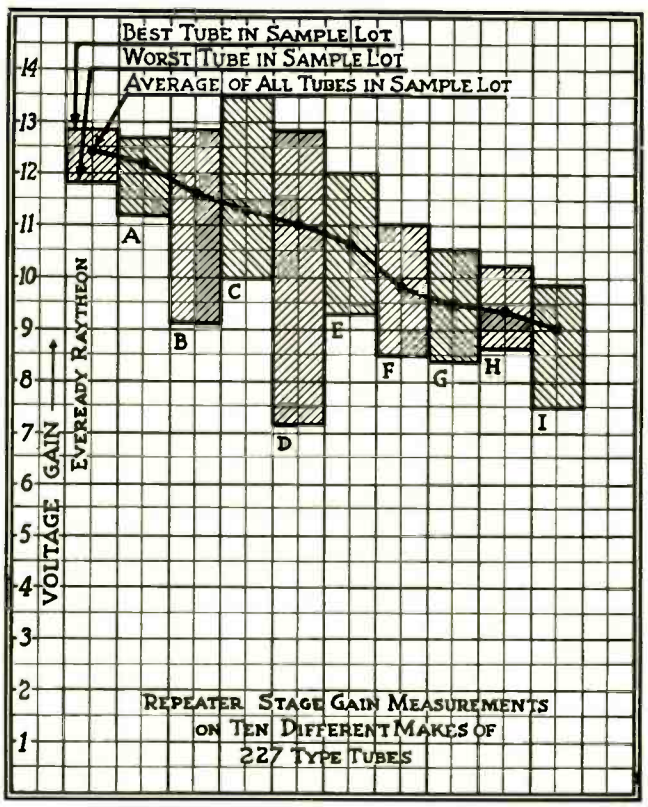
TESTS recently run without our knowledge, and by a laboratory not connected with our organization, give striking evidence of the unusually high quality and uniformity of Eveready Raytheon Tubes.

The curve illustrated on this page shows results with ten established makes of 227-type tubes, all of which were *bought in the open market from dealers.*

It is interesting to note that the best tubes of makes B, C, and D show a voltage gain which compares favorably with that of the best Eveready Raytheon Tube. However, the poorest tube of each make shows a much lower voltage gain than the poorest Eveready Raytheon Tube. Indicating that Eveready Raytheons not only have the least spread in quality (i.e., the greatest uniformity), but that their average quality is highest of all.

These results point to two notable facts: (1) The radio-set owner can be sure of getting the best possible performance by using Eveready Raytheons. (2) There is a sound and fundamental reason behind this uniform superiority — and it lies in the patented Eveready Raytheon 4-*Pillar construction.*

Several of the brands included in this test benefit by quality-control almost as rigid as our own. Beyond any question, these tubes, as produced at their respective factories, would stack up with Eveready Raytheons. Yet, when bought from dealers, these same tubes show a marked lack of uniformity.



Obviously, their elements did not maintain proper alignment, under conditions of rough handling inevitable in transportation. Eveready Raytheon elements can and do — because of the strength and rigidity of the 4-*Pillar construction.*

Eveready Raytheons come in all types, fit every standard A. C. and battery-operated receiver, and are sold by dealers everywhere. We are glad to co-operate on any tests you may wish to make with these tubes.

* * *

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 27 stations.

EVEREADY RAYTHEON

Trade-marks

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*

Impressions *and* Expressions

By AUSTIN C. LESCARBOURA

Midgets

FROM the manufacturer's standpoint, the midgets have been a success. Many plants have kept going, thanks to the midget sets. There are factories on the Coast housing half a dozen midget set manufacturers under a single roof! Everyone, almost, is either turning out a midget or contemplating doing so. Fine business.

But—and here is where some hard thinking comes in—how about the dealers? Are they satisfied? What do they say about midgets?

Originally, it was hoped that the midgets would serve as the long-heralded "second set" in the average home. The midgets were to be the *extra* sales. Actually, midgets have become the first set. Many purchasers have bought a $60.00 set instead of a $125.00 set. Just to what extent this holds true is difficult to ascertain during the subnormal general business conditions we have been passing through. Certainly in normal times, the average buyer would see the considerable difference between the midget and the regular console, and would buy accordingly.

But the dealers, as a whole, feel that they are losing in sales totals by the introduction of the midget sets. They feel that many buyers would be forced to take the standard sets, at twice the price, if the midgets were not there to tempt buyers to economize. And it costs about as much to sell a midget set at $60.00 as it does a standard console at $125.00. The dealers are not satisfied.

Manufacturing is one thing. But let's make sure that our merchandisers are not losing money and becoming discouraged. There are many more years ahead of us. If we have made a mistake, let's correct it.

▲

A Thousand Hours

A GOODLY portion of the 1930 radio tube market was to take the form of replacement tubes. Our hard-working statisticians estimated some 85,000,000 tubes would be sold, whereas the total will probably be less than 55,000,000. The monkey wrench is the thousand hour tube life myth. Whereas the statisticians estimate tube life at a thousand hours, so that the average radio set owner may change his tubes twice a year or more, actually the tubes are used for several thousand hours.

Actually, tubes may last several thousand hours. Practically, they are not efficient beyond a thousand hours. If the average set owner could be shown just how much performance is sacrificed by operating tubes beyond the thousand hour mark, tube replacements would be more frequent and widespread.

Perhaps tube manufacturers should get together, either in or out of the R.M.A. They should plan on general merchandising policies. They should have an educational campaign on tubes and how to use them. They should sell the idea of the thousand hour useful life. Perhaps they should do a collective educational job via broadcasting. They could show, by simple demonstrations over the air, what weak tubes mean to radio performance. After all, their problem is one of increasing the total tube market rather than scrapping for a share of the present market.

▲

Electrical Transcriptions

A FEW weeks ago, some eighty stations were grouped together for the purpose of broadcasting a leading automobile manufacturer's program. No wires were used. No physical network existed in the usual sense of the word. Instead, the eighty-odd stations made use of electrical transcriptions or recorded sounds of the program. The results were virtually perfect. Nothing had been sacrificed in the recording and reproduction, and, if anything, the quality was perhaps better than that of programs distributed over long wire lines.

And so electrical transcriptions, having outgrown the confines of the purely local presentation, are ready to take their place as the basis for additional networks or groups. Naturally, this is a matter of some concern to the large national network systems, with thousands of miles of connecting lines. If their associated stations are going to broadcast electrical transcriptions, cutting out the networks for the purpose, the costly lines cannot be maintained as at present. Surely the spot news programs and sustaining features cannot be maintained on the present scale if the associated stations do not take the sponsored programs on which the revenue is obtained for the operation of the network.

Hence this personal guess as to the outcome: firstly, electrical transcriptions are here for good; secondly, the networks may buy the necessary stations as an assured oulet for their programs; thirdly, the networks must and will go in for electrical transcriptions in the future, reducing their wire line costs, although wire line hookups will continue, on a reduced scale, for spot news or spontaneous features.

▲

Radio Cops

AN answer has been found to the quick getaway of the modern criminal. If he has his high-power automobile as a means of escaping from the scene of his crime, society has its radio cops as a means of raising a widespread hue and cry, whereby to summon and direct the pursuers.

Many police radio stations have been installed during the past year. More are being installed. And more are contemplated. What with limited transmitting power and sufficient separating distances between transmitters, the Federal Radio Commission has made the necessary channels available for this most important function of radio.

The police radio transmitter at East Lansing, operated by the Michigan State Police, was instrumental in the capture of bank robbers and murderers within a few weeks of its inauguration. Other police radio installations have proved their worth. It becomes patent that every police department must and will have a radio alarm system, thereby bringing a new branch of radio communication into existence.

▲

Multiplied Broadcasting

SYNCHRONIZED broadcasting is at last an accomplished fact. C. W. Horn, heading the engineering staff of the National Broadcasting Company, has announced practical synchronization of two or more broadcast transmitters, so that they may be operated on the same frequency or broadcast channel without interference from the carrier waves themselves. If the same program is broadcast, there can be no interference. If different programs are broadcast, it is just a question of sufficient distance between transmitters to avoid cross talk.

An important step, this matter of successful synchronization of broadcast transmitters. We may expect network stations to be synchronized, thereby freeing many channels now employed for the same program.

1906 1931

Recommend Tubes--not tube troubles!

YOU can recommend some radio tubes with every assurance of complete satisfaction to users. Or you can recommend tube troubles that reflect on your good judgment and name. It is simply your choice between playing safe and taking a sheer gamble.

So why not recommend good tubes—not tube troubles? If you are an engineer, you cannot afford to jeopardize your circuits and products through the use of uncertain tubes. If you are a service man, you cannot afford to jeopardize service and reputation through the use of uncertain tubes. Tube troubles are costly at any price.

Fortunately, tubes are no longer a gamble. You can positively recommend 1930 tubes and not tubes produced a year or two ago and therefore without the improvements and refinements recently scored in the vacuum tube art.

Play safe! Recommend and use DeForest Audions—the oldest tubes on the basis of history and prestige, the newest and latest on the basis of improvements and refinements.

DeForest Audions are standard equipment in Crosley and Brunswick sets.

Let us tell you more about 1930 radio tubes and what they mean in your work. And if you have any engineering or servicing problems, do not hesitate to place them before our Engineering Department

Remember, there is no substitute for twenty-five years' experience

DE FOREST RADIO COMPANY
PASSAIC NEW JERSEY
Export Department: 304 E. 45th Street, New York City, N. Y., U. S. A.

de Forest (AUDIONS) RECEIVING AND TRANSMITTING **TUBES**

CLAROSTAT Presents 3 New Items

Two New Clarostat Tone Controls . . . .

PORTABLE MODEL

This season's sets all boast of Tone Control. Owners of older sets are anxious to bring their receivers up to date. And here is something to sell them. Already proving itself a boom accessory.

Handsome black and gold case with felt base. Long flexible cord with handy adapters to fit under tubes. No tools or special knowledge needed to install.

PANEL MOUNTING MODEL

For the Dealer who wants to easily add Tone Control to older receivers still unsold.

For the Serviceman who wants to make a sale out of every call.

For the set manufacturer this panel mounting Tone Control all in one bakelite case saves time and assembly details.

Here is the handiest and most simply installed panel mounting Tone Control.

Clarostat Soldering Iron Control

Soldering Irons burn out and get pitted rapidly when operated on full line voltages. Good work may be done at lower voltages which saves both heating elements and copper tips. Reduces labor wasted in constant filing and re-tinning the tip. Iron may be left on all day without needing any attention.

The Clarostat Soldering Iron Control gives exact temperature adjustment by a turn of the knob. Full line voltages may be appiled for quick heating or extra heavy work at the snap of the switch.

The pilot light shows when current is on and also by its brilliancy indicates the approximate voltage. Has outlet for iron plug. Three position switch for "Full On," "Through Rheostat" and "Off."

Mounted in a sturdy metal case with proper ventilation and knockouts for BX cable.

Rated for use with one or more irons having a total consumption of not over 250 watts.

Write for Descriptive Literature on These and Other Clarostat Radio Essentials

CLAROSTAT MFG. CO. 285-287 N. 6TH ST. B'KLYN. N.Y.

Sets built to sell
—*must satisfy*
tone-conscious

ears...

Sangamo Transformers in the audio end give your set a "tone" advantage over competition . . . . .

Successful custom builders and manufacturers know the importance of *tone quality*. Fully 90% of all receiver sales are made or lost on the first hearing. Nothing takes the place of accurate reproduction. Today, the buying public judges by *tone* more than by *price!*

The only way to be sure of tone quality is to be sure of the transformer you use.

Obviously, transformer building, an exact science in itself, should only be undertaken by an organization of specialists. Sangamo is such an organization.

30 years of research experience combined with unsurpassed precision manufacturing facilities guarantee in Sangamo Transformers the most satisfactory amplification over the entire musical frequency scale.

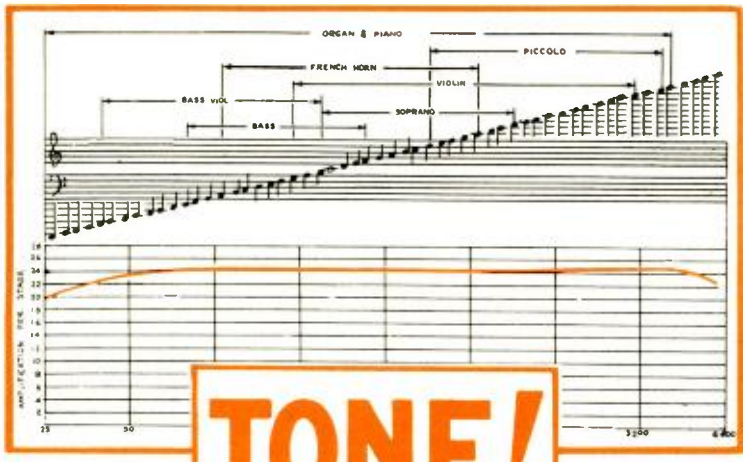
Sangamo "A" Line Transformers give your set a "tone" advantage over competition. The cost is a little higher, but they cut your selling costs by lowering sales resistance.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS, U. S. A.

Manufacturers of Precision Electrical Apparatus for 30 years.

SANGAMO

(see reverse side)



TONE!

Curve of Type "A" or Sangamo Straight Audio Transformer showing uniformity of amplification at all audible frequencies.

True Tone—

is the real basis of comparison for a receiving set.

"X" Line Transformers

Type AX straight audio amplification. List price.....$6.00

Type BX Push-pull Input unit. List price.....$6.50

Type CX-171 Push-pull Output Transformer, for 171 or 250 power output tubes for cone speaker. List price.....$6.50

Type DX, same as CX except for 210 and 112 power tubes. List price.....$6.50

Type HX Push-pull Output for 171 or 250 Power Output tubes to match the impedance of moving coil of Dynamic loud speakers. List price.....$6.50

Type GX, same as HX except for 210 and 112 power tubes. List price.$6.50

Type E Output Choke to match impedance of the various type power tubes. List price.....$5.00

"A" Line Transformers

Similar to X Line but with special core metal to give greater amplification at low frequencies

Type A straight audio amplification. List price.....$10.00

Type B Push-pull Input Transformer for all tubes. List price.....$12.00

Type C-171 Push-pull Output, for 171 or 250 type power tubes with cone speaker.....$12.00

Type D-210, same as C except for 210 and 112 power tubes.....$12.00

Type H-171, Push-pull Output for 171 or 250 power tubes for Dynamic Speaker. List price.....$12.00

Type G-210, same as type H except for 210 and 112 tubes.....$12.00

Type F Plate Impedance for use as a choke to prevent oscillation and for impedance coupled amplifiers. List price.....$5.00

Unusual facilities for furnishing transformers with or without cases ready for mounting and quick assembly with the receiver. Prices on application.

PIN THIS TO YOUR LETTERHEAD AND MAIL

SANGAMO ELECTRIC CO.
Springfield, Illinois, U. S. A., Dept. W-942

☐ (*For manufacturers*) I am interested in engineering data regarding your transformers and condensers.

☐ (*For set builders*) Please send circulars describing your apparatus and latest audio hook-ups. I enclose 10c to cover cost of mailing.

Name.....

Address.....

The Sangamo Type "A" Condenser

Every sound characteristic is affected by the quality of the fixed condensers in a set. Sangamo builds accurate mica condensers, molded within an overall enclosure of genuine bakelite with only the terminals brought outside. Moisture, heat, shocks or jars will not alter their characteristics nor affect operation after the set leaves the factory.

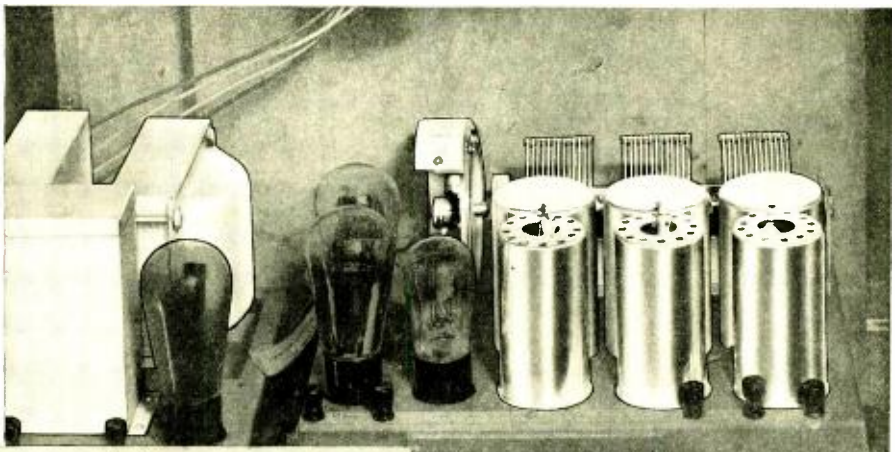
Sangamo "Illini" Condensers

"Illini" Condensers are standard with those manufacturers who insist on ratings being actually what the specifications call for. Manufactured by exclusively designed equipment, held to the tolerances your engineering department demands, Sangamo Condensers will reduce to a negligible quantity inspection department rejects and "reassembly" losses in profit.

Sangamo High Voltage Condensers

Tested at 5000 volts D. C. and 3500 A. C. and built to Sangamo standards, known throughout the radio world, amateurs, commercial men and manufacturers have learned to depend on Sangamo High Voltage Condensers. Accurately rated and adequately tested — these condensers offer the maximum protection in high voltage, high frequency circuits.

Prices on request



Use Alcoa Aluminum Shielding for tubes . . coils . . condensers . .

Successful sets, today, must be efficiently shielded. This is especially true since the advent of the screen grid tube and the latest developments in band pass circuits. Alcoa Aluminum construction checks vibratory disturbance and hence eliminates microphonic and other resonance effects. It provides an efficient shielding material that is also reasonable in cost.

Alcoa Aluminum, due to its electrical and physical properties and its price, has become standard for many parts of the leading radios. Used for shielding, this metal gives better results than much higher priced materials. It is the only metal that is used, commercially, for the electrodes of electrolytic condensers. It is also widely used for foil condensers, variable condenser blades, for wire, for chassis, for panels and other parts.

No lacquering or finishing is necessary for Alcoa Aluminum. As it is extremely light in weight, supports can be made light and a generous use of Alcoa Aluminum insures that there is less likelihood of misalignment of parts in shipping.

Our nearest office will gladly supply you with specific data on the application of Alcoa Aluminum to your needs. Address ALUMINUM COMPANY *of* AMERICA; 2468 Oliver Building, PITTSBURGH, PENNSYLVANIA.

ALCOA ALUMINUM

THE METAL THAT IS *TUNED* TO RADIO

RADIO ENGINEERING

Production, Administration, Engineering, Servicing

November, 1930

A Review of High Frequency Attenuation Devices

By RALPH P. GLOVER *

A Useful Knowledge of Radio Transmission Phenomena, of Receiver Performance, and of Amplifier Gain is Dependent Upon the Generation of Small Radio-Frequency E.M.F'S. In This Article Mr. Glover Presents Information of Direct Value to Engineers.

PRACTICALLY all methods of obtaining quantitative data on radio transmission, the performance of receiving circuits and the gain of radio amplifiers, depend on the generation of more or less minute radio-frequency electromotive forces. In perhaps a majority of instances, it is quite impossible to obtain a direct measure of the magnitude of the signal voltage. This serious difficulty is generally avoided by interposing an *attenuation* device between the generator and the output terminals of the system. The function of the attenuator is to diminish or *attenuate* the measurable voltage supplied to some lower level required by the test conditions. The attenuating properties of such devices are governed by the dimensions and arrangement of the constituent circuit elements. Usually the construction is such that the attenuation may be more or less readily calculated from circuit data.

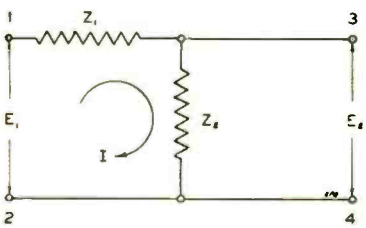
The first application of the attenuator to radio measurements probably dates back to about 1917. Much apparatus already developed for telephone circuit measurements was found to be suitable for the relatively low frequencies involved in long-wave work. However, as interest shifted to the higher frequencies, many special types of attenuators and other devices for producing small signals were developed. Today, we find the name attenuator loosely applied to a wide variety of systems ranging from an ordinary potentiometer to a pair of inductively-coupled circuits. Most of these instruments bear little outward resemblance to each other but the underlying electric circuits are nevertheless quite similar. On the other hand, each device has its own special virtues, inherent limitations and field of application. It is believed that the wide interest in radio measurements justifies the following review of the fundamental circuits employed in the production of small voltages at high frequencies.

* *Radio Engineer, The Crosley Radio Corporation.*

Potential Dividers

The simplest piece of apparatus for obtaining known fractions of a given voltage is the potential divider or potentiometer, as it is commonly known. Suppose that, as in Fig. 1, two impedances are connected in series and provided with input and output terminals as shown. If the open-circuit output voltage is measured between terminals 3 and 4, it will be found that the ratio of output to input voltages is the same as the ratio of the impedances measured at the output and input terminals. The input impedance is, of course, the vector sum of Z_1 and Z_2. Strictly speaking, the expression given for the voltage ratio is correct only for an infinite load impedance although good accuracy is obtained by keeping the load impedance at least one hundred times as large as Z_2. The correction for a particular load impedance may be calculated quite simply but for the conditions under which the potential divider is usually operated, this will seldom be necessary.

