Ninth Year of Service

RADIO ENGINEERING

Vol. IX DECEMBER 1929 No. 12

IN THIS ISSUE

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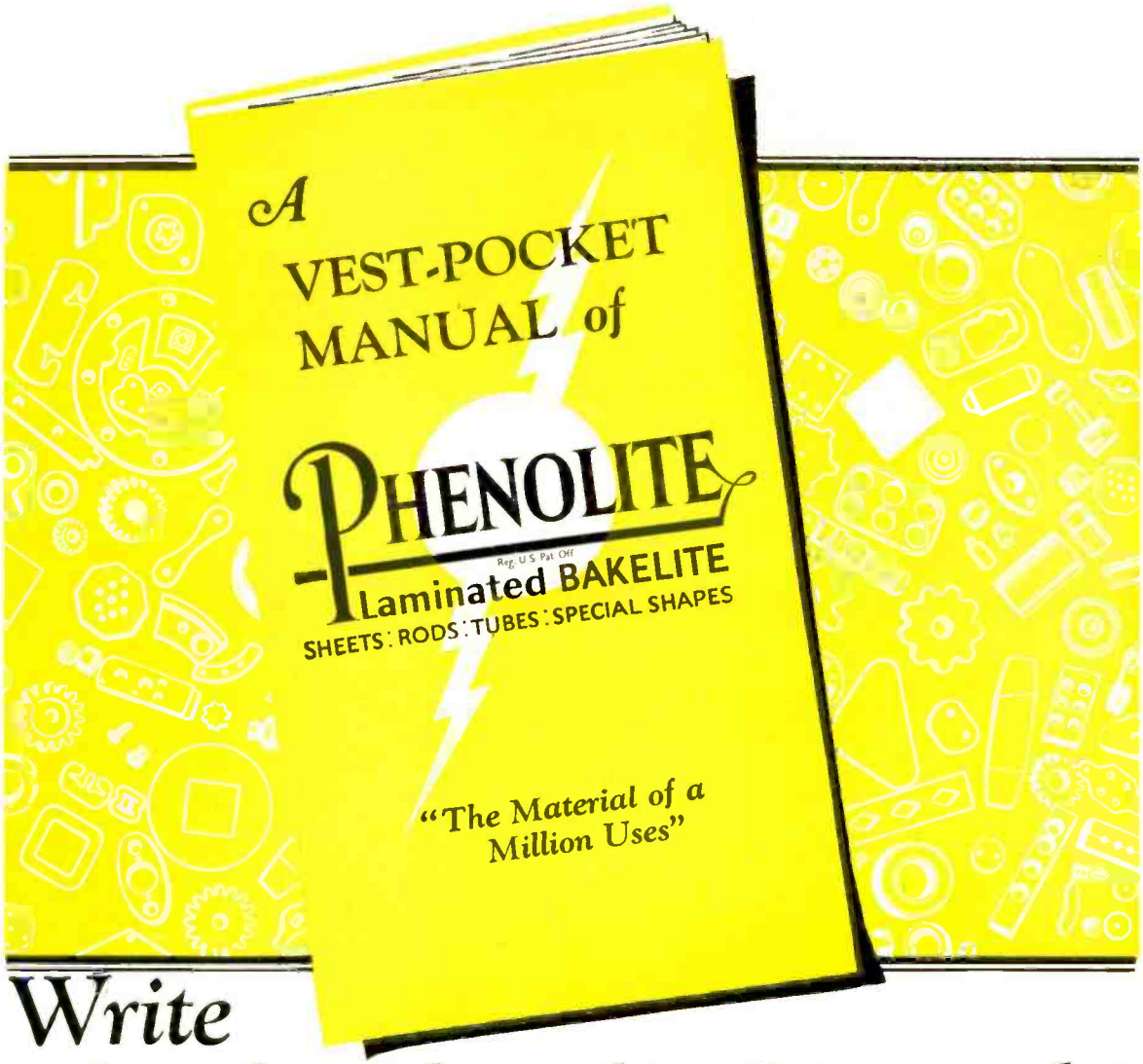
The Journal of the Radio Industry



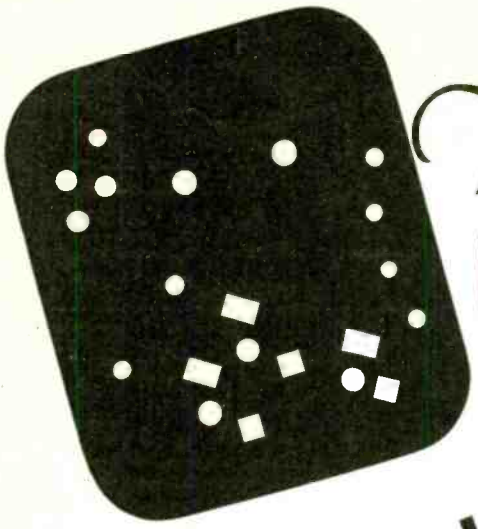
Write for the Phenolite Manual

Know why Phenolite is replacing Hard Rubber, Metals, Porcelain and Glass, Wood. Find out how *you* can use Phenolite in many different ways, for many different purposes. Inform yourself as to its Toughness, Rigidity, Permanence, High Tensile and Dielectric Strength, Noiseless Operation, Resistance to Solvents and Moisture. The Phenolite Vest-Pocket Manual tells you how and why Phenolite punches, turns, mills, taps, threads, saws and drills with astonishing ease, speed, accuracy.

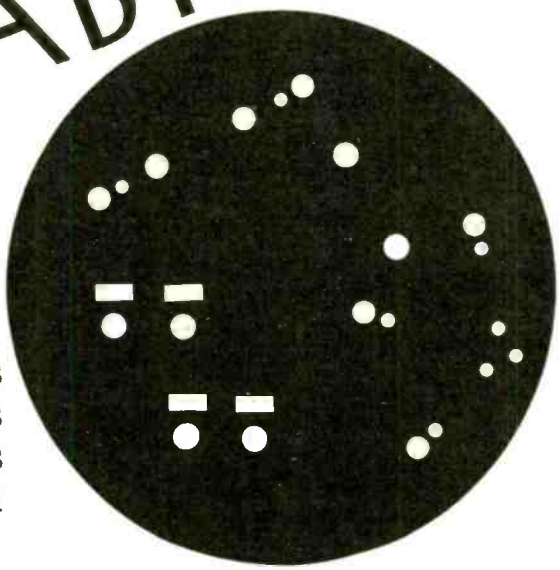
Read the facts that make the proof of Phenolite superiority. Then, let our Service Engineering Department help you determine whether or not Phenolite will bring you benefits of improved quality of product with added economy. Let these specialists help you determine which grade of Phenolite is best suited to your requirements. Our laboratory is the place "where known requirements meet known performance." Anyway, let us mail the Manual. Write for it today.

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

Offices in Principal Cities



The UTMOST in PUNCHABILITY



When punching stock is under discussion nothing is mentioned that punches better than the Formica cold punching grade.

This material also combines with easy punchability, very good insulating characteristics.

Furthermore the material is available in a handsome brown color that gives it the best of appearance.

The Formica laboratory works constantly to improve the material --- and distinct steps forward are occasionally accomplished.

This punching stock is one of them. Send for a Sample or if you want us to punch the parts, send your blue prints for a price.

THE FORMICA INSULATION COMPANY
4638 Spring Grove Avenue Cincinnati, Ohio

FORMICA
Made from Anhydrous Bakelite Resins
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RADIO ENGINEERING

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Vol. IX | December 1929 | Number 12

Contents

Departments

Higher Type Servicemen in Demand

BY J. E. SMITH
President, National Radio Institute

THERE is a steadily growing demand for a higher type of radio serviceman, not only in the matter of better radio training so as to service present-day radio sets, but also in appearance, convincing speech, and selling ability.

It is generally realized by the radio industry today that the serviceman is in the best position to sell not only tubes, replacements, accessories and parts, but also new radio sets. After all, the serviceman obviously gets into the home. He arrives at the critical moment, when the old set is giving trouble. He is ideally suited to point out the advantages of a new set over the old, without appearing as a salesman. What could be more conducive to sales?

Taking advantage of such a psychological situation, the radio industry is seeking a far higher type of man for servicing than heretofore. In fact, men with all the attributes of successful salesmen are being sought for servicing, inasmuch as they are thus provided with live leads and real prospects. The fellow with a smattering of radio, a handbag with a few tools, a black shirt, baggy trousers, cap, and a heavy growth of hair on head and face, is going into the discard as highly trained radio men of good appearance, well equipped with trouble-shooting meters and tools and spare parts, and provided with a car for rapid transportation, are coming into the field.

Servicing, once looked upon as a total loss to be avoided whenever possible, is now becoming recognized as one of the greatest assets of the established radio dealer. The servicemen are being paid higher salaries than were ever thought possible.

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EDITORIAL

December, 1929

OUTLOOK

IT IS not well that we completely ignore the recent depression in the stock market. This depression has had a far-reaching effect and for a while one must expect a decline in buying power. To ignore the situation is to demonstrate an utter lack of horse-sense.

It is no secret that radio manufacturers have made large cuts in production, in some instances production has been stopped completely. Such procedure is commendable. Dealers have been given the chance of closing out their present stocks and clearing their shelves for the coming year.

We are all in a position to hope that there will be no general over-production. With the consequent stability, there is little chance of a repetition of drastic price-slashing and loss of public confidence.

Just so long as radio manufacturers continue to demonstrate common sense there is little room for worry. Just so long as all industry keeps on an even keel and industrialists keep their wits about them there is little danger of the public becoming financially panic-stricken.

It is our belief that the decline in buying power is not due to any decline in public wealth but rather to a purely psychological condition — similar to the public attitude shortly after the Armistice. This belief appears to be shared by most industrialists—which is very fortunate, as the psychological condition can be removed only by the continuance of public faith in the impregnable quality of American industry.

