Tenth Year of Service

RADIO ENGINEERING

Vol. X APRIL, 1930 No. 4

IN THIS ISSUE

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The Journal of the Radio Industry

A Prosperity of New Thoroughness

THE new prosperity, now preparing, will be on a new basis, different from the past. Based on new thinking, new ways, new thoroughness.

New conditions are ahead of us. Some are here now.

Production-thinking is sharper, faster, more complete and with a stronger will to mesh perfectly with *every* aim and problem of the business.

* * *

Dips are turning points—in business history, and in industry's development. Always have been.

Every great and fast advance started, in reality, from a dip or emergency.

A great new advance,—a correction of direction: a betterment of thinking and method,—is getting ready right now.

It is starting. You can feel it; see it; it is all around you.

* * *

Dips jolt thinking. They jolt minds everywhere, from top to bottom in industry and commerce.

Instantly the thinking is faster, fresher, freer, bolder,—more open-minded, more self-critical,—more constructive.

Just the *hint* of a dip was enough this time. Because men in industry today know more, are better equipped, quicker to see and act.

Even if the hint of a dip is over by the time you read this, the fast, clear, sharp thinking it started is *going onward*. It is getting more momentum. Its results will be permanent.

In industry and business the new direction is being determined.

* * *

Already you see the changes, the trend . . . New thinking. New planning. New openness of mind. New search for Useful Knowledge:—for the new facts on which new ideas *and new action* can be based.

You see re-designing everywhere,—for profit,— for better margin. For better position in competition. For betterment of the various satisfactions that can be delivered to the consumer or user;—better performances, better values. Re-designing for better adjustments to the present and coming Consuming Power and Purchasing Power.

New designs, new tries, new modifications of present designs,—they are going on everywhere.

* * *

In mass-production; realize what is happening—New realization that mass-production principles don't stand still. That they grow and change. That the new, more highly perfected Principles of mass-production are on the way, and *taking shape right now.*

The New thoroughness—you feel it everywhere you turn—can't shut your eyes to it. New balancing of considerations. New determination to find and weigh EVERY consideration that has a bearing on design, purchase, capital, profit, or competition.

New realization that, in past designing and purchasing decisions or plans, too many considerations have been left out of the scales.

New searching out of the Wastes that in easier days were allowed to exist: "leech wastes" that *now* are stopped by the new, more complete balancing of *all* considerations.

* * *

In all production, of small quantities or large, you see more "hand to mouth." And keener planning for it.

More search for the best conveniences, cooperations, services, and certainties as to later supplies and prices.

Sharper looking-ahead, even where small or try quantities are concerned:—you see and feel it everywhere; there is no mistaking it.

You see foresight and mass-production thinking applied to production that at present is very small. The demand for rightness in *every* detail that can affect business in *any way*.

* * *

And through it all, everywhere, the new awakening to the fact that, now, too often, the REAL drag on profits, and on success in competition, is the using of WRONG MATERIAL.

In all the New thoroughness, the foundation—the one indispensable factor, is—THINKING IN THE RIGHT MATERIAL.

From FACT-SHEETS OF INDUSTRY No. 1, to be issued April 15th, 1930. Mailed FREE to ANY Worker, any Executive. Write NOW. No charge. State work you do, your company's product or business, and whether request is for self. Address Librarian (Dept. E-4), National Vulcanized Fibre Company, Wilmington, Del.

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NATIONAL VULCANIZED FIBRE COMPANY

RADIO ENGINEERING

Reg. U. S. Patent Office

Member, Audit Bureau of Circulations

Western Editor EVANS E. PLUMMER

Editor DONALD MCNICOL

Associate Editor AUSTIN C. LESCARBOURA

Vol. X | April 1930 | Number 4

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Cheerful News!

NOTWITHSTANDING that radio receiver sales for January, 1930, were 12 per cent. above those for December, 1929, sales for February were a little ahead of January. Reliable information indicates that there are approximately 85,000 sets in manufacturers' warehouses at the present time. With the sets now in the hands of jobbers and dealers throughout the country, the total manufactured supply of receivers is about 190,000. At the present rate of absorption by the public the available stock should be hooked up and in service by the time the R.M.A. meets at Atlantic City in June.

Continued steady improvement in the radio industry is being made, according to surveys and reports received by the board of directors of the Radio Manufacturers Association, which met at Buffalo March 21. Similar reports were exchanged at a meeting on the preceding day of the R.M.A. group organization of receiving set manufacturers who discussed merchandising and other problems. President H. B. Richmond presided over the board of directors' meeting, and stated that conditions in the radio industry were definitely improving.

"Things certainly are looking up," said President Richmond. "The storm clouds which have hovered over our industry have shown definite signs of passing and by the time of the R.M.A. trade show we should be well out in the open again and ready for a year of constructive effort."

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EDITORIAL

April, 1930

THE R.M.A. SHOW

THE R.M.A. Show to be held at Atlantic City, June 2nd to 6th, next, promises to be the most largely attended gathering ever held in the interests of radio merchandising.

There is a uniformity in the problems occupying the thoughts of practically every radio manufacturer. Common problems have common solutions. A congress of interests such as that to be held at Atlantic City will have benefits immediately available to all, and benefits that will have a lasting good effect upon the entire industry.

The officials of the association are outstanding leaders in the radio industry. The program of events and conferences these men are arranging for the convention is based upon the recognized needs of the times.

▲

THE TUBE

ONE hundred and twenty million vacuum tubes will have to be supplied by manufacturers to take care of the tube demands during the 1930–31 season. This estimate has been arrived at by analysis of tube sales during the past three or four years.

These figures do not include tubes that will be called for from industries other than radio including sound amplification.

What an astonishing total this is! Not a few radio engineers recall vividly the situation prior to 1912; but eighteen years ago. At that date the audion was six years old.

Prior to the war years procuring a tube for radio telegraph uses meant visiting a miniature electric lamp shop on Murray Street (or was it Warren Street?) New York, run by an industrious chap by the name of McCandless.

McCandless made audions for Dr. deForest, and presumably there was a contract to the effect that tubes should be made up only as required by and ordered by deForest. Inducing someone in the McCandless shop to part with one or more audions, on a bootleg basis, at six dollars per tube, required no little finesse on the part of a ship operator, a bold experimenter or an inquisitive scientist. Success in this brought forth tubes without bases but with terminal wires dangling delicately from sealed holes in the glass bulb.

Years ago Major Armstrong related how he came into possession of his first audion, which led to big things for radio. Later, more than one of the group of plugging amateurs envied Charlie Logwood his unrestrained access to a rack of audions at the deForest Highbridge laboratory.

War needs forced development of the tube. And, then, in 1920, came radio as we know it today. What stupendous progress has been made in these last ten years!

One hundred and twenty million vacuum tubes per year!

▲

NEW MACHINERY FOR TUBE MAKING

WITH a market of above one hundred million vacuum tubes per year it is natural that manufacturers should lay plans for production plant by means of which the market may be supplied with good tubes at reasonable prices.

Making the round of the modernized factories one discovers that noteworthy improvements have been made during the past year in tube manufacturing plant. In the newer plants the old style basing machines with hand operated clamps for applying and cementing the tubes to their bases, at 300 units per hour, have been replaced by machines with many times this capacity. Likewise, the sealing machines operating at 300 tubes per hour have given way to machines with outputs of 2,000 per hour.

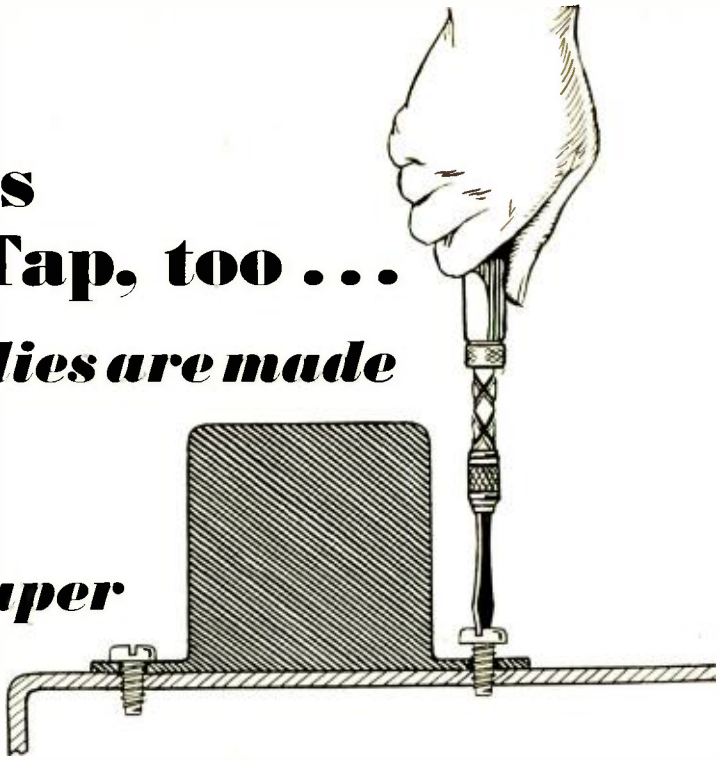
The exhaust machines, with pumps located on the floor, with slow working, long air lines have been replaced by modern compact units designed to avoid all possible lost motion. An automatic grid winding machine, without manual aid winds grids, spot-welds each turn to support wires and cuts and trims to exact form ready for mounting, six hundred units per hour.

Many giant steps have been taken since the days of the McCandless shop on Warren Street, where fragile, candelabra base audions were produced at the rate of a dozen per day—or per week.

DONALD McNICOL, *Editor.*

With Screws that Tap, too . . .

Radio assemblies are made easier quicker cheaper



Used by Philco, Stromberg-Carlson, General Motors Radio, Edison, Crosley, Colonial, U. S. Radio and Television . . .

All along the assembly lines of leading radio manufacturers, Hardened Self-tapping Sheet Metal Screws have cut costs and speeded up production. Because no other means of fastening parts securely to the chassis is so easy, quick and economical.

In the Philco plant, for instance, Self-tapping Screws eliminated 14 troublesome tapping operations on each receiver. Besides, a saving of $16,000.00 a year in time and labor was effected.

Unskilled workmen can make first class assemblies with these Screws. No tapping or tapping plates required. No nuts or washers to fumble in hard-to-get-at places.

Just one simple, quick operation to join sheet metal or make a fastening to sheet metal with these Screws. Merely turn the Screw into a drilled or punched hole. It forms its own thread in the material. Makes a stronger fastening than a machine screw in light metal . . . does not loosen as readily under vibration.

See what these Screws will do on your assemblies. Send for samples—the coupon brings them, free.

Some of the applications for which they are used

Among the many applications for which radio manufacturers use Self-tapping Screws are: Fastening padding, power, by-pass and neutralizer condensers; power chokes; power and push-pull transformers; volume control shields, shield plates; wire clamps; braces, etc. You can use them profitably for similar assemblies.

Free Samples for Trial . . .

If you make sheet metal assemblies, do not fail to test Self-tapping Screws. The coupon brings free samples for test—use it.

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

Please send me samples of Hardened Self-tapping Screws. I want to try them for:

.....

Name .....

Address .....

PARKER-KALON

HARDENED TYPE Z SELF-TAPPING

Sheet Metal Screws

PATENTED APR 1 1916 – No 1209232 – MAR 28 1922 – No 1411184
AUG 14 1923 – No 1465148 – FEB 10 1925 – No 1526182 – OTHERS PENDING

When the Coil's IN CONFERENCE

When the coil's up for consideration in a radio factory, it faces a *real* inquisition. Here "quality" is only one factor out of half a dozen with which it is confronted. The purchasing agent demands uniformity . . . he visualizes ideal coil shipments in which there are no rejects. The engineer demands accuracy, adherence to specifications, and able engineering assistance.

The General Manager, with an eye toward economy, wants the cost kept down without sacrificing quality. Altogether a tough proposition, and one that only a *good* coil would want to tackle. The fact that Dudlo coils have become standard in the country's finest receivers is conclusive evidence of their ability to pass the demands of any conference.

DUDLO

DUDLO MANUFACTURING COMPANY, FORT WAYNE, INDIANA

Division of General Cable Corporation

"Your Engineers Have Perfected

A RADIO TUBE MIRACLE

. . . we want these tubes for our set!"

That's what the U. S. Radio and Television Corporation said, when they selected the New National Union Radio Tube as the exclusive matched tube equipment for the ***New*** **APEX Unified Radio**

THE United States Radio and Television Corporation have created a new standard of radio value in the NEW APEX UNIFIED RADIO.

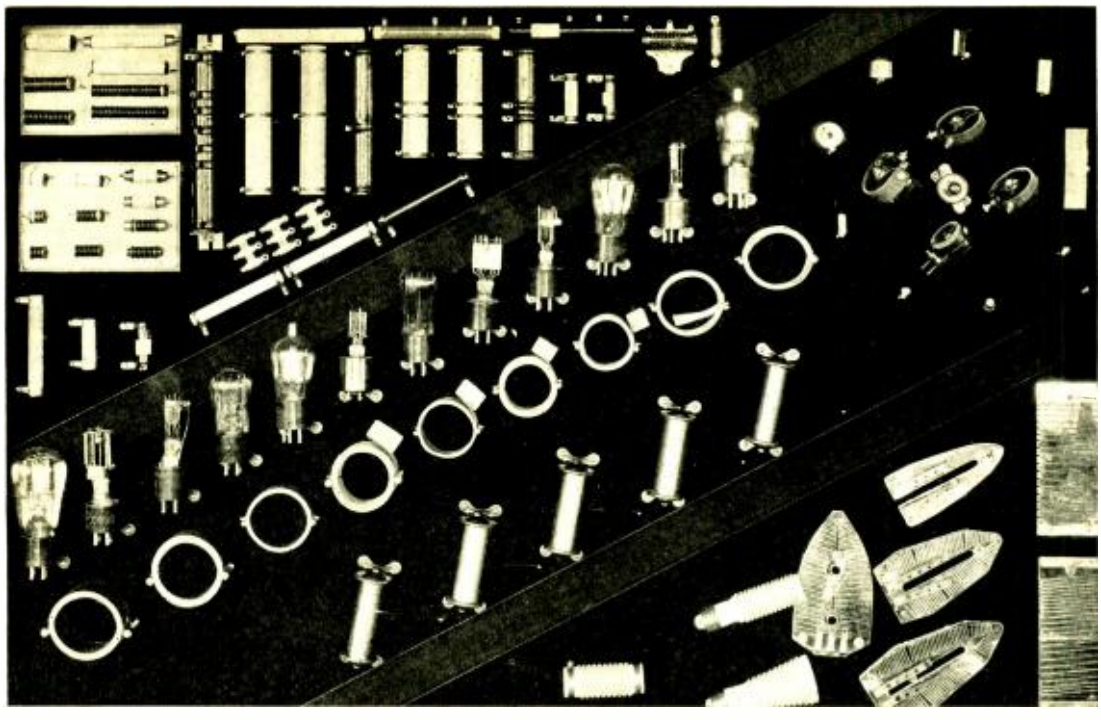
This new radio presents a highly developed co-ordination of set and tubes. Through our close co-operation, it has been made possible to offer this screen-grid receiver, complete with dynamic speaker, in a beautiful console at the unchallenged price of $101, *with tubes!*

Long and exhaustive tests in the research laboratories of the United States Radio and Television Corporation singled out the New National Union Radio Tube as a worthy companion to the set. Closely matched to the operation of the receiver, these tubes will make possible a new, thrilling clarity of tone, and a new sense of power.

The striking uniformity of characteristics, the superb design and construction which the United States Radio has found in National Union tubes, brought forth the strongest of praise. United States Radio engineers did not hesitate to call the New National Union tube a radio tube miracle. In its rigid adherence to the highest quality standards in the industry, it is just that. Interested manufacturers are invited to write. Dealers and jobbers are urged to ask for the New National Union 1930 Proposition.

NATIONAL UNION RADIO CORPORATION
400 Madison Avenue
New York City

The NEW NATIONAL UNION RADIO TUBE



The **Oldest** *source of supply . . . . . .*

The **Largest** *source of supply . . . . . .*

The **Most Experienced** *supply source . .*

for

Resistance ALLOYS

Nickel—ribbon—wire—strip

Special Enamel insulation—
Silk and cotton insulations

The Name:

Nichrome

— the highest resistance available.

The Maker:

DRIVER-HARRIS COMPANY

HARRISON, NEW JERSEY

Chicago Cleveland Detroit Morristown, N. J. England Italy France

BACK OF PROGRESS

RADIO has made phenomenal progress. But its progress would not have been so rapid or so great were it not for the radio engineer — and the manufacturers who have been able to keep abreast of his inventive genius.

SCOVILL was a pioneer in the making of radio condensers and SCOVILL is proud that it is one of those manufacturers who have kept step with progress.

Back of the radio engineer and back of every radio set is the SCOVILL emblem of quality and service as exemplified in SCOVILL radio condensers. SCOVILL has served, serves and will continue to serve those leaders in the field who insist on the best.

SCOVILL

MANUFACTURING COMPANY

WATERBURY, CONNECTICUT

Boston
Atlanta
Chicago
Providence
Cleveland
Los Angeles
New York
Detroit
San Francisco
Philadelphia
Cincinnati
In Europe—
The Hague, Holland

Heavy going!

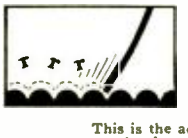
PROPER power control is necessary to propel your automobile through the winter drifts.

The music from your radio receiver, wallowing through the sleets of static and the storms of internal self-inflicted noises, needs ample power PROPERLY CONTROLLED.

That's where the scientifically calibrated CENTRALAB volume control plays a major part in the proper performance of your radio.

For smooth, quiet operation insist that your radio be CENTRALAB equipped.

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



This is the action of the usual wire wound control after it has been in use for some time . . . like dragging a stick over a cobblestone pavement.

The tailor uses the same principle as Centralab. He does not want to ruin the garment by placing the iron on it so he places a cloth in between. Centralab controls can not ruin the resistance because the rocking disc is in between the pressure arm and the resistance.

SERVICE MEN!
First come — first served.
Send 25¢ for the New Centralab Volume Control Guide, exclusively for Service Men. Send your Letterhead or Business Card.

"Volume Control, Voltage Control & Their Uses"
Write Dept. 212-B for Free Booklet

Centralab
CRL
CENTRAL RADIO LABORATORIES
Dept. 212 B., 20 Keefe Ave. Milwaukee, Wis.

W when Your problems — are Ours

The Vitrohm Resistor illustrated above is equipped with ferrule terminals for insertion in fuse clips. It can be supplied for all National Electric Code standard diameters.

Other types of terminals and mountings are available to meet every requirement and condition of service.

WARD LEONARD ELECTRIC CO.
31 South Street
Mount Vernon, N. Y.

Resistor Specialists for More Than Thirty-Nine Years

WHEN you invite us to help decide the proper resistor for use in your equipment, the chances are good that you will save time and future expense. Make your resistor problems ours and you have the cheerfully-given advice which comes from more than 39 years' experience in the design and manufacture of Vitrohm Resistors.

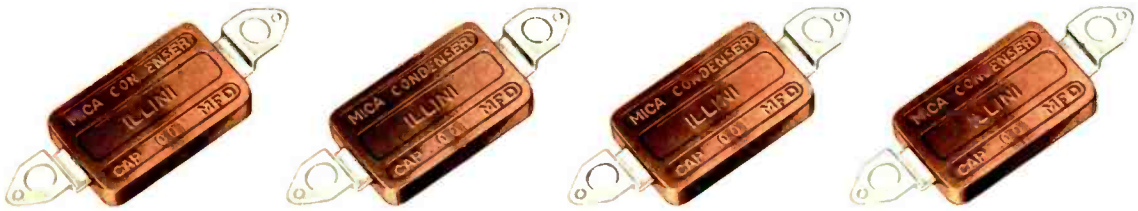
It is surprising how frequently difficulties in space, mounting or heat dissipation are difficulties no longer when reference is made to the records of one of the more-than-a-million jobs turned out by Ward Leonard.

You have in Ward Leonard an auxiliary plant, modern, skilled in the development of new resistor requirements, speedy and accurate in production, and capable of meeting your production requirements, however large.

Meet and know the Ward Leonard Sales Engineer serving your territory. His knowledge of the industry in general, and control equipment in particular will interest you. Ward Leonard manufactures a wide variety of products* and operates in many divisions of the electrical industry.

* Vitrohm (vitreous enamelled) Resistors and Rheostats . . . . Voltage Regulators . . . . Theatre Dimmers . . . . A.C. and D.C. Motor Starters and Controllers . . . . Field Rheostats . . . . Arc and Spot Light Rheostats and Ballasts . . . . Mobile Color Lighting Equipment . . . . Adaptorans . . . . D. C. Battery Charging Equipment . . . . Circuit Breakers

Don't gamble on "long chance" condensers



Sangamo Fixed Condensers are accurate and they *stay* accurate

If you want to play the ponies, or sit in on a friendly game, or even take a flier in Consolidated Tombstone, that's your business.

If you want to risk production losses by gambling with "long chance" condensers, that's your business, too. But whether or not it's *good* business is questionable.

No item can cost so little and cause so much trouble in a receiver as a fixed condenser. Why risk reassembly and service losses that far outweigh any possible savings that might result from the purchase of condensers of uncertain dependability?

Sangamo standards of precision carried into the manufacture of Fixed Condensers, have made it possible for manufacturers and custom set builders to eliminate condenser troubles.

The standard line of Sangamo Fixed Condensers leaves the factory tested to maximum variation of 10%. The reliability of these ratings is attested to by a number of nationally known radio manufacturers. Sangamo is equally reliable as a source of supply.

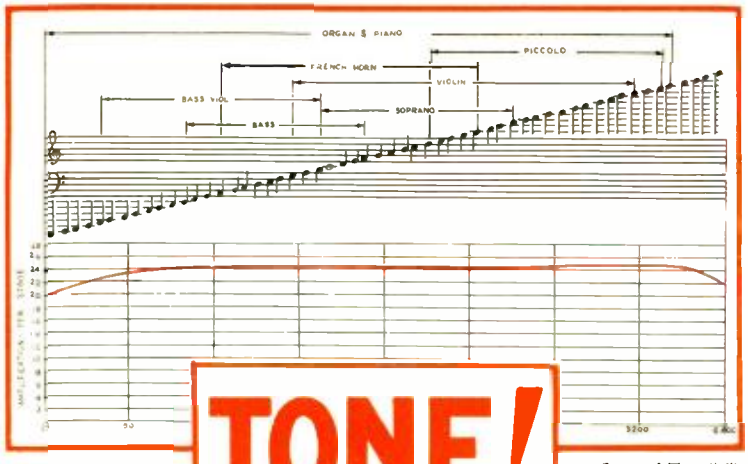
SANGAMO ELECTRIC CO

SPRINGFIELD, ILLINOIS, U. S. A.

Manufacturers of Precision Electrical Apparatus for 30 years

SANGAMO

See Reverse Side



TONE!

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

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

"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..... list price $12.00

Type D-210, same as C except for 210 and 112 power tubes; list price $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; list price $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. T-9422

☐ (*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

Volume Controls—A la Carte!

There is as much difference between plain, hand-me-down, stock volume controls and CLAROSTAT volume controls as there is between a plain *table d'hote* dinner and a Ritz Carlton *a la carte* banquet. The first may come within a mile of meeting your tastes, requirements and pocketbook; the second is absolutely your own selection. And in radio, as in eating, if you would have your volume controls *a la carte*,

Simply Specify

VOLUME CONTROL CLAROSTAT

Switch Type

The new bakelite wire-wound volume control CLAROSTAT is a precision device—in design, construction and application. But not in price. It is the cheapest volume control in the long run—low first cost, positive satisfaction, and no service costs in the future. The unique winding permits of matching any desired resistance curve. Indeed, we supply you with graph paper and you draw your resistance curve, which we precisely match by our unique winding method. Winding is on bakelite strip, and turns cannot slip or short-circuit. Contact is positive, smooth, silent and non-wearing. Comparative life tests indicate that this device will outlast most of the volume controls now on the market, even among the wire-wound types. Resistance values up to 50,000 ohms. Dust-proof and tinker-proof, because of sealed-in construction. Neat. Compact. Nothing to adjust. Foolproof. Install it—and forget it.

Duo Type

And now you can have the VOLUME CONTROL CLAROSTAT in multiple form—duo and triple types, with each unit arranged for the desired resistance curve, increasing or decreasing the resistance as required, and all controlled in tandem by a single knob. The most elaborate receiving and amplifying systems can be arranged for single volume control by means of these multiple VOLUME CONTROL CLAROSTATS.

The power switch can be included in the single or multiple VOLUME CONTROL CLAROSTAT assembly, so as to be turned on or off by turning the single knob.

REMEMBER—There's a VOLUME CONTROL CLAROSTAT for every radio purpose—strictly *a la carte*. Order what you like—we shall fill your order.

***WRITE** for engineering data regarding the VOLUME CONTROL CLAROSTAT, as well as the LINE BALLAST CLAROSTAT and other resistors fitted to your needs. Samples cheerfully supplied to designing and production engineers.*

Clarostat Manufacturing Company, Inc.

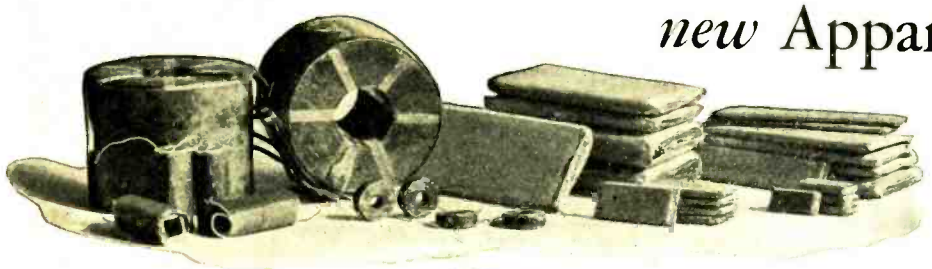
MEMBER RMA

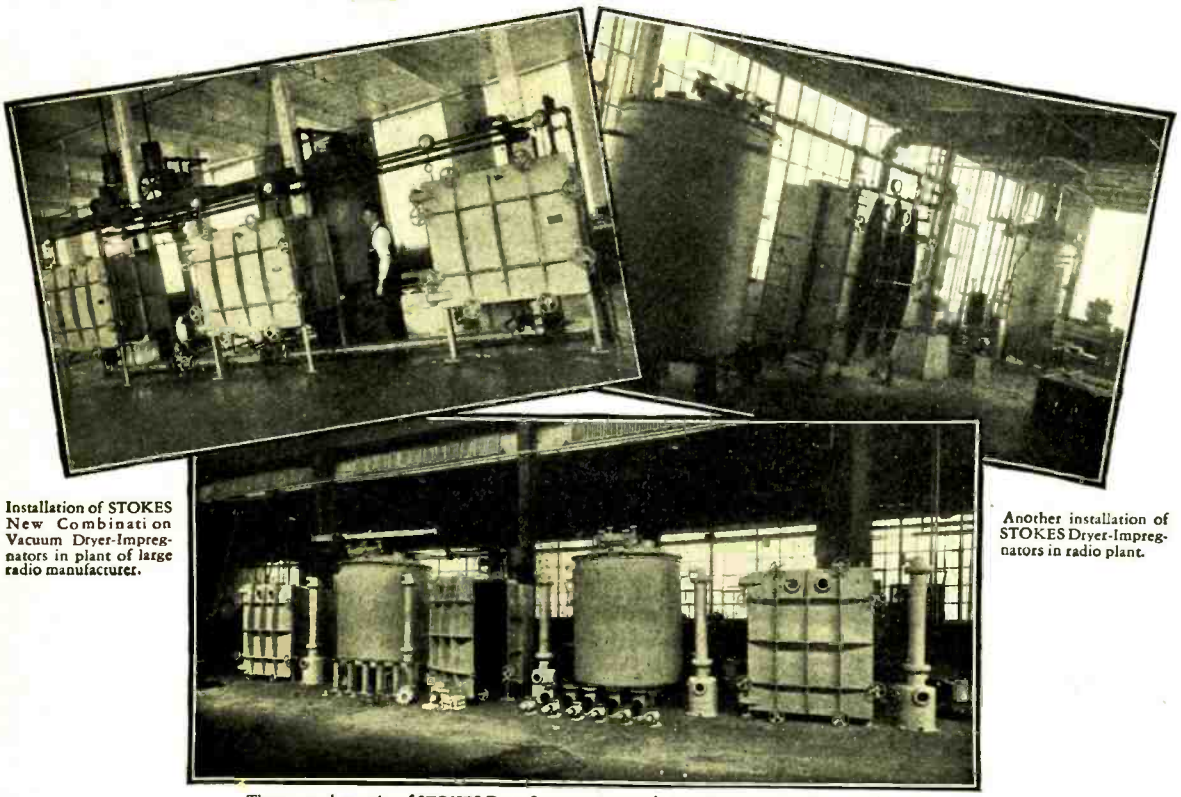
Specialists in Variable, Fixed and Automatic Resistors

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

Remember—there's a CLAROSTAT for Every Purpose

Dry and Impregnate Coils and Condensers in 25% Less Time With STOKES *new* Apparatus





Installation of STOKES New Combinati on Vacuum Dryer-Impregnators in plant of large radio manufacturer.