Non-inductive resistances are commonly used for the impedance arms since this insures that the voltage



$$E_2 = IZ_2 = \frac{E_1 Z_2}{Z_1 + Z_2}$$

$$\frac{E_2}{E_1} = \frac{Z_2}{Z_1 + Z_2}$$

POTENTIAL DIVIDER OR "L" NETWORK

Figure 1.

ratios will be independent of frequency. Very small amounts of reactance will usually not disqualify a resistance unit for this purpose since the reactance is added to the resistance in quadrature and contributes relatively little to the total impedance of the unit. Usually the total impedance (Z_1+Z_2) is constant and a number of taps or a slider is provided so that a third potential terminal is available.

It is theoretically possible to obtain any ratio of output to input from zero to unity. However, practical considerations set a more or less definite limit to the amount of voltage stepdown which may be obtained with a simple potential divider network. Suppose that a potential divider must be designed with a total impedance of 40 ohms and a voltage ratio of 100 to 1. This requires us to construct a 0.4-ohm unit, which is about as small a high-frequency resistor as can be made with a reasonable degree of accuracy and without too great difficulty. It would obviously be impractical to attempt a much larger voltage ratio with this value of impedance.

Practical Form of Divider

A very practical form of the resistance potential divider consists of a number of fixed, noninductive resistance units connected in series with the ratio controllable in steps of 1, 2, 5, 10, 20, 50 and 100 to 1 by means of a simple tap-switch arrangement. The total impedance, viewed from the input terminals may conveniently be 40 to 100 ohms. Such instruments are very commonly employed in single-stage r-f. gain-measuring sets. Inappreciable shunting of the output terminals will occur since the potential divider will work into a tube grid circuit or a fairly high impedance artificial antenna.

While a single potential divider section, or "L" network as it is sometimes called, seems to be limited to voltage ratios of the order of 100 to 1, more complex networks giving higher attenuations may be constructed by cascading a number of sections. Some discussion of the more complex networks will be given later.

Reactance Potential Dividers

The arrangement shown in Fig. 1 is by no means limited to the resistance potential divider. As illustrated in Fig. 2, capacities may be used as the dividing elements. The voltage ratio is independent of frequency and depends simply on the values of C_1 and C_2. The input and output impedances will, however, vary as the capacity reactances of C_1 and C_2 in series and

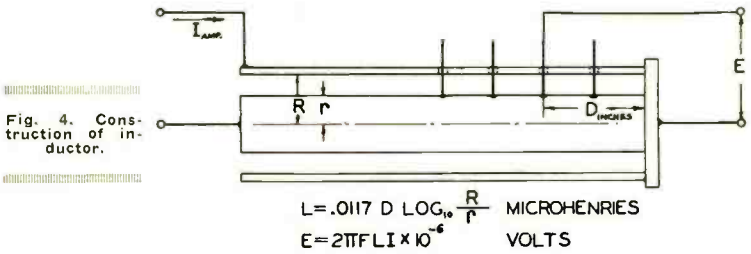


Fig. 4. Construction of inductor.

C_2 alone, respectively, vary with frequency. As in the previous case, the load impedance must be very high compared with the reactance of C_2 at the frequencies involved. C_1 is usually a variable condenser so that continuously variable voltage ratios may be had. Fig. 2 will be found useful for roughly determining voltage ratios from capacity ratios.

In this case it is extremely important that stray capacitances be taken into account in computing the voltage ratios. Large errors may be introduced if these effects are neglected. The series inductance of leads between the two condensers should be reduced to a minimum for the presence of such

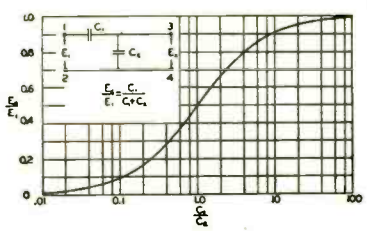


Fig. 2. Capacities as dividing elements.

inductance will upset the ratios, especially if the potential divider is used at frequencies much above the broadcast band.

Voltage Drop Devices

While not strictly classifiable as attennators, voltage drop devices have occasionally been used to obtain small high-frequency potentials. They make use of the principle that the difference of potential or voltage drop which occurs across an impedance in a circuit through which current is flowing, is given by the product of the current[1] and the impedance. Thus if both the current and the impedance are very small, the voltage drop will be extremely small.

Fig. 1 will serve also as an illustration of such a voltage-drop network. We are not concerned with the value of Z_1 in this case; it functions merely as a device which controls the flow of current through the element Z_2. Means must be provided for accurately measuring the current which flows into the circuit. This circuit will be recognized as that commonly used for vacuum-tube voltmeter calibration and other similar purposes. As in the case of the potential divider, we assume that the load circuit has practically infinite impedance compared to that of Z_2.

An interesting device of this type has been developed by the National Physical Laboratory of England.[2] The instrument is particularly noteworthy since it is used for overall measurements of receiver performance at frequencies up to 60 megacycles (5 meters). It consists of a thoroughly shielded small impedance in the form of a very short length of fine wire of high specific resistivity. Under such conditions, it is permissible to assume that there is no change of resistance with frequency and the direct-current value may therefore be used. The inductance is calculated from the dimensions of the wire between potential terminals. This provides sufficient information so that the impedance may be calculated at any frequency. Fig. 3 is a schematic arrangement and indicates the method of calculating the voltage drop. The current is measured by means of a special thermocouple, placed close to the impedance wire and shielded from it.

The principal limitation of this and other similar instruments lies in the fact that the lower limit of the output voltage is determined by the sensitivity of the current-indicating device. The lowest voltage obtainable from the British instrument described was stated to be 250 microvolts, apparently involving the measurement of currents down to about 300 microamperes when flowing through approximately 0.76 ohms.

Hull and Williams[3] have described a method of constructing a small, known inductance which may be of the order of one one-thousandth microhenry and which is particularly adapted for work at radio frequencies.

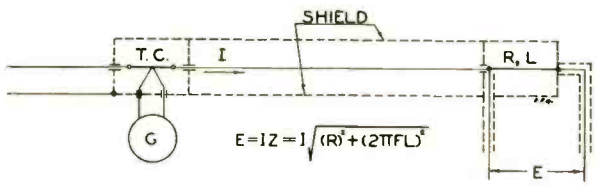


Fig. 3. N. P. L. shielded small Impedance (schematic).

[1] *This assumes that the current is uniform throughout the entire length of the impedance between potential terminals, a condition which is not obtained if there is appreciable capacity between the impedance and the return circuit.*

[2] *Abstract of "A Method of Measuring the Overall Performance of Radio Receivers," Ex. Wireless and W. E., Feb.,* 1930; *p.* 78.

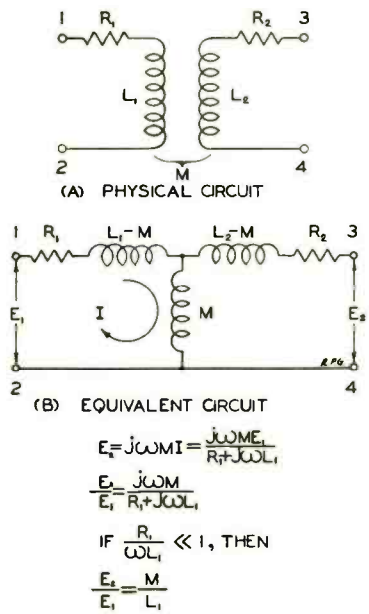
[3] *Hull and Williams, Phys. Review, Feb.,* 1925; *p.* 147.

The inductor is composed of a brass rod placed concentrically within a brass tube, a good connection being made between the two at one end. The open ends of the rod and tube are the input terminals of the system. The common end of the rod and tube forms one output terminal. The other terminal is obtained by making connection to the rod at various points along its length by means of short pieces of small wire which may project through holes in the tube. Fig. 4 shows the construction of the inductor and gives the expression for the voltage drop between potential terminals.

This form of inductor makes it possible to obtain a very much lower impedance than with a straight wire. With proper construction the high-frequency resistance should be negligible in comparison with the computed reactance. Another advantage of the instrument is its mechanical strength and ruggedness. There is very little experimental data available with reference to the limitations and errors which may be encountered when using an inductor of this sort. It would seem, however, that capacity between rod and tube might be a limiting factor at frequencies much above 1500 kilocycles per second.

Mutual Inductance

The fact that mutual inductance exists between two electromagnetically coupled circuits is frequently made use of in the design of high-frequency attenuation devices. Among these might be mentioned such special instruments as iron-cored current transformers and the mutual inductor attenuator[4].



MUTUAL INDUCTANCE

Figure 5.

Let us examine the simple coupled circuit of Fig. 5-a. As shown, two inductances L_1 and L_2 are placed in such relationship that a mutual inductance M exists between them. The inherent resistances of primary and secondary are R_1 and R_2, respectively. In accordance with the usual conception of mutual inductance, we may replace this circuit with the equivalent arrangement of Fig. 5-b in which there is no electromagnetic coupling between circuit elements. With this done, there is a striking similarity between the coupled circuits and the networks which have previously been discussed.

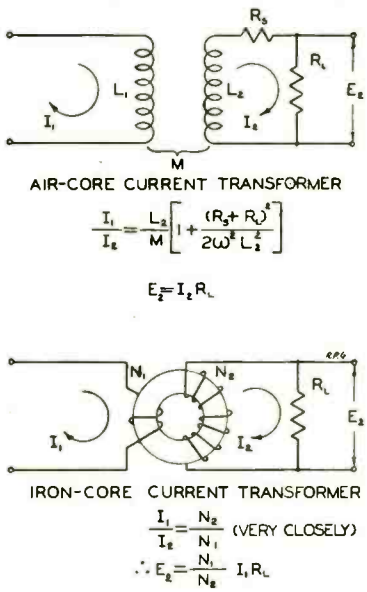
Suppose that the output terminals 3 and 4 (Fig. 5-b) are either open or shunted by a very high impedance. If a known current is flowing through the primary inductance, the voltage across the output terminals will be simply the product of the primary current and the reactance of the element M. This of course involves a knowledge of the frequency. We have here an example of the use of mutual inductance as a voltage drop device, or at least, we are at liberty to interpret the action of the circuit in this manner.

Obtaining Small Voltages

The simple coupled circuits illustrated constitute a perfectly feasible means of obtaining the required small voltages. The mutual inductance must, of course, be extremely small in order to obtain the desired voltage with a readable input current. It is practically out of the question to measure such small values of mutual inductance directly and calculations must generally be resorted to. In most cases the method leaves much to be desired.

The equivalent direct-coupled circuit also suggests the employment of coupled circuits as a potential divider. If, as will usually be the case, the primary resistance is negligible compared with its reactance, the ratio of output to input voltages will be very closely equal to the ratio of mutual inductance to primary inductance. The relationship is essentially independent of frequency. In this case we would measure the impressed primary voltage rather than the primary current.

Although varying greatly with the design, voltage ratios up to about 100 to 1 can be rather easily secured in this manner. The attenuation may be made continuously adjustable by variation of the mutual inductance. This suggests that an ideal application of the mutual inductor as described would be in conjunction with single-stage gain measurements. Suppose that a constant voltage of 1 volt is impressed on the primary of a mutual inductor whose secondary terminals feed the grid of an r-f. tube. Let us arrange the r-f. stage so that it works into a detector which is calibrated for 1 volt applied to its grid. Thus, whenever the output meter indicates 1 volt, the stage gain will be given directly by the amount of attenuation inserted in the circuit. This would make possible the construction of an extremely simple, direct-reading instrument for obtaining the characteristics of r-f. transformers.



R.F. CURRENT TRANSFORMERS

Figure 6.

High-Frequency Current Transformers

Both air-core and iron-core high-frequency current transformers are merely special cases of the use of mutual inductance. Circuits and quantitative relationships are given in Fig. 6. Their application lies chiefly in connection with voltage drop devices of low impedance where small currents, not easily measured otherwise, must be dealt with. The effect of the transformer is to "step-down" a relatively large, easily metered current to one which is sufficiently small to give the required drop across the terminal impedance.

Almost no experimental data as to this particular use of coupled circuits in air has been published, although it is definitely known that the iron-core transformer is superior in many respects.

The iron-core current transformer has found favor in England[5] for a variety of high-frequency measurements. Its properties have also been studied by the Bureau of Standards.[6]

---

[4] *Noteworthy Development in High-Frequency Measuring Equipment*, RADIO ENGINEERING, *June* 1930; *p.* 42.

[5] *Current Transformer Methods of Producing Small Voltages and Current at Radio Frequencies for Calibrating Purposes, Dye, Journal I. E. E., v.* 63, *p.* 579.

[6] *Simple Theory of the Iron-Cored Current Transformer, Cir.* 74, *Bureau of Standards, p.* 155.

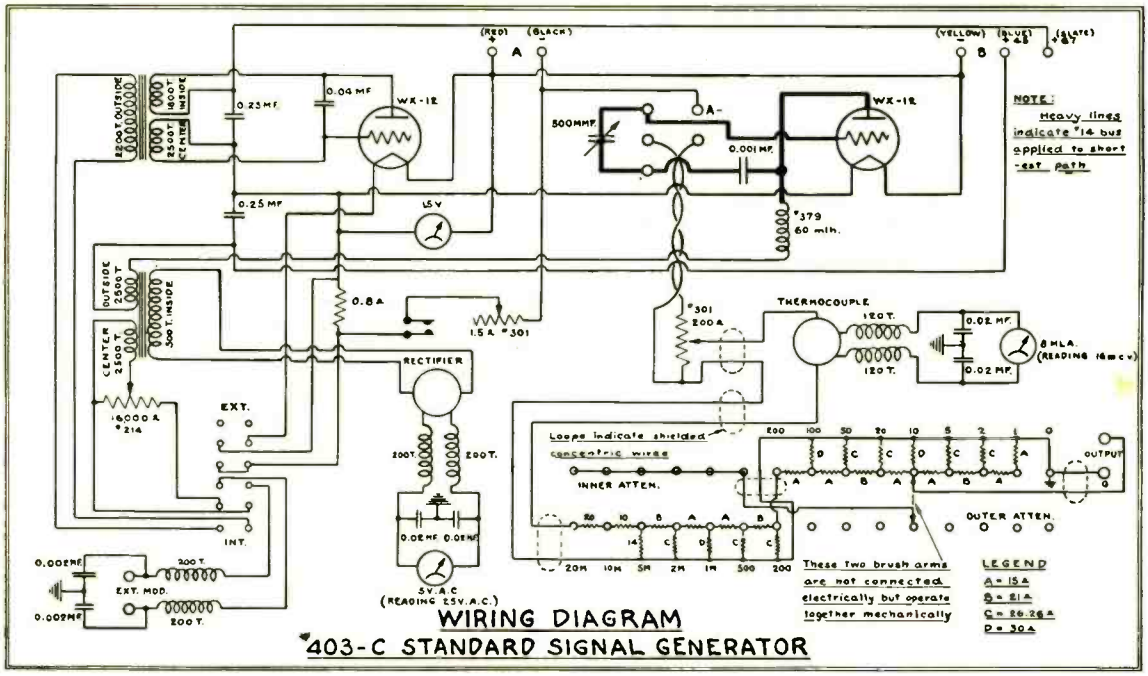


Figure 7.

One of the chief advantages of this type of current transformer is that the current ratio is almost exactly equal to the inverse turns ratio. This fact has been verified by a number of experimenters for transformation ratios as high as 100 to 1. The load current was sensibly independent of the value of load resistance up to about 50 ohms in the case of instruments constructed by the National Physical Laboratory. Careful construction is necessary in order to secure good results. Thin laminated core material should be used. For constructional data, the reader should consult the references mentioned.

Combination Arrangements

A combination of two or more attenuation devices of different sorts is often advantageous. Thus the current transformer might be used successfully with the Hull and Williams inductor and simplify the measurement of small currents or still further extend the lower limit of measurable output voltage.

Many other such combinations will no doubt occur to the reader, although any such arrangements should be thoroughly analyzed as to suitability and the mutual effects of the units on each other.

Cascaded Attenuation Devices

Many of the circuits described are inherently limited to an attenuation of the order of 100 to 1. For many purposes, such as overall receiver measurements, this is not sufficient. If known voltages of one microvolt or so are required and the input voltage can be conveniently measured at a level of 0.1 volt, then it is obvious that an attenuation of 100,000 to 1 must be provided. This is usually accomplished by cascading two or more attenuation devices. Thus a number of coupled circuits may be connected together to form a mutual inductor attenuator. Several potential dividers or current transformers constitute a very practical means of obtaining more attenuation than is possible in one unit.

Special Resistance Networks

Resistance networks of various sorts are by far the most prevalent form of attenuator encountered in communications work. Numerous special forms have been developed which are quite satisfactory for use in the radio spectrum at least to 2,000 kilocycles per second. In general they possess the advantages of rapidity of manipulation, rather compact assembly, more or less direct-reading calibration and attenuation which is practically independent of the frequency within limits. These characteristics are not obtained without considerable care in design and construction. Space does not permit an extended discussion of resistance attenuator design but the following principles are generally recognized:

1. Low resistance networks are usually most suitable. This is due to the fact that small noninductive resistance units are more easily constructed than larger ones and inherently possess less inter-element admittance due to their smaller physical dimensions.

2. Careful shielding and a proper disposition of component parts are of primary importance. Poor judgment in this respect may result in stray pickup in associated apparatus and mutual effects within the attenuator itself which alter the attenuation ratios.

3. The use of the shielding system as a common return circuit is especially to be avoided. The effectiveness of the shielding is reduced and stray potentials of uncertain character may appear in the output.

Resistance attenuators are usually formed of a number of basic potential divider or "L" sections. The shunting effect of the successive sections, however, modifies the values of the individual resistance units. Fig. 7 is a wiring diagram of the General Radio 403-C standard signal generator which contains an attenuator of the conventional type.

Ultra High-Frequency Attenuators

It is a lamentable fact that but little development work has been done toward perfecting attenuators which may be relied upon at the ultra high frequencies. Ordinary resistance networks are limited in use to those frequencies at which stray capacitance and inherent inductance effects make negligible contributions to the impedances of the network units. Since neither of these effects can be entirely eliminated, any attenuator of this sort has an upper limiting frequency which is definitely set by the physical characteristics of the instrument and the amount of permissible error. This upper limit is reached, in most cases, just above the broadcast band. The National Physical Laboratory's small

(*Concluded on page* 36)

Broadcast Program Protection

Control Room and Engineering Details for Setting Up and Maintaining Satisfactory Broadcast Service

By W. A. R. BROWN*

This paper describes briefly some of the precautions necessary to maintain high quality and continuity in the operation of a modern broadcasting system, including volume control, audio energy limitations of wire circuits, program switching and distribution, program monitoring and protection of a radio transmitter.

PROGRAM protection may be defined from the operating viewpoint as those steps which are taken to preserve the fidelity and continuity of the program. Such protection is demanded by the operating company because it is essential that the best possible service be provided to meet the competition existing in the broadcast advertising field. To satisfy this demand is one of the major functions of the operating department and many of its activities are directed to that end.

Because of the complexity of present-day broadcast systems and the oftentimes considerable physical distances separating the component units it is doubtful whether the latent possibilities of trouble, or the safeguards utilized, in such extensive systems are recognized. As an aid in visualizing the complexity of operation the component units of the National Broadcasting Company's system, local to New York, are indicated in Fig. 1. When it is considered that several programs may be in progress simultaneously, some in studios and some at outside points, and are being supplied to local transmitters and networks and that the combinations are continually shifting, the possibilities of trouble and the necessity for adequate safeguards are readily apparent.

Broadcasting Use of Wire Lines

The general problem of protection is of considerable magnitude as each type of unit has problems peculiar to itself and for many phases of operation it has been necessary to develop methods to cope with the problems which have arisen with the increasing expansion of broadcasting. Broadcast operation is, to a certain extent, telephone communication and the problems encountered in this phase of operation do not differ fundamentally from those encountered in other communication fields. Briefly, these problems as they apply to broadcasting are: (1) that the circuits transmit the frequencies of the audio band with substantially equal attenuation; (2) that impedances be matched at junctions of individual equipment units; (3) that the audio levels be confined within prescribed limits. These are treated in accordance with standard engineering practice and need no elaboration.

In actual operation one of the first safeguards introduced is volume control and upon the proper handling of this problem depends to a considerable extent the quality of the program. This function is exercised by the studio engineer for studio programs and by the field engineer for outside pickups. Such control is necessary because the dynamic ranges encountered are greater than can be handled by existing equipment.

The telephone lines and repeaters offer an unsurmountable obstacle, at present, to the transmission of the full dynamic ranges encountered in broadcasting. This equipment, designed before broadcasting was in general use, was intended to handle only the dynamic range of the human speaking voice, and although improved equipment is constantly being placed in service broadcasting is limited in its expression by the limitations of the telephone circuits since such circuits must be used on networks. These limitations expressed in energy levels are plus 6 db. for the upper value and about minus 25 db. as the lower figure, a range of 31 db. There are very definite reasons for confining the levels between these values. Telephone repeaters will not reproduce faithfully at levels greater than plus 6 db. and any greater level than this overloads the repeater and causes distortion of the program. On the other hand, at levels below minus 25 db. the inherent line noise of a wire circuit (induction, cross talk, etc.) becomes apparent. In order to allow a factor of safety the upper operating limit is placed at plus 2 db. leaving a range of 27 db. for normal operation. Under these conditions the dynamic range of a symphony orchestra, which is about 60 db., must be compressed into less than half its normal value. If this is to be accomplished

Delivered before the Radio Club of America, Sept. 10, 1930.
**Assistant Development Engineer, National Broadcasting Company.*

successfully the average listener must not be aware that volume control is being exercised.