The stock market decline has not been quite so disastrous as some people would make it. The number of people who have lost money in the decline—including those suffering only the loss of paper profits—is relatively small; too small to have been the main cause of a decline in buying power.

Actually, there have been a number of good points realized in the recent liquidation. First; most corporations are in a better financial condition than they ever were before, having reduced their obligations and placed their earnings in a better light by the purchase, out of surplus, of their own common stocks at extremely low figures. Second; the market itself is in a much better technical position and capable of withstanding attempts at forced deflation. Third; a huge amount of money has been released for industrial purposes, a great deal of which has flowed into agricultural and building channels. Furthermore, money is cheap. Lastly, the decline has brought on something new in the form of industrial cooperation . . . instituted by President Hoover . . . and we may expect a great deal from this movement alone.

Translated into terms of the radio industry, it appears that, after the short-lived decline in buying power, the radio business will be greater and more extensive than ever before. When the public is released from the present psychological condition it will buy as it never bought before . . . the public, with a newly-born enthusiasm, will make up for lost time.

We are confident that the coming year will show a tremendous increase in the sale of battery sets—if for no other reason than the fact that money is easy in our great agricultural districts. We are sure that, considering the large construction programs and appropriations being planned by Cities and States throughout the Nation, the sale of radios and public-address systems for schools, parks, city halls and other public institutions will show a tremendous increase. We are confident, too, that the growing appreciation of radio, brought on by effective advertising and sane propaganda, will be a large factor in increasing the size and the scope of the business. Radio, after all, is the cheapest form of good entertainment to be had.

We expect a banner year. We expect it because we are sure everyone from the manufacturer to the dealer and serviceman is willing and ready to dig in and work hard.

M. L. MUHLEMAN, *Editor.*

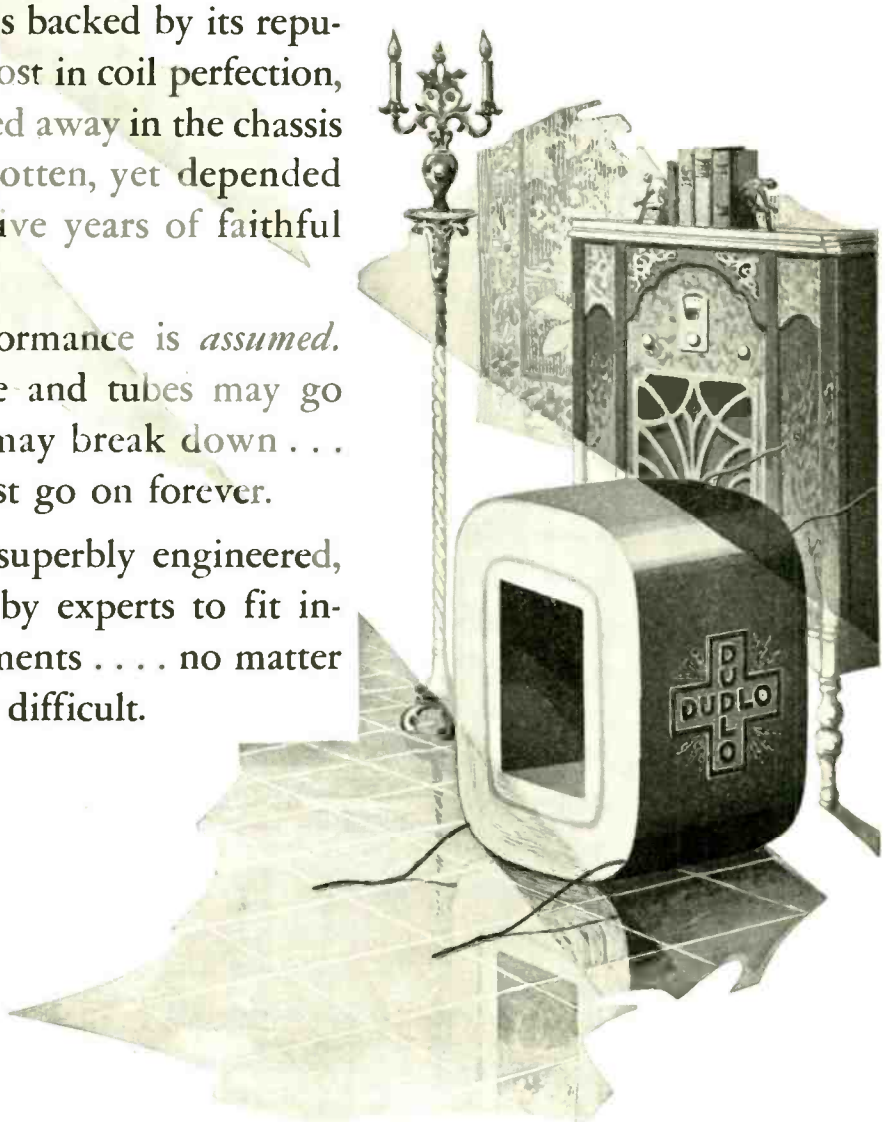
the Coil's the thing!

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

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

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

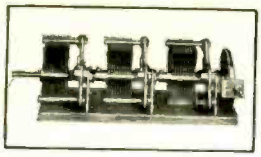
Dudlo coils are superbly engineered, and constructed by experts to fit individual requirements . . . . no matter how complex or difficult.

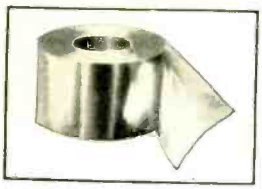


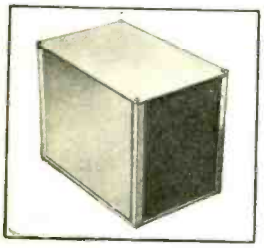
DUDLO

DUDLO MANUFACTURING COMPANY, FORT WAYNE, INDIANA

Division of General Cable Corporation







THEY MEET THE DIFFERING CONDITIONS OF RADIO DESIGN

LIGHTNESS, permanent beauty, resistance to corrosion, high electrical conductivity, shielding efficiency and workability are a combination of qualities that make Aluminum the ideal metal for Radio.

Aluminum shielding insures greater selectivity, closer tuning and improves tone. It is easily worked into special shield shapes—cans, boxes or casings. It adds less to the weight of the set than any substitute metal, makes for greater compactness, and presents few limitations in matters of size and shielding design.

Aluminum condensor blades are fabricated from special ALCOA Aluminum sheet that meets new close tolerances for thickness and flatness.

Aluminum foil has a high electrical conductivity and a very great covering area. A pound of Aluminum foil .0003 inch thick will cover 34,000 square inches.

We solicit inquiries on the use of Aluminum in radio, for the purposes just described—and for loud speaker frames and bases, condensors and condensor frames, drum dials, chasses and cabinets.

ALUMINUM COMPANY OF AMERICA
2468 Oliver Building, Pittsburgh, Pa.
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ALCOA

ALUMINUM

The mark of quality in Radio

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FOR THE MANUFACTURE OF
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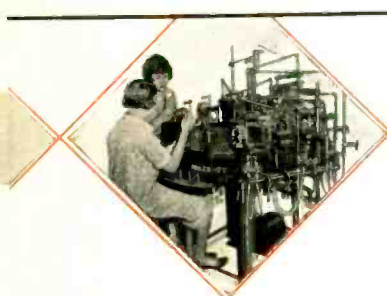
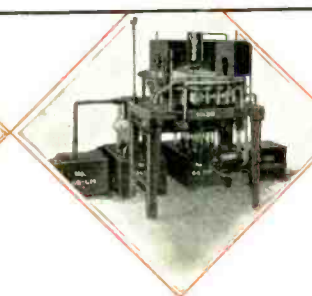
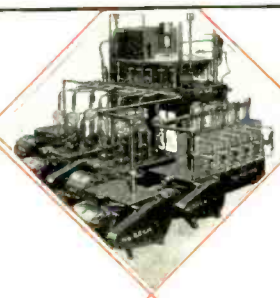
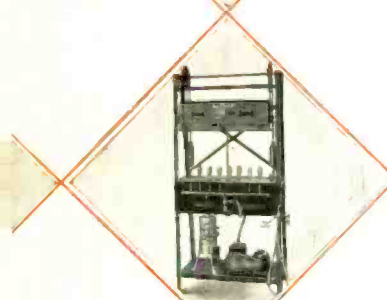
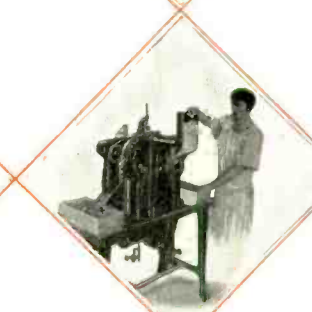
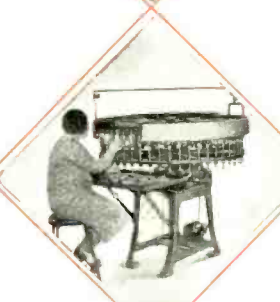
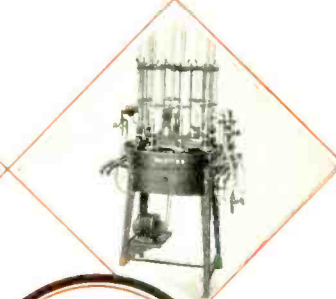
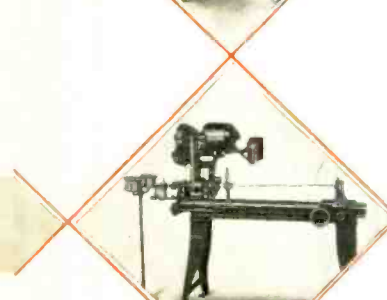
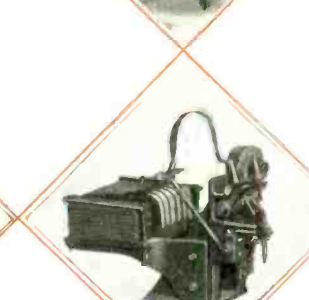
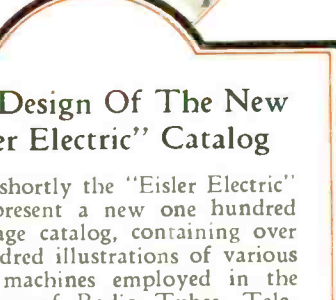
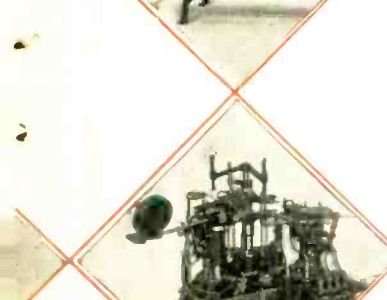
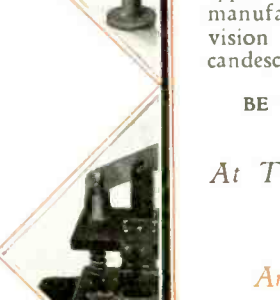
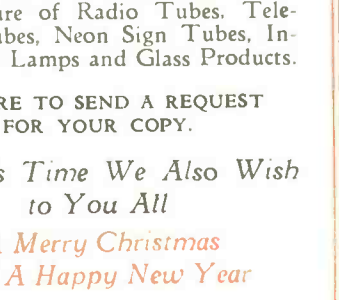