Another installation of STOKES Dryer-Impregnators in radio plant.

Three complete units of STOKES Dryer-Impregnators ready for shipment to leading radio factory.

By doing the entire job of drying and impregnating in *one* piece of apparatus and with *one* handling the new STOKES Dryer-Impregnators — as installed in leading radio plants — save at least 25% in time.

And they do a better job! The material comes in direct contact with the heating surfaces in a vacuum within one millimeter of the barometer, thus eliminating all moisture and securing 100% penetration of the impregnating compound.

Absolute insurance against coils and condensers breaking down!

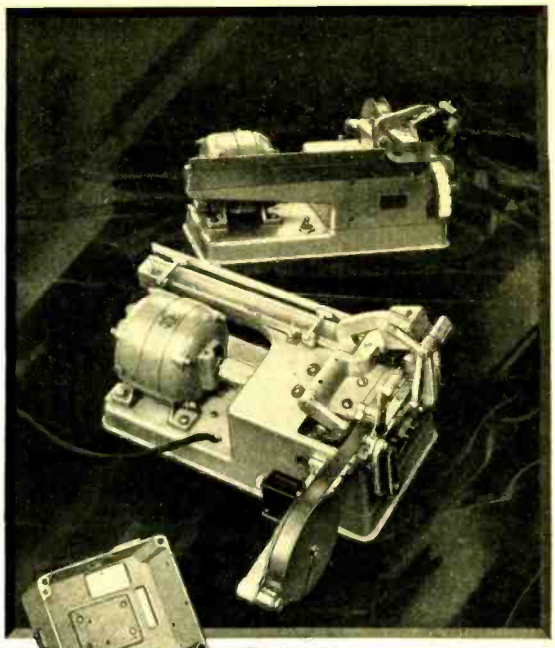
Write for detailed information to fit your production requirements

FJS STOKES MACHINE COMPANY

PROCESS MACHINERY SINCE 1895

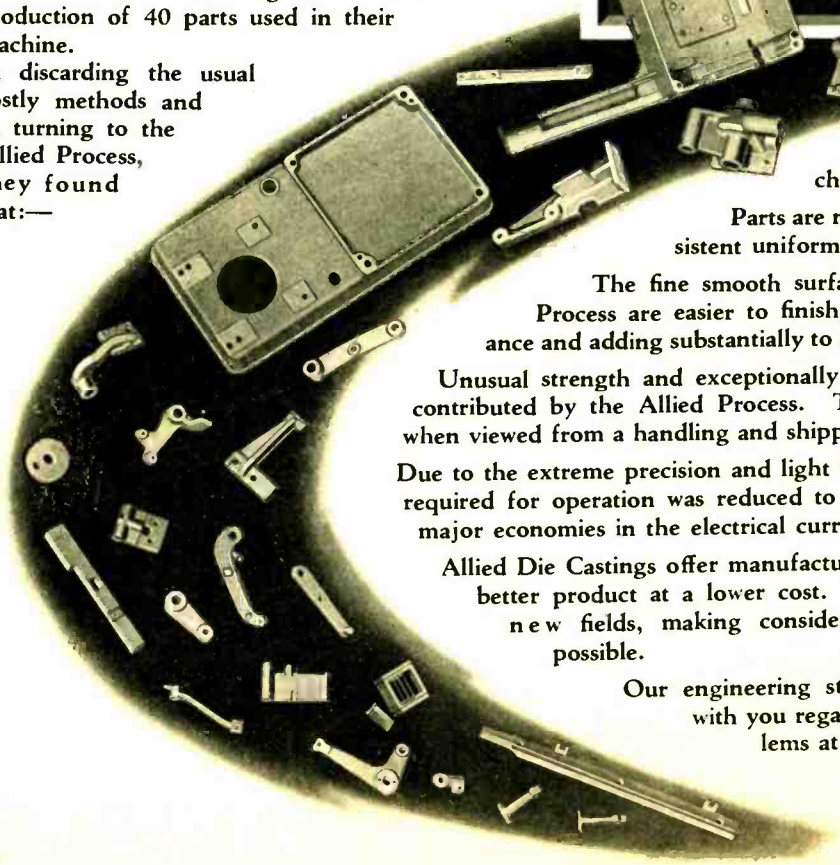
5972 Tabor Road Olney P. O. Philadelphia

40 Parts— Die Cast by Allied-reduced Costs 60%



Because the A. Kimball Co., manufacturers of the pin ticket machine illustrated, is one of the most progressive leaders in their industry — and because they are constantly on the alert to give their customers better quality at lower cost, they turned to the Allied Die Casting Process for the production of 40 parts used in their machine.

In discarding the usual costly methods and in turning to the Allied Process, they found that:—



Costs on the entire machine were reduced 60%.

Parts are now standardized and of consistent uniformity on all specifications.

The fine smooth surfaces obtained by the Allied Process are easier to finish, presenting a finer appearance and adding substantially to the salability of the machine.

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Due to the extreme precision and light weight obtained, the energy required for operation was reduced to such an extent as to effect major economies in the electrical current consumed.

Allied Die Castings offer manufacturers the means of making a better product at a lower cost. This very often opens up new fields, making considerably increased production possible.

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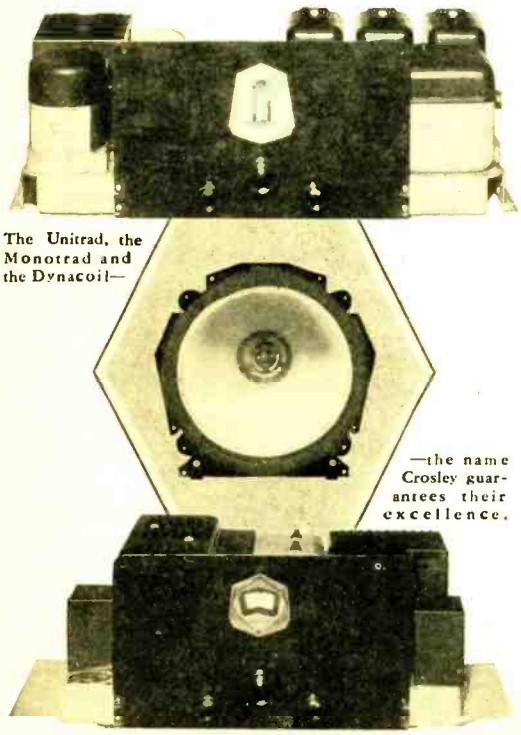
LONG ISLAND CITY, N. Y.

Crosley Radio *and* Micarta Insulation

. . . . . both products of pioneers



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CROSLEY radios have deservedly earned the confidence of the radio buying public. Such widespread popularity is only achieved through excellency of performance. Electrical insulation plays a major part in the performance of radio sets and this quality is most successfully obtained by the use of Micarta insulation.

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Specialists who are trained in punching, threading and engraving this material may be consulted, and will be pleased to submit samples and prices on request.

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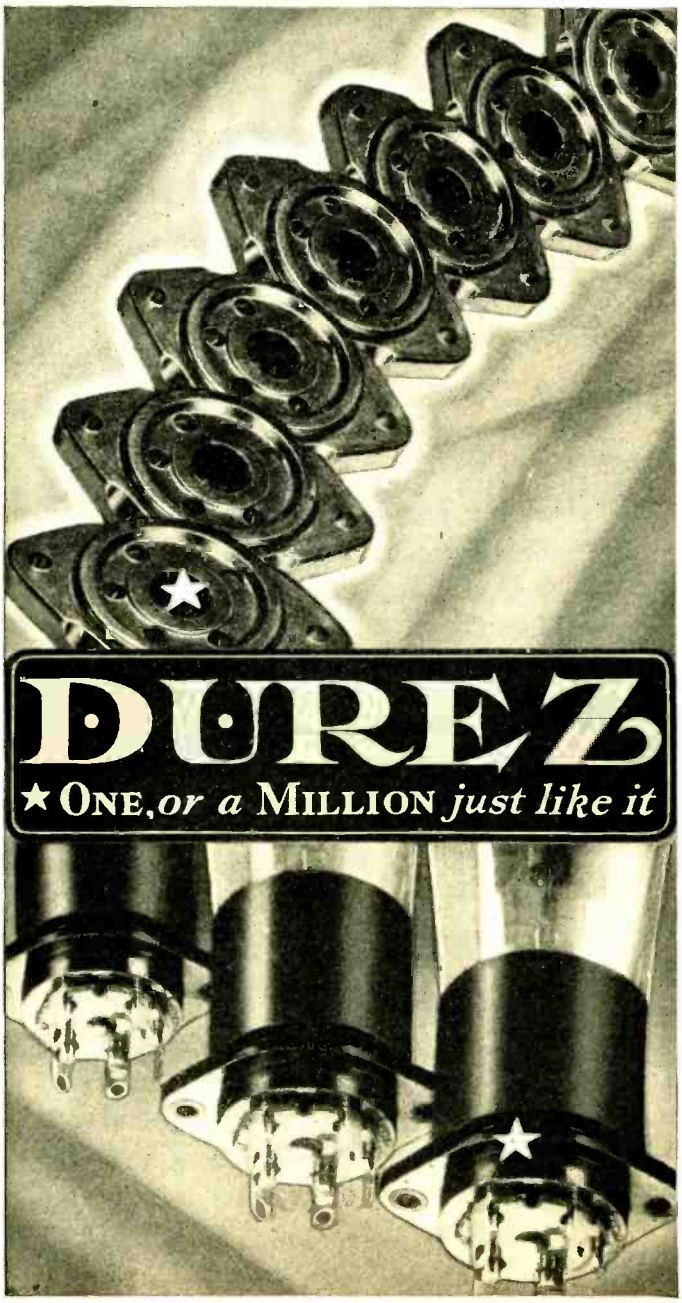

ANY way you look at it, the radio industry is highly competitive. You know that. Refinements, improvements, radical changes—continually! For anything new and better, instantly comes into public favor . . . which is one good reason why many radio manufacturers are switching from wood, porcelain, metal, hard rubber and other materials in favor of Durez!

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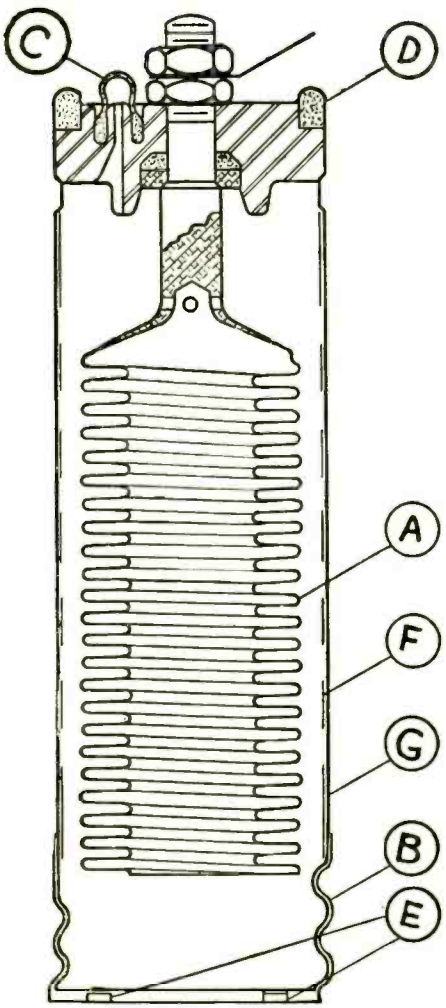

A One piece anode made entirely of pure aluminum; no welded or riveted joints either above or below the electrolyte.

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C Protected vent, vulcanized in hard rubber top, forming one piece unit.

D Pressure seal, with no possibility of cutting gasket.

E Locking lugs in socket to prevent condenser shaking loose during shipment.

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Individual cathodes eliminate all leakage between anodes and allow maximum flexibility in circuit design. Increased life, less leakage and much better shelf characteristics due to anode with edge effect of less than 10% of spiral type. Leakage current guaranteed not to exceed .2 milliamperes per MFD at 400 volts after 5 minutes or .065 milliamperes per MFD at 350 volts after 5 minutes.

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SPRAGUE ELECTROLYTIC AND PAPER CONDENSERS
WILL SOLVE YOUR CONDENSER PROBLEMS

SPRAGUE

IMPRESSIONS *and* EXPRESSIONS

By

AUSTIN C. LESCARBOURA

Fool Specifications

MANAGEMENT will never know the mischief caused by the splitting of hairs indulged in by certain engineering staffs. It seems to be a favorite indoor sport these days for young engineers fresh out of college, probably holding down their first job, to draw up specifications calling for parts made to so many thousandths plus or minus. Frequently, such extreme accuracy is entirely unnecessary. Meanwhile, the purveyors of materials and parts, faced with such rigid specifications, are forced to jack up prices in order to allow for the considerable shrinkage that is quite unavoidable in meeting such tolerances.

To the young engineer: we know you can talk in terms of extreme accuracy. We know that you have mastered the use of the micrometer caliper. We know that you have a highly precise mind. But for goodness sake don't talk in terms of thousandths of an inch when it is quite unnecessary. Remember, the making of watches is more expensive than the making of radio sets.

To the management: look into the specifications of your engineers. Remember, they are entitled to their opinions, in so far as they affect the goodness of the set. But don't stand for foolish specifications which mean unnecessary costs.

To the purchasing agent: pay close attention to specifications. Don't substitute. Don't let price dominate all decisions. But nevertheless, watch out for fool specifications.

▲

New Life for The Portable Set

WHAT happened to the portable radio idea? Several years ago, there were many portable radio sets on the market, some enjoying real popularity, for a time at least. And then, quite unexpectedly so far as the public was concerned, a modern version of the Boston Tea Party ended the career of the portable radio set, so far as leading radio manufacturers were concerned.

The cause is simply explained. The -99 type radio tube, on which most of the portable sets were based, proved unsatisfactory. With a weak filament, electrically and mechanically speaking, the -99 never was a satisfactory tube. Not only did it have a very short life at best, but at worst it was a tube which often failed to provide results from the very beginning. There are hundreds of thousands of portable and so-called farmer's radio sets, utilizing the -99 type tube, on the bargain counters of the radio trade, as a monument to the failure of that tube to deliver satisfactory service.

But during the past month, an improved form of -99 type tube has appeared. Vacuum tube engineers have sought a come-back. A new -99 tube has been developed, utilizing a special form of oxide-coated filament with three times the emission of the old -99 type. Microphonic troubles have been eliminated by a filament about three times the usual cross-sectional area. Life tests so far indicate a positive emission and satisfactory life of several thousand hours. Such a tube, together with a pentode which is bound to follow, will doubtless pave the way for a satisfactory portable radio set.

There is a market for portable radio. But the public, having learned the joys of modern radio perfection through the all-electric home set, is in no mood to buy an experiment. Perhaps we are on the eve of giving the public a real portable radio set, at last.

▲

Untuned Radio Frequency

RECENT engineering developments on fixed radio-frequency transformers, especially designed for use with the screen-grid tube, may yet bring about a change in present-day broadcast reception practice. Untuned radio-frequency amplification makes for a comparatively simple and inexpensive set of extreme compactness. The only tuning member required is a single variable condenser with fixed inductance for the input circuit, with perhaps a band-pass filter to sharpen the tuning. In the case of a loop antenna, only a tuning condenser is required.

It is claimed for these new radio-frequency transformers that they have a gain of about ten, as contrasted with twenty for the best tuned radio-frequency stages with screen-grid tubes. Obviously, it may require more tubes to equal the gain with tuned radio-frequency stages. But on the other hand, the equipment is so much more simple, so compact, and so much lower in cost, that the lowered gain is more than made up. In the portable set particularly, the untuned radio-frequency amplifier may have decided advantages because of compactness and light weight.

With regard to the patent situation, it is well to note that the untuned radio-frequency amplifier detours around most of the troublesome receiver patents now in force. This may or may not be an attraction, according to the point of view.

At any rate, a very old idea is now a very new idea. History repeats itself, but always with a definite gain, of course.

▲

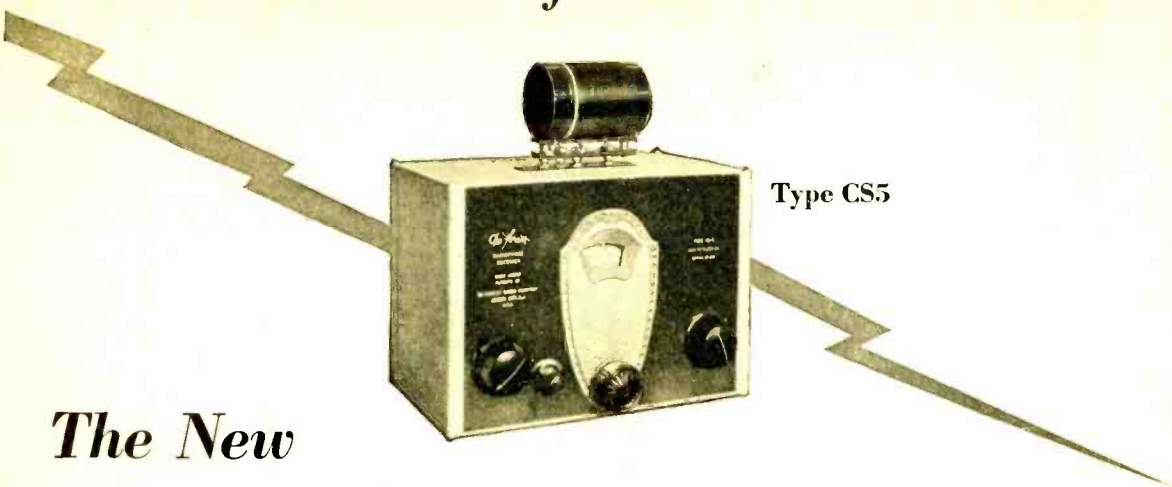
Radio Tube "Seconds"

MUCH of the so-called overproduction of the radio tube industry is not actually overproduction. Critically examined, it proves to be nothing more than the dumping of veritable garbage on the market, in the guise of non-standard brands of tubes. These brands are actually camouflaged "seconds" and "thirds" of well-known brands, which should be scrapped in the first place. Good tube manufacturers market only one kind of tube—the best they know how to make.

It is with considerable misgivings that we note the growing tendency on the part of radio tube manufacturers to market every tube they produce. Fewer are scrapping the tubes that fail to pass the usual standard tests. To make matters worse, there are merchandising organizations now at work, asking tube manufacturers to sell them the "seconds" and "thirds," unbranded, so as to supply that portion of the radio public that buys "at a price." Unfortunarely, too, the rejected tubes are dressed up with high-sounding names, flamboyant cartons, and lavish claims, so that the public is deceived into buying them at a bargain price in the firm conviction that standard brands must be sold at high prices in order to defray the "high cost of advertising."

The selling of "seconds" is, frankly, unethical practice. It is a short-sighted policy. It takes away from the sale of good products. Everyone is bound to suffer from the evils of this growing practice.

The latest achievement of the De Forest Laboratories



Type CS5

The New

DE FOREST SHORT WAVE RECEIVER

TRANSMITTING AUDIONS

510	—15 Watt Oscillator	$ 9.00
503A	—50 Watt Oscillator and R. F. Power Amplifier	40.00
511	—50 Watt Oscillator, R. F. Amplifier, Modulator or R. F. Power Amplifier	40.00
545	—50 Watt A. F. Amplifier and Modulator.	45.00
552	—75 Watt Oscillator and R. F. Amplifier	32.50
504A	—250 Watt Oscillator, Modulator or R. F. Power Amplifier	140.00
500	—500 Watt Special Oscillator	130.00
520B	—5000 Watt Oscillator and R. F. Power Amplifier—water cooled	250.00
565	—7½ Watt Screen Grid R. F. Amplifier	22.00
560	—75 Watt Screen Grid R. F. Amplifier	50.00
561	—500 Watt Screen Grid R. F. Amplifier.	390.00
566	—A half-wave hot cathode, mercury vapor rectifier Medium Current	12.50
572	—A half-wave cathode, mercury vapor rectifier, Heavy Current	30.00

The new De Forest Radiophone Receiver, Type CS5 illustrated above, is designed to receive both telephone and telegraph signals on all frequencies between 1,500 and 15,000 kilocycles (20 to 200 meters).

Being small and light it is excellent for portable work. Its enormous amplification giving loud speaker signals on a 10 ft. antenna.

The special circuit uses four Audions; two Screen Grid Audions as radio frequency amplifier and space-charge-grid detector (power detector) and two Audions in a transformer-coupled audio amplifier. Housed in an aluminum case, 5" x 6" x 9", this receiver, although full-grown in strength and performance, makes an ideal short wave receiver for aircraft reception where light weight is a necessity. It is also adapted for general amateur use, small yachts, police cars and automobiles.

DE FOREST RADIO CO., PASSAIC, N. J.

Branch Offices Located in

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

de Forest AUDIONS

Specifications for De Forest Radiophone Receiver Type CS5

Battery Requirements

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

Features

Extremely compact and light in weight.
Screen grid R. F. Amplifier.
Space-charge-grid power detector.
Two stages of audio amplification.
Zero body capacity.
Frequency calibration independent of antenna used.
Moisture and climate proof.
Negligible microphonics.

USE THIS COUPON

S. W. Receiver type CS5 (less tubes)		$75.00	☐
510	$ 9.00 ☐	552	32.50 ☐
503A	40.00 ☐	504A	140.00 ☐
511	40.00 ☐	500	130.00 ☐
545	45.00 ☐	520B	250.00 ☐
560	50.00 ☐	566	12.50 ☐
561	390.00 ☐	572	30.00 ☐
565	$22.00 ☐		

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Counting the Heart Beat of Radio

A Survey of the Vacuum Tube Situation and Expectations for 1930 Production

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

THE heart of radio is the vacuum tube. By a determination of trends and production plans of the tube manufacturers, we may arrive at a fairly accurate indication of the prospects of radio as a whole during the present year. The set manufacturers, of course, have something to say on the matter. But we are taking for granted that the tube and set manufacturers have arrived at an agreement whereby the former will produce the types of tubes necessary for the sets, and the latter will produce sets with a sufficient number of tubes to satisfy the tube manufacturers. The broadcasters are another consideration. The quality of their programs must influence the purchase and per-hour-a-day use of radio receivers. The broadcasters may be called the lungs of radio, breathing fresh air and the sustaining ozone into the red corpuscles of the receivers, whose blood is circulated by the heart in the form of vacuum tubes. With this physiological explanation of radio let us examine the heart of the patient, which, we are happy to say, having passed the crisis of its present ailment in December, is on the road to rapid recovery.

A group of leading heart specialists, or tube manufacturers to be precise, was called in for consultation. Like most medicos and manufacturers, they were, for the most part, general in their terms, vague in their replies, and optimistic in their attitudes. They saw only a golden ray of sunshine in the tube situation for the current year. True, many of them still have enlargement of the heart, or, in layman's terms, bloated inventories, which must, like the vicious boils that they cause on the neck of the industry, be reduced, either by the assimilation of the inventory in the general flow of tubes to the market, or by a surgical operation, which, while cutting out the inventories at one fell swoop, would be much more painful, wasteful of tubes, and expensive.

Stocks Being Absorbed

In all probability, the inventories will be absorbed in the general marketing of tubes. That the market will be able to take care of all the tubes manufactured seems apparent from the views of the several manufacturers who voiced opinions on the matter. Most of them expect a rise of tube sales for 1930 to the extent of from 10 to 25 per cent. over last year's sales, with the opinion averaging about 15 per cent. increase.

On what these optimistic estimates are based is uncertain. Partly, perhaps, on the fact that more and better and quicker automatic production machinery will tend to a lowering of price and a consequent larger replacement of old tubes. Also, to the fact that most tube manufacturers are agreed that the average set manufactured during the year will require a total of seven or eight tubes. One pessimistic concern looks for only six sockets in each set, a few as many as nine, and one manufacturer, mistaking the question to mean how many tubes will be used in radio sets throughout the country for the year, answered 38 to 43 million! Castles in the tube manufacturer's vacuum, we call it.

The seven-tube set will probably make use of one -27, three -24, two -45 and one -80. The types used in the eight-tube set will be the same with an additional -24.

Another factor that may justify the outlook for a bigger and better year for the tube manufacturers is the development of industrial or extra-radio applications of the vacuum tube. Most of the manufacturers are agreed that this field is most fertile. But it needs plowing, sowing and most careful cultivation before the rich harvest of vacuum tubes may be taken to market and sold.

Most manufacturers see in this use of the vacuum tube, not an immediate market, but the possibilities of huge sales in from one to five years from now. They are conducting research as to the commercial uses to which the tube may be put, some of them in close cooperation with industries that may find the vacuum tube valuable. Already counting, sorting, controlling furnaces, measuring and weighing may be facilitated by the use of the vacuum tube. The cooperation of the tube manufacturers with the industrial concerns in developing not only tubes but the use of those tubes and photoelectric cells, shows an interest wider than that of merely manufacturing and getting rid of tubes. It is to be commended.

How Many Tubes in 1930?

Still on the subject of how many tubes will be placed on the market during 1930, and sold, one factor may, at first glance, tend to the opinion that sales will not be as great as in former years. That concerns the average life of the tube. According to prevalent opinion, tubes should last about 1000 hours. Most manufacturers are agreed on that. One places the probable life as low as 800 hours, another as high as 1500. But 1000 seems to be the concensus of opinion. Some figure has also been obtained as to the average daily use of each radio receiver. This varies considerably. Some radio stores, attracting people to its doors by music issuing through loudspeakers into the street, may use sets as much as fifteen hours a day. Other sets are used only one or two hours. Manufacturers' estimates vary from three to twelve hours, the average being about five.

Viewing the situation as a whole, however, we are inclined to believe that the greater expectancy of life in the 1930 tube will cause a more widespread use of tubes. Due to the high cost of tubes in the past, most set owners have been loath to change until absolutely necessary. The point of necessity was when music, or let us say, sound, no longer issued from the receiver. Anything better than nothing was all right. The lowered price of tubes today, due in part to improved production methods and machinery, has made the public more willing to change tubes. And an educational campaign, carried on by some tube manufacturers, is showing people that a tube that lights does not necessarily mean a tube that gives good results. The increased quality of reproduction in new sets is making the public dissatisfied with

anything but the best. If, after a year, the receiver does not sound as good as when it was new, the trend is not toward buying a new set, but rather replacing the tubes, an obviously less expensive process than it has been in the past. The public is being taught the inefficiency of having any but the best tubes in a fine set. The beauty of our radio programs demands the continuous employment of good tubes for reception on a par with the broadcast performances.

Quality Reception Requires Good Tubes

The realization of these facts is making for more tube consumption. No longer are tubes used until they no longer light. The demand for quality reception, quality sets and quality programs means that tubes must be changed after say 1000 hours of use. The longer life of present tubes is making for better reception, not less sales.

All in all, it is estimated that between 75,000,000 and 125,000,000 tubes will be used throughout the country in 1930. The wide divergence of opinions on this matter is due to the fact that those manufacturers who believe the average set will have only six tubes and the lives of those tubes will be about 1200 hours, naturally figure low, while those who look for more eight and nine tube sets, and tubes of 800 to 1000 hours life, see the volume of tubes in terms of the larger figure. Of course, due to the inventories already on hand, the number of tubes to be used does not correspond to those which will be produced, since last Fall's crash of the tube market will caution manufacturers against overproduction this season.

The radio industry must progress in the future as it has in the past. At present the types of tubes on the market are greater than ever before. Still, the question arises, are new tubes contemplated? For the most part, the manufacturers look toward a standardization of tube types, with no new models being added at present or in the near future. There is, however, a hearty disagreement as to the effect a new type might have on the industry. Some believe that the desired stabilization of the tube industry can be attained only by perfecting the present types without disturbing the market with new devices. Others believe that new life can be pumped into the tube industry only by innovations. The majority opinion favors no new types this year.

The Pentode Tube

Several concerns are investigating the chances of pushing the pentode, which has recently disturbed the serenity of the tube atmosphere. One company in particular is backing this type to the limit, evidently on the assumption that set manufacturers, to create a demand, will design circuits for this tube. Such a move, however, appears from present indications to be pretty much of a gamble, in view of the recent statement of the Radio Manufacturers' Association to the effect that they do not expect to incorporate the pentode in their 1930 sets. Of the set manufacturers who have investigated the possibilities of employing the pentode, none, according to the meeting of the RMA, will use the tube. And still, the selling point is undoubtedly great, in spite of the avowed determination of set makers not to push a new item merely because it is new. In line with this view, the tube manufacturers do not look for any change in radio circuits which would radically influence tube design or production. Of course, such concerns as are going into or hope to go into pentode production point to a change of circuit design which will permit the use of this tube. Others believe such a circuit may be perfected during the year, for production in 1931. But evidently, "all's quiet on the circuit front."

MODULATION FLASH!

