Ninth Year of Service

RADIO ENGINEERING

Vol. IX AUGUST 1929 No. 8

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Sold only by subscription
$2.00 per year

The Journal of the Radio Industry

The aim of every far-sighted manufacturer

"A better product for less money"

But production managers of factories doing a capacity business have little time for experimental work even though changes or improvements in their products seem advisable.

To these busy executives we can render valuable assistance through our Service Engineering Department.

The duty of this staff of chemists and engineers is to determine whether or not Phenolite will facilitate the manufacture or sale of your products, and exactly what grade is best suited to your requirements. A letter putting it up to us will bring immediate action.

PHENOLITE

Reg. U.S. Pat. Off.

Laminated BAKELITE

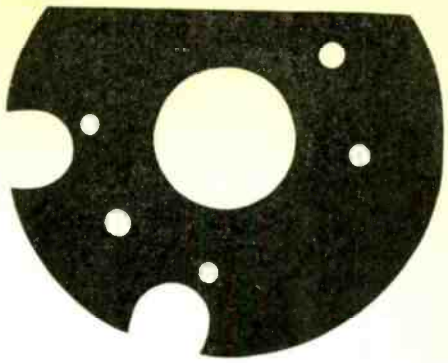
SHEETS : RODS : TUBES : SPECIAL SHAPES

After experimenting with many materials, Grade O, Canvas Base, Phenollte was selected for this bushing because of its perfect machining qualities, high tensile and dielectric strength, and because of its immunity to deterioration from heat, water or oil. No other material could answer the requirements of this part as perfectly as Phenollte.

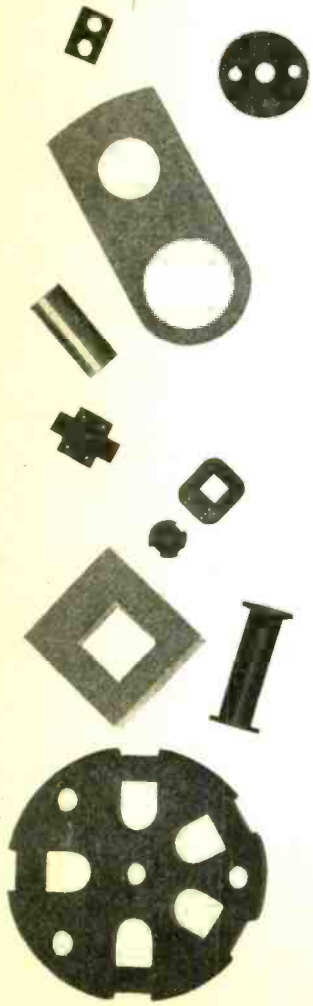
NATIONAL VULCANIZED FIBRE CO., Wilmington, Del., U.S.A.

Offices in Principal Cities

BIG PRODUCTION OF



RADIO INSULATING PARTS



THE production of insulating parts for radio receivers is now getting into full swing at the Formica plant.

A large, new sheet press, several new tube machines and presses, and important additions to the machining equipment have been made since last year to enable Formica to keep up with the very large demands the trade is making on the Formica factory.

This large and always growing equipment makes it possible for Formica to give manufacturers the best of service - - - and a uniform and thoroughly efficient material.

Send your blue prints for quotations

THE FORMICA INSULATION COMPANY
4626 Spring Grove Avenue Cincinnati, Ohio

FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

RADIO ENGINEERING

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Association Activity Vital To Business Success

By M. F. FLANAGAN
Executive Secretary R. M. A.

ONE of the surest measuring rods of the solidity of purpose and growth of the Radio Manufacturers Association is the record of attendance and the interest in the Annual Trade Show and Convention held in Chicago each year.

In the building of this monument to the art of radio full credit must be awarded to the unselfish cooperation and forethought of our members, who have contributed invaluable experience from practically every branch of the industry, as well as to the efforts of our Board of Directors who have taken time from their affairs to promote the welfare of the industry as a whole.

The example which our members and directors have set establishes a goal toward which the jobbing and retail divisions of radio may well head for.

The success with which the R. M. A. has met can be duplicated by the coordination of effort within its sister associations. formed for the advancement of these two vital factors in the sale of radio merchandise.

The day has faded into history when individual effort can expect a satisfactory degree of accomplishment in business. The R. M. A. furnishes striking proof of this.

This same type of spirit constructively directed through the existing jobbing and retail association channels would undoubtedly result in a coordination that would go a long way toward relief and improvement of the double-edged problems of distribution, sales overhead and trade practices.

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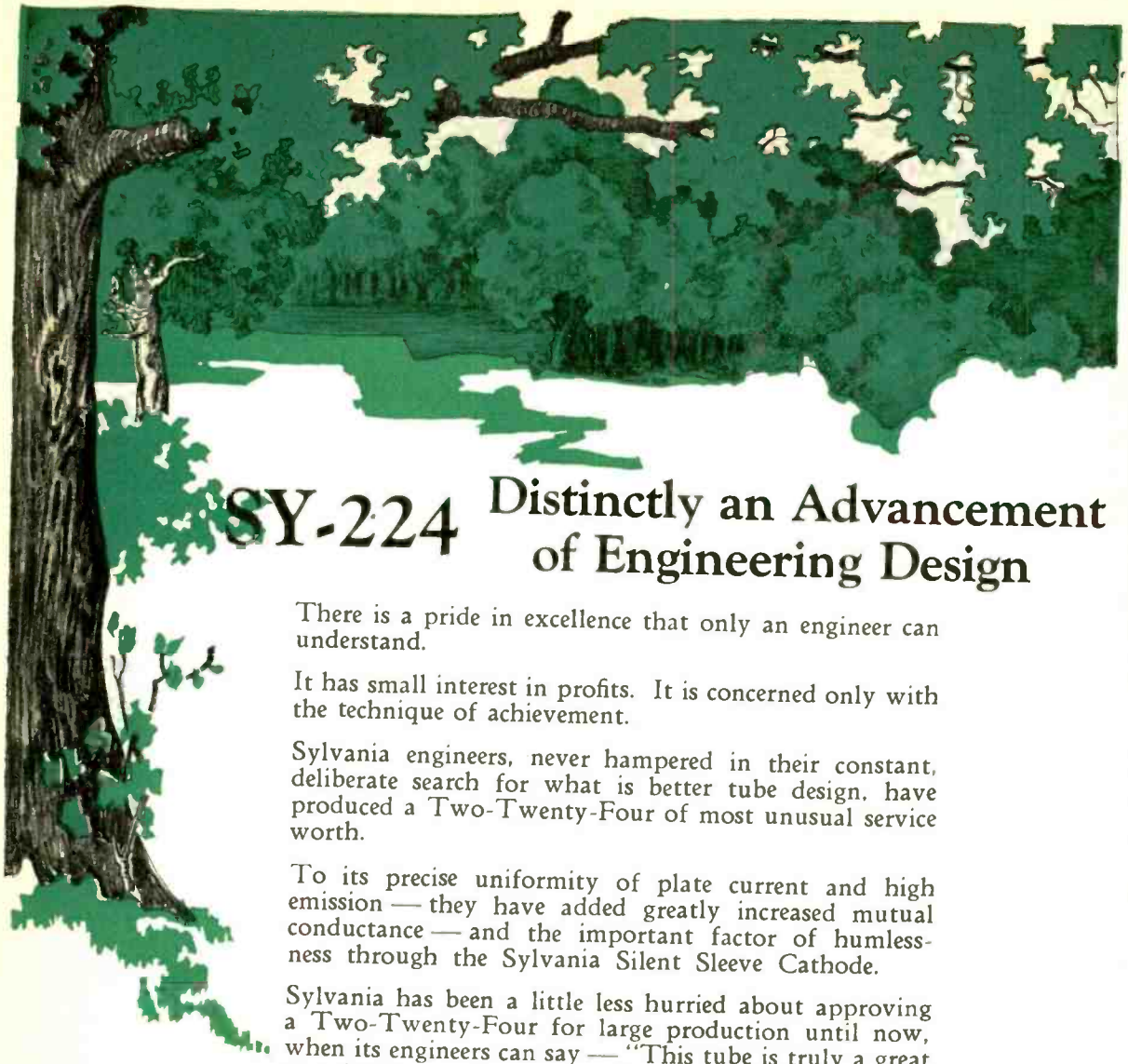


SY-224 Distinctly an Advancement of Engineering Design

There is a pride in excellence that only an engineer can understand.

It has small interest in profits. It is concerned only with the technique of achievement.

Sylvania engineers, never hampered in their constant, deliberate search for what is better tube design, have produced a Two-Twenty-Four of most unusual service worth.

To its precise uniformity of plate current and high emission — they have added greatly increased mutual conductance — and the important factor of humlessness through the Sylvania Silent Sleeve Cathode.

Sylvania has been a little less hurried about approving a Two-Twenty-Four for large production until now, when its engineers can say — "This tube is truly a great contribution to the screen grid circuit."

MEMBER RMA

SYLVANIA PRODUCTS COMPANY
Emporium, Pennsylvania

Sylvania RADIO TUBES

Licensed Under RCA Patents

Glad to Send You Technical Details— Please Use the Coupon!

RE-8-29

W. R. Jones, R. E.
Sales Engineering Division
Sylvania Products Co.
Emporium, Penna.

Please send me bulletins showing characteristics of your humless 224. Also bulletins on the following other types:

Name .....
Company .....
Position .....
Address .....
City and State .....

EDITORIAL

August 1929

PRODUCTION

THE story of Production is one of great interest. In reveals, above all other things, the indomitable spirit and the ingenuity characteristic of the American people.

Production, as we know it today, came into being during the serious Post War decline in business. The World War had a direct influence on the psychology of the people of this country who, sensing a period of depression, saw fit to conserve what capital they had. The public was in no buying mood and in consequence every line of business suffered extreme declines.

The matter became so serious that business heads were forced to devise ways and means of stimulating the public into buying their merchandise. Under the circumstances, the only possible relief lay in the direction of artificial stimulus and there grew, out of the combined efforts of merchandising geniuses, what is known today as installment buying.

This period of readjustment brought forth the first instance of combative psychology in American Industry; the creation of a new state of mind to offset the ultra-conservative attitude set by the public. The effectiveness of this combative psychology is apparent. It has proven beyond a doubt that the shape and character of mass thought can be the most destructive or the most creative element in life.

This idea of "pay as you go along" took such a strenuous hold on the mass mind that business in practically all branches not only regained the normal level but far exceeded the most extreme expectations. The attendant industrial prosperity reflected back to the public, as it does invariably, and the per capita wealth started increasing.

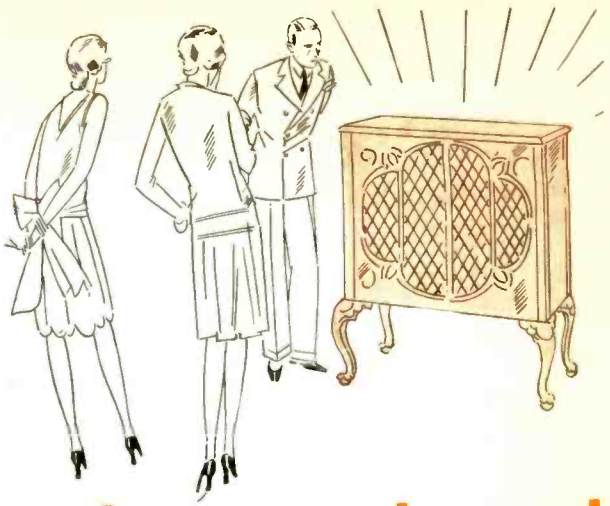
This very circle of events, together with the necessity of producing in larger quantities to meet a steadily-growing demand in all fields, was the conception of Production, a mind-element still in its infancy. Basically, this newly conceived element means the ever-increasing rapidity in the circulation of money, brought about by the manufacture and sale of merchandise in ever-increasing quantities. Theoretically, there is no limit, no saturation point, outside of mass thought, to flatten out the sales curve in an industry. So long as the public is receptive and so long as research brings forth improvements, the old will vanish so rapidly in face of the new that no point of saturation is reached.

This statement is, in many ways, contradictory to open opinions, and one can always select, as proof of the existence of saturation in an industry, the instance of the automobile. It is said that the sales curve has flattened and consequently car manufacturers are developing foreign trade. The building up of foreign trade, however, has little to do with the question of saturation in domestic trade. It is coupled with two other factors, the force of competition, interlinked with a continual increase in production. From this point of view, the saturation point in world trade will eventually be reached . . . and then what?

When more is learned of Production—when manufacturing procedure has become highly standardized, the cost of retooling a factory will not run into an enormous figure, and where we now have seasonal offerings, we may well, in the future, have bi-seasonal, even tri-seasonal offerings. It is a reasonable idea, and desirable, providing prices can be continually reduced . . . and quantity production allows for just that.

The radio industry has only commenced to swing into the "high production" strata. Our industry is in a better position to learn more and accomplish more in this strata than those industries that have paved the way. Furthermore, the radio industry has behind it what is probably the richest vein of potentially marketable devices and the richest field of potential discoveries. If sufficient thought is given to the *technique* of production control, radio may, one day, top the list of major industries.

M. L. MUHLEMAN, *Editor.*



Beautiful . . . but inarticulate

Radio sets may be cleverly engineered . . . they may look like a million dollars. But, unless hooked up to the best speaker unit their performance is not in keeping. For radio sets are sold on sound.

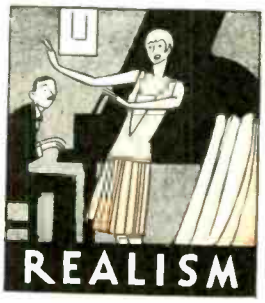
Today radio buyers are more speaker critical than ever before.

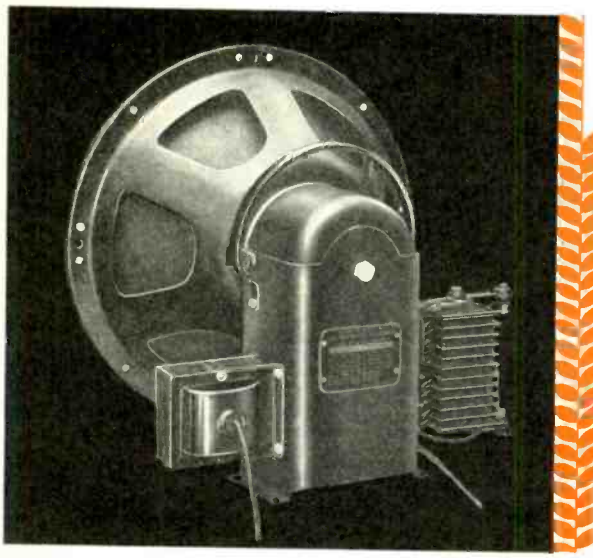
The speaker that sells sets is free from rattle and AC hum . . . gives depth to every tone and definition to every instrument . . . and can be guaranteed for a lifetime. That speaker is the New Magnavox X-Core Dynamic.

MAGNAVOX

Add to these qualities: assurance of deliveries, patent protection, elimination of most of your service troubles, and the prestige of the Magnavox name.

Why not insure your sales and profits with us?





THE MAGNAVOX COMPANY

Factory and Pacific Sales: OAKLAND, CALIF.
Factory and Sales East of the Rockies: CHICAGO, ILL.

Models 401, 403 and 405
12¼" high, 12" wide, 8¼" deep
10½" cone

Models 107, 109 and 201
12¼" high, 12" wide, 8¼" deep
10½" cone

X-CORE DYNAMIC SPEAKER

TRĪAD INSURANCE.

sells more tubes...protects your profits

Tube insurance — a radically new Trīad sales idea! A printed guarantee of six months' perfect service — or a satisfactory adjustment made — with every Trīad Tube. Now — for the first time the dealer can be *sure* of greater tube sales and profit protection!

When a tube is backed by a printed certificate guaranteeing six months of perfect service, *it must be good!* Tube purchasers realize it — that's the reason for the tremendous popularity of Trīad. And that's why dealers are winning greater sales with Trīad than they have ever enjoyed before. But that's only the first step — Trīad does *more than that* for the dealer — it *protects the profits he has won.* The insured certificate assures him and his customer of absolute satisfaction should an adjustment be necessary. He retains every cent of profit that he has made in the sale! No wonder dealers are enthusiastic about this line. For sales, satisfaction and protected profits, it will pay *you* to stock Triad!

Unique triangular Trīad carton. Builds up into a striking attention-getting display. Use Triad cartons in your windows and on your counter to link up with Trīad national magazine, newspaper and radio advertising.

Call your Jobber or write us for complete Triad dealer information

TRĪAD MANUFACTURING CO., Inc.
Triad Building Blackstone, Middle and Fountain Sts.
PAWTUCKET, R. I.

Tune in on the "TRIADORS"—every Friday evening 8 to 8:30 Eastern Daylight Time—on WJZ and associated NBC Stations.

THREE OF A KIND

that beat everything!

The Three New Plants of

POLYMET

(*Ace of Hearts*)—COILTON DIVISION, Easton, Pa., the home of Poly-Coils.

(*Ace of Spades*)—NEW YORK PLANT, 829-839 East 134th St. — where Polymet Condensers and Resistances are made.

(*Ace of Diamonds*)—STRAND & SWEET DIVISION—Winsted, Conn.—where Polymet enameled magnet wire is manufactured.

We Preach— Quality, Service, Dependability —and Practice it.

The Seal of good radio set essentials

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

POLYMET PRODUCTS

NO TENDERFEET HERE!

The technique of radio tube production is no schoolboy's exercise, to be learned in a day, a week, or a year. ¶It takes the knowledge so painstakingly learned over a period of years from the incandescent lamp, properly attuned to the newer concepts of physics, chemistry and radio science. ¶To this must be added the most modern equipment, the finest obtainable materials, the organization necessary to combine all smoothly. Satisfy all these requirements and you have the **"SPEED"** Radio Tube. ¶**"SPEED"** dealers have the best proposition in the field. The reason—¶They have implicit confidence in the complete line of **"SPEED"** tubes—tests for volume, clarity, long-life, quicker-heating, bear them out. ¶They have implicit confidence in the **"SPEED"** organization—J. J. Steinharter, J. J. Grossman, Fred Guinther,—all pioneers from lamp days and making radio tubes since 1924. ¶And, when the product is right, the sales and resales are right and the profits take care of themselves. ¶Think it over. Write us—It will pay you.

CABLE RADIO TUBE CORPORATION

(Formerly Cable Supply Co.)
84-90 North Ninth Street
Brooklyn, N. Y.

224 A. C.
Developed by Cable
in 1928

MAKERS OF RADIO TUBES SINCE 1924

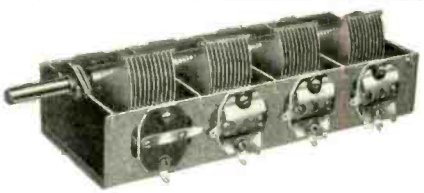
When the *Rada* Drums Boom

In Haiti, magic island, the beating of the rada drums summons the natives to religious ceremonies. Voodooism, the ancient ritual of the Congo, is practised and sacrifices are made to Papa Legba, the benevolent; Damballa Oyeddo, wise and powerful; and to Ogoun Badagris, the bloody dreadful one whose voice was thunder.

Here the priest makes the ouanga packet or charm. A hair from the central crown of the victim's head . . . a paring from the right thumb nail . . . a small square cut from a shirt worn next to the skin. Muttered incantations and cabalistic rites. Marked for death by the voodoo curse, the victim died. Or perhaps it is a benevolent ouanga, for better health or success in business. Black magic, and the faith of the black man is deep.

There is no secret charm for the radio manufacturer in this day of new developments. Only by purchasing equipment that will meet the most exacting demands can he survive a highly competitive market.

Scovill condensers and radio parts are manufactured in accordance with the latest and most efficient scientific developments, and Scovill service insures satisfaction.



Every step in the manufacture of Scovill condensers is under strict laboratory supervision.

SCOVILL

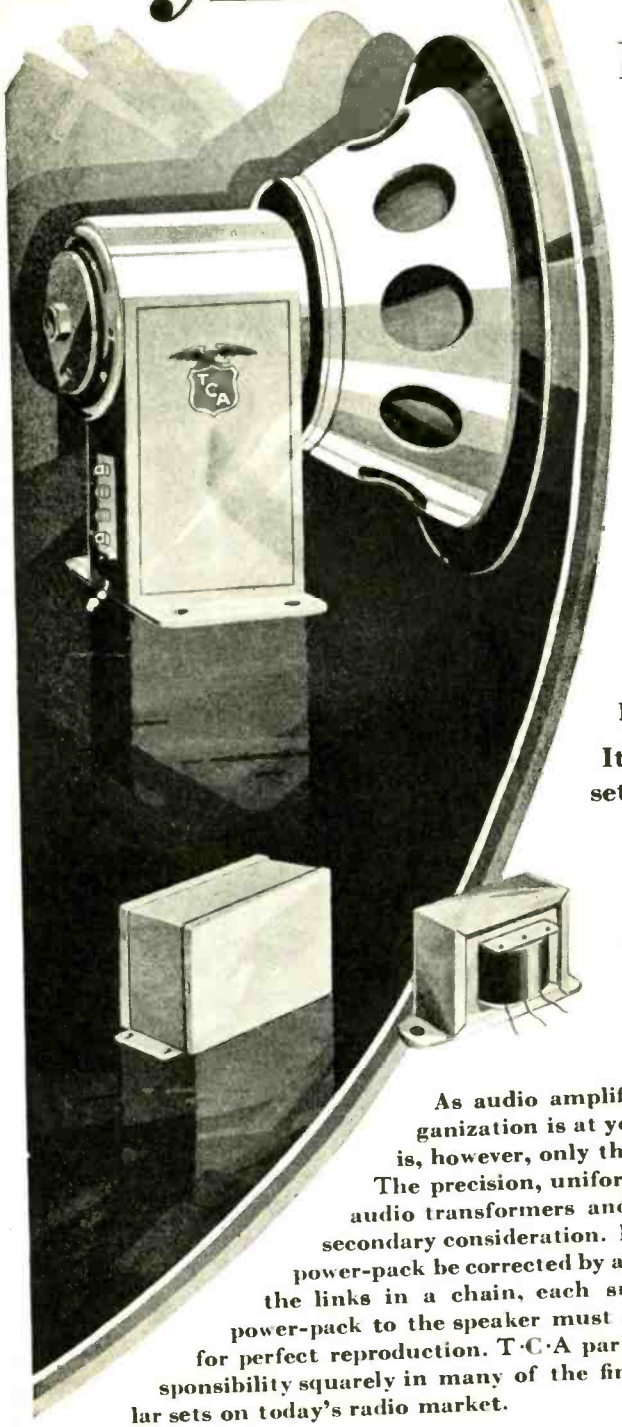
MANUFACTURING COMPANY

WATERBURY, CONNECTICUT

MEMBER COPPER & BRASS RESEARCH ASSOCIATION

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

will *you* trust your ears?



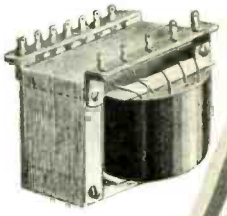
By the only standard which gauges sales success — *the ears of the purchaser* — the T·C·A Dynamic is a better speaker.

T·C·A's claim for superiority does not hang on the slender thread of a detail here or a detail there. It does not hang on an obscure characteristic of only academic interest.

It hangs on a definite and perfectly apparent *tone value* that impresses itself not only upon the critical ear of the engineer, but upon the unpracticed ear of the ultimate layman who buys the set.

After all, the most important function of a speaker is to *faithfully* reproduce the broadcast program.

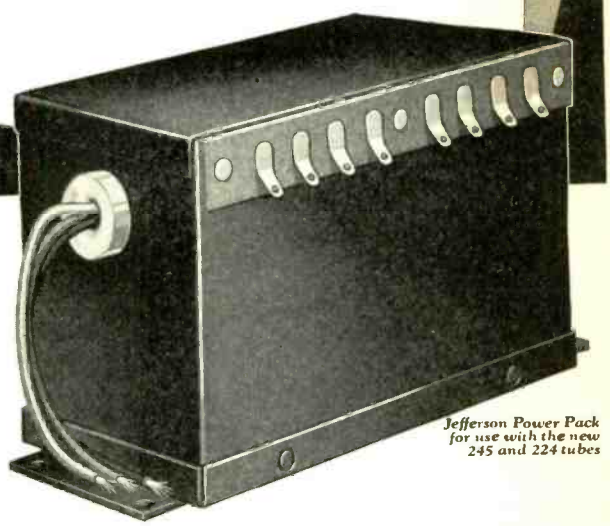
It is this characteristic that sells the set and pays the dividends.



As audio amplification specialists, the T·C·A organization is at your service. The T·C·A Dynamic is, however, only the final step in the audio series. The precision, uniformity and tone quality of the audio transformers and chokes are by no means a secondary consideration. Nor can a noisy, humming power-pack be corrected by any companion parts. Like the links in a chain, each successive unit from the power-pack to the speaker must carry the responsibility for perfect reproduction. T·C·A parts are meeting this responsibility squarely in many of the finest and most popular sets on today's radio market.

TRANSFORMER CORPORATION OF AMERICA
2301-2319 South Keeler Avenue, CHICAGO, ILLINOIS
SALES OFFICES IN PRINCIPAL CITIES

You Must Keep Up with Competition in Quality... in Price...



Jefferson Power Pack for use with the new 245 and 224 tubes

EVEN though you are "all set" on your present set models, you are thinking of next season, knowing full well that each year you must produce a better set, embodying the latest developments.

Your job was comparatively easy when you could develop without regard to price, but competition has decreed a low price today and the mass public buys the best set at the lowest price. Thus today, your job is doubly hard, for you must design that better set at a lower price.

Jefferson stands ready to help you with your transformer problems, offering you the benefits of the highest degree of specialization at attractive prices.

In our large well-equipped laboratories, Jefferson engineers are continually working on amplification problems for manufacturers of many of the most popular receiving sets on the market.

Whether you desire audio, output, power-transformers or chokes, let us help you solve your problems.

JEFFERSON ELECTRIC COMPANY
1592 South Laflin Street Chicago, Illinois

Your Transformer Problems made Easy by Jefferson Experience

The long experience of Jefferson Engineers enable them to keep a step ahead of transformer demand—to develop transformers in advance of the requirements of set manufacturers.

For example, Jefferson Transformers, Choke Units, etc., for use with the new power tubes 224 and 245 have been fully perfected, your problems already solved. Thus the use of Jefferson not only help you reduce development costs but assures tried and tested transformers for every requirement.

JEFFERSON

AUDIO and POWER TRANSFORMERS and CHOKES

(9484)

INSPECTION

the cue to quality

YOUR PRODUCTS must earn the right to markets which each year are becoming more critical of QUALITY. New models and price reductions will continue to court favor with consumer interest only so long as quality and dependable service are maintained.

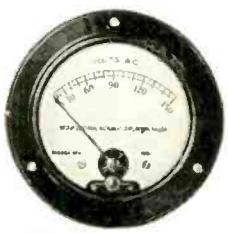
The benefits of mass production are cumulative when machine speeds are efficiently regulated, processes carefully controlled and progressive operations accurately checked. Otherwise, wastes quickly multiply, rejections become excessive and production losses vitiate profits.

Checking the manufacture of the product, step by step, with frequent inspections is not only the cue to quality, but the best means of accelerating production, improving deliveries and keeping pace with sales demand.

Manufacturers of radio receivers, tubes and other electrical equipment have told our representatives without reservation that they could not possibly maintain the speed necessary to meet production schedules without the unstinted use of Weston Instruments—particularly the 3¼" diameter panel models which can be employed for the majority of electrical inspection tests.

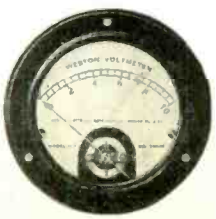
The unusual electrical characteristics, speed of measurement and dependability of these instruments for bench testing work, their adaptability to every type of service both for panel mounting and portable testing sets, coupled with their low cost, easily make them the outstanding choice.

A number of leading companies employ hundreds of these instruments in daily use and manufacturers of radio, therapeutic and general electrical equipment carry stocks of selected ranges constantly on hand, both for mounting on their products and for maintenance and inspection testing. Communicate with our nearest sales office for full particulars, ranges and prices.



3¼" diameter A.C. panel type.

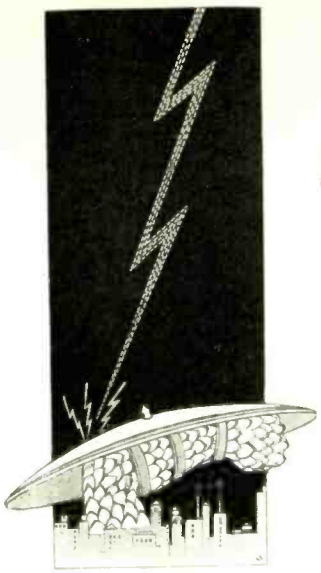
3¼" diameter Thermo-Couple type.



3¼" diameter D.C. panel type.

WESTON ELECTRICAL INSTRUMENT CORPORATION
578 Frelinghuysen Ave. Newark, N. J.

Weston
PIONEERS SINCE 1888
INSTRUMENTS



ALUMINUM FOR RADIO

means
manufacturing economy
better reception
greater selectivity . . .

IT is now a matter of proven record that Aluminum's workability, lightness, resistance to corrosion and high electrical conductivity make it the one metal that most efficiently meets the differing conditions encountered in radio design.

Used as shielding Aluminum reduces interference. It eliminates electrostatic and electro-magnetic interaction between the various stages of radio-frequency amplification. It eliminates modulation of radio frequency stages by feed back from audio-frequency amplifier. It is so easily worked into cans, boxes or casings that it presents few limitations of sizes and shapes, and makes possible more compact designs.

Used as variable condenser blades, Aluminum is available in special sheets of an accuracy and uniformity beyond anything previously developed for that purpose. Gauge tolerance in thickness is limited to ±.001 inch, with a total variation within one sheet never exceeding .0005 inch.

For fixed condensers Aluminum Foil is ideal, because of its high electrical conductivity and its great covering area. A pound of Aluminum Foil .0003 in thickness covers 34,000 square inches.

And Aluminum Die Castings combine lightness, strength and accuracy. They are used with great success for loud speaker frames and bases, condensers and condenser frames, drum dials, chassis and cabinets.

We solicit inquiries for Aluminum foil, sheet, wire, rod, tubing, stamping, die castings, sand castings, extruded shapes, screw machine products, wood grain panels, strong Aluminum alloys and magnesium products.

Aluminum Company of America
2468 Oliver Building Pittsburgh, Pa.
Offices in 19 Principal American Cities

ALUMINUM
The mark of Quality in Radio

JEWELL 409 Set Analyzer for Expert Servicemen

AGAIN Jewell takes the lead with a Set Analyzer that accurately meets service needs. In the Jewell Pattern 409 the dreams of expert radio servicemen are realized. This remarkable instrument gives filament, grid, and plate voltages, as well as plate current, simultaneously.

Two of the four 3½ inch face Jewell Instruments read plate voltage and current continuously. Pressing the A. C. and grid voltmeter buttons gives the remaining values of the stage under test for instant comparison and analysis.

A Complete Portable Laboratory

The Jewell Pattern 409 tests all receivers—including those equipped with the new screen grid tubes—A and B eliminators, tubes, batteries, circuits, grid, plate, and cathode voltages, plate current, chargers, and line voltages. Comes equipped with test leads, adapters, a pad of Jewell Set Analysis Charts, and "Jewell Instructions for Servicing Radio Receivers."

Commands Confidence of Servicemen

The professional appearance of the Pattern 409 commands the confidence of radio set owners. The 3½ inch face Jewell Instruments in bakelite cases, the engraved bakelite panel, push button switches, combined with the excellent finish and workmanship of this instrument, instil confidence in servicemen.

The Pattern 408 includes the 409 in large case with drawer and compartments for tools and replacement tubes.

List Price Pattern 409 · · $122.50
Dealers' Price · $91.88

List Price Pattern 408 · · $137.50
Dealers' Price · $103.13

JEWELL 199 Set Analyzer

TESTS SCREEN GRID Sets

The pattern 198 includes the 199 set analyzer in a large case with drawer and compartments for tools and replacement tubes.

List Price Pattern 198 · $110.00
Dealers' Price $82.50

The improved Pattern 199 is still the leader in the popular priced set analyzer field. It tests screen grid sets, and handles every other requirement. The two large instruments are of highest quality, and assure accuracy of service that is a sure foundation for profitable service work.

List Price Pattern 199 · $97.50
Dealers' Price $73.12

Sold by radio jobbers everywhere

29 YEARS MAKING GOOD INSTRUMENTS

JEWELL

JEWELL

409 SET ANALYZER

Jewell Electrical Instrument Company
1650 Walnut Street, Chicago, Illinois

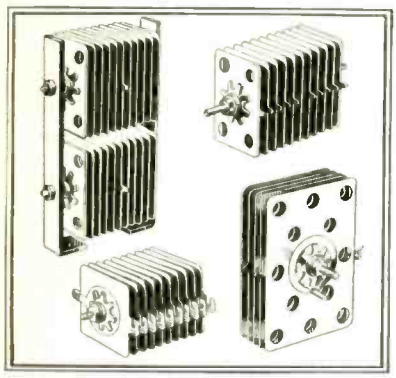
Please mail booklet entitled, "Instructions for Servicing Radio Receivers," and circular which gives complete data on Jewell Set Analyzers.

Name----------

Address----------

Rectifiers

DESIGNED TO MEET *your* REQUIREMENTS



Examples of a few KUPROX rectifiers which have been designed and produced by KUPROX to meet individual requirements are shown above.

KUPROX rectifiers, by the very nature of their construction, lend themselves readily to assembly in a wide variety of units, different both in mechanical construction and electrical characteristics. Special rectifiers to meet individual requirements can be quickly designed and will solve rectification problems where standard units cannot be applied.

Special rectifiers do not mean slow deliveries. All KUPROX rectifiers are manufactured only on order—and special rectifiers, once designed, require no more production time than standard units.

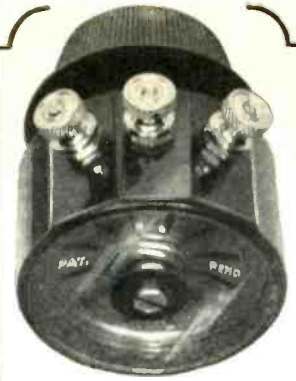
A special KUPROX rectifier can be designed for you. Send us your speaker. In a week's time it will be returned to you completely equipped.

FREE! Our new Booklet "KUPROX Rectifiers for Dynamic Speaker Use," illustrating all the various KUPROX Units for such purpose and containing complete engineering data thereon, will be sent gratis to any speaker manufacturer, engineer or designer writing us upon his firm's letterhead.

The Kodel Electric & Mfg. Co., *Cincinnati, O.*

KUPROX

DRY COPPER OXIDE RECTIFIER



Here's a volume control that matches *your* requirements

What is a Volume Control? Why, it's a device to reduce or to increase the loud-speaker volume at will, without introducing tone distortion in the usual rendition.

What else should a Volume Control be? It should be silent both mechanically and electrically; velvety smooth in operation; compact and handy to install and connect; absolutely free from wear and tear; and positively immune to troubles and to the costly and troublesome servicing to which all too many volume controls are heir. The clanging and clashing of make-believe chimes from a faulty volume control and microphonic tubes, or again the banging and crashing of a battle-field as simulated by the rasping contact and uneven turns of a volume control, may be good atmosphere in their proper place, but they brand your radio engineering as mighty poor work. Remember, the volume control is usually the weakest link of the present-day radio set. And yet it is probably the smallest, lowest-priced, and simplest component.