Cover Design Of The New "Eisler Electric" Catalog

VERY shortly the "Eisler Electric" will present a new one hundred twenty page catalog, containing over seven hundred illustrations of various types of machines employed in the manufacture of Radio Tubes, Television Tubes, Neon Sign Tubes, Incandescent Lamps and Glass Products.

BE SURE TO SEND A REQUEST FOR YOUR COPY.

At This Time We Also Wish to You All

A Merry Christmas
And A Happy New Year

Eisler Electric Corporation
760 South Thirteenth Street
Newark, New Jersey U. S. A.

CATALOG - C

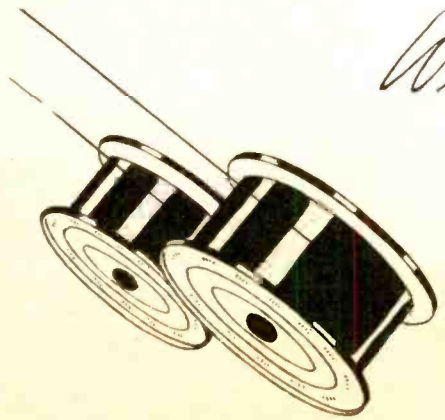
A Message from Wilbur B. Driver To the Radio Tube Industry

SINCE its introduction to the Radio Industry the popularity of Gilby Selvage Mesh has steadily increased. Leading Manufacturers of Screen Grid Tubes hail this new product as an important development, advancing, as it does, the quality of the tube and making possible substantial economy in the cost of manufacture.

In this selvage mesh we have developed a product that is rigid and which lends itself to the most accurate forming. We are prepared to supply this Mesh accurate in width within .005 plus or minus that specified. Its use approaches an economic necessity in Screen Grid Tube Manufacture. The solid even edges greatly facilitate welding operations. The finished element not only is far better in appearance than the usual screen material but will stand up under the bombarding processes.

This new idea in screen material, in which the mesh is interlocked, will successfully withstand intensive conditions at high temperature. Through its use, production shrinkage is very materially reduced—a matter of prime importance at this time. The finished element is more rugged than any material of this type now in use, lessening the possibility of damage in shipment and handling and keeping the tube characteristics the same as when it left the inspection department.

We would appreciate inquiries, and an opportunity to co-operate with your engineering staff.



Wilbur B. Driver

President,
GILBY WIRE CO.

A better base—a better tube ...

make yours with DUREZ!

Change! There's the radio industry in a word! In a month, the new method may be outworn. With a single shipment, the material you thought more than satisfactory proves inadequate. . . . In their search for the best, many radio manufacturers have abandoned other materials, and switched to Durez—with uniform success!

The Sylvania Products Company of Emporium, Pa., known over the country through their effective broadcasting as makers of Sylvania Radio Tubes, is one concern that changed for the better. The toughness of Durez, its durability, its workability and efficiency were carefully analyzed. They probed its economy under modern production methods. . . . The inquiry proved Durez superior in every way.

Durez has remarkable insulating qualities. It is tough, non-brittle. Hard as flint. Resists acids, heat, moisture, gases. alkalines. Durez is simple and easy to mold. One operation, and the part is complete—without any burnishing, polishing, or tooling whatever. Studs may be inserted; holes, threads, intricate designing cared for in the one molding process!

Perhaps you're having trouble in the basing operation with material you now use. Is it strong enough? Can it resist destructive agencies sufficiently? Is it economical? And—this is important from a competitive standpoint—is it *modern?* Durez, with its wide range of beautiful colors, will brighten up your product, freshen it, modernize it—economically!

Tell us what you make. We'll tell you how to make it better—with Durez. General Plastics, Inc., 115 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 possible applications.

They must meet *the exacting* De Forest standards

—that's why they are better— *and last longer*

De Forest Audions are subjected to the most rigid inspections and tests of any radio tubes on the market. De Forest Engineers demand far closer tolerances than are ordinarily demanded by manufacturers of radio tubes. Before an Audion is permitted to leave the De Forest Laboratories it is as nearly perfect as it is possible to make a radio tube. It is as accurate as a fine watch. That is why De Forest Audions have set the world's standard of excellence for 23 years.

Under these tests the superiority of a higher vacuum, oxide-coated filaments instead of thorium, the use of molybdenum instead of nickel, and the many De Forest refinements of filament design, improved chemical processes and more rigid mechanical construction are immediately apparent. Thus every De Forest Audion is equipped to assume its full share of the responsibility in keeping the name "De Forest" in its rightful position of leadership.

DE FOREST RADIO COMPANY
JERSEY CITY NEW JERSEY

Branch Offices Located in

Boston	Chicago	Los Angeles
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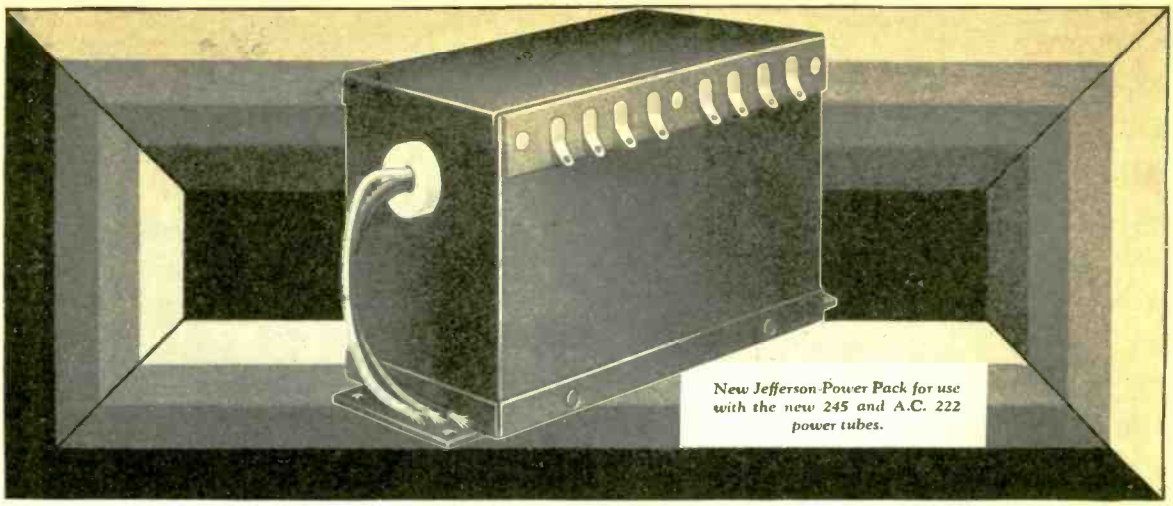
De Forest AUDIONS



New Jefferson Power Pack for use with the new 245 and A.C. 222 power tubes.

Transformers and Chokes *for* New Power Tubes

Specially Engineered by Jefferson

AGAIN Jefferson Engineers have anticipated the need of the Radio Industry. The transformer and choke problems which will be met in building sets around the newly developed power tubes have already been solved by Jefferson Engineers.

A new power transformer has been designed, perfected, and thoroughly tested for use with the new tubes No. 245 and No. A.C. 222 shield grid tube.

A wide choice of choke units are ready—heavy single duty chokes, double chokes of the conventional design—or staggered choke units consisting of one heavy and one light choke. The last is an especially economical method which minimizes hum and allows maximum voltage on the tubes without overloading the rectifier.

Special audio transformers have been developed with improved design to make use of all the possibilities of these new tubes.

Jefferson reputation, backed and maintained by Jefferson engineering is your guarantee of quality, service, and satisfaction on these new units. And the foresight of Jefferson Engineers together with the Jefferson production capacity are your insurance of prompt deliveries now and throughout the season.

Take advantage of this engineering work already done for you by writing us your problems. Complete electrical specifications and quotations will be supplied on request.

JEFFERSON ELECTRIC COMPANY
formerly Chicago-Jefferson Fuse & Electric Co.
1592 S. LAFLIN STREET, CHICAGO, ILL.

JEFFERSON

AUDIO and POWER TRANSFORMERS and CHOKES

(9460)

Jewell RADIO INSTRUMENTS FOR EVERY SERVICE NEED

Pattern 199 Set Analyzer

Makes every essential radio service test, including screen grid sets.