Every broadcast station engineer and every radio receiver engineer who reads the story in the May issue of RADIO ENGINEERING on the subject of Modulation, will have a complete and understandable knowledge of this important subject.

The article was prepared by Ralph P. Glover, radio research engineer.

Manufacturing Betterments

We have mentioned improved production facilities. Most tube companies are trying to cut costs of production, speed up the manufacture, and cut down on rejects. Some independents are installing equipment heretofore not used by them. One firm has just provided itself with machinery that will speed production more than 100 per cent. Another has installed new R.C.A. apparatus. For the most part, manufacturers are trying to make more efficient use of present equipment, cutting down the handling, and in other ways improving production methods. At least one concern is working in close cooperation with purveyors of tube manufacturing machinery. The DeForest Radio Company has just announced the results of months of intensive study of the situation. They are installing new machinery by which they can produce tubes at the rate of 2000 an hour. On the basis of the savings which these facilities will effect, this company has recently cut its tube prices from 20 to 35 per cent. Undoubtedly, other concerns will follow suit in short order, both as to price and the designing of better equipment. The race of economical and speedy production is on.

The optimism of the tube companies is perhaps best shown in their statements as to the number of tubes they expect to make this year. One firm hopes to make 75,000 per day. Another expects to produce between 2,500,000 and 3,000,000 for the year. A third, whose 1929 production was only 300,000 hopes to more than triple that this year. Still another firm looks forward to hitting the 6,000,000 mark. One well-known company estimates between 4,000,000 and 5,000,000. Let us figure it out. These five tube manufacturers plan to produce a total of 16,000,000 tubes for the year, or an estimated total, produced by all the companies in the country, of about 100,000,000. There are in the country more than 80 tube manufacturers. And the single largest tube maker is not among the five listed. The five concerns whose estimates are given equal 6.2 per cent. of the total. They plan to make 16 per cent. of all the tubes produced.

Although these estimates will probably remain just estimates, the fact remains that tube production is tending towards the selection of a few firms, who will make almost all the tubes. Of the eighty, the next few years will probably see about a dozen remaining. The others will have dropped by the wayside, or have developed some other profit-making product.

As we glance over the situation it is apparent that the quality of tubes is improving steadily. Quick heating seems not to be the factor that a few manufacturers tried to make it. The public has become accustomed to waiting 15 or 20 seconds. It does not much mind the delay. The life of tubes has been materially improved. The public is learning to discard tubes when they lose their effectiveness, not when they no longer light. This education and discrimination on the part of the public is tending to the use of more tubes in spite of their longevity of life. Production equipment will speed up production and cut costs, aiding the frequent replacement of tubes. This trend will make the tube manufacturers more independent of the set manufacturers, since replacements will play an increasingly important part as compared to initial equipment. The sales policies of tube manufacturers will be adapted to meet this situation, catering to the dealers and public as well as to the manufacturers.

All these trends and situations are for the good of the radio industry as a whole and the tube industry in particular. Nineteen hundred and thirty will prove to be a banner year in tubes, if—we knew there would be an "if" in this article, even though we kept it out until the last sentence—the manufacturers keep production under control, their tubes in line with set design, and their prices right.

That should not be so difficult.

High-Speed Automatic Tube Manufacture

Tubes Now "Pulled" from Atmospheric Pressure to the Required High-Vacuum State in 20 Seconds

*By Raymond M. Zimber and Allen B. DuMont**

WHEN broadcasting first made its bow to a startled public, the demand for radio tubes to be employed in receivers and transmitters was relatively small. Only a few types were manufactured. The existing practice was to make one type serve several purposes, even if inefficient in many of its rôles. Tubes were manufactured more or less on a piecemeal basis. Parts were formed by operators with hand jigs. Hand pumping positions were employed. The final product was far from uniform, quite weak mechanically, and possessed an erratic life. Furthermore, there was no satisfactory means for determining, at the factory, the life and performance of the tubes, although tubes were inspected before shipment for a few supposedly essential characteristics. However, as the demand for tubes of all types increased, it became more and more evident that the old methods must be supplanted by new ones, devised for making better tubes. Also, as the broadcast reception art developed, the number of tubes per set increased several fold, calling for a marked reduction in the price of tubes so as to meet the limitations of the average family's pocketbook.

The growing demand for radio tubes brought several manufacturing organizations into the field by virtue of license arrangement with the deForest Radio Company, which organizations had previously been engaged in the manufacture of incandescent lamps. These concerns had considerable experience in the handling of lamps in quantity, and had perfected certain machines for the production of incandescent lamps. Such machines were a decided advance over the purely hand methods previously employed in the fabrication of radio tubes, and soon brought about a production rate of 250 to 300 tubes per hour from each production unit. Also, more uniform tubes were produced. Such modified lamp-making machinery has remained in use from that time until the present, serving the radio tube industry at large. In fact, given the same standardized equipment produced by several machinery companies, together with more or less standardized production methods and the same purveyors of parts and raw materials, the radio tube industry has necessarily operated on the basis of practically standardized production costs, resulting in a uniformity in list prices for given grades of tubes. When one company has dropped list prices, others have immediately followed suit, in the past, because if one could do so, all could do so. However, this standardization may cease. At least one organization has seen fit to design and produce its own radio tube equipment. The demand for lowered list prices now brings about keener competition among tube manufacturers, and can best be met by individual designing of the necessary equipment for greater production and lower costs.

*Engineering Department, DeForest Radio Company.

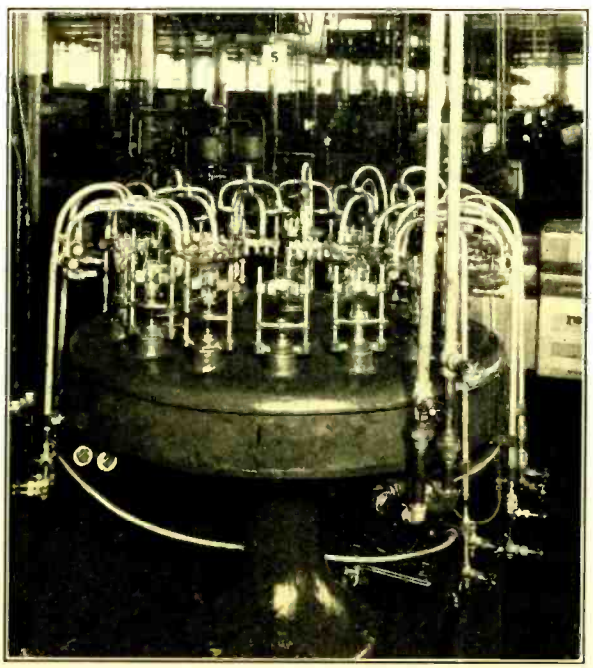
The authors of this article have long been identified with radio tube progress. Allen B. DuMont is now chief engineer of the deForest Radio Company. He was formerly a member of the engineering staff of the Westinghouse Lamp Company, assigned to the Radiotron division. He designed the first automatic radiotron aging and testing machine, now in use and already described in these columns. Raymond M. Zimber has charge of machine development work for the deForest Radio Company. He was formerly in charge of vacuum tube machine development for the Edison lamp division of the General Electric Company.—Editor.

Modern Manufacturing Machinery

About fifteen months ago, the deForest organization decided that the radio tube industry had attained such proportions that it might be well to think in terms of high-speed automatic equipment entirely distinct from electric lamp practice. Instead of utilizing lamp machinery technique as the basis, this organization decided to design unique equipment from the ground up, based on radio tube requirements exclusively.

In designing such equipment, many factors had to be considered. The general layout of the factory in which the equipment is to be employed, is perhaps the most important one. In this connection it may be noted that there are two general production schemes, namely, the departmental system and the unit system.

In the departmental system, each department handles a separate operation and passes the results on to the next department. This system has, on its face, some rather decided advantages, but in practice these advantages usually fail to materialize.



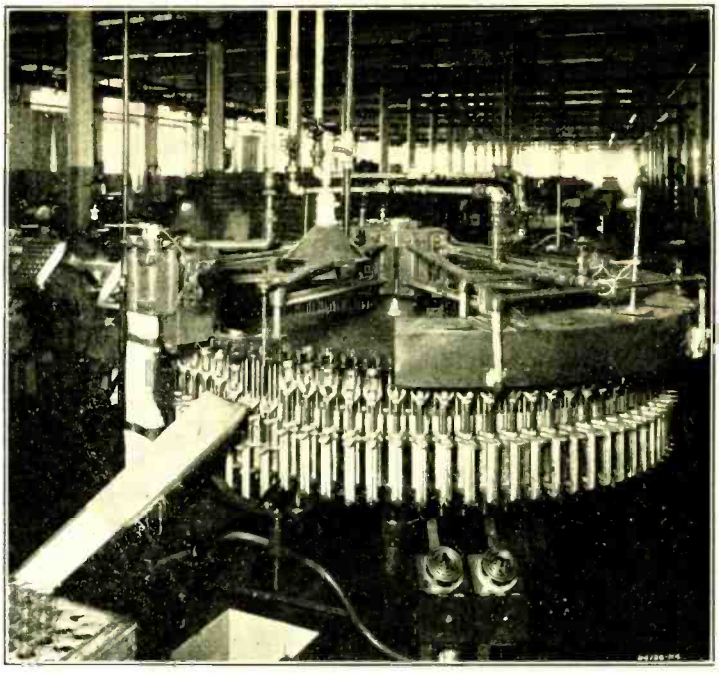
High speed automatic sealing machine, operating at the rate of 2000 tubes per hour.

To be more specific, a typical departmental system for the production of receiving tubes, such as the —27 type for instance, would comprise a parts department, for producing welds, grids, plates, getter caps, etc.; a department for assembling the welds and glass into stems; a department for taking the stems and assembling thereon the metal parts such as filament or heater, grid and plate; a department for taking the mounts and sealing the glass bulb thereto; a department for handling the sealed-in mounts and exhausting them; a department for basing, or applying the base to the sealed-in and exhausted bulbs; and finally, a testing department to handle the completed tubes, aging them for a period of time to stabilize the operation, and then testing and packing the perfect tubes.

The departmental system, which has been in general use, has the one big drawback that if there are any errors in carrying out the specifications, it may require several days before a mistake in the mounting department is discovered by the testing department. In the meantime, many thousands of tubes are in process of manufacture, and may have to be scrapped because they fail to pass the test specifications. A further disadvantage of this system is that all metal parts for a vacuum tube must be thoroughly cleaned and degassified. It is highly important that after this process the metal parts be immediately sealed-in and exhausted, so that they will not pick up dust and moisture which would seriously affect the operating characteristics and life of the tube. With the departmental system, it is almost impossible to accomplish the prompt sealing-in and exhausting of cleaned and degassified parts. One of the most serious factors affecting tube production is water vapor. With the departmental system, good results may be obtained during winter months and dry periods; but during the summer, when high humidity is commonplace, very high shrinkage obtains, due to the amount of water vapor picked up by bulbs and metal parts. In this connection the deForest organization is fortunate in having a huge air-conditioning system available in its Passaic, N. J., plant, quite aside from the prompt handling of parts as described further on.

The big advantage in favor of the departmental system of tube production is that individual machines may be operated at practically maximum capacity, because there is a stock of work constantly kept between each department, upon which the machines work.

The other system of radio tube production in general use is the so-called unit system, in which the parts, as in the departmental system, consisting of welds, grids, plates, getter caps and so on, are made in a separate department. However, instead of having all subsequent operations arranged in different major departments, such as a stem-making department, a stem-mounting department, a sealing department, an exhaust department, a basing department, and an aging and testing department, the plant is arranged in the form of complete units for producing complete tubes of different types. Each unit consists of a mounting section, sealing unit, exhaust unit, basing unit, aging unit and testing unit, laid out in a line and practically connected together for the ready handling of materials and progressive assemblies. In this system the parts are brought to the mounting unit, mounted up immediately, passed on to the sealing machine, from this machine into the exhaust machine, and so on through the production unit, so that it is possible to take the parts which have been cleaned and degassified, and have them sealed-in and exhausted within a half hour from the time they are cleaned, as against three to four days which is by no means uncommon practice with the departmental system.



High-speed automatic basing machine, with 90 heads. Operates at 2000 tubes per hour. In service in deForest factory.

Control of Shrinkage

The unit system makes it possible to maintain uniform shrinkage day in and day out. It is also possible to locate any trouble that develops within a few hours, and clear up the cause without delay since it is known from which machine the stock of another has come. The disadvantage ascribed to the unit system is that if one machine breaks down, the other machines of the unit are held up until such time as this machine is put back into operating condition. To a certain extent this drawback is probably true, but with proper design of equipment and the designing of each piece of equipment for its particular use without trying to combine too many operations, the drawback is overcome in the high-speed automatic equipment about to be described.

In designing an entirely new line of radio tube equipment, the first features that have to be considered are those for the parts department, wherein the raw materials are transformed into the various components of the tube. For instance, in the parts department the plates to a large extent have been manufactured on punch presses operated at approximately 2000 plates per hour. Using a high-speed automatic machine, a speed of 6000 plates per hour is now attained, with considerable saving in shrinkage otherwise caused by defective plates.

The machines employed for winding grids have heretofore been operated by hand, with a capacity of approximately 150 grids per hour. The grids have had to be cut to size and trimmed by hand, in most instances. The present deForest grid winding machine not only winds the grids, but also welds each turn to its support and in addition cuts them to exact size and trim so that they may be mounted directly on the stems. Approximately 20 per cent of the wire formerly wasted, is saved by this process. This machine operates at better than 600 per hour, and requires no attendant operator. Various other machines in the parts department have been arranged for automatic production, producing positively uniform parts at high rates of speed, with labor costs reduced to lowest possible levels. Welds, or lead-

in wires imbedded in the usual press of the radio tube, are produced in the deForest plant. Also nickel cathode sleeves, oxide-coated wire and other parts.

The complete assembly unit comprises mounting tables, sealing machine, exhaust machine, basing machine, and automatic aging and testing machine.

Cooling and Lubrication Provided

The old method of sealing consists of a six-head machine operated at approximately 300 tubes per hour. The newly-designed machine is a sixteen-head machine, operating at approximately 2000 tubes per hour. Because of the speed at which this machine operates, it is necessary to incorporate certain novel features. For instance, there are certain parts of the machine which are cooled, so that mounts being inserted in the machine will not crack from heat applied to the tube just preceding it. The new machine, because of its high speed, has been designed with a centralized oiling system including forced and splashed feed, in order to properly lubricate the parts. Also, because of the high operating speed, it is essential that the revolving parts stop for loading at an exact pre-determined position to permit the operators to keep up with the machine. These refinements make it feasible for one operator to handle the huge production of such a device.

The next machine in the new de Forest automatic high-speed unit is the automatic exhaust machine, which pumps out the sealed-in mounts. As soon as a tube is placed in the rubbers and the machine starts rotating, the mechanism automatically gauges the height of the tube by means of a bulb locator, so that in passing through the machine its height will be such that the various operating mechanisms will be in perfect alignment with it. Also, the tube is adjusted so that the exhaust tube is located at the desired depth in the exhaust rubbers. The tube then passes through an oven operating at high temperature, which drives out occluded gases and water vapor from glass and metal parts, while the vacuum is being applied. As the tube leaves the ovens, the filament is lit to decompose the carbonates which have previously been applied to the filament, allowing the CO_2 gas to be pumped out by the vacuum pumps, leaving the active oxides on the filament. As the filament is being heated, a high-frequency bombarder heats the metal parts by induced currents to incandescence, further driving out any gases which may be imbedded in those parts. As the tube is by now thoroughly exhausted, it is tipped off by an automatic tipping torch and removed from the machine. It is well to note such unique features as operating the high-frequency coils on an oscillating cam, so as to provide more uniform bombardment for all metal parts.

The main feature of the deForest automaric exhaust machine, however, is the design of the exhaust system proper. In all present exhaust machines, the general procedure is to locate the pumps on the floor, and to connect them by means of rubber hose and brass tubing with a valve located at the center of the rotating head. There are two face plates to this valve, the upper plate connected through sweeps to the tubes to be exhausted. With this system it is quite common to have anywhere from five to ten feet of tubing between pumps and tubes to be exhausted. This is not only a dangerous practice from the standpoint of good results, but it also necessitates a relatively slow exhaust in obtaining a satisfactory vacuum inside the bulb. The speed of exhausting from any given pump depends upon the length of the connection between the vessel to be exhausted and the pump, as well as the diameter of the connection. It also depends upon the tightness of the exhaust system. It must be apparent that with a connection between pump and tube of about five to ten feet, with five or six rubber connections, which are certain to be porous and of relarively small sized tubing, it requires considerable time to obtain anything near a high degree of vacuum in the tube to be exhausted. Furthermore, using a valve with this method, if one tube becomes a "leaker" or is broken during the process, one pump and sweep system is filled with air, which affects the next dozen or so tubes, causing marked shrinkage further on in the process as well as unsatisfactory operation during life.

Pumps Rotate With the Machine

With the design of the new deForest exhaust machine, instead of having five or six feet of connections between pump and tube, the pumps themselves rotate with the machine, while the length of connection between pump and tube is reduced to six inches. Furthermore, there is no valve to cause trouble. It might be well to state that this particular machine can pull a tube from atmospheric pressure to the desired high vacuum generally employed, in twenty seconds as against three and a half minutes on the old type of machine. Furthermore, allowing slightly more than twenty seconds for exhaust, permits of obtaining a much higher vacuum than is possible with the usual machine, no matter how slowly the latter may be operated. This is due to the fact that the leakage factor, caused by the porosity of the rubbers, is reduced to minimum proportions. An-

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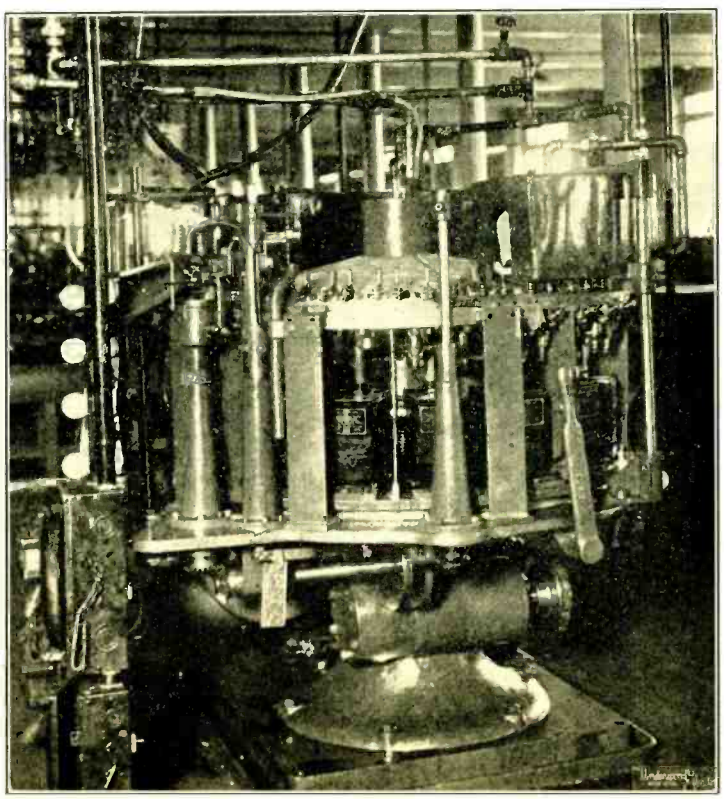

De Forest high speed automatic exhaust machine with direct mounted pumps.

The Chemistry of the Vacuum Tube

The Chemical as Distinguished from the Mathematical Treatment of Electron Emission

By Dr. Paul G. Weiller

NOT so long ago chemistry and physics were two distinct branches of science, the first dealing with changes affecting the composition of molecules, the latter with relations of energy and changes affecting only matter as an aggregate of a great number of molecules.

Except for the relations of current to electrochemical reactions and the early recognized fact that every chemical reaction is related to some change in thermal energy there was very little in common between chemistry and physics.

The chemists excelled in accurately describing and cataloguing elements and compounds and their reactions. The physicists, while they were doing a large amount of experimental work, were given considerably to theoretical deduction and even speculation sometimes not sufficiently supported by facts.

At that time an atom was imagined as an elastic tidbit, a sort of minute billiard ball, nothing being known about the difference between atoms of different elements.

A physical solution and a chemical compound were considered radically different entities.

With the rise of physical chemistry during the last few years of the past century both sciences began to coalesce, it was proven that solutions did not differ so very much from some chemical compounds. Between the most stable compounds with marked characteristics and a very definite composition, and the typical solutions with a composition varying in wide limits there occurred some easily decomposed substances which could not be definitely classified as either without a thorough investigation. The hydrates and the metallic alloys are striking examples.

As a rule when substance "A" is mixed in the liquid state with substance "B" all physical properties will change from those of "A" to those of "B" along a definite curve with increasing proportions of "B" added to the mixture.

If the curve is continuous we speak of the two substances as forming a solution but no compounds. When the solution solidifies without giving rise to any discontinuity we call it a solid solution.

This behaviour of two or more substances is rather the exception than the rule. The physical property curves of most mixtures have a number of kinks or discontinuities. Wherever there is such a discontinuity we have a chemical compound, which mostly can be identified by a crystal habitus, melting point or some other significant characteristic.

Some of these substances will be found to have very salient characteristics and would have been recognized as compounds by the old school. Many others however can barely be distinguished from a mere mixture or solution.

Physical and Chemical Phenomena

Anyone investigating these relations must come to the conclusion that there is no clear cleavage between physical and chemical phenomena.

This impression is confirmed when we find that both are controlled by the same thermodynamical laws. We will find that a proper recognition of these facts is important for a thorough understanding of the vacuum tube.

Just when these facts had become generally recognized among the scientific fraternity, radio activity began to call attention to the fact that the atom was something very definite but rather complicated. The study of discharges in rarefied gas, in vacuum and the X-ray spectra, soon gave an insight into its structure.

Chemistry had become amenable to mathematical treatment and the old descriptive chemistry was pushed into the background. Investigations are carried on more for the purpose of proving some theory than to discover new compounds. If any are found their identification and isolation are neglected in favor of mathematical speculations.

The modern mathematics of chemistry are often so complicated that close connection with the phenomena treated is sometimes lost.

For this reason much of the recent findings in chemistry and physics are difficult to apply to any special problem at hand. Due to the mental habit described above we are now in a curious position in relation to our knowledge of the vacuum tube.

Behaviour of the Electron

We know a great deal about the behaviour of the electron once it is liberated from the filament. In spite of the fact that the electron is a rather abstruse conception; that we are not yet quite sure whether an electron is a particle of matter, a wave "nucleus" or just energy, it is like an old friend. We know its habits; we can coax it to go where we want it; we can generally make it do our bidding. It is quite different with the emission itself. In spite of voluminous literature on the subject our theories of emission fit the facts only with difficulty.

In a whole world of compounds we have found so far only three combinations which make practical emitters, These are, tungsten, thoriated tungsten and barium strontium oxide mixtures.

While the emitters are rather simple systems of substances we have found that the minutest traces of some other substances present either in the emitter or in the residual gases in the bulb will not only affect the emission adversely but prevent it entirely.

It is difficult to reconcile this fact with present theories of emission. Experience indicates that very small quantities of water vapor, oxygen, sulphur, nickel vapor, carbon will prevent an ordinary coated filament from emitting.

At present the best theory covering emission from coated filaments assumes that the latter is carried by barium metal formed by electrolysis of the oxide. If this is true it is difficult to understand how quantities of substances many times smaller than that of the electrolysed barium metal should have such a considerable effect.

However this may be, it is our task in manufacturing tubes to either prevent such substances from getting into the tube or if that connot be done to remove them with a thoroughness never before approached.

These quantities are so small that they will not yield to ordinary methods of chemical analysis. Here is a mountainous task for investigators of the future. Extremely valuable contributions for tube manufacturing processes may be expected in this field.

Up to the present very little work of this nature relating particularly to the vacuum tube has been published.

Relations of Tube Materials

In this article we can only point out some of the more important problems and discuss these in the light of certain well-known relations between the materials used in the construction of tubes.

When the carbonates decompose on the filament there is definite relation between the gas pressure in the bulb and the temperature of the casting. In fact, if the reaction is carried on in a closed vessel CO_2 will be dissociated from the carbonates until a given pressure is reached, this pressure being

dependent upon the temperature. If the latter is raised, more carbon dioxide issues from the carbon until the pressure corresponding to the higher temperature is reached. If the temperature is decreased some of the dioxide is again combined with the oxide with re-formation of carbonates until the pressure is lowered to the equilibrium pressure corresponding to it.

If the temperature is kept constant and the pressure is lowered by pumping out the gas, more of it will issue from the carbonate; the speed of the reaction increasing with the difference between the pressure in the bulb and the equilibrium pressure at the filament temperature; hence the importance of fast pumps.

The carbon dioxide pressures over strontium and barium carbonates individually are well known. They are given below. Temperatures are Centigrade, pressures in mm. mercury column.

Sr		Ba	
t	p	t	p
492	9.3	1017	5
650	18	1051	45
850	50	1097	120
950	99	1137	240
1050	175	1157	340
1256	744	1197	675

It is plain that strontium begins to decompose appreciably at reasonably low temperatures. Barium however does not decompose rapidly until the temperature reaches 1000.

This table however does not tell the whole story. The vapor pressure over a mixture will differ from that of the components if these form compounds or solutions.

We have also to take into account the effect of the products of decomposition of the barium nitrate used as binder, and of any nickel compounds formed by interaction of the coating and the cathode metal. There is even a possibility of the minute quantities of impurities contained in commercial nickel having some influence on the process.

We also have to consider the effect of heat and vacuum on the decomposition of carbon dioxide to monoxide and oxygen; particularly in the presence of metals.

The foregoing table relates to the decomposition of barium or strontium carbonates to hypothetical basic carbonates. Of the breaking down of this basic carbonate to oxide we know next to nothing.

High Vacuum

It should also be remembered that most investigations of this sort are undertaken with no regard to high vacua. Most of them stop the series of measurements at a few mm. pressure. A few go to a fraction of a mm. but none include pressure of the order of one or a few microns. It is obvious that at such extremely low pressures and when even the minutest quantities are concerned reactions may be quite different from those at higher pressure.

It is quite likely that a thorough investigation of the reactions possible on a coated filament would lead to worthwhile improvements in tube making processes. It will be plain to anyone familiar with the technique of such work that the investigation of all or most of the reactions in question would keep one competent researcher occupied during several years. To obtain worthwhile results after a shorter period it would be necessary to put a number of men to work under able direction.

The task may probably be too great for even the largest manufacturer, individually.

If however a number of manufacturers would cooperate financially, work of this sort could be carried on with the added cooperation of some institution at a price sufficiently reasonable to the individual concern and within a reasonably short period of time.

Behaviour of Metallic Oxides

Another important problem of vacuum tube chemistry concerns the behaviour of metallic oxides. Careful tube manufacturers make most of the parts in hydrogen and let it go at that. The inference is that by so doing any oxide present will be reduced. That is, however, true only in a general way.

The reduction of oxides like the decomposition of carbonates is dependent on a number of factors. The reduction may not be complete if any water vapor is present. It is therefore necessary to pass the hydrogen over the metal fast enough to rapidly remove any water vapor formed by the combination of the hydrogen with the oxygen of the oxides. It is also necessary for best results to carefully remove from the hydrogen the last traces of water by passing it over large quantities of water absorbing substances before admitting it to the furnace.

Such treatment will remove most of the trouble due to the presence of oxides or oxygen in the tube, but not all. The surface of the metal may absorb oxygen from the air after being taken from the furnace. Moisture will adhere to it. When the plate is heated during exhaust some oxides will form.

Some manufacturers use oxidized nickel plates instead of carbonized plates, particularly in transmitting tubes, with excellent results. This practice is at variance with the general belief that oxides of most metals when present will impair operation of the tube.

It is believed by many that oxides when bombarded by electrons will be decomposed and release oxygen. I doubt that such a reaction has ever been uncontrovertibly proved.

Let us see what the relations between oxides and the heavy metals look like.

Most metals used in the manufacture of tubes, as nickel, molybdenum, tungsten, can form several oxides with various oxygen contents and various chemical and physical properties.

All such oxides will have definite oxygen pressures at any given temperature. Some of these oxides will give up oxygen at temperatures quite within the range of technical processes. Their oxygen pressures at high temperatures is appreciable. If for instance copper oxides are heated under suitable conditions they will give off oxygen until Cu_2O is the result. The latter as far as we know does not decompose any farther at temperatures at which observations have been made so far.

As we have noted in connection with carbonates, no observations at extremely low pressures have been made. It is therefore quite possible that Cu_2O may split up into copper and hydrogen when exposed to high temperatures or electron bombardment in a high vacuum.

Incidentally the reader may have reasoned that copper is no part of the conventional tube structure. True enough, but every time the welder jaw does its work a tiny bit of copper adheres to the weld, enough to lead to some freakish occurrences off and on.