Well, all the good points, and none of the poor points, of volume control practice are incorporated in the latest member of the CLAROSTAT family. So you will be interested to meet the

New *Genuine Wire Wound* CLAROSTAT VOLUME CONTROL *up to 50,000 ohms*

The photograph above tells much of the story—note the neat appearance of this device, with its bakelite case and end cover, which keeps out dust and dirt; note the compact dimensions—not a cubic inch of waste space; note the single-hole mounting feature, and the handy terminals.

But there's more to this story, when you look inside. It contains a special wire winding on a bakelite strip—turns cannot loosen, shift or short-circuit, even with the finest wire. You can have any resistance up to 50,000 ohms. Contact is established by means of a pressure contact disk—no sliding contact to cause wear and tear. Absolutely noiseless mechanically and electrically. Microscopic examination of the wire, after 100,000 turns of knob, indicates no appreciable wear!

— AND YOU CAN HAVE IT *MATCHED* TO YOUR *EXACT* REQUIREMENTS

Yes, just that. The Clarostat Engineering Staff has developed an ingenious winding machine which varies the number of turns of the resistance wire from 8 to 600 per linear inch along the entire strip. This makes possible any resistance value at any point in the turn of the knob. You can have a tapered winding, arithmetical or geometrical progression of resistance, a peak at any part of the winding, and so on. In fact, you draw the specification curve of your resistance requirements throughout the turn of the knob, and our engineers design a new BAKELITE VOLUME CONTROL CLAROSTAT that matches that curve and your needs.

If you're from Missouri, all the better! Just draw the desired resistance curve on our specification sheet, and we'll submit the samples.

WRITE, if you are engaged in actual radio production or designing, on your firm letterhead, stating your resistance requirements, so we may co-operate with you in taking care of them. Let us send you the technical data and specification sheet so that we may submit samples on our ideal volume control.

CLAROSTAT MANUFACTURING COMPANY, Inc.
Specialists in Radio Aids
282 North Sixth Street : : Brooklyn, N. Y.

CLAROSTAT

GILBY WIRE

ASSURES DEPENDABLE FILAMENTS

THE increasing demand for Gilby Filament Wire by leading tube manufacturers is the reward of a truly "Better Product". Nothing is spared nor stinted in manufacturing Gilby Wire. The materials employed are the finest obtainable anywhere. Samples of Gilby Ballast Wire, Pure Nickel Wire, Gilby Resistance Wire, Pure Nickel ribbon, will be gladly and promptly sent on request

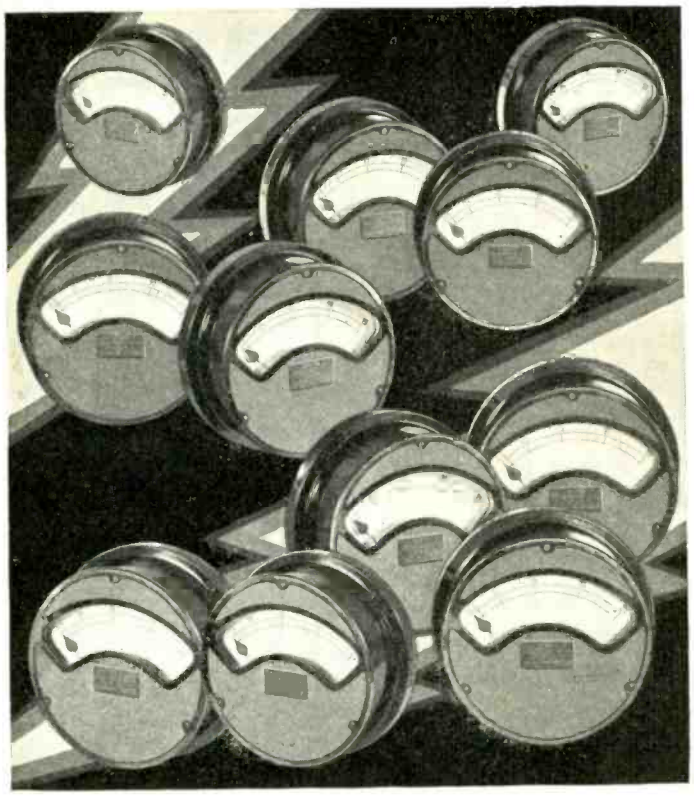
THE LARGE ALUMINUM SPOOL
IS A GILBY FEATURE

GILBY WIRE COMPANY

WILBUR B. DRIVER, *President*

NEWARK, NEW JERSEY

These could be made of DUREZ...



Ammeter. Using Durez, these will be strong, hard, tough. Acids, moisture, gases, steam will have no effect on delicate parts. Lettering, designing and the mottled surface will be made in one operation. Colors can be used. *One of countless Durez applications.*

then they would be

light
non-brittle
acid and alkaline resistant
perfectly insulated
beautiful
uniform in any quantity

HEAT AND MOISTURE RESISTANT ★
durable—strong
complete without tooling or polishing
made in one operation
economical

DUREZ
The perfect molding compound

★ Heat and Moisture Resistant

MANY a product, otherwise satisfactory, fails because of its vulnerability to destructive agents. Radio manufacturers frequently switch to Durez for that very reason! So much so, that metals, porcelain, wood, hard rubber, glass, ivory and other materials are rapidly giving way to this perfect molding compound. Durez resists heat, acids and moisture!

Yet the mechanical and physical stability of Durez—even under the most exacting conditions—is but one of its many advantages. Durez has high dielectric strength. It is quickly and easily molded—in one operation! In that operation, holes can be made, studs imbedded, threads cut, intricate designing cared for. No tooling, burnishing or polishing is necessary. And no matter how many parts you make, each will be exactly like the other.

What do you make? Is it continually subjected to deteriorating agencies? Is your present material adequate to fight them? Investigate Durez! Learn how this amazing material can give your product durability, added efficiency and beauty—*economically!* (Durez comes in all practical colors—colors that can be blended, striated, mottled as you want them.) You owe it to yourself and your production line to try Durez!

Durez engineers and laboratory staff will gladly co-operate with you on any problem. Address General Plastics, Inc., 85 Walck Road, North Tonawanda, N. Y. Also New York, Chicago, San Francisco, Los Angeles.

Write for this free booklet—"Do It With Durez." Contains complete information about Durez—physical and dielectric properties, color ranges, and scores of possible applications.

Some Aspects of Radio Production

Meeting the Rigid Requirements of a Highly Competitive Market Through Better Engineering and Manufacturing Practices

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

IN a nutshell, the story of radio production is told in this striking contrast: 1924—a three-tube regenerative receiver, using dry batteries, housed in a simple table-type cabinet, with enclosed loudspeaker, priced at $275.00, and considered a rare bargain. Nineteen hundred and twenty-nine—an eight-tube receiver, full a-c. operation, push-pull power amplification for enormous volume, dynamic loudspeaker for realistic rendition, housed in a handsome period cabinet, priced at $167.50, yet considered just typical fair value.

In those two examples, there is reflected a marvelous record of engineering achievement and production progress. Beyond doubt, the public is receiving just about ten times as much value for its radio investment today than it received five years ago. And yet radio manufacturers, despite the marked decline in prices and the astounding rise in values, are making ample profits, in most instances. It is the story of the automobile industry all over again, with standardized and stabilized engineering principles and mass production practices come to reduce costs and consequently the selling prices, followed by increased sales, still greater production, and a further lowering of production costs. In a word, the radio industry is on a firm foundation, if all those engaged in it will only observe a few simple fundamentals of good business.

Stabilized Engineering

Despite all the early adverse criticism regarding the grouping or pooling of patents and the establishment of a patent license system, it is generally agreed today that such practices have been most beneficial to the industry in the long run. If we hark back five years in the history of the radio industry, we recall that the wide diversity of circuits made standardization, and consequently stabilization, impossible. The manufacturers were constantly in a quandary as to what to produce; new circuits, so called, made their appearance at the rate of several dozens per week; and the public hesitated to invest in radio equipment, for fear that something radically different and better lurked just around the corner. Under such conditions, the manufacturers did not dare launch on a mass production schedule, for fear their line might be obsolete before the first sets emerged from the conveyor belt assembly.

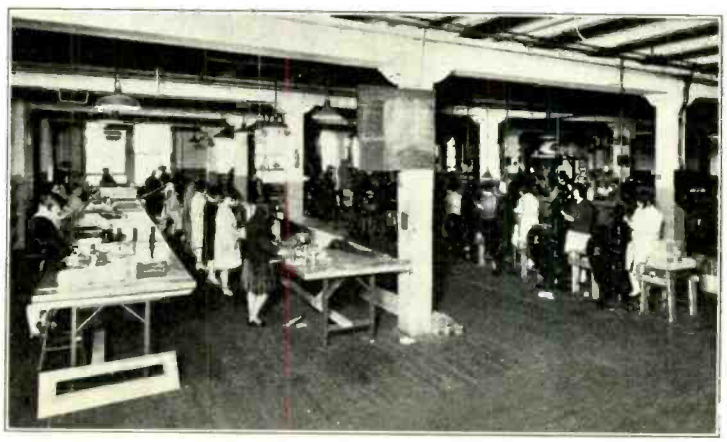
Today, with the tuned radio-frequency circuit well established as an ideal broadcast receiver, not forgetting the improved superheterodyne circuit which is a more exclusive proposition, together with a-c. tubes, transformer-coupled audio amplification, and certain types of loudspeakers, the manufacturer can proceed with complete assurance of sound merchandise and the public can buy with full confidence.

It is the standardization and stabilization of radio principles, more than any other contributing factor, that has made mass production an economic reality. Also, the patent licensing groups have learned to render coordinated engineering service, so that a remarkable degree of stabilization is assured among licensees, yet without preventing each licensee from introducing such novelties and minor departures as he may elect for the sake of variety and originality.

Standardization and stabilization are vital factors in our present radio prosperity, yet they should not, like all good things, be abused. The individual manufacturer in other words, given standardization and stabilization as a foundation upon which to build, should not stop here and be lulled into a sense of false security. Rather, he should build up his own engineering staff. Freed from the task of unravelling the maze of radio principles, he should start out with the present fundamentals and refine them to the utmost, not alone in the strictly radio end but even more so in the electrical and mechanical ends. Today an engineering staff is more essential than ever before: and by an engineering staff we are not speaking in terms of a personnel of young men who work with soldering iron and pliers rather than with formula and slide-rule. The cut-and-try method has its advantages, but it certainly should be guided by trained engineering minds.

Who Shall Make Radio Parts?

With the engineering of the radio set or other assembly definitely settled, the next step is production, which in-



A portion of the Buckingham Radio Corporation's machine and assembly shop. Note the ample space and the special corrugated run-ways for hand trucks between the different groups. Female labor has been found to be highly efficient for this light work.

cludes the plant, equipment and personnel, the selection and purchase of raw materials and components, the actual manufacturing and testing, and finally the shipping and subsequent servicing in the field.

Just how far the radio set manufacturer should go in his production plan, so far as the starting point is concerned, is a serious question, the answer to which is found in such factors as capital available and to be invested, size of plant, engineering facilities, relative costs, and so on.

After making a long study of the parts situation while engaged in special sales promotion work for the Radio Parts Committee of the R.M.A., the writer came to the conclusion some time ago that the average set manufacturer could best buy his components from parts specialists. Even the largest manufacturers, who now make probably all their components, would fare better if they bought from parts manufacturers, for the reason that much of their capital and facilities and engineering talent might be released for more intensive action on the sets themselves, resulting in greater profits.

To understand the importance of the parts manufacturer in the radio scheme of things, one must be told that the leading parts manufacturers have gone in for mass production and volume sales quite after the manner of set manufacturers. Three years ago, the parts manufacturers were catering mainly to radio fans who were then building their own sets, due to the state of flux of the radio art. They were selling mainly to the jobbing trade. Today, the parts manufacturers, having lost the former fan market to a very large degree, are compelled to cater to set manufacturers. Prices are being shaved pretty closely. The fraction of a cent on a given component usually determines the acceptance or rejection of a bid or quotation. Consequently, mass production has become the rule with parts manufacturers. Recently several of the leaders in this field have taken over larger plants and have gone in for belt conveyors, automatic machinery, step-by-step assembly, and so on, in an effort to reduce costs still further.

Still, the cost of parts is to a large extent dependent on the co-operation of set manufacturers. Too often the set manufacturers do not make up their minds regarding models until the last moment, and then proceed to load up parts manufacturers with rush orders. It is well known in business that no one makes money on rush orders. To a large extent, therefore, parts manufacturers are still experiencing seasonable demands, which means unprofitable business or high prices. Set manufacturers are paying higher prices than seem necessary, because they fail to spread out their orders throughout the year. There seems to be little excuse for this situation, since with standardized and stabilized designs the set manufacturers should know pretty much what they are going to produce quite a while in advance.

Every argument seems in favor of buying parts from parts manufacturers. In the first place, the parts specialists, such as the transformer, filter condenser or variable condenser manufacturer, certainly can afford to devote more concentrated engineering talent on a given component of the radio set than can the set manufacturer. Today we have excellent components available, representing engineering research and development which could never have been devoted to such components if the average set manufacturer were solely concerned. In fact, the more critical buyer of radio sets has been educated to the point where he looks for certain well-known condensers or transformers in an assembly, just as the critical automobile buyer looks for Timken bearings or Stewart-Warner accessories.

The production of a radio set from the absolute raw materials, although emulating the genius of Ilivver fame, is a gigantic undertaking. Even the largest set manufacturers are prone to purchase certain components outside, despite the fact that they command the necessary capital and facilities. It is usually felt that better and cheaper components can be purchased from parts specialists than can be turned out in the plant: and that whatever capital and facilities might be available for the purpose had best be utilized in set production. Of course, this is not a plea for converting the average set manufacturing plant into a strictly assembly proposition: certainly, if the manufacturer should buy everything from outsiders, he becomes little more than a glorified version of a custom-set builder. There should be due discretion exercised. Thus it is perfectly legitimate for the set manufacturer to buy condensers, transformers, sockets, jacks, chokes and other items: the power amplifier manufacturer may buy core laminations and complete windings and condensers: the tube manufacturer may buy plates, bases and welds, and so on. Thus is a *manufacturing* business maintained.

Detail Production

Few manufacturers build from scratch, which is to say from raw materials rather than parts and components. This is known as detail production. One of the largest manufacturers has an entire building of vast proportions devoted to so-called detail production. Here the variable condensers, sockets, jacks, plugs, transformers, resistors, choke coils, and other units, even to enameled wire, are made up and sent to the radio set factory proper, there to be assembled into sets. It should be noted, however, that this manufacturer has a research and engineering organization probably second to none the world over, so that the last transformer or condenser or resistor is of the highest grade, in order that the subsequent ensemble may not be found wanting.

The average set manufacturer does engage in detail production to a certain extent, making such components as he finds convenient and economical. Another large set manufacturer, for instance, buys his variable condensers. These are individually tested for capacity over their entire range, and then grouped into sets of fairly closely matched condensers for single control. This manufacturer, however, makes his inductance coils, which are likewise measured and matched in sets. He also makes his audio transformers,

The assembly lines in the Stewart-Warner Corp. Chicago plant are considered the last word. Each side of the assembly bench is equipped with a slowly-moving conveyor carrying the chassis in special frames and stopping them before each operator long enough to permit them to finish their individual task. Outlets for welding, soldering and testing are also on the tables.

power transformers and chokes, although he does not hesitate to purchase the laminations outside. The filter condensers are made in his factory, although it is generally admitted that this is a highly specialized field best left to the condenser specialist. Loudspeakers are bought outside. Cabinets are also bought from outside sources. Resistors are made in the plant itself. It will thus be noted that this manufacturer very wisely makes such components as he finds most profitable to make, and buys others which can best be made by outsiders. And that is precisely the correct answer to detail production.

The Part Played by Moulded Products

If there is any one item that has counted heavily in modern low-priced radio sets it is the moulded product. Materials such as bakelite, durez, casein, cold moulded composition and others are being utilized to an ever-increasing extent. The most elaborate forms are now possible in these moulded products, together with metal inserts. Machining is reduced to a minimum; excellent insulation is provided; good mechanical strength is secured; and the ultimate assembling operations are reduced to a minimum. Nevertheless, there are still many manufacturers who fail to take full advantage of moulded parts, hesitating to make the necessary investment in moulds. This policy is to be deplored, for the moulded product is perhaps more a development of the electrical and radio industries than of any other industry, and full advantage should be taken of same.

More recently, various synthetic porcelains have appeared, with excellent electrical, mechanical, thermal and chemical characteristics. These materials, presented under various trade names, have heretofore been used to some extent in the insulation of variable condensers, tubes, sockets and so on. Today, with bigger and better extrusion presses and moulding presses available in the plants specializing in these synthetic porcelains, it becomes possible to obtain socket slabs, gang sockets, terminal strips, coil forms and other large pieces of excellent radio characteristics, let alone great mechanical strength, immunity to moisture and temperature and salt air, and attractive appearance. Certain manufacturers have been using such synthetic porcelains year after year, claiming marked improvement in radio characteristics.

Die Castings and Stampings

A close second to moulded products is the die casting, which is playing a steadily growing role in radio production today. In fact, the latest inexpensive sets are making use of elaborate die-cast cabinets and stands, which are more attractive than the "cans" of pressed metal and certainly simpler and less expensive than the wooden cabinets. The die castings in aluminum or aluminum alloys are especially popular at the present time, with certain raised parts showing through the paint for attractive highlight effects. The most intricate forms are entirely feasible in die castings, and machining and assembly operations are being reduced to a minimum, with further economies in production costs.

Punchings and stampings are also of prime importance. In fact during the past three years the stamped metal chassis has become standard practice, replacing the wooden breadboard construction which held sway for years, even in the best of radio sets, or again the frail panel and skeleton type which followed. Today the universal practice is the steel platform or chassis foundation, punched to exact shape and complete with all holes. The assembly now becomes a simple matter, since the components can be grouped in just one way—the right way. The panel has been dispensed with, since the purpose of the furniture radio is to disguise the mechanism of radio as far as possible.

With the introduction of extensive shielding, particularly for the new screen-grid tubes, the use of the metal chassis is most fortunate, as a foundation on which to build. In the latest sets, the wiring is entirely beneath the steel platform, so that no wires with the possible exception of the control grid cables to the caps on the screen-grid tubes, are in evidence. Metal cans for coils, transformers, and condensers, together with caps for tubes and partitions between parts, complete the excellent shielding.

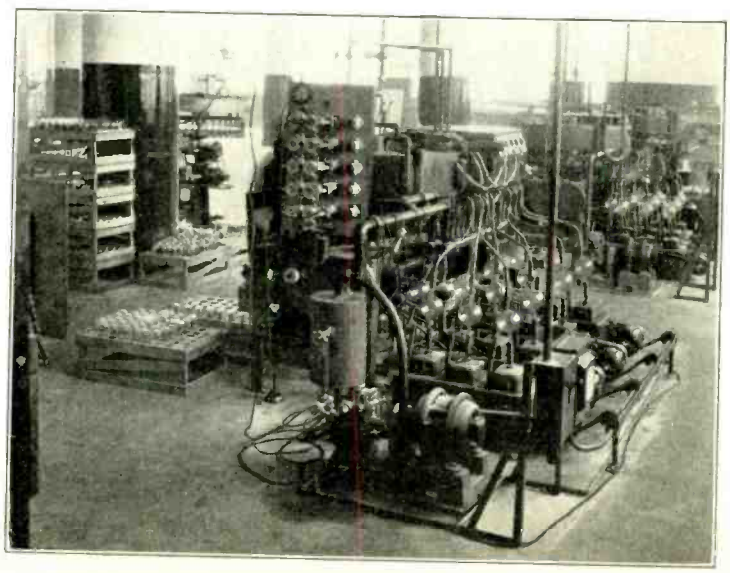
With the acceptance of the steel platform and the general use of metal wherever possible, there has come about the universal use of the eyelet in place of screws or bolts. Even the smallest parts are now held in place by eyelets, resulting in a simple, economical and permanent assembly. Where the eyelet is not used, the rivet is used. In the very latest sets, about the only screws in evidence are adjustment screws on the one hand, and the screws holding the steel chassis in place in the "can." Removing the four or six screws permits of lifting out the chassis and getting at the underside, which contains all wiring, fixed condensers of small size, resistors, and so on.

Simplified Wiring

Speaking of wiring, it seems only a short while ago that radio sets were assembled by skilled radio workers painstakingly mounting each instrument in place and then wiring the assembly with stiff bus bar beautifully shaped and soldered by a dexterous hand. Later came the idea of bending bus bars to standard shapes for a given type of set, so as to expedite production. Still later came the harness idea, which has persisted until now and is apparently the final step in mass production wiring.

The harness is an ideal method of wiring. Whether made up in the plant itself or purchased outside, it is by far the cheapest way of connecting up the components. The wires can be arranged to branch out of the cable at the right place and be of proper length and distinctive color, so that errors are quite impossible.

A more recent development in wiring is the flexible resistor, comprising a cotron or asbestos wool core, wound with fine wire to provide the desired resistance, and covered with varnished cambric or spaghetti. The flexible resistor is used as part of the wiring



A bank of automatic evacuating machines in the Duovac Radio Tube Corp., Brooklyn, N. Y. The timing here is automatic and temperatures from 400 degrees above to 140 degrees below zero centigrade are used in this process.

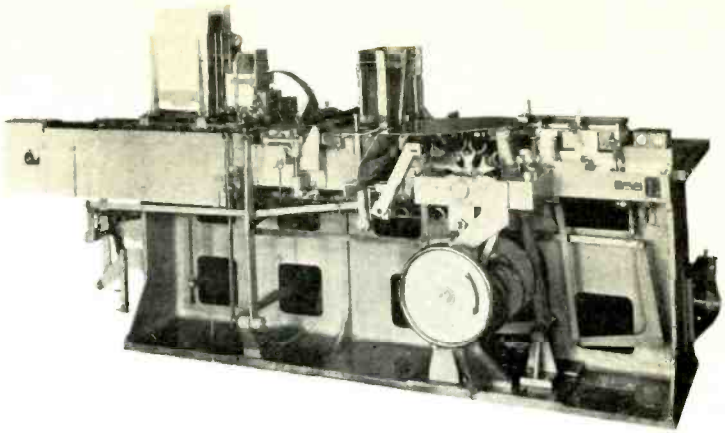
itself, thus simplifying the assembly still further. In many sets these flexible resistors are employed for grid bias and plate resistors, and save considerable mounting and wiring.

The Day of Progressive Assembly

All of which leads to simplified assembly, which reaches its climax in step-by-step or progressive assembly by operatives who do not know the difference between a socket or a resistor. In many plants today, the plain steel plate for the chassis starts at one end of the conveyor belt, and bit by bit it accumulates an assembly of components and wiring as it travels down the gauntlet of girls or men, as the case may be. Each operative adds and handles some specific detail. In the case of one well-known radio set of rather intricate design, the conveyor belt, some 200 feet long, carries a chassis from scratch to finish in about 1¼ hours. Girls are employed throughout the assembly process, working with interchangeable components and wiring harness, and even to the soldering operations. Incidentally, soldering is generally the bottleneck of conveyor belt assembly, and the girls at the soldering stations determine the speed of the belt.

In other plants, the belt conveyor is not employed, but the progressive assembly takes place from one work bench to the next, as each step is taken in the forming of the set.

The practice is to arrange complete production units. In fact the largest plants keep each type of receiver quite by itself. While the detail manufacture may be pretty much scrambled, the production of each type is isolated from all others, and workers are trained on a given type, for maximum efficiency. There are so many channels or chains for this type and so many for that type, in most of the present mass production plants. To facilitate the progressive assembly, there is a marked trend toward the single-story factory building, rather than one of several stories. Recently large manufacturers have moved into single-story buildings, extending over a wide acreage, in order to have the entire detail production and progressive assembly operations on one floor. In fact, it is the handling and rehandling of parts and assemblies, perhaps more than any other factor in present-day radio manufacture, which decides between a good profit at a low selling price, or no profit at a high selling price.



This combination wrapping and cartoning machine for vacuum tubes was developed by the F. B. Redington Co. and wraps 60 tubes per minute at the R.C.A. tube factory at Bloomfield, N. J. The corrugated protector and circular are fed from magazines, shaped, placed over the tube, the whole being slipped into the cartons and the end-flaps tucked in.

One condenser manufacturer about a year ago decided to place his plant on a conveyor assembly basis, after having considered the high cost of additional factory buildings. He was assured by conveyor belt engineers that he could gain between 50 and 75 per cent additional production from his existing space, by reducing the handling and rehandling operations. Until that time, the wound condenser sections were carried to the impregnating kettles, and from there to the block assembly department, and from there to the testing department, and again to the shipping department. Conveyor belt, overhead trolleys, block and tackle, automatic dipping and drying baskets, and other labor-saving devices have been installed, with the result that the production has been almost doubled in the same building, with a marked decrease in proportionate overhead. He is a penny-wise-pound-foolish radio manufacturer who hesitates to invest in the latest aids to mass production labor, for not only is he making less profit today, but tomorrow he is destined to pass out of the picture because his competitors are all the while going ahead with improved methods and lower selling prices.

The cabinet-finishing plant of the Grigsby-Grunow Co. where 100 polishing machines, developed by the Paasche Airbrush Co., are doing the work of 400 hand rubbers. The floors in the cabinet shop are of highly-polished hard wood, thus making it possible for a man to slide a line of cabinets from one place to another.

The Importance of Tests

There is nothing more intricate than a radio assembly, with delicate paper sheets for insulation in filter condensers, wires as fine as a human hair in transformers, a maze of connecting wires which must be correctly applied, and so on. Therefore, testing is imperative, for a radio set can be either a useful product, when properly assembled and wired, or a useless conglomeration of nondescript components.

The present-day practice in most plants is to test, test and test some more. The components are individually tested before being passed on to the assembly department. The progressive assembly is tested at frequent stages, so as to catch any flaws at the earliest possible moment and thus reduce the cost of rejects to a minimum. Finally, the complete assembly receives a critical test.

In many mass production plants, the completed chassis passes from the conveyor belt into the test department. Here it is tested on several carrier frequencies or wavelengths, usually high, low or medium, with either a quantitative measurement by means of a meter in the output of the set, or again with modulated signals. Rather than depend on the usual broadcast signals, many manufacturers make use of a miniature radio telephone transmitter, whereby a known standard of signal strength, frequency and modulation may be obtained for routine testing.

Packing and Shipping

The final link in radio production is packing and shipping. Here again, marked advances have been scored, particularly in the direction of ingenious

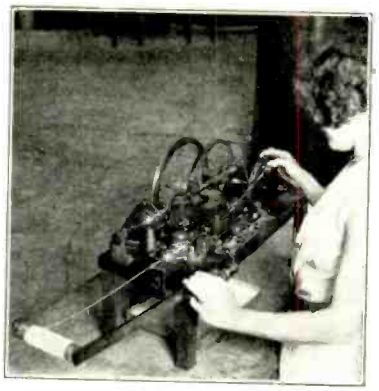
and labor-saving packing means. For the smaller radio sets, the corrugated fibre container has come into extensive use. In most mass production plants, the completed radio set, as it comes off the conveyor belt after receiving the tests, is dropped into a corrugated fibre container, properly wrapped and padded, the package is sealed, and it goes to the shipping room or stock room, as the orders may determine. In the case of the larger furniture radio sets, strong but light plywood containers are used, together with special cradles which serve to remove the weight from the legs of the cabinet, and from other parts.

In the case of the larger radio sets shipped in plywood containers and calling for ingenious cradles and padding, it would seem that many manufacturers have failed to provide the proper instructions for those who must unpack such shipments. Often the dealer or the consumer is at a loss to know just how to proceed, and often some damage may be done to the radio set as the result of applying main strength and stupidness rather than intelligent effort. It would seem that a label, giving full instructions on how to unpack, and placed on the packing case, would be of real value.

Servicing

A fundamental of good business—and we might say permanent business—is continued interest in one's product even after it has passed through the hands of jobber, dealer, and into the customer's home. In other words, servicing is part and parcel of successful radio manufacturing.

The largest radio set manufacturers are giving considerable attention to servicing. In fact, no sooner is a given set determined upon, than the parts catalog is prepared. Each part, even down to the last screw, is photographed and listed. Instruction sheets or booklets are prepared. Service manuals are issued to dealers and servicemen, so that sets may be intelligently repaired.



The Nucrometer automatically and precisely measures, cuts, scrapes the ends and removes none of the oxide coating of filament wires. This machine—and it is one of two in the world—is used in the Duovac Radio Tube Corp., Brooklyn, N. Y.

The manufacturer is under moral obligation to keep his radio sets in service over a reasonable length of time, not free of charge, please understand, but more by providing the necessary data for dealer and serviceman, and more especially making the necessary replacement parts available. Heretofore, certain mass producers have given virtually no thought to replacements, and thousands of sets have been tied up in dealers' and jobbers' hands because of lack of replacement parts, particularly filter condensers. This is very bad practice, and it is certain to injure the manufacturer in the long run.

Mass production, so far as radio is concerned, is here to stay. Selling prices are bound to go to even lower levels. Labor-saving methods and equipment are essential if one wishes to remain in the radio industry.

Take the vacuum tube, for instance. Remarkable machines have been developed. Girl operators do little more than load and unload these machines. Production flows along from one machine to the next, with the tubes growing, as it were, from mere glass tubes and wires to stems and then the bulbs and finally the based tube. Yet today, continuous production units are being developed. Soon the entire process, from tubing and wires to complete and tested vacuum tubes, will be handled automatically by machinery. There will be no rehandling. The operatives will be reduced to a mere handful. Production costs will attain new low levels, and selling prices are almost certain to go to new low records. Obviously, the vacuum tube manufacturer who persists in utilizing scattered units will be quite unable to meet the new day competition.

Remarkable winding machines are being introduced. We have recently seen machines winding wire finer than a human hair—1½ thousandths of an inch, 300 ohms to the foot, 450 turns to the inch, 8 ten-thousandths of an inch spacing, yet flawless perfection, in producing high resistance volume controls. Such things would have been impossible a few years ago—and the commercial prices obtained for production volume controls.

All in all, it is no longer a matter of just radio engineering. It is a matter of mechanical engineering. The production man now comes into his own. Even the metallurgist and chemist are necessary in solving many problems.

Radio has reached its majority. It is no longer the baby industry.

Production Control In Receiver Plant

BY MEANS of an elaborate production control system the Temple Corporation has been able to increase production from approximately 15 sets a day on March 1, 1929, to about 500 per day at present.

This production control system means, for example, that when the sales director reveals that sales have reached an average of one thousand sets per day the information is communicated to the assistant superintendent in charge of production control and he in turn sets the machinery in motion which provides the needed increased production.

The production control director's orders go direct to all division chiefs. Division chiefs give their orders to department heads who, in turn, transmit the orders to supervisors. Supervisors give their directions to operators under them and the increased production process is under way.

Simultaneously with orders going down the line to operators, plant branches, including engineering, machine shop, tool shop, supply office, carpenter shop, inspection service and office departments, including auditing, purchasing, employment, and the like, are notified and corresponding speed follows in each department. This system is so arranged that every department in both office and plant is coordinated.

It is absolutely necessary for each individual operation and job to "click" in unison with the general plan. Previous instructions outline every task in detail so that there is no loss of motion.

Code Number for Every Operation

Every plant operation as well as every department has its own code number. When orders referring to these operations go out the code number is always used as well as the code number of the department in which the operation is performed.

In building a Temple receiver approximately 500 individual operations are performed. For instance, one of these operations is labeled "soldering." It has only the one code number, tho thruout the receiver close to 500 soldering connections are made.

Mr. Alfred Marchev, General Manager, knows every minute, while sitting in his front office, how the production schedule is going along.

A battery of six veeder counters on his desk tells the story of plant production. They are attached by means of an electric button system to the speaker, power pack, installation and final inspection lines and two chassis lines.

If the counters indicate a slowing down in production, Mr. Marchev can go right to the point of apparent trouble and determine what is the cause.

Production Testing of Audio-Frequency Amplifiers

Description of Test Set Employed For Making Rapid Measurements of Gain and Overload Level in Amplifiers

*By Arthur E. Thiessen**

HOWEVER much engineering development the manufacturer of an audio-frequency amplifier expends on its design, there remains the problem of comparing the performance of the quantity-produced unit with that of the laboratory model. Without rigorous inspection some defective units are likely to reach the user, which makes necessary expensive replacements and breeds ruinous ill will

Some manufacturers check the component parts before assembly and follow this with a supplementary "try-it-and-see-if-it-works" test This, however, is only partially satisfactory because errors in assembly may still creep in and because any kind of a trial inspection requires highly-competent, specially-trained inspectors if the rests are to mean anything. Even then, it is doubtful whether any listening rest can be relied upon to detect small abnormalties in the performance of a high-quality amplifier under production conditions.

When preparing to manufacture their new radio receivers, the Victor Talking Machine Company realized the importance of thorough inspection and the limitations of the usual methods. They asked the General Radio Company ro build suitable test equipment, and the engineering departments of the two organizations collaborated on the design of the audio-frequency amplifier test set that is described here. It makes possible a speedy and accurate rest and is capable of operation by an inspector with no special training.

The most important characteristics of an amplifier's performance are its ability to show the required amount of gain or amplification over the desired frequency range and to deliver the required amount of power without overloading. It was decided that the test of the Victor Company's amplifiers should include an accurate measurement of both these quantities.

Gain Test

The method chosen for making the rest for gain is based upon one sometimes used for making measurements

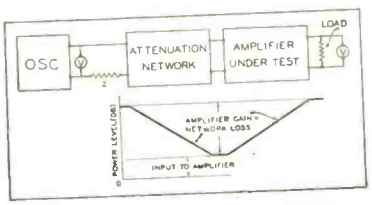


Fig. 1. Outline chart and power level diagram for the gain-measuring method used in the amplifier test set. All impedances are assumed to be matched.

in the laboratory. Fig. 1 shows it in schematic form. An oscillator operating at the test frequency supplies energy through a calibrated attenuation network to the amplifier, in the output circuit of which is connected a suitable load and a meter for measuring the voltage drop across it. The network is adjusted until the voltage across the load is equal to that measured across the input terminals of the network. Then, if all the terminal impedances between units in the circuit have been properly matched[1] the gain of the amplifier is equal to the attenuation or loss in the network. The complete gain-frequency characteristic is obtained by repeating this measurement at as many test frequencies as necessary.

Overload-Level Test

The overload-level test is also based upon a laboratory method for determining where further increases in the input of the amplifier fail to produce proportional increases in the power output. The overload level is the ratio (expressed in decibels) of this power output to the standard reference level or nomal test output[2] of 50 milliwatts.

The audio test panels as constructed are shown in the schematic diagram of Fig. 2. A Hartley oscillator delivers voltages at each of five selected frequencies (40, 100, 400, 2500, and 6500 cycles) covering the audio-frequency band. At each of these frequencies the voltage of the oscillator is made the same by an adjustment of the respective feedback resistances.

From the standpoint of the inspector using the test set, it is desirable that the power output of the amplifier be constant at every one of the test frequencies, in spite of the fact that the amplifier gain is different for each one. Then it is only necessary for him to note whether or not the load voltmeter deviates from a fixed value marked upon the dial in order to tell whether or not the amplifier is up ro standard. This is accomplished by inserting enough attenuation ahead of the amplifier to make the output the same at each frequency. This is the function of the compensation network shown in Fig. 2. Both the frequency change and the throwing in of the proper compensation network are made by means of the large hand-wheel at the left of the panel shown in Fig. 3.