Control of Dynamic Range

Volume control is not merely cutting down the peaks and bringing up the low passages after these have occurred. They must be anticipated. The gain must be gradually lowered prior to the crescendo and raised previously to the pianissimo passages. Otherwise, the peaks are distorted and the low passages lost in the noise. To compress dynamic ranges without the process being too evident to the listener is an art.

Studio Engineer Prepared for Changes

Although an experienced studio engineer can often instinctively anticipate coming changes of volume as the music progresses, previous knowledge of the selections is a great asset. In order that the work of the engineer may be conducted as efficiently as possible he is present at the rehearsals. These may extend over 10–15 hours in preparation for one hour on the air and when the actual broadcast takes place the studio engineer is familiar with all features of the program and volume control is seldom detected by those listening. Each studio booth is acoustically treated to provide faithful reproduction and high quality monitoring and is equipped with a level indicating device for the guidance of the studio engineer in controlling volume.

The duties of the field engineer are fundamentally the same as those of the studio engineer—volume control, microphone placement and musical balance—but often complicated by additional factors such as poor acoustics, limited space and crowds. Under the varied conditions surrounding outside pickups the field engineer must often draw upon his fund of experience in coping with the varied problems, analyse many factors and make decisions quickly. Initiative is essential.

Because of the varying lengths of the wire circuits on these Nemo pickups the average levels of the programs entering the main control room will often differ considerably. This would cause abrupt changes of level when switching and in order to eliminate this and to have these program levels conform to those of the studio outputs the program is routed through a Nemo monitoring booth. This is essentially a repeater station and the primary function of the studio engineer there is to monitor the program and make sure it is passing that point and is being fed to the control room at the proper level for distribution.

Contact Between Studio and Field Engineers

Prior to the start of the program, he checks with the field engineer for the purpose of setting levels. The general practice is for the field engineer to place a sufficiently high level upon the line to insure a good signal-to-noise ratio at the monitoring booth. The studio engineer there regulates the level for program distribution to the control room. After the program has started he checks levels again with the field engineer and remains in constant telephone communication with him. Under certain conditions he may act in an advisory capacity to judge balance and quality when the field engineer may be hampered by excessive noise. His regulative functions are slight as volume controlling is logically done by the field engineer.

These Nemo booths have similar acoustic treatment and equipment as the studio booths. The latter can be used for outside programs but, because of the demand for studios for rehearsals, seldom are.

The main control room is the nerve center of a broadcasting system and upon the efficient performance of the duties connected with its operation rests in large measure the success of network broadcasting. Responsibility for the operation of studios and the distribution of programs to networks and local transmitters is centered here. A typical layout, showing program distribution and monitoring circuits, is given in Fig. 2.

The distribution phase of operation requires a given program to be dispatched to designated points, at the proper level, and at a definite time. This requires (1) an interlocking system for transferring at will the outputs of various studios to one or more distribution channels, and (2) facilities for checking the program at important points. A dual system is used by the National Broadcasting Company with master controls and indicating lights at the master control desk and such duplicate controls and lights in each studio as are necessary for operation of that particular studio. With this system the switching is normally performed in the studios but is under the supervision of the control room supervisor who can detect and correct errors. The indicating lights on the master control desk show each operation involved in the switching of each studio and the supervisor can tell at a glance the status of any particular studio.

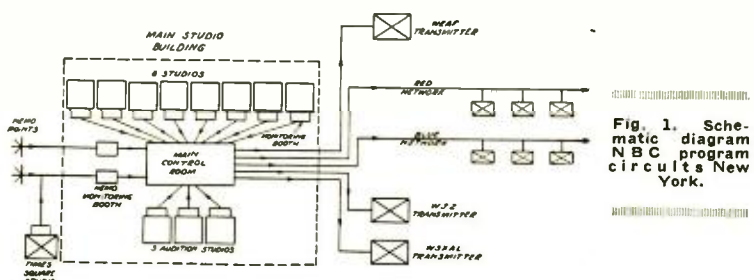


Fig. 1. Schematic diagram NBC program circuits New York.

Announcer Controls Switching

The actual switching is performed by the announcers in the studios. This is because the announcer is the contact between the program and the public and, as it is desirable that this contact be as precise and rapid as possible, the best coordination of thought and action is obtained by having the announcer do his own switching. The switching facilities in each of the studios appear as rows of push-buttons and lights on a small panel. The push-buttons permit the connecting or disconnecting of the output of that studio to, or from, any combination of distribution channels. The lights indicate which channels are being utilized, both by this and other studios, and whether the announcing or program microphones are in operation. As an aid in operation, and to supplement the indicating lights, headphone monitoring of programs in all studios is available to the announcer.

Studio operation is carried out in accordance with a carefully prepared schedule which is in the possession of all personnel. Thus, the announcer in any studio has all the essential information regarding the distribution of that program and is in a position to set up or release the required program channels and make local announcements. As an additional check, certain of these lights and buttons appear in the monitoring booth on the mixing panel of the studio engineer who is in a position to view the activities of the studio and can release the channels if necessary.

Network Problems

Network operation has introduced many problems. One of these is local announcements at the network stations. Because program requirements make it impossible to designate a definite time for these it is necessary that notification be transmitted over the program circuits in order to eliminate the possibility of human error. This is accomplished very simply by utilizing the musical notes of chimes as a cue to indicate that the next fifteen seconds will be available to all stations for their locals. The chimes, since they are given at the conclusion of most programs, are also utilized as switching cues by individual stations and supplementary networks who are joining or leaving the chain. These supplementary networks are smaller chains which tap the basic networks at a distance from New York and which may take program service from either the basic Red or Blue networks. This

raises the problem of synchronization of two programs with the switching in order that these supplementary chains shall not be cut over to a network on which the program has already started. Since the chimes are used as switching cues the solution is to transmit them simultaneously over both networks. In actual practice when one network program has concluded the announcer for the other network takes control of both for the time necessary to give the chimes. This procedure may leave one or the other of the two networks without program for a few seconds at the end of a feature but this is preferable to losing part of a program.

Since the control room supervisor is responsible for the dispatching of programs monitoring facilities must be available for checking. These are located at the master control desk and consist of volume indicators and a loudspeaker, the former showing the output levels of the studio and line amplifiers, while the loudspeaker may be connected to either of these points. Similar monitoring of each studio and distribution channel is possible. Radio monitoring of the two local transmitters, in this case, WJZ and WEAF, is also available and includes in addition to the customary radio reception a signal light to show whether the carrier is on or off and a neon lamp which indicates when the carrier is being modulated and roughly the degree of modulation. With the monitoring and switching systems centered at the master control desk, local troubles can be quickly located and usually quickly remedied for all studio and line amplifiers, channel terminations, et cetera, are located in the control room. The input and output connections of most of the equipment in each studio appear on jacks in the control room and a circuit can be quickly patched around any faulty unit. Telephone communication to each monitoring booth and telegraph circuits to all networks and local transmitters are available at the master control desk so that trouble at any point of the system is immediately detected and appropriate steps are taken to remedy it.

Outside Wire Lines

Line trouble is, of course, beyond the control of the broadcast company. The telephone company is responsible for the maintenance of program service between network stations. In general the same methods of insuring program continuity are used by the telephone company as by the broadcast company. With networks covering most of the country all extremes of conditions are naturally encountered and the causes of interruptions are varied; for instance, a truck loaded with high explosives collided with a telephone pole, or a tornado tore the roof from a farmer's barn and dropped it on the line. Although the telephone company is responsible for the maintenance and condition of the lines, transmission characteristics of all long line networks

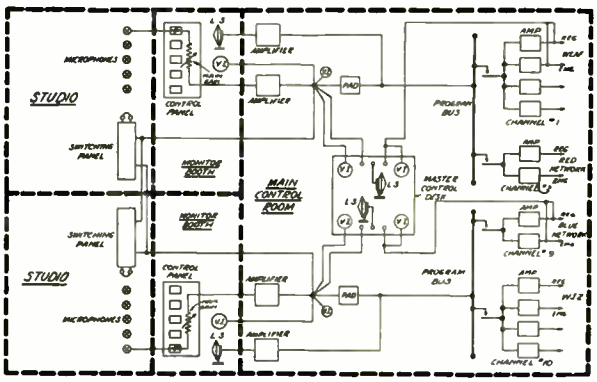


Fig. 2. Schematic diagram of program circuits, studios and control room, New York

are taken by the broadcast company at intervals.

The short local lines seldom give trouble. They are checked daily, however, as a matter of precaution, and rechecked prior to a broadcast. Frequency runs are also taken of the lines to the local transmitters and in these instances include the frequency characteristics of the entire circuit from microphone to antenna.

Studio Power Supply

The power supply for the studios is normally furnished from a commercial source, but storage batteries with a capacity sufficient to operate the equipment for 24 hours are held in reserve. Automatic switching facilities also furnish current for lighting purposes in event of failure of the outside source. Each studio has its separate power line and all current carrying circuits for studio or control room equipment are fused.

Protecting the Tubes

The equipment of a modern high-power transmitter represents a very considerable investment and safeguards must be rigidly applied, especially for the water cooled tubes. Standard power plant protection is utilized to a large extent but is, of course, complicated by the requirements of the radio equipment, so that an elaborate electrical system of interlocking safeguards is necessary.

Tube protection is essential, both because their power limitations must not be exceeded and for continuity of operation, as a tube failure will often produce dangerous transient conditions among the associated equipment. Such protection requires a sustained supply of cooling water to the tubes and certain operational safeguards; for example, filament power can not be applied unless an adequate flow of water is assured and plate power can not be applied before the application of grid bias voltage. In practice this is handled by a step-to-step procedure which must be followed in placing the plant in operation and an interlocking relay system which functions in the event of failure, or overloading of any unit, removing from service any units the continued operation of which would endanger equipment. Water supply protection is usually supplied by hydrostatic pressure devices, which are so connected to the interlocking system that filament power can not be applied, nor left on, when the water pressure is below a predetermined value.

The input temperature of the water must be sufficiently low so that the water will not boil when in contact with the tube anode as this would greatly reduce the heat dissipation at these points and probably result in anode punctures. Distilled water must be used at certain geographical locations to prevent scale formation on the tube anodes which occurs when water with a considerable mineral content is used for cooling. Thermometers are generally used to indicate the input and output water temperatures and when used on individual tubes will often show by a gradual temperature rise the presence of slight obstructions in the water supply of a particular tube.

Continuity of operation is provided by spare tubes which can be rapidly placed in service. This replacement process is handled by a push-button arrangement on the desk of the transmitter engineer who can remove any tube from service, replace it by a spare, and resume operation in a few seconds. Duplicate units are provided for much of the other equipment, ranging from crystals to transformers, and rapid replacement facilities are provided.

Modulation of the carrier is checked by an oscillograph and the program is monitored both in the control room and in the transmitter room, radio monitoring being used at the latter point. Thus, with a monitoring system which checks the program from the microphone to the air and the equipment safeguards utilized, program protection is assured against most causes which are likely to arise.

It has been attempted in this paper to outline briefly some of the precautions which must be taken to insure the maintenance of a high standard of program quality and continuity of operation of a modern broadcasting system.

Making Radio Transmitting Tubes

Methods of Exhausting Tubes are Here Clearly Explained

Great Care is Necessary and Expert Knowledge Essential in the Manufacture of Radio Transmitting Tubes

By DR. PAUL G. WEILLER

THE exhaust of transmitting tubes differs radically from the process practised in the manufacture of receiving tubes. The exhaust of receiving tubes as they are produced at present is not complete. The glass container and the metal parts are not thoroughly freed from gas.

The high-speed production necessitated by severe price limitations do not permit a complete removal of gas from glass and metal parts. Both the diffusion of gas from the inside of the metal or from the lower layers on the glass, and the removal of the liberated gas from the bulb through the narrow exhaust tube cannot be speeded up even by the best exhaust equipment.

At a vacuum of two or three microns gas movements through orifices are sluggish. The time required per unit volume of gas increases rapidly with progressing rarefaction.

In receiving tubes the final vacuum is obtained by the action of the "getter" on the gas ionized by the plate current during the seasoning process. The evacuation need be carried only to a point where the quantity of gas evolved from the parts is not greater than that absorbed by the getter during regular operation. Bulb and plates are so dimensioned that neither is subjected to considerable heating during regular operation. Plate voltages also are limited.

Transmitting tubes are not designed so generously. Plates are worked at red heat visible in daylight. Glass bulbs are required to pass as much as one watt of heat per square centimeter effective surface.

As plate voltages reach several thousand volts for the larger types even a small quantity of gas is much more disturbing than an equivalent quantity would be in receiving tubes. To these factors we must add that there are momentary heavy overloads which are hard to avoid in transmitter operation. Due to these circumstances the removal of gas from the parts must be driven to the farthest possible limit without regard to the time necessary for such operation.

In this connection it may be of interest to touch upon a rather controversial question.

Individual Exhaust or Fixed Schedule

Some manufacturers are in favor of exhausting transmitting tubes according to a fixed time schedule. Such a method of operation makes it possible to operate with low-grade personnel which cannot be expected to use judgment in carrying out allotted tasks. In other quarters exhausters of long experience are employed who can be trusted to use judgment and care.

If transmitting tube parts could be produced with a uniform degree of cleanliness the first method would offer some advantages from the management point of view. It also would permit savings in labor cost.

Such uniformity, however, is difficult or even impossible to attain at the present stage of the art. Therefore the time necessary to complete the exhaust of any given type of tube may vary as much as 300 per cent between extremes. It is then obvious that if a fixed schedule method be applied some tubes will be bombarded much longer than necessary, while others will be taken off before a satisfactory vacuum is obtained.

While the fixed schedule method may appear to be cheaper and easier on the face of it it will result in higher shrinkage. If rare metals and hard glass are used, both of which are expensive, low shrinkage is essential to profitable operation. In the writer's opinion the second method should be preferred at least until such time as the production of transmitting tubes has reached a much larger volume.

At present even the largest manufacturers produce only a few dozen daily of the small types and only a few of the larger types.

In mass production large expenditure in research and equipment is necessary to obtain the high degree of uniformity so essential to production more or less independent of the operator's skill. Such expenditure would be entirely unwarranted by a production schedule of only a small number of items daily.

May I also point out that no satisfactory degree of uniformity will be obtained so long as mounting is a hand operation, dependent for its success on the skill and good-will of the operator?

Carbonizing

Most glass envelope transmitting tubes have thoriated filaments as emitters. The thoriated filament will not yield sufficient emission in its original condition. The thoria in the filament must be first reduced to metallic thorium. This is accomplished by lighting during a short time in an atmosphere of hydrocarbon gas or vapor at low pressure. Acetylene is mostly used as the carbonizing agent.

The operation must be carried out on a separate exhaust position as the hydrocarbon gas or vapor and the invariaby formed carbon black are apt to impair the effectiveness of the evacuating system.

Equipment

An oil pump of large displacement coupled with a mercury vapor pump but without liquid air trap is provided with a mercury seal, (Fig. 1) between the vapor pump and the tube to be exhausted.

A reservoir is connected to the exhaust system through two stopcocks separated by a narrow glass tube. A third cock permits filling the system with the carbonizing medium.

Two manometers permit observation of the pressure in the reservoir and in the tube on exhaust, respectively.

Process

An acetylene tank is provided with a length of vacuum tubing which may be closed by a pinch-cock. The latter is opened a little and acetylene is blown off until all the air back of the

pinch-cock is displaced. The pinch-cock is then closed.

The rubber tubing is connected and all stop-cocks and the mercury seal are open; the pinch-cock is closed.

When the system is thoroughly evacuated, the dosing cock to the right is closed and acetylene admitted until approximately atmospheric pressure is built up in the acetylene reservoir. The closing cock to the left, and the filling cock are then turned off. The system is now ready for operation.

The right closing cock is now opened and a good vacuum is pumped. The right-cock is now closed and the left closing cock opened to admit acetylene to the space between cocks and then closed again. The mercury seal is now closed and the acetylene admitted to the tube by opening the right hand closing cock. The pressure should be between one and two millimeters.

Before admitting acetylene the filament is lighted and its resistance checked. Normal filament current should be obtained with a voltage approximately 20 per cent below normal. After checking, the filament current is turned off. Acetylene is admitted with the filament cold. The filament is now lighted at a voltage somewhat higher than normal during twenty seconds and switched off. The filament heat has decomposed some of the acetylene and deposited a layer of carbon on its surface.

The tube is again evacuated and the filament lighted at approximately double normal voltage. The current will be found to be about 50 per cent over normal, but will decrease rapidly. When it has become constant the carbonizing process is completed. The resistance is again checked. If it is low the process is repeated but the filament is lighted in the gas atmosphere only during a few seconds.

If the filament has been overcarbonized there is however no remedy. Besides having abnormal filament characteristics overcarbonized, filaments are so brittle that they will not stand the shocks of transportation. The carbonized tube is cut off and transferred to the exhaust position.

The information given here about carbonizing should be considered only as general guidance. Exact schedules can be worked out only for a given set of conditions. Even with great care in working out such schedules it is difficult to obtain uniform results.

Tungsten filaments vary considerably in structure and cross-section. Drawing operations leave particles of graphite on the surface and form carbide during the resistance check. We have therefore no rigidly determinable starting point. Only great care and experience will yield good results.

Sealing

The tube is sealed to the all-glass system; the pumps are started and the system tested for leaks by moving the electrode of a spark coil along the glass. Wherever there is even the tiniest hole the sparks will be drawn in.

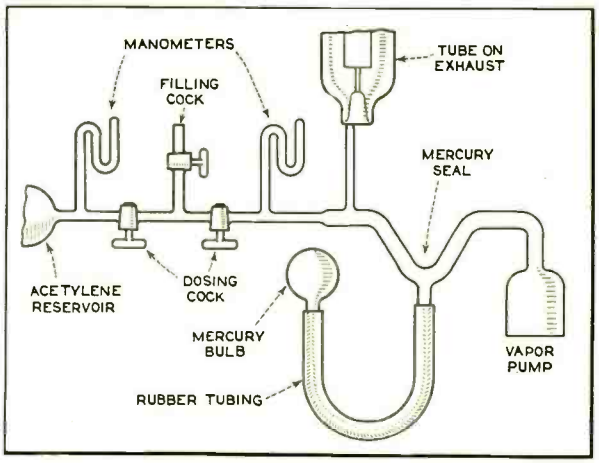


Fig. 1. Schematic of exhaust line.

If a high-frequency coil is used a feathery stream of sparks will strike between the electrode and the glass. The individual discharge threads will spread brush fashion over the glass.

When a hole is struck a thread of light much brighter than the others will strike the hole and enter it. If the electrode is moved further along the glass the brush will move with it while the bright thread will keep striking the hole until the distance to the electrode becomes too great.

If no leaks are found the system is permitted to work during a few minutes. The spark coil is then touched to the plate lead.

If the vaccum is insufficiently high a glow discharge will be visible in the exhaust tube. The discharge will disappear as the vacuum improves. At last, only a tiny bright point is seen where the leads enter the vacuum, even when there is no visible discharge in the exhaust tube. The vacuum should not be considered satisfactory unless these bright spots disappear entirely. If the pumping system is functioning satisfactorily and the tube does not leak no trace of any glow discharge can be seen.

These precautions will prevent spending a lot of time and power on tubes with minute leaks not detectable in any other way.

Baking

The oven which has been previously brought to temperature is lowered over the tube. The baking period must be extended over a minimum of 30 minutes at 450 to 475 degrees Centigrade. If either time or temperature are skimped exhaust troubles will result. If the temperature is pushed to 500 degrees Centigrade the bulb will be sucked in.

The baking time may to advantage be extended to 45 minutes. The oven is then raised and the vacuum test is repeated as previously described.

If any trace of a visible discharge is detected either in the exhaust tube or around the leads something has gone wrong. The parts may have been unclean. In this case repeated baking may correct the trouble. The pumping system may not be functioning properly or the tube has become leaky during baking.

At this point it may be proper to note that well-designed pumping systems very seldom cause any trouble. Most exhaust difficulties are due entirely to causes originating within the tube itself.

Bombarding

Bombarding may be divided into two quite distinct periods. During the first period all of the gas absorbed on the surface of the metal parts and the bulk of that within the metal escapes rapidly, giving rise to a glow discharge whether the heating of the plate is accomplished by induction treating from the outside or by bombarding by the plate current.

During the second period, which is a longer one, gas escapes at a very slow rate; no visible discharge is produced and the progress of the exhaust operation may be observed only by watching the meters.

As tubes are apt to show an erratic behavior during this period the proper control of this part of the operation, and the recognition of the end point requires considerable experience and skill. During both periods it is easy to totally wreck the tubes by improper adjustment of currents and voltages.

First Period

After one has made sure of the proper vacuum the filament leads are clipped on and the filament is lighted, as a rule, with a voltage 100 per cent in excess of its rating. The current may be roughly 50 per cent in excess of rating. This is necessary to evaporate any trace of oxide or other matter adhering to the filament. Such impurities would impair emission.

The filament temperature must be kept higher than normal during most of the exhaust period as the thorium emission is destroyed by the gas evolved in the tube as fast as it is produced.

During exhaust the tube is operat-

ing on tungsten emission which requires higher filament temperatures. After one minute has elapsed sufficient plate voltage is applied to give a plate current of about 400 ma. A glow discharge filling the entire tube will immediately appear. After a few minutes the plate will become dull red in color. It is necessary to watch the operations with great care at this point.