Assume that we have a slight coating of oxide on some part of the plate. What may happen when the plate is heated in vacuum? As a rule any oxide formed under uncontrolled conditions consists of compounds, mixtures and solid solutions between different oxides. Some of these form solutions with the metal. All have definite oxygen pressures and also definite vapor pressures of the entire compound.

If the plate is heated in vacuum, the oxide mixture, if its vapor pressure is high (if the substance is volatile as such) may volatilize in its entirety before any reaction takes place. It will then be found as deposit on the bulb. The oxide mixture may give off oxygen until a stable oxide with an oxygen pressure lower than the pressure in the bulb is formed.

The oxides may react with the metal with the formation of low oxides. The oxides may form a solution with the metal and diffuse to its interior. They may be decomposed by electron bombardment. Several of these processes may take place simultaneously.

Sufficiently prolonged heating will mostly cause the disappearance of the oxides from sight but not necessarily out of the tube.

As we have seen they may remain in the metal or be present as an infinitesimal deposit on the walls of the vacuum vessel.

If a trace of hydrogen or water vapor is present the reactions are even more varied and complicated. The well-known "water cycle" in tungsten lamps is an example.

Some oxides as the dark colored

(*Concluded on page* 48)

The Pentode Tube

R. M. A. Engineer Says that for American Uses the Advantages of the New Tube are Largely Offset by Disadvantages

BROADCASTS from abroad, increase in number of radio listeners in the islands of the Pacific and in practically all of the countries of Europe recently has brought to the attention of the growing family of radio fans in the United States the question of the type of sets used in foreign countries.

And with England, outstanding as a listener-in to American broadcasts, technicians among America's radio fan audience are told that the dweller in the British Isles hears his programs by use of the pentode tube, as a part of his radio receiver's equipment. The question of value of the pentode tube in the radio receiver has caused sufficient interest in this country to bring a statement from Walter E. Holland, manager of the research and engineering division of Philco radio, and Director of the Engineering Division of the Radio Manufacturers' Association of the United States. Issued by the Radio Manufacturers Association, Holland's statement tells how different conditions and laws in different countries make use of different types of radio tubes advisable.

Use of the pentode tube is more widespread in England, Holland explained, because of the greater popularity of battery-operated portable sets, and because patent licenses are based on the number of tubes in the receiver.

Reduction of the number of tubes has, therefore, been more important in England, just as low-powered automobiles are more popular there on account of the license taxes being based upon horsepower of the motor. These factors are not important in this country, so that there is no advantage here at present in either low-powered automobiles or pentodes.

There is nothing new or revolutionary about pentodes, according to Holland. No improvement in performance can now be obtained with pentodes that cannot be had with present tubes. A given result is possible with less tubes, using pentodes, but it is unlikely that the cost of a complete radio receiver would be any less.

"The pentode tube has long been known abroad and has found limited commercial use there, especially in England," said Holland in summarizing the development in Europe of the pentode tube and experimental work in this country. "Many radio receivers and vacuum tube engineers in this country have experimented with this type of vacuum tube, and are thoroughly familiar with its characteristics and possible applications.

"The pentode, as the name implies, has five electrodes or electrical elements. It has the usual cathode and plate, but between these elements there are three grids or screens as compared with two in the tetrode, commonly known as the screen-grid tube.

"The pentodes developed abroad are designed for use in the last audio stage, where we use triode power tubes, such as the -45 and -50 tubes.

"There is a possible application of the pentode to radio-frequency circuits, but it is unlikely that this type of tube will prove of much practical importance as a radio-frequency amplifier. All it could do would be to reduce the number of stages of amplification required for a given sensitivity. The elimination of a stage of radio-frequency amplification ordinarily means a reduction in the number of tuned circuits, and such a reduction is impracticable for the reason that a given number of tuned circuits are essential to give the high degree of selectivity needed under the broadcasting conditions existing in this country.

"The pentode power tubes used abroad have greater sensitivity, and, therefore, provide higher amplification per stage than our triode power tubes. This makes it possible to eliminate a stage of audio amplification and work from the detector directly into a single power stage without overloading the detector or the radio-frequency amplifier tubes. Another advantage is that it is possible with pentodes to obtain greater undistorted output where the plate voltage is limited, as in battery receivers and receivers for operation on the 110-volt direct-current supply used in certain sections of a few cities.

"Against the above advantages the pentode has a number of disadvantages. It is a most difficult tube to manufacture with uniformity owing to its complexity, and to the fact that it must be exhausted to an extremely high degree of vacuum. Non-uniformity of pentodes will make greater differences in the operation of a radio receiver than with tubes of the present type. It is inherently a high-cost tube.

"In radio receivers for use on the common alternating-current supply used for house lighting, the pentode presents a more difficult problem from the standpoint of manufacturing cost, than the standard type of power tube. With present power tubes of the -45 type it is almost universal practice to use two tubes connected in push-pull circuit to reduce hum and improve the quality of reproduction. Owing to the high cost of pentodes and the greater complexity of the circuits, it is a question whether it is practical to use pentodes in push-pull. On the other hand, if a single pentode is used to give the same result as two triode power tubes in push-pull, the cost of the filter, required to smooth out the ripple in the rectified alternating current, will sum up probably enough to more than offset any possible saving in eliminating the power tube and the usual first stage of audio amplification. In addition a larger and more expensive output transformer would have to be used on account of the high direct current flowing in one direction in the primary winding of the transformer.

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CROSLEY STUDIOS MOVED

MOVING day at radio stations WLW and WSAI, Cincinnati, Ohio, took place in March when all controls were shifted from the old studios to the new control rooms on the eighth floor of the new Crosley manufacturing plant, and the offices on the same floor will be occupied by station executives and staff.

The formal dedication of the studio will not take place for some weeks, it is understood, since some finishing touches will remain to be made after the moving. Arrangements for the elaborate program being planned for the dedication broadcast will take several weeks to complete.

Announcers and control operators under the direction of J. A. Chambers, technical supervisor, spent their free hours the week before moving day in classes designed to teach them how to operate the new equipment.

Each of the eight studios is equipped with a control box to be operated by the announcer. From this box, push buttons will select one or more of the four channels over which the program will be sent and will connect the announcer's microphone or the program set-up. Supplementary control of the studios is in charge of the monitoring control operators in the small monitoring rooms just outside the studios and viewing them through small double panes of glass.

Supervisory control of all outgoing programs is in the large master control room in which all lines terminate.

High Impedance Tubes for Voltage Amplification

Mutual Conductance of Circuit Important Factor

By Walter E. Bonham

THERE is often much doubt as to what are some of the advantages and disadvantages of high impedance vacuum tubes; that is, the high mu and the screen-grid tubes. In some respects all high impedance tubes have similar performances. However, because of some of the additional features possessed by the four-element or screen-grid tube, this article will deal mostly with that type of tube and it is believed that it will clear up some of the present misunderstandings.

The voltage amplification obtainable with this tube is rather fabulous compared to that of the so-called Standard tube, being as high as 150 gain per stage in some cases, as compared to 6 or 8 with the common tube. Yet, often the tube is used in circuit and results obtained are not as anticipated from its rated gain per stage. However, an elementary analysis of the tube and study of the circuit requirements show wherein enormous voltage amplification is obtainable.

It can be mathematically shown that the maximum undistorted amplification is obtainable from a vacuum tube when the load impedance matches the plate to filament a-c. resistance of the tube. And, the amount of voltage amplification obtainable from any tube can easily be shown and derived as follows.

The amount by which a grid voltage change requires the plate voltage to change in order to maintain the same plate current is known to be $E_g\mu = E_p$ which also means that if

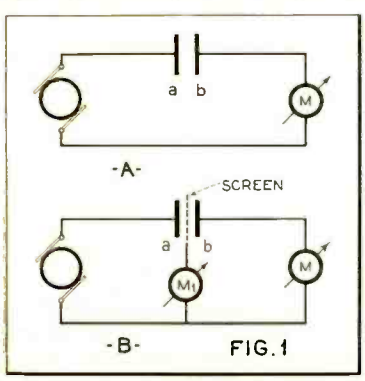

FIG. 1

Fig. 1. The placing of the screen between "a" and "b" practically short circuits the former capacity between these elements, by-passing most of the current through meter M_1 allowing very little through meter M. Accordingly the resistance between the elements "a" and "b" is said to be very much increased and likewise the capacity between these elements is decreased or eliminated.

Although in this excellent article by Mr. Bonham the fundamental distinction between gm-tube conductance and Gm-circuit conductance, is noted, the familiar nomenclature is followed designating gm for mutual conductance. It is of interest to bear in mind that there is a present leaning toward the employment of *transconductance* in place of *mutual conductance*: symbolically, $S_{ab} = \delta i_a / \delta e_b$

Editor.

the grid voltage fluctuates, the amount by which the plate current would fluctuate would be equal to $E_g\mu$ divided by the total plate circuit resistance, or

$$i_{ac} = \frac{E_g \mu}{R_p + r}$$ in which i_{ac} is the fluctuating plate current. E_g is the fluctuating grid voltage. μ equals amplification factor of tube. R_p equals resistance in external plate circuit. r equals internal resistance of tube.

The i_{ac} is actually the current in the plate circuit which gives the signal and from the viewpoint of circuit operation it is this component in which we are interested. This pulsating current flowing through the resistance in the external circuit develops a fluctuating voltage of,

$$i_{ac} R_p$$

which then would also be $E_p = \frac{\mu E_g R_p}{R_p + r}$

or

$$\frac{E_p}{E_g} = \frac{\mu R_p}{R_p + r} = \left(\frac{\mu}{R_p + r}\right) R_p$$

Mutual Conductance

The ratio E_p/E_g shows the voltage amplification obtainable from any tube in terms of the amplification factor, plate and load resistance. The actual functioning factor of the circuit that we are interested in is the amount of plate current change that a given grid voltage change can produce; or, the circuit mutual conductance, which will vary for different values of total circuit resistance. If the load resistance were zero then the circuit resistance would be that of the tube itself or $g_m = \mu/r$. The total circuit is composed of the internal resistance of the tube plus the external resistance or, $r + R_p$, so that the circuit mutual conductance becomes, $G_m = \mu/r + R_p$, then substituting in the above equation we can say the voltage amplification is equal to $E_p/E_g = E_a = G_m R_p$, which shows that the voltage amplification is directly dependent upon the circuit mutual conductance and the load resistance.

The mutual conductance is more nearly the same value for all tubes than any of the tube constants. Thus the voltage amplification becomes nearly dependent upon the external load resistance that can be built up, and as the best results are obtained when the load impedance matches that of the tube, the advantage of high impedance tubes for voltage amplification is apparent.

It is a well-known fact that the tendency of a tube to oscillate becomes greater as the plate load impedance increases, so that the building up of high plate impedance is an objectionable feature, ordinarily.

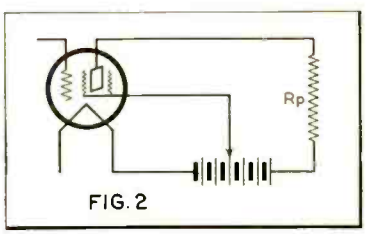

FIG. 2

Fig. 2. The load impedance in the plate circuit represented by Rp.

In the case of the screen-grid tube there is a very high plate to filament resistance and the tendency to oscillate, when a high plate load impedance, is used to match it, is overcome by the neutralization of the inter-electrode capacity of the tube.

The method whereby the plate to filament resistance is made high and at the same time the inter-electrode capacity eliminated is schematically shown in Fig. 1-A and 1-B.

Two elements 'a' and 'b' in close proximity have an amount of electrical capacity such as would permit a-c. to flow in the circuit as would be indicated by meter M. If now another element is interposed between 'a' and 'b', such as a wire screen, then practically all the current flow would be through the new circuit formed. Very little would flow through M. In fact only such amount as would pass through the holes in the wire gauze. The new circuit would practically short circuit the capacity between the

gauze screen and 'b'. In other words it would be said that 'b' is screened from 'a', or, there is no capacity between the elements 'a' and 'b' and as there is but small current flow through M it is said that there is a high value of resistance between 'a' and 'b'.

Fundamental Characteristic of Screen Grid

This represents the fundamental principle as is used in the case of the screen-grid tube. The screen which is placed between the usual control grid and plate, screens the grid from the plate and accordingly, as in the foregoing case, eliminates all capacity between these elements.

The screen grid is placed at a lower potential than is the plate, so that actually the screen acts as an electron accumulator, and by-passes the major portion of the plate current through the lower resistance circuit. The higher potential of the plate draws a small number of electrons through the screen. It may seem that the screen-grid circuit would practically "short" all the plate current, decreasing the effective signal strength. Even though it by-passes most of the electron emission from the filament the efficiency of the tube is still maintained for the following reason.

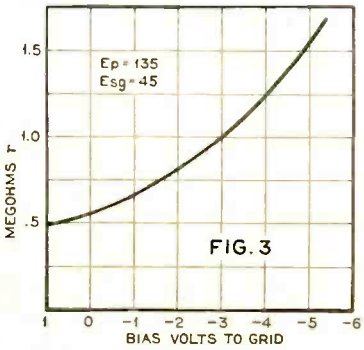

Fig. 3. Graph showing the internal plate resistance of the screen-grid tube for normal grid bias voltages.

The internal resistance between filament and screen grid is nearly the same as the plate to filament resistance of any common type tube and the external impedance of that circuit is very low. In fact, only a few ohms as there is no inductance; thus the external impedance comes far from matching the internal resistance. Thus, accordingly there is represented in that circuit no available voltage or power amplification and in that respect there is produced no loss of tube efficiency.

The very high internal resistance between filament and plate allows but a very small quantity of plate current flow, and because of the positive charge upon the screen grid, the plate current is not appreciably affected by change in plate potential. Accordingly it requires a very high resistance in the plate circuit to produce an appreciable IR drop for the pulsating component of current.

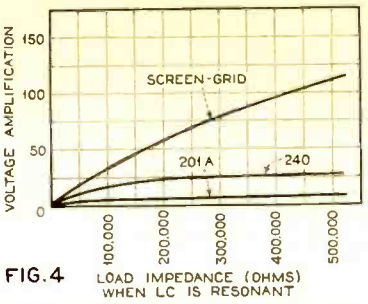

Fig. 4. Showing the amount of voltage amplification obtainable with various load impedances of three common type tubes.

The curve of Fig. 3 shows that the plate resistance can be varied between one-half and one and three-fourths megohms: for bias value between 0 and 5 volts, and in order to have a high plate impedance circuit to match the tube the usual type of circuit employed is the parallel resonance circuit which has very high impedance when adjusted to resonance.

Maximum Amplification

The maximum undistorted amplification is produced when the load impedance matches the tube, and the amount of amplification is dependent upon the load resistance. The chart Fig. 4 showing the mutual conductance of the tube enables one to determine the voltage gain per stage for any load impedance.

The only limiting factor preventing extremely high impedance is the point at which it breaks into oscillation. For increased frequencies it is shown that the load impedance must necessarily be reduced, for the tendency to oscillate increases with frequency. This is to some extent determined by the circuit itself, as neutralizing the electrode capacities does not prevent oscillation if feedback is permitted by way of poorly arranged circuit wiring. However with a well arranged circuit having no capacity between plate and grid leads the load impedance permissible at 100 kc. is nearly 600,000 ohms, 200,000 ohms at 500 kc. and decreases to 40,000 ohms at 10,000 kc.

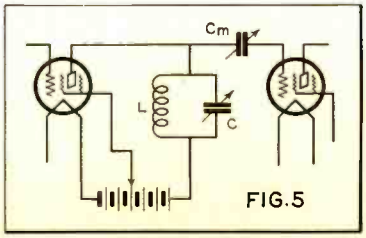

Fig. 5. The building up of a high external plate impedance by the parallel resonance circuit LC. In this manner the load impedance is made more easily to match the impedance of the tube, besides permitting high resonance curves to be obtained.

Thus the voltage amplification obtainable is considerably determined also by the frequency. These limits however can be greatly exceeded by additional feedback preventing oscillation.

The calculated voltage gain for a low radio-frequency may accordingly, from the relation $g_m R_p$, be equal to as high as 150 or better. But in view of distortion at these high voltage gains the actual amount is limited to 50 or 80 where it is desired to maintain resonance curves of proper band width.

In order for a parallel resonance circuit LC as shown in Fig. 5 to build up a high impedance it is necessary that its circuit resistance be very low for with 0 resistance there will be no pulsating component of current flow in the plate circuit, when the circuit LC is adjusted to resonance. Now the shape of the resonance curve in LC is dependent upon the circuit decrement,

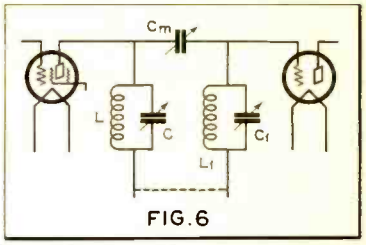

Fig. 6. The tuned band-pass filter circuit capacitively coupled by Cm. The value of Cm is adjustable to give proper band width over the band of frequencies desired to be amplified.

or upon the ratio R/L, and as R is necessarily small the circuit has very low decrement, meaning that its resonance curve is very peaked and sharp, which is objectionable in view of the desirability of obtaining flat resonance curves over a 5 or 10 kc. audio-frequency band. Thus to obtain good reasonance curves the circuit sometimes requires added resistance, or the inductance L itself is usually made of sufficiently high resistance to give good performance, as the coupling condenser Cm for this type of coupling usually cannot produce tight enough coupling to broaden the resonance curve.

Band-Pass Circuit

By means of the coupling of two parallel resonance circuits shown in Fig. 6, the resonance curve can be any desired shape by proper selection of circuit constants and coupling values. Because of some of the more desirable features of the 5 kc. band width it does not require a considerable amount of coupling between the two circuits to give this width.

It is evident that the flattening of a sharp resonance curve to give nearly equal amplification over a 5 kc. band of frequencies decreases the amplification that would otherwise be obtained at resonance frequency.

The over-all resonance curve of this type of circuit is dependent upon both

parallel circuits and upon the value of the coupling. The band width of each parallel circuit considered separately is given by the relation

$$B_w = \frac{R}{2\pi L}$$

which gives a very narrow band, or, R is negligible, showing that in order for a resonance curve of 5 kc. band width to be obtained the coupling must be the main factor for its determination.

Tight coupling is known to be discriminating toward the resonance frequency making the two side-frequencies pronounced. However, the discrimination of the resonance frequency becomes less as the band width decreases, which is one advantage of the 5 kc. band width.

One of the most elementary yet accurate methods for determining the band width of a resonance curve which a circuit possesses is to determine the coupling coefficient in terms of the circuit constants, then from the relation

$$K = \frac{f_2 - f_1}{f_o}$$

in which f_2 and f_1 are the two side-band frequencies one on each side of resonance frequency f_o, the value f_2—f_1, which is the band width, may be determined.

The coefficient of coupling of the elementary capacitively coupled circuit is given by the relation

$$K = \frac{C_m}{\sqrt{C\,C_1}}$$

where, as in Fig. 7, the capacities C and C_1 are coupled by that of C_m. However, when the inductances L and L_1 are across C and C_1 respectively, the formula needs added consideration.

Referring to Fig. 6. Through the circuit connection the capacity C_m is in parallel connection with C, and likewise it is in parallel with C_1. It is in this respect that it forms the coupling capacity of the circuit. Thus, for the consideration of the coupling coefficient for the entire circuit C_m is added to C and C_1 respectively in the formula, or coupling coefficient K becomes

$$K = \frac{C_m}{\sqrt{(C + C_m)\,(C_1 + C_m)}}$$

and as $K = \frac{B_w}{f_o}$

$$B_w = \frac{C_m\, f_o}{\sqrt{(C + C_m)\,(C_1 + C_m)}}$$

This relation shows that for negligible resistance in each oscillatory circuit affecting the decrement of each circuit the band width will increase but not directly with increased coupling capacity C_m. It also varies directly with the resonance frequency. Thus the 5 kc. or the desired band width is selected for the lowest radio frequency to be amplified. By making C_m adjustable for the higher frequencies it may be decreased, allowing the band width to be maintained at a more constant value.

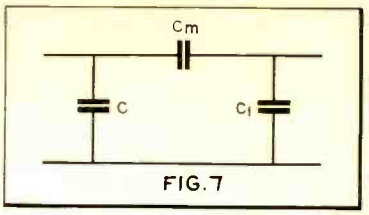

FIG. 7

Fig. 7. The fundamental capacitive coupled circuit in which the two capacities C and C_1 are coupled by the capacity Cm. The coefficient of coupling of this circuit is given by the relation, $k = \frac{Cm}{\sqrt{C\,C_1}}$

The decreased amplification by coupling to produce good resonance curves is more than compensated for because of the high impedances that may be built up with tuned coupled circuits. In this respect is seen the advantages of high impedance tubes for voltage amplification. This type tube is nearly a requirement for good band-pass filter circuits as the low impedance parallel resonance circuit has a high decrement or broad resonance curve and likewise the series resonance circuits have broad resonance curves because of the high ratio R/L in which R is the plate resistance in series with the circuit.

RMA TRAFFIC HANDBOOK TO BE PUBLISHED SOON

FOLLOWING the success in securing railroad rate reductions aggregating over $1,500,000 this year, the Radio Manufacturers Association as a further service to RMA members in traffic matters is preparing publication of an RMA traffic handbook. This will contain tables of railroad shipping rates, bill of lading conditions, information regarding claims for loss and damage, breakage and overcharges. There will also be information regarding procedure before the Interstate Commerce Commission and other regulatory bodies. Another chapter will deal with packing and containers for radio products, to be illustrated with photographs and cuts showing various successful methods of packing various articles.

The traffic handbook is being prepared by the RMA traffic committee, of which Mr. B. J. Grigsby of Chicago is chairman, and the RMA traffic department, of which Mr. W. M. J. Lahl is manager, and will contain detailed radio information to be of value to manufacturers and jobbers of raw materials, as well as of radio products.

The handbook and other traffic matters were discussed at a meeting of the traffic committee at Cleveland, March 11th. Among other matters was the question of ratings on radio chassis and figures are being secured covering weights and values with a view to filing a request for specific ratings. It is also proposed to request a change in the present rating applicable on radio loudspeakers, and to provide specifically for separate ratings on console type loudspeakers, table, box or cone type loudspeakers, and also loudspeaker chassis and parts thereof.

There have recently been published commodity rates from two or three producing points in western territory on radio cabinets carrying a 14,000 pound minimum. The traffic committee is going to make an effort to have the minimum weight in these cases reduced to 12,000 pounds. Also, there have been a number of requests filed for commodity ratings on radio cabinets as well as an effort made to have radio cabinets added to the furniture list in the classification, so that shippers and receivers may have the benefit of furniture commodity rates, which are published only between certain points, particularly in central territory. There have been no definite conclusions reached in the latter cases, but the situation is being followed up very closely.

BEWARE OF IRON WIRE FOR ANTENNA LEAD-IN CONDUCTORS

To get the best possible broadcasting reception it is necessary that all the accessories be of the very best quality. An important part of the radio set equipment is the antenna lead-in wire.

The Crosley Radio Corporation's engineering department has notified all distributors that the National Electrical Code specifies that "lead-in conductors from antennas to sets, shall be of copper, approved copper clad steel, or other metal which will not corrode excessivley . . . ."

The Safety Section of the RMA discloses the fact that wire is being sold on the market for use as radio antenna lead-in conductors which is composed wholly or largely of iron. Such material is liable to corrosion and consequent bad contact and eventual breakage of the wire. Where such contact or breakage occurs in the connections to or from the protective device, the effectiveness of the protective device is removed or lessened, and hazard thereby introduced. In addition to the hazard aspects of the use of such wire, the performance of the receiving equipment connected through such contacts is likely to be very seriously affected and poor performance and service difficulties are to be expected.

Electronics

An Engineer's Excursion Into the Realm of the Electron.

THE student of radio engineering does not progress far in his studies before he realizes that a knowledge of electron physics is of first importance. One of the best presentations of the subject thus far written is that by Harris J. Ryan, of Leland Stanford University. As originally written the paper was given the title, "The Study of Ions and Electrons for Electrical Engineers."

Much of what has been written about electrons contains matter of direct interest only to advanced physicists. Dr. Ryan's paper deals with fundamental concepts; is understandable and of value to electrical and radio engineers. The text of the paper complete follows:

"Physicists and chemists in their studies of the foundation of matter during the last quarter century have been profound students of ions and electrons. Virtually all of their discoveries and results are of direct or indirect value to electrical engineers. The technical and practical uses of knowledge of this character today are extensive. Many important developments have been possible only by its means. And such developments have encountered difficulties that in turn have defined the great need of further knowledge of the same general character. The need for the electrical engineers is being formed up, however, in an entirely different mold from that which shapes the requirement of the more general science worker.

"In many of the problems originating nowadays in the electrical industries wherein ions and electrons are involved, the physicists and chemists are, in all ordinary circumstances, so loaded with necessary duty in the solution of their own problems that they can rarely afford the time and facilities to come to the aid of electrical engineers. The electrical engineers can, therefore, no longer depend largely upon the physicists and chemists for enhanced results that will enable them to solve their own problems of this class. They will have to do their full share from this time forth to extend knowledge of the facts in regard to ions and electrons and their behavior.

"It is of corresponding importance that all advanced students among the incoming generation of electrical engineers be reasonably well equipped with an understanding of the present-day expediency for attacking problems encountered in the electrical industries that require for their solution a clear understanding of the behavior of ions and electrons. It is also recognized that advanced students are not always young men in the colleges. It is important that all,—old and young,—wherever situated, should know that it will be most helpful to them and to the electrical industries to acquire a well-founded knowledge of ions and electrons and how to take advantage of every opportunity to apply or to extend such knowledge.

"Millikan has splendidly summarized existing knowledge of electrons and ions in his book on The Electron, more especially from the point of view of the physicist. J. J. Thomson has rendered a similar service from the point of view of the chemist, though himself a physicist. To these recent classical treaties the advanced student, at the threshold of the subject, is referred.

Fundamentals of Electrons

"The following are some of the fundamental facts in regard to electrons that must always hold the attention of many electrical engineers: There are two varieties of electrons, distinguished primarily by the signs of their respective electric charges. The quantities of these charges are alike for each,—4.78 by 10^{-10} electrostatic units, or 1.59 by 10^{-20} ampere-seconds. In respect to other attributes they differ decidedly. The mass of the negative electron is 1/1845 that of the hydrogen atom,—the lightest of all atoms. Correspondingly, the mass of the positive electron is approximately 2000 times the mass of the negative electron, or nearly the same as that of the atom of hydrogen. In atomic structure the positive electrons behave as though they and some of the negative electrons formed the atomic nucleus, while the rest of the negative electrons associated with an atom behave as though they were set in orbits about the nucleus. So far as is known, positive electrons do not exist in the free state. They exist only within the nuclei of atoms accompanied by some of the electrons that bind them in close proximity by electrostatic attraction. The numbers of positive and negative electrons present in the same neutral atom are equal.

"The spontaneous breaking up of the nuclei of the heavy (radioactive) atoms into helium atoms and negative electrons is the nearest known approach to the existence of free positive electrons. On the other hand, free negative electrons exist in abundance. An almost endless variety of physical or physicochemical actions may break their orbital bonds to their corresponding atomic nuclei and set them free. The removal of a negative electron from an electrically complete or "neutral" atom results in the presence of one free negative electron, ordinarily called *electron* and an atom carrying the positive charge of one electron. Such an atom is ordinarily referred to as a *positive ion*. Under all ordinary conditions approaching quiescence, free electrons adhere to atoms, otherwise neutral. The bond is weak and easily broken when the atom is driven electrically or mechanically through gases, fluids, or near the walls of solids.

"All conduction of every character is now known to be due to the movement of positive and negative electrons or more simply ions or electrons, or both. The electrons or ions may be moved mechanically, electrically or electromagnetically. An example of their movement electromagnetically is encountered in the electron jet cyclograph, wherein the electrons liberated from a hot cathode are driven forth in a jet by a strong electric field, and the jet is then deflected transversely by a magnetic field.

"It follows that the mobilities of electrons and ions through solids, liquids, gases and empty space are factors of the highest importance. Far too little is known about these mobilities. Physicists, however, have determined them as the velocities of positive and negative ions in electric fields of unit strength in air and in hydrogen at the usual density occurring at a temperature of 15 deg. C. and a pressure of 76 cm. as follows:

	Mobilities in cm. per sec. in unit fields, *i. e.*, one volt per cm.	
Air	ions	ions
Hydrogen	.....	.....
Air	0.35	1.83
Hydrogen	6.1	7.8

"For practical purposes the relations of these mobilities to their corresponding fields of strength may be assumed to be linear for the time being.

"Correspondingly, all non-conduction must be due to one of two things,—the non-movement of all ions and electrons present or their total absence. Materials through which ions or electrons can be moved freely are designated as conductors. Materials through which ions and electrons can not be moved are designated as true insulators.

"With the new understanding of electrical phenomena, it is helpful to distinguish three sorts of conductors and corresponding conductions.

1. **Metallic conduction**—due to the free movement of electrons from atom to atom, requiring no e. m. f. for their detachment and only that e. m. f. which is required to supply the heat absorbed through the increased atomic agitation that has been produced.