An alternating-current-operated vacuum-tube voltmeter is used to measure the voltage across the load and to check occasionally the output voltage of the oscillator. It is sufficiently sensitive to indicate deviations of amplifier gain from normal by as little as one or two decibels. The voltmeter is the one in the center of the panel.

The input and output networks for

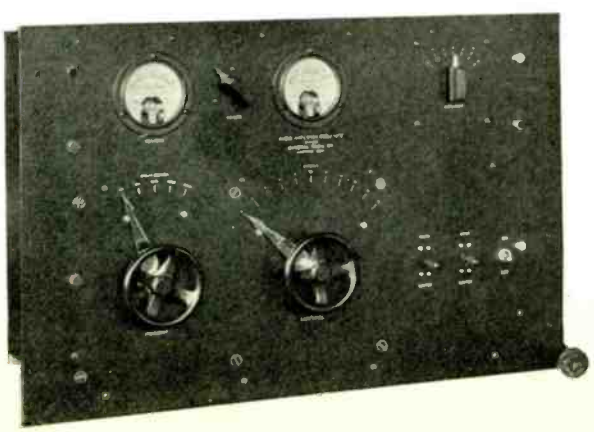


Fig. 3. Panel view of the audio-frequency amplifier test set. The left hand-wheel is for gain test, the right wheel for overload test.

* *Engineering Dept., General Radio Co.*

[1] *This requirement makes necessary the impedance Z. If the oscillator output voltage be maintained constant as shown by the voltmeter, the network behaves as though it were working out of a power source of constant internal electromotive force and internal impedance Z. See K. S. Johnson, Transmission Circuits for Telephonic Communication (New York: D. Van Nostrand Co., 1925), Chapter VIII, in particular.*

[2] *I. R. E. Standard. See Year Book of the Institute of Radio Engineers (New York, 1929), p. 107.*

making the overload-level test are controlled by the other hand-wheel. As its pointer is moved from left to right in ten successive steps, an attenuation of two decibels per step is removed ahead of the amplifier, and, simultaneously, the same amount is inserted in the output circuit. So long as the amplifier is operating below its overload level, the reading of the voltmeter remains fixed, but, when overload occurs, further increases of input fail to produce proportional increases in the output power. Thus, the overload level is indicated when the output voltage begins to drop off as the test switch is advanced.

Use of Equipment

In testing an amplifier under working conditions, it is merely necessary to connect it to the test panel by means of a set of flexible leads. With the overload-level switch set at zero the gain test is made at each of the five test frequencies, and, if the reading of the output voltmeter does not deviate from standard by more than a specified tolerance, the amplifier has been shown to have a gain-frequency characteristic like that of the laboratory model. The next step is to set the frequency control at some point —400 cycles, for example—and to advance the overload-level switch until the output voltage begins to fall off. The setting of the switch where this occurs indicates in decibels the overload level of the amplifier referred to the reference level.

At the extreme lower right of the panel, next to the toggle switch for controlling the power supply to the test set, may be seen two key switches. One of these throws the voltmeter from the amplifier output circuit to the output of the oscillator for checking its voltage.

Since the audio amplifier is intended for use in conjunction with a phonograph pickup (low impedance) as well as the detector tube of the radio receiver, its input circuit has a low as well as a high-impedance winding. Gain and overload-level tests are made for each winding, and the second key switch makes the necessary internal

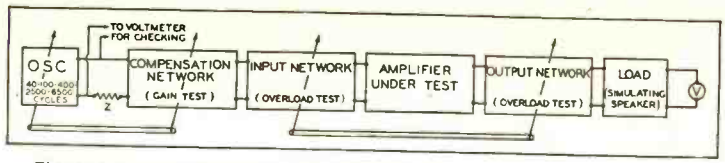


Fig. 2. Schematic diagram of the test panel for making rapid measurements of gain and overload level in amplifiers.

changes in the test panel.

By means of this extremely rapid check practically all of the possible errors in construction will have been shown up. When the first production-built amplifiers were being tested, several were found to have a sub-normal amount of gain in the middle of the frequency band. Checking them upon the elaborate laboratory gain-measuring set proved that the test panels were operating correctly, but the trouble could not be traced to any fault in the amplifier until it was discovered that the lower-grade wax used for impregnating the power transformers had been inadvertently used in the inter-stage coupling transformers. It is highly probable that a simple listening test would not have found the trouble, yet the accident is one that could happen in any assembly plant.

Speed and Accuracy Gained

By the use of the test panels, the Victor Company makes its production with great speed and accuracy and with a consequently low unit cost of test. The average time necessary for a complete check is about one minute, and the amount of deviation from standard is held to a tolerance of one and one-half decibels. This test compares favorably in accuracy with the more elaborate laboratory measurements requiring considerably more time, equipment, and technical skill. Such high accuracy is justified, for there is no excuse for the manufacturer making heavy investments in research and quality materials unless he is sure that the finished amplifier is as good as the approved laboratory model.

In addition to the check upon the completed amplifier, all of the component raw materials are tested before assembly. All input, interstage, and output coupling transformers are inserted in amplifiers of known excellence which are then tested on the test panel. If the amplifier shows normal performance, the transformers are shown to be satisfactory.

Ten of these amplifier test panels have been built for the Victor Company and five more are now in process.

The flexibility of the test set makes it adaptable for use with almost any audio-frequency amplifier, and it may be readily altered to take care of such changes in the design of the amplifier that may be made after production has begun. The method of working out the problem is general enough to show definitely that laboratory methods can successfully be applied to production tests.

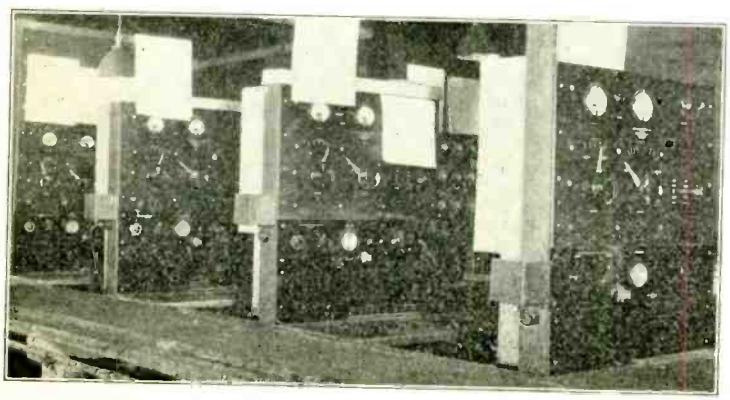


Fig. 4. Four of the group of audio-amplifier test panels as used by the Victor Company for making production inspection tests on completed amplifiers.

UNIQUE TESTING METHOD FOR RECEIVERS

NEW equipment for the production testing of radio receivers is now being installed by the Steinite Radio Company in their new plant in Ft. Wayne, Indiana. This consists of a system of crystal controlled oscillators for testing receivers, and represents a distinct innovation in testing methods.

Three oscillators are used whose frequency is controlled by quartz crystals, the wavelengths of these oscillators representing the high, medium, and the low wavelengths to which the receiver must respond.

The power output of these oscillators is calibrated and is then reduced from the high power by an attenuator system until the signal is approximately the same as that received from a distant broadcasting station when the receiver is hooked up to an average antenna. This minute power is then fed from each oscillator into a single carrier and is piped around to the individual positions where the radio experts are at work testing the receivers as they come from the production lines.

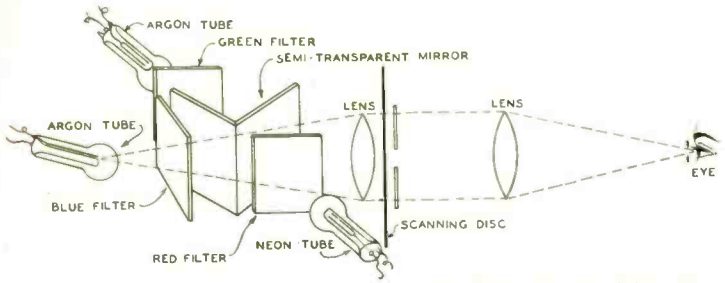
The testers use these signals on the three different wavelengths to test the ability of the receiver to pick up and amplify a signal to the same degree as a standard receiver by which their position is calibrated. The degree of sensitivity of the receiver is measured by meters, and all the various tests to which the receivers are subjected are made by means of measuring instruments rather than by listening.

Television in Color

Natural Color Television Accomplished Through the Use of Three Sets of Special Photoelectric Cells and Color Filters

*By Herbert E. Ives**

OVER two years ago Bell Telephone Laboratories demonstrated a practical system of television. For the first time successful representations of objects at rest or in motion were transmitted electrically—over wires or through the ether—for considerable distances. The reproduction of the scene then transmitted was in monochrome—the orange-red color of the neon lamp. Recent developments of the laboratories, however, have made it possible to reproduce scenes with their true color values. The appearance of reality in the reproduced scene is thus greatly enhanced.



One semi-transparent mirror reflects red light from the neon tube; one reflects green light from one argon tube, and through both mirrors passes blue light from the other argon tube.

One of the most significant features of this new achievement is that it does not require completely new apparatus. The same light sources, driving motors, scanning discs, synchronizing systems, and the same type of circuit and method of amplification are used as in the monochromatic system. The only new features are the type and arrangements of the photoelectric cells at the sending end, and the type and arrangements of the neon and argon lamps at the receiving end. The outstanding contributions that have made the present achievement possible are a new photoelectric cell, new gas cells for reproducing the image, and the equipment associated directly with them.

New Type Photo-Cell

To render the correct tone of colored objects, it was neecssary to obtain photoelectric cells which—like the modern orthochromatic or panchromatic plate—would he sensitive throughout the visible spectrum. This requirement has been satisfactorily met. Through the work of A. R. Olpin and G. R. Stilwell a new kind of photoelectric cell has been developed, which uses sodium in place of potassium. Its active surface is sensitized by a complicated process using sulphur vapor and oxygen instead of by a glow discharge of hydrogen as with the former type of cell.

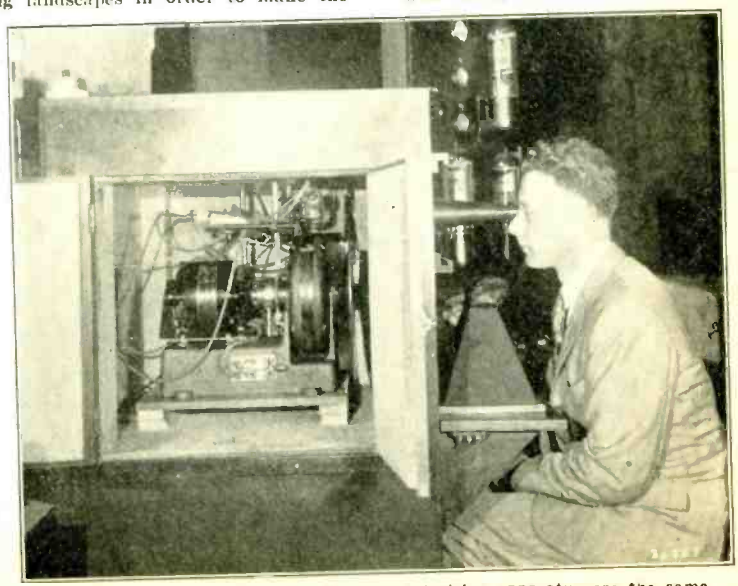
The response of the new cell to color, instead of stopping in the blue-green region, continues all the way to the deep red. Because the former potassium cells were responsive only to the blue end of the spectrum, objects of a yellowish color appeared darker than they should have and the tone of the reproduced scene was not quite correct. This disadvantage applied particularly to persons of dark or tanned complexion. When the new cells are used in the original television apparatus and with yellow filters—similar to those used in photographing landscapes in order to make the blue sky appear properly dark—this defect is corrected and the images assume their correct values of light and shade no matter what the color of the object or the complexion of the sitter. It is the availability of the new photoelectric cells which makes color television possible by their use.

The development of color television has been greatly simplified by the fact that as far as the eye is concerned any color may be represented by the proper mixture of just three fundamental colors—red, green, and blue. This fact was utilized in the development of color photography, and all the research that had been done in that field was available as background for color television. A host of methods of combining the three basic colors to form the reproduced image was available but, insofar as the sending or scanning end is concerned, a method was developed which has no counterpart in color photography. The method of "beam scanning"—used in the first television demonstration[1]—has been employed.

Color Filters

To apply this method to color television, three sets of photoelectric cells are employed in place of the one set used before. Each of these sets is provided with color filters made up of

[1] *Bell Record, June,* 1928. *page* 325.

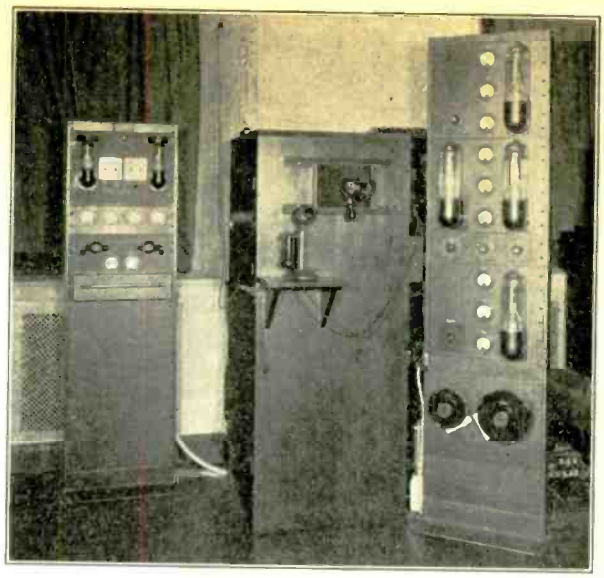


The disc and motor drive for the color television apparatus are the same as for monochromatic television. The mirror and colored filters are in the small box behind the disc, at the right side of the cabinet. Note the disposition of the tubes.

**Member of the Technical Staff, Bell Telephone Laboratories.*

sheets of colored gelatine. One set has filters of an orange-red color which make the cells see things as the hypothetical red sensitive nerves of the retina see them; another set has yellow-green filters to give the green signal, and the third set has greenish-blue filters which perform a corresponding function for the blue constituent of vision. The scanning disc and the light source are the same as with the beam scanning arrangement use in monochromatic television. The only difference is in the photoelectric cells, and thanks to the tri-chromatic nature of color vision, it is only necessary to have three times the number of cells used previously to reproduce all colors. Three series of television signals, one for each set of cells, are generated instead of one and three channels are used for the transmission of the television signals.

The photoelectric cell container, or "cage," has been built in a somewhat different form from that used in our first demonstration. There three cells were used arranged in an inverted "U" in a plane in front of the object. In the new photo-cell cage twenty four cells are employed, two with "blue" filters, eight with "green" filters, and fourteen with "red" filters. These numbers are so chosen with respect to the relative sensitiveness of the cells to different colors that the photoelectric signals are of about equal value for the three colors. The cells are placed in three banks, one bank in front of and above the position of the scanned object, one bank diagonally to the right, and another bank diagonally to the left, so that the cells receive light from both sides of the object and above. In placing the cells they are so distributed by color as to give no predominance in any direction to any color. In addition large sheets of rough pressed glass are set up some distance in front of the cell containers so that the light reflected from the object to the cells is well diffused.



The complete apparatus at the receiving end. On the left is the synchronizing panel and on the right are the amplifiers for three channels. In the center is the cabinet containing the scanning disc, the argon and neon lamps, and the color filters.

The television signals produced in the color sensitive photoelectric cells through the color filters are no different electrically from those used in monochromatic television. Three sets of amplifiers are required, one for each color, and three communication channels in place of one, but the communication channels are exactly similar to those which were used with the same scanning disc before.

For color television the three images must be received in their appropriate colors, and viewed simultaneously and in superposition. The first problem was to find light sources which, like the neon lamp previously used, would respond with the requisite fidelity to the high-frequency signals of television, and at the same time give red, green, and blue light. With such lamps available a decision would have to be made as to how the three colors could best be combined to form a single image.

Methods of Reception

Several methods of reception are possible. For displaying the transmitted image to a large audience a grid[2] could be employed similar to that used for the earlier demonstration but it would consist of three parallel tubes instead of a single one.

Thus far the television images have been received in a manner similar essentially to our method for monochromatic television. The surface of a disc similar to that used at the sending end is viewed, and the light from the receiving lamp is focussed on the pupil of the observer's eye by suitable lenses. To combine the light of the three lamps, they are placed at some distance behind the scanning disc and two semi-transparent mirrors are set up at right angles to each other but each at 45° to the line of sight. One lamp is then viewed directly through both mirrors and one lamp is seen by reflection from each, as illustrated by the accompanying diagram.

The matter of suitable lamps to provide the red, green, and blue light has required a great deal of study. There is no difficulty about the red light because the neon glow lamp which has been used previously in television can be transformed into a suitable red light by interposing a red filter. For the sources of green and blue light nothing nearly so efficient

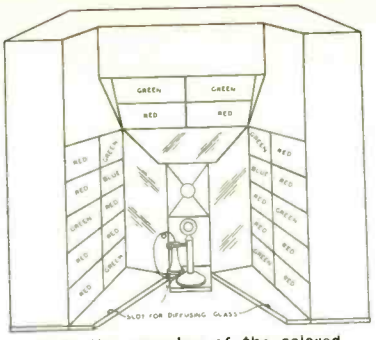
Side view of sending apparatus with cabinet doors removed. With the exception of the photoelectric cabinet at the left, the apparatus is identical with that used for monochromatic television.

[2] *Bell Record, May,* 1927, *page* 319.

as the neon lamp was available. The decision finally made was to use another one of the noble gases—argon—which has a very considerable number of emission lines in the blue and green region of the spectrum. Two argon lamps are employed, one with a blue filter to transmit the blue lines and one with a green filter transparent to the green lines of its spectrum.

These argon lamps unfortunately are not nearly so bright as neon lamps and it was, therefore, necessary to use various expedients to increase their effective brilliancy. Special lamps to work at high current densities were constructed with long narrow and hollow cathodes so that streams of cold water could cool them. The cathode is viewed end-on. This greatly foreshortens the thin glowing layer of gas and thus increases its apparent brightness. Even so it is necessary to operate these lamps from a special "I" tube amplifier to obtain currents as high as 200 milliamperes.

The receiving apparatus at present consists of one of the 16 inch television discs used in our earlier experimental work. Behind it are the three special lamps and a lens system which focusses the light into a small aperture in front of the disc. The observer looking into this aperture receives, through each hole of the disc



How the grouping of the colored filters before the color-sensitive photoelectric cells is arranged.

as it passes by, light from the three lamps—each controlled by its appropriate signal from the sending end. When the intensities of the three images are properly adjusted he therefore sees an image in its true colors, and with the general appearance of a small colored motion picture.

Difficulties Presented

Satisfactory television in colors is a far more difficult task than is monochromatic television. Errors of quality which would pass unnoticed in an image of only one color may be fatal to true color reproduction where three such images are superimposed and viewed simultaneously. In three-color television any deviations from correct tone rendering throw out the balance of the colors so that while the three images might be adjusted to give certain colors properly, others would suffer from excess or deficiency of certain of the constituents. A further source of erroneous color exists at the scanning end. If the light from the object were not distributed equally to all the cells, the object would appear as if illuminated by lights of different colors shining on it from different directions.

Color television constitutes a definite further step in the solution of the many problems presented in the electrical communication of images. It is, however, obviously more expensive as well as more difficult than the earlier monochromatic form, involving extra communication channels as well as additional apparatus.

Group Address System Used at R.M.A. Show

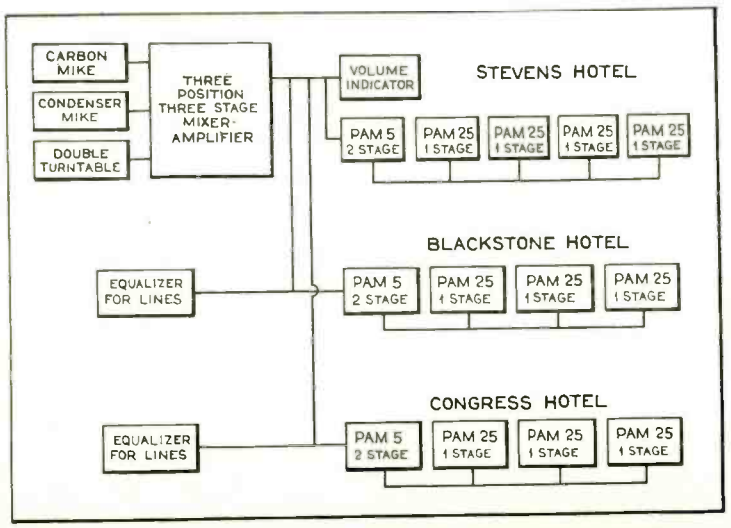
Description of a Centralized Amplifier and Speaker Network

*By A. Earl Cullum, Jr.**

FROM June third to seventh, inclusive, the third R.M.A. Radio Trade Show was held in Chicago. This was the largest show of its kind ever held and presented some very interesting problems because of the magnitude upon which it was carried on. Exhibits and demonstration rooms covered three of Chicago's large hotels; the Stevens, the Blackstone, and the Congress, located in a group on Michigan Boulevard.

A radio show would not be complete without a group address system of modern design. Such systems have in the past often consisted of a mediocre amplifier driving a few scattered horns and it was rightfully dubbed a "loud-speaking system" by the public. This year, in order to compete with other advances, more was required. The United Reproducers Corporation and the Samson Electric Company undertook the problem, and this time not to cover one hotel but to simultaneously cover three. All music and announcing was to originate in the show manager's office in the Stevens Hotel and to be reproduced in the lobbies and exhibit halls of the hotels. Such a system is somewhat unique and it is thought that a somewhat more detailed description might be of interest.

* *Engineering staff of Samson Electric Co., and WFAA, Dallas.*



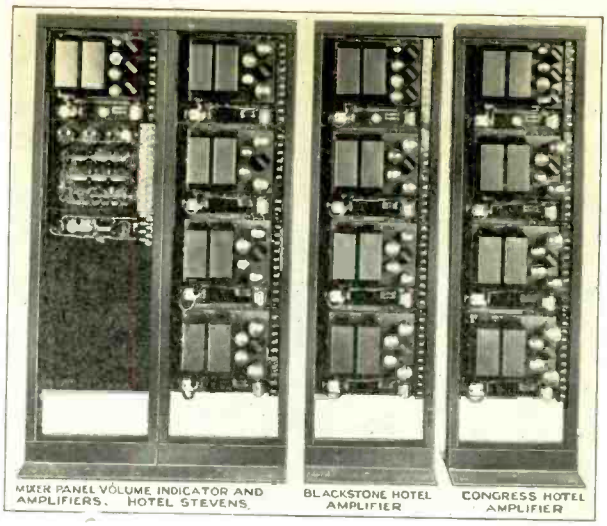
Layout of the equipment which comprised the group address system. Each one stage amplifier fed twelve speakers.

A high-quality carbon microphone and its control switch was installed on the desk of Mr. Clayton Irwin, the show manager, for his personal use during the show. An acoustically treated studio was built and in it was placed a condenser type of microphone for the use of Mr. John Stanford of WGN, the official announcer during the show. Music was provided by a double turn-table and associated pickup arrangement. These three sources of audio were connected to a three-stage, three-position, high-level mixing amplifier which brought the level up to zero volume.

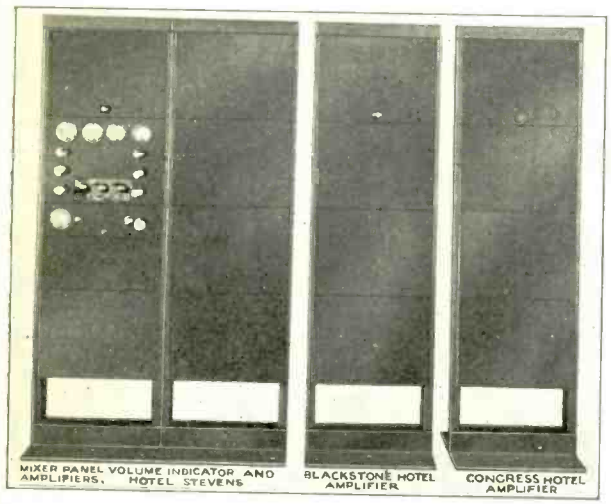
The Amplifier Network

This amplifier fed the input of a volume indicator, the input of the

Hotel Stevens power amplifier, and the two equalized telephone lines connecting with the other hotel power amplifiers. The amplifiers used were the standard Samson amplifiers, mounted on 14" x 19" steel panels so that they might be set on standard frames. A power amplifier consisted of a two stage amplifier as a basic and one power stage to drive the speakers. The basic amplifier has a 227 in the first stage and two 112-A tubes in push-pull for the second. The power stage consists of the required number of PAM 25 amplifiers in parallel to give the desired output, the PAM 25 being a single push-pull stage of 250s. At the Stevens Hotel four PAM 25s were used, while at the Blackstone and Congress only three were required. The ten amplifiers gave a power output of 150 watts. Each PAM 25 drove twelve of the United Reproducers Corporation's new Kylectron condenser speakers.



Rear view of the mixer and amplifier racks. Each of the three right hand racks carries a two stage amplifier, the basic amplifier unit, which feeds three single stage power amplifiers employing 250s in push-pull. The two-stage amplifier for the Stevens Hotel is mounted on the mixer rack, the second rack carrying four power stages.



Front view of the amplifier racks installed in the three hotels. The first rack, installed in the Stevens Hotel, contains the three-position, three-stage, mixer amplifier, a two-stage amplifier, the volume indicator and the necessary controls. The microphones and pickups fed into this panel.

making a fraction over one watt of power available for each speaker. There were forty Kylectrons in the Stevens Hotel exhibition hall, twenty-eight in the Blackstone Hotel ballroom, twenty-eight in the Congress Hotel Gold Room, and eight in the lobby of each hotel. This gave a total of one hundred and twenty speakers, all or any part of which could be used by proper switching.

Layout of Equipment

The actual layout is self-explanatory from the accompanying sketch and pictures. At the Stevens Hotel two frames were used to mount the apparatus. At the top of one was mounted the basic amplifier, next the high-level mixing speech input equipment and below that the volume indicator, an instrument that is invaluable for the proper control of group systems. On the other Stevens Hotel frame was mounted the four paralleled power stages. The Blackstone and Congress frames were similar to each other, a basic amplifier being located at the top of the frame and three parallel power stages below. It will be noticed that the tubes were mounted horizontally but not the least bit of trouble resulted.

The input speech amplifier and volume indicator were the only special built units used and thus were the only part that was battery operated, all the remaining equipment being operated from the a-c. supply.

The over-all characteristic of this system was excellent with only ½ a db. drop at 60 cycles. The high end went up to a point where, with the Kylectron speakers, a 8,000 cycle tuning fork, struck before the condenser transmitter, was heard at full value over the entire system.

To make the system flexible switches were available whereby lobbies could be cut out and equivalent capacities substituted. Hotel lines could be cut out and suitable loads imposed. If any one section of the output system had refused to function for any reason whatever, that panel could be switched off without any reflection back into any preceding stages and only affecting 12 speakers spread over a small area.

This apparatus was tested and given the final engineering OK some thirty hours before the opening of the show and from that time to the last minute of the show not one bit of trouble was encountered. By use of the great number of speakers and by each running at a comparatively low level, a very effective system resulted without any noticeable echo or resonant effects in the halls. This system, without a doubt, proved that a group address system, if properly designed and operated, could be as effective as a well designed loudspeaker in the home.

HOTEL WINS RADIO SUIT

THE right of hotels owning central receiving sets to receive and transmit to guest rooms over loudspeaker systems copyrighted music broadcast from radio stations was upheld by Federal Judge Merrill E. Otis, at Kansas City, April 18th.

The decision, said to be the first of its kind, was handed down in the suit of the American Society of Composers, Authors and Publishers against the La Salle Hotel of Kansas City.

The decision drew a line between radio programs and talking machine records and the plaintiffs were awarded $250 damages for alleged transmission of a record by the hotel.

Judge Otis held that in the case of the radio program, the hotel owners did not perform the copyrighted work but merely provided means by which it might be heard.

"The right to perform a musical composition does not carry with it a proprietary interest in the waves that go out upon the air," the decision said.

Electromagnetic Phonograph Pickups

The Design and Interpretation of Pickups and the Reproducing Network, With a Preface on Mechanical and Electrical Reproducing Systems

*By George B. Crouse**

PART I

IT is the purpose of these articles to discuss broadly the subject of electromagnetic phonograph reproduction from disc records, and more particularly the design and construction problems of the electromagnetic pickup device.

The process of electromagnetic reproduction of sound from disc records comprises picking the vibrations off of the surface of the revolving record with a needle or stylus, transmitting them to a tiny electric generator, or pickup, where they are converted into corresponding electric oscillations, amplifying these oscillations in an audion amplifier, and reconverting the amplified oscillations into mechanical or sound, vibrations by means of a reproducer, or loudspeaker.

One is struck at the outset with the complexity of this process and the apparatus required to carry it into practice, in contrast with the simplicity of the older mechanical phonographs, in which the vibrations of the stylus were transmitted directly to an acoustical diaphragm working into a horn, and one may reasonably inquire whether sufficient advantages are gained with the electrical method to justify the added complexity and cost of apparatus.

Mechanical vs. Electrical Reproduction

Except where extreme portability of the apparatus is the prime consideration, the answer to this question is an unqualified affirmative.

In the first place, in the mechanical phonograph, the volume of sound obtainable is limited by the amount of energy which it is possible to abstract from the groove of the record, without undue wear. Obviously, in the electrical apparatus, the volume of sound may be made anything we wish by suitable amplification, without increasing record wear.

The importance of this feature will be immediately apparent in such applications as the talking movies, where it would be impossible to fill the large auditoriums with a mechanical phonograph, but is a simple matter with the electrical device. The importance of large available volume is not so apparent in apparatus designed to be used in the home, until one has had the experience of trying to follow the rhythm of the music from a mechanical instrument above the noise incident to six or eight dancing couples at a house party.

Further, the control of the volume of sound from a mechanical phonograph is still an unsolved problem. Two methods have been used. Either the horn is throttled somewhere in its length, in which case its acoustic properties are radically changed, and always for the worse on small volumes, or needles of different stiffness are used to secure differences in volume. This latter method also has the serious defect of altering the tone quality as well as the volume; unfortunately, the needle forms an important element in the acoustic system starting at the surface of the record and terminating at the input of the horn and it is impossible to design this acoustical system to remain unaltered with different needles. With the electric phonograph, resistance potentiometers are used, which make possible the control of volume without the slightest distortion, from the merest whisper to the maximum capabilities of the apparatus, by the simple turn of a knob.

Fig. 3. A modern pickup mounted on a "tone arm."

In the matter of tone quality, the electric device has a tremendous advantage, because it can correct the unavoidable defects in the record. It is impossible to cut a disc record with a flat response curve. That is, both the very high and the very low frequencies must be relatively reduced in amplitude.

Record Limitations

Consider the "lateral cut" record, the type in most general use. In this type, the sound is recorded in the form of a wavy groove, causing the needle point to vibrate at right angles to the direction of travel of the record surface. Given a diameter of record, rate of revolution and time of playing, it will be apparent that a certain total number of grooves will be required, and that in practice the required conditions will space these grooves very close together. Since, for a given energy, the amplitude of the wave in the groove will be larger, the lower the frequency of the note to be reproduced, it is necessary to sacrifice base note amplitude to avoid cutting through from one groove to another. The limitation on the amplitude of the very high frequencies arise from a somewhat different cause. At the higher frequencies, the radius of curvature of the wave decreases, and finally becomes so minute that unless very small amplitudes are used, the stylus will cut away the sides of the groove very rapidly. It is, therefore, necessary to sacrifice amplitude in the very high register also. In the mechanical phonograph it is difficult, if not impossible, to compensate for these defects in record construction, whereas in the electrical apparatus, it is a simple matter to introduce compensating variations in the response curve, by suitable design of the pickup or amplifier.

A further advantage of the electrical system lies in the fact that filters may, at the discretion of the designer, be introduced into the system, whereby the unavoidable surface noise of the record may be reduced to a considerable extent, without serious loss in tone quality. While the surface noises cover a wide band of frequencies, the most objectionable portion of the scratch has a frequency range of somewhere between 4,000 and 5,000 cycles. Accurate band suppression filters may be introduced to reduce the response at these frequencies.

It will thus be seen that the electric phonograph has many and important advantages over the older mechanical devices. As a practical matter, the cost to the consumer who has, or is acquiring, a radio receiver, is less than the cost of a mechanical phonograph, since the audio amplifier and reproducer of a modern receiver are perfectly adapted for phonograph amplification and reproduction, and the only additional elements required are the pickup and the turntable, both of which are obtainable at small cost.

Radio and Phonograph

When radio broadcasting first came into prominence, it was a common belief that it would completely super-

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cede phonograph reproduction, but it is now generally realized that the two devices are complimentary instead of mutually exclusive. For the instantaneous transmission of the accounts of games, and events of timely interest, of political debates, speeches, etc., the radio, of course, has the field to itself, but for the best reproduction of music of all kinds, the phonograph is superior and will probably remain so. There are several factors which contribute to this superiority of the phonograph.

In the first place, electrical phonograph reproducing apparatus operates directly from the pickup into an audio amplifier, and the distortion introduced by the radio amplifiers and the detector is eliminated. In modern receivers, which must have a high degree of selectivity because of the large number of powerful broadcasting stations operating in small areas, the phenomenon of "sideband cutting" is usually present in greater or less degree, with resulting loss of high frequencies. It must also be admitted that in nine cases out of ten, a radio receiver is not properly tuned, so that sideband cutting will be present, even though the receiver is perfectly designed. The detector is also responsible for some distortion, due to the introduction of second and higher harmonics.

All sound reproducing means have an inevitable background of undesirable noise. This background noise in radio reproduction is due to a great number of factors, among which are: detector tube noise (due to slight variations of grid charge), true static due to atmospheric discharges, noises due to transients in nearby electrical circuits, microphonic noises, carrier wave noises (due to slight variations in the carrier radiation) and many others. The phonograph has only one source of background noise, that due to irregularities in the surface of the record. As a result, only on very rare occasions does radio reproduction approach the phonograph in low volume of noise background.

Not only is this superfluous sound of the noise background objectionable in itself, but where it is large, or variable, it introduces a limitation in the reproduction which, in the case of music, is very serious. To explain this limitation, it will be necessary to digress to discuss the human ear and its associated mental apparatus. Hearing is, of all the senses, the most easily tired. Whether this is due to fatigue in the ordinary physiological sense, or due to boredom on the part of that section of the mind which is associated with the ear, is uncertain, but that the fact itself is true, will be apparent to anyone who recollects his discomfort when forced to listen to some monotonous sound or cadence, or even to one of those unfortunate individuals whose speech is unmodulated and flat. As a result of this characteristic of hearing, music, to be pleasing, must be an ever-changing, ever-contrasting series of sounds. These changes and contrasts must take place in every characteristic of sound. Not only must the pitch change, the tone quality change, but the volume must change as well. This last point has often been overlooked, even by musicians.

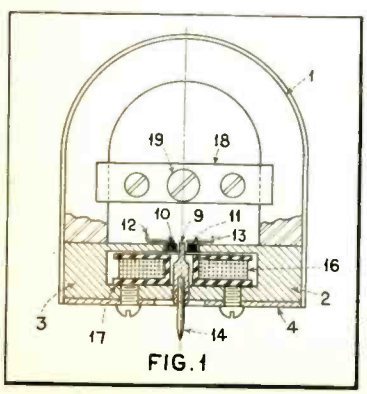


FIG. 1

The front elevation of a pickup head. The different parts are explained in the accompanying text.