Simple to operate. Doesn't require a radio engineer to use it.

Built to highest standards throughout.

Backed by a complete radio data service.

Lowest priced, high grade set analyzer.

List Price, $97.50
Dealers' Price, $73.12

Pattern 409 Set Analyzer

Has four high grade 3½ inch bakelite case instruments.

Gives plate current, plate, filament, and grid voltages simultaneously.

Binding posts make all instruments available for independent tests.

Backed by the same data service that has made Jewell Pattern 199's famous.

List Price, $122.50
Dealers' Price, $91.88

Pattern 210 Tube Checker

Gives direct reading on all tubes from UX199 to UX250—no mental arithmetic necessary.

Adjustable for line variations between 100 and 130 volts.

Operates from A. C. service line.

Gives individual readings of each plate of double wave rectifier tubes.

List Price, $65.00
Dealers' Price, $48.75

A NEW EDITION of the Jewell booklet, *"Instructions for Servicing Radio Receivers,"* has just been received from the printer. This 64-page booklet contains data on receivers of 38 manufacturers or 139 of the most popular sets.

Furnished Free to Servicemen

This valuable booklet is furnished free to servicemen. Mail the coupon for your copy!

Pattern 581 Test Panel

Provides every requirement for rapid and accurate testing of radio receivers, including screen grid sets.

The seven instruments are all large flush type, approximately 5 ins. in diameter.

Jewell Electrical Instrument Company
1642-E Walnut Street, Chicago

Of course we want your booklet, "Instructions for Servicing Radio Receivers," which contains data on sets of 38 leading radio manufacturers. Please mail without obligation.

Name----------

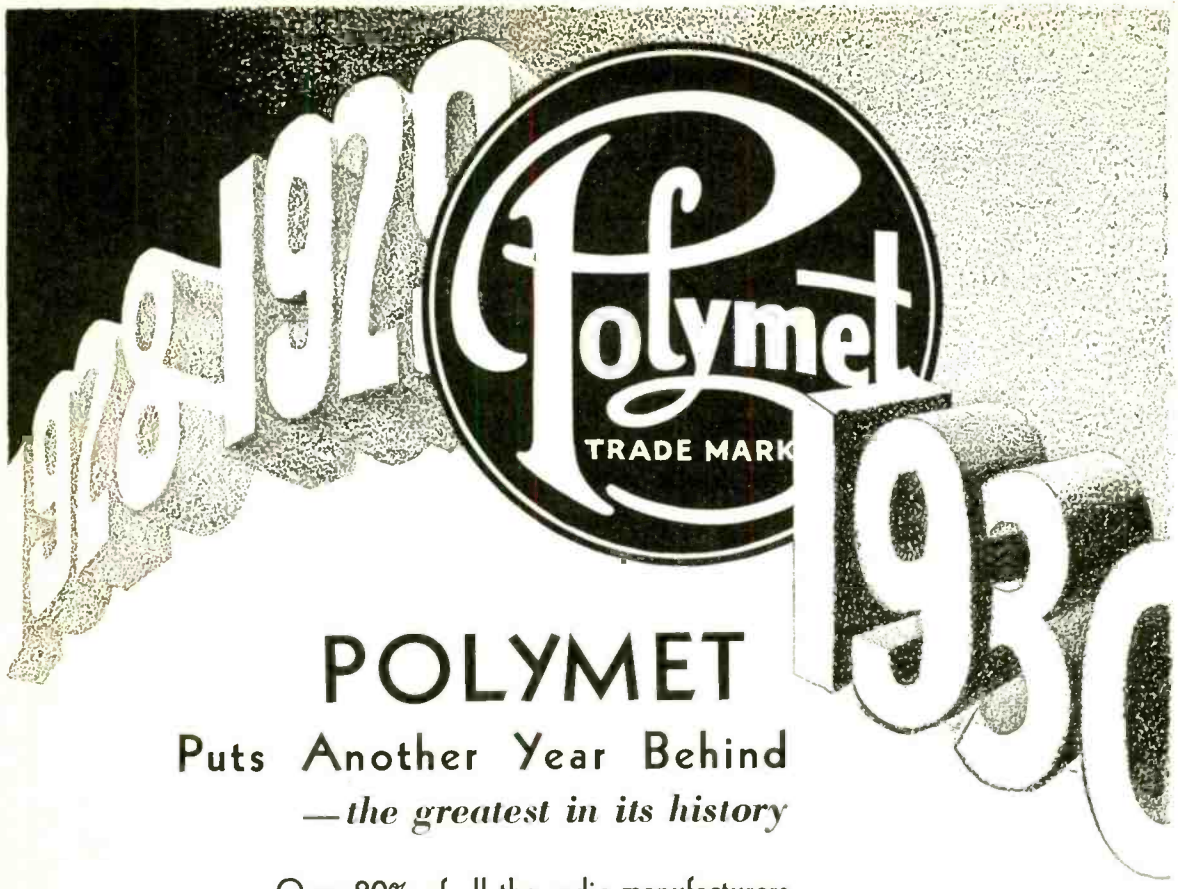
Address----------

29 YEARS MAKING GOOD INSTRUMENTS

JEWELL

JEWELL

199 Set Analyzer



POLYMET

Puts Another Year Behind

—the greatest in its history

Over 80% of all the radio manufacturers have turned to Polymet in 1929 for standard radio essentials for incorporation in their sets. But December 31st ends nothing but a calendar; January 1st begins nothing but another.

Starting right where 1929 leaves off, the Polymet Manufacturing Corporation will strive in 1930 to occupy an even more dominating position in the radio parts industry than ever before, by the simple expedient of offering to radio manufacturers the same unapproachable Quality, incomparable Service, and unexampled Dependability in

CONDENSERS
RESISTANCES
COILS *and other*

POLYMET PRODUCTS

839-C East 134th St. Polymet Manufacturing Corp. New York City

IMPRESSIONS *and* EXPRESSIONS

By

AUSTIN C. LESCARBOURA

Side Lines

THERE is no disgrace in any radio manufacturer turning to a side line, if need be. Now that it becomes obvious that we cannot turn out millions upon millions of radio sets each year, but rather must produce with some discretion in view of a limited market, we may well emulate the examples offered by other industries, and manufacture profitable sidelines whereby to keep our plants operating at the necessary capacity for economical production.

Where are those side lines? Well, that is for each and every radio manufacturer to determine for himself, based on his production possibilities. We might suggest aviation, for one thing. The radio industry is going to find a vast field for equipment, radio and otherwise, in rapidly moving aviation. The application of photoelectric cells to no end of inspection problems, is going to call for a vast amount of radio equipment. The introduction of radio control is going to open up a large field for radio apparatus—let us not overlook the super-short waves still to be exploited. Television, we hope, may provide us with a brand new field in the same homes in which we have already placed sound radio sets. Likewise with home talkies. And again likewise with radio musical instruments, of which the Theremin is the forerunner. Automobile radio is most promising. Someone recently said that within five years there would be more tubes used in industry than in broadcasting.

Are we downhearted? No! It's just a matter of looking around, using our heads, and developing new products which we can make—*and sell*.

Good Heater Type Tubes

THE weak link of the a-c. radio set has now been strengthened to the point where it is one of the strongest links. We refer to the heater type a-c. tube, whether of the plain -27 or the elaborate -24 screen-grid category.

The development of a pure magnesia insulator, better mechanical design for the elements, the use of perforated metal instead of wire mesh for the plate, the use of an alloy heater filament and other changes, have brought into being certain tubes which have a life well in excess of 1,000 hours. Indeed, it is claimed that some of the new heater tubes have a span of life exceeding 5,000 hours.

A hard problem has been solved. An important stone in our a-c. radio foundation has been laid. A most troublesome factor in servicing has been eliminated. The improved heater type tubes promise a better radio season to come.

More Radio Men

WE might well be forgiven for taking the usual advertising messages of radio schools with a grain of salt. Promises of unlimited positions at big salaries, may sound like so much sucker bait to an audience grown super-critical through the superlatives of modern American advertising.

And yet, strange as it may seem, there is more truth than fiction in those advertising messages. Radio is badly in need of more man power. Its very future depends on the training of the necessary radio men to carry out the plans. Radio manufacturers are flooding radio schools with requests for trained radio men to serve in production testing, inspecting and servicing capacities. Radio merchandisers are seeking trained radio men as servicemen and salesmen. Radio communication companies are threatened with a shortage, particularly with the early increase in the usual radio staff of ships, the elaborate inter-city radio networks, and the growing transoceanic radio circuits. Aviation organizations are seeking radio men. Sound pictures call for radio-trained men.

For the moment, demand exceeds supply. And as usual, competitive bidding is bringing about higher salaries and wages. Radio has indeed become a lucrative profession. May we always keep it that way.

We Expected It

THE recent stock crash has found echoes in the radio industry. Certain radio organizations are finding themselves in serious difficulties. We expected it.

The three great curses of the radio industry have at last been brought to a head. First, the game of stock promotion, whereby some companies have endeavored to make their money in stock rather than in radio merchandise, has now come to an end—at least for a long while to come—perhaps two years, before the public once more is willing to invest hard-earned money in problematical enterprises. Secondly, over-production has brought about a buyer's market, with the manufacturer seeking frantically to dispose of his wares at any price. Thirdly, and predicated on over-production, many have grown sloppy in the matter of credits, with the result that they are now caught holding the bag.

With some, the present period of show-down is going to be hard. With others, it is going to mean just a normal period of fair business. But with all of us, it means getting back to normalcy, as the late President Harding would say. Plain diet is good for everyone, following a wild period of wining and dining.

Next Year Is Another Year

WELL, we are about to enter another year, another radio season, another sowing for another crop.