2. **Electrolytic conduction**—the free

movement of ions through an ionized liquid (or salt solution) from anode to cathode and vice versa, using an e. m. f., part of which is consumed positively or negatively in detaching or attaching ions at the electrodes in dissociation and recombination of the electrolyte and for the rest in supplying the inevitable heat due to the increased mechanical molecular agitation.

3. **The movement of free ions or electrons in a non-ionized fluid.** Conduction of this type is dependent upon two factors: (*a*) A requisite source of ions or electrons and, (*b*) the e. m. f. required to overcome the counter e. m. f. of space charges and again to supply the inevitable heat.

"Fluid conduction may be set up in every kind of fluid, liquid or gaseous. No fluid of any sort pervaded with a supply of ions or electrons can properly be regarded as an insulator. Correspondingly every fluid in which ions and electrons are absent must function as an insulator.

"Amorphous bodies or the precooled liquids, such as glass, the matrix of porcelain, fused quartz, etc., should be remembered as belonging to fluid conductors. The hardness of these bodies is due to their high viscosities, occurring when they were cooled from the molten state without crystallization. Pure, normal sulphur is an example of a non-fluid or crystalline body free of ions that intereepts completely the flow of ions and electrons and functions, therefore, virtually as a perfect insulator. Fluids can have no such dependable barrier quality. This is the great reason why fluid insulators must always be supplemented with substantial barriers that break up the thread-like channels occupied by moving ions when driven by applied e. m. f.

"Many have a feeling that air is a well-nigh perfect insulator or barrier to the passage of current forced along by applied voltage. The fact is that air has little or no barrier quality. If ions are liberated into the air, as by the passage of X-rays, on the application of a few volts only, the air may be observed to conduct with relative facility. It is actually no insulator in the sense that sulphur is. The great reason why air appears to function as an insulator in all ordinary cases is because of the absence of virtually all facility for liberating ions or electrons into the air. To detach an electron from a metal electrode into gas requires an electrical field terminating on the wall of the electrode that has been formed by the application of a million volts per centimeter. Above such voltage gradient terminating upon a conductor, air ceases to function as an insulator because the applied e. m. f. is sufficient to expel ions copiously from the one metal electrode, and drive them through the air to contact with the opposing electrode where they are discharged, thus completing the electric current circuit. At correspondingly lower voltage, the air will function as an insulator only because electrons can not escape from the conductor walls.

"Because metals and carbon when raised to sufficiently high temperatures will radiate electrons and thus supply ions copiously, air in the presence of highly heated electrodes ceases to be an insulator and functions abundantly as a conducting medium.

"We are thus compelled to recognize once for all that actually air and other gases are not really insulators—the thing that did the insulating, which was mistakenly attributed to the air, was actually a property of the wall of the conductor-electrodes by which electrons were confined within the conductor and not permitted to escape into the air or other gases occupying the space between and surrounding the electrodes.

"It is particularly in this 'no-man's-land' of ions and electrons, wherein insulators are not insulators and conductors are not conductors, that the electrical engineer is much concerned today.

"The most important of the expedients for liberating electrons are:

1. From metal electrodes immersed in air or other gases
   a. By heating the electrodes.
   b. By applying ultraviolet light to the electrodes, for which some metals are more effective than others.
   c. By coating the electrodes with certain salts that emit electrons copiously when heated.
   d. By intense electric charges, 1000 kv. per cm. in air—1250 kv. per cm. in vacuum.
   e. By evaporation or boiling of the metal or carbon electrodes.
2. From gases by
   a. Exposing the gases to X-rays or by the emanations from radium and other radioactive substances.
   b. Collision ionization, commonly called corona.
3. From metals to fluids

"Electrons pass out from the cathodes and into the anodes immersed in electrolytes by the phenomenon known as electrolysis, long since well understood through the activities of the chemist.

4. From metals to solids.

"Herein little is known as yet. There appears to exist no general understanding of the phenomenon of the passage of electrons from a metal to a non-conducting solid. Nevertheless, among the classical experiments of a century ago there was the one in which the metallic coatings of a 'Leyden jar' were made removable. With the electrodes mounted the jar was charged. The coatings were then removed and the jar and coatings were examined to determine the seat of the charge. The coatings were discharged and replaced and the jar thereafter discharged as a whole, when it was found that the discharge was virtually as strong as if the coatings had not been removed, discharged and remounted. Through the new knowledge we now know that when metal electrodes make good contact with solid dielectrics, electrons, pass easily from the metal electrode to the atoms of the contacting dielectric and vice versa. The conclusion is inevitable that the contact e. m. fs. between the metallic and dielectric walls are extraordinarily low, permitting the easy exit of the electrons from the negatively charged electrode to the adjacent dielectric, and conversely from the dielectric to the positively charged electrode. Because in solid dielectrics neither electrons nor charged atoms can migrate with any but the slightest degree of freedom, the dielectric functions as a barrier; an excess of electrons in the superficial face of the dielectric under the cathode and the opposite condition under the anode occurs and develops until the counter e. m. fs. of the bound charge thus produced balances the applied voltage whereon the action rests in a potential state.

5. Liberation of ions and electrons is produced by friction, splashing of liquids and bubbling of gases through liquids.

"Of the highest importance, likewise, are the facilities available for the quantitative observation of the causes and corresponding effects of the activities of ions and electrons. In occasional circumstances, the quantities to be measured are all suitably large, including the expenditures of power, for which there is at hand, a wealth of well-known measuring expediencies. Often, however, one or more of the essentials to be measured are relatively very small or very large and the corresponding facilities available are as yet few, if at all, and general experience in their use may be lacking.

"For the detection and gauging of small free charges in the air and gases, the gold-leaf electroscope, the delicate electrometer or galvanometer are often necessary. New uses for the old expedient of the potential plate or potential electrode are being found for the determination of potentials due to position, potential gradients, voltage duties and potentials as modified by the presence of space charges. Conducting or non-conducting barriers in plates, tubes or other forms as required to limit the migrations of ions or electrons are often most helpful. A metal woven mesh, coarse or fine, may have its uses as a kind of 'grid' for high voltage studies of the migrations of the electric carriers in air, gases and liquids. The modern cathode-ray oscillograph and electron jet recorder are of extraordinary value for the promulgation of these studies.

"In many studies the time-relation wherein a thing happens within the duration of a cycle or transient is of dominating importance. In these cases some dependable criterion in time relation must be found. When the actuating voltage is cyclic or transient and maintained with the requisite power, the non-inductive, non-capacitive re-

sistor for 'tapping out' fractional replicas of the total actuating voltage is a valuable expedient herewith. The potential plate, judiciously used, is also a helpful expedient for the same purpose.

"Studies of this character in one way or another require electric power supply-sources in almost every thinkable voltage-current-time relation. Herein for continuous high voltages the old electrostatic machine and modern kenotron (the latter with requisite accessories) are available. Below and above commercial frequencies laboratory form of alternators, and arc-converter and electron-tube oscillators are available,—the choice must be determined by the special circumstances.

"In the aggregate, there must be provision for the use of almost every character of substance occupying the immediate space about the electrodes which in turn must be available in every required form taken with respect to the method by which ions or electrons are to be detached from them. Among these electrodes there must be those which are made of boiling metals or carbon.

"Henceforth, problems without number will come up for attention in the electrical fields, the solution of which will be feasible only through the use of abundant knowledge of ions and electrons to be acquired only by orderly, persistent effort. In closing, by way of example herein, one may mention the problem of the reduction of the damage done by power line flashovers. In a considerable percentage of these flashovers the trouble is started by indirect lighting, surges or other forms of over-voltages on some sort of attenuated conducting material laid across the circuit, usually from conductor to tower. In a great many of these cases the trouble is known to have had a very small beginning that now and then is not augmented and clears itself. But in the majority of cases the local metal faces of the conductor and tower are heated with great rapidity to the boiling point in those spots that happen to be located at the termini of the thin ion-electron stream that inaugurated the action. The ionized vapor liberated by the boiling that ensures enormously augments the conductivity of the original stream of electric carriers, resulting in the rapid development of a heavy short. An effective procedure of the solution of the problem may be to cover the conductors at the towers suitably with a heat resisting barrier that will not permit the discharge to terminate on the conductor in a sufficiently narrow spot to produce boiling so as to permit the action to clear itself. It is not forgotten that in procedures of this sort not one but all perceivable options that promise a solution must be worked through at least to that point from which it is seen that they may or may not be given up effectively.

"In conclusion, it should be helpful to all electrical engineers to acquire a knowledge of the more important factors in the behavior of ions and electrons; and for the maintenance of a well-balanced progress in the electrical industries, it is highly necessary that some of the electrical engineers acquire, augment and apply the highest attainable knowledge of this subject."

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b. J. L. R. Hayden and C. P. Steinmetz, *High Voltage Insulation.* A.I.E.E. TRANS., Vol. XLII, p. 1029, 1923.

Radio Stations Can Now Broadcast Near or Far at Will

TWO methods for improving radio broadcasting were presented during the Federal Radio Commission's symposium held recently in Washington, D. C., by representatives of the Westinghouse Electric and Manufacturing Company.

The methods were: (1). Synchronization of two or more stations upon a single wavelength. (2). A radio transmitting antenna system for increasing the strength of the local signal and at the same time minimizing the amount of signal sent to a distance, or for just the opposite purpose, to decrease the local signal and increase the distant signal.

According to Walter C. Evans, superintendent of the Westinghouse radio operations department, the new antenna system will make it possible for a cleared channel station to broadcast with high power without blanketing the surrounding area. The system can also be used so that a local station can send out a strong signal in its own territory without interfering with distant stations.

Synchronization has the advantage of making it possible to increase the service area of a program furnished identically to two or more stations without increasing the number of channels used. It also reduces fading. A third advantage claimed is that a small booster station can be erected to give service in a "dead spot" area where the parent station is not received.

Westinghouse was represented before the Commission by Mr. Evans, Dr. Frank Conrad, assistant chief engineer, and S. M. Kintner, research department manager. Dr. Conrad invented and superintended the development of the synchronization and antenna methods, according to Mr. Evans.

It was said that Westinghouse has operated synchronized stations since 1925 when WBZ in Springfield, Mass., and WBZA in Boston first successfully broadcasted on the same wavelength. Late in 1929 KYW in Chicago was synchronized with KYWA in order to eliminate a "dead spot" on the north side of the city.

The new system will first be applied in the new KDKA which is being built near Saxonburg, Pa. Experiments with the antenna have been carried on for several months with a short-wave station on the Saxonburg site.

When it is desired to have a station send out a strong local signal without distance transmission the antenna is built so that it radiates a powerful wave along the ground but does not send one into the air where it would be deflected to distant areas by the Kennely-Heaviside layer. If the station is on a cleared channel it can be made to send out a strong skywave with a small amount of ground

(*Concluded on page* 49)

Research on Steel for Radio Applications

Working Steel of High Silicon Content

UNTIL recent years, research in the steel industry was on a modest scale, but the change in this regard may be illustrated by the fact that even on such a specialty as sheet steel for use in the coils of radio receivers, the most progressive producers of this class of steel are carrying on an extensive research program. This involves a study of the magnetic characteristics of various classes of electrical sheet steel now in use under conditions similar to those under which the steel will be used in radio apparatus. With the materials now available, the difficulties in slitting and punching the steel increase as the characteristics of interest in many radio receiver applications improve. A study is being made of methods of improving the magnetic properties without increasing the problems of the punch shop.

The situation at present in the radio industry is that only the largest manufacturers of electrical apparatus have developed tools and methods which enable them to use sheet steel of the highest silicon content. This class of steel results in the most compact and efficient power-pack transformers and facilitates the production of audio-frequency transformers of the highest quality. An effort is being made to develop electrical sheet steel of even better quality than is now used by any electrical manufacturer and at the same time to improve the physical characteristics so that the sheet steel can be punched without undue difficulty.

Some of the steel which is the most difficult to punch has the highest effective permeability. If the designers try to get as good performance at low frequency in an interstage transformer by using a larger core composed of steel of lower quality or by using more turns, it is usual to find that the longer length of copper required has increased the capacity effects enough to spoil the performance at high frequency.

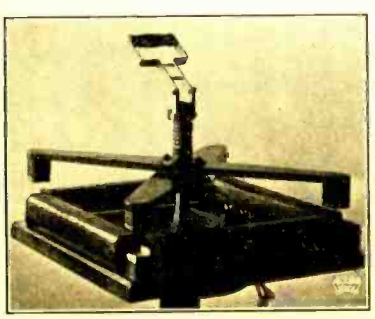

Fig. 1. Epstein apparatus for core loss measurements.

Power-Pack Requirements

Inasmuch as the requirements for power-pack transformers are practically the same as for distribution transformers, it is logical that sheet steel for the two classes of apparatus should be purchased on the same type of specification. The principal requirement of such a specification is that the core loss shall not exceed a specified value

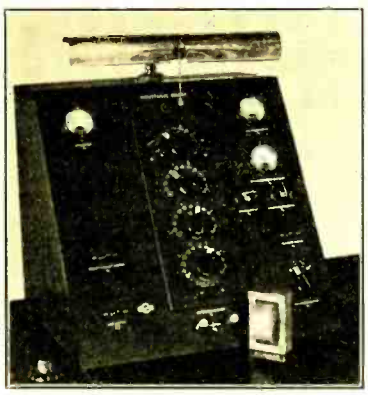

Fig. 2. Instrument for research on sheet steel.

—for example, 0.80 watts per pound when tested in accordance with the method specified by The American Society for Testing Materials. This method involves the use of an Epstein apparatus shown in Fig. 1, which is in international use for core loss measurements.

It is simply a special transformer so designed as to facilitate the use of the specimens of steel which it is desired to test as the core of the "transformer," the specimens being in the form of strips 3 cm. wide and 50 cm. long. The core loss is usually determined for an induction of 10 kilogausses at a frequency of 60 cycles per second. The development of steel of lower core loss than is now used in power-pack transformers will permit the use of higher inductions without increasing the amount of heat that must be dissipated from the radio receiver.

In inter-stage and push-pull transformers and chokes, the heat generated is of no importance, but steel of lower core loss is used than is usually employed in power-pack transformers. The reason for this incongruity is that high effective permeability, under conditions of interest in these radio applications, usually is found in steel of low core loss. However, at least two of the largest producers of radio sheet steel are not relying on this indirect method of studying quality for radio applications but are determining the permeability by d-c. methods at very low inductions or magnetizing forces. In this investigational work, the Rowland ring-test method has been employed but as the magnetizing forces of interest are very small (even weaker than the earth's magnetic field), great labor is involved in winding the test specimens. As a result magnetic testing laboratories are now using modifications of the Burrows permeameter.

The Permeameter

This device measures the d-c. permeability of a portion of the steel which is in strip form. Extra coils compensate for the reluctance of the joints in the magnetic structure, resulting in conditions similar to those obtained by the ring method. The Burrows method is recognized as a standard method of The American Society for Testing Materials and has been in use by The Bureau of Standards for many years.

In addition to the Burrows method, The American Rolling Mill Company has been carrying on research on radio sheet steel by means of the device shown in Fig. 2.

This testing device simulates operating conditions in radio apparatus in that a very small a-c. pulsation is superimposed upon a comparatively strong d-c. polarizing force and the air gap in the magnetic structure as well as the a-c. and d-c. can be varied to correspond to that in commercial apparatus. This device enables the manufacturer of steel to better understand the problems of the radio manufacturer, to better evaluate the relative importance of various factors, and to insure that the development proceeds along the lines of greatest advantage to radio manufacturers.

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TUBES IMPORTANT IN SALES VOLUME

Figures available make it apparent that more than 22 per cent. of the total amount of money expended by the American public for their radio needs during 1929 went into the purchase of radio tubes, it was declared by C. R. King, vice-president and assistant general manager of E. T. Cunningham, Inc., radio tube company.

From his figures, Mr. King also computes that tube demands and sales equal 37 per cent. of the total amount spent specifically for receiving sets. In comparison to other accessories, including cabinets, the sale of tubes showed a superior volume exceeding the former's mark by about 25 per cent.

International Broadcasts

Magnetic Storms and Static Interfere

By C. W. Horn *

AN ENEMY more difficult to cope with than static confronts radio engineers when they venture into the field of international program exchanges. The new enemy is the so-called magnetic storm, an effect known to electrical engineers for years.

We have known for many years that magnetic storms affect land-line communications to quite an extent and influence delicate instruments, such as ships' compasses. However, it is only in recent years, since the advent of long-distance radio communication, particularly on short waves, that we have noticed any great effect from this source.

It is a peculiar fact that the magnetic disturbances act differently in the case of long waves. Dr. L. W. Austin, of the Bureau of Standards, who has been making measurements for many years on long waves, reports a general increase in signal strength at about the time that magnetic disturbances take place.

We have found that these disturbances react in just the opposite manner on short waves. That is, they reduce the signal strength very greatly and seem to offer impedance to the passage of the wave.

The uncertainty as to when magnetic storms may be expected makes it difficult to plan trans-Atlantic program exchanges in advance. Twice recently the National Broadcasting Company's attempts to relay European programs in this country were defeated by magnetic storms, which attacked the programs coming from England and Germany, and made it impossible to pick them up on this side of the ocean.

Static is an enemy which engineers believe can be partially conquered. Static does not reduce the strength of the signals, but is an interference, manifesting itself in the form of noise. It is conceivable that programs might be broadcast at such high power that the interference from static might be reduced to a point where it would not be objectionable. In other words, static might not be eliminated, but it might possibly be weak in ratio compared with the signal strength.

No one really knows much about the causes of magnetic storms, but there seems to be a general belief among scientists that the sun spots, of which so much has been heard in the last few years, are responsible to a large degree. During the periods of greatest sun spot activity the earth is bombarded by streams of electrons which react upon the magnetic lines of force surrounding the earth. The aurora borealis is believed to be associated in some manner with these phenomena.

During the last several years, during which very high sun spot activity has been noticed, there has also been a large number of these magnetic storms. Astronomers' records show that the periods of greatest sun spot activity evidently run in cycles of approximately eleven years. The activity is now on the decline, and for the next five or six years improved conditions in radio reception are to be expected.

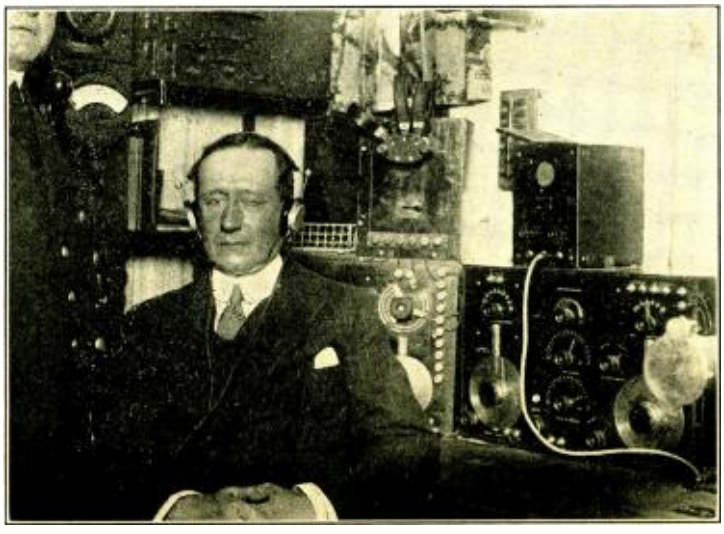
This gives us a great deal of hope, and a breathing spell during which scientists and engineers will actively pursue their investigations, and perhaps find a way of overcoming some of Nature's eccentric and irresponsible behavior.

The United States Coast and Geodetic Survey, at its observatory at Cheltenham, Md., has made many studies of magnetic storms, and their reports on these and other natural phenomena have been widely used by NBC engineers in working up plans for international broadcasts.

Whatever knowledge can be gained in this field is much more valuable than reports of probable weather conditions, for the worst that can be expected of the weather is sharp electrical storms resulting in static. Observations of the weather are of value only in so far as variations in weather may possibly be caused by the same agency that affects long-distance radio transmission—the sun spots.

Failure of programs originating on the other side of the Atlantic, and transmitted to this country on short waves, to arrive at a high enough volume level to permit rebroadcasting is less likely during the next few years than in the year just past, although such attacks by magnetic storms are not likely to cease entirely.

* *General Engineer, National Broadcasting Company.*



Mr. Marconi "listens-in" on board ship.

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IMPORTANT SURVEY STARTED

One of the most important surveys ever started by any trade association is now well under way in the executive offices of the Radio Wholesalers Association. This survey is being made among members of the Association, with regard to their monthly radio sales in dollars and in units and their monthly radio inventories in dollars and in units.

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BIG RADIO TUBE SALES

The lowly radio tube outshines the fabled Aladdin's lamp when it comes to opening store-houses of treasure, suggests the National Radio Institute of Washington, D. C. It's this way—the Institute predicts that Mr. Radio Fan will shell out over $200,000,000 in 1930 for 80,000,000 tubes! Looks like some nice pickings for the radio sales and serviceman!

Your Solder Problems Are Mine

It Pays Well to Give Due Consideration to Soldering Operations

By P. C. Ripley *

RECENTLY a call sent me on a hurried journey of a thousand miles. The Blank Radio Company complained of trouble in soldering twelve double ended lugs which were riveted on a sort of terminal strip. The reason for this trouble was apparent—too much metal in the lug for the heat generation capacity of the iron. Little relief could be gained from an iron of greater capacity because of limited available space for iron contact and the increased hazard of burning vital insulations on parts to be attached.

The lug was poorly designed and of a thickness beyond reason for the mechanical strength or conductivity demands. I rendered my verdict to the production superintendent: he in turn appealing to the engineering department for relief. At the round-table conference that ensued, I was dismayed to find that my diagnosis of the trouble had aroused the ire of the designing mechanical engineer. He had designed the lug, specified the metal and gauge of stock and had been responsible for its use. Furthermore, he had no desire to admit his error or lack of knowledge of the basic fundamentals of soft soldering. I asked him if a lighter gauge of metal would be adequate from the viewpoint of mechanical strength and electrical conductivity. He grudgingly admitted that it would. His attitude was that their need was for a cored solder that would speedily and satisfactorily solder those lugs as they were, and not for someone to come in and tell them to change their material specifications and parts design.

In defense of my argument, I suggested preparing four terminal strips with their lugs and a like number with suitable lugs that I happened to have with me at the time. This was done. Two of their most efficient operators thoroughly accustomed to this portion of their assembly were given the standard solder then in use and told to do their best. The operator working on the lugs I had supplied, *completed ninety-six connections before the other operator completed forty-eight.* Of greatest interest to me was the very superior quality of the soldering on the ninety-six connections as compared to the quality of the forty-eight. I won my point.

The chief engineer of a large midwestern radio manufacturer called me. Their soldering, he frankly admitted, was poor—would I suggest the correct solder for them? A trip through the production and stock departments told me the story. *No particular grade or alloy of solder could correct the troubles I found.* The origin of the trouble dated back to the embryo stage of the set—the laboratory model. From then on, trouble had multiplied, reaching its climax in the hurried pressure of the mid-season production. The radio engineer's ability was above reproach but, unfortunately, he lacked in knowledge of the basic and secondary factors contributing to successful soft soldering. Soldering was a mere detail with him—his duty demanded the careful balancing of the

P. C. RIPLEY

circuit—checking the electrical values of this and that—selectivity—range and tonal quality held his undivided attention. This resulted in the selection of many units produced by other manufacturers because of their electrical fitness but with little or no regard for their soldering quality.

Expert Soldering Neglected

The designing engineers worked up the layout into a compact unit. Theirs was the problem of securing compactness, speed of production on machined or manufactured parts, and the conservation of raw materials. Soldering still remained a neglected consideration. The result of their work and that of the radio engineer took form and was passed on to the purchasing department. There it became a problem of whose materials and parts were the cheaper, what supplier could make the promptest deliveries, which resulted in substitution on many items because of cheapness. Further tests of the substituted items were in order, still soldering was ignored. Finally, after a great deal of delays, the three interested persons agreed and orders were placed.

The incoming materials arrived and the inspection department checked for electrical values, size deviation, quantity and appearance, *but not for soldering quality.* That was not their job, they admitted. The stockroom keepers accepted the materials and stored them as fancy or convenience dictated. If rubber parts were stored in close proximity to metal parts, it was considered satisfactory. If rubber insulated wire remained in stock while a more recent shipment of the same item passed into production, they saw no harm in such procedure. *In other words, there was no effort made to preserve the soldering quality of parts or raw material.*

Then the time arrived for production activity, and with this came trouble. The alibi was passed among the interested groups that the operators were new and green; that soon they would have their organization perfected and production would flow at the schedule rate. It did not. Then the production department drew the wrath of "the powers that be" for their inability to deliver. As a matter of fact, they were doing as well as could be expected with conditions as they existed. Finally the solder was blamed and an idea came into being; send for a solder expert and find out what grade of cored solder to use to achieve the result mathematical computation had arrived at as a proper production.

This honor and opportunity to serve was conferred on me, but at too late a date for really effective and constructive work. I explained the futility of the situation but availed myself of the opportunity to outline a more productive policy for future effort. It has borne fruit, although not as perfectly as I have wished, due largely to the failure of the human element.

Wasteful Methods

Another prominent producer of radio apparatus called me. "Our solder bills are excessive," he said, "something has to be done." Before I could question him on the matter of the probable cause, he was excitedly complaining of the poor quality of their soldering. Realizing that little could be done over long-distance telephone, I agreed to catch a night train and to go over the situation with him in the morning.

Their bills for solder must have been excessive for several quite apparent reasons. It seemed that operators in

* *Research Engineer, Kester Solder Co.*

need of solder had a practice of cutting lengths of from eight to twelve inches from the spool. When these were reduced to lengths of from three to four inches they were discarded as scrap. Assembly lines were heavily littered with such ends. Passing down the production lines I observed that assemblies were not moving at a consistently uniform rate. This led to congestion at certain points and forced idleness at others. Several of these idle operators, in an effort to pass the time, were moodily melting solder on their iron's working faces from whence it dripped to the floor or bench.

I approached one and asked: "What is that stuff"? She replied, without looking up, "It's solder." My query apparently left her unabashed and at perfect ease so I ventured: "What does the stuff cost"? This time she shot back the information with an irritated manner, "I dunno, I ain't been working here but a week." I passed on, meditating as I went.

My attention was next attracted to a small group of excited employees in one of the production lines. A line foreman was reprimanding two operators whose work seemed suddenly to have developed more than the customary number of rejections. Making a mental note of the particular operations, I made my way down to the inspection group at the end of the line.

"Yes," I was told, "rosin joints are occurring with alarming regularity on the work of those two operators." I hastened back to their positions just in time to meet the foreman bearing away the spool of solder the girls had been using. "Too much rosin in this solder is the trouble," he said. I had heard that explanation before and it failed to satisfy me. I asked and was granted permission to take charge of the spool until further investigation could be conducted.

Rosin Joints Due to Sulphur

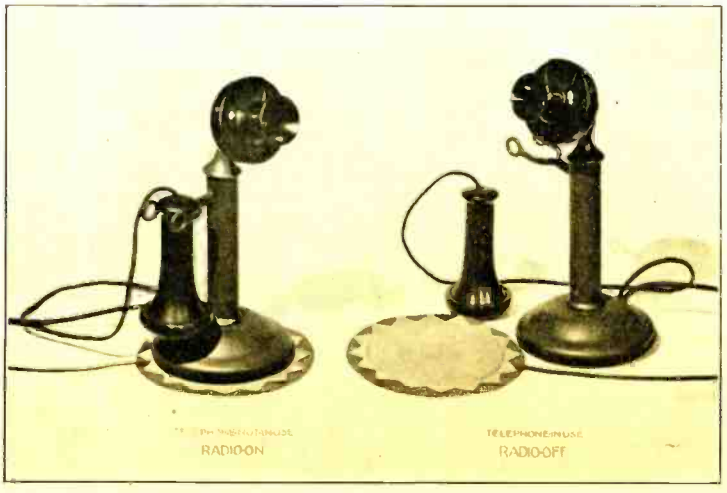
Immediately I gathered up a handful of the wires from these girls' positions and walked to a window to examine them closely. They were rubber insulated stranded conductors and the sulphur from insulation had played havoc with the wire. Some were much worse than others and the bad ones were responsible for the so-called rosin joints. I called the foreman and explained the situation. The explanation did not appear to entirely satisfy him. Realizing that I must furnish proof that my contention was correct, I asked permission to go to the stockroom and select wire for a test. To this he readily assented. In the stockroom I carefully culled wire until I had accumulated three hundred pieces that were reasonably free from the sulphur's attack. These wires and the solder alleged to contain too much rosin were handed the operators with instruction to do their worst. The result was a hundred and fifty receivers without a single rosin joint in the area previously affected. My next suggestion was for the selection of a like number of wires that I felt were capable of causing trouble and for the foreman to personally solder them. This was good-naturedly refused for he was convinced then that the wire played its part.