The value of volume contrasts in adding to the beauty of music will be apparent to anyone who has listened to a dance orchestra playing for a dance, and the same orchestra playing the same selections in an auditorium for concert purposes. The difference in the beauty and interest of the music is amazing. The reason is that when playing for dancing, the lower limit to which the volume can be reduced, is limited by the fact that the sound must be sufficiently loud to be heard above the noise background of the dancing, and the possible volume contrasts are greatly reduced[1], whereas, when playing in a hall, with a quiet audience, the sound can be reduced almost to a whisper, or may rise to the maximum of which the instruments are capable.

The difference between an orchestra playing for dancing and for concert is an almost exact analogy to an orchestra playing for radio and for phonograph reproduction. In radio reproduction, the large amount of background noise which must be allowed for, requires a comparatively constant volume level, and volume contrast is almost entirely lacking. In the phonograph, however, the background noise is small, practically constant and known, so that much larger contrasts in loudness can be obtained, with a resultant of greater interest and beauty in the reproduced music.

Still another factor which makes for better reproduction from a record lies in the fact that more time and greater care can be taken in rehearsing before recording, than would be practical in most radio programs. It is well known that the arrangement of pieces in an orchestra when playing for a present audience is quite different from that required for reproduction, and the latter arrangement is a matter of experimentation in every individual case. Radio programs, which must be new every week and must be rehearsed in studios which are greatly in demand, obviously cannot be brought to the state of perfection which is practical in the case of record making. It is also obvious that mistakes in the rendition cannot be corrected in radio reproduction[2], whereas, this is always done in the case of the phonograph.

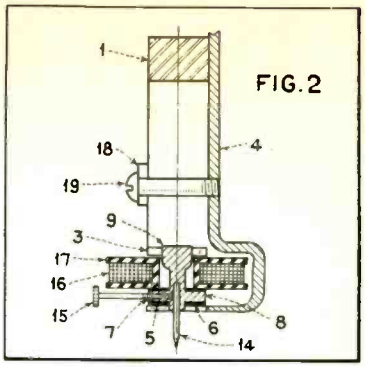


FIG. 2

The side elevation of the pickup shown in Fig. 1.

For these reasons, for one who desides the highest quality in musical reproduction, it will be apparent that the phonograph offers many advantages over the radio.

In the electric phonograph, the problems of design of the amplifier and loudspeaker are no different than in the design of the same apparatus for radio reproduction. In fact the same apparatus is used interchangeably for both. Since both of these elements have been fully discussed in the current literature, we will pass directly to the discussion of the electromagnetic pickup, the device which forms the heart of the electric phonograph.

Electromagnetic Pickups

In Figs. 1 and 2 are shown respectively a front elevation and a vertical section of a modern pickup head of usual design. A "U" shaped permanent magnet of alloy steel, designated by the numeral 1, is provided with the soft iron machined pole pieces 2 and 3, which are generally supported and aligned against the back plate 4, of non-magnetic material, by screws, as shown.

The adjacent ends of the lower legs of the pole pieces are hollowed out to support the pair of tubular soft rubber bearings 5 and 6, through which project the shaft extensions 7 and 8 of the soft iron armature 9. This armature extends upward between the upper legs of the pole pieces and is centered there between by the two

[1] *A condition that can be rectified somewhat by the super-amplification of reproduced music.*

[2] *Suggesting canned programs as a worthy contribution to the art of broadcasting.*

soft rubber blocks 10 and 11 carried in the adjustable metal holders 12 and 13.

The lower end of the armature is provided with a broached hole into which the stylus 14 is inserted and clamped in position by the stylus screw 15.

Surrounding the armature is the coil of fine copper wire 16 wound in the bakelite form 17. The leads of this coil are brought out to terminals carried on the terminal block 18, which is clamped against the back plate by the long screw 19, and is thus made to serve additionally as a clamp for the permanent magnet. The entire mechanism is enclosed in an ornamental pressed metal cover not shown in the figures.

The complete pickup head is mounted on a "tone arm," a common form of which is shown in the photograph of Fig. 3, with pickup head attached.

The usual method of connecting the pickup to its associated electrical circuits is shown in diagramatic form in Fig. 4, in which 16 is again the coil in which the electrical oscillations are generated. Connected directly across the coil is the resistance 23, of suitable value, and provided with the hand adjustable contact 24, forming a potentiometer, the output leads of which are connected to the primary of the first audio transformer 25. The balance of the amplifier and reproducer circuits are standard, and need no description.

When the pickup is mounted in playing position on a moving record, the lateral variations in the record groove cause the point of the stylus to vibrate, which in turn vibrates the armature. Movement of the armature between the poles causes a corresponding variation in the magnetic flux supplied by the permanent magnet to be diverted through the armature and therefore through the coil, thus generating a corresponding electrical oscillation, which is properly attenuated by the potentiometer, amplified in the amplifier and reproduced in the loudspeaker.

Interpretation of Systems

It will be seen that the pickup and its associated electrical apparatus form a coupled mechanical and electrical and electrical system, for the conversion, transmission and amplification of a band of frequencies lying in the acoustical range. Very satisfactory and easily handled methods have been worked out, and are familiar to all electrical engineers, for analyzing the behavior of electrical networks in the transmission of alternating currents as functions of frequency and it has recently been discovered that these same methods may be applied to the analysis of mechanical systems, by forming electrical analogs of the dynamical system under consideration. This method immediately makes available all of the short cuts which have been developed in the electrical case, to the mechanical problem, and is an extremely valuable analytical tool.

The method of forming these analogs is as follows:

Let

Mechanical force	= Electric potential
Mechanical velocity	= Electric current
Mechanical dissipative resistance	= Electric resistance
Mechanical mass	= Electric inductance
Mechanical spring compliance	= Capacitance

Consider now the simple dynamical system, shown in Fig. 5, comprising an alternating mechanical force F-F, applied to the end of a leaf spring 26, connected to a bar 27 pivoted about the axis 28 perpendicular to the plane of the paper. It is also assumed that there is some bearing friction. This system may be represented by the equivalent electrical diagram of Fig.

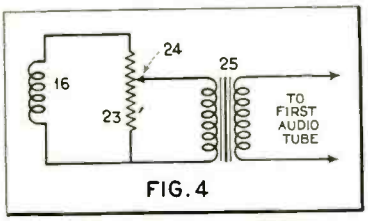


FIG. 4

The usual method of connecting a pickup to its associated electrical circuit is indicated in this diagram.

6, which we form by first representing the force F-F as a constant potential generator 29. A constant potential generator is used to represent the force because the value of the force is supposed to be constant, independent of any conditions of the dynamical system which it is driving.

The spring 26 will, of course, be represented as a condenser, and the question as to whether this condenser should be connected in series with the rest of the load, or directly in parallel across the generator is determined as follows. In the electrical case, a capacitance connected across a constant potential generator would absorb current, but would not affect the voltage in the circuit beyond the condenser; whereas, if it was connected in series between the generator and the rest of the load circuit, it would absorb voltage, and reduce the potential available beyond it.

Turning now to a consideration of the effect of the mechanical spring 26, it will be at once apparent that, due to the flexibility of the spring, it will absorb motion; that is, the end of the spring where the force is applied will move through a greater amplitude than the other end. The force available at the point where the spring is attached to the bar, however, will, within the limits of strength of the spring, be no less than the applied force. It is, therefore, apparent that we should place the equivalent capacity directly in parallel with the generator, as shown at 30.

To represent the mass of the bar 27, we first determine the moment of inertia of the bar about the axis 28, and then convert the mass of the bar into an equivalent mass at some one point of the system, as for instance, the point where the spring joins the bar. We represent this mass as an equivalent inductance. In a similar manner, we convert the friction effect into its equivalent effect at the same point.

We must now determine whether the resistance and inductance should be represented in parallel or in series. Since it is apparent that the effect of the resistance will be to reduce the motion of the bar (in other words, limit the current) we must put the resistance and inductance in series. It is obvious that the combination will be in parallel across the condenser and generator, and we, therefore, have the complete analog as shown in the figure, where the inductance is represented by 31 and the resistance by 32.

We may now determine any characteristic of the mechanical system by an analysis of the equivalent system by the usual and well known methods. In a similar manner, we may form analogs of any dynamical system of almost any complexity.

Study of Dynamical System

We are now in position to study the dynamical system of the pickup shown in Figs. 1 and 2, by forming the equivalent diagram, show in Fig. 7. The moving system is energized at the point of the stylus as the record rotates under it. This source of energy is represented by the generator 33, which in this case, is a constant current generator, for the reason that the velocity imparted to the needle point is fixed by the amplitude of the wave in the groove, and the surface velocity of the record, and is not affected by any conditions of the load, within the limits of the strength of the walls of the groove. On the other hand, as in a constant current generator, the pressure applied to the point of the needle will be determined by the load conditions.

From the previous explanations, it will be clear how the balance of the diagram is determined.

34 represents the compliance of the stylus.

35 represents the total mass of the pickup and the mass of the tone arm effective at the center of mass of the pickup head. It is this quantity which prevents the pickup head, as a whole, following the variations in the record groove.

36 is the equivalent of a transformer, and represents the fact that the distance between the pivot axis of the armature and the point of the stylus is different from the distance between the pivots and the center of the active upper magnetic air gaps. This factor is required to be represented in the

diagram because we are interested in the motion of the armature at the center of these upper gaps.

37 represents the compliance of the rubber bearings in a direction parallel to the normal motion of the needle point. These bearings are slightly compressible, and this results in a slight absorption of motion between the stylus point and the upper gap.

38 represents the energy absorbing factor in the rubber bearings, due to the motion explained under 37.

39 represents the compliance of the rubber bearings to normal rotary motion. This is represented as a series capacitance, since it does not absorb motion (equivalent to current) between the stylus point (generator) and the active gap.

40 represents the energy absorbing factor in the rubber bearings, due to the motion explained under 39.

41 represents the effective mass of the armature to normal motion.

42 represents the compliance of the rubber blocks.

43 represents the energy absorbing factor of the rubber blocks.

44 represents a quantity which has no actual equivalent in electrical circuits, but which may be regarded as a negative capacity. It represents the upsetting pull on the armature due to the difference in the flux values in the two upper gaps when the armature is displaced from its center position.

45 represents the effect of the electrical circuit as reflected into the mechanical.

The behavior of the mechanical system may now be completely determined from the characteristics of the equivalent electrical system.

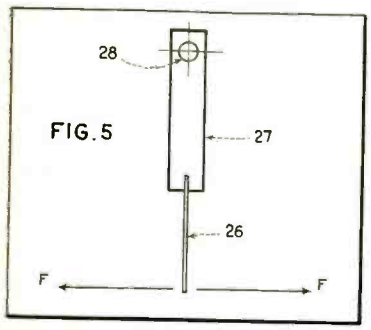


FIG. 5

A simple dynamical system of the needle and armature of a pickup.

The design of the mechanical system must be determined in relation to the following factors of performance.

(1) Sensitivity of the device.

(2) The wear which the device imposes on the record at all frequencies.

(3) The shape of the response curve, (generated voltage versus frequency) which determines the quality of the reproduced sound.

Sensitivity and Record Wear

Considering first the matter of sensitivity, as affected by the design of the mechanical system, and remembering that 33 represents a *constant current* generator, it will be apparent that all impedances in shunt with the generator should be as large as possible, to prevent the by-passing of current (velocity of motion). Thus, we should, for high sensitivity, use as stiff a needle as possible, so as to keep the quantity 34 high, and for the same reason, there should be as little side sway in the bearings as possible, in order to keep impedances 37 and 38 high.

Similar reasoning in regard to the impedances in series between the generator and the load, shows that the values of these elements should be kept low. Thus, the quantity 41, representing the mass of the armature should be made small, or, in other words, the armature should have a very low moment of inertia; and similarly for the other quantities in series.

The above considerations apply, of course, at frequencies other than a natural frequency. The system will have natural periods of vibration, and some of these will in practice, lie within the range of frequencies to be translated. At these frequencies, the output will be limited only by the dissipative losses.

Record wear occurs because of pressure, corresponding to the voltage of the stylus point against the side of the groove, and this pressure, which the generator is required to deliver, will be different at different frequencies. As in any constant current generator, the voltage which the generator will be called on to deliver, will depend on the impedance of the load, the higher the impedance, the higher the voltage delivered. The shunt impedances will all, therefore, tend to decrease the voltage, and, therefore, the record wear. The series impedances will play the decisive part, and it will be obvious that the total series impedance should be as small as possible. At the low frequencies, it will be the effective mass of the armature which will be important, whereas at high frequencies, the quantity 42, representing the compliance of the rubber blocks, will be the controlling factor.

Summing up these observations, we note that in order to obtain the desirable characteristics of high sensitivity and low wear on the sides of the record groove, an armature of small effective mass should be employed, centered by rubber blocks of small stiffness.

Response Curve

The response curve is a curve plotted with frequency as abscissa and voltage generated in the electrical system by the pickup with constant velocity of the stylus point, as ordinate. A theoretically perfect pickup working into a theoretically perfect amplifier and reproducer, should have a response curve forming a straight horizontal line: in other words, the voltage generated by the pickup should be the same at all frequencies for the same velocity of the needle point. In practice, using present amplifiers and reproducers, it is desirable that the pickup should deviate from this theoretical, as pointed out in the early part of this article. For our present purposes, however, we may assume that the theoretical form is the desired one, and examine the equivalent diagram, Fig. 7 from this standpoint. It will be clear at once that if the

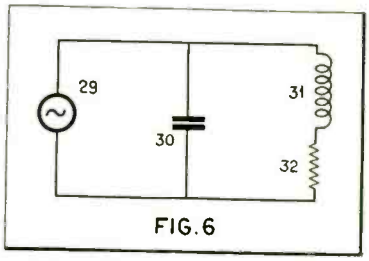


FIG. 6

The equivalent electrical diagram of Fig. 5.

system contained no dissipation, or in other words, was undamped, that the voltage generated at different frequencies would be widely different, because of the varying impedance of the system as a whole. At the points of natural frequency, the impedance would be small and the response abnormally large, or the reverse, and the response curve would consist of a series of sharp peaks and deep valleys. In order to avoid this, damping is introduced by means of the soft rubber bearings and rubber blocks. Rubber has a very high internal, or molecular friction, which makes it most suitable for this purpose, although it has the disadvantage that its use in the system also introduces a reactive effect because of its springiness.

Amount of Damping

The amount of damping which will be required to produce a response curve of satisfactory shape will depend upon the amount of energy stored in the reactive elements of the system. For the shunt elements, the larger the value of impedance, the smaller the energy which will be absorbed. For instance, if the stylus were infinitely stiff, it would transmit to the armature all of the motion imparted by the record to its point, and thus would store no energy in itself. Conversely, the values of the series elements, such as the effective mass of the armature, the spring reactance introduced by the rubber blocks, etc., should be made low if small dissipation in the system is desirable.

It is desirable that the losses in the system be small for two reasons. In the first place, large dissipation means reduced efficiency or lowered sensitivity. Secondly, the energy to supply the damping losses must be taken from the record, and the larger the energy required, the greater the record wear.

Turning again to the equivalent diagram of Fig. 7, consider the quantity 44, representing the effect of the electrical system as reflected into

the mechanical. The significance of this quantity should be clearly understood. It is the load impedance in the mechanical system, and all of the mechanical energy dissipated in it is converted into electrical energy in the electrical system. Its relation to the other quantities in the diagram indicates that the greater its relative value, the greater will be the efficiency of the device as a converter.

(To be continued)

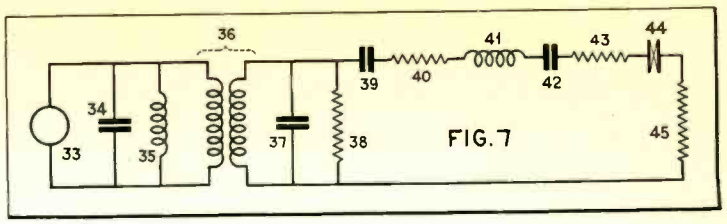


FIG. 7

The equivalent diagram of the pickup shown in Figs. 1 and 2.

Problems Confronting the Radio Industry

Judge Van Allen Warns R. M. A. Members Against Evils of Over-Production

HON. JOHN W. VAN ALLEN, Legal Counsel of the Radio Manufacturers Association, told delegates at the Fifth Annual Convention:

"We have a few fundamental matters which concern this industry requiring immediate attention. Among these will you permit me to mention five?

1. The proposal to make broadcasters by legislation, public utilities or common carrier.

As business men the full significance of such a proposal does not readily occur to you.

You are engaged in a field of endeavor where except for the anti-trust laws you are not subject to governmental regulations of sale. You may sell whom you please on such terms as you please or you may refuse to do so, whereas public utilities or common carriers have no such choice but must sell to everyone who pays the price fixed by a governmental commission.

We cannot conceive of the listening public tolerating programs of broadcast made up of a miscellaneous mass of material produced by the forced acceptance of any program offered for which the prescribed rate has been paid, regardless of quality, human interest or entertainment.

The public expects that the operator of broadcasting stations will select for it such material as will hold its attention and discard for it all material that will not. This material cannot be selected for in the same manner that street cars take their riders or as railroad companies sell tickets or as telephone or telegraph companies accept messages, or gas or electric companies accept consumers. These public utilities function by public necessity and lack of discrimination and selection conforms rather than conflicts with the public interests.

Radio broadcast comes rather in the class of newspapers, periodicals, magazines, musical and theatrical productions where the delicate ear or eye of the expert must be utilized. No one so far has been able to convince the public that these mentioned means of information and entertainment should be supervised by government commission or reading matter selected or plays produced in the order in which they are offered.

2. The proposal to tax the user of radio receiving sets either through the manufacturer, jobber, dealer or buyer or through the broadcasting station.

Common aims and intelligent action by a united people, the dissemination of information, education and cultured entertainment should be encouraged rather than restricted by special charges by way of taxes.

We hear much that radio bears a tax in England but we emphasize again that radio broadcasting stations in England are managed by the government and the tax imposed to pay the expense of programs, whereas we in the United States have accepted private ownership and payment of expenses by sponsors of programs that are given free to the listeners.

We do not object to the payment of ordinary taxes imposed on property and income on the same basis as others are taxed, we do, however, in the interest of all concerned and particularly upon the radio listeners upon whom the burden would ultimately rest characterize the proposal of special taxes wholly unjustified. Even the expense of government supervision amount to less than four mills for each possible listener, in a population of one hundred fifteen million people and no such petty tax in our opinion would be with popular approval.

3. The proposal to hamper installation of radio receiving sets by the adoption of local ordinances requiring the approval of local boards or bureaus, whether established by the behest of selfish interests or on the pretense of fire risk, of which there is comparatively none, we should therefore, maintain in our respective communities a united effort to combat the species of arguments with which such ordinances are attempted to be supported.

4. The tendency of radio sponsors to impose on broadcasting stations, sales talks in programs.

We offer a caution to the sponsors of radio programs in this respect.

Radio sponsors need listeners to be successful. When programs fall below the standard set by those whom you wish to hear, a simple turn of the dial deprives you of an audience. The public has accepted sponsors of programs but it has not accepted sales talks as sufficiently entertaining to sustain interest.

5. Lastly, a word of caution to our own family of manufacturers. We began a new industry, public demand for radio sets was very great, we feverishly produced a supply, we have improved in production, in quality and in methods of distribution. We have learned some bitter lessons from over-production and its attendant evil of over-buying by jobbers and dealers during the few feverish months.

This experience has taught us much. We still need the steady stride of constant normal production based on reliable data of market absorption. Until we do this financial statements mean little without inquiry as to the amount of merchandise in the hands of distributors. Over-production has produced orphan sets in the past with all of the demoralizing effects which followed it. When we shall have attained constant normal production with reasonable regard to market absorption, we shall take our place in radio as the equal of any industry in the nation.

We have been entirely free as an association from any litigation or semblance of litigation. Your directors and officers have been most scrupulous in confining association activities within the lines plainly marked by the laws of the Federal government. This is as it should be for observances of the laws which prohibit oppression are as vital to prosperity as are those which foster it.

You may rest assured that this is an association, membership in which need cause you no anxiety from the viewpoint of law violations. We hope that membership in this body has engendered a like respect on the part of individual members.

The Problems of Radio Servicing

V. Further Data on the Servicing of Audio Amplifiers

By John F. Rider, Associate Editor

CERTAIN forms of trouble are associated with audio amplifiers, irrespective of type. We mentioned the various forms of coupling used in audio amplifying systems in Part IV of this series. When assembled they form audio amplifying systems. However, if we analyze any one stage, we find that with respect to the vacuum tube or tubes employed in that stage, an open grid resistance used as a grid leak, an open choke used as a grid leak, or an open transformer secondary winding will produce the same effect. The same is true of a short circuit in these units. Consequently it is unnecessary to dwell upon individual types of audio amplifiers. Of course, we shall consider at length, the various systems of securing operating potentials.

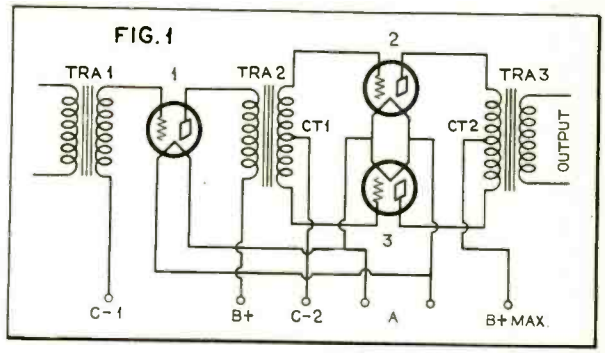
Exclusive of types of coupling units, the greatest difference between audio amplifiers is the use of a push-pull stage. In this connection, the exact location of the push-pull stage is of very little importance. What is applicable to the push-pull output stage is applicable to a push-pull first or second stage. Because of its popularity, we are going to use for the purpose of illustration a two stage transformer-coupled audio amplifier, employing a straight stage and one push-pull stage. Obviously it is impossible to designate each part of the audio amplifier and we take for granted that the reader of these pages is sufficiently versed in radio to recognize the symbols representing the respective units.

Basically the a-c. and the d-c. units are identical, the greatest difference being found in the filament circuit. It is true that the possible troubles in the a-c. unit are more numerous than in the d-c. installation, but all things considered it is possible to discuss audio amplifiers without special mention of the type of filament potential. The reason for this is that the connections to transformers, plate coupling resistances, plate coupling chokes, grid leaks and grid chokes remain unchanged in all systems, unless, of course, one particular system requires special circuit structure.

Our scope at this time is not to discuss the advantages or disadvantages of circuits, but to dwell upon trouble. Hence, push-pull stages must be arranged in a certain manner in order to secure the desired results. First, it is necessary that the direct current flow in the two halves of the windings connected in push-pull fashion be the same, in order that the effect of the d-c. in the system be eliminated. Second, that circuit continuity in the two halves be uniform, so that the operating voltages are uniformly applied to the tubes in the stage. Third, that the tubes in the stage be of like characteristics.

With respect to push-pull systems and the loads applied, it is necessary to remember that the output impedance of two tubes connected in push-pull fashion is equal to twice the impedance of one tube, since in effect the impedances are in series. This means that for maximum undistorted power output, it is necessary that the load impedance be four times the impedance of one of the tubes in the push-pull stage, or twice the impedance of the complete stage.

It is logical, in order that correct results be obtained, all circuits must be correct and that circuit continuity must be perfect. Partial shorts cannot be condoned. All circuits must be intact, and all units connected into the circuit when called for by the wiring diagram. This means that if the diagram calls for a certain unit, that unit must be in the circuit. If the results are unsatisfactory when that unit is applied the fault is in the amplifier and not in the unit applied.



A typical d-c.-operated, two-stage audio amplifier with push-pull output.

Distortion

One of the most frequently voiced complaints in audio-frequency amplifiers is distortion. Now, distortion in any one system does not limit the possible troubles in that system, because distortion may be present during two conditions of operation. First we may encounter distortion with normal signal intensity and second, we may encounter distortion with low signal level. It is, therefore, necessary to consider two conditions. However, we cannot discriminate between battery and a-c.—operated receivers, that is, to list the reasons for any one status, in each type of receiver. As a matter of fact it is unnecessary, because comment to the effect that the plate potential may be low, points definitely to the trouble in the system. It is true that the number of reasons for low plate potential are more numerous in a-c. units than in d-c. installations employing batteries, but the test to indicate low plate potential is the same in both cases. After the condition has been definitely determined, it is time to search for the cause. Following along these lines, we leave the choice of specific units in the reader's hands. If the suggested trouble is "low plate potential" and also "low B-eliminator output voltage" the reader must select the item employed in the installation being serviced. If it is a battery-operated receiver, the former applies; if it is an a-c. installation, the latter applies.

Furthermore, all units should be under suspicion and no one unit absolved from blame, because it is new. New units have been found defective. Mass production cannot provide for the elimination of each and every defective unit. Poor parts slip through. However, once a certain stage has been found satisfactory, it may be eliminated and further thought in connection with that stage is unnecessary.

With respect to distortion, we shall enumerate the possible troubles and symptoms. The remedy in each case is obvious. Where special mention is necessary, it shall be made. It is needless to suggest that a resistance be replaced when it is found defective and repair is impossible. It is needless to mention that circuit continuity must be completed when the trouble is an open circuit in any one part of the amplifier. Such operation stands to reason. Hence we proceed with the possible reasons for distortion:

DISTORTION

A. Normal signal level

(1) *Tubes overloaded.*	Signal input excessive for the tubes used in the amplifier. Output voltage from detector excessive for amplifier. Incorrect tubes in the audio amplifier.

(2) *Insufficient grid bias*	Grid bias insufficient for the values of plate potential used.
(3) *Excessive hum*	See reasons for hum.
(4) *Excessive regeneration*	See reasons for excessive regeneration.
(5) *Defect in speaker*	Speaker out of alignment, diaphragm loose, cracked.
(6) *Excessive B-battery potential*	Excessive line voltage when eliminator is used. Incorrect tap. Incorrect battery tap.
(7) *Unbalanced push-pull stage*	Partial short in winding. Non-uniform tubes. Non-uniform operating potentials.
B. Low signal level	
(1) *Insufficient filament potential*	Run down A battery. Incorrect adjustment of filament control resistance. Low line voltage in a-c. systems. Overloaded filament transformer winding. Poor contact between tube and socket. Incorrect voltage adjustment when A eliminator is used. Overloaded eliminator when series filament wiring is employed.
(2) *Insufficient B voltage*	Run down batteries. Low B-eliminator input voltage. Low B-eliminator output voltage. Incorrect tap on B-battery. Incorrect tap on B-eliminator output. Defective B rectifier.
(3) *Incorrect grid bias*	Lack of grid bias. Defective grid bias battery. Defective grid resistance. Incorrect polarity of grid bias. Incorrect grid resistance.
(4) *Defective tube*	Wrong tube. Deactivated tube filament or cathode. Poor contact between tube and socket. Gassy tube.
(5) *Open or defective grid circuit*	Transformer secondary open. Transformer secondary shorted. Open in one-half of push-pull unit. Defective grid choke. Defective grid resistance. Wrong connection to transformer secondary or grid resistance or grid choke. Grounded secondary winding. Leak between plate and grid windings or resistances (shorted isolating condenser).
(6) *Defective units*	Shorted by-pass condensers in plate and grid circuits. Defective jacks. Push-pull primary partially shorted. Leak between primary and secondary of output transformer. Shorted coupling condenser in parallel feed.

AMPLIFYING POWER WEAK

(Also see data associated with low signal level and distortion).

(1) *Lack of plate potential and defective plate circuit*	Open between tube and socket. Open in transformer primary, plate coupling resistance or coke. Short in transformer primary, plate coupling resistance or coke. Shorted plate circuit by-pass condenser.

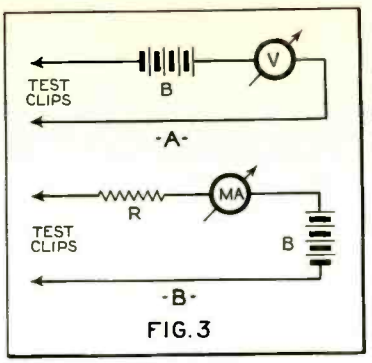


FIG. 3

Two test circuits for checking continuity.

	Open resistance or coke in shunt plate supply. Open coupling condenser in shunt plate supply.

HUM

(1) *Filament circuit*	In a-c. receivers—Incorrect adjustment of filament shunt resistance. Open filament shunt resistance. Excessive hum in output of A eliminator. Excessive hum in line supply. Reversed input connection to line. Incorrect filament circuit center tap. Coupling between filament wiring and receiver.
(2) *Grid circuit*	Open grid bias resistance condensers. Lack of grid bias resistance condenser. Open grid circuit filter by-pass condenser. Lack of grid circuit filter by-pass condenser. Insufficient grid bias voltage. Open secondary transformer winding, grid choke or grid leak resistance. Grounded secondary winding. Pick-up of external hum by audio units.
(3) *Plate circuit*	Insufficient plate voltage. Excessive plate voltage. Excessive hum in output of B-eliminator. Open primary input winding (detector stage).
(4) *Lack of ground on cores and cases and shields*	
(5) *Defective tubes*	Deactivated filaments or cathodes. Poor contact between tube and socket. A-c. tubes may hum, yet test well in tube tester. Elements out of alignment. Excessive hum in speaker eliminator.
(6) *Coupling between a-c. line and speaker cable*	
(7) *Reversed power supply plug in a-c. systems*	
(8) *Bad hum in detector output*	

HOWLING AND EXCESSIVE REGENERATION

(1) *Coupling between stages*	Lack of grounds on cores. Omission of regeneration control resistance. Audio coupling units too close to each other. Grid and plate leads too close. Coupling between speaker cable and amplifier.
(2) *Microphonic tubes*	Loose elements in tubes. Operation of speaker causes vibration of receiver cabinet and tubes in receiver. Moving air column causes vibration of tubes in receiver.
(3) *Open circuits*	Open grid circuit. Open grid bias resistance circuit. Lack of grid bias. Open in amplifier input winding (detector output). Open plate circuit by-pass condenser. Lack of grid circuit by-pass condenser.
(4) *Defective sources of potential*	Run down A battery. Run down B battery. Run down C battery. Open by-pass condenser in B-eliminator (voltage divider network and C bias resistance).

NOISE

(1) *Filament circuit*	Imperfect contact. Poor contact between elements of filament voltage control resistance. Poor contact between elements of filament shunt resistance. Poor contact between tube and socket. Defective A battery. Defective A eliminator. Momentary short in filament transformer. Corroded A battery terminals. Defective rectifier in A eliminator. Imperfect ground. Imperfect connections to A eliminator, to A battery.
(2) *Plate circuit*	Poor contact between tube and socket. Defective transformer primary. Overloaded plate coupling resistance. Excessive current flow through plate coupling unit. Defective volume control in plate circuit. Leaky by-pass condenser. Poor soldered connections. Loose terminals. Defective voltage divider resistances in B-eliminator. Defective rectifier in B-eliminator. Defective B battery. Corroded battery terminals.
(3) *Grid circuit*	Loose contact between tube and socket. Poor contact to socket. Defective grid bias resistance. Poor ground. Defective volume control in grid circuit. Leaky grid by-pass condensers. Partial short in grid choke. Defective grid leak resistance. Defective grid bias resistance in B-eliminator.

Application of Data

Suppose we apply some of this data to the two wiring diagrams shown in Figs. 1 and 2. The two stage amplifier shown in Fig. 1 is apparently a d-c. unit, consequently all the data associated with a-c. filament circuits may be ignored. However, it is necessary to consider the possibility of battery or eliminator source of filament

potential. No matter which is used, the subject is exclusive of the audio amplifier and means another discussion on potential sources. Reference to input circuits means the coupling unit connected to the dectector plate, in this case the primary winding of the first audio-frequency transformer.

The push-pull stages are the tubes marked 2 and 3 in Fig. 1. The push-pull units are TRA2 and TRA3 in the same illustration. The two halves of the push-pull windings are the windings each side of CT1 and CT2. Reference to non-uniform tubes refers to tubes 2 and 3 in Fig. 1. A partial short in one of the windings of the push-pull unit secondaries means the secondary windings in TRA2. The primary circuit of TRA3 is likewise allied with possible shorts in the push-pull transformer primary.

Discussion of the various troubles and symptoms will be made in connection with the wiring diagram of the Grebe Synchrophase AC-6, shown in Fig. 2. The audio tubes which may be subjected to excessive signal input are the 326 and the 171 in the audio system, but the most frequent point of such trouble is the output tube. As is evident, the bias applied to the first audio stage is 4 volts which means that an *effective* signal voltage of 2.8 volts may be applied to this tube. In other words, the output from TRA1 may be 4 volts *peak* and 2.8 volts *effective*. The output of the first audio stage would then be 2.8 x 8, assuming realization of the full mu of the tube. With a 2:1 transformer at TRA2 the effective voltage available for application across the output 171 tube would be approximately 44 volts, whereas the use of a 40-volt grid bias permits only 28 volts. The result is overloading. As a matter of fact when distortion is encountered with normal signal level, the point of trouble will be found to be the output tube, unless the hum in the system is objectionable, in which case it will be necessary to seek the cause for the hum, because the distortion may be due to the cause which creates the hum.

Insufficient grid bias for the voltages being applied makes necessary check-up of the resistances R4 and R5. R4 supplies the grid bias for the first audio stage and R4 and R5 together supply the grid bias for the output tube.

Excessive B potential to the output tube may be due to incorrect placement of the plus 180-volt lead with respect to the resistance R. It is possible that this lead is erroneously connected to the junction of R and R2; in other words, the junction of the 750- and the 2800-ohm resistances. Or it is possible that the 750-ohm resistance is partially shorted.

As is evident in the wiring diagram, the eliminator is grounded at the B-minus and C-plus terminals. An accidentally ground in one of the audio transformer secondaries will cause a short across the grid bias resistances, unbalancing the grid bias voltages and causing hum.

The above instances show how the quoted data is applicable to the wiring diagram and an analysis of circuit structure shows how this data is applicable to all audio amplifying systems, despite the fact that all amplifiers are not wired in like manner.

Checking Continuity

After a complete check of circuit structure it is necessary that some means be available to check continuity. Two such arrangements are shown in Figs. 3-A and -B. The first is the regular voltmeter-battery arrangement wherein judgment is rendered according to the deflection noted upon the voltmeter. A full voltage reading indicates a short across the test clips or at least very low resistance. A partial reading indicates appreciable resistance across the test clips. In the second unit, Fig. 3-B, we make use of a low range d-c. milliammeter (0-1 ma.) connected in series with a battery and a fixed resistance. The battery is a 22.5 volt block and the fixed resistance is of 22,500 ohms. A short across the test clips causes a full reading of one milliampere.

In contrast to the first arrangement, the current flow shown upon the meter may be considered as a guide to determine the exact value of resistance connected across the test clips. For example, a reading of 0.5 milliampere means that 0.5 milliampere is flowing in the circuit, through the unknown resistance connected across the test clips. According to Ohm's law for resistance $R = E \div I$ the total resistance in the circuit is $22.5 \div .0005$ (0.5 milliampere) or 45,000 ohms. Since the fixed resistance in the circuit (R) is 22,500 ohms and the total is 45,000 ohms, the value of the unknown is 45,000 minus 22,500 or 22,500 ohms. In other words, Rt minus R, where Rt is the total resistance determined by solving for the resistance according to the current indication upon MA and R is the resistance of 22,500 ohms fixed in the circuit. The function of this resistance is to limit the current flow to within the range of the milliammeter.