So let's stop talking and fretting so much about the present situation and get going on next year's plans. In our travels about the radio industry, we note that in many quarters there is an atmosphere of the end of the world—that there will be no tomorrow. That is ridiculous. There will be next year and many years after that. Whatever may be the present situation, it is imperative that we think in terms of next year. We can correct our past mistakes. We can gauge our production more carefully. We can design with greater care. But let's get going on our future activities.

012 Transformer

PAM adds crowning touch to a famous hospitality

The lure of mountain grandeur, framed in sunset gold, is enhanced by Pam amplified music at the Flintridge Biltmore Hotel, near Pasadena, California.

Wherever people gather to enjoy nature's beauties, sport's keen competitions, or just the privacy of their rooms, PAM installations add pleasure and keep them in touch with the world.

There are many opportunities for such installations right in your vicinity and each will bring other orders.

The 012 Variable Impedance Output transformer shown above has a primary which matches the output impedance of any of our PAM amplifiers or its primary may be reduced to 500 ohms. The secondary of this transformer may be varied in impedance from 8 to 1000 ohms to suit most any condition. The 012 permits the use of two circuits of unequal impedance to be operated from the same PAM amplifier.

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations and many new PAM Amplifiers will be sent upon receipt of 10 cents in stamps to cover postage. When writing ask for Bulletin No. RE7.

Samson Electric Co.

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Tantalum in Vacuum Tubes

A Discussion of the Uses and Advantages of Tantalum in the Manufacture of Vacuum Tubes

*By F. L. Hunter**

Foreword

TANTALUM is an elementary metal, noted and named in 1802 by Ekeberg, produced in the form of lamp filament wire in 1903 by Von Bolton, and first refined as a pure, workable metal in commercial forms in 1922 by Dr. C. W. Balke, of Fansteel Products Company.

Tantalite, the ore from which tantalum is refined, comes from a remote spot in the Pilbarra district of Western Australia. The ore is shipped to North Chicago, Illinois, where it is put through intricate and exacting chemical and metallurgical processes at the plant, finally emerging as 99.9+% pure tantalum in the form of bars, rods, sheets, wire and shapes.

The metal tantalum is number 73 in the Moseley series. It occurs in the periodic chart of the atoms adjacent to tungsten in Group 5. Next to tungsten, tantalum has the highest melting point and lowest vapor pressure of all metallic elements.

Several of the properties and characteristics of this unusual metal make it particularly useful in vacuum tubes. The following discussion of tantalum in tubes is carried on from the point of view of the designers and manufacturers of vacuum tubes with particular emphasis on those properties which greatly assist the manufacture and add to the quality and life of the tubes.

Although what is said herein applies to both receiving and power tubes, the writer has in mind particularly the manufacture of power tubes.

The possibilities which the use of tantalum brings to other types of discharge apparatus are manifold. Several unique properties will be discussed in relation to the design and manufacture of gas-filled and glow tubes.

A consideration of all the possibilities would occupy far too much space for this discussion. It can only touch those uses which are readily apparent.

Tantalum as a Plate Material

The plates of air-cooled power tubes require a material having, in general, the following properties:

(1) Ductility and "workability".

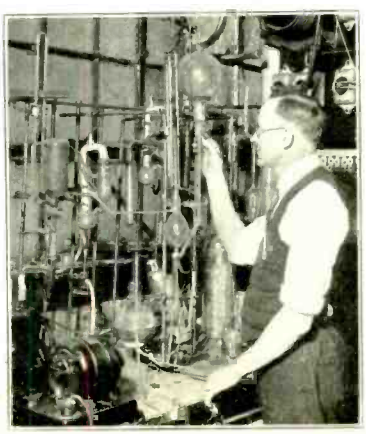
(2) Ability to stand high temperature.

(3) Complete and permanent degassing.

(4) The ability to form joints with the same or different material by riveting or welding, which retain their strength after prolonged heating at high temperatures.

Tantalum fills these requirements more completely than any other material.

(1) It is workable in all directions to the grain, even permitting of drawing operations. When annealed, it takes a permanent set during a stamping operation much the same as nickel and there is no tendency to spring back after the part is removed from the dies. This means that dies can be made for stamping plates without having to allow for the springiness of the material. This property is particularly advantageous where accurate curves, bends, and cooling fins are required. Since the tantalum sheet is very uniform in softness and ductility, its use will speed up production of stamped parts and materially reduce rejections.



A special section of the Fansteel laboratory under F. L. Hunter, helps solve the problems of vacuum tube manufacturers.

(2) The melting point of tantalum in vacuum is 2850°C. Its vapor pressure at any temperature under the melting point is far less than that of molybdenum at the same temperature. The darkening of the bulb of a tube having a tantalum plate which has been heated to 1600°C. for one hour is negligible. This point is of real importance in the design of oscillators for very high frequencies where extreme hardness with complete freedom from deposits on the glass is essential.

A tantalum plate of good design will not buckle or warp when subjected to great temperature changes.

Many of the advantages of a tantalum plate may be secured at a reduced cost by combining it with another metal in the plate body. For example, the plates of a –50-type tube may be stamped with a rectangular hole in the faces and a piece of tantalum welded in. Very thin metal can be used without loss of strength or rigidity. The insert must be ribbed, however, to compensate for the difference in rate of expansion of the two metals.

(3) The properties of tantalum and molybdenum are quite different when it comes to the exhaust process. The rate of gassing from a tantalum plate heated quickly to 700°C. is very great and decreases rapidly. Nearly all of the total gas contained in the tantalum will leave it at 800°C. in a few seconds. Thereafter the rate of gassing steadily and rapidly decreases, *even at higher temperatures*. With molybdenum the rate of gassing increases with each elevation of temperature and remains fairly low, yet constant, at elevated temperatures. Where internal bombarding is used on power tubes containing molybdenum plates, great care must be used to keep a sudden burst of gas from wrecking the filament. Where induction heating is used, a prolonged treatment at high temperature is necessary which often deforms the plate or seriously darkens the bulb. With tantalum the process is quite different. On internal bombarding, so much of the gas is given off during the

* *Specialist in Vacuum Tube Research Fansteel Products Co., Inc.*

Sheet tantalum may be rolled as thin as .001 inch.

period when the plate voltage is low that the filament is never in danger. Thereafter, when the plate voltage is raised to elevate the plate temperature, the small amount of gas which does come off, does so at a steadily decreasing rate and at no time is there danger of the sudden bursts of gas which occur with molybdenum. This property of tantalum is especially noticeable when plates are degassed by induction heating. One heating to 800°C. and another to 1000°C. to 1200°C. is sufficient to completely denude the plate of all gas so that it can later (when the tube is sealed off) be run at a bright red heat without any fear of further gassing.

A highly important property of tantalum is its ability to absorb gases. When a tantalum plate has been thoroughly degassed it will absorb gases liberated by other parts of the tube and permanently hold them as long as the plate temperature does not exceed 800°C. The maximum rate of absorption occurs at a temperature of about 600°C. so the tube may be operated with the plate a dull red and the full benefit of the clean-up action of tantalum realized.

(4) Tantalum welds to tantalum with great ease, forming joints of excellent strength. It also welds directly to molybdenum without the use of nickel laid between. If sufficient power is used to form welds quickly, the metal surrounding the weld remains ductile and is not badly oxidized. Such welds clean up quickly on bombarding. Furthermore, they are not sources of gas pockets which may cause trouble in internal bombarding.

Overwelding or excessive heating may cause a hard, high resistance film to form around the welds. This is removed by a vacuum clean-up and the plate used readily.

Tantalum does not become brittle through prolonged heating in high vacuum as does molybdenum. Hence, plates may be reclaimed from tubes which have had long service and used as new ones.

There is no condition in the building of power tubes which tantalum plates will not fulfill better than any other material.

Tantalum as a Grid Material

Accuracy of grid dimensions and resistance to deformation throughout a wide range of temperatures determines the uniformity of tube characteristics. The springy, semi-flexible structure must take a permanent set to definite dimensions with an accuracy of plus or minus .001-in. and retain that set through handling, mounting and bombarding.

Furthermore, the grid wires in the completed tube should have certain physical and chemical properties which tantalum alone seems to possess.

The requirements for a material which will be ideally suited for grid making are given below:

(1) High tensile strength combined with moderate and constant ductility.

(2) Low initial gas content with rapid and complete evolution of occluded gases at low temperatures (600°-700°C.).

(3) The grid wires must be chemically inert towards thermionically active material thrown off of the filament and toward condensed flash material.

Each of these requirements will be discussed in detail, considered in its relation to tantalum.

(1) ***Strength and Ductility:*** The production of grids by automatic machine requires a wire, for laterals, of constant hardness and considerable tensile strength. The wire must be soft enough to take a "set" in the exact form of the mandrel and not bow out in the center or at the ends. The tensile strength must be high enough to permit of considerable tension between the reel and the mandrel.

During the process of "stretching" the grids to "set" their dimensions, some of the laterals must stretch until all of them reach the same tension. This requires a material which is soft, yet which will have sufficient rigidity to resist deformation on subsequent handling.

Tantalum alone conforms to the first requirement completely. Its tensile strength is high and its softness can be readily controlled. The second requirement, however, is really where it excels. The stretching operation is materially speeded up and the grids can be mounted directly after. That is, no "annealing" is necessary because the tantalum wire is all vacuum annealed at the factory. Where nickel side supports are used, the welding produces no appreciable oxidation so that the welded grids having tantalum laterals will really have no more gas than grids where the tantalum laterals are "rolled" into the supports. In the case of power-tube grids, the tantalum laterals can be welded directly to tantalum or molybdenum uprights. Here also tantalum is superior to molybdenum in that it welds more perfectly and contains less gas.