In this particular case, the criticized operators were using from five to six times as much solder as would have been necessary had the solder receptiveness of the wire been what it should. The girls tried to make the connections by repeated applications of soldier and flux. I further pointed out that when any operator encountered difficulty in the execution of her work, the whole line suffered. Idleness would be forced on others beyond her position and episodes such as the one of amusement by melting solder might be expected. Their practice of cutting solder into short lengths was largely inexcusable. Just a habit that had crept into the organization and no one had taken the time to analyze it economically.

THE PURPOSE AND INSTALLATION OF RADIO SILENCER

THE device known as the radio silencer is the result of considerable effort to eliminate interfering sounds while using the telephone. The interference to a person carrying on a telephone conversation is caused by a radio receiver in two ways, namely, the direct transmission to the ear not being used for receiving the conversation, and the side-tone caused by the telephone transmitter picking up the radio sounds and delivering them to the receiver, thence to the other ear.

In order to eliminate the above disturbances three means have been considered: First to have a manual key interposed in the loudspeaker circuit of the radio, second the use of a switch operated by the switch-hook of the telephone and the third by means of a switch on which the telephone rests when not in use. In the first of these it was found that the switch was difficult to mount and was unsightly. The second presented the problem of foreign attachments to the telephone which is very much frowned upon by the telephone companies, since repairmen are likely to become confused in clearing troubles, and the instrument occasionally is rendered inoperative by such an attachment. The third method was found to be practical with proper construction in that the telephone companies do not designate where the instrument shall stand when either in or out of use.



This switch was constructed in the form of a pad on which the telephone rests when not in use so that the weight of the telephone operates the switch to close the loudspeaker circuit. When the telephone is to be used it is taken from the pad, which opens the loudspeaker circuit.

The switch consists of a lower sheet of felt or leather or other material which will not mar furniture, upon which is placed a rigid sheet of insulating material. Carried on this sheet are two strips of metal, one of which is secured at both ends, the other being secured at one end, the other end of which is free to move in order to close the circuit when a weight is placed upon it. Over this combination is placed a second piece of felt or leather which is stitched to the lower sheet of felt or leather. Conductors are extended from the two metal strips to the loudspeaker circuit and so connected that the switch is in series therewith.

On account of the low power carried in any loudspeaker circuit no particular problems of switch contacts or large conductors are presented. The wire to the loudspeaker can be made very small on account of the low current required to operate the loudspeaker.

Landing Indicator for Airplanes

Safe Landing Made Possible During Fog

THE perfection of the Hanson audio piloting cable system for guiding blind aircraft to safe landings, keenly followed by radio engineers and leaders in the aviation industry for two years, was announced by Earl C. Hanson, of Chicago, the inventor, January 29 at the Ford Transportation Exhibit in that city.

Before its announcement numerous successful landings were made at the Ford airport, Lansing, Ill., by pilots relying solely upon headphones and meter readings for their altitude-above-ground-readings and direction. In making the announcement Mr. Hanson said the development of the system, which will rob the air lanes of the hazards of blind flying, was made possible by the equipment placed at his disposal by the Ford Motor Company. Ford tri-motored monoplanes, and the use of the company's airport at Lansing were made available to him for the two years of experimentarion.

Principle of System

Briefly, the system, based upon the principles of electromagnetic induction, provides for parallel cables radiating from the edges of flying fields, every other cable emitting a code in dots; the code picked up by a loop attached to the plane and made audible —or visible—to the pilot by the use of amplifier tubes.

An altitude checking ground antenna activates an electric altimeter which translates that intensity into actual height above the source—or cable. Thus, if the loops are draped over high-tension lines, poles, bridge heads, roofs or other ground obstructions, the pilot receives an altitude reading which is exact from the height of that obstruction.

The altitude checking ground antenna equipment consists of a loop of buried cable several thousand feet long and 600 feet wide. The loop may be elevated on short poles if the terrain or conditions favor such an installation.

A motor-generator provides the alternating-current for energizing the loop antennae. A wattmeter associated with the cable system would show the amount of power delivered to the radiating system. Since atmospheric conditions or time of day or night does not in any noticeable way affect the transmission of electromagnetic wave energy emanating from the ground cable system it is possible to obtain the approximate height of aircraft above the ground pilot cable system.

The United States Department of Commerce, Bureau of Mines' report, November 1929, says that experiments based on the Hanson inventions conducted at Mammoth Cave show that the audio-frequency electromagnetic wave energy passes readily through 900 feet of continuous rock. Large bodies of salt water offer virtually no opposition to the transmission of the audio wave energy from submerged cables to marine vessels.

Simple System for Airport

The following is a description of the simplest cable installation for indicating the entrance to one side of an airport:

Two closed loops of buried cable spreading from 200 feet near the entrance to the field to 1000 feet across at the outer extreme form one complete dot-dash system. An alternating-current generator is connected through constant energy regulating devices and a rotating contact breaker to each cable. The rotating contact breakers are arranged in such a manner as to allow one cable to project an invisible beam of audio-frequency wave directly above the cable system, the interruptions in the one cable forming dots and in the other dashes.

This system allows a pilot to know if he is going in a definite direction. His map of the airport would indicate the location of the cables in respect to the landing field. To indicate to the pilot the exact edge or entrance of the field, another loop, 600 feet long by several hundred feet wide, is positioned at the entrance and at right angles to the entrance cable loops and connected directly to the generator. No rotating contact—breaker or interrupter is used in this circuit though a constant energy regulating device is required.

A more elaborate airport installation would consist of several of the units mentioned in order that a plane could approach a field in a direction best suited to the weather conditions prevailing. A directional signal, to indicate compass points, might be transmitted from the dash guiding cables spaced with pauses to indicate the cardinal points.

A still further refining feature of the system would be the utilization of buried cables stretched across the landing field and positioned, for example, 1,000 feet from the edge. This cable system could be energized by a 500-cycle generator. The object of this cable would be to indicate to the pilot when his craft is taxi-ing across the field to within a thousand feet of the far end. The same generator could be used to furnish power to the protective cables for various sides of the field. If desired, interrupting switch mechanism would indicate which edge of the field the craft was approaching.

Most Practical System

The most elaborate and the most practical system, if cost of installation were not important, would be to use a high power electric generating phonograph to energize the "gun coil," the coil positioned at the edge of the field, and give the name of the airport and its position on the compass. Voice and music transmission at audio frequency has been tried at the Ford airport and proven successful. By use of special relays, a row of vertically placed electric lights should be used to indicate general height of aircraft above the altitude ground cable loops.

Receiving equipment for aircraft may be of several kinds. For small private craft there may be loop antennas comprising thousands of turns of a fine copper magnet wire, enclosed in a waterproof bakelite case approximately 14 inches in diameter and 2 inches thick. A small waterproof flexible cable would connect the loop antennas to the input of a three-stage audio-frequency amplifier. This amplifier greatly increases the strength of the audio-frequency signals received wirelessly from the electrically energized cable system located on the ground. With slight modification, the present aircraft radio receiving set may be employed.

Audible or Visual Signal

Either headphones or a calibrated electric meter may be used. As a plane descends over the electrically energized ground cable system the electromagnetic wave energy intercepted by the loop antenna increases. The amplified energy actuates the meter causing the needles to indicate to the pilot that the craft is reaching a point a definite distance from the ground. The headphones may be used in conjunction with the visual indicating meter.

A light metal waterproof battery case is provided to encase the batteries furnishing electrical energy to the vacuum-tube amplifier. The condition of the batteries can be determined at any time by the pilot by means of a small double-scale meter mounted on the front panel of the amplifier.

For passenger planes the loop antenna is mounted within the metal wings, as was the case with the Fords used in flight tests, and placed several feet from the wing tips. To prevent absorption of the electromagnetic wave energy, non-metallic material such as laminated micarta, may be employed. The micarta may be secured in such a way as to maintain the streamline of the wing. The audio-frequency wave energy from the ground passes readily

(*Concluded on page* 49)

HIGH-SPEED AUTOMATIC TUBE MANUFACTURE

(*Concluded from page* 33)

other feature of this machine is that the tube, from the time it is placed in position until it is tipped off, is constantly being exhausted by the individual pump, whereas on the old type of machine there is a loss in pumping time between each index or stop.

The basing machine is designed to cement the bakelite base to the glass bulb. Before the tube is removed from the machine, the lead wires are cut so that the assembled base is ready for soldering. The main feature of this machine is the method of holding the the bulb and base in definite relation, so that it is impossible to obtain tubes with crooked or loose bases. In the new basing machine, the holders are automatically opened for insertion of bulb and base at the beginning of the cycle, and again opened for ejection of the based tube at the end of the cycle. The old method calls for the opening of the clamp by hand. This machine has ninety heads as against twenty-four heads for the usual basing machine.

Aging and Testing

As for the automatic aging and testing machine, the aim here has been to provide a single or combination machine which would age and also test all tubes for electrical characteristics, segregating the good tubes into one group, and the defective tubes, properly classified, into another group. For instance, there are four testing positions, namely: the first position throws out all open filament tubes or tubes with short-circuits between any of the elements; the second position throws out all tubes in which the gas current, leakage current or plate current is outside of the specified limits; the third position throws out all tubes which are not within limits for emission; the fourth position is available for any other desired classification. The tubes which clear the preceding positions are then ejected mechanically into a belt which contains only perfect tubes.

Previous automatic testing machines were designed solely for filament type tubes, and, due to the fact that the aging and automatic testing machines were separated with just a belt conveyor to serve as the connecting link, the indirectly heated type of tubes could not be tested since the cathodes cooled down between the aging and testing machines. With the deForest aging and testing machine, combining both functions, it is possible to test any type of tube including the screen-grid type.

The automatic high-speed equipment not only produces from seven to ten times as many tubes for a given unit of time, but the products are far more uniform than the products made on the old type machines. Also, automatic testing and aging, essential to the high-speed automatic production units, is proving far more accurate than the usual hand aging and testing, since it does away with the ever-questionable human element.

At the present time the one large remaining labor item in the production costs is the assembling of the parts on the stem, or stem mounting. At this writing even this phase of radio tube production is in process of being eliminated by automatic machinery, so that in the near future there will be radio tubes made from start to finish with an absolute minimum of human intervention.

Several years ago, the simple -01-A battery tube sold for $9.00. Today, a much improved -01-A tube can be purchased for $1.25. Even the most intricate types such as the a-c. screen-grid tubes are sold at surprisingly low prices. And yet, with the possibilities of the new automatic high-speed production equipment now coming into use, as well as other contemplated improvements, still lower list prices are coming into view. Even the most complicated types which may be developed in the future, will eventually be purchased at startlingly low prices, thanks to the mechanical and electrical robots now taking their places in the radio tube industry.

▲

THE CHEMISTRY OF THE VACUUM TUBE

(*Concluded from page* 35)

nickel oxide used for blackening plates are evidently sufficiently stable. They have a vapor pressure and oxygen pressure lower than the full vacuum.

Flashing

One of the most essential processes of large scale manufacture of tubes is "flashing." It consists in volatilizing by heat a small quantity of magnesium in the bulb before or after sealing.

We know that magnesium vapor will react easily with oxygen, nitrogen, carbon dioxide and carbon monoxide and that it also will absorb a small quantity of hydrogen.

The basic reaction of the magnesium flash therefore appears simple. On close investigation however we perceive some inconsistencies.

The flash seems to absorb only a limited amount of gas. If a tube which has been flashed and sealed off in the regular way is flashed again, as a rule no further improvement of the vacuum results.

When such a tube is then seasoned, further absorption takes place and a very high vacuum is obtained. Strong ionization is however essential for this reaction to take place. It is quite likely that ionization of the gases has an important function also during flashing.

The Glow Discharge

The glow discharge in ionized gases is an unusually powerful means of producing chemical reactions. Nitrogen is known as a very inert gas. It can be made to react only with great difficulty and very incompletely by any of the well-known means.

If it is however exposed to electrical discharges it is converted into so-called active or triatomic nitrogen. In this form it is absorbed by many metals with the formation of nitrides.

The chemical effects of the glow discharge in relatively high vacuum has not been investigated thoroughly.

These three typical examples of problems in vacuum tube chemistry indicate the magnitude of the tasks in this field. Only scattered bits of information are available at present, leaving to investigators a nearly virgin field.

Methods used in metallurgy, physical chemistry and electrochemistry will have to be purloined and modified so as to permit complete investigations in high vacuum.

▲

PURE MAGNESIA SOLVES TUBE PROBLEM

The search of the radio tube industry for a satisfactory insulating material to use in heater type tubes, appears to have borne fruit in pure magnesia, according to J. E. Smith, President of the National Radio Institute of Washington, D. C.

After trying no end of insulating materials and ceramics, pure magnesia in pulverized form, extruded from dies in the desired cross section, broken to proper length, and then fired at a high temperature to rock-hard consistency, is apparently the solution. Tubes with magnesia insulation for the heater, have been tested at over-voltage and excessive temperature, and apparently possess a normal operating life of thousands of hours. Thus the most troublesome problem of radio, a satisfactory heater for a-c. operation, is now solved through the persistency of specialists.

▲

TUBE DEPENDS ON MINUTE ELEMENTS

The importance of the radio tube's development is all the more recognized with the realization that it bases its operation upon the proper control of one of the smallest subdivisions of matter known to science, it is stated by a representative of E. T. Cunningham, Inc.

Electrons are the electrical satellites of the atom, which in turn, is a subdivision of the molecule, it is pointed out. It is the movement between positive and negative charged atoms, resulting in a flow of electrons, that has been directed by science into the principle by which the radio tube operates.

The achievement of the present-day precision of the individual tube, upon a mass production basis, can be seen as a marvel of science, when one considers the minute units upon which each valve operation depends.

RADIO STATIONS CAN NOW BROADCAST AT WILL

(*Concluded from page* 42)

wave. This will allow the powerful stations of the country to cover wide areas without interfering with receivers in their immediate vicinity.

At KDKA this effect will be achieved with eight individual antennas set on 110-foot poles ranged in a circle 800 feet in diameter. In order to send out a strong sky-wave the antennas are so arranged that the horizontal radiations of each one will be "blocked off" by the signals of the other antennas. Thus the only way in which the major part of the signal strength can escape is upward whence it will be deflected back to earth at a distance by the Kennely-Heaviside layer.

This upward movement of the signals is compared to the action of a lawn sprinkler which sends its spray upward and outward so that it is distributed at a distance, but not immediately around the source.

The method of synchronization advocated by the Westinghouse group is that of generating a frequency and supplying it to one or more radio stations over either wire or radio facilities to be multipled at the several stations sufficiently to be put out on the air as a carrier wave. Methods which do not depend upon a wire or radio connection between the stations have not proved satisfactory, it was said.

Both the New England and Chicago synchronization projects utilize wire connections. At one time the Westinghouse organization effected synchronization between KDKA and KYW by sending the carrier frequency from Pittsburg to Chicago by short waves. In this experiment the trouble caused by fading was avoided by the insertion of a mechanical link in the circuit at each station the inertia of which carried it over the period of fading. However the short-wave means of synchronizing was carried on only as an experiment while the connection of the stations by wire is a thoroughly tested method.

▲

THE AMERICAN SCHOOL OF THE AIR

RAY S. ERLANDSON, executive director of The American School of the Air, and who also is educational director of the Grigsby-Grunow Company, in a printed prospectus says:

"The American School of the Air is the first nationally conducted program of educational broadcasting ever to be attempted in the United States. Its sponsors, the Grigsby-Grunow Company with the cooperation of the Columbia Broadcasting System, wish the public to know that it therefore must be essentially experimental in nature. It is not an institution with an unyielding curriculum; it belongs to the schools and the homes of the country.

"Educators, whether they be acting in an administrative capacity or as teachers in the classrooms, are urged to make constructive suggestions. Parents and all others interested in the education of youth are asked to cooperate in every way. It is a well-known fact that the worthwhile organizations in the world are not the product of the imagination of single individuals, but the result of concerted effort in the direction of social betterment.

"The finest producers, performers and continuity writers skilled in the difficult technique of presenting material artistically have been obtained. In addition, some of America's leading educators have made valuable contributions relative to subject material and child participation activities. There remains still much to be discovered regarding the best method of classroom reception and the best way to utilize the excellent material sent out over the air.

"All suggestions based on observation of this experimental series, not only regarding reception but also regarding the type of material presented and the manner of presentation, will be welcomed by the American School of the Air. These suggestions will materially help in the development of these courses of instruction. They will also be turned over to the research authorities of the U. S. Bureau of Education."

▲

MARKETS FOR THE "B" BATTERY

WHILE certain new uses for "B" batteries have come into existence of late, the battery-operated radio receiver is by far the largest and most important "B" battery user, and from all present indications, will continue to be so for a long time to come, according to a recent survey of the field compiled by E. E. Horine, sales engineer of National Carbon Company.

Well over half of the battery-operated receivers are in towns and cities, the remainder being on farms and in rural communities where central station power is not available, the survey developed.

The "B" battery market created by town and city owned battery receivers is too large and too important to be neglected. Progressive dealers here and there actually have increased their "B" battery sales in 1929 over those of 1928 by taking advantage of the fact that other radio dealers in their vicinity have allowed their interest and their efforts to be diverted from "B" batteries to other radio products. There is a golden opportunity in practically every city and town in the country for certain dealers to capitalize on the tendency of other dealers to neglect the highly important "B" battery.

The rural market is running the city market a close second and is gradually gaining on it. Dealers in position to serve this market should be kept keenly alive to the possibilities of profit through the sale of "B" batteries to this growing market.

The talking moving picture theatre is the largest of the non-radio users of "B" batteries. This market is growing rapidly. Additional theatres are being wired for sound almost daily and practically all such theatres use "B" batteries.

Automobile radio and radio installations aboard pleasure boats are other uses which may develop a large demand for "B" batteries.

Police radio patrol systems are being adopted by certain of the larger municipalities. Each radio-equipped squad car requires three or four 45-volt "B" batteries and renewals must be made at comparatively frequent intervals because of the almost continuous nature of the service. As more and more cities adopt this scientific method of crook catching, another large and important "B" battery market will be developed.

Aircraft radio is still in its infancy, but gives promise of growing to important proportions in time. Battery-operated beam and beacon receivers as navigation aids already are being used by commercial air transport companies, and it requires no great stretch of the imagination to visualize the air of the future congested with privately owned planes, all radio equipped to give traffic signals and to aid in landing.

The future of the "B" battery is bright. The rising popularity of the a-c. set reduces only one of the many markets for this product; the others are all growing.

▲

LANDING INDICATOR FOR AIRPLANES

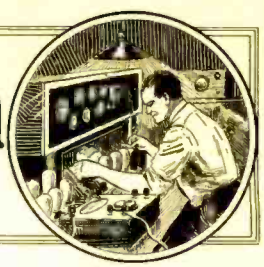
(*Concluded from page* 47)

through the micarta and creates electrical energy in the thousands of turns of wire comprising the loop antenna.

The multiple stage amplifier may be located in any convenient part of the craft. The apparatus can be turned on or off by remote control switch mechanism mounted on the instrument board. The battery case may be placed at any convenient point. Besides the use of the audible signal and visual indicating meter, it is possible to use electric relays in such a manner as to control flight of the craft over a predetermined course without the aid of anyone on the craft except in making final landing.

The Trend of Invention

By RICHARDS & GEIER
PATENT AND TRADE MARK ATTORNEYS 274 MADISON AVE NEW YORK CITY

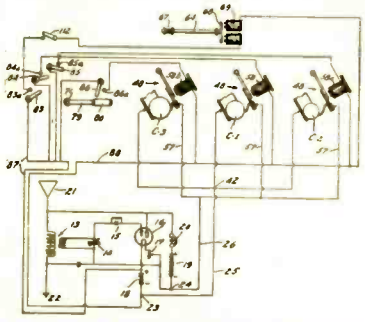


COIN-CONTROLLED RADIO-RECEIVER

Richard Sause, of New York, N. Y. U. S. Patent No. 1,745,506. (Issued Feb. 4, 1930)

This invention relates to improvements in coin-controlled radio receivers, and has particular reference to such devices wherein coins of different denominations can be selectively employed to operate the radio receiver during time cycles of different lengths commensurate with the values of the several different coins.

An important object of the invention is to provide a coin-controlled radio receiver in which the respec-



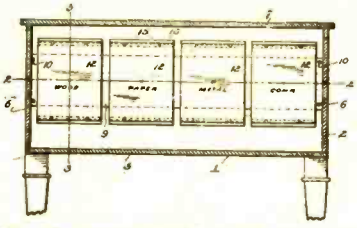
tive time cycles are accurately defined by automatic means, and in which the commencement of the pre-paid time cycle is manually controlled after insertion of a selected coin in the apparatus.

▲

SOUND-REPRODUCING APPARATUS

Theodore Lindenberg, of Columbus, Ohio. U. S. Patent No. 1,742,402. (Issued January 7, 1930.)

This invention relates to improvements in sound reproducers especially designed for use in connection



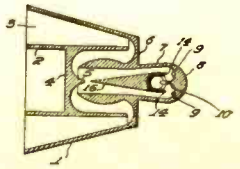
with radio receiving apparatus or other sound apparatus utilizing electrical sound developing and amplifying means.

▲

SOUND AMPLIFIER

Arvid Emanuel Brandstrom, of Milwaukee, Wisconsin. U. S. Patent No, 1,744,101. (Issued Jan. 21, 1930)

This invention relates to improvements in sound amplifiers and its object is to provide a device of this type that is adapted for use on combination radio



and phonograph sets. One object is to provide means for interchangeable associating the amplifier operatively with either the radio or the phonograph.

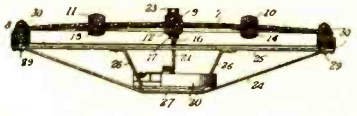
Free books on patent and trade-mark law can be obtained by our readers upon request to Radio Engineering or direct to Richards & Geier. Copies of the patents described on this page may be obtained through the above mentioned firm of patent attorneys.

SPEAKER

Hobart A. Simpson, of Ocean Grove, New Jersey Assignor to Asparad Radio Corporation, of Asbury Park, New Jersey. U. S. Patent No. 1,746,289. (Issued February 11, 1930.)

This invention relates to what are generally known as loudspeakers.

The objects of the invention are to improve the tonal qualities of this class of devices, to provide a speaker which will reproduce faithfully the tone values ranging from the lowest through the highest of the



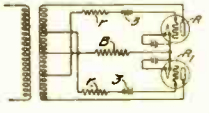
audible scale, which speaker will be artistic in appearance as well as in the musical sense, and furthermore, be of relatively simple, inexpensive design and structure.

▲

VACUUM-TUBE RECTIFIER

Milton K. Akers, of Troy, Ohio, Assignor to Western Electric Company, Incorporated, of New York, N. Y., a Corporation of New York. U. S. Patent No. 1,747,852. (Issued February 18, 1930.)

This invention relates to a rectifier, and more



particularly to a three-electrode electric discharge rectifier.

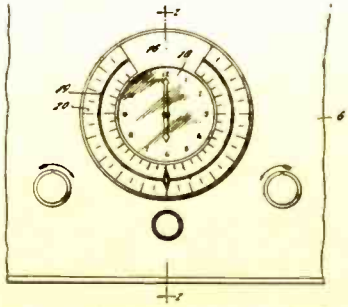
One of the objects of the invention is to produce by means of rectification, a flat-topped or substantially uniform continuous current wave.

▲

RADIO RECEIVER CONTROL MECHANISM

Robert Martini, of Chicago, Illinois. U. S. Patent No. 1,735,972. (Issued November 19, 1929.)

The present invention relates to a control mechanism for radio receiving sets and has for one of its important objects to incorporate a clock in the receiv-

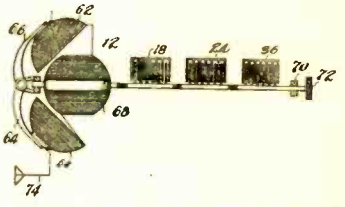


ing set so as to be mounted in the panel and to provide circumjacent the face of the clock a dial with indicia thereon for tuning purposes and an indicator associated with the dial controlled by the tuning operating mechanism.

CONTROL OF RADIOCIRCUITS

Leroy F. Dyer, of Quincy, Massachusetts. U. S. Patent No. 1,748,640. (Issued Feb. 25, 1930.)

One object of the present invention is to provide an arrangement which will facilitate the simultaneous



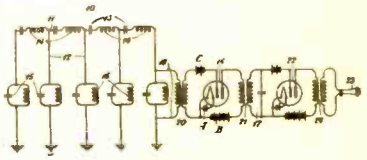
tuning of related circuits of different electrical characteristics.

▲

RADIO SIGNALING SYSTEM

Lloyd Espenschied, of Hollis, New York, Assignor to American Telephone and Telegraph Company, a Corporation of New York. U. S. Patent No. 1,746,305. (Issued February 11, 1930.)

This invention relates generally to systems for transmitting energy and particularly to the protection



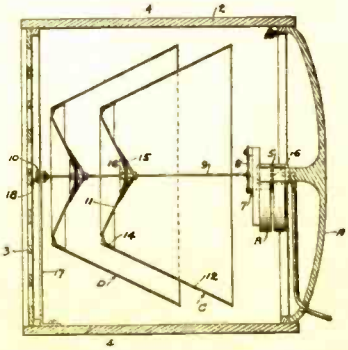
of such systems against disturbance. Its object is to provide a method of and apparatus for eliminating or minimizing the effects of disturbances in such systems, whether in power circuits or signaling systems, and in either wire or wireless systems of communication.

▲

ACOUSTIC DEVICE

Frederick Boxley, of Oakland, California. U. S. Patent No. 1,748,632. (Patented Feb. 25, 1930.)

The object of the present invention is to generally improve and simplify the construction and operation of sound reproducing diaphragms; to provide a sound



reproducing diaphragm of the cone-shaped type in which the diaphragm may be materially decreased and the total area presented materially increased and further to provide a novel mounting which leaves the peripheral edge of the diaphragm entirely free and unsupported so that the vibrations transmitted to the diaphragm will bodily move the same throughout its entire area.

NEWS OF THE INDUSTRY

RSMA JOINS NFRA

The Radio Service Managers Association, of 324 West 42nd Street, New York City, has the distinction of being the first and only service organization to be admitted to membership in the National Federation of Radio Associations, Inc.

Word has just been received of the approval of the application of the Radio Service Managers Association and its election to membership. Coming at this time, when the RSMA is but one month short of being a year old, this is a fitting climax to eleven months that have been filled with accomplishments far exceeding even the most optimistic expectations of its organizers.

The monthly meetings of this Association which have been largely attended since its inception, have grown to such an extent that larger meeting quarters had to be provided. Future meetings will be held in the Engineering Societies Building, 29 West 39th Street, New York City, on the last Monday of each month at 8 p.m. All who are interested in radio and radio service are welcome to attend.

▲

OPTIMISTIC

That the United Scientific Laboratories Inc., 113-115 Fourth Avenue, New York, are optimistic over prospects for big business during the coming season is evidenced by the fact that they have enlarged their plant and floor space and have installed much new machinery and equipment to provide for effective and rapid production of their new type S. G. shielded condensers.

Pierce-Airo, Inc., a subsidiary of United Scientific Laboratories, is also planning for big business by increasing their facilities for the production of their new 1931 Triple Screen-Grid Pierce-Airo Chassis.

▲

MANUFACTURERS OF VACUUM TUBE MACHINERY

The present high standard the radio industry has achieved in the manufacture of its products has been due mostly to improved mechanical methods. Machinery of intricate design has been incorporated throughout the industry and, as a consequence, radio receivers able to perform with a high degree of perfection, to sell at a nominal price have resulted.

One company that has followed the trend of rapid progress in this branch is the Arrow Manufacturing and Machine Co., Inc., of North Bergen, N. J. This firm has made a special study of the radio tube industry's requirements for many years and the reputation it has gained in this endeavor has gained nation-wide recognition. It specializes in the manufacture of all types of vacuum tube machinery, including vacuum pumps, single and compound automatic hot cut-off flare machines, and 24-position automatic exhaust machines.

This firm, in a newly constructed factory, has provided every facility and convenience for designing machinery that may be needed in the future improvement of the radio vacuum tube.

Its staff of engineers and designers are in a position to advise vacuum tube manufacturers on any intricate problem arising in particular cases. Advanced engineering methods, the result of a long period of experimentation, are available from the officers of this organization.

▲

STRAYER AND PICARD START ON TOUR

Convinced that marketing problems of today imply unusual merchandising plans, an unusual type of business voyage has just been started upon by Fred H. Strayer, sales manager for the Sylvania Products Company, accompanied by Richard A. Picard, of Picard-Sohn, Inc, advertising counsel for Sylvania Radio Tubes and Sylvania Lamps.

The idea of research into marketing conditions and resale problems is not new, but one of the prime factors of this tour is to lay the ground-work for a new type of business helpfulness for retailers handling the company's products.