(To be continued)

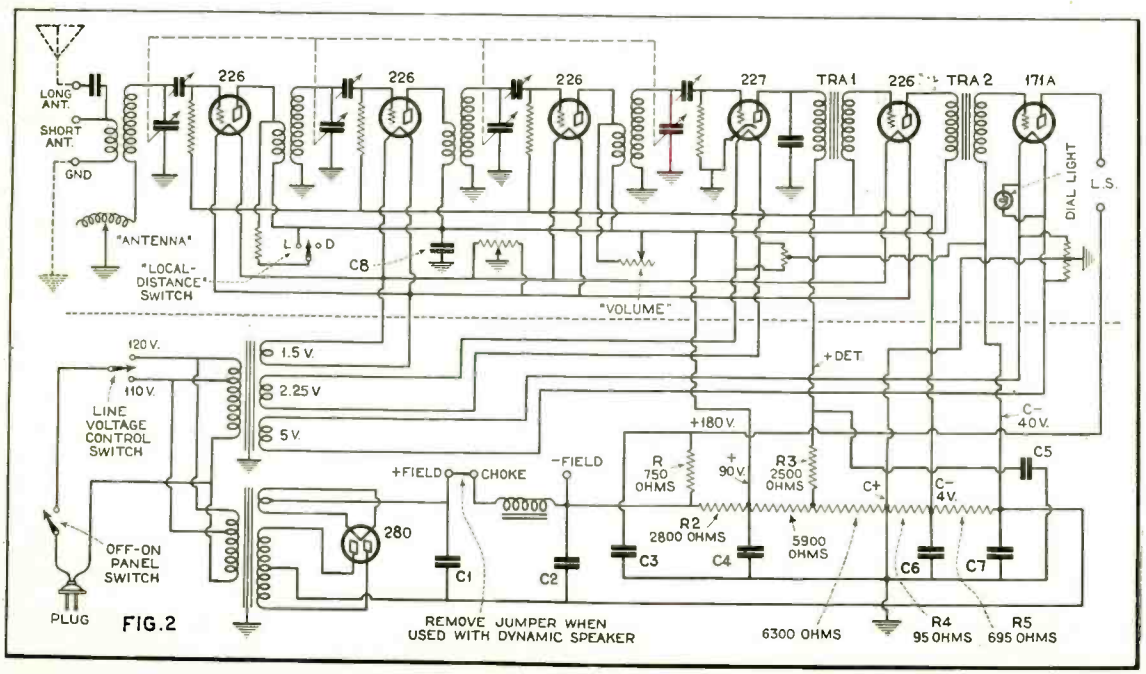


FIG.2

The schematic diagram of the Grebe Syncrophase AC-6.

The Engineering Rise in Radio

By Donald McNicol

Fellow A.I.E.E., Fellow I.R.E., Past-President, Institute of Radio Engineers

Part XV

RISKING repetition in the interest of the lay reader it may be stated that in ordinary broadcasting the station sends out radiation made up of the carrier wave and the modulating sidebands. The carrier wave is the one to which the radio receiver is tuned when the condenser and tuning coils are properly set by means of the dials. The sidebands are introduced when voice waves affect the microphone (or music or sound waves of any kind).

In transocean radio telephony the speech frequencies are transmitted by the method known as single sideband, carrier-suppressed, and a receiver capable of responding to transmission of this type must be one designed to create locally the suppressed carrier wave.

The first public demonstration of the single sideband eliminated carrier method of radio transmission was made on January 5, 1923, by the engineers of the American Telephone and Telegraph Company, in telephony tests between New York and a station in England.

In the technical paper referred to in footnote 1, this chapter, the engineers of the American Telephone and Telegraph Company, presented the results of a thorough survey of the conditions encountered in broadcasting. Their examination into the causes of fading disclosed that different frequencies do not "fade" together, and when it is remembered that the three frequencies making up the customary broadcast transmission; the upper sideband, the carrier and the lower sideband, the significance of this selective fading will be apparent. The three frequencies exist as three separate waves bound together only at the transmitter. If, therefore, selective fading in any instance causes the carrier wave to disappear; or rather, not to appear at the receiver, it is plain that the sidebands, should they reach the receiver, can only "beat" together in the detector of the receiving set. From this it may be seen that it is essential for good reception that the carrier wave reach the receiver in about the same outlines it had when it left the transmitter, and it will be apparent also that reception varies depending upon whether the components of the signal wave encounter vicissitude or arrive in a condition indicating no interference.

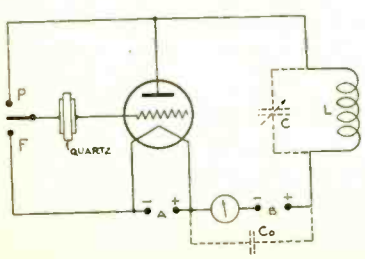


Fig. 22. Circuit connections for a piezoelectric oscillator. The quartz crystal may be inserted between grid and filament or grid and plate, by means of the switch shown on left.

Here then we have a measure of progress, a summary of the state of the art. With three methods of transmission under consideration: carrier and upper and lower sidebands; carrier and single sideband, and suppressed carrier wave, it might be concluded that the choice for dependable service would be the method having a wave of the smallest number of components—single sideband with carrier suppressed. And this is perhaps the method of transmission which would be the least subjected to the dangers of wave travel, but the fact is the particular method of transmission employed by the broadcast station is important only to the broadcast listener who is situated a distance away from the station approaching its rim of range. Were single sideband suppressed carrier transmission used it is obvious that owners of receiving sets would perforce have to supply themselves with sets which would locally supply the carrier wave, and this with close accuracy as to frequency and phase. From the practical viewpoint this would involve various difficulties which the broadcast listener is in no humor to have imposed upon him.

In radio broadcast service a valuable use of the single sideband suppressed carrier system is that in which this is used to transmit from a central, high-power broadcast station to a number of local broadcast stations, which in turn re-broadcast or relay the matter transmitted by means of the usual carrier and double sideband method so that the ordinary receiver may pick up the program.

Regulation of Frequency

In the early days of radio whether or not a transmitting station was able to adhere to a stated channel in the ether was a matter of concern to a very small number of persons, but with a dozen or more broadcasting stations transmitting simultaneously from a single city it may be realized that it is of the utmost importance that each station shall remain within the bounds of its assigned waveband.

Even when a station has assigned to it a definite frequency (wavelength) it is customary to maintain between that station and other stations in the same territory idle gaps in the ether not used for radio transmission. With a station separation of 10 per cent. the relations might be for station "A," 270 meters (1,111,000 cycles,) station

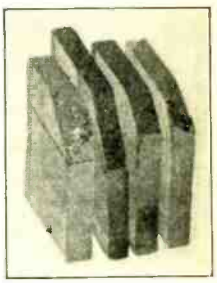


Fig. 21. Showing four piezoelectric plates cut from a quartz crystal.

"B", 300 meters (1,000,000) and station "C", 330 meters (909,000 cycles.) Obviously, the closer the various stations transmitting from a given city adhere to their assigned wavelengths the less there will be of wave interference, and the easier it will be for persons operating radio receivers to tune satisfactorily to a desired station.

In this respect radio in its progress toward a great destiny was again aided by another branch of physics which had throughout a century developed slowly because along the way no practical use appeared for the utilization of the phenomena disclosed. It was a by-product of the science of optics and involved phenomena observed in studies of crystallography.

The Crystal Oscillator

For long it was known that there are certain crystals which, while being heated or cooled produce electrical effects in certain regions or at certain polar extremities. Crystals producing electricity in this manner are said to be pyro-electric. It has for instance been known for many years that tourmaline when heated attracts light bodies to its extremities.

During the late war a line of investigation undertaken by the engineers of one of the large American electrical laboratories was that concerning the phenomena of piezo-electricity. The expression piezo is derived from the Greek word "piezein" which signifies "to press."

The foundation of our knowledge of piezo-electricity was laid down by Abbe Huay, in France, who about the year 1800 discovered that a crystal of calcspar pressed between the fingers so as to compress it along the blunt edges of the crystal, became electrical, and that the crystal retained its electric charge for several days. The fact established was that pressure upon or between crystals in a particular direction produces electricity. Hauy observed that this property is peculiar to those crystalline minerals which are capable of being reduced by mechanical division to plain and smooth laminae. In 1884 Sylvanus Thompson, in England, pointed out that if two opposite edges of a hexagonal prism of quartz are pressed together one becomes positive, the other negative electrically. Much additional information has been contributed on this subject within the past fifteen years by A. McL. Nicolson and A. C. Crehore, in America. Previously (1889) P. Curie and J. Curie, in France investigated in a quantitative manner the piezo-electric peculiarities of quartz, deriving equations which showed the relation between the pressure applied and the piezo-electric charges on the faces of the crystal. These physicists showed also the effect upon the dimensions of the crystal due to electric charge.

It remained, however, for G. W. Pierce and W. G. Cady[3], in America, to introduce the crystal and its peculiarities to the radio art as an agency for the determination of frequency of oscillations.

Dr. Cady discovered that a quartz crystal could be employed as a resonator having a use as a standard or gauge of frequency. Later he made the very important discovery that by means of crystals the frequency of self-oscillating circuits, such as those employed in radio transmission, could be maintained constant.

This was a most timely contribution to the engineering of radio broadcasting, and which also has been of great value to those who during the past three years have successfully put the higher frequencies at work in order to increase the number of available channels for radio telegraph and radio telephone communication. The higher frequencies usually are regarded as those above 3,000,000 cycles (100 meters.)

[3] *Physical Review, Vol. 17, page 531, 1921, and Vol. 18 page 142, 1921.*

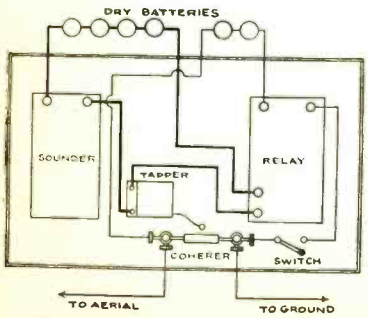


Fig. 23. Actual wiring of instruments used in a radio telegraph receiver employing a coherer as detector. The instrument labeled "tapper" is the de-coherer.

The natural quartz crystal may be regarded as a hexagonal cylinder surmounted by a hexagonal pyramid, having four principal axis of symmetry, three of which exhibit electric phenomena; inasmuch as pressure exerted on the crystal in a direction parallel to any one of these produces electric charges of opposite sign at the terminals of the axis, and, electric charges of opposite sign applied at the extremities of axis produces a small compression in the crystal itself.

The fourth axis of the crystal is that which exhibits optical properties, and as employed in piezo-electric oscillators crystals usually are cut in such fashion that the optical axis lies in a plane of the oscillator and perpendicular to one of the sides. (See Fig. 21).

Although various crystals exhibit the piezo-electric property it is found that the natural quartz crystal, because of its freedom from deterioration and of its mechanical strength, is the most suitable for the purpose. A section of the crystal is taken at right angles to its length: that is, along its optical axis, and when this is placed between two metallic electrodes it is ready for use as an oscillator. Within the required limits for radio the natural mechanical vibration frequency of a given crystal are converted into electric vibrations or oscillations, the oscillation frequency of a given crystal depending upon its dimensions, (the thinner the crystal the higher its frequency) and this frequency remains constant provided its temperature is maintained constant.

Application of the Crystal

An elementary application of the crystal is one where the crystal unit is connected in parallel with the grid tuning condenser in a self-oscillating tube circuit, as in Fig. 22. With this circuit adjusted to the resonant frequency of the crystal the action of the latter is to maintain the frequency of the circuit in step with its own natural oscillation period, provided there occurs no change of plate voltage, filament voltage, or of load.

Later, associated circuits were devised by means of which a single piezo-electric plate may be employed as a standard for the entire range of frequencies used in radio signaling, and methods were devised for grinding plates to have very accurate frequency characteristics[4]. Noteworthy circuit arrangements were devised by G. W. Pierce[5], J. M. Miller, Alfred Crossley, and Dr. August Hund, in America, and by Dr. Heegner and Mr. Giebe, in Germany.

[4] *Proc. Inst. Radio Engineers, November, 1925.*

[5] *Journal American Academy of Arts and Sciences, October, 1923.*

One noteworthy advantage of having various interests, various independent laboratories, together with a host of bright and industrious amateur experimenters engaged in radio research and the application of radio to commercial and social needs, is that when original scientific investigations such as those of Dr. Cady and Dr. Pierce, result in the invention of a new and useful device, as the crystal oscillator, the invention is at once taken up and given a wide and thorough service application.

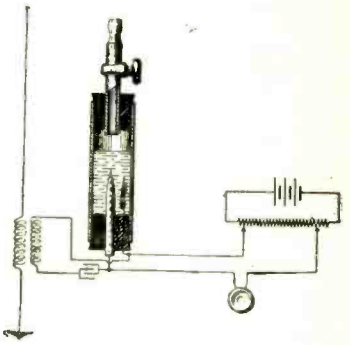


Fig. 24. Fessenden's liquid barretter detector and associated receiving circuits.

Thus, within a few years after the crystal oscillator appeared we find it in use by amateurs using a few watts of power as well as by the large broadcasting stations with 50 kilowatt ratings. In the broadcast transmitters which have been successful in operating at nearly exact frequencies it has been necessary to employ master oscillators, and the crystal regulator is now employed to accomplish the same purpose.

An example is the General Electric Company's 50 kw. station at Schenectady, New York, operating on 790 kilocycles (380 meters). At this station a quartz crystal is used for frequency control, associated with a single exciting tube, in which the 5-watt tube and the crystal in combination serve as a high-frequency generator the output of which is determined by the contraction and expansion of the crystal, the crystal having a frequency of 790 kilocycles.

The 5-watt tube directly connected to the crystal works into a 50-watt tube, resulting in amplification of the original energy at the desired, fixed frequency. By connecting the 50-watt tube in turn to a 250-watt tube, further amplification is obtained, and so on to a fourth stage of amplification where a 1,000-watt tube is connected; thence amplification proceeds to a water cooled 20-kw. tube (formerly the position occupied by the master oscillator). The 20-kw. tube instead of being a self-excited generator of oscillations, now is excited by the preceding stages of crystal controlled am-

plification. The 20-kw. tube then excites a bank of eight 20-kw. power tubes which produce the energy to be radiated from the antenna.

CHAPTER 13

Radio Receivers

IN Chapter 3 there is a record of the early state of the art with reference to the electrical tuning of transmitting and receiving circuits, and in Chapter 9, dealing with disturbances which from extraneous sources interfere with the satisfactory operation of radio receivers, progress with reference to the development of

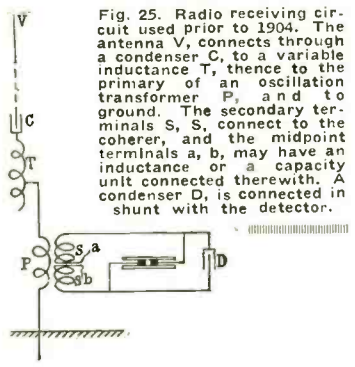


Fig. 25. Radio receiving circuit used prior to 1904. The antenna V, connects through a condenser C, to a variable inductance T, thence to the primary of an oscillation transformer P, and to ground. The secondary terminals S, S, connect to the coherer, and the midpoint terminals a, b, may have an inductance or a capacity unit connected therewith. A condenser D, is connected in shunt with the detector.

receiving antenna systems is reviewed.

In the very beginning it was realized that by tuning the transmitting and receiving circuits to the same frequency greater distances should be covered, and within two or three years following Marconi's first demonstrations other inventors entered the field of radio and the need for "selectivity" took on additional importance. Little headway could be made in operating competing radio telegraph systems, or in operating a number of stations in a limited territory unless a particular sending station could work with a given receiving station without interfering with signals passing to and from other stations and without being interferred with by such other signals.

So long as the strongly damped wave, induction-coil system of transmission was employed close tuning was not practicable, and while in a commercial radio telegraph service the arc oscillator and machine alternator methods of producing continuous waves came into use following the year 1907, the number of stations employing continuous waves was until ten years later small compared with the number of stations using the older system or modifications of it.

The results of the attempts at tuning prior to 1912 were mainly in the nature of increased distances of operation between a given transmitter and given receiver. Remembering, as related in the previous chapter, that exact methods of determining the frequency of transmitted waves were not available until 1923 or later, it may be realized that the waves sent out from antennas throughout the years 1900-1912, occupied a rather wide swath in space, and that seldom uniform.

So that the historical situation may be clear it may be well to state here that Marconi, deForest, Fessenden, Blondel, and all of the early workers in radio mentioned in this work, were quite aware that receiving antenna situated in the path of transmitted electric waves had set up in it to-and-fro currents, the energy of the currents being the energy of the up-and-down moving fluxes set up by the passing waves. They understood also that the alternating currents in the antenna were capable of being built up, or successively increased in strength, by the impulses of succeeding waves, provided the receiving circuit was in resonance to the frequency of the incoming waves. Further, it was known that in order to have selective signaling it is necessary that the receiving antenna and associated apparatus be tuned to the frequency or wavelength of the transmitter of the distant station.

The first radio receivers, those using the filings coherer as a detector, were simple in design and construction compared with the complicated multi-tube receivers which have come into use since the introduction of radiophone broadcasting. In the year 1900, aside from the crude tuning coils inserted in the antenna, a receiving set for radio telegraphy (it could not have been used for radio telephony) consisted of a coherer, electric bell type of de-coherer, telegraph relay and telegraph sounder or tape register, similar to the arrangements shown in Fig. 23. These instruments together with a few cells of primary battery made up the outfit necessary to receive telegraph signals through space at distances up to 100 miles or more, depending upon the power of the transmitter and upon atmospheric conditions.

Prior to 1905 receivers were in use which contained antenna loading inductances, variable by means of a contact arm, and air-core oscillation transformers. The practice was to connect one side of the primary of the coupler (transformer) to the loading coil switch, the other side being connected to earth. The secondary of the coupler was connected in series with the detector, an adjustable tuning coil and a small condenser, while in shunt with this circuit (from the detector terminals) a telephone receiver and local battery in series were connected.

A typical Fessenden receiver of the time of the barretter had an adjustable tuning inductance in series with the antenna and earth connection. (See Fig. 24. Adjustable contacts of the antenna inductance were connected to the terminals of the detector, the lower leg connected through a condenser. In shunt with the detector a telephone receiver was connected in series with a potentiometer-shunted local battery.

As the electrolytic and the crystal detectors followed the coherer as the multum in parvo of receiving sets, almost everyone engaged in experiments devised a *different* way to connect the detector to the receiving antenna. Although the receiving oscillation transformer had been introduced early in the art, the advent of the crystal detector was followed by wide use of a single antenna tuning coil connected directly between antenna and ground. The detector terminals were connected to two sliding contacts which could be moved so as to make electrical contact with any two individual turns of the tuner winding. Many attempts were made to set up receiving circuits which distinguished between voltage operated detectors and current operated detectors.

In the oscillation transformer, or coupler, the primary consisted of a few turns of rather coarse, insulated wire, while the secondary had a larger number of turns of a smaller size wire, the two being mounted so as to be in inductive relation. With the primary adjustable (as to the number of turns in series with the antenna) the advantage of resonance with the frequency of the intercepted wave was availed of, and by virtue of the oscillatory action of the coupler windings maximum voltage was applied to the terminals of the detector. It was thought also that by giving the antenna currents a direct path to ground that the detector in the secondary circuit would be less subjected to disturbances from "static" sources. (See Fig. 25).

It was found, however, that practically as good results were had when a single antenna inductance was employed which served both as primary

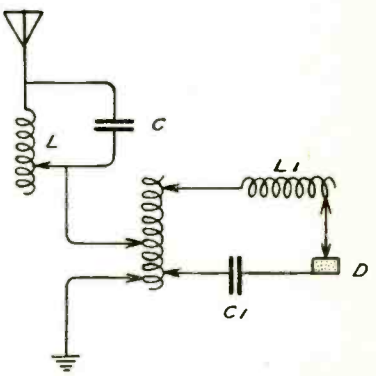


Fig. 26. A typical tuned receiving circuit using a crystal detector.

and secondary, on the principle of the auto-transformer or compensator used in alternating current power applications. A receiving circuit typical of those with which good results were had, using crystal detectors, is illustrated in Fig. 26. Resonance was established by means of the inductance L, and the capacity C; the detector circuit in turn being tuned to the

antenna circuit by means of condenser C-1 and inductance L-1.

There were many variations of this type of receiving circuit, and of the forms of tuning coil used from about 1901 until about 1912. A difficulty developed when it was desired to receive very long waves, in which case the single antenna inductance of single layer construction took on brobdingnagian dimensions.

Improvements in the design of oscillation transformers of the compact loose-coupler type came into use about 1908, (See Fig. 27) and as these were made up with series of turn taps both on primary and secondary windings and with a rotary adjustment between the two windings, the best was accomplished in the way of receiver tuning until such time as radio transmitters employing continuous waves and closely regulated transmitting frequencies came into general use.

Need for Greater Precision of Wavelength

By the year 1910 the growth of ship-shore radio telegraph traffic had grown to such volume that on many occasions serious delays and losses resulted from station interference. The situation in the ether was about what the situation is in a navigable water channel where the number of vessels using the channel increases rapidly. With but a few vessels there is little likelihood of collision and little need for established regulations, but with increasing traffic a state is reached where vessels may proceed only when they have clearway.

This was the situation presented in radio about the year 1910, which together with the then approaching international conference on radio telegraphy to be held in London in 1912, stirred the engineers of the time into renewed activity in an effort to devise ways and means of operating an increasing number of radio stations with less interference.

Forthwith methods were devised for measuring outgoing and received waves. To this end a great deal of important knowledge was contributed by G. Eichorn, G. Seibt, Franke and Donitz, in Germany; by J. A. Fleming, H. J. Round and C. C. Monckton, in England; by G. W. Pickard, Lee deForest, J. E. Ives, J. Murgas, F. A. Kolster, A. S. Blatterman, M. A. Deviny, P. Mertz, G. W. Pierce and J. O. Mauborgne, in America, and by other scientists in various countries.

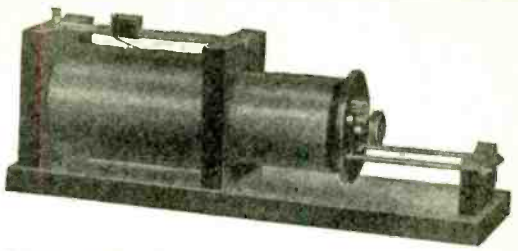


Fig. 27. Common type of early (1908) loose-coupler, with outside primary winding and sliding contact; the secondary winding being movable in and out of the primary and equipped with an end switch for cutting in any number of turns of the secondary winding.

(To be continued)

Book Review

SPEECH AND HEARING—*By Harvey Fletcher, Ph.D., Director of Acoustical Research, Bell Telephone Laboratories. 331 pages. Illustrated. 6 x 9 inches. Stiff buckram binding. Published by D. Van Nostrand Co., Inc., New York City. Price, $5.50.*

If the average engineer employed in the radio industry were asked something about sound he would very likely give you a more or less learned dissertation on the frequencies which he has encountered in his work and let it go at that. He would know, for example, that a loudspeaker, for effective operation, must reproduce a band of frequencies covering the musical range, with audibility. But, that is only the start of the story.

Dr. Fletcher, who for thirteen years has been studying sounds, how they are made and heard, covers in this book many facts that the radio engineer should know, whether he designs sets, loudspeakers, or collects his paycheck from a broadcast station. Dr. Fletcher's presentation of his subject is most clear and interestingly written; well illustrated by curves and tables, and where mathematical formulae are necessary for clarity, they are wisely included.

"Speech and Hearing" is divided into four parts: Speech; Music and Noise; Hearing, and The Perception of Speech and Music.

The opening chapter discusses the beginnings and the evolution of language, the functions of the lungs, vocal cords, and other organs of speech, the principal English speech sounds and their formations, artificial speech sounds—their production, and the artificial larynx.

Chapter two is devoted to the recording and characteristics of speech waves: to the principles, development, and operation of such recording instruments as Koenig's "phonoautograph," Miller's "phonodeik," the phonograph, and the oscillograph; to the differentiation of speech sound; the general characteristics of speech; and to tabular data showing these characteristics.

The third chapter deals with speech power. The various kinds of speech power and the units expressing difference in speech powers are defined. The power required in producing speech sounds is discussed, and something of the manner in which this power is determined is explained. The chapter closes with a section on the distribution of speech power into frequency bands.

Chapter four develops the frequency with which speech sounds occur under the headings of words, syllable combinations, and fundamental sounds. Tables are included that show relative frequencies of occurrence.

The opening chapter of Part Two takes up the characteristics of typical music sound waves, the operation of the electrical harmonic analyzer, the determination of acoustic spectra of musical instruments, and musical range and intensity.

The second chapter affords a treatment of noise; its physical properties, methods for its measurement, and the results obtained from noise surveys.

The third section begins with an explanation of the mechanics of hearing; giving a full description of the ear, its structure, and the functions of its several parts. The Helmholtz theory is developed with relation to recent work, and the reaction of the nerves in transmitting auditory stimuli is explained.

The "threshold of audibility" and the "threshold of feeling," together with other factors governing the limits of hearing, such as feeling intensity and pitch are treated in chapter two.

The applications of the Weber-Fechner law and the determination of minimum perceptable differences in sound are studied in chapter three. In this connection the work of such experimenters as Knudsen, Riesz, Wegel, and Lane has been reviewed.

Chapter four treats of the masking of sounds—one by another, taking up in this respect pure tones, subjective tones, complex sounds, and the calculation of the form of vibration of the basilar membrane. The masking of sounds is a phenomenon long known to physicists, but which has been accurately measured for the first time in Bell Telephone Laboratories.

Binaural phenomena, including complex sounds, binaural beats, and sound images are taken up in chapter five.

In chapter six are explained the various tests used in determining the acuity of hearing. This chapter also offers a description of the audiometer, an instrument for the measurement of hearing, developed under the author's direction.

A discussion of loudness, which covers loudness of sound, pure tones, complex sounds, the calculation of loudness losses, and the comparison of observed and calculated values introduces the fourth section.

Chapter two explains how the pitch of musical tones are recognized.

Speech sounds and their recognition, intelligibility tests, and probability applied to articulation are covered in chapter three.

In chapter four the effects of change in intensity on the recognition of speech sounds are shown, together with a description of the method and apparatus used.

Chapter five shows how frequency distortion affects the recognition of speech sounds, and describes the performance of tests that indicate the importance of frequencies in recognizing sounds.

In the sixth chapter the influence of other types of distortion on the recognition of speech sounds are pointed out. Those considered are: the "overload" on the vacuum tubes in amateur radio receiving equipment, reverberating qualities of rooms, the variance in speed between a phonograph turntable and the turntable used for producing a given record, and the difference in the frequency of sending and receiving carriers in carrier telephone systems.

Chapter seven is given to noise and deafness and their effects upon the recognition of speech sounds. Experiments and discussions are included that are explanatory and descriptive of these relations.

The book is brought to a close by five appendices: the first of which relates to the calibration of a condenser transmitter through the use of a thermophone; the second to the derivation of equation relating to the properties of a plane wave; the third applies Hook's law to the transmission of sound in the inner ear: the fourth establishes the mathematical relation between hearing loss and the maximum distance for hearing and understanding speech; the fifth gives a method for computing the loudness loss with a known characteristic impedance, and the sixth relates to the mathematical determination of the velocity in singly-resonant systems.

Electro-Medical Apparatus

Radio Interference Created by Diathermy Apparatus Destroys Reception Over Wide Area

*By W. K. Fleming**

HIGH-FREQUENCY apparatus, such as is used in the medical profession, has long been one of the most prolific sources of radio interference. Unlike the majority of electrical devices which create interference in their immediate locality only, certain types of high-frequency apparatus set up interference which destroys reception over a large area. In fact, in some cases where the supply lines to the apparatus parallel the primary supply or telephone circuits, the disturbance may be spread over a considerable distance and even carried into cities several miles away.

How Interference Is Spread

The interference created by this type of apparatus is distributed in several ways. Undoubtedly, the most serious form of interference is that created by oscillations set up in the supply lines to the apparatus. These oscillations will, in a great many cases, entirely blanket reception over the secondary distribution network to which the high-frequency apparatus is connected. As previously mentioned, this interference may also be transferred to the primary distribution network and to telephone lines and, of course, by this means cover a much larger territory.

Another form of serious interference is that due to direct radiation from the apparatus. By this means, the interference is transferred not only to radio sets in the immediate vicinity, but also to both the primary and secondary distribution networks. The oscillations thus induced considerably augment those which, due to conductive coupling, are already present in the supply lines. The widespread distribution and intensity of the interference is due to the methods employed in obtaining the frequencies required for diathermy treatments, and to the fact that these frequencies are usually within the broadcast range. Since the apparatus used for generating these frequencies is similar to that used in the operation of spark transmitters, which are now forbidden by Federal law, the difficulty of eliminating interference from this source can readily be appreciated.

Line Filter Required

The first thought that comes to mind is that a single section inductive-capacitive type line filter would prove effective. This is not the case, however, for several reasons. First of all, the frequency at which the apparatus is operated is not the same for all types of machines; in fact, some apparatus is provided with means whereby the frequency may be varied at the will of the operator. Second, even if a satisfactory line filter were developed, the direct magnetic radiations from the apparatus would couple with the supply wires on the line side of the filter, as well as with telephone or other wired circuits, thus minimizing the effect of the filter. This readily proves the fallacy of attempting to use a simple line filter.

The thought then presents itself that perhaps several filters might be used in various parts of the supply circuit, thus effectively preventing the distribution of interference along the supply lines. This method, however, is practical for use only when the high-frequency apparatus is in a relatively isolated location, as it is of course impractical, in a congested district, to filter every circuit which may be in the immediate vicinity of the apparatus. Due to the intensity of the directly radiated interference, even the most elaborate system of line filters would be of no avail in suppressing interference under these conditions.

Shielding Necessary

As the majority of the installations of this type of apparatus are in congested districts, it is plainly evident that not only a line filter but also some means of suppressing the directly radiated interference must be provided. The answer to this problem is, of course, shielding.

The application of suitable shielding, however, is not the simple matter it might appear to be. The first shield constructed enclosed only the high-frequency generator. This shield effectively prevented the direct radiation of energy from the machine, thus making it possible to determine the most effective type of line filter for preventing the distribution of interference along the power lines.

Single section filters were found to be ineffective; in fact, it was necessary to go to three sections before complete suppression of the interference was secured. However, due to the complication involved in the manufacture of such a filter, further experiments were carried on, with the result that a new type of line filter was developed which was found entirely satisfactory for commercial use.

With the development of the line filter which, in conection with the shield, gave satisfactory results, the apparatus was then tried in actual operation. It was found that the greater part of the interference returned as soon as the machine, even though shielded, was used for treating a patient. This meant, of course, that the patient as well as the apparatus must be satisfactorily shielded.

Type of Screen

As the problem now seemed relatively simple, a screen cage sufficiently large to contain both the apparatus and the patient was constructed. This cage was constructed of copper screening bolted to an angle iron framework, and to all appearances should have been entirely satisfactory. However, upon further experimentation, it was found necessary to solder screening across all the joints in the angle iron framework in order to prevent radiation. As this construction was quite complicated, a third shield was constructed.

In the construction of the third shield, copper screening was again used. A wood frame, however, was substituted for the iron, and the screening was so arranged that firm metallic contact was maintained between screen sections. This shield proved entirely satisfactory.

A fourth screen was then constructed on the same principle as that previously employed, with the exception that galvanized iron screening was used in place of copper screening. This screen was, if anything, more satisfactory than the copper screen.

After having finally secured a combination of shield and filter which was satisfactory, further experimentation was carried on in order to determine what precautions were necessary for the satisfactory operation of this equipment.

First of all, it was found that although with some types of apparatus the door to the cage could be left open without creating serious interference, with other types of apparatus it was necessary to have a complete metallic contact between the edges of the door and the cage in order to secure satisfactory shielding.

Second, it was found that if a drop light were run into the cage, the cord to the light must be completely shielded, and the shield connected to the cage, or the interference would be distributed through the lighting circuit. This was also true of any bell wires running into the cage, in fact, it was found that absolutely no wiring of any description could be carried through the cage if complete suppression of interference were to be obtained.

Third, in attaching the filter it was found necessary either to build the filter directly into the screening or to run the supply wire to the filter in BX or conduit and to attach the latter to the screening. If this were not done, or if a long supply wire were used, even though this wire were run in BX, the shielding was rendered ineffective.

* *Chief Engineer, Tobe Deutschmann Corp.*

Radio Altimeter for Aircraft

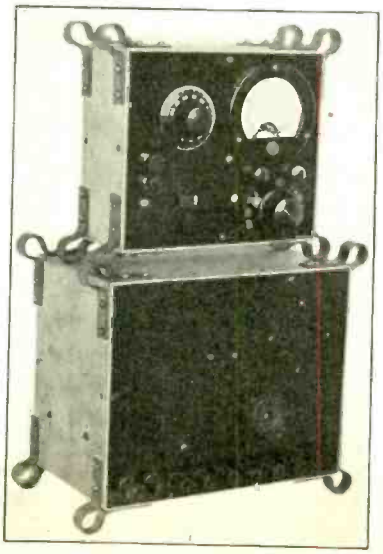
A Description of the Capacity Altimeter Developed by Dr. Ross Gunn, of the Naval Research Laboratory

*By J. E. Smith **

THE hitherto secure position of the barometric-pressure altimeter as a height-indicating instrument on aircraft is threatened or, at least, its always illusory effect of registering altitudes in terms of sea level invites the use of a supplementary device for recording true heights of an airplane above the ground. While so-called "radio altimeters" are not intended to displace conventional altimeters, a capacity altimeter designed by Dr. Ross Gunn of the Bellevue Naval Research Laboratory is destined to occupy a niche of real service in landing an airplane in fog, darkness, or poor visibility when flying at or below 200 feet in the air. Not unlike radio visual indicators and directive radio beacons, it is primarily a safety device and it functions oblivious to fog, nightfall, and other adverse landing conditions.

Application of the principle of computing the height of an airplane by small variations in the electrical capacity of a conducting system as the flying machine approaches the ground seems to have originated in England a dozen years ago. However, similar ideas were given birth in this country, and late in the fall of 1923 a young college professor—Ross Gunn—then in charge of the high-frequency laboratory of the physics department of Yale University decided to reduce the theory to practice. Two years later he had completed a workable model and during the summer of 1925 he was assigned to duty at McCook Field, Dayton, Ohio, in order that he might subject his instrument to flight tests. The original model has since undergone an evolution of improving processes, and now after having been subjected to experimental use on both airplanes and seaplanes, this physicist of recognized attainments has introduced his brain child as a potential safety factor in future flying.

Recent tests in a naval seaplane yielded positive proof as to the value of this capacity altimeter in giving true altitude readings from zero to 150 feet, and Dr. Gunn is of the opinion that further refinements in the present model will increase its serviceable application from the ground up to 200 feet. The two distinguishing features of the Gunn altimeter is that its sensitivity increases as an airplane nears the ground—a forewarning of value to pilots landing in fog or other obscure conditions—and it affords a direct reading on a dial and the indications are not subject to confused interpretations. Unlike the "radio altimeters" of C. Francis Jenkins of Washington, D. C., and Dr. E. F. W. Alexanderson of the General Electric Company, this capacity measuring device functions with an uncanny directness and does not depend upon a reflected wave or so-called "echo" signal transmitted from a plane and rebounds to the flying craft with an indirect report of the distance to the ground. Furthermore, the Gunn altimeter is subject to the so-called "infinity" adjustment during the course of an airplane flight—at any height above the highest point on the meter and at any period previous to the real application of the altimeter.