Because tantalum does not become brittle through long heating in a good vacuum, grids containing it can be reclaimed from old and discarded tubes. In many types of tubes the grids are expensive so that this is a very material advantage.

(2) Rapid and complete degassing of grids is a matter of extreme importance, whether the method of exhaust be internal bombarding or induction heating. The remarks on degassing of tantalum plates are equally applicable here. Too much emphasis cannot be placed on the ability of tantalum to give up its gas at relatively low temperatures. Where induction heating alone is used the grid receives its heat mainly by radiation from the plate. With molybdenum grids, it is necessary to carry the plate to high temperature and hold it there for relatively long periods. Even this treatment is often insufficient to completely denude the grid of gas.

(3) Tantalum grid wire materially reduces the problem of secondary emission from the grid due to active material thrown off of the filament. When nickel or molybdenum grids are used this trouble often becomes serious, especially with oxide-coated filaments. Such deposits can usually be driven off of tantalum grids by heating them to a bright red. A short period of internal bombardment of the grid alone will suffice. There is no need to elaborate upon the importance of this point to those experienced in the manufacture of vacuum tubes.

This matter of active deposits from the filament does something else, however, to molybdenum and nickel grids. It causes the grid to assume a potential with respect to the filament which has the effect of an external bias. Condensation of the flash on the grid does this also. This potential, called contact potential, may be positive or negative, although with molybdenum it is usually positive and may have the values of a volt or even higher. There is no need to dwell upon the effects of this here, but it is sufficient to state that it is always undesirable and disturbing. Also the contact potential varies erratically depending on numerous conditions.

The use of tantalum grids will assure relief from these troublesome effects.

Gas-Filled Discharge Tubes

Gas-filled tubes of any character present a fertile field for new applications of tantalum. Some such uses are:

(1) Electrode material in glow discharge apparatus.

(2) Selective gas absorbent material for preserving the purity of argon, neon, helium, etc.

(3) Gas carrier for introducing small quantities of pure gas into tubes of any sort.

(4) Electron emitter for lowering

the voltage drop of gas-discharge tubes.

Each of these uses will be discussed briefly.

(1) *Electrodes:* Numerous devices employing electrical discharge through gas are vitally concerned with maintaining the original pressure of the gas. Vaporized particles of the electrode material deposit on the glass or other portions of the device, imprisoning gas molecules. While there are probably other causes of decrease in gas pressure, this one is by far the most pronounced. Tantalum, because of its low vapor pressure at all practical temperatures should greatly prolong the life of such devices as neon signs. Another point of importance is that the electrodes, which are usually cylindrical, can easily be completely degassed by induction so that absolutely no foreign gas will be introduced by them. Because of its low vapor pressure, the electrode temperature may be raised very materially. This has several advantages which will be referred to later. It is only necessary to point out here, however, that tantalum is particularly free from "sputtering". In many cases where small copper cylinders have been employed, they may be replaced with tantalum wires or rods which need none of the elaborate treatment demanded by other metals.

(2) Another worry which tantalum can dispel for the producer of gas-filled tubes is gas poisoning. Minute quantities of gas other than the discharge medium may raise the starting voltage of the device and cause a progressive cleanup to occur which will soon make it inoperative. Tantalum electrodes worked hot, will quickly absorb any such diluting gases and hold on to them. They are positive insurance against the effects of gassing from the glass or lead wires. The amount of the discharge medium (neon, argon, etc.) absorbed will be small and an equilibrium established during the filling process. Will insure that none of it is lost by absorption in the electrodes. This will not, however, prevent its absorbing the unwanted gases.

(3) In certain types of vacuum tubes it is desirable to introduce very small amounts of certain gases. Tantalum affords a simple manner for doing this and will actually greatly extend the range of gases which can be used.

If a piece of tantalum is thoroughly degassed and then heated to a dull red in the presence of any pure gas, it will absorb that gas until equilibrium is reached. With some gases, such as hydrogen, nitrogen and carbon monoxide, great quantities of gas are absorbed per square inch of metal. The tantalum will now hold this gas until it is driven out at a higher temperature. This might be of particular service in activating certain types of filaments. Where the tantalum is so placed in the tube that it may be heated by induction, the gas can be liberated and reabsorbed at will.

Where low pressures of pure gases are required in amplifier or power tubes this presents an ideal method.

(4) Tantalum which has been properly treated commences to emit electrons at about 800°C. Now if the cathode in a gas-discharge device emits electrons, the potential drop across the device, which is mainly at the cathode, is small compared to the drop when the emitter is absent. If the electrode size is so proportioned to the power carried that it remains at an emitting temperature, all of the benefits of the tantalum may be secured.

Finally we come to a less conspicuous use of tantalum, but one which is none the less important—that of insert wires. Wherever support wires are anchored in glass of any kind from pyrex to lead glass, tantalum is excellent. It holds firmly in the glass, *does not trap air bubbles*, and remains firm and strong. The metal is stiffened by the heat of the inserting fire just at the junction of the glass and metal and left pliable and ductile throughout the remainder of its length. Unlike nickel it does not burn and weaken nor will it pull out or loosen in service. No flattening is necessary to keep the wires from turning, and unlike molybdenum, it does not soften and become lifeless at the heated spot nor does it form volatile oxides nor gas pockets.

Some Facts About Acoustics in Cabinets and Rooms†

The Quality of Reproduction Can Be Greatly Improved by Following a Few Simple Rules

*By F. X. Rettenmeyer**

THE purpose of this paper is to acquaint you with some of the fundamentals of cabinet acoustics. Its contents will make evident the reasons why reliable manufacturers of high quality radio receivers refuse to sell radio chassis. It should also enable you to intelligently attack the problem of microphonics in console sets. It is of interest to note that while the fundamentals set forth below are common knowledge to acoustic engineers, general comprehension is still lacking.

Sound consists of a series of compressions and rarefactions that are set up by a vibrating body and progress rapidly outward in the surrounding medium. The progress of a sound wave through a transmitting medium is similar to the waving of a field of wheat when gusts of wind blow across it. Each stalk of wheat moves back and forth in a limited space while the gust progresses across the field. So, in the case of sound, each air particle performs an oscillating motion about its position of rest under the forces of the compressions and rarefactions while the resulting waves travel rapidly on through the medium. Any vibrating body may create sound waves, as for instance, walls, floor and beams of a building when vibrated by machinery, walls of a cabinet vibrated by a loudspeaker or water vibrated by subterranean explosions, etc.

The volume of sound depends upon the size of the moving member (i. e. amount of air moved) and the amount of movement. Thus a drum head must move a large distance to produce a sound as loud as that due to a small movement of the wall of a room. Sound waves set up by a vibrating body are transmitted through the surrounding medium—solid, liquid or gaseous—with velocity dependent upon the elasticity and density of the medium. For example, the velocity of sound in steel is about 16,000 feet per second, in water about 5,000 feet per second, and in air about 1,100 feet per second.

Sound may be reflected and absorbed as are light and radio waves. A porous material like felt presents little resistance to sound and consequently it reflects very little and absorbs a great deal of sound energy. Glass, on the other hand, absorbs very little sound but reflects it quite well. It should be kept in mind that sound is a form of energy and as such cannot be destroyed. It may by converted into heat in a sound-absorbing medium; it may be reflected or deflected in directions away from the observer; or it may be controlled and delivered in whole or in part to the observer's ears. A familiar example of sound deflection exists in some of the early console-type radio-receiver cabinets. Early attempts to prevent

† *From "The Electrad Forum.*
* *Chief Engineer, F. A. D. Andrea, Inc.*

microphonics consisted generally in building the loudspeaker compartment in the form of a sound reflector to force the air vibrations set up in the compartment out of the back of the cabinet. This diminished the microphonic tendencies in the receiver, but the sound reflected from the wall back of the receiver reinforced certain notes at the observer's ears and diminished others. The result obviously is over-emphasis of some notes and diminution of others, causing the observer to feel that the loudspeaker had a multi-peaked response characteristic.

Resonance in Cabinets

Suppose that sound waves impinge on an elastic cabinet wall or shelf (i. e. thin wood or metal) that is not too rigid. If the waves are correctly timed (i. e. proper frequency) the wall or shelf will be set in vibration. The shelf or wall will then vibrate under the action of the sound, with which it is in tune and will reinforce it. Resonance may occur in any enclosure in which air is confined. The resonant pitch or frequency depending on the volume and shape of the enclosure, the smaller the volume the higher the pitch.

When a loudspeaker is placed in an enclosure or chamber such as the usual speaker compartment of a console cabinet, it sets up sound waves in the enclosure just as it does in front of its baffle. Every chamber has a natural period of resonant frequency (usually between 100 cycles and 200 cycles in the average radio cabinet) and that when the loudspeaker produces notes of this frequency, the air in the chamber responds much more readily than under normal conditions and continues to vibrate even after the vibrations of the loudspeaker have ceased. These sustained vibrations may continue for several seconds in aggravated cases. The result is that the walls of the cabinet are set in vibration and the loudspeaker itself may be driven at the resonant frequency for a noticeable period AFTER the note should have ceased. This produces an overemphasized note, (of the resonant frequency) and a distinct hangover. Both tend to produce the familiar boomy rain-barrel sound so common to this type of device. In addition, the radio receiver may be vibrated due to propagation of sound through the cabinet walls and panels or through the receiver compartment being set in vibration directly by the air of the resonant loudspeaker chamber. This causes the receiver to show microphonic tendencies which augment the effect already mentioned. While the receiver may not have a sustained microphonic howl, it will tend to reproduce the resonant notes after the signal itself has ceased. That such effects are detrimental to faithful reproduction goes without saying.