▲

CONTAINER CORPORATION OF AMERICA

According to an announcement made by J. P. Brunt, executive vice-president of the Container Corporation of America and president of the Midwest Box Company with headquarters at 111 W. Washington Street, Chicago, Ill., the Container Corporation has acquired the Sefton Container Corporation and Dixon Board Mills, Inc. The Sefton Container Corporation owns and operates three plants, one in Brooklyn, N. Y., one in Chicago, Ill. and one in Anderson, Ind. The products manufactured in the Brooklyn plant are corrugated fibre boxes and corrugated paper products. The Chicago plant of the Sefton Container Corporation manufactures paperboard cartons, paper pails and corrugated fibreboard products while the Anderson plant manufactures corrugated fibreboard products and folding paperboard boxes. The Sefton Container Corporation has been a large supplier to the radio parts and radio tube industries.

▲

BAUKAT DIRECTS PUBLICITY FOR RCA RADIOTRON CO., INC.

There is perhaps no one better known to the radio trade than Henry W. Baukat. It will, therefore greatly interest everyone to know that he has just accepted a position with the RCA Radiotron Co., Inc., as director of publicity and will also be editor of their new publication, "Good News." He will be located in Harrison, N. J., where the main offices of the RCA Radiotron Co., are located.

HENRY W. BAUKAT

Having been an amateur as far back as 1912, and having studied radio in all of its phases ever since, he may well be said to be a charter member of the radio industry.

For the past five years he has been technical and associate editor of "Radio Retailing" and has constantly been calling on and interviewing radio manufacturers, wholesalers and dealers. In the course of his travels he has come into close contact with thousands of members of the radio trade. He has sold merchandise over the counter with them, and has helped them solve their problems. Being a member of the Institute of Radio Engineers he has maintained contact with other engineers. His genial smile is a well known feature of engineering meetings.

▲

ALL PURPOSE LINE OF SPEAKERS

The Oxford Radio Corporation, 3200 Carroll Avenue, Chicago have issued a new display sheet and price list of their line of electrodynamic loudspeakers for the home, for public-address, auditorium and theatre uses.

▲

POLYMET DECLARES REGULAR STOCK DIVIDEND

At a regular meeting of the directors of the Polymet Manufacturing Corporation, the quarterly dividend of 25c. per share in cash and 1 per cent. in stock was voted and passed, payable April 1, to stockholders of record March 22. The record of Polymet for sales earnings and dividend payments is extraordinary, and this is but a further example of it. Mr. Nat. C. Greene, vice-president of the company, reports that confidence is once more apparent in radiodom and that production plans of many radio companies are rapidly being completed. This spirit is reflected in substantial orders falling to the Polymet lot, for resistances, coils and condensers of the various types made by the company.

MACHINE MADE PARTS

Metal stampings, finished metal cases, shields for coils and tubes, as used in radio manufacture, can be turned out uniformly and economically only in quantity. The Marquette Tool and Mfg., Co., Chicago, Illinois has just issued a booklet entitled "Better Stampings," which will be mailed upon request.

▲

ARCTURUS ANNOUNCES NEW HIGH SPEED PRODUCTION

Recent statements from officials announce that the Arcturus Radio Tube Company, Newark, New Jersey, has gone into high speed production on ten improved types of Arcturus tubes in their new factory. These tubes are being made on the latest design of automatic machinery insuring uniformly perfect production of the tubes which represent new developments in the standard Arcturus line of a-c. and d-c. tubes.

▲

ENAMELED WIRE AND TUBE FILAMENT WIRE

Because of the rather limited source of supply of enameled wire and of carbonized nickel strip, the radio manufacturing industry will be interested to learn that the National Harris Wire Company, Verona and Mount Prospect Avenues, Newark, N. J. has purchased the Standard Alloy Wire Company. The Company also makes a patented tube filament wire known by the name of silectron alloy.

▲

CONDENSERS AND DIALS

Precise Products, Inc., 254 Mill Street, Rochester, N. Y., have issued a pamphlet illustrating that company's precision condensers and drum dials.

▲

SET PRICE ADVANCED

Effective March 15th, The Sparks-Withington Company has announced that a slight increase will be made in the list price of their newest instrument, the Sparton Model 589. Until that time all present eastern, western and Canadian prices will remain in effect.

Early sales volume on this model indicates, according to Sparton officials, that this new model will enjoy greater popularity than any other Sparton that has preceded it. It has accomplished the object of bringing Sparton instruments within the means of nearly every home, and the buying response has been beyond expectations, it is said.

The increase to be announced will not remove it from its present price class, and will continue to include its full equipment of ten tubes.

▲

NEW PRINCIPLES IMPROVE BOTH RADIO AND PHONOGRAPH TONE

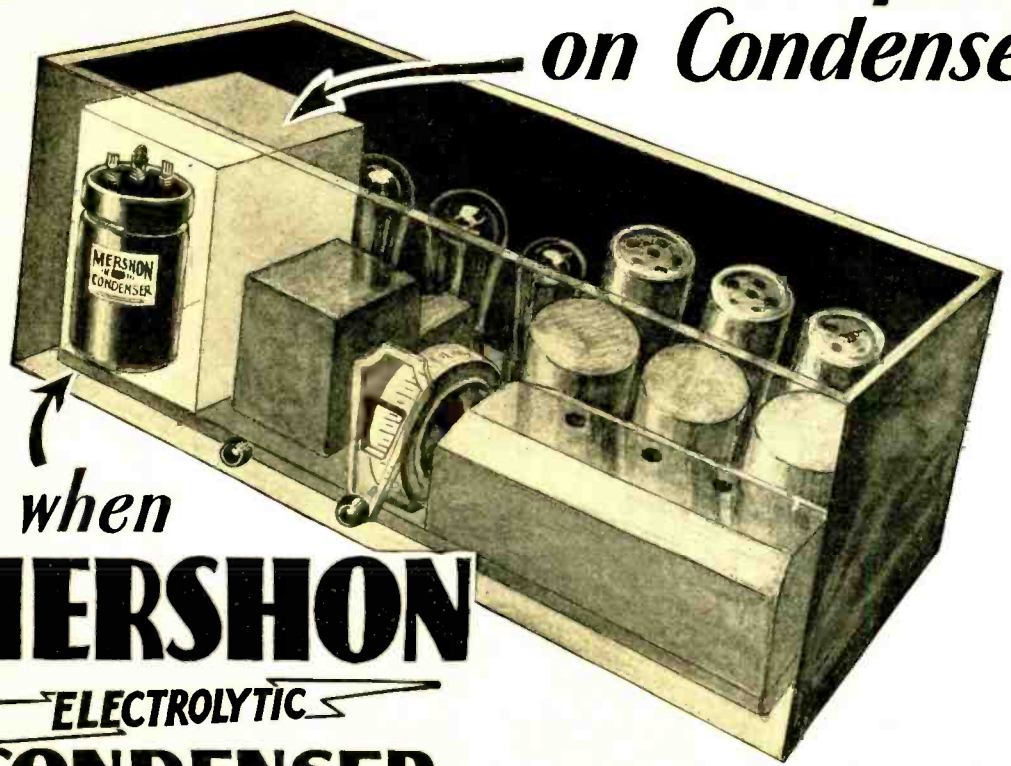
Both radio and phonograph have reached their present state of perfection through valuable contributions from telephone laboratories. For example the electrical recording methods used in making the present fine phonograph records is a product of telephone laboratory research. Electrical reproduction by means of the electromagnetic pickup and the high quality audio amplifier also are telephone laboratory developments.

Another contribution that is credited to the telephone laboratory is the marked improvement in broadcasting that is made possible by what is known as high modulation. Broadcast stations using this new system impress on their carrier wave a greater percentage of the useful modulation signal which is in fact the program signal. This results in several advantages, such as an increase in service range of the station and improved quality of signal within this area.

In order to take full advantage of this improvement in broadcasting, the radio receiver should have linear power detection such as is provided in the Stromberg-Carlson No. 654 receiver. This new receiver is a radio-phonograph combination designed in a telephone laboratory, to take full advantage of the fine audio reproduction available on modern high-quality phonograph records as well as on the air.

The flexible armature magnetic pickup which is incorporated in the phonograph portion of this combination reveals exquisite tones that have hitherto remained concealed in the record grooves, it is stated. The flexible armature in this type of pickup permits the needle to follow the minute fluctuations of the record groove with accuracy and bring out the subtle and distinctive overtones which would be omitted otherwise, it is said.

Why Waste *all this Space on Condensers*



when

MERSHON

ELECTROLYTIC CONDENSER

Contains 72 mfd. in 35 cubic inches

The experience records of manufacturers using the Mershon Condenser, as well as those of our laboratories, are available to engineers. Bulletins, diagrams and a consulting service for your particular problems are yours for the asking. Write today.

The use of heavy, cumbersome condensers is passing with the realization that the famous Mershon Electrolytic Condenser not only saves WEIGHT and SPACE, but delivers abnormally HIGH CAPACITY in small space. Thirty-one leading radio manufacturers specify the Mershon Condenser as standard equipment because it is self-healing, economical, humless and trouble-proof.

For the engineer interested in designing a new power-pack; for the builder of a Television set or a short-wave transmitter or receiver; for the sound engineer, the expert service man, the laboratory worker — the MERSHON CONDENSER is an indispensable aid.

Mershon Division, Dept. R-3
THE AMRAD CORPORATION,
Medford Hillside, Mass.

SELF-HEALING

ECONOMIES EFFECTED BY NEW TUBE PRODUCTION UNITS

An entirely new conception of production costs is being brought about with the initial operation of the new high-speed, automatic tube fabricating units now installed in the DeForest Radio Company's plants, according to Allen B. DuMont, Chief Engineer of that company.

"Until recently," states Mr. DuMont, "the standard tube production units such as the sealing machines, exhaust machines and basing machines, have been set for a speed of approximately 300 an hour. I am speaking in terms of good tubes, of course, with the necessary pumping time. About fifteen months ago, the DeForest engineering staff, realizing the need for greater volume of radio tubes, set to work developing entirely new production units. Recently, these high speed, automatic production units have been placed in operation in our Passaic, N. J., plant, and the results have exceeded our expectations. We are now handling as high as 2000 tubes per hour on these new units, as contrasted with 300 per hour on the former standard units.

"We hope to have in operation shortly our automatic stem machine, which will assemble the stem or 'innards' of the radio tubes by mechanical means instead of the time-consuming and costly hand assembly of the present time. With this automatic process, together with automatic aging and testing, we shall have radio tube production on an entirely new basis.

"The DeForest Radio Company, in addition to developing and building its own production equipment, which is unique in the radio tube industry, also makes all its parts, including plates, coated filaments, cathodes, grids and so on, using special automatic machines."

▲

GOOD A-C. TUBES SHOULD LAST FULL 1000 HOURS

That good a-c. tubes should provide satisfactory service over a period of 1000 hours, is the claim made by radio tube manufacturers. However, there is one stipulation which should be observed, namely, the maintenance of applied voltages within 5% plus or minus of those specified. Tube manufacturers will not stand back of tubes which have been abused, knowingly or otherwise, by their users. The better tube plants have experts who examine the returned tubes most critically, even under a microscope, and know precisely what has been done to the tubes.

If a set uses up tubes at a rapid rate, the line voltage may be at fault. Users generally take the 110-volt current supply for granted, yet it may vary all the way from 85 to 140 volts. Furthermore, while the radio set may be provided with a "high" and "low" voltage arrangement to compensate for permanently high or low line voltages, it is the rapidly fluctuating line voltages that cause the trouble. Unless the set user has a line voltmeter at hand and watches the voltages, so as to work the "high" and "low" taps or switch accordingly, the tubes are apt to be subjected to severe overloads on the one hand, and to insufficient voltages for satisfactory operation, on the other. The need for automatic line voltage compensation is therefore obvious, and has brought into existence the line voltage regulator or line ballast clarostat. This device is being featured in several of the standard broadcast receivers today.

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WESTINGHOUSE ELECTRIC REPORTS RECORD SALES AND EARNINGS FOR 1929

As shown by its annual report, which was made public March 12, the sales billed, the orders booked, and the net income of the Westinghouse Electric & Manufacturing Company for the year ending December 31, 1929, exceeded those for any previous year in the company's history.

The gross billed totaled $216,364,518.

The volume of unfilled orders on January 1, 1930, was $62,025,399, a gain of approximately $15,000,000 over last year.

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CANADIAN MARCONI COMPANY BUILDS NEW FACTORY

The success achieved by Marconi radio receivers and Marconi commercial transmitting and receiving equipment, in recent years, has resulted in present production facilities becoming entirely inadequate to care for the steadily growing demand for Marconi products.

It has just been announced that the Canadian Marconi Company has purchased a site of 125,000 square feet of land in the Town of Mount Royal, P. Q., where work on the erection of a new Marconi manufacturing plant has already been started.

It is felt that the location of the new plant in the Town of Mount Royal will offer strategic advantages, inasmuch as it borders Montreal where the head offices of the Canadian Marconi Company are situated in the Marconi Building. In addition it provides excellent rail shipping facilities at its very door.

▲

SCREEN-GRID NEUTRODYNE

Screen-grid neutrodyne, according to R. H. Langley, director of engineering of the Crosley Radio Corporation, is not just a name but means something. It is a new type of radio-frequency transformer incorporating several of the important patents held by the Hazeltine Corporation. It is particularly adapted to the screen-grid tube and has been developed through the engineers of the Crosley Radio Corporation and the Hazeltine Service Corporation.

This transformer involves an entirely new conception of the mechanism of transferring the signal from one tube to another. If the engineers had been content to base their development work on the usually accepted theory, they never would have produced this remarkable new device.

The concentrated primary which is placed outside the secondary rather than inside the secondary is one of the secrets that gives not only a greatly increased gain, but a degree of constancy of amplification over the entire broadcast frequency range.

Not only does this transformer produce much greater sensitivity in the set, but it also gives a correspondingly important increase in the selectivity. Here again the important departure from conventional design is the reason. This new radio-frequency transformer is by no means the most economical transformer to build, but the improved performance obtained and the mass production methods used in the Crosley plant offset this additional cost and give to the Crosley set a perfection of performance that cannot be obtained in any other way.

▲

R. C. A. TUBE LICENSES

The Perryman Electric Company, and the Cable Radio Tube Corporation, have been granted tube manufacturing licenses by the Radio Corporation of America.

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INSPECTION INSURES PHONOGRAPH SATISFACTION

Those radio manufacturers who have had experience in telephony have learned—perhaps better than most set makers—the value of frequent and thorough inspections. The reputation which Stromberg-Carlson Telephone Manufacturing Company enjoys for high-grade radio apparatus is due in no small measure to the careful inspection behind each item of material and construction that goes into the making of each of its sets. Many of the Company's radio inspectors are trained switchboard men and their careful training and telephone experience is of value to them.

In the case of the company's No. 654 radio-phonograph combination, inspection is particularly thorough as it must cover both radio and phonograph aspects. After mechanical, power, aligning and other tests are given the radio portion, the phonograph also receives rigid inspection. Chassis bolts are tried for tightness so that there will be no rattling or insecurity of parts. The tester ascertains by checking code numbers that parts designed for use together are so used. He sees that screws on the lid and door hinges are tight and that the lid and doors work without binding. He tries out the motor switch seeing that starting and stopping are instantaneous; he also switches the volume control key into the pickup position to see that it makes proper contact. Then the tester puts a stroboscopic disc on the turntable and rotates it to check speed. When the speed is properly adjusted, a record is played for ear test. He also plugs in the pickup jack and turns on the pickup switch when the pickup is disconnected to see that there is no troublesome hum. The phonograph volume control is rotated to see that a proper grading of volume is obtainable over the entire range.

▲

REDUCTIONS IN RADIO TUBE PRICES

Officials of the deForest Radio Company have announced reductions up to 35 per cent. in the list price of the most popular types of radio tubes, due to the perfection and operation of automatic high-speed production machinery. It is said that the new methods of producing radio tubes will, within a short time, mean a substantial saving to every one of the more than 10,000,000 owners of radio sets in the United States.

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STEINITE'S 1929 PRODUCTION CLEANED UP—BEGIN ON 1930-31 LINE

"Steinite is already under way with the production of its offerings for the 1930-31 radio year, and there is not a single receiver of the past season unsold or in stock."

That's the statement of Arthur T. Haugh, Steinite's vice-president and general manager, at the March meeting of the directors of the Radio Manufacturers' Association at Buffalo.

"We are well along with the coming season's production," said Mr. Haugh, "and already many of our jobbing friends have come to Ft. Wayne for a look and a talk."

▲

TRANSFORMER CORPORATION ENTERS SET FIELD

Word comes from E. J. Dykstra, general sales manager for the Transformer Corporation of America, that this company in addition to supplying many of the trade's outstanding receiver manufacturers with electrodynamic speakers, coils, chokes, etc., will launch a radio receiver—to be known as T. C. A. Radio—manufactured under license granted by Radio Corporation of America and associated companies.

▲

WIRE-WOUND RESISTORS

"Cresohm" is the name designating a new wire-wound resistance added to the line of resistors manufactured by the Cresradio Corporation, 106 Jamaica Ave., Jamaica, N. Y. These resistors possess several advantages, chief of which is the new enamel coating with which "Cresohms" are covered. This company went quite fully into the matter of vitreous enamels for coating resistors, developing a coating which is entirely neutral; that is neither basic nor acid and will not affect the fine resistance wire after many cycles of heating and cooling.

The well-known and standard Crescent Larite resistors also are manufactured by the Cresradio Corporation.

▲

R. E. SMILEY TO DIRECT KEN-RAD SALES

Richard E. Smiley, formerly vice-president in charge of sales of the Kremer-Tully Manufacturing Company, Chicago, counterphase radio sets, has been appointed sales manager of The Ken-Rad Corporation, Owensboro, Ky., manufacturer of Ken-Rad radio tubes. He was, at one time, assistant general sales manager of the Atwater Kent Manufacturing Company, Philadelphia.

▲

SCIENTIST JOINS NATIONAL UNION

Due to the formation of the new RCA Radiotron Co., Dr. Ralph E. Myers of East Orange, N. J., has been made available as chief engineer of the National Union Radio Corporation, 400 Madison Avenue, New York City, to whom RCA made a $2,000,000 loan.

Dr. Myers has been chief engineer in charge of research and development on lamps and radio tubes for the Westinghouse Lamp Company, Bloomfield, N. J., and was with Westinghouse for twenty-one years. He was one of the scientists who developed the 227 tube, was one of those developing the general line of oxide-coated filament tubes and has participated in the laboratory and actual manufacturing task of perfecting radio audition ever since the industry's earliest days.

Dr. Myers joins National Union Radio Corporation's board of directors as vice-president and chief engineer, according to E. A. Tracey, vice-president in charge of sales.

▲

CABLE RADIO AND TUBE CORPORATION

A letter from A. D. Strathy, director of sales, Cable Radio and Tube Corporation, Brooklyn, N. Y., reads, in part:

"I have just returned from a trip which I started the first week in January, during which I have been out on the Pacific coast and in most of the states west of Indiana.

"I have noticed all along the line that surplus merchandise which has been disposed of through so-called dumping methods, has been absorbed with remarkable celerity in most cases, and as things are taking shape at this moment I feel that the manufacturers of quality tubes are going to enjoy a banner year in 1930."

▲

SILVER-MARSHALL APPOINTMENT

C. W. Hunter, recent Pacific coast manager of Kellogg Radio, has been appointed to a position with Silver-Marshall, Inc., well-known Chicago manufacturers of Silver Radio and of the S-M line of radio parts.

Mr. Hunter, with headquarters in Los Angeles, is closely affiliated with the radio distributors and dealers of California, Oregon and Washington, and is unusually well equipped to manage the West coast interests of Silver-Marshall and to carry out their expansion program for the coming year.

▲

H. W. KADELL TRANSFERRED TO NEW YORK

H. W. Kabell, formerly of National Carbon Company's Research Laboratory in Cleveland, has been transferred to the Eveready Raytheon, tube division of National Carbon Company headquarters in New York City, attached as sales engineer in the Eveready Raytheon tube division of the general sales department.

Mr. KaDell will be responsible for contacts with set manufacturers, development of new uses of tubes, technical instructions for the organization, handling of technical inquiries on which the districts require help and all work of similar nature.

▲

ARTHUR T. HAUGH

Arthur T. Haugh, formerly president of the Radio Manufacturers' Association, has been elected vice-president in charge of merchandising of Valley Appliances, Inc., Rochester, N. Y. Mr. Haugh is well known in the radio and automobile fields.

▲

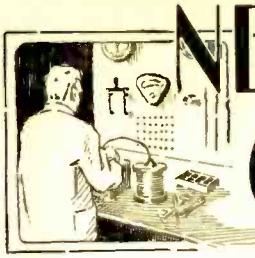
BOOK REVIEW

Principles of Radio Communication.

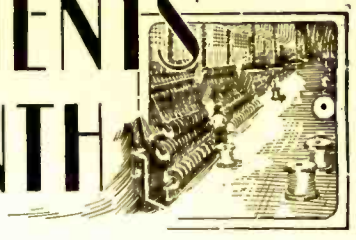
John H. Morecroft.

1001 pages, 9x6 inches. Cloth. Illustrated. Published by John Wiley & Sons, New York.

This is the revised edition of Professor Morecroft's book, first brought out in 1921. The book belongs in the library of every radio engineer who desires to have at hand a textbook that covers every phase of this subject. The chapters on vacuum tubes, amplifiers and filter circuits are replete with information of value to the laboratory as well as the practical engineer.

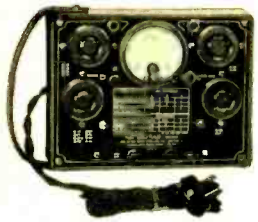


NEW DEVELOPMENTS OF THE MONTH



NEW A-C. TUBE CHECKER

The model "B" Day-Rad Tube Checker, recently developed by the Radio Products Co., Dayton, O., is applicable to tubes: 112, 199, 201A, 171, 226, 227, 210, 222, 224, 240, 245, 250, 280, 281, Kellogg and Cardon. It can be plugged into any 110-v. 60 cycle, a-c. source and is supplied with extra leads for special types. Table of readings is engraved on the panel. There are no rheostats to regulate. Tests both plates of type -80 rectifier tubes separately. It has a standard milliammeter, genuine D'Arsonval movement (either Jewell or Weston meter). It is housed in a moulded bakelite case with carrying strap.



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PILOT "A-C. SUPER-WASP" RECEIVER

A new screen-grid short-wave receiver, operating entirely on alternating current and known as the "A-C. Super-Wasp," has been brought out by the Pilot Radio & Tube Corporation, of Brooklyn, N. Y. It is said to be the first low-wave instrument possessing the advantages of full house-current operation, tuned screen-grid amplification and double shielding, features found heretofore only in regular broadcast receivers. The set is intended for home construction by the individual radio fan, all the parts being accurately drilled and supplied in kit form ready for assembly.

A special 27-type tube, designed particularly for use in the detector stage of the A-C. Super-Wasp and suitable for use in any other set requiring 27's, is also announced by the Pilot company. This tube was developed to meet the peculiar requirements of short-wave operation. The new tube, known as the Pilotron P-227, slides into oscillation as smoothly as a battery tube, its manufacturers claim, only a weak residual 60-cycle hum revealing the nature of the power supply. Even when a pair of sensitive earphones is used with the full two-stage audio system, the hum is so slight that the operator forgets it is present at all after he has listened for ten or fifteen minutes.

The A-C. Super-Wasp is supplied with five pairs of plug-in coils, giving it an unbroken wavelength range of 14 to 500 meters. Although designed primarily to be a short-wave receiver, it is also an excellent set for the regular broadcast band, the fifth pair of coils tuning from 200 to 500 meters. The components of the radio-frequency and the detector stages, respectively, are enclosed within aluminum shield cans, additional shielding against the detuning phenomenom of the operator's body being furnished by a metal front panel. The set is therefore free from the annoying "hand capacity" effects common to most short-wave receivers.

Because of the amplification afforded by the "tuned" screen-grid stage ("tuned" as distinguished from the resistance or choke-coil coupled stages used in all other screen-grid short-wave sets now on the market), the A-C. Super-Wasp is decidedly less critical in operation than previous receivers, and the reception of short-wave broadcasting stations is thus made more certain.

▲

STROMBERG-CARLSON PRESENTS NEW D-C. SCREEN-GRID CONSOLE

The new Stromberg-Carlson No. 645 is a radio receiver designed particularly to meet the special conditions where a set must operate on power from direct rather than the usual alternating-current sources.

This receiver—which is housed in a walnut finished art console—employs screen-grid tubes in three tuned radio-frequency circuits for selectivity; a grid-bias detector, two resistance-coupled audio stages and a final push-pull power audio stage.

UNUSUAL SHORT-WAVE RECEIVER APPEARS

A short-wave receiver that is as radical in appearance as it is in performance has just appeared on the market under the familiar trade-mark of the deForest Radio Company, of Passaic, N. J., This receiver, although approximately four times as sensitive as similar existing types, and possessed of four tubes, is enclosed in an aluminum case measuring only 5 by 6 by 8 inches. Furthermore, the tubes are all inside the case.

The new receiver although designed primarily for aircraft, police car, and motor-boat use, has been made available to the public, since its tuning range covers the band of popular interest. Through the use of four coils of the plug-in type, the receiver has a tuning range of from 20 to 200 meters. The coils are made of heavy enameled wire, wound on hard-rubber tubing. Tuning is accomplished by means of a single dial.

The receiver, known as the type HM-1, may be either storage battery operated or dry-cell operated. If used with a storage battery, a type –22, a type –01-A, and two types –12-A tubes, are required. If dry-cell operated, a 422-A and three type 499 deForest audions are necessary. Although small in size, the receiver incorporates all the necessary adjuncts to satisfactory short-wave reception, including the unusual item of some 5 microfarads of bypassing condensers.

▲

NEW SHIELDED LEAD-IN WIRE ELIMINATES INTERFERENCE

A shielded lead-in wire designed especially to eliminate man-made interference in radio reception is announced by the Belden Manufacturing Company, 4657 West Van Buren St., Chicago.

High tension lines, household refrigerators, oil burners, vacuum cleaners, electrically-operated phonographs, and a number of other electrically-operated devices interfere with radio reception. By the use

of this new shielded lead-in and ground wire interference can be reduced and frequently eliminated, it is said.

This shielded lead-in can be run right through a troublesome interference zone without harmful results because the shield grounds the interference. The wire consists of 7 strands of tinned copper with rubber insulation and an over-all sheath of finely woven tinned copper which acts as a shield. The tinned copper shield is easily grounded and the whole cable is flexible and easy to install.

▲

DUBILIER SCREEN-GRID DURATRAN

In addition to the Dubilier duratran or radio-frequency transformer which has been popular since 1923, the Dubilier Condenser Corporation, 342 Madison Ave., New York City, now announces the new Dubilier screen-grid duratran for those desiring to take advantage of the greatly increased amplification possible with present four-element tubes.

The Dubilier screen-grid duratran is in the form of a metal case with pig-tail leads for connections, and a shielded conductor with cap for the control grid of the screen-grid tube. All connections are plainly stamped on the case. This device serves as the coupling between successive stages of tuned radio-frequency amplification, in place of the usual coils with tuning condensers.

This device, which permits of building receivers without infringing on the various tuned r-f. circuit patents, is especially desirable for automobile and portable radio sets, since it reduces a receiver to the simplest proportions.

▲

THE ROAMIO

After an extensive investigation, the Crosley engineers decided that an automatic volume control is an essential feature on an automobile radio set due to the frequent changes in broadcast signal strength encountered on the highway. They have developed and incorporated in this set a new type of automatic volume control which does not require additional tubes and which almost entirely removes the necessity for adjusting the volume while tuning the set, even when the broadcast signals received vary over wide limits in strength.

The set, which the Crosley Company has named The ROAMIO, is controlled from the small panel mounted on the lower edge of the instrument board without the necessity for drilling any holes in the instrument board. It has an illuminated dial, a tuning knob, a volume level control knob, and a locking switch for the batteries so that no person without the key for the lock can operate the set.

The set employs five tubes, two -24's, two -27's and one -12A type, and these tubes are connected in series parallel in such a way as to accomodate them to the changing voltage of the automobile storage battery without any danger of filament burnout.

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A NEW HAND JOINTER

J. D. Wallace and Company, 134-158 South California Avenue, Chicago, Ill., has introduced a new Skew Knife cutterhead of improved design. This jointer cutterhead will find a wide use in the woodworking industries.

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ELECTRODYNAMIC SPEAKERS

In the last decade sound has become an increasingly important factor in many industries. In the first place radio has come to the front and surpassed anything ever hoped for in the early days. Then, sound has come into the domain of the formerly silent drama. No home is complete without a radio set. No movie house is complete without talking pictures.

To meet these changing conditions loudspeaker manufacturers had to make rapid strides. Years ago a manufacturer could make one type of good loudspeaker and it would work well with any of the radio sets on the market. Ability in a speaker to operate satisfactorily under extreme volume was unheard of. The function of a loudspeaker, with its associated amplifier, was to build up the weak signals arriving by way of an antenna.