An early model of the Gunn radio altimeter, including the oscillator and the control or indicator unit.

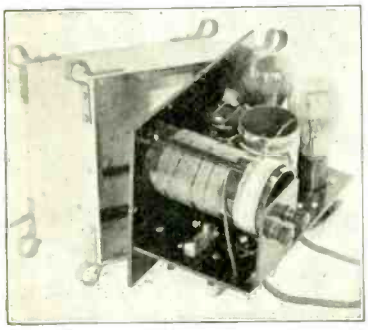
General Description of Altimeter

There are four essential units to the Gunn radio altimeter—the wires or metal plates which figure in the measurements of minute electrical capacities; the oscillator or radio transmitting set; the control unit which conveniently enables a pilot to manipulate the instrument; and a dry-cell B-battery of 100 volts. The capacity elements, in the original installation on an airplane at McCook Field, were mounted below the fuselage. When the capacity plates were installed in the wings of the plane false readings were given due to the vibrating or "shimmying" effect of the wings. These metal plates or wires, sensitive to small changes in electrical capacity, function in accordance with the radio principle that a perceptible change in capacity takes place when two electrical conductors come within close proximity to a third conductor. The latter, in this instance, is the earth, and when two wires or metal plates are mounted below the fuselage of an airplane these two conductors reflect a change in capacity as the airplane approaches the ground—the third conductor. These small variations in capacity are utilized in yielding true indications of the altitude of a plane going downward from a height of 200 feet.

The oscillator, with dimensions of 12 inches wide, 5 inches deep and 7 inches high, is contained in a box subject to convenient placement near the pilot. It weighs, minus batteries, approximately 10 pounds. This oscillator radiates a high-frequency oscillation of the order of one million cycles, transmitted either through an antenna

* *President, National Radio Institute.*

or plate. A balanced circuit is so operated that it reacts to the approach of an electrical conductor like the earth. The capacity variations are determined with an accuracy of less than five per cent. The control unit, also placed within easy access to the pilot, has dimensions of 4 by 5 by 2½ inches—weighing 10 pounds. It includes switches for turning on and off the instrument and a dial for the so-called "infinity" adjustment. The control unit may also contain an indicator or this meter may be installed on the instrument board of the airplane. A 5-pound dry-cell battery completes the essential equipment. The oscillator, control unit, capacity plates or wires, and battery weigh a total of less than 25 pounds.



Interior view of the oscillator unit comprising a section of the radio altimeter.

No Special Adjustments Required

The outfit lends itself to ready operation. With the simplicity of turning on our home electric lights, a switch is snapped to the "on" position and the dial adjusted until the meter needle reads at the top of the scale—say 200 feet, the objective of future models. This simple performance defines the forbidding "infinity" adjustment—which corresponds to the usual zero adjustment on other instruments. Preferably, the instrument is placed in operation for a period of five minutes before actual service to enable the vacuum tubes in the radio transmitter or oscillator to stabilize their performance. Then, once the dial is turned until the meter needle reads 150 or 200 feet—depending upon the ultimate of the scale of operation—this capacity altimeter is ready for service. The outfit does not require trick adjustments and the starting process necessitates a minimum attention of the pilot.

The true altitudes of flying craft above the ground are registered, oblivious to such weather factors as varying atmospheric pressures and conditions of fog and low visibility. The readings on the face of a dial are continuous and as accurate as similar devices in which the human equation has been eliminated. The pilot is not compelled to give unremitting attention to this instrument—an occasional glance suffices. Fortunately for the pilot who is fumbling around a few feet from the ground in a fog, the Gunn radio altimeter increases in sensitivity as it approaches earth. For instance, at a height of 100 feet a variation of five feet is observable but at 20 feet from the ground a change of five inches will reflect a like variation on the indicating instrument.

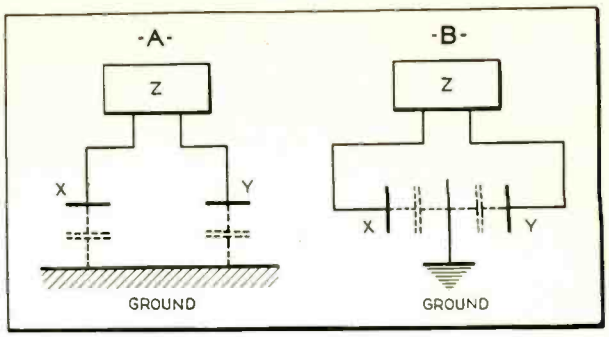
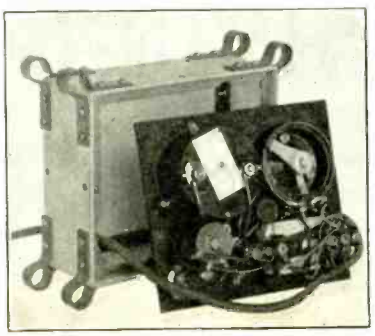


Diagram of two equivalent circuits showing the capacity effect between the metal plates and ground. X and Y are two plates mounted on aircraft and connected to a measuring device Z. The dotted lines represent the capacities which exist between the plates and ground.

"Background Capacity" Main Hindrance

The relatively large "background capacity" is the major obstacle confronting the complete success of all so-called "radio altimeters." The product of Dr. Gunn is no exception; in fact, one great physicist placed the label of "impossible" on the original attempt in designing this instrument. Despite this pessimistic attitude, a veteran naval pilot has expressed complete willingness to entrust his life to the Gunn altimeter in landing a plane through surface fog. A slight tendency to drift is another handicap which somewhat retards a full realization of the intents of this instrument—and this drift is apparent despite the stability of the electrical circuits. Future models of the device may eliminate the undesirable tendency to drift.

The air-mail service, when operated by the United States Post Office Department had its memorable record of having sacrificed only a few lives over a period of ten years blotted by the singularly tragic circumstances surrounding the death of a pilot on a mountainside in Pennsylvania. The barometric-pressure altimeter, a snare and a delusion in giving altitudes only in terms of sea level, could not warn this air-mail pilot, flying in fog, of the dangerous mountain into which he crashed and came to grief. The radio altimeter could have indicated, directly in feet, the plane's approach to this mountainside, and the electrical capacity-measuring device of Dr. Ross Gunn and similar instruments are designed to avert such accidents as well as to facilitate ready landings in fog, darkness, and low visibility.



Interior view of the indicator unit; an early model.

CANNING SOUNDS—A NEW INDUSTRY

THERE is nothing decidely new or brilliant about referring to a phonograph record plant as a canning factory. However, when it comes to canning miscellaneous sounds which have nothing to do with building up a library of recognized music, we have something decidedly new, and that is precisely the present status of a present development in the phonograph industry.

"Imagine if you will," states J. E. Smith, President, National Radio Institute of Washington, D. C., "a plant devoted to canning all kinds of sounds. Yet that is precisely what is being done today by certain phonograph record companies. The rapid growth of the 'talkies' has led to a healthy demand for all kinds of sound effects. Thus the phonograph companies have prepared special sound libraries, comprising hundreds of records of sounds. There are barking dogs, crying babies, mob yells, hotel lobby backgrounds, sewing circle backgrounds, railway train, fire engine, steamship whistles, church bells, artillery fire, machine guns in action, tanks soldiers marching, etc., etc. These records are intended primarily for small theatres which cannot afford the synchronized equipment of the regular 'talkies,' but desire to employ records for incidental music, and the required sound effects."

"At the recording studio quite as well as the theatre, there are important tasks awaiting the radio man. The technique, of course, is nothing more than an outgrowth of radio communication methods, but involving the highest order of training and skill for the utmost realism in the sound canning and sound reproducing processes."

NEWS OF THE INDUSTRY

A TUBE MERGER

Plans are now definitely under way for the formation of a new radio tube organization with the Sonatron Tube Company of Newark, N. J., and Chicago as the nucleus, according to an announcement made recently by Harry Chirelstein, president of the Sonatron company.

"A special meeting of the stockholders has been called for August 16 to vote on the proposed merger," said Mr. Chirelstein, "which will include beside the Sonatron company, the Televocal Corporation of West New York, N. J.; and the Magnatron Corporation of Hoboken, N. J. The new company will have an authorized capital of 1,000,000 common shares of no par value of which about 325,000 shares will be outstanding.

"The Radio Corporation of America has granted the new company a license at the standard rate of royalties for the manufacture of radio tubes under patents owned and controlled by it, and has also agreed to loan the new company $2,000,000 for a period of five years. The Radio Corporation of America also will be granted an option to purchase within that period 50,000 shares of stock of the new company with provision against dilution.

"Under the proposed plan the Sonatron Tube Company will be dissolved and the assets and business of the company turned over to the new organization. In addition to the distribution among Sonatron stockholders of the 235,000 shares of stock of the new company, there will be available for distribution a special cash dividend of 23 cents a share payable August 16 to stockholders of record August 1.

"Lehman Brothers of New York have negotiated the reorganization which officials of the Sonatron company believe to be along the lines of sound and constructive progress."

AN ATTRACTIVE TELEVISION BOOKLET

So little is understood and so much is misunderstood regarding television that a booklet entitled "Television—The Eye of Radio," is most welcome at this time. Under this title, the Jenkins Television Corporation of Jersey City, N. J., has published an attractive booklet of 32 pages and cover, which contains a conservative, interesting, readily understood discussion of just what television is, what has been done so far, what is being done for the future, and why the television experiment is about to develop into the television industry. The booklet contains photographs and descriptions of the equipment about to be introduced for home use, as well as the television studio and transmitting equipment. A copy is free for the asking.

ZENITH ANNOUNCES FINANCE PLAN

Hugh Robertson, Treasurer and General Sales Manager of the Zenith Radio Corporation of Chicago, reports that an exclusive contract has been executed for the financing of Zenith dealer retail installment sales, between the Zenith Corporation and the Commercial Investment Trust Corporation of New York, universally known as "C.I.T." and the largest independent financing organization in the country.

"Five thousand Zenith dealers in the United States have found that installment sales represent a large proportion of their entire volume," states Mr. Robertson. "To that end, the Zenith finance plan was created to enable the Zenith dealer organization to expand its sales volume and to provide a sound financial background for time-payment sales.

"The Zenith plan is particularly adapted to meet the requirements of present day radio installment sales and because of its nation-wide service and liberal terms, will meet with instant acceptance."

TRIAD TUBE INSURANCE

Complete protection for dealers on all tubes is guaranteed by the Triad Manufacturing Company on all their tubes through the insurance certificate packed in each of the cartons.

A minimum six months service is guaranteed to users of Triad tubes and replacements are made without question except in the case of broken bulbs. Dealers return the defective tubes to their distributors who in turn return them to the factory.

New tubes to replace those found defective, or those which do not give the minimum of six months satisfactory service, are given the consumer by dealer who in turn is given new tubes by his distributor.

KOLSTER INSTALLMENT SALES

Ellery W. Stone, president of the Kolster Radio Corporation, announces that the Company has renewed its contract with Commercial Credit Company for financing retail installment sales of Kolster and Brandes radio receivers.

"The 10,000 Kolster and Brandes dealers in the United States will use installment financing this year in approximately 85 per cent. of their sales," he said. "The Commercial Credit deferred payment plan for Kolster and Brandes dealers is particularly adapted to the radio trade, having been prepared to secure maximum sales with sound financial assistance."

In Europe, installment sales of the products of Kolster-Brandes, Ltd., Kolster's European subsidiary, are financed by Kolster-Brandes itself.

KOLSTER ENTRENCHED IN GERMANY

Ellery W. Stone, President of the Kolster Radio Corporation, announces that an agreement has been signed in Berlin between Kolster-Brandes, Limited and Telephonfabrik Berliner Aktiengesellschaft of Berlin for the manufacture and sale of Kolster and Brandes models in Germany.

Under the proposed plan the radio division of Telephonfabrik Berliner Aktiengesellschaft, one of the oldest telephone and radio companies in Germany, will be merged with Kolster-Brandes' German operations. In the future, the Kolster-Brandes receivers will be manufactured in the factories of Telephonfabrik Berliner Aktiengesellschaft in Berlin and Hanover, and will be sold in Germany by a company to be known as Kolster-Brandes Tefag. Control of the latter company will be held by Kolster-Brandes Limited, but there will be no public offering of the minority stock since it will be subscribed for by Telephonfabrik Berliner Aktiengesellschaft.

"The arrangements with Telephonfabrik Berliner" said Mr. Stone, "will permit Kolster-Brandes Limited to avoid the German duties on Kolster-Brandes models imported from our British plants. In addition, Kolster-Brandes Limited will secure the benefit of the strong radio patent situation which Telephonfabrik Berliner now holds in Germany.

"Arrangements on similar lines are also being worked out for Kolster-Brandes" entry into other European countries through affiliations with European radio companies already established."

NEW STEINITE PLANT

Production is now under way in the Steinite Radio Company's new ten-acre plant in Ft. Wayne, Indiana, according to a recent announcement. The formal opening of the factory will take place some time in August.

"Two thousand sets per day as a minimum is the goal we have set for ourselves when we are in full production," said J. Abelson, president of the Steinite Company, who has just returned from an inspection of the new factory.

"The administrative and executive offices of the company have been moved to Ft. Wayne, where all the cabinets and parts for Steinite sets will henceforth be made and assembled. A branch executive office will also be maintained in Chicago.

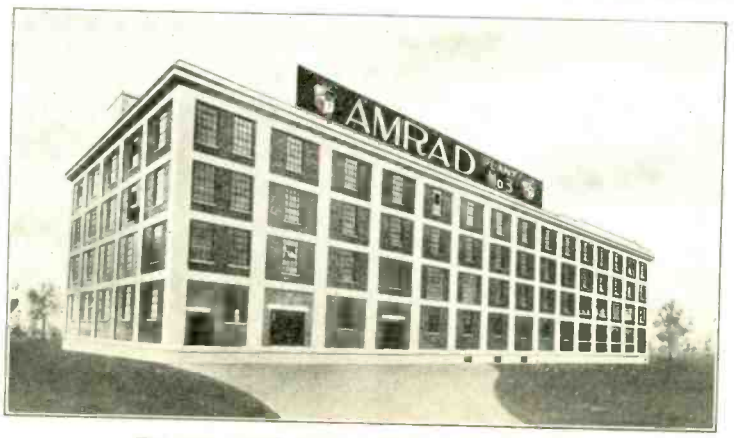
"The Auburn factory is to be kept in operation for the making of cabinets, and the Atchison plant will be maintained for the fabrication of d-c. sets only.

"It is interesting to note that production of sets was kept up to a peak during the entire time required for the moving of all facilities and offices to Ft. Wayne."

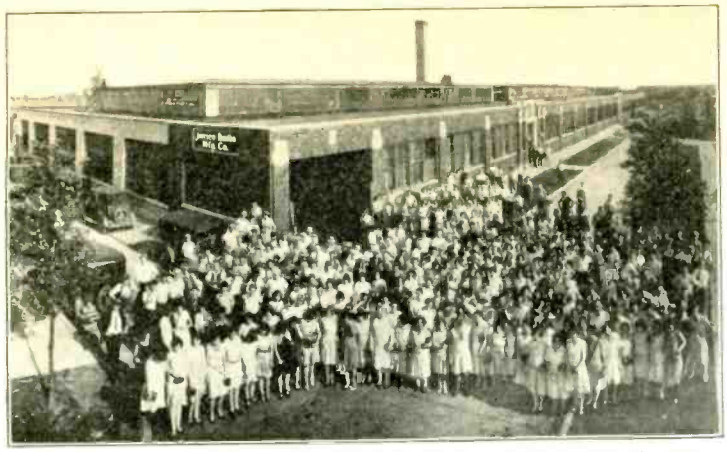
AMRAD ACQUIRES THIRD PLANT

To meet the demands of a trebly increased business, the Amrad Corporation, of Medford Hillside, Mass., has acquired a large factory in North Somerville, on the Mystic Valley parkway, a few hundred yards distant from its present central plant. The Amrad Corporation now has three factories working at top speed.

The new factory is advantageously located, and offers 140,000 feet of floor space for the use of Amrad's production department. It adjoins railroad sidings which accommodate twenty freight cars. The chasses of the Amrad radio receivers will be turned out in the central plant, and



The new Amrad Plant at North Somerville, Mass.



The new unit of the Jensen plant, located in the Clearing Industrial District, Chicago.

then transferred to the new factory to be assembled with speakers into the consoles.

This is Amrad's second expansion within a year. One year ago the company acquired a factory near Davis Square, Somerville, to be used for the manufacture of Mershon Condensers.

SCHWEITZER NEWARK PLANT

Of the intense business developments of the decade, it has been gratifying to note that the firm of Peter J. Schweitzer, Inc., of New York and New Jersey, which, in its paper manufacturing and importing enterprise, has achieved vast proportions.

New indication of the company's position, comes with the announcement that a plant in Newark, New Jersey, has recently been acquired, which will be devoted to the manufacture of Schweitzer papers, proportionate with the existing demand throughout the nation.

That this property is valued at practically half a million dollars, and consists of seven acres of land on the Pennsylvania Railroad sites, serves as some indication of the vast development which will be effected.

THREE NEW POLYMET PLANTS WORKING AT CAPACITY

The expansion of this well-known radio parts company in the past year has been little short of phenomenal.

From one factory on lower Broadway, New York City, Polymet today boasts three of the most modern and up-to-the-minute plants to be found anywhere.

A huge new factory at 829-839 East 134th St., New York City, has supplanted the old, while other Polymet divisions operate in Easton, Pa., and Winsted, Conn.

Each plant is a specialist in its own field and each plant has been completely equipped with the most modern machinery available for the particular work to be done.

The New York plant, employing nearly 600 persons, is engaged in the manufacture of filter and by-pass (paper) condensers and molded bakelite (mica) condensers, resistances, volume controls, potentiometers, etc. Here the head office of the company is located.

The Coilton Division located at Easton, Pa., specializes in the manufacture of coils. The entire plant was designed, built and equipped to be the ideal coil-winding plant of the country. Batteries of the very newest semi-automatic winding machines are here engaged in turning out thousands of Poly-Coils, daily.

The third plant, at Winsted, Conn., makes enameled magnet wire. Formerly the Strand and Sweet Manufacturing Corporation, long specialists in the finer sizes (18-42 B & S gauge) magnet wires; now under Polymet management, new equipment and machinery has greatly expanded and improved production. In a few more weeks, production will be double that possible in the old plant. Enameled magnet wire produced in the Strand & Sweet Division has been approved by the largest electrical companies in the country. Well-known abroad too, great quantities of wire are shipped to foreign users.

NEW UNIT ADDED TO JENSEN PLANT

Photograph shows the Jensen Radio Mfg. Company's plant in the Clearing Industrial district at Chicago as it appears with the completion of the new unit which was built in record breaking time. Less than a month elapsed from the time ground was broken for the foundations until the installation of machinery and equipment was started. The Jensen plant is now a city block long and measures 140 feet deep, providing over 60,000 square feet of manufacturing floor space. It is said to be the largest single factory in the world devoted exclusively to the manufacture of loud-speakers and reproducers.

In the foreground is the Jensen day shift numbering approximately 600 employees.

Switch tracks of the Chicago Belt Railroad, which run directly into the building for the loading and unloading of materials enter at the rear of the structure.

GROUP INSURANCE FOR BOND EMPLOYEES

Executives of the Bond Electric Corporation, manufacturers of batteries, flashlights, condensers and various radio accessories, announced recently the adoption of a group life insurance policy for the protection of their several hundred workers.

The policy, issued by the Prudential Insurance Company of America, provides for a total coverage of about $600,000 and became effective immediately. It is of the contributory type, with the employing company paying a part of the premiums and the workers assuming the remainder of the expense.

Each factory worker is protected to the amount of $1,000, while foremen, office employees, salesmen and executives are eligible to coverage of from $2,000 to $5,000 each, according to the position held. New employees will receive the protection after three months of service.

The Bond Electric Corporation's eastern plant is in Cornelison Avenue, Jersey City.

MUCHER JOINS CLAROSTAT ENGINEERING STAFF

George Mucher, of the well-known family of Mucher brothers, who operate in the radio field under the name of Clarostat Manufacturing Company, Brooklyn, N. Y., has just joined the Clarostat engineering staff, following his graduation from the Rensselaer Polytechnic Institute. George was made historian of his class at R. P. I., graduated with flying colors, and made the E. E. grade in four years. He joins his uncle, John Mucher, Stephen Anderson, Jr., William A. Bruno and others in rounding out the very active and efficient Clarostat engineering staff which not only engages in research and development work to the end of developing the new products of the organization and supervising the production, but also in extensive co-operation with the many users of Clarostat products.

MERRICK ELECTED WESTINGHOUSE PRESIDENT

F. A. Merrick, an executive well-known within the electrical industry was elected President of the Westinghouse Electric and Manufacturing Company by the Board of Directors of the Company, meeting in New York City, Wednesday, June 26.

In announcing the election of Mr. Merrick to the Presidency of the Company, A. W. Robertson, Chairman, also stated that the Board of Directors, while accepting the resignation of E. M. Herr, President since 1911, in order that he might go on an extended vacation, had elected Mr. Herr vice-chairman.

Mr. Merrick advances into the position of President from the position of Vice-President and General Manager of the Westinghouse Electric and Manufacturing Company. He is a native of New Jersey and received his technical education at Lehigh University.

KETCHAM ELECTED PRESIDENT OF GRAYBAR

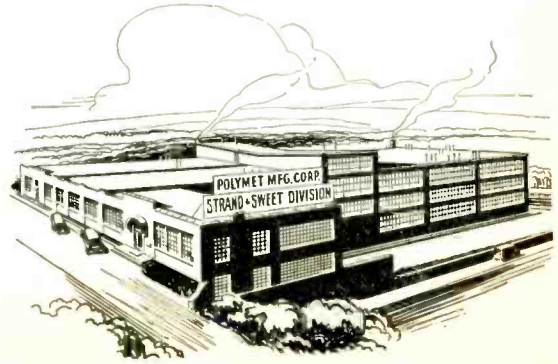
Frank A. Ketcham, formerly executive vice-president, was elected president of the Graybar Electric Company at the first director's meeting of the organization on January 1st. Mr. Ketcham succeeds Albert L. Salt, who is now chairman of the board.

The action taken is particularly significant in that Mr. Ketcham's appointment took effect on the very day in which the Graybar company, in its entirety, became the property of its employees.

At the same time, announcement was made of the appointment of Walter J. Drury of New York, and Walter P. Hoagland of Chicago, eastern and central district managers respectively, to the board of directors of the company.

Mr. Ketcham, newly elected Graybar president, started to work for the Chicago office of the company he now heads in 1900. After serving his apprenticeship in the stock room, he worked through various clerical jobs and in 1906 became chief clerk. A year later he was advanced to the assistant managership and in 1911 became manager. In 1918 he came to the executive offices in New York as general manager, and with the formation of the Graybar Electric Company in 1926 to succeed the Supply Department of the Western Electric Company, Mr. Ketcham became executive vice-president.

Mr. Salt, the new chairman of the board, started his career in New York as an office boy with the Western Electric Com-



One of Polymet's new factories, in Winsted, Conn., where enameled magnet wire is manufactured. This plant is a recent acquisition and was formerly a Strand and Sweet Mfg. Corp factory.

pany at the age of fourteen. He later was mail clerk, bookkeeper, salesman, assistant manager of the New York office, and then became general purchasing agent and traffic manager with the title of vice-president. In 1926, when the Graybar Electric Company was formed to succeed the Supply Department of the Western Electric Company, he was named to head the new company. He now has assumed office as chairman of the board of the Graybar Electric Company, exactly three years to the day following his assumption of the presidency of the company.

The complete list of officers of the company as announced following the directors meeting January 1st, follows: Albert L. Salt, chairman of the board; Frank A. Ketcham, president; George E. Cullinan, vice-president; Leo M. Dunn, vice-president; Elmer W. Shepard, treasurer; and Louis Flille, secretary.

CUNNINGHAM PROMOTIONS

Three important executive promotions have just been announced by E. T. Cunningham, Inc., following a Board of Directors' meeting of the company held July 5th, in which approval was given creating a new executive vice-president, and two vice-presidential positions.

The promotions effected, as released by E. T. Cunningham, president of the company, are as follows:

George K. Throckmorton, formerly Vice-President and General Manager, to the position of Executive Vice-President and General Manager; C. R. King, formerly Assistant General Manager to the position of Vice-President and Assistant General Manager; and M. F. Burns, formerly General Sales Manager, to the position of Vice-President and General Sales Manager.

NEW ROLLER-SMITH REPRESENTATIVES

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces some additions to its sales organization.

Mr. Jackson Brown, Jr., 701 Kittridge Building, Denver, Colo., is representing the Roller-Smith Company in Colorado, Utah, Wyoming and Northern New Mexico.

The Manila Machinery & Supply Company, Inc., Manila, Philippine Islands, is representing the Roller-Smith Company in the Philippine Islands.

Both of these new representatives will handle the Roller-Smith Company's lines of electrical measuring instruments, relays and circuit breakers.

NEW FRESHMAN DISTRIBUTOR

The Empire Electric Manufacturing Company, of 25 East Juneau Avenue, Milwaukee, Wis., has been appointed distributor for the Charles Freshman Company in Central Wisconsin. The appointment of distributors by the Freshman organization is a new policy dating from its recent reorganization under the Presidency of C. A. Earl, noted automotive executive. Prior to this time the distribution of the Freshman radio receivers was made directly through dealers.

CONDENSER CORP. OF AMERICA APPOINT NEW REPRESENTATIVES

The Condenser Corporation of America have appointed two new representatives as follows: The Ekko Company, Daily News Building, Chicago, Illinois, and W. C. Laing, Southern Ohio Bank Bldg., Cincinnati, Ohio.

For the present the Ekko Company is covering Illinois and Wisconsin, while W. C. Laing covers Ohio, Indiana and Kentucky.

MOUNTFORD APPOINTS SALES REPRESENTATIVES

C. E. Mountford, manufacturer of resistances, with offices and laboratories at 105 Sixth Avenue, New York City, announces the appointment of Rosse M. Gilson of Los Angeles as representative for California, and Mr. G. M. Cameron of Cleveland Heights for Ohio. Mr. C. E. Reymond, who has been associated with C. E. Mountford for the past six years, has been appointed salesman to cover the Metropolitan-New York territory.

Mr. W. S. Sole, formerly of the New Jersey Bell Telephone Company, has been added to the Mountford engineering staff.

REPLOGLE APPOINTED SALES ENGINEER OF EVEREADY

Announcement has been made by Harry S. Schott, General Sales Manager of National Carbon Company, of the appointment of Delbert E. Replogle as Sales Engineer in the Product Development Division.

Mr. Replogle comes from the Raytheon Manufacturing Company, the control of production and sales of whose products has recently been acquired by the National Carbon Company. There, since its early organization, Mr. Replogle has been very closely associated with the development and technical merchandising of all Raytheon Products, at first working on circuit development and directing a customer technical service laboratory. He also directed publicity and edited the Raytheon technical bulletins. He has always been keenly interested in new developments in the communication field, especially in television and was responsible for production of the Raytheon television products, and at present is Chairman of the Television Committee of the Radio Manufacturers Association.

His first interest in radio, or wireless as it was then called, goes back to the early

D. E. REPLOGLE
Sales Engineer in the Product Development Division of the National Carbon Co.

days of the science. After graduating from Pacific College near Portland, Oregon, he entered the service of the United States Government, taking charge of an Eskimo reservation at Noocvik, Alaska, 200 miles due north of Nome and forty miles north of the Arctic Circle. Communication with outside civilization required two months. Mr. Replogle persuaded the Government to purchase a simple wireless equipment, which he installed, thereby establishing the farthest north station on the American continent. From the first the station was a success. News was received from all parts of the world, and a small newspaper which was made up each day, was carried by native hunters to the few white prospectors and teachers in the northern wilds. During the time Stefansson, the Arctic explorer, was sick at Herschel Island, his only news from the world came through these sheets.

Mr. Replogle left the Government service in 1920, and entered the Massachusetts Institute of Technology, where he studied Electrical Engineering, graduating in 1925, with Bachelor and Master's degrees. During his course he was associated with private radio interests around Boston and upon graduating, after a short time spent with the Boston Edison Company, he joined the then newly organized Raytheon Company.

Mr. Replogle will make his headquarters in the New York office of the National Carbon Company, where he will welcome technical inquiries and continue his work with Eveready-Raytheon products.

MARVIN COMPLETES ITS SALES FORCE

With the appointment of additional distributors throughout the country, the sales force of the Marvin Radio Tube Corporation of Irvington, N. J., is now complete, according to F. A. LaBaw, General Sales Manager.

"In addition to the distributors announced some time ago," states Mr. LaBaw, we have appointed 31 additional distributors. This latest addition gives the Marvin organization a sales force that covers every territory of importance in the entire country.

"Furthermore, with the tremendous and unexpected increase in our export trade, we have granted exclusive sales rights in Japan, the Near East, Continental Europe and Scandinavia. While this export trade forms a comparatively small percentage of the total production of the Marvin organization today, it has exceeded our expectations to the extent that we find it necessary to keep all six of our plants in operation for some time to come, instead of centralizing them in our largest plant at Irvington, N. J."

W. E. COLL JOINS FEDERAL SALES

W. E. Coll, prominent in the music trade, has joined the sales staff of the Federal Radio Corporation, Buffalo, N. Y., and will act as one of their traveling representatives throughout the United States. Mr. Coll has had many years experience in the music and radio trade, and most recently was manager of the various music shops of Waterson-Berlin & Snyder.

SPEED ADDS TO SALES FORCE

Ames Radio Sales of 6 East 14th Street, New York City, is the latest distributor to join the Cable Radio Tube Corporation.

With Ames Radio Sales are the well-known Messrs. M. L. (Mike) Miller, A. Saphin and E. R. Jones. They will cover the New England territory including Connecticut, where they enjoy wide-spread and important connections.

M. A. GORDY APPOINTED SOUTH-EASTERN MANAGER FOR "U. S."

Growth in the popularity of "U. S." drills, grinders and other products in the southeastern states has made it necessary to appoint a district manager for this section, according to G. M. Lawrence, General Sales Manager of The United States Electrical Tool Company, Cincinnati, O.

Selection of M. A. Gordy for this office will be of interest to his large circle of friends among the trade who know him better as "Jack" Gordy. For several years, he has successfully handled a number of lines as manufacturer's agent, including "U. S." products. Now Mr. Gordy will give his time exclusively to the sale and service of the "U. S." line, co-operating with jobbers and working closer to the users. He reports the addition of seven jobbers to the "U. S." family within his territory during the past few weeks, and expects several more in a short time.

Mr. Gordy's headquarters will remain at Atlanta, Ga., in the Norris Building on Peachtree Street. This office is one of several new ones established in the United States and Canada during the last few months by the U. S. Electrical Tool Co.

R. G. KITTLE WITH PARAMOUNT

Mr. Robert G. Kittle, for many years associated with Benjamin Electric Mfg. Company, has become associated with Mr. Leslie Ablett, of the Paramount Manufacturing Co., 79 Orange St., Newark, N. J., in the manufacture of rectifying tubes.

I. V. I. CO. SELLS COIL BUSINESS

The Irvington Varnish & Insulator Co., of Irvington, N. J., have sold the coil winding and enameled wire branches of their business to the Rome Wire Co., Division of the General Cable Corporation.

The General Cable Corporation is planning to operate the above mentioned branches in the same quarters and with the same operating and selling personnel as heretofore, thus assuring the trade, from a production and geographical standpoint, the same service under the new ownership as under the old.

The announcement refers only to the coil and wire branches of the business of the Irvington Varnish & Insulator Co. The Insulating Line will be continued as heretofore, without any change in ownership.

WHOLESALE RADIO SERVICE MOVES

The Wholesale Radio Service Co., Inc., formerly of 6 Church St., have moved their entire organization to 36-38 Vesey St., New York City.

CHICAGO-JEFFERSON FUSE CHANGES NAME

The officers and directors of the Chicago-Jefferson Fuse & Electric Co., announce a change of name to be hereafter the Jefferson Electric Company, with general and executive offices at 1500 South Laflin St., Chicago.

R.C.A. EASTERN SALES HEADQUARTERS MOVES

The Eastern District Sales Offices of the Radio Corporation of America have moved to new and enlarged quarters in the 261 Fifth Avenue Bldg. The new offices take up the entire twenty-fourth floor, and provide double the amount of space vacated in the Woolworth Building, for the expansion of the activities of the Eastern District Sales Office.

In its new quarters at 261 Fifth Avenue, the Eastern District Sales Office is operating as a separate and self-contained unit, serving the R.C.A. authorized dealers and distributors in its territory. The space vacated is being used to expand the national and executive sales offices, which remain on the twentieth floor of the Woolworth Building.

KOLSTER ELECTED TO FEDERAL TELEGRAPH BOARD

Frederick A. Kolster, the designer of Kolster radio receiving sets, has been elected to the board of directors of the Federal Telegraph Company of California, subsidiary of Kolster Radio Corporation. He will fill the vacancy caused by the resignation of C. A. Spreckels, who spends much of his time abroad.

New Plant of the Perryman Electric Co., Inc., at North Bergen, N. J., embracing more than 50,000 square feet of floor space.

INTERNATIONAL GROUP PLANS PATENT COMBINE

Any review of industrial progress discloses that the force of standardization is a dominant factor of nearly every activity. It is especially so in radio. Standardization means an interchange of ideas and dimensions and their application for the benefit of the greatest number of people.

With this idea as a basis, plans for the international exchange of patents and products between manufacturers in England, Germany, France and Switzerland, and the Temple Corporation of Chicago, have been tentatively drafted.

Messrs. J. Lenzen, president of the Lenzola Speaker Factory at Krefeld, Germany, and Edward Rosen, engineer of Ultra Electric Ltd., London, are now in the United States for the purpose of making the final arrangements with Alfred Marchev, President of the Temple Corporation, which will put the plan into effect. The alliance also includes manufacturers of radio and allied products at Zurich, Switzerland, and Paris.

The representatives from England and Germany plan to make an intensive study of United States engineering, merchandising and production methods for application in their respective countries.

Both are engineers of note and long standing, having worked individually in Europe more than thirty years ago on the problem of acoustics and sound reproduction.

Mr. Marchev plans to make the interchange or patent-pooling plan as comprehensive as possible. All ideas possessed by the several adherents independently are to be made immediately available to all the members. The patents will comprise radio, loudspeaker, radio accessory and phonograph applications. The complete notes of the various radio and general laboratories concerned will be published for the benefit of a general engineering body which will review the work carried out individually. Ideas developed abroad will thus become available to the Temple company, and vice versa.

GOTHAM OPENS CHICAGO OFFICE

The Gotham Engineering and Sales Co., national sales representatives for Transcontinental Coil, Inc., of Newark, N. J., announce the opening of a Mid-western sales office under the direction of Mr. Fred Garner, located at 9 Clinton St., Chicago.

Transcontinental Coil, Inc., is a firm specializing in the manufacture of radio-frequency transformers and impedances for use in manufactured radio receivers.

Mr. Garner is well known to the radio trade of the Middle West, being a familiar figure all the way from Pittsburgh to the Mississippi, and from the Lakes to the Ohio river. He is one of the oldest "old timers" in the radio business, and his many friends will be glad to hear of his new line, which will not affect any of his present connections.

DUBILIER SALES OFFICE MOVES TO NEW QUARTERS

The Dubilier Condenser Corporations' sales office is now located in the Canadian Pacific Building at 346 Madison Avenue, New York City.