The Remedy

There are a number of simple methods of remedying or even preventing such a condition by proper construction of the cabinet itself. It might appear that lining the loudspeaker compartment with sound-absorbing material such as felt or other known substances would solve the problem. If more perfect absorbers of sound were available or if the entire loudspeaker compartment would be filled with the best sound absorbents available, this would be a solution. About 50 per cent of the unwanted sounds can be absorbed in this manner if proper care is taken, however, it is necessary to absorb about 90 per cent of the interfering sound in order to accomplish the desired results. For that reason all such attempts will fail until better sound-absorbing materials are produced. The other method of attack obviously lies in proper construction of the cabinet. For example, vibrating members such as the shelves, etc., may be vented, holes of considerable area may be inserted in the floor, walls and back of cabinet. Sound vibrations in the panels and cabinet walls may be reduced to a negligible degree by shock-mounting the loudspeaker. The baffle board may be made of material which does not readily conduct sound. Finally, the cabinet itself must be as solidly constructed that it will not tend to vibrate as a whole. Thus a loudspeaker mounted on felt feet and acoustically connected to its baffle through a felt ring at the edge of the diaphragm transmits very little sound directly to the cabinet or baffle. The sound which is transmitted to the baffle may be absorbed if the baffle is of a sound-absorbing material which is solidly supported only at its ends, the criterion being the distance the sound must travel before reaching the cabinet. The sound transmitted through the speaker frame and through the felt feet to the floor will produce very little vibration, if the floor is solidly constructed of heavy material. The sound waves set up by the loudspeaker diaphragm may strike the front paneling of the cabinet and thus set it in vibration. This can only be prevented by using a grille so large that no appreciable sound strikes it directly. Cavity resonance of the air in the loudspeaker compartment may be greatly reduced by proper use of vents to permit circulation of the air which is confined in the cavity.

Remove the Back

Obviously then, sufficient openings to permit free circulation of air will materially reduce the effect. Such procedure is usually not possible since it would require large openings in five sides of the cabinet. However, if the points of maximum air pressure at the resonance frequency are located, and vents are suitably placed to permit the escape of a sufficient volume of air at these points the same results will accrue. Thus if the back of the compartment is removed and the floor vented with large openings at the points of maximum pressure, the effects of cavity resonance will disappear. The desired condition can be secured by slotted receiver shelves, vented floors, solid braced cabinet construction, baffles, large loudspeaker grilles, shock mounting of the loudspeaker, etc.

Acoustics in Rooms

The radio listener desires to hear the signal from his loudspeaker exactly as he would hear it were he in the broadcasting studio. Naturalness involves faithful reproduction of all notes with equal relative intensities without any additions or subtractions and with proper directional effects. That is to say, the radio listener is accustomed to hear a single speaker's voice come from a single point and, therefore, his psychological reaction to a single voice reproduced by a loudspeaker with or without musical accompaniment is normal. However, he is not accustomed to listening to an orchestra or a number of voices concentrated in a small area and consequently feels that the reproduction, however perfect, lacks naturalness. For this reason exacting listeners prefer to locate the receiver in one room and listen in another through an open doorway. Similar results are obviously not accomplished by pointing the loudspeaker at the ceiling, or an opposite wall, since the listener is not accustomed to hearing all notes emanate from walls, ceiling, etc. Such attempts to increase naturalness actually introduce distortion due to echoes, high frequency, absorption by rugs, drapes, etc. A loudspeaker pointed at a rug will sound boomy (i. e., lack of high frequencies) and a loudspeaker pointed at a bare floor will have a predominance of high frequencies. When possible, the loudspeaker should point toward the center of the room so that most of the sound energy will be expended in setting the air in vibration rather than in agitating floors, walls, etc.

Room acoustics also play an important role in good reproduction. In general, a room with a rug practically covering the floor and a few curtains or drapes is more satisfactory than a sun parlor with glass sides and bare walls, or a room entirely devoid of rugs and drapes. The obvious reason being that glass, brick, stone and plaster are very efficient reflectors of sound with the result that numerous reflections occur which tend to reinforce some sounds and annul others. Consequently the exacting radio listener usually locates his receiver in a room or hallway adjoining the living room. He sees to it that there are no loose pictures, vases, etc., which may rattle when sound waves impinge on them.

Quality in Radio Receivers

So Little Has Been Accomplished in View of the Factors Still to be Subjugated

By Kenneth W. Jarvis *

HERE is an excellent dissertation on the subject of fidelity of sound reproduced by radio receivers, together with notes on attendant subjects, such as Binaural Reception, Time Distortion and Phase Shift.

Mr. Jarvis has managed to provide us with a clear perspective of the "quality situation" and the many problems as yet unsolved. We are thankful for his true but ironical statements, in connection with Frequency and Harmonic Distortion, which serve to indicate only too clearly that in most of our endeavors we lose on the return what we gain on the swing.—EDITOR.

WHY does a radio sound like a radio? This question seems sort of foolish unless we assume that the object and purpose of a radio set is not to furnish good music, but to transplant and place in our home the artists themselves. We speak of the almost perfect fidelity of a modern radio receiver, sure that this characteristic insures perfect quality. Are we quite sure that such a characteristic alone will produce a result comparable to the original?

Why is it that the majority of radio receivers as used today are simply to furnish a musical background for other activities, and are not used with the same motives as impel the music lover to journey to the Opera or the Symphony? Do you believe that the lack of "personality" entailed by the mechanics of the receiver is the reason for this musical apathy? Or, is it true that a radio receiver is treated as such, simply because it sounds like a radio?

If this be true, why does a radio sound like a radio, and what can we do to give the equivalent of an individual artistic rendition in our own music rooms? In the discussion to follow, distortion is assumed to mean any characteristic of the aural impression which fails in producing the desired illusion. Naturally, those psychological barriers to illusion, such as the obvious impossibility of placing a 100-piece band in the living room, or playing off a world series on the front porch, cannot be charged against the operation of the radio equipment. Even if the receiver is our hypothetically perfect one, some form of self-hypnotism must be indulged in to complete the illusion. Fortunately this part of the game is the easiest. A dark room or closed eyes, a relaxed body, and an active imagination will do the job. We have, therefore, some logical justification for making a perfect receiver.

To make this ideal receiver, we must know first what is wrong with the one we have. The well-designed modern radio receiver is a tone marvel compared to those of a few years ago, but the design engineer cannot stop yet. Our receivers are not perfect, and although people are not aurally conscious of the defects, the engineer must "carry on." The various kinds of distortion can be named and discussed. One or more classes may be quite prominent in even the best receivers. The following list may not be complete but merely notes the worst offenders.

**Chief Engineer, Sterling Manufacturing Co.*

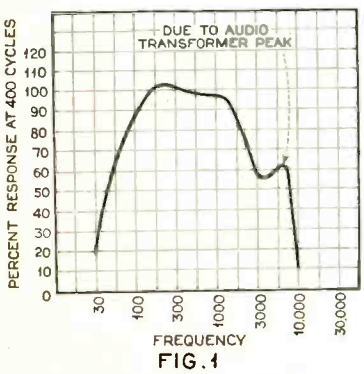


Fig. 1. Typical fidelity curve, showing relative attenuation at 400 cycles.

Frequency Distortion

This is the term applied to that distortion shown by the usual fidelity curve. If a uniform signal (uniform in amplitude and percentage of modulation) is impressed on a radio receiver and the audio frequency of modulation be varied, a uniform response will not be obtained. In general, notes having a frequency as low as 60 cycles or as high as 5000 cycles will be attenuated compared with those around 400 cycles. Fig. 1, a typical fidelity curve, is shown for reference.

Fidelity curves may vary greatly in shape and consequently give a different sense impression in different receivers. If there are not sufficient low notes present, the music lacks "depth" and "background." If the high notes are greatly attenuated, the sound lacks "definition," and the character, especially of voice sibilants, is greatly affected[1]. This is why some receivers will sound good on music (good low-frequency response) and poor on speech. Others will be just the reverse, and although both types may sound good, the apparant difference in "pitch" of the two receivers makes direct comparison very difficult.

If there is too much low-frequency response the receiver will sound "drummy" and in time will be quite fatiguing. Too much high-frequency response makes the receiver "shrill," produces an over-emphasized sibilant hiss, and incites nervousness.

The usual receiver has too much middle and not enough on either end. This fact has brought about one almost universal comment regarding radio reception to the great detriment of the art. Fig. 2 shows minimum ear response plotted against frequency. Notice that it takes more actual sound pressure at both low and high frequencies to be heard by the ear. Now suppose that the receiver is deficient (as is usual) in both high and low notes. In order to obtain a sense of good fidelity, both high notes and low notes must be present. Therefore, the operator increases the volume control until the intensity of these low and high notes is sufficient (see Fig.2) to be observed. But the output of the receiver is high between 500 and 1000 cycles, and the ear is most sensitive in the same range. The sense is that the receiver is too loud. How many times have you heard the comment, "Oh, I'd like the radio if it wasn't run so loud." And yet if the volume is not run high, the frequencies at both ends of the spectrum will not be heard and the quality will be poor. This is an easy experiment to try on most receivers. Tune accurately on some broadcast station with the volume quite high. Notice the general impression of quality, and the relation of the low and high notes to those in the middle range. Now slowly decrease the volume control and notice how the high notes and low notes are gradually lost. With quite-low volume, can you understand clearly? Are sibilants clean-cut and understandable? Do you hear the rich bass background? Here you have a basis for one of the hardest problems of quality reproduction. To make the receiver of good fidelity when the

[1] *It is very hard to describe aural sense impressions, especially as few people hear the same complex sound alike. It is hoped that the descriptive terms used will convey the proper sense.*

volume is low enough not to "overload" the sound capacity of an average room, is a problem which taxes the genius of any laboratory.

The trend of the fidelity curve over the last five years shows that this problem is appreciated. There was a time when audio transmormers of 10 to 1 ratio were quite in order. More volume, more sensitivity, more advertising. Later came a desire for quality and the curves were flattened out a little. Recently the synonym for good quality was lots of bass. This year the talk will be for more high notes. But out of this swinging pendulum will come good fidelity.