Often a quantity of gas will be evolved suddenly, causing the plate current to increase rapidly. It is necessary then to decrease the voltage immediately as otherwise either the plate would be overheated causing it to melt, or the filament might be destroyed. Often the plate current must be switched off entirely for a minute or two.

When the pump has caught up with the gas freed from the plate the plate current is adjusted again to normal. If the tube parts are perfectly clean, and baking properly carried out, this part of the operation can be carried out with very little trouble by a skilled exhauster. Only general rules can be given as tubes sometimes differ considerably in their behavior.

The amount of emission obtained in the finished tube, the amount of gas, the amount of distortion of the elements and other factors affecting the quality of the finished tube depend very greatly on the care and skill with which this part of the exhaust is carried out.

The heavy glow discharge produced during the first period of exhaust has several drawbacks. The thorium in the filament is used up by oxidation if any oxygen is present in the gas. The heavy positive ion bombardment also has a detrimental effect on the filament. Metal particles are scattered over the entire tube by sputtering. The glass is blackened by sputtered metal and, also, if hydrogen is present by reduction of a small amount of lead. This blackening besides giving the tubes an unsightly appearance also increases the absorption of heat by the glass which in turn favors sucking-in during subsequent periods of the exhaust operation. A skilled operator will therefore avoid any too heavy glow discharge.

If the filament is plain tungsten the operation is easily carried out in the manner described. Even heavy discharges do not greatly impair tungsten emission.

If thoriated filaments are used it is better to remove most of the gas by heating the plate by induction with a bombarder. The filament is not lighted during induction treatment. When all of the glow discharge has disappeared the filament is lighted and one proceeds further with bombardment by plate current.

From now on the plate voltage is kept as high as possible without causing the plate current and plate temperature to rise suddenly. The end point of the exhaust operation is not easily recognized. With pure tungsten filaments the only indication of completed exhaust is obtained by close observation of the plate current.

So long as gas in appreciable quantities is present the resistance of the tube is lowered by it. As the removal of gas from the parts proceeds the pressure in the vessel also becomes lower, the plate current will therefore decrease if the voltage is kept constant. When nearly all gas is removed the plate current will not change.

If, however, the plate is heated at any point near to its melting point large quantities of gas will escape. It is necessary therefore to take plate temperature into consideration. Because of the varying degree of blackening of the glass it is not easy to correctly judge temperatures. An optical pyrometer while somewhat more reliable than the eye is subject to the same difficulties.

The variations in plate dimensions unavoidable in production make it difficult to set standards for plate currents and voltages. It can be readily seen that much depends on the operator.

Ionization gauges have been tried for judging the end point but with little practical results. The same applies to measurement of gas current in the tube itself. If the tube is measured at standard operating voltages the reading will always be low because the pump carries gases off faster than they evolve at plate temperature corresponding to normal operating conditions.

At conditions corresponding to high plate temperatures measurements of gas currents are hardly practical because of lack of stability of conditions. There is however one method which offers some promise of success. The plate surface does not vary appreciably between different tubes of the same type. Neither does the ability of the plate surface to radiate heat. Therefore a definite plate temperature will correspond to a definite power input regardless of what particular current and voltage make up the input.

If we can then observe plate current constancy during a given time at a definite power input given by a wattmeter we would have a practical method of end point determination. With thoriated filament the end point is more definite.

We have said that thoriated filaments are operated during exhaust at a temperature at which the thorium diffuses to the filament surface as fast as it is used up by the gas discharge. A balance is reached at approximately 100 per cent above normal voltage.

Until the exhaust is well along the emission current will drop fast whenever the filament temperature is reduced. If the exhaust is completed however the emission current will drop only by a few milliamperes when the filament current is reduced to normal.

The emission will remain stationary under these conditions if the tube is in perfect condition. Often however it is found impossible to obtain perfect stability in spite of prolonged exhaust. Such tubes are to be regarded as subject to check.

The end point test on thoriated filaments should never be extended over an unnecessarily long period as it constitutes a considerable strain on the emission resources of the filament which are not ample at best with thoriated filaments. When the end point is reached the tube is sealed off carefully.

A small quantity of gas is sometimes introduced by prolonged heating of the glass when sealing off. This operation should therefore be carried

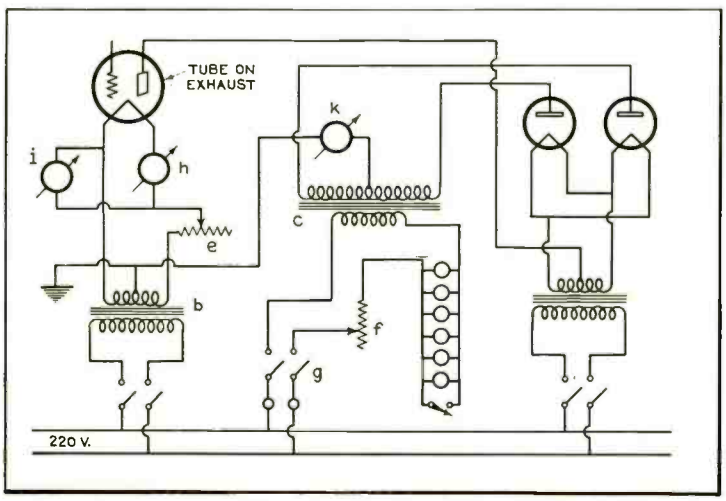


Fig. 2. Power supply unit for exhausting 50 and 75 watt tubes. b Filament transformer—220 v. primary; 25 v. secondary, 150 watts. c High voltage transformer—220 v. primary, 6000 v. secondary, 5 KVA, d Rectifier filament transformer—220 v. primary, 2.5 v. secondary, 50 watts. e Rheostat—6 ohms, 9 amperes. f Rheostat—50 ohms, 7½ amperes. g Toggle switch extension handle, h Ammeter 0-5 a-c. I Voltmeter 0-.5 a-c. k milliammeter 0-800.

out quickly. So far we have said nothing about getters. Transmitting tubes can and should be exhausted without aid of the getter. The latter should be flashed either after the end point is established or after sealing off.

If thoriated tubes are exhausted without the use of induction heating it may be useful to place the getter in such a position that it will volatilize when most of the glow discharge has disappeared. This will shorten the first period and save the thoriated filament from deterioration. Good tungsten filament tubes can be made entirely without getter.

Thoriated filament tubes of good quality cannot be produced in practice without a getter.

Equipment

The exhaust equipment for transmitting tubes is relatively simple.

Any good oil pump backing a mercury vapor pump will do. An all-glass system is used. Each tube has its own pumping system.

The ovens are electrically heated. The older types have nichrome helix or ribbons as heaters. The newer ones use globar which is much more satisfactory as burned out elements can be replaced without much delay.

The power supply includes a filament transformer with grounded secondary, a suitable rheostat to vary the filament voltage between normal and double normal, filament voltmeter and ammeter.

The plate voltage is supplied by a full-wave rectifier using two —866 tubes. The transformer supplying the —866 filaments must have a secondary insulated from the primary for about 10,000 volts as it must stand surges besides the full voltage of the plate supply transformer.

The latter should be chosen of four KVA and 4400 volts r.m.s. on each side of the middle tap. It is then good for tubes up to about 250 watts.

A rheostat is provided in series with the primary sufficient to reduce the secondary voltage to 1,000. The highest voltage used during exhaust of tubes up to 250 watts is about 4000 measured with a d-c. instrument on a full-wave rectifier.

Provision must be made to be able to switch the plate current on and off rapidly. A push-button-operated relay is most satisfactory. A 30-ampere toggle switch with a long extention handle which makes operation less tiring may be used in installations where simplicity and low first cost are desired. It must however be of good make as it must stand a great number of operations in rapid succession.

As overload protection fuses or overload relays are suitable. The latter are however to be preferred as fuses are sometimes too slow to prevent injury to the tube on exhaust when sudden gas rushes cause instantaneous increases in plate current.

A few large tungsten lamps in series-parallel with the primary of the high-voltage transformer are useful as current regulators, during the glow discharge period, particularly where one operator is handling a number of exhaust positions simultaneously. A shorting switch should be provided so that the lamps can be cut out when not wanted.

Time

From the aforesaid it appears clearly that the first cost of a power tube exhaust installation is relatively low. Power and labor however are items to be considered. The ovens take 2-KVA per tube. The power drain during exhaust varies but it can be figured at roughly 2 to 4 KVA per position. As to time necessary to properly exhaust tubes we may figure as follows: Baking 30 to 45 minutes for all-glass tubes; glow discharge period 15 minutes for all tubes; finishing period: 30 minutes for 50 watters and 2 to 4 hours for 250 watters; one good exhauster can handle up to eight positions simultaneously.

TRANSPORTATION AND EQUIPMENT EXPENSES CUT DOWN SERVICEMAN'S INCOME

By Grover C. Kirchhof*

YEARS ago, when radio was in its infancy, the experimentally inclined persons were universally attracted by the mysteries of "wireless." In the endeavor to gain a knowledge of this comparatively new science, it was necessary to build every new circuit and pry into every available commercial set. Many an attic, back room, kitchen and cellar was transformed into a miniature experimental laboratory. The embryo radio engineers of those days are now the leading figures in the industry. It was from the ranks of those early home experimenters that the first radio service crews were drawn.

Today, when standardized circuits and prices of factory built receivers make it ridiculous, as well as expensive, to "roll your own," the attic engineer and home laboratory has all but passed out of existence. The serviceman of the present is either a product of a radio school or has gained his knowledge, such as it is, at the expense of some dealer who considered cheap labor of greater importance than ability.

Such was the past, but what about the future? Is radio attracting the most desirable type of man? Our answer is NO. We reason that the most desirable man is one who is anxious to advance in his field. There now arises the question: How is it possible for a man of good caliber to advance himself when there is scarcely any spare time to devote to the study of technical journals, attend meetings, lectures etc.? Men, who work from early morning until late at night have very little time for self-improvement; and, furthermore, are fatigued physically and mentally.

Also the matter of remuneration cannot stand fair investigation. The average dealer requires his service staff to furnish an automobile, a complete test kit, and a good assortment of tools. This investment, on the part of the serviceman, is conservatively figured at three hundred dollars. Operating expenses of the car are six cents per mile at the lowest possible figure; and the average man is lucky, if he covers less than fifty miles a day which adds up to three hundred miles a week. Speaking in terms of dollars and cents, it means eighteen dollars a week. In return for his labor and expenses, the serviceman receives between forty and forty-five dollars a week, so that the net earnings amount to not more than twenty-seven dollars a week.

Intelligence Required

Viewing the situation broadmindedly, how can one expect men who must possess more than the average intelligence, who must give thought to their personal appearance, who must be capable of pleasing the most unreasonable customers, who must be salesmen as well as good technicians who must have a thorough knowledge of a complicated and intricate piece of electrical apparatus, to invest three hundred dollars for a position that only pays twenty-seven dollars a week?

Radio business executives will undoubtedly come forward and say that irresponsible radio servicemen do not merit higher salaries. The writer answers that responsible married men cannot afford to work for the present scale of wages. It happens that irresponsible youngsters, just out of school and anxious to earn a few dollars with which to see the latest shows, apply for radio service positions and do the least possible amount of labor for the salary.

* *Secretary, R.S.M.A.*

Practical Radio-Frequency Choke Coils

By A. BINNEWEG, JR.

In This Article Mr. Binneweg Gives the Engineering Requirements for Choke-Coil Construction, to Meet Various Needs in Vacuum Tube Circuits.

A RADIO-FREQUENCY choke coil is ordinarily rated in units of inductance by manufacturers, but the important factor is its impedance to r-f. currents. Its function is to reduce as far as is practicable the r-f. currents through that part of a circuit in which it is connected.

In an ordinary short-wave regenerative receiver with fixed tickler coil, a choke is found connected so as to allow most of the r-f. currents to pass through the regeneration-control condenser. One also finds chokes connected in series with plate resistors in an audio amplifier, across the input of a short-wave r-f. amplifier, or between 2 r-f. stages, as an impedance coupling, or across the crystal in a crystal-controlled transmitter.

Test results on some practical types of chokes are given, as well as methods of testing which can be employed in the laboratory with but little equipment. Chokes for receiving and transmitting are discussed.

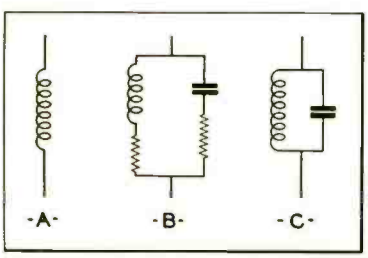


Fig. 1. Theoretical choke as at A. Practical chokes function as B, and C.

In r-f. amplifiers, the r-f. plate currents from the various stages have a common path in the plate supply unit. If this common path has appreciable impedance, undesirable couplings result. The proper use of chokes will allow each component to pass to filament, while only the d-c. will flow through the supply. As in audio amplifiers, speaker filters are employed to separate a-c. and d-c. components, so in r-f. amplification, advantages of the same sort are realized by using r-f. chokes.

In general, the higher the impedance the better the choke, but little is known about proper design, as there are many variables. A choke tested in the laboratory may function differently when connected in a practical layout. In some cases, the tube capacity is shunted across the choke. The distributed capacity and stray capacities introduced by connections themselves, are important at the higher frequencies. Ordinarily, such capacities are considered as "lumped" across the inductance of the choke winding. This does not always give correct results. The combination may function as a parallel circuit consisting of an inductance shunted by a lumped capacitance. One would expect that the parallel circuit would become resonant at some frequency, exhibiting a high impedance, and lower impedance at other frequencies. At frequencies higher than the natural frequency of the choke, the inductive reactance predominates, while at lower frequencies, the capacitive reactance is greater. At resonance, current "circulates" in the parallel circuit.

Requirements for Effective Chokes

There are some principal requirements of chokes which are important for study. In an oscillator, a choke should not reduce the strength of oscillations. In an r-f. amplifier, a shunt-feed choke connection should not result in a reduction in output voltage. The above statements are more or less equivalent; the first applies to a self-excited oscillator and the latter to a separately-excited arrangement. Chokes are also used for filtering; little or no r-f. current should be allowed to pass. The causes of the rather complicated electrical phenomena existing in some chokes is of secondary importance. Impedance value, r-f. resistance, positive or negative reactance, natural period, etcetera, are terms which are useful to the engineer, however.

Especially for short waves, the optimum choke is best determined by experiment. The characteristics of various types furnish an aid to design. Desirable qualities for a choke are obviously compactness and effectiveness over a wide frequency range, especially so for the usual short-wave receiver.

Actual impedance values of chokes are usually not as important as the variation of impedance with frequency. The way in which the wire is wound or the manner in which connection is made in a given circuit, may have considerable effect. A study of various constructions on results is important.

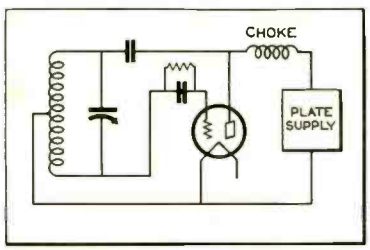


Fig. 2. Shunt-feed Hartley Transmitter circuit, showing choke coil.

One can start with a construction giving nearly the requirements and modify it for particular needs.

Difficulties with Short-Wave Chokes

Short-wave chokes must cover a relatively enormous frequency range with preferably no hollows in the choke's impedance. Ordinarily there is no difficulty if the range to be covered is small, such as the broadcast range. The usual choke cannot be expected to furnish a very high impedance over the entire short-wave range covered by the usual short-wave receiver. A choke designed especially for a transmitter, which usually operates in comparatively narrow bands, and at harmonic frequencies of these,

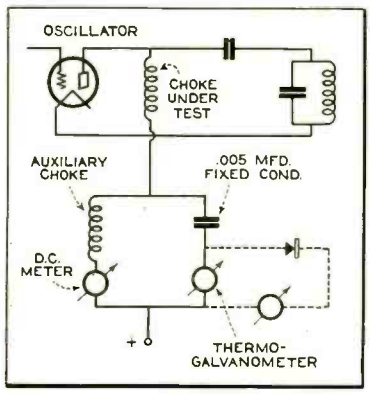


Fig. 3. One method of testing chokes.

can be of an exceptionally effective design; the voltages involved, however, are comparatively quite high.

Multiple Resonances

The inductance and self-capacity of a choke "tune" it to a definite frequency. When at resonance to the frequency supplied, the choke presents a high impedance with respect to the external "lines," which is desirable, but, if the effective shunt-capacity is relatively large, a large circulating current will cause losses. This current may be considered as going in one direction through the inductance and returning through the capacity of the parallel circuit. In a coil having distributed capacity the action is more complicated, but the result is similar. A coil with distributed capacity is capable of exhibiting multiple resonances, having on one side of the resonant point a capacitive reactance and on the other an inductive reactance. In many cases, it is not important whether the reactance is inductive or capacitive, so long as it is of a sufficiently high value. No general statements can be made on what is meant by "high," since any values will depend upon the circuit and particular factors involved. In some cases it is only necessary that the reactance be "high" at some definite frequencies and, in this case, it does not particularly matter whether it is high or low at frequencies which are not of as much interest.

Results with Single-Layer Solenoidal Coils

A simple, single-layer winding of small wire will show a prominent resonance at which it absorbs power from an oscillator, when inductively coupled to it, such that a half-wave (like an antenna — voltage loop at the end and a voltage node at its center) is standing on it. Other resonances at frequencies approximately 3, 5, 7, etc. times the natural frequency will also show resonance with an oscillator although these will be less pronounced. These resonances are not exact multiples of the fundamental frequency, although for ordinary considerations, sufficiently so. For each resonant condition, there is a different current distribution in which the currents in the various parts of the coil's distributed capacity are rearranged, changing the effect of the self-capacity over that at the fundamental. But a coil placed in a circuit arrangement is quite different in its results than a coil tested in the laboratory, especially so at short waves.

A coil for use as a choke should be comparatively longer (theoretically—but there are space requirements) for high r-f. voltage, otherwise one has rather strong electric fields between coil ends, regardless of how the wire is wound. In short-wave sets working at 40 meters and under, in transmitters employing shunt feed, and in screen-grid sets employing shunt plate feed, a special design and high impedance are necessary, but the cure for each case is somewhat different. Shunt-feed for screen-grid tubes is common practice and a choke-coil has quite an effect on the gain of the stage if improperly designed. It is not possible to reduce the size, or space the wire too much to reduce capacitive effects, since the inductance soon suffers badly. Some of the usual windings are either complicated or are poor for use as chokes.

For example, a certain commercial choke is constructed of spirals, one wire wide, laid side by side. Such construction is hardly practical with limited facilities. For short-wave use it is possible to construct simple chokes having good characteristics. The "hollows" can be shifted to less desirable frequencies.

Some commercial chokes are very poor as the hollows appear exactly at the wrong frequencies. Experimental results on practical chokes which can be constructed quite easily are easily obtained as described in a later paragraph.

Testing Radio-Frequency Chokes

Chokes are employed to quite an extent in transmitting circuits. Such connection illustrates important principles. They are usually connected so as to allow the passage of direct currents but to offer a high impedance (preferably) to the radio-frequency generated. For example, in Fig. 2 is shown a common connection for a choke coil. In general, there are certain advantages in using the shunt method of connection; for instance, the r-f. and d-c. circuits are independent, the condenser and inductance are at low d-c. potential and the d-c. supply can be taken from any convenient point such as from a voltage divider independently of the r-f. return path. Since this method of connection has its advantages, it is desirable to design and construct chokes of suitable electrical characteristics for this purpose.

An important factor for such a connection is the amount of leakage through the choke at the frequencies at which it is required to operate effectively. In Fig. 3, is shown a connection which can be used to determine the leakage through the choke coil. The choke under test is connected in its normal position in the oscillator circuit and an auxiliary parallel arrangement for separating the d-c. and r-f. components is employed. An .005-mf. condenser blocks the d-c. from the r-fs. branch, while the auxiliary choke prevents the passage of r-f. through the d-c. branch.

Thus the d-c. registers on the d-c. plate milliammeter while the r-f. is read on the thermo-galvanometer. The condenser reactance is comparatively low so that the auxiliary choke need only be of indifferent construction, to properly shunt the major proportion of the r-f. component into its proper path. Care should be taken that the condenser and its parallel inductance (choke) do not resonate at or near the frequencies under test, as a comparatively large circulating current would result, with possible burn-out of the meter, and erroneous experimental results, for the leakage through the choke tested. The ordinary 100-milliampere thermo-galvanometer is rather large for measuring the leakage through a choke, except in high-power oscillators. For low-power oscillators, the connection shown dotted in Fig. 3 can be employed for relative readings, which is all that is required. The actual value of current passing through the choke is usually not of any significance; the results usually desired are the leakage currents as a function

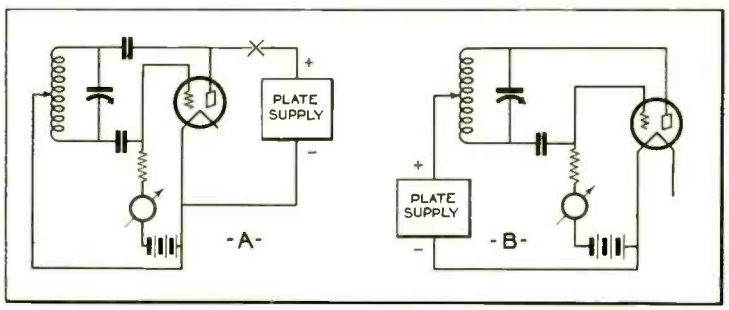


Fig. 4. Shunt-feed Hartley circuit. Series-feed Hartley circuit.
Comparison of r-f. voltage with and without chokes.