Due to the rapid increase in business, necessitating a more accessible location, the sales office of the Dubilier organization was moved from the huge plant building at Woodlawn, on the outskirts of New York City, down to 10 East 43rd street, almost a year and a half ago. These quarters have since been outgrown, and new and larger office space is now occupied in the Canadian Pacific Building.

VACUUM TUBE PRODUCTS MOVES

Vacuum Tube Products, formerly in the Steneck Trust Bldg., Hoboken, N. J., have moved into new quarters located at 219 Bloomfield St., Hoboken, N. J.

Mr. D. R. Donovan, formerly associated with the Westinghouse Lamp Co., has been retained as general manager and chief engineer of the Company. Mr. Donovan has had considerable engineering experience in the design and manufacture of incandescent lamps and vacuum tubes.

R.C.A. EXPORT DIVISION MOVES

The removal of its export division to enlarged quarters in the Woolworth Building and at Bush Terminal, Brooklyn, was announced by the Radio Corporation of America.

Large business expansion and the need for additional facilities was the reason for the change, according to the announcement. The new Woolworth Building location provides 2024 square feet of floor space, with an additional 1700 square feet at Bush Terminal, making a total floor area of 3724 feet. This compares with the 2300 square feet available in the old quarters.

The activities of this rapidly growing division of the Radio Corporation have been divided into two distinct sections, each occupying separate quarters. The export merchandise and apparatus sales work of the department will be carried on from offices on the twentieth floor of the Woolworth Building; the export order and shipping section has been installed at Bush Terminal, Brooklyn. Mr. Van Ness Philip, Export Manager, and Mr. J. M. Regottaz, Assistant Export Manager, have made their headquarters in the Woolworth Building.

FRESHMAN APPLIES FOR TELEVISION CHANNELS

The Chas. Freshman Company, Inc., has made application for two television broadcast channels with the transmitters to be located at its factory situated at Clifton (Allwood) New Jersey. The channels have been requested for experimental purposes with the avowed intention of broadcasting regular television programs to aid the rapidly augmenting group of television 'hams'.

WITZ, OF WEBSTER, MOVES

Mr. A. Irving Witz, eastern representative for the Webster Company, 850 Blackhawk Street, Chicago, has moved his offices from 222 Fulton Street, New York City, to 225 West 34th Street, New York City.

K. G. BAKER JOINS WAGNER ELECTRIC

Wagner Electric Corporation, of St. Louis, announces the addition of Mr. K. G. Baker to their Cincinnati sales force. Mr. Baker is a graduate of Purdue University, and has previously been connected with Century Electric and Fulton Iron Works, both of St. Louis.

INFORMATION BOOKLET ON RADIO UNITS

A booklet of sixteen pages on Rittenhouse Radio Units is an excellent example of the trend of catalogues prepared by manufacturers for the use and information of the public. Not only does it convey the desires of its sponsors concerning the products offered, but it also supplies pages of informative paragraphs.

The reader will find well written explanations of the preferred method of obtaining A and B power from transformers, as well as a recital of the capabilities of the numerous types of AC tubes. A careful count of the diagrams reveals a total of nineteen, covering four and five tube sets, with and without regeneration; A, B and C power supply circuits and several audio amplifier schemes, not to omit the space accorded the new screen-grid tube.

It is a booklet that successfully accomplishes what its makers set out to do. It is distributed gratis by Hatheway & Company, 225 Varick Street, New York.

CITY RADIO ACQUIRES RADIO CIRCULAR CO.

City Radio Stores, which operates twelve retail radio stores in Greater New York, is entering the mail order field. The company has just acquired the Radio Circular Company, a large eastern mail order company, which is doing a present business at the rate of $1,000,000 annually. It is stated that with this acquisition City Radio Stores is enabled to enter a field holding great promise for additional business. The transaction was partly for cash and partly for stock but the purchase price was not announced.

DUBILIER ISSUES NEW CATALOGUE

A new condensed catalogue and price sheet combined has just been issued by the Dubilier Condenser Corporation, covering the full line of Dubilier socket-power condensers, micadons and specialties. With this catalogue, it becomes a simple and positive matter to select the correct condenser block of the necessary capacities and working voltages for any given radio purpose.

A copy of the new Dubilier catalogue and price sheet will be sent to anyone addressing the Dubilier Condenser Corporation at 346 Madison Avenue, New York City.

R.M.A. ENGINEERING SERVICE WILL BE EXPANDED

EXPANSION of engineering service to members of the Radio Manufacturers Association and to the industry generally is being planned by Walter E. Holland of Philadelphia, the new Director of the R. M. A. Engineering Division.

The Engineering Division has been reorganized by Director Holland, in consultation with President Richmond of the R. M. A., whom Mr. Holland succeeded as head of the engineering activities of the Association. As reorganized by Director Holland, standardization and other needed technical work of the industry will be handled by a unified technical organization under the leadership of eminent engineers.

There will be three major sections of the Engineering Division, the Safety Section, the Service Section and the Standards Section. The Chairman of the Safety Section, appointed by Director Holland, is Mr. A. F. Van Dyck, Manager of the Technical and Test Department of the Radio-Victor Corporation, Camden, New Jersey.

Heading the Service Section as Chairman is Mr. H. A. Fenner, General Sales Manager of the American Bosch Magneto Corporation, New York City.

Ray H. Manson, Vice-President and Chief Engineer of the Stromberg-Carlson Company of Rochester, New York, has been appointed Chairman of the General Standards Committee. Mr. Manson is one of the principal contributors to radio standardization during the development of the radio industry.

As reorganized, the General Standards Committee will consist of five special committees as follows:

Committee on Receivers and Power Supply: Ralph H. Langley, Director of Engineering of the Crosley Radio Company, Cincinnati, Chairman.

Committee on Vacuum Tubes: George Lewis, Vice-President of the Arcturus Radio Company, Newark, N. J., Chairman.

Committee on Acoustic Devices: F. W. Kranz, Chief Engineer of the United Reproducers Corporation, St. Charles, Ill., Chairman.

Committee on Television: D. E. Replogle of the National Carbon Company, New York City, Chairman.

Committee on Cabinets: R. H. Ewing, Chief Engineer, Adler Manufacturing Company, Louisville, Ky., Chairman.

The Safety Section, a small but important group, will maintain contact with the Underwriters Laboratories, Inc., and handle all work in connection with safety standards.

The Service Section is a new activity, formed in response to demands for cooperative work among service managers to solve the ever-increasing service problems in connection with radio sales. This group will keep in close touch with the R. M. A. Merchandising Committee.

Standardization will be a major function of the Engineering Division under Director Holland. A review of all existing radio standards with a view to developing such new standards as may be needed, under a procedure that will safeguard manufacturers and the R. M. A. against improper or undesirable standards, is planned.

NEW LEGISLATIVE SERVICE PLANNED BY RMA SERVICE

New service for R.M.A. members, designed to protect radio interests in state and local legislation, has been ordered by the R.M.A. Board of Directors, at their meeting at Cleveland, April 26-27th. A cooperative information service, for joint action between the radio manufacturing and distributing interests, in connection with state and local legislation will be established.

The R.M.A. Board of Directors ordered the R.M.A. Legislative Committee, headed by Mr. C. C. Colby of Boston, to formulate plans for the new legislative service, in cooperation with the Federated Radio Trades Association.

The legislative information service, which will secure complete data regarding all radio legislation proposed in various states and cities will be secured by the R.M.A. With the assistance of Frank D. Scott, Legislative Counsel at Washington for the R.M.A., the Legislative Committee will take necessary action in conjunction with state and local radio jobbers and dealers' local organizations, to safeguard the interests of radio manufacturers and distributors in connection with local legislation.

The Legislative Committee is now taking appropriate action in connection with "serial number" bills pending before the Missouri, Illinois and other legislatures, and also in opposition to a bill in Maine proposing a license tax on receiving sets. The R.M.A. Board was advised by Chairman Colby of the Legislative Committee that nine state legislatures will meet in 1930, and legislatures of 44 states in 1931. Therefore, the R.M.A. Board ordered the establishment of a new legislative service in ample time for appropriate action to protect the interests of R.M.A. members, and also jobbers and dealers and the industry generally, in connection with new radio legislation throughout the country.

R.M.A. GOING AFTER RADIO EXPORT TRADE

American radio products will be sold more widely throughout the world under plans announced by the Radio Manufacturers Association to aid its members in developing their foreign sales, especially in Latin America.

A complete and the first radio export guide has just been compiled by the Radio Manufacturers Association comprising virtually all prominent makers of all radio products, and issued free to its members.

The export campaign of the R.M.A. is expected to greatly increase radio foreign sales, which last year were $12,061,410, as compared with $2,000,000 five years ago. This record was made despite inability of American manufacturers to fill radio demands in the United States, but the radio industry now feels able to develop the foreign market for the American industry.

The radio export guide of the R.M.A., prepared under the direction of Mr. George H. Kiley, of New York, Chairman of the R.M.A. Foreign Trade Committee, includes complete radio information in all Latin America, and most other countries of the world. The population, number and character of radio stations, control of radio, number and type of receiving sets in use, license fees, trade marks, patents, and other valuable export information are detailed in the R.M.A. export guide. Lists of radio exporters, Latin American importers, foreign broadcast stations, foreign tariffs and import regulations are also given. The data will be supplemented, in loose leaf form, in future additions to the R.M.A. radio export information.

R.W.A. REPORT

ONE of the most important Committees operating at the present time in the Radio Wholesalers Association is that of Dealer Relations, headed by Mr. Roy Whipple of Wakem & Whipple of Chicago.

It is the purpose of this Committee to assist in developing retail radio stores in becoming more profitable enterprises. The Radio Wholesalers Association intended to work harmoniously with all of the radio trade and intends to do its utmost in developing the retail outlets of distribution.

The Radio Wholesalers Association, through the Federated Radio Trade Association is cooperating with a national survey on the Retailers Cost of Doing Business as conducted by RADIO RETAILING. Such a survey was undertaken in 1925, but since that time no national attempt has been made to analyze the dealers cost of doing business. This survey has been made through all dealers belonging to various local associations scattered throughout the country so that it is thoroughly national in character and represents a cross sectional view of the Retailers' business throughout the United States.

When this survey is completed, the Radio Wholesalers Association will be in a better position to make recommendations concerning the operation of the retail stores.

The Dealers Relations Committee is analyzing all phases of the retailer's business and working hand in hand with the retailers in making such an analysis.

Another way that the retailer's work is being assisted and the radio industry in general benefited, is by the sponsoring and assisting in the formation of local radio trade associations. The officers of the Association believe that in close harmony and cooperation many evils of the trade can be corrected and for this reason are assisting in the establishment of new associations. These local groups have for their prime motives: the increasing of friendliness between competitors; the watching of city, State and national legislation; the establishing of a Code of Ethics affecting the sales policies and guarantees of radio apparatus; uniform cost accounting systems and many other activities which are directed to benefit the radio dealers.

The examination and registry of servicemen plays an important part in every local group and most associations are cooperating with local schools or educational institutions whereby the dealers may have their servicemen examined both on a strictly technical basis as well as through practical experience. The examination papers are examined and regraded by a Technical Committee composed of several members of the association versed in the technicalities of radio. Through this plan of grading, the servicemen receive a grade of A, B, or C, symbolical of his accomplishment in the service line. An "A" grade man is one thoroughly qualified and competent to handle the service department of a radio dealer or wholesaler. He must have at least four or five years' experience. A "B" grade man is one who is thoroughly competent and qualified to take care of the regular service work in the shop and in the home. He must have had at least two years' practical experience. A "C" grade man is one thoroughly competent and qualified to erect antenna, make ground connections and install sets. The Associations who are members of the F. R. T. A. are standardizing their examinations and gradings so that a serviceman might move from one city to another and be able to secure an immediate rating from the city to which he moves. This will greatly facilitate the serviceman securing a new position and will add much to the mutual benefits to be obtained by an interchange between local associations.

By the use of cards, stating the grade of the serviceman, the public is amply protected from having an unqualified serviceman call in his home and service his set. The dealer in turn is protected by knowing that the serviceman working for him is qualified and able to handle the work. He need not be dependent upon his own judgment of the serviceman's ability but can rely on the grading of the school and the Technical Committee. The serviceman himself is protected because if he is an efficient man he wants to be recognized as such and if he is not an "A" grade man he is ambitious to secure such grade knowing that it will mean increased revenue to him and a better position.

The operation of a local radio show stimulates radio buying and increases the interest of the public in radio sets. The revenue from such a show, successfully staged can provide sufficient funds to maintain an association headquarters where members can seek and find information concerning any phase of the industry within their localities. It is a known fact that in localities where successful radio trade associations are functioning, selling conditions are cleaner and more satisfactory than in localities where there is no evidence of cooperation between members of the trade. Increased use of radio in every section, therefore, represents an increase in the industry's business and if Radio is developed and marketed in competition with other lines of merchandise, the associations can be of great assistance in promoting such sales; thus, by the sponsoring and establishing of local associations, the Radio Wholesalers Association is increasing the benefits of the dealer and stabilizing the entire industry. The benefits that will result from a more stabilized industry will more than compensate any radio wholesaler for the time and money he may be called upon to spend in the interest of his members in the Radio Wholesalers Association.

R.W.A. Elect New Directors

The Radio Wholesalers Association has elected Mr. Fred Wiebe of the Brown & Hall Supply Company, St. Louis, Mo., as Vice-President of the Association from the central zone. Mr. G. N. Provost of the Doubleday-Hill Electric Co., Pittsburgh, Pa., has been elected to fill the vacancy from Zone 3 while C. C. Matthews of the Capital Electric Company, Indianapolis, Ind., has been elected to fill the vacancy from Zone 5.

The next meeting of the Board of Directors of the Radio Wholesalers Association will take place in Chicago on Thursday, August 1. Several important subjects will be brought up for discussion at that time.

The work of the Tube Committee has resulted in a great deal of good will being created for the Association and it is believed that the organization's membership will increase materially from this good work. Other committees of the Association are very active at the present time and hope to duplicate the successful performance of the Tube Committee.

SUCCESSFUL MEETING OF M.R.T.A.

THE regular meeting of the Midwest Radio Trades Association, held in the North Hall Room of the Stevens Hotel, was one of the most successful meetings the Association has ever known. There were over 225 members present.

Mr. Harry Alter, of the Harry Alter Company, President of the Association, opened the meeting and stated that the Midwest Radio Trades Association was making rapid strides toward becoming the largest local radio trade association in the country.

A report was given stating that at the present time, the association had over 500 members.

Mr. Allan C. Forbes of Triangle Electric Company, Chairman of the Technical Committee, spoke on registration and grading of Servicemen, stating that there were four outstanding benefits to be obtained by the Servicemen—

1. The advantage of an employment agency without additional cost.
2. The self confidence gained by knowledge.
3. The regognition by the public that you are qualified to service their radios.
4. To prove your radio ability to your employer.

Mr. H. E. Richardson, of Young, Lorish & Richardson, retiring President of the Association and Chairman of the Board of Directors, acting as spokesman for the members of the association and of the Board, presented Mr. Alter with an engraved ebony gavel.

Mr. J. B. McManus, Field Secretary of the Employers Association, speaker of the day, gave a very interesting talk in which he displayed numerous articles that were of great interest to all present.

In closing the meeting, Mr. Alter requested that every member of the association bring in at least one new member by the time of the next meeting.

F.R.T.A. REPORT

THE Executive Committee of the Federated Radio Trade Association will meet in Chicago on Thursday, August 1. One of the activities of the Federated to be discussed at this meeting will be the establishment of a standard Code of Ethics covering radio sales. This Code of Ethics will amalgamate the various Codes now in use by local associations generally. Steps will also be taken to establish standard forms for the examination and registry of servicemen so that servicemen, who are connected with local associations affiliated with the Federated, can move to other cities and be assured of their standing as registered servicemen in the new city.

Federated Publishes Booklet

The Federated Radio Trade Association has just published a booklet on "How to Conduct a Successful Public Radio Show." This booklet deals with the subject of local show operations very successfully. It was prepared by the Show Managers Committee of the F. R. T. A., H. H. Cory, Chairman, and is the result of the experience of several of the most successful shows throughout the country.

The booklet outlines in detail all of the steps necessary to conduct a Show and gives to the reader a very complete set of rules to be used covering exhibitors as well as a sample contract and floor diagram. The booklet warns the new promoters of the various elements that might hamper the successful show and tells him how to successfully cope with such difficulties. Members of the Show Managers Committee are: H. H. Cory, Chairman; Wm. P. Mackie, St. Louis; L. F. Thomas, Buffalo, A. G. Farquharson, Los Angeles, Calif.; Geo. H. Curtis, San Francisco, Calif.; and Michael Ert, Milwaukee.

This is the second of a series of booklets published by the F. R. T. A. in the interest of the local radio trade associations. Copies may be secured by writing the executive offices at 32 W. Randolph Street, Chicago, Ill.

THE FEDERATED SPONSORS LOCAL ASSOCIATIONS

One of the chief activities for the Federated Radio Trade Association during the coming months is the fostering and sponsoring of new local radio trade associations. The executive offices are just completing a booklet on "How to Organize a Successful Local Radio Trade Association." This booklet gives all of the important activities which a local association can rightfully carry on for the benefit of its members. It also fully explains the method and procedure to be followed in organizing such an association.

The Federated is a very firm believer in the necessity and importance of local associations and are doing their utmost to install a successful local in every city in the country.

Such activities as a Code of Ethics, Trade-Ins, Standard Trade Practices, Examination and Registry of Servicemen are all of prime importance to every retailer and wholesaler in their respective communities. The Federated offers to assist any city in the country to get a proper start for their organization. Full information will be sent to them and they will be given every help from the officers and the executive offices.

Any radio retailer or jobber who is interested in starting a local association in his city should write to the offices of the Federated Radio Trade Association at 32 W. Randolph, Chicago, care of H. G. Erstrom, Executive Secretary, for further information. This affords a wonderful opportunity for every locality in the United States to secure valuable aid in the organizing of a successful local radio trade association.

TRIAD EXECUTIVE FORCE

The executive officers of the Triad Tube Company, of Pawtucket, R. I., are George Coby, president, Ely Egnatoff, treasurer, Harry Steinle, vice-president and general sales manager, and William Cepek, secretary.

The engineering staff includes S. U. Marie, Ph. D., Roger Williams, Ph. D., A. S. Friedman, Sc. B., and Gregory Ryisky, E. E., M. E., in addition to graduates of the foremost technical and engineering schools in the country.

PORTFOLIO ON SPEED TUBE LINE

An extremely attractive sales portfolio has been prepared for radio dealers, outlining in detail every phase of the Speed Tube proposition.

Prepared under the direction of J. J. Steinharter, President of the Cable Radio Tube Corporation, and A. D. Strathy, Director of Sales, this portfolio is particularly attractive in form and method of presentation.

The cover, having the appearance of leather, is embossed with large red letters reading "Speed," and in addition, carries the slogan "Step Right Up and Call for Speed."

The text is profusely illustrated and embellished with striking borders, and carries the reader through from the factory, the officers, construction departments, the returns policy, the complete Speed Tube Line, shipment time, the carton, trade and consumer advertising and display material, and terminates with reproductions of Saturday Evenng Post and newspaper advertisements now running.

Requests for the portfolio should be addressed to the Cable Radio Tube Corporation of 84-90 N. Ninth St., Brooklyn, N. Y.

NEW SIMPLIFIED SPEAKER CHART

Oxford Radio Corporation, of Chicago, has prepared a very useful chart showing the proper Speaker for use with various chassis of leading set and chassis manufacturers. This chart is prepared for the particular use of jobbers and dealers, also the cabinet manufacturer who buys chassis and speaker separately and assembles them together into a complete Radio Console.

WHITE PANTS IN A ROLLING MILL

Workmen garbed in white trousers are more efficient and more careful, is the theory that is being worked out at the Ashland plant of the American Rolling Mill Company, where efficiency and safety are valued rather highly. The white pants idea came into being a few days ago, it is reported, and is not, as some suppose, an innovation placed in effect by the company, but is a movement on the part of individual groups that has the approval of the company.

Several days ago, according to one of the plant officials, the leader in one of the small departments of the plant, brought his men out to work all dyked out in spic and span duck trousers. This might not have attracted any attention at Palm Beach or Atlantic City, but in a steel plant it created quite a furore, as the society editor would say.

Since that first squad dared to institute a new style in steel plant wearing apparel, the number of pairs of white duck pants have increased until about 400 men of the plant personnel are now going about their work in spotless white—and liking it.

The idea has a psychological trend, and it will be news to many today to learn that a steel man doesn't think that psychology is some foreign language. The idea, in fact, in this: A man who is careless or slovenly about his wearing apparel will likely be slovenly about his work. Dress him up in neat clothing and you make him into a more careful worker. Likewise you find a man who is particular about his clothing and he will be particular about his work.

That's the idea of the white pants. Put white ducks on the average man and you change his character and his habits. The old saying that "clothes make the man," is being worked out on a large scale at Armco.

Behind all this "store clothes" stuff is the rivalry that goes on within the plant between the various departments. Each department is out to keep its total of accidents as low as possible, in order to win, if possible, the plant trophy. The leaders of the departments, and the men themselves, are constantly on the lookout for any factor which will increase their margin of safety. When one foreman brought his gang out all dolled up in immaculate breeches, it was agreed among the others that he knew his psychology. Immediately, an epidemic of white pants broke out all over the mill.

RADIO WORLD'S FAIR AND CHICAGO RADIO SHOW

This pair of national radio expositions which "set the pace" for the radio public throughout the year are almost here. In less than two months the first will be history. By the time the second is over the likes and dislikes of the public will have been well disclosed, and in factory and office, plants for the next year will have begun.

These shows, by the way, are the only public shows which the Radio Manufacturers Association sponsor. The co-operation which the membership gives is, no doubt, responsible, in part, for the rapid strides which the industry has made. For today they are regarded as part and parcel of the merchandising plans of the association.

Elaborate plans for the conduct of the shows were begun immediately after last year's events. As perfected they include the necessary features which maintain these association activities "head and shoulders" above all similar shows in this country.

Aside from the widespread influence upon the public, the shows perform another important function for the trade; for during regularly scheduled trade show hours, dealers, jobbers and manufacturers have an opportunity to transact business with even more freedom from "outside interference" than in their respective places of business.

In dollars and cents, this feature of the two sponsored shows assumes considerable magnitude and millions of dollars worth of business is always booked while they are in session. Frequently this fact is overlooked by the casual outsider who is impressed rather by the obviously interested hundreds of thousands of interested radio fans who crowd the exposition floors to overflowing. But it is a fact, nevertheless, and one of special significance to the New York and Chicago shows. They are the ones which draw radio men from the four corners of the country.

IGRAD MOVES

The Igrad Condenser & Mfg. Co., Inc., announces that the new company address is 4322 Lake Ave., Rochester, N. Y.

NEW RATING FOR CX-380

A new rating basis for their CX-380 rectifier tube, just announced in a bulletin of E. T. Cunningham, Inc., places the maximum R. M. S. voltage input at 400 volts per anode with a rectified current not exceeding 110 milliamperes. Under the old rating the maximum R. M. S. voltage input was 350 volts per anode, with a rectified current up to 125 milliamperes.

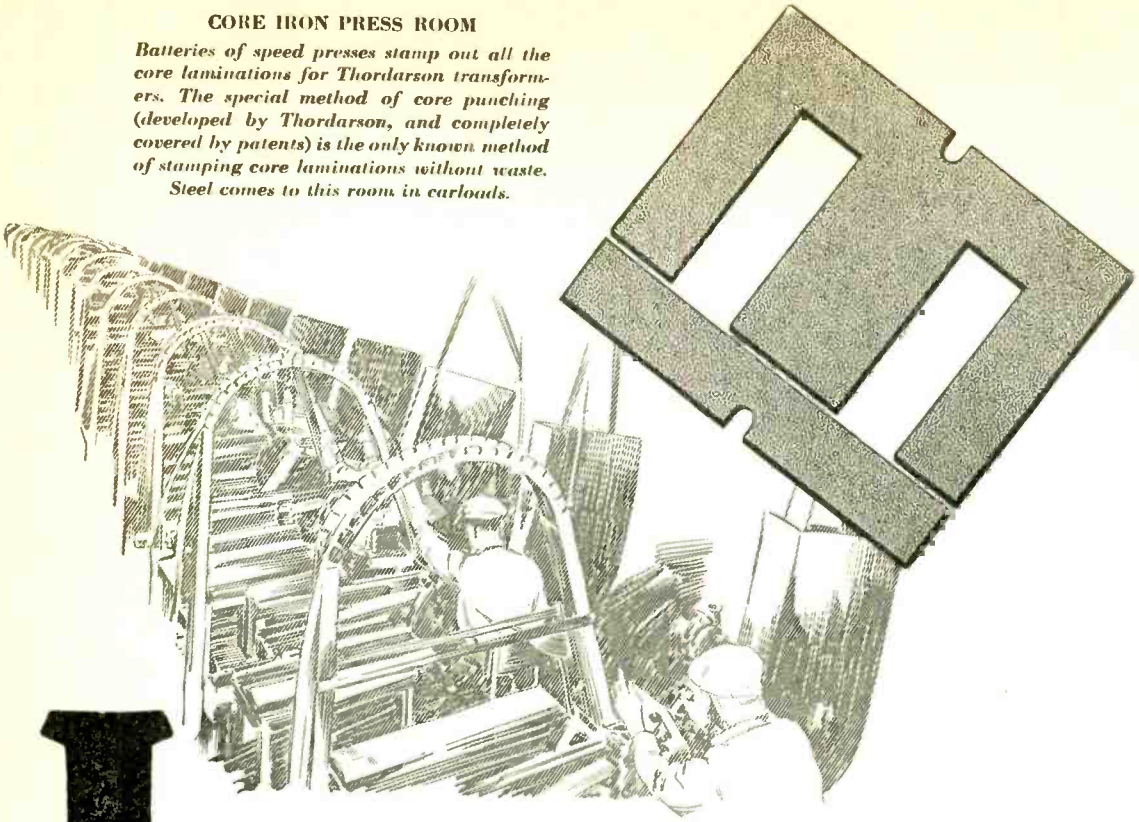
This new method of rating will allow a CX-380 tube to supply sufficient voltage and current for sets employing two CX-345 tubes, and using the rectified output for dynamic speaker field excitation.

Under the old rating the maximum input voltage rating was based on tube operation at the maximum current rating. As the rectified current through the rectifier is reduced, the wattage dissipation is reduced to such a point that it was believed the input rating could be increased. After exhaustive live tests, it was found that after the tubes were operated at reduced current rating, the voltage rating could be increased.

For example, if the current output is 110 ma., or less, the voltage input may be increased to 400 volts R. M. S. per anode. According to the Cunningham bulletin, it is noted that with 110 ma. rectified output the voltage is approximately 390 volts, while at the current output of 100 ma., it is approximately 400 volts.

CORE IRON PRESS ROOM

Batteries of speed presses stamp out all the core laminations for Thordarson transformers. The special method of core punching (developed by Thordarson, and completely covered by patents) is the only known method of stamping core laminations without waste. Steel comes to this room in carloads.



Laminations

Iron for Thordarson transformer laminations is cut in the Thordarson factory from special sheets by methods patented and controlled exclusively by Thordarson.

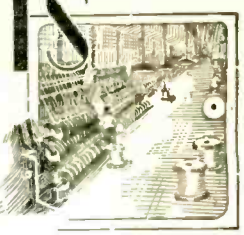
THORDARSON

Transformer Specialists Since 1895

THORDARSON ELECTRIC MANUFACTURING CO.

Huron, Kingsbury and Larabee Streets, Chicago, Ill.

NEW DEVELOPMENTS OF THE MONTH



NEW POWERIZERS

PXP-245 Powerizer is typical of the present line of power amplifiers for every purpose, manufactured by the Radio Receptor Company, 106 Seventh Avenue, New York City. Here is a three-stage amplifier employing two stages of 227 amplification, and a power stage with two 245 tubes in push-pull. This Powerizer is especially intended for use in conjunction with a low-energy input, and provides a 5-watt undistorted output or more than ample for use in extra large living rooms, club rooms and small auditoriums.

Similar are the Powerizer PX-245, comprising one 226 stage and one 245 stage, with a 280 rectifier and an output of 1.5 watts, and the Powerizer PXP-245, with one stage of 226, a power stage of two 245 tubes in push-pull, with a 280 rectifier, and an output of 5 watts.

For large auditoriums and outdoor applications, there is the Powerizer PXP-250, comprising two units in steel cabinets, with one stage of 227, one semi-power stage of 171-A in push-pull, and a high-power stage of two 250 tubes, together with one 280 and two 281 rectifiers, and an output of 15 watts or sufficient for a battery of loudspeakers.

All Powerizers employ nickel alloy transformer cores, together with matched impedances for the highest tone quality standards.

POWERIZER AMPLIFIER RACKS AND CONTROL PANELS

Amplifier racks and control panel equipment for centralized use in theatres, schools, auditoriums, stadiums and other places where music or voice is to be "piped" over large areas, has just been introduced by the Radio Receptor Company of New York City. This equipment is of the panel or vertical rack type, although made up essentially of the well-known powerizer units. In the case of the two-channel assembly, it stands 6 feet high by 20 inches wide, comprises six panels, and weighs 200 pounds complete.

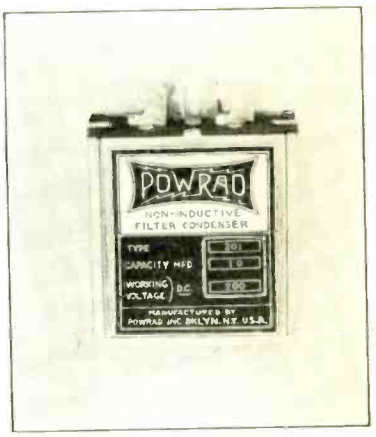
The two-channel amplifier assembly, which is certain to be the most popular for most installations, comprises a PXP-250 powerizer, made up of two units, for each channel. Thus the panel assembly represents a monitoring loudspeaker and distortion meter for the top panel; a switch and pilot light for the PXP-250 or power output unit, representing the second panel; a switch and pilot light for the voltage amplifier or PXP-171 unit, representing the third panel; the fourth panel contains the main switch and throw-over switch from one channel to the other, the a-c. field switch for the dynamic speakers and a throw-over input switch from synchronous to non-synchronous; the fifth contains the second PXP-171 powerizer and its switch; and the sixth contains the PXP-250 and its switch. The assembly is so arranged that any of the complete units with panel may be removed and another unit substituted, such as a monitor, or a radio set with amplifier and microphone panel, which, of course, would take care of the microphone meter and switch. The power units are the standard powerizers arranged for bracket mounting. All audio wiring is carefully shielded so that these units are found very quiet in operation.

POWRAD CONDENSERS

Powrad, Inc., of Brooklyn, New York, are marketing a complete line of by-pass and filter condenser blocks housed in metal cans with mounting and soldering lugs both in standard blocks and to manufacturers' specifications.

These condensers are conservatively rated and guaranteed in capacity from —5% to +15%.

A unique method of impregnation acquired through six years' of skill and experience in the manufacture of paper condensers have led to the production of an exceedingly rugged product noted for its remarkable working strength and high insulation resistance.



Powrad non-inductive filter condenser.

YAHR LANGE KABINETTENNA

Yahr Lange, Inc., of Milwaukee, Wis., have introduced a new product known as the "Kabinettenna," which is a combination of "light socket antenna," a connecting plug for an a-c. receiver and a plug for a dynamic speaker. A binding post is mounted on the side of the case for the aerial connection.

The Kabinettenna lists at $4.50.

PILOT "VOLUMGRAD"

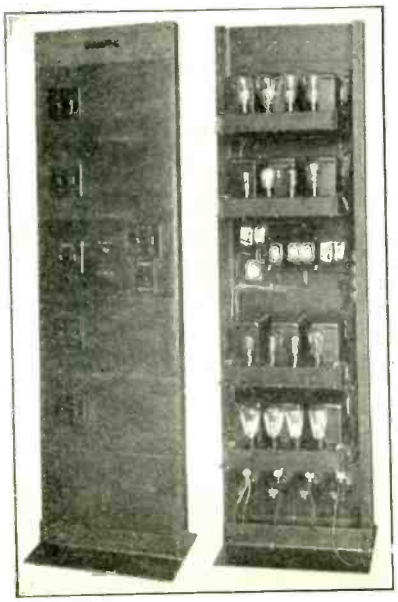
A new varinble resistor designed especially for the purpose of volume control in radio receivers has been brought out by the Pilot Electric Mfg. Co., of Brooklyn, N. Y. It is known as the "Volumgrad," and is made in four resistance ranges: 0-50,000 ohms; 0-100,000 ohms; 0-200,000 ohms; and 0-500,000 ohms.

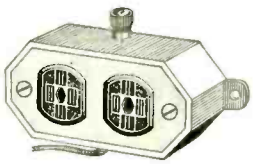
With a volumgrad of the proper size connected in any one of several places in a receiver, the volume can be adjusted from zero to maximum with only one turn of the knob.

The instrument consists of a one-piece molded case of genuine black bakelite, 2 inches in diameter and 23/32 inch thick. The resistance element is a strip of non-hygroscopic material impregnated with a special chemical preparation. It is coiled inside the case, contact to its surface being made by a flexible phosphor-bronze ring slightly smaller in diameter than the resistance strip itself. A button attached to a rotating arm presses a small section of the ring against the strip, making good electrical connection with it.

This unusual arrangement relieves the resistance strip of the frictional wear of the contact arm. The thin phosphor-bronze ring is made to press down lightly on the strip, and does not tend to rub off the surface of the latter. The overall resistance of the strip therefore remains unchanged, and is not affected by constant rotation of the knob.

The Volumgrad will safely dissipate .125 watt. This power capacity is more than adequate for a volume-control device, which is called on to handle currents of only slight value.

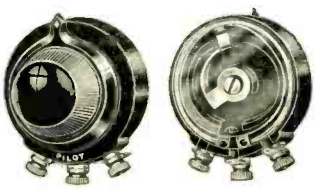




Above: The Yahr Lange "Kabinettenna," a combination dual connecting plug and light socket antenna.

Left: New Powerizer two-channel amplifier, containing a distortion meter, a monitoring loudspeaker and all the necessary control equipment.

Below: A front and rear view of the new Pilot "Volumgrad," a high resistance volume control.



"that's just what we wanted"—

explained the superintendent to the General Manager of an electrical manufacturing plant. "We've been experimenting around with different makes of coils long enough, now let's stick to these Dudlos and play safe. Those people sure know how to make trouble-free coils if anyone does, and that's the only kind we want in our product."

"You're the doctor," said the G. M., "the best is none too good when it comes to coils. We all know that."

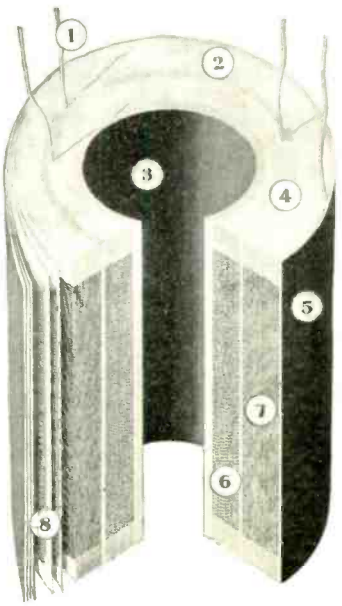
"Seems to me there's another reason why Dudlo is entitled to the business," the engineer interrupted. "They've always been so accommodating on samples for our experimental models and they have given us many valuable suggestions, too."