Now that the powerful radio sets and amplifiers have made their debut and have been generally accepted, the speakers now have to be built to hold up under high power. Of course, for the home this volume is unnecessary and for this purpose Oxford speakers are made in the smaller sizes such as 9 inches and 11 inches. There is no less care exercized in engineering or building these speakers, but they are built to suit the job. In some of the more powerful sets 12½ inch Oxford speakers are used.

For powerful amplifier systems Oxford builds the auditorium and Jumbo series of speakers. The auditorium speakers have field coils of extra large size wire. All parts are oversize, though perfectly balanced with each other to withstand tremendous volume.

The Jumbo speaker, though measuring 15½ inches overall has a diaphragm which is perfectly controlled and is as sensitive as the 1⅝ inch mica diapbragms used in the old horn type speakers. It will respond to all frequencies with perfect accuracy. These speakers should only be used in theatres or in public-address systems.

Although Frank Reichmann, the designer of the Oxford electrodynamic speaker, has been working on the development of speakers since 1912, he believes the development in speakers in the last several years has been marvelous. The action of the large cone diaphragms and their response to the rapidly changing frequencies is far beyond the expectation of the early speaker engineers. However, it is hoped that the future will show still further advances in speaker design and the aim and entire purpose of Oxford engineers is to keep their speaker at the top of the art at all times.

ENGINEERING FACTS HAVE A UTILITY VALUE

GOOD DEMONSTRATIONS MAKE DIVIDENDS GROW

by GEORGE LEWIS

Vice President—Arcturus Radio Tube Company

Most radio sets look fine when they're shown at the factory. The demonstration is carefully planned and skilfully executed. Enthusiasm is natural. But the only demonstrations that bring in dividends are the demonstrations made on the dealer's floor —when cautious customers are carefully comparing the merits of different sets.

Realizing the importance of fool-proof set performance *at the point of sale,* critical engineers recommend Arcturus *Blue* Tubes.

They find that the 7-second action of Arcturus Tubes gets the demonstration away to a good start because it eliminates the usual embarrassing wait of 30 to 60 seconds.

They know that the clear, humless tone of Arcturus Tubes does away with outside noises.

And they have learned that Arcturus dependability insures satisfactory operation with the minimum of servicing after the sale is made.

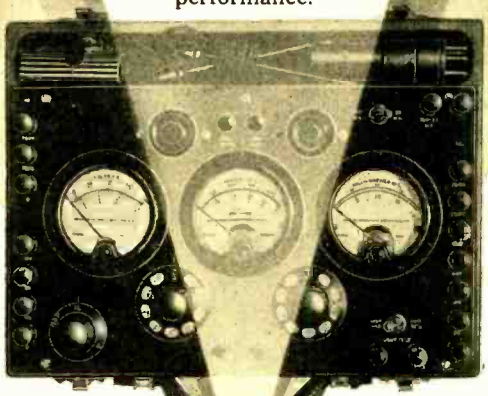
Your sets, too, will be "dividend demonstrators" with Arcturus Tubes in every socket. Check up on the possibilities of Arcturus Tubes today.

ARCTURUS RADIO TUBE COMPANY
Newark, N. J.

ARCTURUS
Quick Acting
RADIO TUBES

VALUABLE
Data Sheet Service furnished with the Weston Model 547 Radio Set Tester

With every Weston Radio Set Tester there is furnished a loose-leaf instruction book containing specific directions for servicing practically every make and model of receiver on the market. As designs are modified or new models introduced we mail to every registered purchaser of the Weston Model 547 Set Tester a data sheet of useful information, thus keeping your instruction book always up-to-date. These data sheets cover the servicing requirements of each receiver as authorized by the manufacturer—*based on the use of the Weston Set Tester*—thus insuring correct servicing and continuous, satisfactory set performance.



PLEASE THE SET OWNER

AND YOU PLEASE ALL

WESTON ELECTRICAL INSTRUMENT CORP.,
612 Frelinghuysen Ave. Newark, N. J.

Weston
PIONEERS SINCE 1888
INSTRUMENTS

SUPREME TUBE CHECKER

The Supreme Instruments Corporation of Greenwood, Miss., announces as a part of its line of testing equipment, a new tube checker, known as Model 17.

This instrument is equipped with a two scale Weston milliameter. It is said that its construction is particularly rugged, and measures have been employed that make it practically "fool-proof."

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GATES SOUND EQUIPMENT INSTALLATIONS

The Gates Radio and Supply Company, of Quincy, Ill., have installed complete double rack amplifier and speaker equipment in the United States Penitentiary at Atlanta, Georgia. This installation was decided upon by the Southern Penitentiary after a thorough inspection of the same type of installation which this concern installed in the United States Penitentiary at Leavenworth, Kansas, in October, 1929.

▲

NEW LATHES

The South Bend Lathe Works, South Bend, Indiana, have just announced a complete line of metric system precision lathes suitable for cutting a wide range of International and French metric standard threads, from .5 to 8 mm. pitch. These machines correspond in every way to the regular line of 1930 new model South Bend back geared screw cutting engine lathes, being of the same quality and made in 9-inch (235 mm.) to 18-inch (470 mm.) sizes, in a wide variety of styles.

The new lathes are equipped with metric thread precision lead screws, a metric gear box, and a metric thread spindle nose. Cross feed and compound rest screws are furnished with micrometer collars graduated for regulating depth of cut by hundredths of a millimeter.

▲

TRANSMITTING TUBES NOW MADE WITHOUT GETTER

Another of those radio dogmas, to the effect that transmitting tubes cannot be made with a getter or chemical clean-up, has been exploded by the DeForest engineering staff. Instead of using a chemical clean-up during pumping, these tube producers make use of a novel grid bombardment method which heats the grid to incandescence and drives out the imbedded gas. The result is a clear, "hard", entirely quiet tube.

At the Passaic, New Jersey plant, the DeForest engineers have installed the latest type of hand positions for evacuating transmitting tubes. The positions are in the form of compartments with screen doors. The doors must be closed before the high-voltage current is applied to the tubes. Below the tubes are the pumps and air traps. Above are the panels with the various electric, temperature and other meters. The bombarder is portable and may be applied to any tube on the racks. The baking ovens are mounted on pulleys and can be raised or lowered at will, in each position.

The DeForest transmitting audions now include all standard types from the 7½ watter to the 5-kilowatt water-cooled tube, with screen-grid, water-cooled, mercury-vapor rectifiers and other types, represented.

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LABORATORY OVEN

A new series of controlled heat, electric, laboratory ovens, with horizontal-flue forced air circulation, has been introduced by the Frear Thermo-Electric Company, 1206 South Grove street, Irvington, N. J. These ovens have the advantage of heat transfer by mechanical air movement in a design which permits the use of shelves and trays without obstructing its air circulation.

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EAGLE ELECTRIC MFG. COMPANY

The Eagle Electric Mfg. Company, Inc. of 59-79 Hall Street, Brooklyn, N. Y. announces a new commercial toaster element which can replace many elements in commercial toasters such as the Toastmaster. This element bears the same long life guarantee as all other types of elements manufactured by this company, made in 2.3, 2.6, 4.6 and 4.9 amperes to meet all requirements.

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VOLTAGE CONTROL

For completely connecting the radio receiver to the service power or light outlet, the X-L Radio Laboratories, 1224 Belmont Avenue, Chicago, are marketing the X-L Link, a compact unit which no doubt will find a wide use.

▲

AUTOMOBILE RESISTORS FOR RADIO-EQUIPPED CARS

The Allen-Bradley Company, 286 Greenfield Avenue, Milwaukee, Wisconsin, are producing automobile resistors for the suppression of interference from ignition systems in radio-equipped cars. These resistors, which are being used by several leading car manufacturers, are furnished to provide individual resistors for each spark plug and for the common cable to the distributor. These resistors increase the resistance of the high tension ignition system and minimize the disturbing oscilliations in the ignition circuit which interfere with the operation of a radio receiver in the car. When used with suitable by-pass condensers in other parts of the ignition circuit, the use of shielded ignition cables is avoided.

▲

WIRE-WOUND RESISTORS

The International Resistance Co., of 2006 Chestnut Street, Philadelphia, Penn., announces a line of precision, wire-wound resistors.

These resistors are non-inductively wound to provide for an accurate and stable resistor to be used as a voltmeter or milliameter multiplier for laboratory use or wherever non-inductive resistors wound to accuracies of ½ of 1% or 1% are required.

The resistors are made in all values of from 500 ohms to ½ megohms in the size shown, and can be provided in values even higher with slightly larger winding forms.

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RADIO RECEIVER FOR AUTOMOBILE

After a long period of research and experimentation, General Motors has announced a radio receiving set for automobiles together with complete plans for servicing and national distribution. The set has been called the Delco Automotive Radio and is manufactured by the Delco Radio Corporation at Dayton, Ohio. National sales and service are under the direction of United Motors Service with 27 branches and 3,000 authorized service stations.

The Delco Automotive Radio is a five-tube receiver, using three screen-grid tubes, and operated by remote control from the instrument panel. It can be installed without changing a single unit of the car.

Simplicity and neatness are features of the set, which is entirely out of sight beneath the car's cowl. Only three devices are to be found on the instrument panel—mounted in an attractive manner, at the right, where they do not interfere with the other instruments. They are a tuning dial, a volume control and a key switch. The tuning dial is connected to the set by a flexible cable and operates three variometers, all mounted on a single shaft.

In the Delco Automotive Radio, two tuned radio-frequency stages are used with –24 amplifier tubes, connected in series. A similar screen-grid tube is used as a detector. For audio frequency a -27 tube is used in the first stage and a –12-A in the second. A voltage regulator tube is employed to keep the voltage constant in spite of varying engine speeds or extra drain on the battery when the lights are turned on. This is an exclusive feature and prevents surging of volume, keeping the tone even under all conditions.

Interference from passing objects is offset by an automatic volume control to increase the amount of current when the car passes steel buildings or overhead wires, which normally would cause a reduction of received current.

Current is supplied by the car's storage battery and by four vertical type standard size 45-volt "B" batteries and one 22.5 volt "C" battery. The "B" batteries are carried in a specially-designed metal box placed under the floor boards and fully protected against mud and water. The "C" battery is conveniently located, depending on the type of car.

A conespeaker—found to give the best tone value and speech reproduction—is mounted on the dash, out of sight, and protected by a screen across its face.

Electrical interference from the ignition system has been guarded against by the use of specially-designed spark resistors on each plug and on the coil, and by by-pass condensers across the generator contacts and on the starting motor. These spark resistors are designed to prevent oscillations in the ignition circuit and have no effect on the running of the motor.

To protect the tubes against the jars and jolts of road shocks a special cushioning device is used and the dial is held secure in any position by a reduction gear. The antenna is concealed in the top of the car.

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NEW INGERSOLL-RAND AIR COMPRESSORS

Ingersoll-Rand Company announces a new line of air-cooled, two-stage air compressors, known as the Type 30. V-type belt drive is employed. Both motor and compressor have ball bearing.

The units are self-contained, the motor and compressor being mounted on a steel base, which is attached to the top of the air receiver. The latter, which is made of heavy pressed steel, is built to withstand a working pressure of 200 pounds. With this arrangement, no special foundation is required for correct alignment of the compressor and motor. The compressor is ready to operate as soon as the electrical connections to the motor have been made and the crankcase filled with oil.

The intercooler is located behind the fan-type flywheel, and a constant current of circulating air is driven directly across the cooling coils. This reduces the temperature of the discharge air.

Automatic start and stop control, furnished as standard equipment, operates independently, but in conjunction with the unloader. When the pressure in the air receiver reaches a point at which the regulator is set to unload, the motor is automatically shut off. A centrifugal governor allows the air in the high-pressure cylinder and intercooler to exhaust through the crankcase. This prevents the compressor from starting against a load.

Honed cylinders and two oil control rings reduce the oil in discharge air to a minimum. Each piston is run into its respective cylinder, insuring a perfect oil seal.

The base of the compressor unit forms a reservoir for the oil, and no oil pump is required. A bayonet gauge gives positive indication of the amount of oil in the reservoir.

A self-cleaning air cleaner keeps dirt out of the compressor and requires no attention. The compressor is entirely enclosed, and no dirt can get into it to wear out the working parts.

A balanced crankshaft, eliminates destructive vibration.

This improved two-stage design reduces power from 10 to 30 per cent. At the same time, less floor space is required.

It is built in four sizes: 3/4, 1½, 3, and 5 horsepower. All sizes are built for a working pressure up to 200 pounds continuous duty.

A free copy of bulletin 3060 can be obtained by addressing the Ingersoll-Rand Company, 11 Broadway, New York.

▲

A DIRECT READING RESISTANCE METER

A direct reading resistance meter is announced by the Jewell Electrical Instrument Company, which gives direct reading of resistance values in ohms when used in connection with a dry battery.

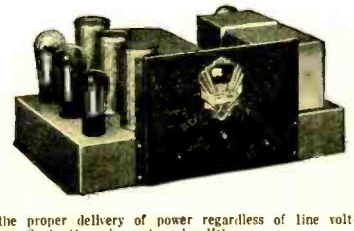
The Pattern 135 Ohmmeter, as this instrument is called, has a combination voltage and resistance scale. In the lower values of the resistance scale a division is provided every ten ohms. This instrument is furnished with a flange for mounting in a box or on a panel and is available in a number of ranges for use with both 3 and 4½ volt dry batteries. The 4½ volt instrument is designed especially for use with radio set analyzers, since this voltage is commonly used with them.

▲

NEW PIERCE-AIRO CHASSIS

Pierce-Airo, Inc., 113 Fourth Avenue, New York City, announce their new screen-grid chassis for the 1930-31 season. It will be known as model 724. It is a 7-tube set, 3 of which are screen-grid tubes.

The chassis is constructed of heavy gauge drawn and welded steel and the self-contained power supply is an integral part of the chassis. Provision is made for the regulation of line voltages to insure



the proper delivery of power regardless of line voltage fluctuations in various localities.

The tuning drum is illuminated from the rear; large type makes station reading easy. An automatic phonograph attachment is included in the chassis for use with phonograph pickup. The Pierce-Airo chassis fits any standard console.

THE PROOF OF THE TUBE

The proof of the tube is in the using. Tubes equipped with Gilby Selvage Mesh and Filament Wire have an added quality of superlative performance.

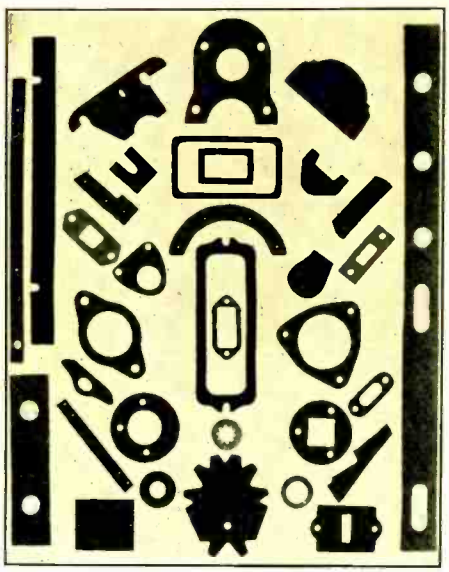
Gilby Selvage Mesh is the screen grid material with the solid even edges. Supplied accurately within .005 plus or minus as specified. Pending patent applications cover both this material and the tube of which it is a part.

Gilby Filament Wire has long been established as the Superior Product. Uniformity, Accuracy and Long Life are synonymous with Gilby. Look for the large diameter aluminum spool, — it's an original Gilby feature.

An opportunity to confer with you would be appreciated. Samples on request.

GILBY WIRE COMPANY
Wilbur B. Driver, President
NEWARK, NEW JERSEY

VERSATILITY OF FELT



THE largest manufacturers of felt in the world can supply you with cut parts to meet any specification.

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

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

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☐ Have your representative call.

Name.....

Address.....

.....

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF RADIO ENGINEERING.

Published monthly at Albany, N. Y., for April 1, 1930.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24th, 1912, embodied in section 411, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York; Editor, Donald McNichol, Roselle, N. J.; managing editor, F. Walen, Jersey City, N. J.; Business Manager, B. S. Davis, Scarsdale, N. Y. 2. That the owners are: B. S. Davis, Scarsdale, N. Y.; Roy T. Atwood, Albany, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me this 1st day of April, 1930.
(Seal) J. A. WALKER, Notary Public.

Kings County.
Kings Co., Clerk's No. 363.
Kings Co., Registers No. 1062.
New York Co., Clerk's No. 167.
New York Co., Registers No. 1W177.
Commission expires March 30. 1931.

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 80.

ADAPTERS:
Lynch, Arthur H., Inc.

ALUMINUM:
Aluminum Co. of America
Fairmont Aluminum Co.

ALUMINUM, SHEET:
Fairmont Aluminum Co.

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

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

ANTENNAE, LAMP SOCKET:
Dubilier Condenser Corp.
Electrad, Inc.

ARRESTERS, LIGHTNING:
Jewell Elec. Inst. Co.

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

BASES, VACUUM TUBE:
(See Tube Parts)

BEARINGS, RADIALL:
Chicago Gear Works

BINDING POSTS:
General Radio Co.

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

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

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

BUTTS:
Scovill Mfg. Co.

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

CASTINGS:
Fairmont Aluminum Co.

CELLS, PHOTOELECTRIC:
National Carbon Co., Inc.

CEMENT, LOUD SPEAKER:
Maas & Waldstein Co.

CENTRALIZED RADIO SYSTEMS:
Samson Elec. Co.

CHASSES
Aluminum Co. of America
Metal Specialty Co.

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

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

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

CLAMPS, GROUND:
Scovill Mfg. Co.

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

CLOTH, WIRE:
(See Wire Cloth)

COIL FORMS:
General Radio Co.

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

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

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

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

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

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

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

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

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

CONDENSERS, ELECTROLYTIC:
Aerovox Wireless Corp.
Amrad Corporation
Sprague Specialties Co.

CONDENSERS, FILTER:
Acme Wire Co.
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
Sprague Specialties Co.

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

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

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

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

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

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

CONNECTORS:
Cornish Wire Co.
Scovill Mfg. Co.

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

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

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

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

COPPER:
Scovill Mfg. Co.

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

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

CUSHIONS, SPEAKERS:
Western Felt Co.

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

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

DIE-CASTINGS:
Allied Die-Casting Corp.

DIES:
Willor Mfg. Corp.

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

DYNAMOTORS:
Electric Specialty Co.

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

EXPORT:
Ad. Auriema, Inc.

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

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

FILAMENTS:
(See Tube Parts)

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

FOIL:
Aluminum Co. of America

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

GEARS:
Chicago Gear Works

GENERATORS:
Electric Specialty Co.
Janette Mfg. Co.

GETTER MATERIAL:
(See Tube Parts)

GRID LEAKS:
(See Resistances, Fixed)

HEADPHONES:
Amplion Co. of Amer.

HINGES:
Scovill Mfg. Co.

HORNS:
Amplion Co. of Amer.

INDUCTANCES, TRANSMITTING:
General Radio Co.

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

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

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

INSULATION, REFRACTORY:
The Stupakoff Labs.

INSULATION, VARNISHED:
Acme Wire Co.

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

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

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

LACQUER, WOOD:
Maas & Waldstein Co.

LACQUER, METAL:
Maas & Waldstein Co.

LACQUER, ENAMEL:
Maas & Waldstein Co.

LAMINATIONS:
Lamination Stamping Co.
Willor Mfg. Corp.

LAMPS, MINIATURE:
National Carbon Co., Inc.

LAMPS, PANEL:
National Carbon Co., Inc.

LEAD-INS:
Electrad, Inc.

LOCK WASHERS:
Shakeproof Lock Washer Co.

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

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

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

MAGNESIA, TUBES:
The Stupakoff Labs.

MAGNESIUM:
Aluminum Co. of America.

METAL RADIO PARTS:
The Metal Specialty Co.

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

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

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

MOLDING MATERIALS
(See Insulation, Moulded)

MOTORS:
Electric Specialty Co.

MOTOR-GENERATORS:
Electric Specialty Co.

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

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

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

NUTS:
Shakeproof Lock Washer Co.

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

OSCILLOGRAPH:
General Radio Co.

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

PACKING MATERIAL:
Holed-Tite Packing, Inc.

PANELS, COMPOSITION:
(See Insulation, Moulded)

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

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

PAPER, CONE SPEAKER:
Seymour Co.

PHONOGRAPH MOTORS:
(See Motors)

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

PHOTOELECTRIC CELLS:
(See Cells)

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

PLATES, OUTLET:
Carter Radio Co.
Howard B. Jones

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

PORCELAIN TUBING:
The Stupakoff Labs.

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

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

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

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

POWER UNITS, PARTS FOR:
Acme Wire Co.
American Transformer Co.
Dongan Elec. Mfg. Co.
Ferranti, Inc.
General Radio Co.
Jefferson Electric Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Thordarson Electric Mfg. Co.
Transformer Co. of Amer.

PRESSED METAL PARTS:
The Metal Specialty Co.

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

PULLEYS:
Chicago Gear Works

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

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

PUNCHINGS, BAKELITE:
Electrical Insulation Corp.

RECEPTACLES, WALL:
Carter Radio Co

REFRACTORY SPECIALTIES:
The Stupakoff Labs.

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

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

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

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

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

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

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

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

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

SEALING COMPOUNDS:
Candy & Co.
Cochrane Chemical Company

SELECTOR, SOUND CONTROL:
SAF Elec. Equipment Co.

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

SHIELDS, TUBE:
Carter Radio Co.

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

SOCKETS, TUBE:
Electrical Insulation Corp.
Frost, Herbert H.
General Radio Co.
Howard B. Jones
Lynch, Arthur H., Inc.

SOLDER:
Amplion Corp. of Amer.
Kester Solder Co.
Jensen Radio Mfg. Co.

SPAGHETTI:
(See Wire, Spaghetti).

SPEAKER PARTS, METAL:
The Metal Specialty Co.

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

SPROCKETS:
Chicago Gear Works

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

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

SWITCHES:
Electrad, Inc.

TABLES, STEEL WORK:
Angle Steel Stool Co.

TAPE, COIL:
Johnson and Johnson

TAPE, INDUSTRIAL:
Johnson and Johnson

TAPE, LOUD SPEAKER:
Johnson and Johnson

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

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

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

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

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

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

TESTING LABORATORIES:
Electrical Testing Labs.

TIN COATED METAL:
Baltimore Brass Co.

TOOLS:
Willor Mfg. Corp.

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

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

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

TRANSFORMER CASES, METAL:
Metal Specialty Co.

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

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

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

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

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

TUBE MACHINERY:
See (Machinery, Tube.)

TUBE, PACKING:
Holed-Tite Packing, Inc.

TUBE PARTS:
American Electro Metal Corp.
Buffalo Wire Works Co., Inc.
Callite Products Co., Inc.
Cleveland Wire Cloth & Mfg. Co.
Fansteel Products Co., Inc.
General Plastics, Inc.
Gilby Wire Co.
Goat Radio Tube Parts Inc.
Lepel High Freq. Labs.
Nat'l.-Harris Wire Co.
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
Marvin Radio Tube Corp.
National Carbon Co., Inc.
National Union Radio Corp.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.

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

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

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

TUBING, NICKEL:
National-Harris Wire Co.

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

TUBING, VARNISHED:
Alpha Wire Corp.

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

UNIVERSAL JOINTS:
Chicago Gear Works

VARNISH:
Maas & Waldstein Co.

VOLTAGE REGULATORS:
(See Regulators)

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

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

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

WAXES, IMPREGNATING:
Candy and Co.
Cochrane Chemical Company

WAXES, INSULATING:
Candy and Co.
Cochrane Chemical Company

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

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

WIRE BALLAST:
National-Harris Wire Co.

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

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

WIRE, COTTON COVERED:
Acme Wire Co.
Anaconda Wire & Cable Co.
Alpha Wire Corp.
Driver-Harris Company
Dudlo Mfg. Corp.
Polymet Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

WIRE, ENAMELED COPPER:
Acme Wire Co.
Alpha Wire Corp.
Anaconda Wire & Cable Co.
Cornish Wire Co.
Driver-Harris Company
Dudlo Mfg. Corp.
Polymet Mfg. Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

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

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

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

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

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

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

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

WIRE, SILK COVERED:
Acme Wire Co.
Alpha Wire Corp.
Anaconda Wire & Cable Co.
Cornish Wire Co.
Driver-Harris Company
Radio Wire Corp.
Roebling, J. A., Sons Co.
Rome Wire Co.

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

ZINC:
St. Joseph Lead Co.

4th RMA Trade Show

ATLANTIC CITY AUDITORIUM

JUNE 2 to 6th

EVERYBODY WILL BE THERE

EVERY branch of the radio industry will be represented in Atlantic City during the week of June 2nd to 6th. It will be the largest gathering of radio men in the history of the industry for during the same week as the Trade Show, the Sixth Annual R.M.A. Convention, the National Federation of Radio Associations, the Radio Wholesalers Association, and the Institute of Radio Engineers will convene in Atlantic City.

Many important subjects of vital interest to everyone in the industry, particularly dealers and jobbers, will be discussed in the light of the industry's present condition and future prospects.

The latest receiving set models and accessories will be displayed and demonstrated under one roof, making it easy for the trade to see what the manufacturers offer for the coming season.

Atlantic City abounds in first class hotels. Visitors to the Trade Show can be assured that an average of $10.00 per day will cover living expenses. All railroads are offering special fare and one-half rates for the round trip to Atlantic City.

Make your hotel reservations through the Atlantic City Convention Bureau, Atlantic City, N. J. Invitation credentials for the Trade Show will be mailed to the trade about May 1st.

RADIO MANUFACTURERS' ASSOCIATION TRADE SHOW

Times Bldg. **Room 1904** **New York**

Under Direction of U. J. Hermann and G. Clayton Irwin, Jr.

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Variable Voltage Testing Transformer

YOU will prevent countless and costly mistakes by placing one or more (depending upon your volume) of these remarkable Variable Voltage Testing Transformers in your laboratory. When certain voltages are required in electrical devices this new Dongan development assures instant and certain results.

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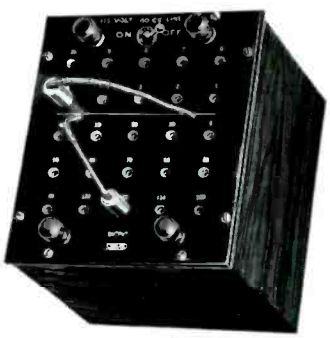
This new Transformer—No. 4612—is beautifully mounted in polished walnut case with engraved bakelite panel. Size of case 7⅜" x 6¼" x 7". Shipping weight 14½ lbs. You may have complete information from our laboratories—engineering data and diagram.



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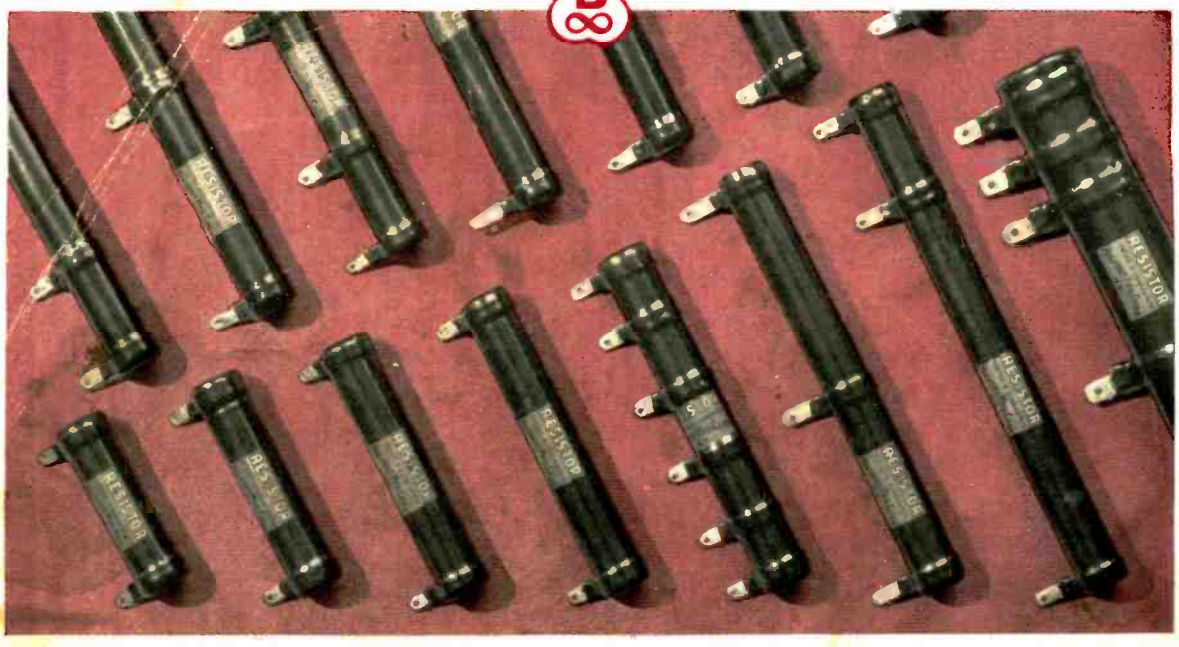

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