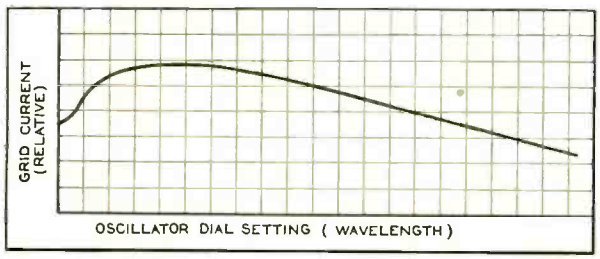


Fig. 5. Typical curve showing variation of grid current with increasing wave length.

of the frequency range over which the choke is required to operate. By testing various chokes, it is possible to select one of good efficiency. A fixed crystal-detector and low-range milliammeter will give results for a low-power set.

"Ideal" and Practical Chokes

In any oscillator arrangement, the "ideal" choke would be a winding such that when connected in the oscillator (for example, as in Fig. 2) the strength of the oscillations would not suffer. A choke of indifferent construction allows a loss of energy from the oscillator, which is equivalent to increasing the resistance in the oscillating circuit itself, in its effect. The strength of the oscillations is decreased. This effect can be studied by means of the two circuits shown in Fig. 4. The upper diagram (A) of a shunt-feed arrangement requires a choke but has certain other advantages; the lower diagram (B), is a series-feed arrangement which requires no choke coil, but has some practical disadvantages as has been described .

By comparing results obtained by the use of the these two circuits, the effect of various chokes on results can be studied by noting the deflection of the grid meter. Circuit values and voltages should be identical in each circuit, or the same circuit can be used by changing connections.

The parts for such an oscillator (tuning from about 50 to 200 meters) consist of a 1000-mmf. condenser, a coil of 10 turns of No. 14 wire on a three-inch diameter, a type '01-A tube, a 5000-ohm gridleak and a 1.5-milliampere d-c. gridmeter. By noting the grid current at various frequencies for the series-feed arrangement, and then changing connections to shunt-feed (with choke) the effect of the various chokes on oscillation strength can be determined. The data obtained from the series-feed connection can be used as a standard for comparison. Since different circuits will alter the characteristics of a given choke, it is best to design experimentally a choke for a given purpose. For testing chokes of various kinds and dimensions, the above arrangement requiring a minimum of laboratory apparatus, is recommended. Due allowance should be made for changes later. It will be noted that the grid current decreases naturally as the ratio of inductance to capacity in the oscillating circuit is decreased as shown in Fig. 5. This reduction will, of course, also appear in the shunt-feed arrangement. The chokes giving the highest grid currents, consistent with a "flat," gradual reduction as the wavelength is increased, are the best. The better chokes will approach closely to the grid-current curve obtained with the series-feed arrangement.

I.R.E. MEETING AT ROCHESTER

THE Rochester fall meeting of the Institute of Radio Engineers will be held at the Sagamore Hotel, Rochester, New York, on November 21, 1930. The program is as follows:

Registration 9:00 a. m.

Morning session 10 a. m.

"The 227 Equi-Potential Cathode Tube," by A. C. Rockwood, HyGrade Lamp Works.

"Notes on Circuit Design," by Fulton Cutting, Colonial Radio Corp.

Luncheon 12:30 p. m.

Afternoon session 2:00 p. m.

"Some Considerations in Superheterodyne Design," by David Grimes, Radio Corporation of America.

"A New Low-Distortion Radio Amplifier Tube, Type 551," by Stuart Ballantine, Radio Frequency Laboratories.

"The Thyratron, What It Is, and What It Does," by J. C. Warner, General Electric Company.

Dinner 6:30 p. m.

Evening Session:

"Extending the Radio-Frequency Spectrum," by A. Hoyt Taylor, Naval Research Laboratory.

Dr. J. H. Dellinger, past president of the Institute, has consented to preside. All the speakers are men of importance in the industry. Their messages will be timely and very valuable.

50 PER CENT OF RADIOS ARE OVER 2 YEARS OLD

MORE than half of the homes in this country that are equipped with radio have sets that are more than two years old, it is estimated by Dwight F. Ketcham, sales promotion manager of E. T. Cunningham, Inc., radio tube company.

With the many refinements which the 1930 receivers have incorporated, Mr. Ketcham believes that the proportion of homes so equipped with old units will be reduced by more than fifty per cent before end of the present year.

BETTER EMISSION EFFICIENCY WITH USE OF THORIUM

The thoriated tungsten filament differs from the construction principles of other types of radio tube filaments in that the active material is not coated on the surface during manufacture, the thorium content being distributed throughout the body of the tungsten wire, it is explained by a Cunningham engineer.

High emission efficiency has been achieved with the thoriated filament, through the characteristics of this material, in which a uniform layer of atomic thorium is built up on the surface of the filament in the final factory process, it is stated.

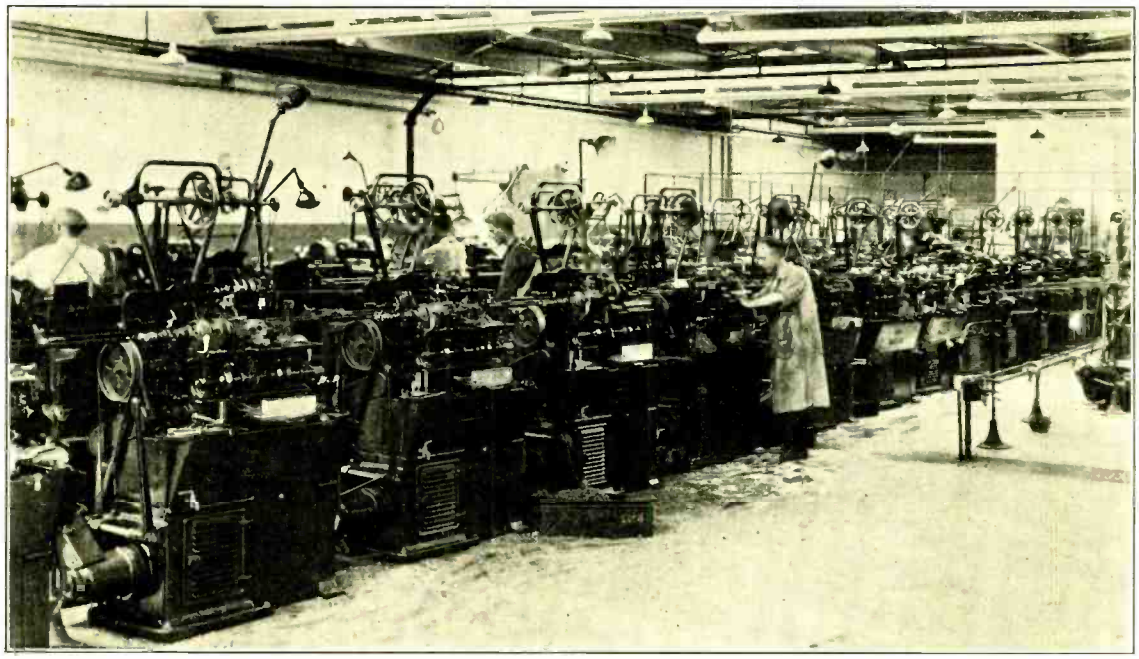
In operation, this surface layer of thorium evaporates very gradually to supply the plate current requirements but additional thorium is continuously supplied at the same rate from the interior of the filament. This cycle continues very smoothly, maintaining a uniformly active surface condition throughout the life of the tube, providing that the operating voltages applied to the tube are maintained at values recommended.

A REVIEW OF HIGH FREQUENCY ATTENUATION DEVICES

(*Concluded from page* 26)

impedance has been found useful to 60 megacycles per second although it cannot be considered a very satisfactory solution due to the high minimum voltage limit of 250 microvolts and its inconvenience for rapid routine laboratory work. The mutual inductor attenuator (RADIO ENGINEERING, June 1930) is stated to hold calibration to about 6 megacycles per second. In view of its simplicity of operation, this instrument represents an important step forward in the extension of measurements technique to the higher frequencies. Short-wave receiver development will undoubtedly be accelerated when more suitable measuring apparatus and methods have been devised. It is to be hoped that this time is not far off.

Fig. 2. It costs a good deal more to keep these automatic screw machines running than the wages of the operator.



Why Cost Finding In Radio?

By AUSTIN C. LESCARBOURA
Mem. I. R. E., Mem. A. I. E. E.

TO the average production man, cost accounting is a highly involved process engaged in by semi-demented individuals who speak a jargon of their own, and who from the secret ritual of black art, produce each month figures that are used as a club on his unsuspecting head to convince him that he doesn't know anything about running his department, anyway. These people speak a language of their own which sounds like good "plant" English, but which doesn't mean anything. The good foreman takes his visit to the carpet resignedly and departs with the accompanying thought that it is all over for another month, and that those "blank-blank cost sharps" are only a bunch of pen pushers. What do they know about production, anyway?

▲

Deprived of Its Mysterious Jargon, Cost Finding Technique Comes Down to a Simple Essential of Radio Production.

In the present state of the radio business the cost accounting man is one who is becoming more and more important as competition becomes keener. This condition is only normal in the life of an industry, and every business has followed the same cycle with its attendant growing pains and upheavals. When an industry first comes into being, production lags so far behind demand that price is a minor consideration. The eager public buys and buys factory output at such a rate that errors and wasteful methods are simply passed on to the consumer as an increased cost. However, as the production gradually catches up with the demand, and as a myriad of companies and individuals engage in the industry to reap part of the profits, competition forces price down until finally the industry reaches the point at which sales are made mostly on a basis of price. The greatest component of price, however, is cost; for it is easily apparent that cost plus a profit makes price.

Radio Must Get in Line

Within the last year every industry in the country has become increasingly cost conscious; and radio, still in the process of stabilization, will become even more so. To the average manufacturing man this emphasis on cost necessitates some investigation as to its real meaning, and the surprise that is in store for many lies in the fact that a subject which, on first inspection, appears so involved, can really be so simple.

Cost is made up in the main of three main divisions. The manufacturer buys *material*; this may be raw material or semi-finished material, such as raw lumber stock, or a finished condenser. In his factory the manufacturer either changes the form of this material or assembles it into his

Fig. 1. One of eight assembly lines in a modern radio plant. A good cost accountant can tell without leaving his desk which of the eight is jacking up costs and whether the cause is too many men, too much overtime, or too high wages.

product. This process is the process of manufacturing and adds the *cost of manufacturing* to the cost of the material. The product completed, the manufacturer must now sell it, which adds a third factor to the cost, *the selling cost*. This selling cost is composed of the cost of the sales organization, and advertising. A profit is then added to the cost and we have the selling price.

But we find in modern merchandising that when the period of keen competition is reached, as it is reached in radio today, the starting point is not the cost of the product, but the price at which it can be sold. In the early days the manufacturer first found out what it cost to make his product and, adding a profit, fixed his selling price. Today he finds out what he can get for his product, and the decision is whether or not he can make it to sell at that price. This condition makes him examine his costs with a very keen eye and gives rise to the importance of cost accounting.

Sales Methods Ahead of Manufacturing

The function of the cost accountant is to tell the manufacturer not only what his unit of production should cost, but also what it does cost and, further, where in the manufacturing process discrepancies occur. Since sales methods have gone ahead a great deal faster than manufacturing methods in the radio industry, we will not touch on selling cost in this article. The average up-to-date sales manager well understands how his selling price is distributed and where it is out of line. Up to the present time, however, the manufacturer has been so busy getting out his production that he does not realize the full possibilities that lie in accurate cost figures as the means of management.

How does the cost accountant go about his job? Well, he first divides the process into its logical accounting divisions. These divisions will be dictated largely by definite completed steps in the process, and in each of these departments he will work up the cost figures. For instance, the screw machines will be taken as one department and cost figured for the screw machine department; the lathes may be taken as another department. Assembly may be divided into its natural groups, and so throughout the plant the cost accountant will break down the unit cost figures into logical steps at those points where the process changes from the control of one foreman to another.

Each department receives a certain amount of material. This may be in the form of a semi-finished product or a raw material. The assembly department will receive screws from the screw machine department, and small parts from it and the lathe department. The screw machine department will receive its raw stock, however, from an outside source. In each of these cases the cost man will determine just how much material will go into the unit of production of the department. Thus he will figure how much raw stock will go into a thousand of a particular type of screw. This establishes a standard amount of material used per unit of production. This standard can then be used as a basis to determine whether or not any department is wasting material. Not only by this means does the management find out whether or not the material is costing more than it should, but the tabulated cost figures show in just which department any excessive waste occurs, so that steps can be taken to eradicate it.

The cost of manufacture is a more highly involved accounting process. Manufacture includes direct labor, indirect labor, power and heat, repairs, supplies, etc., and fixed expense which means investment in the property, bond interest, etc. Of these, unenlightened management is most apt to stress direct labor and neglect the indirect item of expense. The cost accountant reduces the lump sum of indirect expense to its components in the different departments, and so is able to show the management just how much each department is costing in any one of the many items of expense. Since production figures are now available, the management can determine the cost per unit for any item of expense.

Real Costs

However, when the cost department shows actual cost, its work is but half done. It must then compare these costs with the theoretical cost and show where there are wasteful operations. Modern piecework leads many industrial men to say: "We pay only for the labor used on a piecework basis; therefore, we don't have to worry about our costs in manufacturing." This attitude very often leads to a great discrepancy between gross costs and the standard gross cost, for while the direct labor is only paid for on a production rate, the cost of maintenance, power and interest on the investment of a screw machine goes on whether it is running at maximum capacity or not.

In the present condition of the radio industry, therefore, it is advisable, first, for the management to get a cost accountant who knows his business. He will know exactly how to go about breaking down the cost into units that really tell the story. The manufacturer, however, must sit down and try to understand the figures which come from the cost department. The realization that these figures are simply a statement of the cost of manufacture and material broken down in such a way that he can place his finger on waste of any kind, will have to overcome the mental hazards that have been built up around the term "cost accounting." His figures will show him, first, how much material he should have used in each point of the operation and compare it with the amount of material he did use. They will show him the amount of labor he has used as compared with what he might have used. They will show him the indirect cost per unit compared with the standard indirect cost per unit. The danger, however, is that these figures may be sent to the production man stated in terms which he does not immediately understand. If the screw machine foreman is told that he used $320 worth of raw stock more than he should have used, he understands that perfectly; but when he is told that his burden, due to over-consumption of raw material, is $320, he is very apt to come back with a snappy expression. When he is told that his fixed expense exceeded his standard by $200, he is apt to say, at least to himself, "Well, let the superintendent worry about fixed expense; I can't knock fixed expense down." But if he is told that his production per machine hour has increased the cost of running those machines by $200, he is very apt to know what the superintendent is talking about.

Every cost man can translate his trade jargon to the everyday language of a manufacturing plant, but he is apt to use accounting terms unless the operator insists, with a smile, that these terms be translated into "plant language."

Increasing the Number of Radio Channels

The United States Signal Corps Continues to Make Improvements in Government Network. Short-Wave Beam System Installed.

By S. R. WINTERS

WITH the installation of seven short-wave transmitters and with two similar units in process of manufacture, the Signal Corps of the War Department is encroaching heavily upon the high-frequency spectrum in the operation of its nation-wide radio net. This move is made to accommodate the increasing radio traffic of this Government department and also in order that the Signal Corps may keep abreast of the developments in the latest short-wave transmitters and receivers.

The seven transmitting sets, although having a normal power rating of 1,000 watts, this factor is flexible—it being possible to jump from 1,000 to 10,000 watts. This is accomplished by the use of a 10,000-watt short-wave power amplifier, which covers the identical wavelength range of the 1,000-watt transmitter. This flexible power factor is in the interest of economy—that is, when 1,000 watts is sufficient to put the traffic through to destination, only that amount is employed; otherwise, 10,000 watts of electric energy are utilized.

These short-wave transmitters function in four bands of wavelengths, respectively, as follows: 4,000 to 4,525 kilocycles, 8,000 to 9,050 kilocycles, 12,000 to 13,575 kilocycles, and 16,000 to 18,100 kilocycles. Adherence to these assigned frequencies is apparent when we are told that the slabs of quartz crystals governing these respective transmitters are precise to one one-hundredth of 1 per cent at their operating temperature of 50 degrees Centigrade. Moreover, these transmitting sets maintain an unvarying frequency within 0.025 per cent under normal operating conditions.

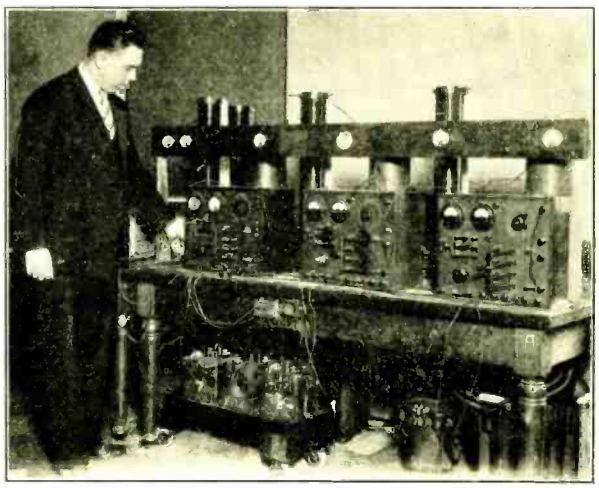
The vacuum tube oscillator unit is of Western Electric Company manufacture and is known in the Signal Corps as type VT-4-B. A thermostat controls the temperature in the chamber occupied by the nine crystals, any one of which can be placed in the crystal circuit by a master switch. The first and second intermediate power-amplifier stages each uses 75-watt shielded-grid tubes, type UX-860, one in the first stage and two in the second stage. This vacuum tube utilizes 3.25 amperes at 10 volts for heating the filament elements and a plate power supply at 1,500 volts. The principal power-amplifier stage employs two 750-watt shielded-grid tubes, type UV-861. These tubes consume 10 amperes at 11 volts for heating the filament elements and their plate voltage is 3,000 volts, direct current. The filaments are lighted from a filament transformer—provided with four secondary windings, one for each stage. A motor-generator furnishes current for the plate and grid bias.

Single Antenna System

The four wavelength bands covered by these transmitters may be embraced by the use of a single antenna. This is accomplished by a flexible feature of the antenna. However, the Signal Corps admits that the use of two antennas—one 50 per cent longer than the other—is advantageous, especially at certain wavelengths. These sending sets are intended to operate into a 4-wave antenna, calculated from the antenna binding posts on the transmitters to the free end and as referred to the operating harmonic in the 16,000 to 18,100-kilocycle band. The Signal Corps also employs the wave-resonance principle, as enunciated by Dr. Louis Cohen, in the operation of several transmitters from one antenna, using different wavelengths and without mutual interference.

New Radio Receiver

The latest acquisition to the receiving equipment of the Signal Corps is the type known as BC-155. Its components are a stage of tuned radio-frequency, a regenerative detector, and two stages of audio-frequency amplification. A shielded grid, 4-element vacuum tube, type UX-222, is employed in the radio-frequency amplifier. A shielded and balanced input transformer is employed on this tube. This, we are told, obviates effect on beat-note frequency, tuning of the detector or setting of regeneration, attributed



Modern equipment in Signal Corps radio center.

A general view of the Radio Section consisting of twelve high-frequency positions and two intermediate frequency positions. Radio routing desk at the left with automatic message carrier system connected with the main message center routing desk.

to changing of the antenna. For example, a trailing-wire antenna on an airplane may thus be used without variations in tuning.

The detector tube is of type UX-240, and in operation it behaves in accordance with the grid-rectification principle. Regeneration is obtained by a fixed tickler coil and this is governed by a variable by-pass condenser. The detector regeneration circuit may be so manipulated as to insure smooth starting and stopping oscillations at all of the wavelengths embraced by this receiving set. Type UX-201A tubes, so common to broadcast listeners, are employed in audio-amplifier stages.

This new receiving set almost runs the gamut of the workable bands of wavelengths—functioning from 1,200 to 25,000 kilocycles. A group of plug-in inductance coils makes the coverage of this extensive frequency band possible. The plug-in coil includes the radio-frequency plate coupling coils the detector grid tuning coil, and the tickler coil. The antenna coupling coil remains constant over the entire band of wavelengths. The signal energy of the two-step audio-frequency amplifier can be snatched directly from the plate circuit or from an output transformer. The latter matches an output impedance of 3,000 ohms when employed with a vacuum tube of 201-A type. The output transformer can be inserted into the output of the detector, the first stage of audio-frequency amplification, or the second stage of audio-frequency amplification.

Shields and Filters

This unusual receiving set is housed in a shielded case and the antenna coupling tube is further divorced and shielded in a separate compartment. The battery lead wires are equipped with radio-frequency filters, thus obviating radiation from the batteries. For a like reason, condensers are placed on the secondary winding of the output transformer. Body capacity effects are thus eliminated. When this novel receiver is rendered extremely compact for use on airplanes it has earned the nickname of "pancake" receiving set—a descriptive term suggested by this writer and accepted by the Signal Corps.