The G. M., turning to his pile of morning mail, added, "Well, I'm glad you boys have the coil question settled. Issue your requisitions and get them in early—it's all right with me."

DUDLO MANUFACTURING COMPANY, FORT WAYNE, IND.
Division of General Cable Corporation

Dudlo Coil Construction

1. Insulated, flexible leads—carefully spliced and anchored.
2. Coil impregnated throughout and ends sealed with highest grade insulating compound.
3. Tough, heavy tube, insulating core from laminations.
4. Special insulation between primary and secondary.
5. Protecting wrapper as specified.
6. Primary winding.
7. Secondary winding.
8. Paper insulation between every layer.



DUDLO

"THE COIL'S THE THING" IN RADIO AND ELECTRICAL APPARATUS

The Volumgrad may be employed as an antenna potentiometer, in which position it exercises very effective control; as a means of controlling the voltage applied to the screening elements of screen-grid tubes; across the secondary of the first audio-amplifying transformer; or as a variable grid leak in capacity-coupled a-f. amplifiers. It is also useful as a regeneration control, for this purpose being connected across the tickler coil.

The retail price of the Volumgrad is $1.50.

RADIOLA 33 DC

A new Radiola designed to meet the demand in certain areas for receivers to be operated from direct current has been announced by E. A. Nicholas, vice-president of the Radio-Victor Corporation of America. The new receiver is called Radiola 33 DC and in external appearance, dimensions and general characteristics of the circuit it is identical with Radiola 33 AC.

The main difference between the AC and the DC models lies in the Radiotrons which are used. In the 33 DC Radiotrons UX-112A are used throughout with the exception of the final audio stage. Fine quality of reproduction and ample volume are insured by two power amplifier Radiotrons—CX-171-A (push-pull) in the output stage. The receiver will operate on any 110 volt direct-current lighting source. Compensation for line voltages within the limits of 107½ to 127½ volts is taken care of by a voltage switch in the power unit. A feature of this model which will be appreciated greatly by the owner is the low current consumption — approximately thirty watts.

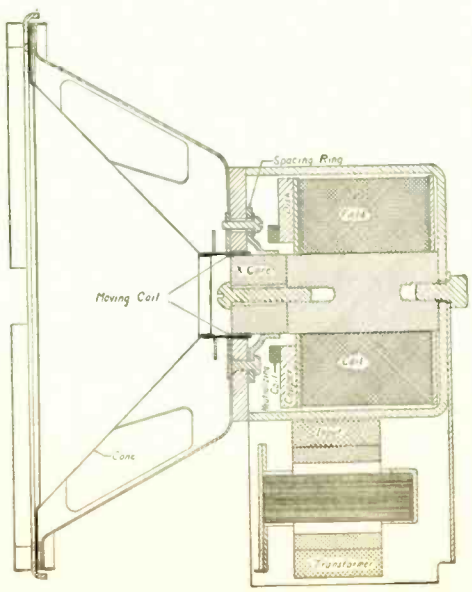
NEW MAGNAVOX X-CORE SPEAKERS

The X-Core marks a further improvement in Magnavox Speakers. It is a very definite refinement and one that provides a positive alignment of the moving coil in the air gap.

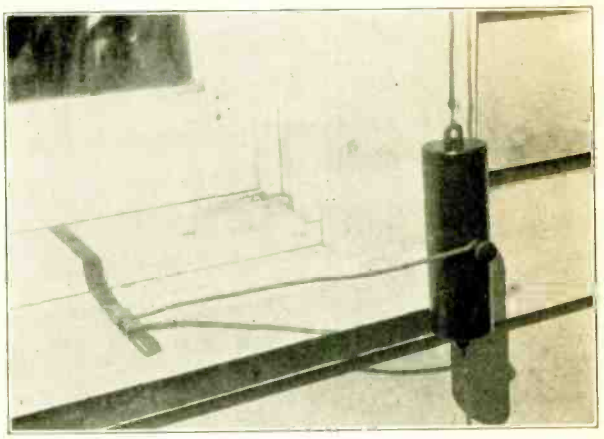
There are two main divisions of the speaker assembly. The cone head and the field coil frame assembly. The cone head includes the cone housing, the paper, cone, the moving coil and the X-Core. The field coil frame assembly includes the field coil, the heavy steel case enclosing the field coil, the main core, the input transformer and the speaker base.

The moving coil, or driving unit is rigidly and directly attached to the cone, and delicately suspended in the strong magnetic field produced by the field coil and transmitted by the steel case and the cores. Bakelite, proved to be the best because of its durability and its resilience, is used to suspend the moving coil. This coil is fastened to the cone with a special cement and rigidly clamped with the aluminum retaining ring. The flexible moving coil leads are completely insulated and very sturdy. The air gap in which the moving coil oscillates is between the X-Core and the outer pole and as the X-Core is pressed into a bearing in the outer pole the air gap must be always uniform.

This construction simplifies conehead assemblies, as the X-Core is included in the conehead and the screw connecting the main cone and the X-Core is used only to hold the two in magnetic contact. It is evident that coneheads can be replaced with absolutely no danger of the coil rubbing in the gap. It is a distinct advantage to have the conehead removable. It facilitates assembly as well as it does replacement or repair. This is an exclusive Magnavox feature, and with the development of the X-Core makes it absolutely positive and sturdy.



Details of the Magnavox X-Core Speaker, a recent new development.



How the Multi-Coupler is installed in the long lead from antenna on roof to lightning arrester near the ground. Note the connection for the radio set at this floor.

SOLVING THE APARTMENT HOUSE ANTENNA PROBLEM

Having specialized in antenna problems of all kinds for several years past, three well-known radio engineers were assigned the task of evolving a simple, inexpensive and altogether practical antenna system for the average apartment house. These engineers, Ernest V. Amy, Julius Aceves, and Frank King, operating as the consulting engineering firm of Amy, Aceves & King of New York City, undertook an exhaustive study of the subject, made many experiments with various devices and arrangements, and finally developed and patented an entirely new antenna circuit arrangement which meets all requirements.

The basis of the new apartment house antenna system is a device known as the multi-coupler. This comprises a bakelite case 6 inches long and 1½ inches in diameter, containing the necessary circuit components. The case has connecting lugs at top and bottom and a binding post on the side. There is nothing to wear out or to renew in the multi-coupler. It provides satisfactory service over many years, without additional expense of any kind.

With the multi-coupler as the basis, the new apartment house antenna system is simplicity itself. As many as 25 radio sets may be operated on a single or common antenna by means of one multi-coupler for each radio set, but a fair average of 12 to 15 is followed in practice. Briefly, a common antenna is installed for every 12 or 15 radio sets in the apartment house. The down lead from the common antenna, instead of being brought to a single radio set as in usual practice, is brought down alongside the wall of the house and close to a vertical row of windows, thus catering to the needs of a row of apartments. The down lead carries a multi-coupler at the level of each floor, or near the window for that floor. There are as many multi-couplers as there are floors in the vertical row. The binding post of the multi-coupler serves as the antenna connection for the radio set of the apartment. At the bottom of the down lead there is installed a lightning arrester with a high resistance shunted across it, so that the antenna system is protected from lightning in accordance with the requirements of the fire underwriters.

With this antenna system, each radio set owner has the use of an excellent antenna of far better characteristics than the usual antenna of today. Furthermore, the multi-coupler serves as a filter, passing mainly the broadcast frequencies to the radio set. Therefore, inductive interference of electric motors and household appliances is reduced to a minimum. However, when short-wave reception or television reception is desired, the apartment house tenant simply winds four or five turns about the down lead, above the multi-coupler, and thereby secures the advantages of an outdoor antenna about 20 feet long.

NEW MOUNTFORD RESISTOR

To meet the demands of set manufacturers requiring a good resistor at a low price, the Mountford Laboratories have produced a product consisting of a compound of two substances, chiefly ceramic, one overlaying the other. The manufacturers claim that they have produced a resistor of great mechanical strength and high heat conductivity. The electrical resistivity of the outer substance is in the neighborhood of 900 megohms under ordinary conditions.

A new resistor, developed by Mountford, particularly for the commercial field.

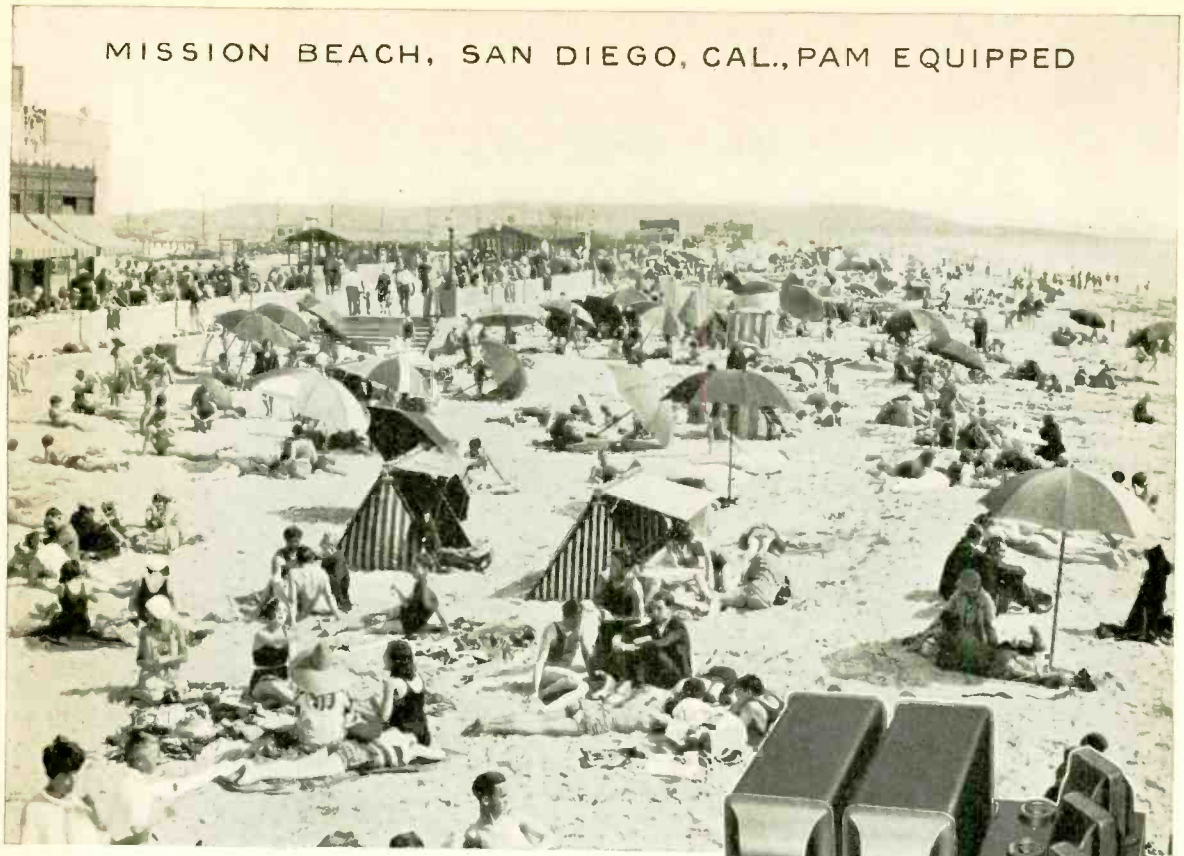
This resister is self-insulated in that the core or body of the resistor is insulated and entirely covered by the outer substance, thus eliminating all possibility of leakage or shorting. The terminals have corrugated ends which are thoroughly embedded in the core of the resistor before being fused. This insures a permanent perfect contact. Connections can be made to the leads only. The Mountford engineers claim that this new resistor is far superior to any carbon product, that it is impervious to all heat, and maintains its given rating under varying climatic conditions.

Manufactured by C. E. Mountford, 105 Sixth Avenue, New York City.

EVEREADY 40 SERIES SETS

The National Carbon Company has announced an addition to its line of Eveready A-C. Electric Radio Receivers to be called the 40 Series. This line uses 245 tubes in the push-pull output in place of the 171-A type tubes in the Eveready 30 Series. Cabinets in the new line are identical with those in the 30 Series.

The new line is designed for purchasers who wish the extra power provided by the 245 tubes, and will be offered in three console models. The 30 Series will be continued and supplied as occasion demands.



PAM

The Playground's Partner

PAM 45 is the newest addition to our line and uses one 227, one 281, and two 245's.

Not only on the beaches and midways, but in dancing pavilions, merry-go-rounds, waiting rooms, and in *any* place where people gather they may be entertained, instructed, or advertised to by PAM amplifiers.

You will find, as other dealers already have, many places for such installations.

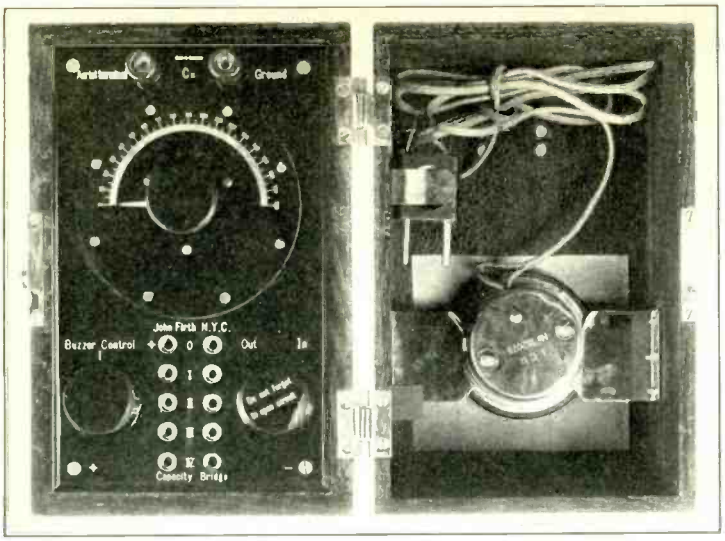
Your worthwhile sales may include phonographs, pick-ups, microphones, radio sets, tubes, loud speakers and wiring.

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations, and many new PAM amplifiers will be sent upon receipt of 10c in stamps to cover postage. When writing ask for Bulletin No. RE3.

Main Office:
Canton, Mass.

Samson Electric Co.
MANUFACTURERS SINCE 1882
MEMBER R.M.A.

Factories at Canton and Watertown, Mass.



The Seibt Direct Reading Capacity Bridge

SEIBT DIRECT READING CAPACITY BRIDGE

This capacity bridge conforms to a long-felt need on the part of Radio, in as much as it permits the measurement of capacities of condensers and antennas by means of a device which both is simple to operate and easy to carry. Dr. Georg Seibt of Berlin-Schoeneberg, one of the pioneers of Radio-Technology was the first to develop an instrument which made it possible to dispense with the complicated physical apparatus hitherto required. The capacity bridge is distinguished by its small dimensions as also by its large range of measurement which is subdivided into five stages ranging approximately from a capacity of 5 to 105000 cm. The apparatus is enclosed in a neat portable cabinet, 140 m/m broad 210 m/m long and 150 m/m high, the lid of which may be detached. The complete instrument weighs 2,830 kg. The Illustration shows the apparatus with the lid open. At the upper edge of the panel may be seen the terminals for connecting the condenser to be measured. Below may be seen the knob of a condenser, of a capacity of 1,000 cm., the indicator of which covers a scale of 180°. At the bottom of the panel on the left there is a knob for adjusting the buzzer and on the right a button by means of which the buzzer-current may be switched on and off. There are five pairs of jacks for choosing the various ranges of measurement. A headphone of 200 ohms resistance has also a curve-diagram and instructions for use are provided with each apparatus and attached by clamps inside the lid.

The complete apparatus, with the exception of the buzzer dry-cell of 1.4 volts may be taken out of the wooden cabinet after releasing the screws in the four corners of the panel. The two lower screws marked plus and minus are directly connected with the dry-cell so that the voltage of the current supply may be tested at the screw heads. The circuit of the apparatus is based on the principle of the Wheatstone Bridge.

The Seibt Capacity Bridge is handled by the John Firth Co., 25 Beaver Street, New York City.

STEVENS PORTABLE PHONOGRAPHS

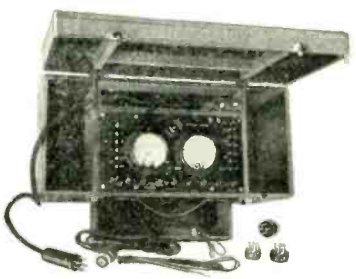
The Stevens Manufacturing Company, of Newark, N. J., announces the development of a portable a-c. phonograph that incorporates a number of unusual features. This portable is enclosed in a black leather carrying case and resembles in size and appearance the usual portable phonograph. The offering includes the new Stevens silent motor and miniature rectifier, operating directly from a-c. house current. A phonograph sound box and arm delivers the music to a built-in horn which utilizes the curve of the carrying case cover as a sound reflector. In addition, the case includes a phonographic pickup and outlet by means of which records may be played through the amplifier of any radio set and reproduced by the loudspeaker.

The last and most original feature is the incorporation of a small battery compartment. If the portable is to be used in a boat or on a picnic where a-c. is not available, a small switch disconnects the rectifier and substitutes the battery source. In any case, hand winding is never necessary.

The case is finished in black imitation leather with all the metal parts heavily nickled.

NEW JEWELL SET ANALYZER

The Jewell Electrical Instrument Company, 1650 Walnut Street, Chicago, Illinois, announces that the Pattern 199 Set Analyzer is now available in a portable cabinet that is provided with a drawer and compartments for tools and extra tubes.



New Jewell Pattern 198 Set Analyzer

Pattern 198, as the new unit is called, provides all the tests made possible by the Pattern 199, including the servicing of screen-grid sets. There are two compartments size 3½x8¼x5 and a drawer size 8x10x2⅜ ; making it possible to carry repair kit, accessories, and test apparatus in one compact and convenient case.

DEVRY PORTABLE PHONOGRAPHS

The Q. R. S. DeVry Corporation is introducing through its music division a new line of portable phonographs, including one instrument operating on small dry-cell batteries that will run six months or a year without winding. The complete line of portable phonographs ranges from $12.50 to $50 in retail price.

The music division of the corporation will introduce in the near future a new product as a musical toy. It will be known as the "Playasax," operating on small music rolls and retailing at $3.50. Advance orders, it is stated by T. M. Pletcher, president of the corporation, indicate a large potential volume in this novelty.

BURT REPRODUCER FOR TALKING MOTION PICTURES

The Burt Synchronous Reproducer illustrated is one of the simplest reproducers of talking motion pictures both film and disk which has appeared on the market.

Synchronous Motor Drive (110 or 220 volts, 50 or 60 cycles). Prevents variation in speed from variation in line voltage, or projection load.

The Super Cells used require only two stages in head amplifier, hence less distortion.

Ease of Threading. When running disk or sd-out, the Sound-on-Film unit is not threaded. Sound-on-Film threads as easily as through a Powers gate.

Turn Table is Accessible, being up high at the side of the machine.

Easy to Install. Installation can be made by the ordinary operator, and wire man.

Projector Head is driven by its main drive gear and is not required to drive any part of the sound equipment.

Only Three Shafts: (1) Motor Drive. (2) Sound Film Shaft. (3) Disk Table Shaft.

Variable Speed can be used for making schedule by driving the head off the Powers Motor, when running silent. Change from synchronous drive to variable speed drive requires about ten seconds.

No Universals—No flexible couplings, flexible shafts, or long unsupported shafts are used, as these produce tremolo.

Fire Hazard is Decreased by use of this equipment. Failure of take-up does not cause film to pile up in light.

The photoelectric cells used have such a high output that only two stages of amplification are required in the head amplifier which feeds through the Fader directly into the power amplifier which may be any standard make of three-stage power amplifier. Two photoelectric cells are supplied with each head in one case, and in the event that one cell ceases to function the other may be put into operation by simply rotating the cell case one-half turn. No amplifier tubes are used in the cell case or on the machine itself. The wires from the photoelectric cells are brought out to a jack which plugs into the head amplifier. Another jack on the disk pick-up arm plugs into the same head amplifier and thereafter control is had by means of the switch on top of the head amplifier. When this switch is in a vertical position everything is "off"; when switched to the left the disk is connected to the Fader; when switched to the right the head amplifier filaments are lighted and the Sound-on-Film pick-up is connected to the Fader.

Manufactured by R. C. Burt Scientific Laboratories, 900-904 E. California Street, Pasadena, Calif.

The Burt Reproducer for Talking Motion Pictures

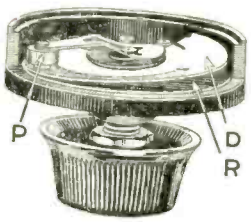
FOR WANT OF A NAIL . . . .

Everybody remembers the verse about the courier in the battle of Waterloo speeding to get reinforcements for Napoleon. His horse faltered and fell. For want of a nail a shoe was cast . . . and the battle lost.

A radio receiver is very much the same. You may have the "re-inforcements" in the form of fine workmanship, good condensers, good transformers and yet there may be a "nail" that causes trouble. Look to the volume control for a great amount of grief . . . mechanical and electrical noise . . . inadequate and uneven control. Are those the symptoms?

Then turn to Centralab controls whose quality is vouched for by this fact: The great majority of radio manufacturers include them as standard equipment. Be sure the manufacturer of the receiver you sell has done likewise.

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 cannot ruin the resistance because the rocking disc is in between the pressure arm and the resistance.

Centralab

CENTRAL RADIO LABORATORIES

20 Keefe Ave. Milwaukee, Wis.

Why De Forest Engineers demand closer tolerances

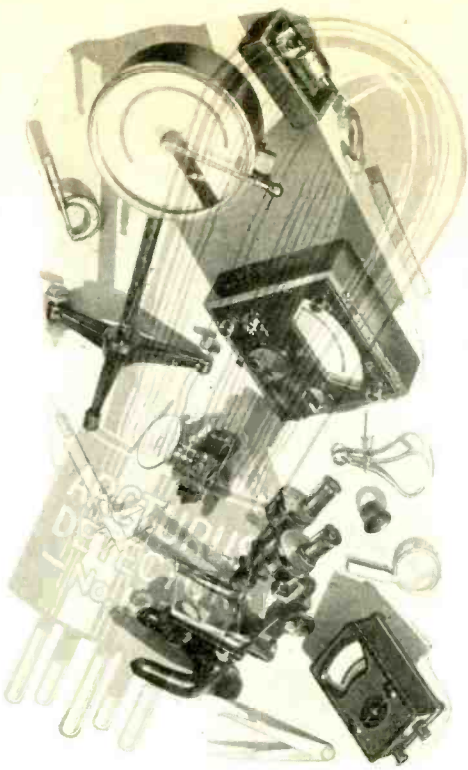
De Forest Audions are made to far closer tolerances than those of any other radio tube manufactured. It is for this reason that before De Forest Audions are accepted by our engineering department they must pass the most rigid and exacting tests to which any radio tubes have ever been subjected.

Meeting these high standards is Screen Grid Audion 424, the outstanding screen grid tube of the year, which has mica spacers top and bottom to assure rigidity in the spacing of elements and to make certain uniformity of characteristics; oxide-coated filaments to double electronic emission; a ceramic-shielded cathode to stop hum and a vacuum to increase tube life, containing less than one-fifteenth the air pressure of most standard radio tubes.

Whenever you buy a radio tube, no matter what its name, remember it was made by license arrangement under De Forest patents. But only De Forest Audions bear the name of the inventor.

DE FOREST RADIO CO., JERSEY CITY, N. J.

de Forest
AUDIONS



Precision manufacturing safeguards correct design

THE most advanced principles of design, the most unique features of construction, cannot in themselves produce tubes of uniform characteristics. *Manufacturing accuracy must measure up to engineering skill in every respect.*

The unvarying excellence of Arcturus Tubes is due as much to painstaking production methods, rigidly adhering to accurate standards, as to unique design. This rare combination has gained widespread recognition for these exceptional tubes.

By inspecting every tube 137 times, approving only those tubes whose characteristics fall within the narrowest manufacturing limits, ARCTURUS has set a standard of uniform quality unsurpassed by any tube on the market today.

ARCTURUS
BLUE A-C LONG-LIFE TUBES

ARCTURUS RADIO TUBE COMPANY
Newark, New Jersey

Floor Space Doubled To Insure Better Condenser Service

A steady increase in condenser business has made it necessary for us to increase our floor space from 16,000 square feet to 36,000 square feet — more than double.

In this modern fireproof factory, ***Fast Condensers*** are built with precision-exactness, so well meeting the needs of leading radio set manufacturers as to make necessary this expansion.

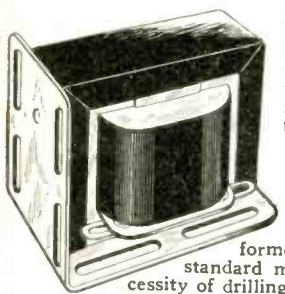
Our facilities now, for producing quality condensers, are unexcelled, as proved by the increased business entrusted to us.

Send us your specifications, in whole or part, and we will gladly quote on your requirements.

JOHN E. FAST & CO.

New address: 3123 N. Crawford Ave., Chicago, Ill., U. S. A.

attention service men



A quality replacement audio transformer for the service man. Possesses the same high degree of performance which characterizes all Thordarson audio units. Provides highest amplification consistent with quality reproduction.

Unique Mounting Feature. The mounting bracket of this transformer is designed to fit all standard mountings without the necessity of drilling additional holes. May be mounted either on end or side or may be used as bracket to support sub-panel.

Remember: Thordarson radio transformers are Supreme in musical performance.

R-100.....List Price $2.25

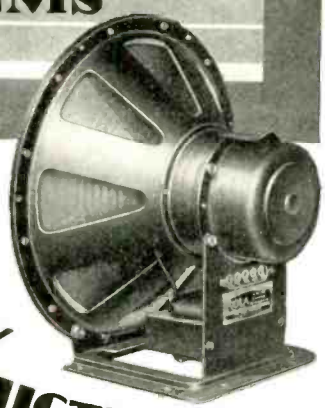
THORDARSON ELECTRIC MFG. CO.
Transformer Specialists Since 1895
Huron, Kingsbury & Larrabee Sts.—Chicago

THORDARSON

replacement audio transformer

FOR

RECEIVING SETS ELECTRIC PHONOGRAPHS TALKING PICTURES AUDITORIUMS SCHOOLS AND PUBLIC ADDRESS SYSTEMS



QUALITY REPRODUCTION

ROLA loudspeakers, long noted for their quality, are now provided for every purpose demanding the utmost in fine sound reproduction.

These electro-dynamic loudspeakers operate at approximately twice the sensitivity of competing dynamics, yet without increase of field energizing power.

Rola reproducers have proven rugged and dependable under the most exacting conditions. The Rola exclusive welded-to-housing construction, adjustable center pole tip, ventilated field windings, and moisture-proof materials insure reproduction of unusual reliability.

The highly desirable compactness and simplicity of the Rola loudspeakers is apparent at a glance. A side-by-side comparison will quickly demonstrate their superior reproduction qualities. Rola provides the consistently brilliant and reliable performance required today by your users.

The Rola model illustrated above is C-90; an electro-dynamic unit with 9-inch diaphragm, field coil wound to 2500 ohms, 75 to 150 volts D.C. It is especially well adapted to amplifiers using 245 tubes in push-pull combination—for radio receiving sets, electric phonographs, and auditorium installations.

Inquiries for details, blueprints and prices from responsible manufacturers are solicited.

The ROLA COMPANY

CLEVELAND, OHIO
2570 E. Superior Ave.

OAKLAND, CALIF.
45th & Hollis Sts.

ROLA

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 86.

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Insuline Corp. of Amer.
Lynch, Arthur H., Inc.

ALUMINUM:
Aluminum Co. of America

ALUMINUM FOIL:
Aluminum Co. of America
Reynolds Metals Co., Inc.

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.
National Co., Inc.
Samson Elec. Co.

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

ARRESTERS, LIGHTNING:
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.

BASES, VACUUM TUBE:
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General Plastics Co.
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BAFFLES:
Wright-DeCoster, Inc.

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BINDING POSTS:
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General Radio Co.

BRACKETS, ANGLE:
Electrad, Inc.
Insuline Corp. of Amer.
Scovill Mfg. Co.

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Baltimore Brass Co.
Scovill Mfg. Co.

BROADCAST STATION EQUIP'T:
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Jenkins & Adair, Inc.
Nelson, I. R., Co.

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BUTTS:
Scovill Mfg. Co.

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G. M. Laboratories, Inc.
National Carbon Co., Inc.

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Maas & Waldstein Co.

CHARGERS:
Benwood-Linze Co.
Elkon Co.

CHASSES
Aluminum Co. of America
United Scientific Laboratories, Inc.

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

CHOKES, RADIO FREQUENCY:
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General Radio Co.

CHOKES, B ELIMINATOR:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Jefferson Electric Co.
Nelson, I. R., Co.
Polymet Mfg. Corp.
Silver-Marshall, Inc.
Transformer Co. of Amer.
Valley Appliances, Inc.

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Fahnestock Elec. Co.
Scovill Mfg. Co.

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

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COIL WINDING:
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Dudlo Mfg. Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, CHOKE:
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Dudlo Mfg. Co.
Jefferson Electric Co.
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.

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Polymet Mfg. Corp.
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Aero Products Corp.
Cardwell, Allen, D., Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
National Co., Inc.
Nelson, I. R., Co.
Rome Wire Co.

COILS, MAGNET:
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Dudlo Mfg. Co
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.

COILS, RETARD:
Hammarlund Mfg. Co.

COILS, SHORT WAVE:
Aero Products Corp.
General Radio Co.
Hammarlund Mfg. Co.

COILS, TRANSFORMER:
Acme Wire Co.
Dudlo Mfg. Co
Nelson, I. R., Co.
Polymet Mfg. Corp.
Rome Wire Co.
Valley Appliances, Inc.

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

CONDENSERS, BY-PASS:
Acme Wire Co.
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.
Fast, John E. & Co.
Flechtheim Co.
Gerd Electric Co., Inc.
Polymet Mfg. Corp.
Powrad, Inc.
Wireless Specialty Apparatus Co.

CONDENSERS, FILTER:
Acme Wire Co.
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Fast, John E. & Co.
Flechtheim Co.
Gerd Electric Co., Inc.
Polymet Mfg. Corp.
Powrad, Inc.
Wireless Specialty Apparatus Co.

CONDENSERS, FIXED:
Acme Wire Co.
Aerovox Wireless Corpn.
Amrad Co.
Condenser Corp. of America
Dongan Electric Mfg. Co.
Dubilier Condenser Mfg. Co.
Electrad, Inc.
Electro-Motive Eng. Co.
Fast, John E., & Co.
Flechtheim Co.
Gerd Electric Co., Inc.
Polymet Mfg. Corp.
Powrad, Inc.
Wireless Specialty Apparatus Co.

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

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

CONDENSERS, NEUTRALIZING:
Polymet Mfg. Corp.

CONDENSERS TRANSMITTING:
Dubilier Condenser Mfg. Co.

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

CONNECTORS:
Cornish Wire Co.
Scovill Mfg. Co.

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Central Radio Laboratories
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Insuline Corp. of Amer.
Polymet Mfg. Corp.
Ward Leonard Elec. Co.

CONTROLS, ILLUMINATED:
Hammarlund Mfg. Co.

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

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

CONVERTERS, ROTARY:
Electric Specialty Co.

COPPER:
Baltimore Brass Co.
Scovill Mfg. Co.

CORDS, EXTENSION:
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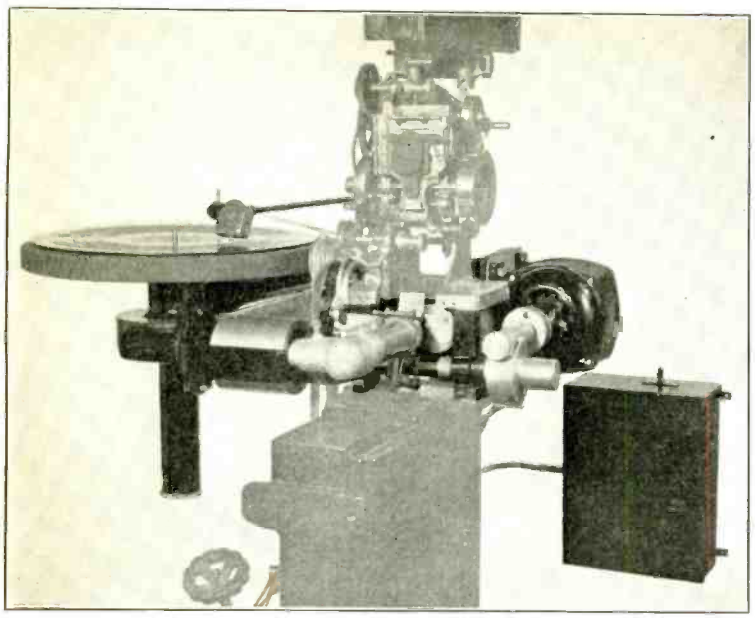

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Write for Bulletin No. 291

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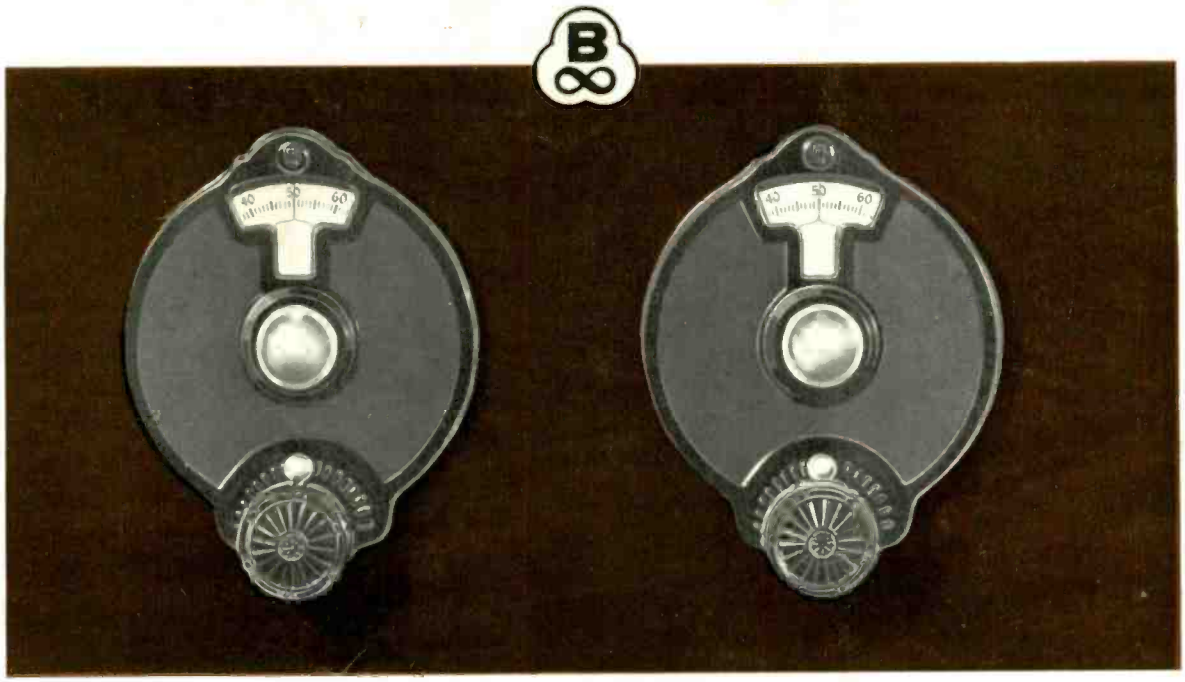

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