Short-Wave Beam Radio

With the completion of a new short-wave transmitting station at Fort Myer, Virginia, the Signal Corps is introducing the beam transmission system of radio communication in handling radio traffic for the 55 Government bureaus now utilizing the facilities of the war department message center. This departure means that directional short waves will carry messages to the far-flung corners of continential United States and our insular possessions—the electric energy being concentrated in a given direction instead of being diffused in all directions. The directional effect is achieved by use of reflectors which catch and reflect back the radio waves in a manner not dissimilar to the mirror of a searchlight in catching and reflecting rays of light.

The new radio installation at Fort Myer is comprised of three groups of transmitting sets—one 10,000-watt, two 1,000-watt, and three 500-watt high-frequency transmitters. Their frequency range is extensive—from 4,000 to 18,000 kilocycles—and the six sending sets have been so installed as to afford maximum flexibility in the selection of any one, or any group of frequencies. Beam transmission—the first attempt to handle traffic out of Washington by directional waves—will be effected on the 16,000 and 12,000-kilocycle bands. The signals on both beams have a spread of approximately 60 degrees, thus insuring coverage of the entire United States from north to south. The directional antenna system is not cramped—there being virtually unlimited room for expansion around the Fort Myer station.

This transmitting station, literally lifted out of a basement and given occupancy in a new 40- by 70-foot building, is to operate on a 24-hour schedule. Hourly, day and night, it will be in direct radio communication with the following points: Seattle, Wash.; San Francisco, Calif.; Manila, Philippine Islands; Hawaii, Hawaiian Islands; Panama, Panama Canal Zone; San Antonio, Texas; Omaha, Nebraska; Chicago, Ill.; Atlanta, Ga.; Columbus, Ohio; and Boston, Mass. In addition to establishing communication with the above-mentioned land stations, these high-frequency transmitters will have contact with United States Army transports at sea. The traffic at present from Washington alone varies from 1,200 to 1,500 messages a day; the short-wave transmitters at Fort Myer being controlled and keyed remotely by enlisted radio operators in the message center, located in the munitions building.

New Message Center

If not by design then a happy coincidence, simultaneous with the completion of the new transmitting station at Fort Myer, is the occupancy of new and larger quarters by the message center of the Signal Corps. Captain Frank E. Stoner and his staff of 52 assistants are now located in a spacious room, 60 by 100 feet, on the third floor, rear, of the munitions buildings. With a single file of 14 radio operating desks and with a radio routing desk at the left—associated with an automatic message-carrier system leading to the main message center routing desk—the system in handling a traffic of 1,500 messages a day is bereft of any confusion and without that bustle that one might expect in a radio operating room of such wide ramifications.

This is a globe-girdling communication system. While its direct radio communication is limited to continental United States, its reach is not circumscribed by interlinking this radio net with the telegraph and cable companies, domestic and trans-oceanic telephones, and international short-wave radio circuits, a message originating here could as easily find its destination in Patagonia as in Boston. The radio receiving and routing desk, for instance, is at present directing into the channels of cable, radio, and telegraph approximately 1,500 messages each day.

Extensive Use of Service

The enlarged and constantly expand-

(*Concluded on page* 46)

Essential Tests for Component Parts of Electrical Radio Receivers†

This Paper Deals With Production Tests Employed On the Various Parts and Also On a Complete Radio Receiver

By HERMAN E. KRANZ*

Power Transformers

AFTER the power transformer has been assembled, it is given a very low voltage test, to determine whether there are any high resistance connections or not. This test is made before impregnation.

After impregnation, the transformer is tested with a dummy core to determine dielectric strength, and it is then placed in a circuit having the same load requirements as the standard unit. The voltages on the various windings are read, and a check for exciting current and leakage is made.

After the coil has been impregnated and laminated, it must meet the same requirements, with an additional test for insulation between layers of the secondary winding. This is accomplished by increasing the voltage of the primary to twice its normal working value, thereby doubling the secondary voltage, and causing poorly insulated windings to break down.

The completed transformer must meet the following requirements; dielectric strength determined, between each winding and every other winding, and between all windings and the case. Other tests such as insulation, resistance, and leakage, and the voltage output of different windings, are also instituted.

Choke Coils

After winding and before impregnation, the coils are given a test for short-circuited turns, to prevent defective coils from being finished and impregnated.

After impregnation and before lamination, they are given a continuity test.

After being laminated, the coils shall meet the following requirements: dielectric strength between winding and core is determined, using approximately four times the normal working voltage.

An impedance test is then given, and the coils are placed in a circuit using the same load conditions as it would receive under normal working conditions. The choke coil is also given a hum test to determine any mechanical or electrical hum.

After the choke has been completely assembled and is in its case, it must meet the same requirements, with an additional check for dielectric strength between the coil and the case.

Audio-Frequency Transformers (Input)

After the winding of the input transformer has been completed, a test for short-circuited turns is given. Also due to the fact that an accurate balance is to be obtained in the secondary circuit, a test is employed whereby one short-circuited turn will show up.

After the coils have been impregnated and after they are laminated, they are given a test for reversed leads and core size.

The coils are now laminated and tested for opens and shorts, dielectric strength between each winding and all other windings, and between all windings and the core, using approximately four times the normal working voltage. Insulation, resistance, exciting current, gain and balance of secondary, are also tested.

The transformers must meet the same requirements, after being completely assembled, and in the case.

Audio-Frequency Transformers (Output)

The output transformer must meet the same requirements as the input transformer with the exception of the exciting current test. The primary of the output transformer is also tested for balance in the same manner as the secondary of the input transformer.

Radio-Frequency Transformers

In the preparation of the radio-frequency transformers to be used in the radio-frequency unit, the following tests are given: each coil (that is primary, secondary, and balance) is tested for short-circuited turns, before being assembled into a completed radio-frequency transformer. The completed radio-frequency transformer is then checked for inductance, and the coils are placed in groups. Usually eighteen groups are used, and five coils taken from any one of these groups may be used in an r-f. unit. Under no circumstance should coils from more than one group be used in one unit. Variance in capacity between group No. 1 and group No. 18 is about 15 μμf.

The coils are also given a test for d-c. dielectric strength between terminals of each winding, and every other winding, to determine whether any acid was used in soldering the leads.

Gang Condensers

After the gang condenser has been completely assembled, it is given a suitable dielectric strength test between rotor and stator throughout the entire range of tuning, to be certain that no short has been caused, due to burrs or flashes.

After this test has been instituted, the gang condenser is then checked with a capacity bridge and aligned in five positions. Variance of accuracy over entire tuning range must not exceed 1 μμf.

Paper Condensers

Paper-wound condensers used in the power supply, and also those used in the radio-frequency plate and cathode circuits, are given the following tests:

Paper: Condenser tissue before being placed in the lines of production is tested for ionization, and for the number of conducting particles per square foot.

Foil: The foil employed in these condensers is tested for thickness, wrinkles, and flexibility.

After dehydration and impregnation, a sufficient number of condensers out of each lot are checked for insulation resistance, to determine the efficiency of the vacuum drying ovens. The completed condenser, impregnated, is then tested for dielectric strength, using approximately three times its normal working voltage as a flash test.

(*Concluded on page* 46)

† *Presented at June* 1930 *meeting, Institute of Radio Engineers, Atlantic City, N. J.*

* *Vice-President in charge of Engineers, Grigsby-Grunow Company, Chicago, Ill.*

Education by Radio

The very extensive and painstaking investigation carried out by Mr. Armstrong Perry of the Office of Education, Department of the Interior, Washington, and which was submitted to the Advisory Committee on Education by Radio, has been embodied in a report to the Secretary of the Interior.

The following is from this report as made up by John Cooper, chairman of the committee.

THE extent to which educational material is broadcast is indicated by the survey conducted by the Office of Education, Department of the Interior.

The Fact-Finding Committee found that:

(a) Seventy-seven (12.3 per cent) of the 627 licensed broadcasting stations are owned and operated by educational institutions. Fifty-one of them report a weekly average of 8 hours of broadcasting, 2½ hours of which is called strictly educational.

(b) Two hundred seventy-one commercial stations report a weekly average of 57 hours broadcasting, of which 7½ hours (13 per cent) are called educational. The National Broadcasting Company reports that the Damrosch Music Appreciation Hour course in music, now in its second year, is reaching 150,000 schools. The Columbia Broadcasting System, in cooperation with the Grigsby-Grunow Company began on February 4, 1930, an educational program in history, literature, music and art, prepared under a corps of experts headed by Dr. William Chandler Bagley of Columbia University.

(c) Eight State Departments of Public Instruction report the use of the radio for educational purposes. The State of Ohio maintains an organized program of school work for one hour every school day, supported by the State legislature which has appropriated $20,000 per year for a two-year period. The Superintendent of Public Instruction for the State of South Dakota reports that the educational forces of the State are organized and ready to institute a State program in South Dakota.

(d) Six hundred and thirty-five (32.6 per cent) of the 1,946 school superintendents who answered inquiries reported radio receiving equipment installed in 1,606 school buildings. 57 of the 253 Massachusetts high schools had receiving sets. North Carolina reaches most of its 142 high school vocational departments by radio; South Dakota reports 22 rural schools and Iowa 46 rural schools equipped. The city of Nashville reports all schools equipped with receivers, and Cincinnati has a school board order requiring all new schools to be "completely wired for radio."

Nature of Educational Material and Some Problems Involved

The Committee finds that there are two distinct fields: First, broadcasting the materials of formal school work; and second, broadcasting for adults.

Since school materials must be broadcast during the hours schools are in session, the various time belts constitute a serious obstacle to successful work over a national chain. Probably the best units are large school districts, a radio union of school districts or State Departments of Education. Successful experiments have been reported from Atlanta, Chicago, Cleveland, Dallas, New York City, Oakland, Calif., Richmond, Va., and other cities; from Fort Bend County in Texas where the County Board of Education owns and operates a station KGHX; from a union of three counties in Illinois; and from several States, the best organized of which is Ohio.

Almost every subject has been broadcast, but little has been done in grading the work and almost nothing in scientific evaluation of the results.

Among the many problems to be solved in this field are: (1) Ascertaining what subjects, if any, may be better taught over the radio than in formal school procedure. Many believe that courses in Government may be better taught in this way. (2) Discovering which subjects may be supplemented by radio. If much of the school work in music and in art, especially the appreciation aspects of these subjects, can be done over the radio by experts the work of the classroom teacher should become more effective. For music, the Standard music hour on the Pacific Coast and the Damrosch concerts have demonstrated almost unbelievable possibilities. (3) Learning in what subjects radio may be used to stimulate interest or motivate the work. It is likely that high school teaching in foreign language, history, literature, and science, can be improved in this way. (4) Discovering the requirements in voice, composition, etc., for good teaching over the radio. (5) Finding out by actual experiment those courses which may be broadcast most satisfactorily on a local basis, on state-wide basis, and on a time region basis. (6) Developing a plan for financing and administering broadcasting if it extends beyond the boundaries of a well-established political division. (7) Perfecting tests to be used in checking the results. If the broadcasting is regional we must determine who will prepare the programs and coordinate the testing. (8) Developing a plan to keep school programs free from propaganda on one hand and the deadening effect of censorship on the other.

Broadcasting educational material intended for adults presents quite different problems. In this field experience in Europe, particularly Great Britain, deserves a special study since the English issue a magazine outlining and illustrating lectures given over the radio which is sold on the newsstands in increasing numbers. In the United States where no monopoly exists commercial stations, political parties, advertisers, organizations of many interests, several Federal departments, notably Agriculture and Commerce, State Departments of Education, colleges and universities, have all tried their hand. Subjects broadcast are as numerous as human interests are wide.

Some of the major problems are: (1) Those involved also in formal school work such as voice, quality and tone, composition, style, etc.; (2) Ascertaining the most favorable hours. For many adults evening hours only can be used; (3) Determination of the proper proportions of materials of formational character and materials designed to raise standards of taste; (4) Obtaining accurately listeners' reaction; (5) Determining the effectiveness of radio instruction where it is formal in character; (6) Ascertaining its value as compared with correspondence lessons, extra-mural lectures,

(*Continued on page* 44)

and other devices used by university extension authorities, and as a supplement to them; (7) Consideration of the advisablity of giving courses for college credit in this way. Eight institutions are now experimenting in courses for credit.

Reconciling Educators and Commercial Broadcasters

In a chapter on educational extension in the Survey of Education for the biennium ending 1922, attention was called to radio particularly as a factor in university extension work. "In radio," it is written, "education has found a new and powerful ally. Sixty educational institutions are broadcasting educational and musical programs, 47 of them being colleges and universities." Thus enthusiastic in the beginning was the schoolman's interest in this subject. In 1929 educators throughout the country heartily endorsed education by radio. Many stress the fact that radio is more a means of intellectual inspiration than of direct communication of facts or culture. The objectives of a series of educational lectures as stated by officials of the University of Cincinnati recently, were "to impart high lights of information," to "stimulate persons to pursue further study," and to "widen the interests of those who have passed their period of formal training." A small minority expressed the opinion that education over the air had a very limited field because the American people are always on a quest for "culture" without any intention of working for it.

The Committee finds the commercial interests declaring themselves interested in educational work, offering "time on the air" without charge, and cooperating in the fullest measure with this survey.

General lack of cooperation between the two groups, however, exists. Doctor Shipherd summarizes these conditions as follows:

> "General lack of cooperation between the two groups appears; as in (a) widespread distrust among educators of commercial motives and "propaganda"; (b) the belief among the educational stations that they are given the inferior positions on the broadcasting spectrum and in the allocation of hours; (c) the tendency among commercial stations to reduce educational programs to shorter and poorer periods as their time becomes more salable; (d) the practice among the commercial stations of offering educational programs to cultivate general good will and create publicity, rather than to build up a sound educational method and research with the help and guidance of educational experts."

Mr. Armstrong Perry of the Payne Fund, who, on behalf of the committee, visited broadcasting stations in every State in the Union and interviewed the persons chiefly concerned, reports that radio is attracting a "large and increasing volume of advertising," and that "time that once was given to educators without charge was being restricted or withdrawn in some instances." In further explanation Mr. Perry writes:

"The only considerable group of broadcasting stations devoted primarily to educational purposes was composed of those owned and operated by colleges and universities, many of which were State institutions. As the well-organized and powerful commercial broadcasters struggled to acquire radio channels, the educational stations were more and more restricted. The tendency was to drive them off the air in the evening and confine their operation to the daylight hours, when their effective range was only one-tenth of the radius covered at night and when listeners were more likely to be at work than sitting at their receivers. There developed also a tendency to restrict the amount of power used, and to assign to the educational stations wavelengths at the ends of the tuning scale, where it might be difficult or impossible for listeners to tune in their programs."

FALL MEETING OF I.R.E.

A FALL meeting of the Institute of Radio Engineers will be held at Rochester, N. Y., on Friday, November 21. The meeting will be held at the Sagamore Hotel, beginning 10 a. m.

There will be presented three technical papers on vacuum tubes and two papers on radio receivers.

Dr. J. H. Dellinger, past president of the Institute, will preside.

The head of the National Broadcasting Company, pointed out to the Committee two of the principal reasons for the apparent tardiness of commercial broadcasting companies or stations in systematic presentation of educational material. They are:

1. The National Broadcasting Company has felt that both in the interest of education and of industry, it was important that educational programs should be developed not by broadcasters, but by representative educators themselves in order that any taint of commercial propaganda might be avoided. Educators so far have failed to act in furnishing us with such programs in spite of offers to make nation-wide facilities available.

2. Educators have so far failed to adapt their material to the technique required by the new art.

In brief it has been found that:

(a) The largest listening audience is available between seven o'clock and ten o'clock in the evening. This audience consists of groups who desire: (1) educational programs for vocational or cultural improvements; or (2) mere entertainment of one kind or another.

(b) The commercial advertiser is searching for the largest number of potential buyers and endeavoring to get them in a frame of mind to receive a clever sales talk. His interest in education apart from this narrow propaganda interpretation of it is slight.

(c) The educator is best acquainted with methods of teaching adapted to young people working under conditions which practically compel them to listen. He must develop voice qualities, new composition styles, and new teaching techniques if he is to get and hold any who do not feel much the same compulsion to hear as do those in regular classes.

(d) Radio broadcasting is expensive in equipment, in maintenance, in operation, and in program making. So far the listeners have paid for benefits received only indirectly in the price of their receiving equipment or in the goods advertised. Assuming that the expenses of formal school programs will be met as other school expenses are met, the financing of programs for adults is as yet uncared for in any satisfactory manner.

At the present time the so-called commercial broadcaster is in a better position as regards the engineering and business aspects and in knowledge of radio technique, while the school people are potentially better equipped in the way of program talent for educational purposes.

Some Research Problems

The subcommittee on research gave special attention to (a) collecting techniques of investigation now in use in attacking problems of education by radio; (b) attempting to formulate policies for a program of further research study.

In the former field those who visited stations and educational institutions collected such material as could be found, which, in toto, the committee reports as "meager" and "almost entirely in the listeners' field." Broadcasters anxious to ascertain the popularity of programs have conducted house-to-house canvasses, employed questionnaires, analyzed newspaper clippings, made telephone surveys, offered prizes to correspondents for reports, and have placed personal representatives in some local communities to gather data. Of all these methods, used in almost feverish haste, none has been refined to a degree which merits the term scientific. In the second field the committee finds the broadcasters very anxious to measure the results of their work accurately and believes that properly staffed research agencies will receive hearty cooperation. Such research agencies are sadly needed.

Organizing the various problems in the order in which they must be solved by those contemplating a broadcasting program, the committee suggests that techniques be developed to enable any

Now....

A NEW PATENTED CONSTRUCTION PRINCIPLE

MANUFACTURED BY WASHERS **Everlock** TERMINALS THOMPSON-BREMER & CO.

U. S. PATENT NO. 1775705

EVERLOCK washers and terminals have a new patented locking feature which is the secret of the tenacious grip and the positive lock.

EVERLOCK steel washers are coated after fabrication to prevent rusting.

EVERLOCK terminals are hot solder coated which makes them easy to solder and speeds up production.

Our manufacturing methods make it possible to quote prices in keeping with present economy programs.

We manufacture

EVERLOCK washers

••

EVERLOCK terminals

••

Eyelet terminals

••

Plain terminals single or double

••

All are hot solder coated after fabrication

••

Special terminals made to order

••

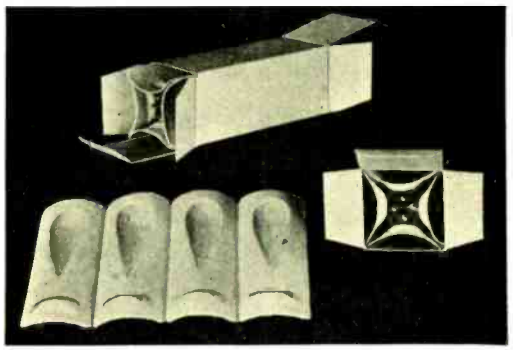
Send us your specifications

THOMPSON-BREMER & CO.
1750 Carroll Avenue .. Chicago

WASHERS **Everlock** TERMINALS

The LAST WORD

More Safety Less Cost



HOLED-TITE
TRADE MARK NEW YORK
Radio Tube Wrapper

HOLED-TITE RADIO TUBE WRAPPER which is revolutionizing tube packing.

Check These Features:

1. Wrapper is light and form fitting and designed especially for each size of tube. Consequently, it provides suspension and perfect protection.
2. Suspension packing protects against lateral shocks and distortion of elements.
3. Tube can be tested without removing from carton, without tearing or defacing the wrapper.
4. Wrapper is easily and quickly handled, even by unskilled packers.
5. Wrapper costs less than any other packing.

Holed-Tite Wrappers are made for all types of tubes *to fit the standard bulb sizes.*

Write for samples and prices today. Protect your tubes; save money.

Holed-Tite pad for packing standard cases of 25-50-100 radio tubes. Pad comes in 3 sizes. Do you want samples?

HOLED-TITE PACKING CORP.
220 E. 42nd St., New York City
Affiliated with International Paper Co.

institution: (1) to discover whether or not it should attempt broadcasting by ascertaining the possible field for its activities, by estimating the cost of broadcasting as compared with other methods of instruction, by study of the possibility of reaching the desired audience and securing results through radio as compaared with other methods, and by estimating the effects of such a program upon other policies of the institution; (2) to develop methods of overcoming intertia, mistrust, and fear of commercialism, should its investigations indicate that it should broadcast; to secure easily official recognition if it uses its own station or to determine what commercial station is best suited to its needs; (3) to handle, after the station facilities are arranged, scores of problems connected with the program itself, such as kind of talent, its availability, and cost; the development of proper voice and manner before the microphone; the maintenace of scholarly accuracy of material in a form which will reach the listeners effectively. This is likely to involve a whole department for preparing manuscripts and conducting rehearsals and its set-up must be studied; (4) to establish curricula best adapted to adults and children. These must be studied carefully, the former in regard to interests, needs, and previous schooling; the latter in regard to subject matter, grades, other interests, and distractions; (5) to secure accurately listeners' reactions and evaluate them.

The problems concerned with equipment appear to be going forward rapidly in the engineering laboratories of the manufacturers themselves and call for no special attention from the Committee.

Recommendations

In view of the facts found and necessarily summarized in brief space the Committee recommends:

1. That there be established in the Office of Education, Department of the Interior, a section devoted to education by radio, and charged with such responsibilities as the following: (a) to receive from the Advisory Committee on Education by Radio its files and collected documents, to keep this material up to date and available for reference by the many students of the subject; (b) to organize some of the material into bulletins to be issued as demand warrants; (c) to outline techniques for research and carry on investigations into the best methods of broadcasting and compare the results of lessons sent to schools by radio with the results obtained by other means; (d) to keep the educational interests of the country fully posted on and alive to the importance of this new instrument as an educational tool; (e) to attempt to prevent conflicts and duplication of effort between various broadcasting interests; (f) to furnish advice on the educational soundness of programs suggested and to supply typical programs upon the request of any station whether educational or commercial.

2. That the funds necessary for financing such a section in the Office of Education be provided in the regular budget for the Department of the Interior.

3. That there be set up in connection with this unit an Advisory Committee representing educational institutions, commercial broadcasters, and the general public. This committee should consist of 9 to 15 persons whose residence is such that they can meet from time to time for actual consideration of problems arising in the Office of Education. This committee may well administer any funds remaining to promote research into the techniques of radio education.

4. That an effort be made to secure from interested persons or foundations an amount of money sufficient to bring to the microphone, for a period of two to three years, a high grade program in certain formal school subjects and to check carefully the results obtained. The Committee believes that as much as $200,000 per year for a period of three years may be wisely expended in this manner, under direction of a nonpartisan committee of educators and laymen.

5. That the Secretary bring to the attention of the Federal Radio Commission the importance of the educational interests in broadcasting, and that he keep the President of the United States informed of the desirability of having on this Commission spokesmen for programs which will tend to improve the general well-being of the American people.

ESSENTIAL TESTS FOR COMPONENT PARTS

(*Concluded from page* 41)

This test also includes a leakage test using a neon lamp in the circuit to indicate same. A test for capacity is also given. After the condensers are assembled into a complete unit, they receive the following tests: dielectric strength, leakage, and capacity. A sufficient number of condensers are checked daily from the output of each winder, the defects being analyzed and the proper person or persons informed so as to avoid its recurrence.

Wire-Wound Resistors

Wire-wound resistors are checked with a standard ohmmeter. This ohmmeter has a resistance in one side of the circuit that has been calibrated to the exact resistance required. Ohmmeters are made to a certain accuracy; therefore, if it was necessary to keep the limit to plus 5 per cent, a 5 per cent ohmmeter should be used, and with the unknown in the other side, indication is given whether it is within the limit or not.

Semi-Final Test

The r-f. unit, which is made up of the r-f. and detector sockets, the various by-pass condensers together with the internal cable, necessary to complete the circuits, is tested separately before being placed into the chassis. A d-c. continuity test is employed and a drop is obtained through every circuit.

When the chassis has been assembled into a semifinal condition, that is, the audio-frequency and radio-frequency unit together with the power unit, a point-to-point a-c. and d-c. continuity is given, after which the variable resistance, namely the volume control is given a test to determine the amount and rise in resistance. A complete check of voltages delivered to the tube sockets is then given.

After the chassis is completed and has met the above requirements together with a complete mechanical inspection, it is aligned at 300 meters. The output gain is also measured.

INCREASING THE NUMBER OF RADIO CHANNELS

(*Concluded from page* 40)

ing facilities of the message center of the War Department are the results of the efforts of Major-General George S. Gibbs, chief signal officer, and Captain Frank E. Stoner, actively in charge. With the Federal farm board and the census bureau as recent users of this radio system, a total of 55 Government bureaus now employ this communication net—and without apportioned cost to the respective branches of the Federal Government. Eventually, the Government's large departments are to be associated with message center by teletype circuits—thus elminating messengers in delivering messages to and from the message center.

▲

CANADA HAS OVER 400,000 LICENSED RADIO SETS

On March 31, 1930, the Radio Branch of the Canadian Department of Marine had issued 423,557 radio receiving licenses, an increase of 126,631 over March 31, 1929.

The Pros and Cons of Electrolytic Condensers*

Paper Condensers Still Hold Important Place in Radio

THE electrolytic condenser depends for its dielectric upon the formation on the positive plate of the condenser of a microscopically thin layer of gas oxide or hydroxide, or a combination of these factors. It may be of the wet type, making use of a liquid electrolyte or chemical, or it may be of the so-called dry type, with the electrolyte in semi-liquid or paste form. Because of the theoretical high capacity that can be obtained at a theoretical low cost, together with the self-healing feature, the electrolytic condenser upon first consideration seems to merit attention.

As regards capacity, it is interesting to note that in theory one can buy a 15 mf. electrolytic condenser for one-half or less the cost of the cheapest grade paper condenser of equal capacity. This is an important factor in radio set production aimed to meet low prices. In fact, purchasing agents whose job it is to buy the most at the lowest price, have been the best friends of the electrolytic condenser. Meanwhile, radio set designers and engineers have frequently overlooked the fact that, due to the relative inefficiency of the electrolytic condenser, only one-third to one-half as much capacity is required in paper condensers for the same filtering action. Therefore, the first impression of cheap capacity is apt to be a false one. It is *usable capacity*, rather than theoretical capacity, that is being purchased.

With the critical radio listener of today, background noises must be kept at absolute minimum. In this connection many sets employing electrolytic condensers are troubled with crackling noises. Usually, the set owner attributes such noises to outside causes. Actually, however, the noises are caused by the breakdown and healing activities within the electrolytic condensers.

Leakage is another factor encountered in electrolytic condensers. Although there is no apparent harm in leakage, it nevertheless places an extra drain on the rectifier. When standing idle for a period of two weeks to a month, electrolytic condensers lose their capacity entirely, due to the disintegration of the film, and become simply resistors. However, if placed at work they will re-form and become capacity units once more. Nevertheless, from the time the rectifier is turned on until the electrolytic condensers re-form, the rectifier is operating under a serious overload. The short life of rectifiers operating with electrolytic condensers is due to the drain imposed while the film dielectric is being re-formed. Some designers of receiving circuits employing electrolytic condensers, insert paper condensers in the first filter section, so as to reduce the strain on the rectifier.

The capacity of a chemical condenser of given plate area, depends upon the voltage at which it is formed and operated. If the condenser is formed at a high voltage and operated at a lower voltage, the capacity will increase, and vice versa. That the capacity times voltage is constant for a given condenser, is approximately true.

The power factor of a good paper condenser is about ½ or 1 per cent, or 99½ per cent efficient as a capacitor. The electrolytic condenser, by way of contrast, has a power factor usually of 15 to 50 per cent with 40 as the average, or an efficiency of about 60 per cent. This, however, means little by way of general efficiency of the set, if taken into account in the original design, as with paper condensers. But when the power factor is variable, it cannot be compensated for. Hum increases with power factor, due to decreased filter action.

Further, temperature has a marked effect on the performance of the electrolytic condenser. It affects capacity and operating voltage. The effect is noted by any marked increase or decrease of temperature. If the set is left in an unheated house, and the temperature drops below the freezing point, the electrolyte or liquid may expand or burst the container. To safeguard the user, most electrolytic condensers now have metal containers instead of the glass formerly employed, in the case of the liquid type.

The paper condenser still holds an important place in the high-voltage field.

* *Engineering Department Dubilier Condenser Corporation.*

Origin of the Word Electron

A RECENT publication in a contemporary radio journal gives the date 1891 as that when the word "electron" was coined. The authority quoted is G. Johnstone Stoney.

In view of the fact that the electron in modern times is fairly well understood and that its migrations in evacuated tubes accounts for many astounding and useful applications of electricity to industry, it is of interest to attempt to trace the origin of the word.

Although it was not until 1896 that the electron as we know it today was identified and determinations made relative to its physical characteristics, it is history that the ancient Greek poets called the sun ηλεχτορ and Homer repeatedly so terms it (Illiad. Z/513: T./398). "Electron" was used indefinitely by the Greek classic writers. In the minds of the Greeks gold and the gold alloys all were children of the sun "elector," and, in common with these, amber, in Hellenic speech, came to be called "electron."

During the past century and a half the unending excursions of investigators in the realm of physics brought to light all of the now known and understood properties of electricity and magnetism. In many of the new discoveries need arose for the coining of new words and terms by means of which particular effects or applications might be identified. Variations of the word electricity were convenient and suggestive. Such words as electro, electrostatic, electroscope, electrotonic, electrolysis, electrolytic, electryze, electrol, electrograph, electrose, electrolyte, dielectric, etc., were coined from time to time to meet the needs of invention.

It is hardly probable that the word electron would escape the notice of workers in electricity until so late as the year 1891.

A thorough search of historical electrical records might disclose that the word had been used long after the Greeks used it to refer to amber. That the term was current and had some significance in scientific circles is evident from the fact that in the electrical journal, *The Telegrapher*, of December 26, 1864, the word electron appears on page 36, at the bottom of the first column.

The Life of Component Parts

By McMurdo Silver

One Company Conducts Rigid Test to Determine Probable Life of the Component Parts of Radio Receivers

IN designing radio receivers, much thought is always given to the factor of the life of the component parts used, and much is done in the way of preliminary accelerated life tests, but once a design has been put into production, it would appear that little is done by various manufacturers to check the actual life of the component parts. Certainly, initial accelerated life tests are no positive indication of what may be definitely expected in actual service, yet due to the exceptionally rapid engineering progress made in radio engineering they are about all that can be made before a unit is put into production, other than to listen to the salesman's story: If the particular part be purchased, or "So-and-so used it last year and had no trouble."

Being very much interested in just what the period of service that might be anticipated from a radio receiver would be, the writer had one of the first production models of a Model 30 Silver-Marshall radio chassis turned out in the summer of 1929 connected up and left permanently connected since July 8, 1929, in order to determine what failures, if any, might develop. No particular check was made on this set during the period of operation other than to measure its overall performance and to test the tubes from time to time, since no failures, nor sign of them, developed at any time in any part of the set itself.

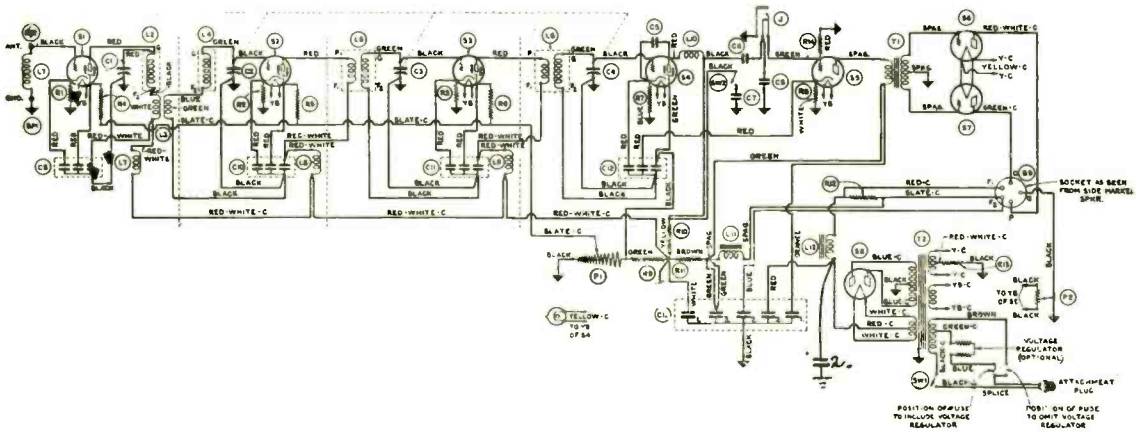
After about 8,000 hours of continuous operation, the set was disconnected long enough to be placed in a glass display cabinet for exhibition at the R.M.A. Trade Show, this cabinet having only passable ventilation, and consequently subjecting the set to conditions of higher heat than had the open operation of the chassis during the first 8,000 hours.

Up to this writing, the set has some 11,000 hours' operation to its credit, with only two failures—that of tubes, and upon measurement, shows a decrease in sensitivity of about 15% from the original measured value—a smaller decrease than might be occasioned by humidity variations alone, not to mention tube deterioration affecting any receiver. Selectivity and fidelity characteristics are substantially the same as when the set went on test, despite the fact that six out of the eight tubes have run 11,000 hours, or about eleven times normal life expectancy.

Parts Stand Up Well

Filter and bypass condensers, and paper-section power transformers and choke coils, stood up without failure, and these, after all, would be about the first parts to fail in normal operation. An examination of the circuit diagram indicates that the filter input condenser is of 2.0 mfd. capacity, and, obviously, is of the dry paper type. The type employed was rated at 600 volts d-c. continuous duty, the rectifier output developing approximately 320 volts with a-c. peaks, of course, being higher. This would indicate that standard paper condensers rated at 600 volts d-c. are adequate filter input condensers for normal outputs from '80 type rectifiers. Following this condenser is an audio choke having a voltage drop across it of about 10 volts, which is, in turn, followed by a 2.0 mfd. 600-volt condenser, of more than ample rating for this position, where there is little in the way of high a-c. peaks left, and only slightly over 300 volts d-c. across it. Following this condenser is the loudspeaker field, of 1,900 ohms resistance, having a drop across it of 70 volts d-c., which is followed by a 2.0 mfd. 400-volt condenser. An additional choke further reduces the d-c. voltage, and is followed by another 400-volt condenser. All 1/10 mfd. plate circuit bypass condensers are rated at 300 volts; cathode

(*Concluded on page 52*)



Circuit wiring of radio receiver tested.

THE LIFE OF COMPONENT PARTS

(*Concluded from page* 50)

and screen bypass condensers at 200 volts. All resistor ratings are 1.0 watt, except R-9 and R-11, which are 2.0 watt resistors, and R-12 and R-13, which form one vitreous enamel unit of around 20.0 watt rating. The power transformer, when operated in a normal room temperature of 25° C. would attain a maximum temperature of 63° C., as against a maximum allowable rise of 55° C. to a temperature of 80° C.

Withstands Rough Usage

While the receiver was transported about somewhat, the actual movement involved was not such as to subject it to excessive mechanical strains or jolts. It is pertinent to remark, however, that no trouble was experienced with tube socket springs, no doubt due, in some measure, to the reinforcement of the contact springs with auxiliary steel tension springs, which, in any event, insured good substantial contact with the tube pins throughout the period of the test.

It is significant that the two tube failures were both -27 type tubes, and not -24's, as public and dealer fears last season would have predicted. The 227 tube in the test set was operated at average voltage of 2.49 heater, 14 volts grid, and 196 volts plate. The excellent tube life observed would indicate what might be anticipated under favorable conditions when tubes are operated conservatively in accordance with makers' ratings. Incidentally, Cunningham tubes were used in the test set.

It is often stated that the average period of radio set use in the home is about three hours per day, and upon this basis, the 11,000 hours of the set under test would represent something over ten years of normal service which, it is the writer's belief, is fully as much service as the public would anticipate from the best of radios. At six hours per day, the life would be five years, though it must not be forgotten that this estimate is upon the basis of a chassis in a test that so far is not completed, and which gives no indication of failing in any part for some time to come. To estimate accurately what the probable life would be before the first chassis failure, would be difficult, indeed, yet it would be reasonably safe to assume that it might be double the present test run, or 22,000 hours, representing twenty years of service at three hours per day—probably a longer period than that during which the design itself would be considered satisfactory, judging from the rapidity of past radio engineering developments.

SEES RADIO SOON IN BILLION DOLLAR CLASS

RADIO having grown to the status of an $800,000,000 *business within a period of but six or seven years and by covering but forty per cent of American homes, should easily enter the exclusive billion dollar class within the next twelve months, is the opinion expressed by George K. Throckmorton, executive vice-president and general manager of E. T. Cunningham, Inc.*

Based upon the foregoing, and due to the fact that there still remains a vast potential market of thousands of homes not yet equipped with radio, Mr. Throckmorton states it is his belief that the next five years will witness an expansion of the industry "that shall pale into insignificance the huge growth already experienced."

NEARLY THIRTY-EIGHT PER CENT OF RADIO SALES MADE BY EXCLUSIVELY RADIO STORES

The National Retail Credit Survey contains a detailed analysis of the credit situation in twelve types of retail stores.

Stores handling radio exclusively accounted for over one-third of the 1929 radio sales, totaling $140,771,378, reported to the Electrical Equipment Division of the Bureau of Foreign and Domestic Commerce by 10,533 dealers in various lines of business. Music stores, however, had higher average radio sales per dealer than stores selling radio equipment exclusively, $38,043. as compared with $25,976. The percentage of sales reported by the various types of outlets and the average sale per dealer for each are shown in the following table:

Kind of business	Per cent of replies	Per cent of total sales	Radio sales per dealer
Radio exclusively	19.6	37.9	$25,976
Music	4.4	12.6	38,043
Furniture	8.2	11.1	18.090
Miscellaneous or no business given	18.4	9.2	6.697
Automotive stores	15.6	7.3	6,263
Department stores	1.0	6.0	1,323
Elec. merchandise	8.2	5.8	9,428
Hardware	11.9	5.6	6.289
Elec. contracting	4.8	1.1	5,729
Gen. merchandise	3.3	0.9	3,545
Drugs	3.1	0.8	3.441
Jewelry	1.5	0.7	6,289
Total	100.0	100.0	$13,365

FRANK REICHMANN SAYS

Frank Reichmann of the Oxford Radio Corporation says: "The public is tiring of 'near' music. There is need for better tone quality in broadcasting, particularly in the chain hook-ups."

RADIO TUBE PHENOMENA BAFFLES SCIENTISTS

A PUZZLING situation now confronting engineers is the use of colored glass bulbs and their reaction on the movement of electrons within a radio tube. Scientists have delved into this peculiar action but have been unable to advance a satisfactory solution.

"Many years of study," says George Lewis, vice president of Arcturus Radio Tube Company, Newark, N. J., "of the comparative behavior of tubes when enclosed in blue glass bulbs and white glass bulbs, still leaves us without any definite answer. Reports received from users show that a tube, when constructed of identical elements, acts much more efficiently when sealed in a blue glass bulb. And the reason is obscure.

"We do know that colors have certain properties in the visible or invisible spectrum. Plant life, photography, and even the harmonies of life are affected by colors.

"But just what causes a greater degree of efficiency in a radio tube with a blue glass bulb is a mystery engineers have been unable to solve," concluded Mr. Lewis.

ELECTRICITY ON 627,105 FARMS, A GAIN OF 68,532 IN SIX MONTHS

IN the first half of this year 68,532 *farms in the United States were electrified, against about* 48,000 *in the first half of* 1929. *On June* 30, *last, the electric power and light industry served* 627,105 *farms, comparing with* 558,573 *on Jan.* 1, *a gain of more than twelve per cent.*

The East and West South Central States added as a group more electrified farms in the first six months of 1930 *than in all of last year. Only New England and the Mountain States fell behind the rate of growth that they showed in* 1929. *There are now* 148,234 *electrified farms in the East North Central States,* 136,691 *in the Pacific States and* 106,402 *in the Middle Atlantic States.*

BOOK REVIEW

RADIO OPERATING QUESTIONS AND ANSWERS:—265 PP., CLOTH, ILLUSTRATED. BY NILSON AND HORNUNG. McGRAW-HILL BOOK COMPANY, NEW YORK.

This is one of the most useful books on radio. It is of particular value to radio telegraphers operating short wave or amateur stations, and to engineers employed in broadcast stations.

ALLOY METAL WIRE PRODUCTS meet all demands of high grade tube production

NEW days—new methods—new requirements! . . . Yesterday's accomplishments thrown in the discard! That has been the story of radio's advancement since its beginning. And to meet this pressure our engineers keep constantly on the alert to cope with this unusual condition.

Among other improvements, they have developed wire, strip and filament ribbon which provide for the reduction of production shrinkage to a minimum; nickel ribbon which is held to .001 tolerance in width and .0001 in thickness; wire screen which acts uniformly in any sort of atmospheric condition. You'll find Alloy Metal Wire products dependable, meeting each new situation unfailingly. Correspondence on special production problems is invited. A capable engineering staff is always ready for any emergency and will gladly answer any technical questions.

RESISTANCE WIRE
Nickel Chrome for Electric Heating Devices, Electric Furnaces, etc.

MONEL METAL
COPPER NICKEL WIRE
for Rheostats, etc.

ALLOY METAL WIRE CO., Inc.

Branch Office
NEW YORK CITY
3637 Grand Central Terminal Bldg.

General Office and Works
MOORE, PA.

Agents
SEATTLE, WASH.
Robinson Sales Co., Polson Bldg.

CRC SOCKETS ARE *BUILT* TO STAND the GAFF

PREFERRED
by the Radio Industry
because:

- They are more *Rugged* than they need be.
- The *Tempered Steel Springs* insure *maximum contact tension* that is *permanent.*
- Cadmium plated contacts with large size terminals permit *easy soldering*—thus *speeding up production.*
- CRC Clips are now available to manufacturers who have assembling facilities.
  Write for samples.
- THINK OF CRC as . . .
  Providing the best Sockets now available . . . constantly striving to improve the design and efficiency of Sockets . . . its only product.

Eight CRC Sockets are incorporated in the Life Test Set which has been in constant operation for a year and a half in the Silver Marshall Laboratories—another proof of the lasting qualities of CRC Sockets.

CRC SOCKETS

West Coast Representatives:
FRANK A. EMMET SALES CO.
Los Angeles, California
R. C. JAMES & CO.
Seattle, Washington

CENTRAL RADIO CORPORATION
156 Roosevelt Avenue Beloit, Wisconsin

NEWS OF THE INDUSTRY

AN OUTSTANDING CATALOG

Engineers, purchasing agents, and others connected with the manufacture of radio tubes have available a book which, by virtue of its elaborate completeness and richness in data on a wide range of tube parts, deserves to be called a handbook rather than a catalog.

On opening it, we find that it is the catalog of Goat Radio Tube Parts, Inc., Bush Terminal, Brooklyn, N. Y., and that in every detail it has been designed to render service to those for whose use it was intended.

It is all in tabular form and in large, clear type, beginning with the 120 plates and ending with a variety of unnumbered small parts such as pins, cups, eyelets, and the like; these followed by specifications of various materials entering into tube parts, and beyond that are conversion tables, calendars, and a liberal supply of memorandum leaves.

▲

CALDWELL HEADS DUBILIER SALES STAFF

The appointment of M. Caldwell as general sales manager of the Dubilier Condenser Corporation, New York City, is announced by N. S. Tobey, Executive vice-president of that organization. Until his recent election Mr. Tobey was general sales manager of the Dubilier organization.

Mr. Caldwell brings to the Dubilier Condenser Corporation a wide and varied experience in sales and merchandising both here and abroad. For years he was the sales manager of the Marion Steam Shovel Company. For nine years he was the export manager of the Certainteed Products Corporation. During the World War, he served as Captain of Engineers. The radio industry at large, quite as well as the Dubilier organization, gains by the valuable knowledge and experiences which Mr. Caldwell brings to radio merchandising circles.

▲

WIRE STRIP AND FILAMENT RIBBON

The non-corrosive nickel and nickel alloy products employed by the Alloy Metal Wire Company, Inc., Moore, Penna., enables the company to manufacture wire strip and filament ribbon which meets all modern requirements, and with minimum shrinkage.

▲

GENERAL CABLE CORPORATION

General Cable Corporation now operates as one organization. All sales, manufacturing and accounting activities in the name of the individual divisions are transacted only in the name of General Cable Corporation.

This plan of operation provides marked advantages. It simplifies purchasing by providing one contact for all sales and sales service. All products of all divisions are now readily available through the nearest General Cable District Office. It simplifies accounting by providing one contact—the central accounting office at Rome, N. Y. Billing will be done only in the name of General Cable Corporation, and at the point of shipment; thus expediting delivery of the invoice.

All customers' accounts will be combined in a General Cable central accounting office at Rome, N. Y., to which all accounts now maintained in the name of the divisions will be transferred.

▲

DR. ING. PAUL SCHWARZKOPF ARRIVES

Dr. ing. Paul Schwarzkopf, President of American Electro Metals Corporation, recently arrived from abroad on an extended visit to survey the tube and lamp industries.

Dr. ing. Schwarzkopf has visited this country before and while here will renew his acquaintance among American engineers.

▲

COMBINATION SET ANALYZER AND TUBE CHECKER ANNOUNCED

E. T. "Ted" Flewelling's latest contribution to the radio instrument field is the new Flewelling combination analyzer and tube checker, manufactured by the Van Horne Tube Company, Franklin, Ohio.

This instrument combines a complete analyzer and a-c tube checker in a single leather carrying case. It will make a complete analysis of all circuit conditions existing in any radio receiver or electrical apparatus within the limits of 800 volts a-c. or d-c., and current up to 100 milliamperes.

It is manufactured for use on 60 cycle 110-115 volt a-c. circuits and can also be furnished for use on 25 cycle 110-115 volt and 60 cycle 220 volt a-c. circuits.

A complete tube checker is included, together with a panel chart of tube ratings, as an integral part of the instrument, thus permitting a complete analysis of any radio receiver and an independent check on its tubes.

The instrument is operated by means of push-buttons, and eleven meter ranges are available through the use of pin-jacks for external testing.

▲

LEAD-IN WELDS

The American Electro Metal Corporation is introducing a new "ELMET" product—known as lead-in welds for use in radio tubes and incandescent lamps.

They have just completed an addition to their plant at Lewiston, Me., where the newest type of welding machinery has been installed.

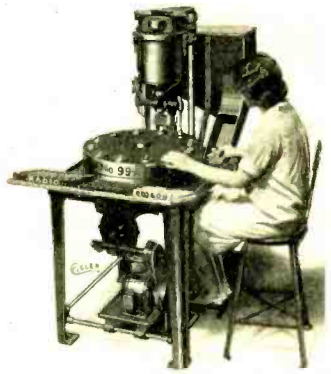
These welds are claimed to be of the highest attainable quality and are available backed by the same service as ELMET products have established.

▲

BASE FILLING MACHINE

This machine automatically and quickly fills a predetermined adjustable amount of mixed cement into any type or style of base.

The operator is required only to remove filled bases and pick up bases from container on machine and to place base in chuck holder. This operation is readily performed with speed.



Machine indexes very smoothly and rapidly at fixed intervals of time, regulated by three step pulley on motor. Base holding chuck rotates only when in filling position and automatic filling arrangement moves down to fill base. A uniform filling is assured by this method. A regulating cup is filled with alcohol keeping free the filling device. Track arrangement lifts filled base, making removal of base easy.

The machine is manufactured by The Eisler Electric Corporation, Newark, N. J.

▲

ACME TRANSFORMERS

Acme Transformers are liberally designed and the coils are especially impregnated to meet conditions in the export field. Care is taken to give each transformer a high voltage insulation break down test at ten times the working voltage, as well as an induced voltage test at twice the normal working voltage, doubling the frequency. High grade non-ageing silicon steel insures a low core loss. Each transformer is furnished with eight feet of cord and plug. They are manufactured by the Acme Electric Mfg. Co., 1440 Hamilton Ave., Cleveland, Ohio. The Company has just issued new bulletin No. 121.

▲

BRIGGS JOINS SILVER-MARSHALL

Howard W. Sams, general sales manager of Silver-Marshall, Inc., recently announced the appointment of Howard C. Briggs as assistant general sales manager.

Mr. Briggs is a well-known man in the radio industry in the Middle West, having been five years with E. T. Cunningham, Inc., a year as district manager of Michigan for Grigsby-Grunow, and a year with the radio division of the Kellogg Switchboard Company before joining the sales organization of Silver-Marshall.

▲

SUPREME INSTRUMENTS

Supreme Instruments Corporation, Greenwood, Miss., announces the recent appointment of the following new district sales representatives:

W. B. Masland Co., 105 E. Franklin St., Baltimore, Md.; Wood & Anderson Co., 915 Olive St., St. Louis, Mo.; Ed. H. Troan, 140 Nunda Blvd., Rochester, N. Y.; Sam H. Fowlkes, 1232 West Peachtree St., N. W., Atlanta, Ga.; C. C. Baines, 26-27 Hale Ave., Louisville, Ky.; Walter A. Stevens, 4018 Marburg Ave., Cincinnati, Ohio.

Supreme now has active sales representatives in every territorial center of the country. Coupled with such representation are warehouses located in the largest cities in the country, thereby establishing a distribution set-up which guarantees prompt delivery on all orders and intelligent attention to all distributor or dealer inquiries developing on Supreme products.

▲

INTERNATIONAL RESISTANCE

Harry Kalker, sales manager of the International Resistance Company, left Philadelphia, for the Pacific Coast, via Air-rail T-A-T lines, the second week of October. Kalker will visit his company's many accounts who are at present busy with the manufacture of mantel type receivers. The International Resistance Company reports running close to peak production in order to fill the increased demand for metallized resistors.

▲

LOW RANGE FUSES

There is a large class of electrical equipment in the field of radio devices, sound pictures, etc., which operate in the range below ½ ampere. In this field, however, very few inexpensive protective devices are found.

One of the features of these fuses is electroplating the filament locally to reduce the resistance, but leaving one or two bare spots where the wire will fuse. Another principle employed is the application of a highly combustible substance to the filament which ignites and burns the wire asunder when it reaches the desired temperature.

The fuses come rated at their blowing points in the following sizes: 1/32, 1/16, ⅛, ¼, ½, and 2 amperes. The safe operating voltages range from about 100 to 1000 volts, being highest for the small sizes. All are standardized to a one inch length and ¼ inch dia. for convenience in mountings. They are available to the trade in assorted display cartons, manufactured by the Littlefuse Laboratories, 1772 Wilson Ave., Chicago.

▲

PLANT ADDITION FOR ALLOY METAL WIRE

"The so-called bogey of business depression must look elsewhere than the radio and allied industries if he expects to get a square meal," said Mr. Elmer Flynn of the Alloy Metal Wire Company, Moore, Pa. As a matter of fact, this company has recently let a contract calling for extensive additions to their plant effecting an increase in furnace equipment and pickling facilities. Already carrying on world wide operations, shipping to all corners of the globe, the Alloy Company will now be better able to handle the steadily increasing demands for their products.

▲

SUPER-TONATROL

Radio engineers no longer need compromise in the selection of inferior types of volume controls incapable of carrying the high currents of modern receiver design.

The Super-tonatrol will safely dissipate 5-watts at any position of the contact, with one-tenth or more of the resistance element in the circuit.

All-metal construction, with a special resistance element fused to an enameled metal plate, obviates the necessity of using either a low-current paper element, or fine wire with its well known hazards.

The Electrad Company, 175 Variek Street, New York, has a carefully designed unit of typical Electrad quality, with an amazingly smooth action—long lived, and mechanically and electrically perfect—embodying new ideas of proved merit. Its generous factor of safety will more than fulfill all expectations.

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 68.

ALUMINUM:
Aluminum Co. of America
Fairmont Aluminum Co.

ALUMINUM, SHEET, FOIL:
Fairmont Aluminum Co.
Johnson Tin Foil & Metal Co.

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

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

ANTENNAE, LAMP SOCKET:
Dubilier Condenser Corp.

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

BASES, VACUUM TUBE:
(See Tube Parts)

BINDING POSTS:
General Radio Co.

BRACKETS, ANGLE:
Scovill Mfg. Co.

BRASS:
Scovill Mfg. Co.

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

BUTTS:
Scovill Mfg. Co.

CABINETS, METAL:
Aluminum Co. of America

CASTINGS:
Fairmont Aluminum Co.

CELLS, PHOTOELECTRIC:
National Carbon Co., Inc.

CEMENT, LOUD SPEAKER:
Maas & Waldstein Co.

CENTRALIZED RADIO SYSTEMS:
American Transformer Co.
Samson Elec. 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.

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

CHOKES, POWER:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Polymet Mfg. Corp.

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

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

CLOCKS, ELECTRIC:
(See Electric Clocks)

CLOTH, WIRE:
(See Wire Cloth)

COIL FORMS:
General Mfg. Co.
General Radio Co.

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

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

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

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

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

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

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

CONDENSER PARTS:
Aluminum Co. of America
Henry L. Crowley & Co.
Scovill Mfg. Co.

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

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

CONDENSERS, FILTER:
Aerovox Wireless Corpn.
Amrad 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

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

CONDENSERS, MIDGET:
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
Polymet Mfg. Corp.
Scovill Mfg. 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.
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:
American Transformer Co.
Central Radio Laboratories
Clarostat Co.
Ferranti, Inc.
Polymet Mfg. Corp.

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

CONVERTERS, ROTARY:
Electric Specialty 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:
Aetna Felt Co.
Western Felt Co.

DIALS:
Crowe Nameplate & 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.

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

DYNAMOTORS:
Electric Specialty Co.

ELECTRIC CLOCKS:
Electric Clock Corp. of America

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

EXPORT:
Ad. Auriema, Inc.

FADERS:
Clarostat Mfg. Co.

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

FELT, PACKING:
Aetna Felt Co.
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
Johnston Tin Foil & Metal Co.

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

GEARS:
Chicago Gear Works

GENERATORS:
Electric Specialty Co.

GETTER MATERIAL:
(See Tube Parts)

GRAPHITE
Acheson Olldag. Co.

GRID LEAKS:
(See Resistances, Fixed)

HANDLING EQUIPMENT:
Nat'l. Vulcanized Fibre Co.

HINGES:
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
Formica Insulation Co.
General Electric Co.
National Vulcanized Fibre Co.
Synthane Corp.

INSULATION, MOULDED:
Bakelite Corp.
Henry L. Crowley & Co.
Formica Insulation Co.
General Electric Co.
General Plastics Co.
National Vulcanized Fibre Co.
Synthane Corp.
Westinghouse Elec. & Mfg. Co.

INSULATION, REFRACTORY:
Henry L. Crowley & Co.
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:
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

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

MACHINES, SPECIAL
Willor Mfg. Corp.

MAGNESIA, TUBES:
Henry L. Crowley & Co.
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
Ellis Electrical Laboratory
Jenkins & Adair, Inc.
Kellogg Switchboard & Supply Co.
Universal Microphone Co.

MOLDING MATERIALS
(See Insulation, Moulded)

MOTORS:
Electric Specialty Co.

MOTOR-GENERATORS:
Electric Specialty Co.

MOUNTINGS, RESISTANCE:
Polymet Mfg. Corp.

NAILS:
Clamp Nail Company

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:
Aetna Felt Co.
American Felt Co.
Booth Felt Co.
Kimberly-Clark Corp.
Western Felt Co.

PACKING MATERIAL:
Holed-Tite Packing, Inc.
Kimberly-Clark Corp.

PACKING AND SHIPPING:
Kimberly-Clark Corp.

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

PAPER, CONDENSER:
Peter J. Schweitzer, 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.
Jensen Radio Mfg. Co.

PLATES, OUTLET:
Howard B. Jones

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

PORCELAIN TUBING:
Henry L. Crowley & 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:
American Transformer Co.
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.

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

PULLEYS:
Chicago Gear Works

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

PUNCHINGS:
Aluminum Co. of America
George F. Mitchell & Sons Co.
Scovill Mfg. Co.
Soreng Manegold Co.

RECEPTACLES, WALL:
Scovill Mfg. Co.

REFRACTORY SPECIALTIES:
Henry L. Crowley & Co.
The Stupakoff Labs.

REGULATORS, VOLTAGE:
Amperite Corp.
Central Radio Laboratories
Clarostat Co.
DeJur-Amsco Corp.
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 Corp.
Frost, Herbert H.
General Electric Co.
Polymet Mfg. Corp.
The S. S. White Dental Mfg. Co.
Ward Leonard Elec. Co.

RESISTANCES, VARIABLE:
Central Radio Laboratories
Clarostat Mfg. Co.
DeJur-Amsco Corp.
Easton Coil Co.
Frost, Herbert H., Inc.
General Electric Co.
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

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.
Henry L. Crowley & Co.
Electrical Insulation Corp.
Frost, Herbert H.
General Radio Co.
Howard B. Jones
Soreng Manegold Co.

SOLDER:
Kester Solder Co.

SPAGHETTI:
(See Wire, Spaghetti).

SPEAKERS:
Amplion Corp. of Amer.
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.

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

SWITCHES:
Polymet Mfg. Co.
Soreng Manegold 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
Thompson-Bremer & Co.

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.

TIN FOIL:
(See Foil.)

TOOLS:
Willor Mfg. Corp.

TRANSFORMERS, AUDIO:
Acme Elec. & Mfg Co.
American Transformer Co.
Dongan Elec. Mfg. Co.
Easton Coil Co.
General Radio Co.
Samson Elec. Co.
Thordarson Electric Mfg. Co.

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

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

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

TRANSFORMERS, OUTPUT:
American Transformer Co.
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.
Dongan Elec. Mfg. Co.
Easton Coil Co.
General Radio Co.
Kingston Products Corp.
Polymet Mfg. Co.
Samson Elec. Co.
Thordarson Electric Mfg. Co.

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

TRANSFORMERS, STEP-DOWN:
American Transformer Co.
Amplion Corp. of Amer.

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.
Cleveland Wire Cloth & Mfg. Co.
Henry L. Crowley & Co.
The Engineering Co.
Fansteel Products Co., Inc.
General Plastics, Inc.
Gilby Wire Co.
Juno Fasteners, Inc.
Lepel High Freq. Labs.
Newark Wire Cloth Co.
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, NICKEL:
Gilby Wire Company

TUBING, PAPER & FIBRE:
Paper Tube Co.

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

TUBING, VARNISHED:
Alpha Wire Corp.

UNITS, SPEAKER:
Amplion Corp.
Jensen Radio Mfg. Co.

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.
Scovill Mfg. Co.
Synthane Corp.
Thompson-Bremer & Co.
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, 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.
Cleveland Wire Cloth & Mfg. Co
Gilby Wire Co.
Newark Wire Cloth 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.
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.

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.

Correction!

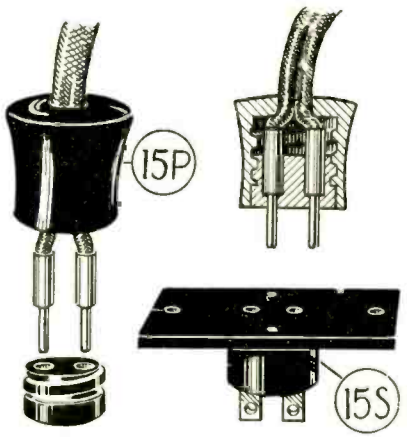
In the advertising of the Central Scientific Co., which appeared on the second cover of the October issue of RADIO ENGINEERING, a typographical error occurred in the caption directly above the chart showing the steep curve of Cenco-Hypervac exhaust.

This caption read incorrectly "70 Tenths of a micron in seconds"

It should have read:

"To Tenths of a micron in Seconds"

Howard B. Jones

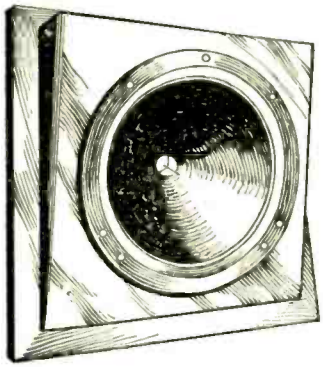


Same type as illustrated but with 3 Contacts, polarized, is popular for speaker connections. Write for samples (No. 52). Small and neat. Priced low for radio manufacturers.

HOWARD B. JONES
2300 WABANSIA AVE. CHICAGO, ILL.

A Big Special—While They Last

$110.00 PHOTOPHONE 12-inch Dynamic SPEAKERS



Brand New in original cases Only Limited Quantity Order today **$15**

Never before was such an astounding value offered. Every carnival owner, motion picture house, theatre, church, fair, American Legion Post, club, sound engineers and radio experimenters will want one.

12-inch Dynamic Field Supply; 110 volts D.C.; Field Resistance. 1000 Ohms; Voice Coil, 8 Ohms; Mounting. Steel angle frame. For adaptation to A.C. operation, $6.50 additional.

Terms: 25% with order; balance C. O. D. or Sight Draft.

Specify Express or Freight

M&H SPORTING GOODS CO.

512 Market St., Philadelphia
Send for Catalog

TODAY RADIO CONSTRUCTION

demands the best materials, including

JOHNSON'S INDUSTRIAL TAPE

TODAY radio excellence is the public demand—radios of cheap construction, appearance and performance are out. Johnson's Tape in panel masking, coil construction, wire wrapping, in field and armature winding, in anchoring leads, in core binding and in many other equally important functions is not only saving radio manufacturers real money, but likewise helping materially to put their products in the class of par excellence.

Have you seen the new Johnson's Tape Dispenser? Holds full size roll of tape up to 1¼ inches wide. Enables you to cut any length of tape instantly. Eliminates pre-handling—no waste.

MAKE THE TEST WITHOUT COST

JOHNSON & JOHNSON, New Brunswick, N. J. R. E. N.
Please send free sample roll of Johnson's Industrial Tape and information on the Tape Dispenser.

Name _____
Company _____
Street and No. _____
City _____ *State* _____

INDEX OF ADVERTISERS

The WISEST Buy in the Long Run

Cheap clothing, or cheap radio parts—it's all the same; in the end they cost the most money. Usually, in radio, the aftermath of the buy-on-price policy is business extinction.

Believing in this business philosophy Dongan has not gone frantically after all and sundry orders. On the contrary the sales department directs its efforts toward those set manufacturers who demand the best parts available—because those are the manufacturers who will be selling sets this year and next year, therefore will continue to be users of Dongan Transformers.

Radio has come to expect leadership in Transformers from Dongan and, in return has rewarded us consistently with business. A busy factory and a sincere optimism for the future characterize the Dongan organization today.

Dongan Electric Manufacturing Co.
2991-3001 Franklin St., Detroit

Arcturus Photolytic Cell housing of Bakelite Molded. Arcturus Radio Tube Co., Newark, N. J.

BAKELITE MOLDED PROVED MOST PRACTICAL

FOR "ELECTRIC EYE" OF INDUSTRY

In sound reproduction and color analysis, in fire detection and television, and in an ever increasing number of other devices, successful performance is dependent upon photo-electric cells. To function efficiently, and to assure the longest span of useful life, those cells must be insulated with a material that retains its high insulation value unimpaired under any conditions of service.

The Arcturus photolytic cell provides a splendid example of the advantages of Bakelite Molded for highly sensitive electrical devices. The initial high insulation value of the material does not diminish with age or use. Its extremely low moisture absorption is a special advantage when the cells are used outdoors, and exposed to rain and fog.

Bakelite Molded also provided decided production economies, and made an attractive design practical. Each one of the three housing parts is formed in one molding operation, with lustrous internal and external finish, and threading of unvarying accuracy. The rim, the body, and the cone tip, thread together to form the complete housing, and fit so perfectly that it appears to be one piece.

Bakelite Engineering Service—We manufacture a wide variety of Bakelite resinoid molding materials, varnishes, lacquers, enamels, cements, and other products. Twenty years experience in the development of these materials for mechanical and other uses, provides a valuable background for the cooperation offered by our engineers and laboratories. Write for Booklet 38M, "Bakelite Molded."

BAKELITE CORPORATION, 247 Park Avenue, New York. CHICAGO OFFICE, 635 West Twenty-Second Street

BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Ontario

BAKELITE

REGISTERED U.S. PAT. OFF.

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

THE MATERIAL OF A THOUSAND USES