What Causes Frequency Distortion

Lots of factors must be considered. What the broadcasting station does (or doesn't), the receiver, the reproducer, the room; all enter the picture. Low notes are lost in the transformer design. To obtain uniform amplification down to 60 cycles will require a transformer much larger than any used at present, in size, cost, trouble. Resistance-coupled audio isn't any better. Big condensers cost lots of money and get leaky very easily. It takes three stages to equal two transformer stages, and, therefore, cubes the infidelity of one stage.

The efforts of most broadcast stations are centered on chain programs and features requiring line services. The newer broadcast stations, having an enormous capital investment, have found it economically advisable to make their transmitters as near perfect as possible, and the criticism of poor transmitted quality cannot be directed against them. But there are about five hundred others—

Not the least source of infidelity is the reproducer. Some mercy should be shown when we consider that even now, the principal demand of loudspeaker designers is sensitivity. When reproduction, even if it takes 50 watts into the speaker, becomes the goal, we may get somewhere. The movement on a dynamicspeaker giving average (?) volume at 1000 cycles was recently measured. In order to give the same apparent sound intensity at 60 cycles a rough calculation showed that the cone would have to move about an inch and a half[2]. Ever see one that would?

A lot of the bass from a speaker might be termed "synthetic bass." It is the sense impression of a bass note, but is actually due to the presence of multiple harmonics of the fundamental. That is a properly combined note of 140, 210, 280, and 350 cycles will sound like 70 cycles, the greatest common multiple. More anon. However, the true bass reproduction (below 100 cycles) of the average speaker is a nebulous quantity and cannot be measured with the same scale that is used on the middle range.

So much for the low notes. High notes also go astray. The principal offender is the radio-frequency amplifier. We demand and expect 10-kc. separation in our radio receivers. With a typical sensitivity ratio of 10 to 1 in 10 kc. shouldn't we get a 5 to 1 ratio at 5 kc. off resonance? That is, our 5000-cycle audio note should only have 20% of the amplitude of those notes near resonance; 3000 cycles should be more than cut in half, and even 1000 cycles should show a 10% decrease. Fortunately the response curve shape near resonance is not linear and things aren't quite so bad. Band-pass tuning is being seriously considered as a means of correcting this well-known defect. Proper design may solve this difficulty.

There's the problem of the broadcast transmitter. Tuned r.-f. circuits are used in all transmitters. *Good*

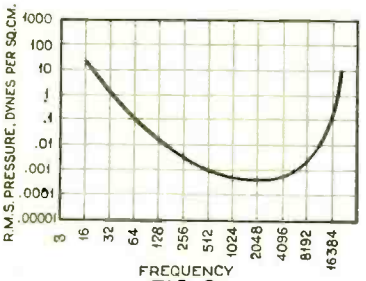


FIG. 2

Fig. 2. Minimum perceptible sound intensity.*

stations use added resistance in the tuned circuits so that they will not cut sidebands and will correctly transmit the high audio frequencies. Would that such a simple panacea might be applied to a receiver!

There are always idealists, regardless of cost. Most people in noting the greater price for audio transformers to get the low notes properly would say, "what of it? I'll pay the difference." Bigger transformers require more turns of wire, and more turns mean more distributed capacity, and more distributed capacity means more loss of high notes. As we gain in low frequencies, we lose in high frequency.[3] We have to draw the line somewhere.

Gridleak and condenser detectors discriminate against the high audio frequencies. This fact has been mentioned somewhere. They are also quite sensitive compared to "power" detectors, and so make the choice of a detecting system a rather difficult compromise.

It takes more force to move an object at high frequencies than at low frequencies. Or, for a given force, the movement is less. This is quite apparent in a loudspeaker where the inertia of the moving parts decreases the movement at high frequencies. For a while this tends to flatten the response curve, but beyond a given point, varying between 2000 and 5000 cycles in different speakers, the output drops rapidly and with it the piccolo exeunts.

Then as distinguished from the "low-pass" and "high-pass" effects of frequency distortion, there is another possible frequency distortion due to peaks. These peaks are usually due to resonance of some form, and tend to raise the amplitude of the resonance frequency away above the adjacent frequencies. There may be electrical resonance in the audio-amplifying system. Major resonance effects are usually due to coupling or feedback. Improper filtering, magnetic or capacity coupling will produce such peaks.

There is often mechanical resonance in the loudspeaker parts. The effect is to greatly increase the "transducing"[4] efficiency of the reproducer at these resonant frequencies and produce a peaked output.

Cabinet resonance is often pronounced and tends to accentuate certain frequencies. This is further augmented by the fact that when the receiver and speaker are mounted in the same cabinet acoustic regeneration may take place. The speaker shakes the tubes, the change in tube characteristics modulates the signal, and this modulation frequency from the speaker continues the cycle. This may be so pronounced as to produce a continuous howl; it may be so low that only close observation will detect this common fault.

In continuing the list, the characteristics of the "music" room should be noted. Most receivers are not placed in anything approaching a music room, and the quality resulting is almost as individual as the situation. The variation in absorption and reflecrions in the average room serves to distort the field pattern and frequency intensity curve enormously.

It is common practice to measure loudspeakers under ideal sound-absorbing conditions, because with other conditions, almost any kind of a curve can be obtained. These "any kind" of curves are not errors—they are what the ear would hear if in the same place—but are merely indicative of the enormous effect of room conditions on quality. The reason this effect is not so pronounced to our senses is twofold. First, other sounds in the same room have the same type and degrees of distortion at the same frequency. These other sounds, voices, etc., are natural to us and, therefore, the receiver, suffering similar distortion, sounds "natural." Second, the absorbing and reflecting effects are "spotty" with respect to frequency and the ear will not notice them as quickly as if all the low notes were missing.

All of the above discussion has pertained to only one type of distortion, namely, frequency distortion.

[2] *This was assuming that the entire cone moved at 1000, which is probably in error.*

* *From BSTJ Vol. IV, No. 3, p. 376.*

[3] *Or, we can reduce the turn ratio and thus lose amplification. In making up this amplification we usually increase other distortion.*

[4] *Changing electrical energy to sound energy: See I. R. E. Standards.*

The correction of these faults involves finding the magnitude, frequency and cause of the distortion first of all. Then inventive genius, precise measurement and intensive development will find an answer. This form of distortion has been known the longest and discussed the most and its problems are nearest solution. Three other major forms of distortion, not so well known, will now be taken up.

Harmonic Distortion

This form of distortion almost defines itself. If a pure sine wave of one frequency be applied to a transmitting and receiving system, the output will contain, in addition to the original or fundamental frequency, harmonics of unit multiples of this frequency. That is, if a note of the frequency of middle C. 256 cycles, be impressed, energy having a characteristic frequency of 256, 512, 758, 1024, 1280, etc., cycles may be detected. Obviously this complex tone resulting is not like the original pure tone; distortion has resulted. The reason for this distortion and its magnitude will be discussed later.

The sense impression of such distortion is principally a change in timbre or "quality" of the sound. Difficulty will be had in recognizing individual instruments of an orchestra; a viol will sound more like a violin. Those minor characteristics which distinguish one instrument or one voice from another will be lost, not due to the loss of characteristic frequencies, but due to the introduction of such other frequencies as will destroy the individuality of the original.

If two notes are in musical harmony, the first few harmonics are usually also harmonious, and no discord results. However, if more than the first few harmonics are present (due to their introduction in the receiver system) the various harmonics are dissonant and a discord results. In some cases where the higher harmonics have appreciable amplitude this discord will completely ruin the otherwise good quality of a receiver.

Although this problem has been appreciated for a long time, this is the first year that anything has been done about it in a commercial receiver. (Except to avoid overloading.) Experimental work is slow and difficult—theoretical calculations are as yet of little value. A lot must be done on this problem before perfect reception is here.

A most fundamental cause of this harmonic distortion lies in our methods of modulation and demodulation. The present double sideband method of signal radiation, and the customary "square law" detection produces an irreducible harmonic distortion. The introduced frequency is practically all second harmonic or double the fundamental frequency, and bears a direct relation to the percentage of modulation. If K is the percentage of modulation, the percentage of second harmonic[5] will be $\frac{K}{4}$

Thus at 100% modulation, the harmonic distortion will be 25%. With 40% modulation, a fair average for present-day broadcasting stations, the harmonic distortion will average 10%. (This is an irreducible minimum; other factors may raise this figure.)

As before noted, the second harmonic thus produced is usually harmonious with the other notes. Another view of this effect is to notice that this distortion may be expressed as the "beating" of the sidebands. In the case of a pure note, single sideband transmission would correct this difficulty. However, in a complex note (many individual frequencies present) each of the sidebands "beats" with *all* of the others and single sideband transmission would only eliminate the beating of those frequencies on *opposite* sides of the carrier frequency. Distortion would still occur due to the remaining sidebands. As these sidebands are not related to each other in any very definite manner, the resulting harmonic distortion would certainly be dissonant.

The harmonic distortion at low volume is usually due almost wholly to this demodulation process. In the past this has been overlooked, but as modern transmitters are raising their average percentage of modulation, and the peaks run very close to 100%, this problem is becoming quite important. At least two receivers this year have used detector systems differing from the customary "square law" type in an endeavor to reduce this harmonic distortion.

When energy, having sine wave form, is introduced into an asymmetrical or non-linear system, currents and voltages are produced having a complex wave form, indicating a transferral of the energy at a single frequency to energy distributed at several frequencies. The magnitude of this redistribution depends on the relation of the applied voltage and the degree of asymmetry. In general, the amplitude of any particular harmonic varies as the applied voltage is changed in the order of the harmonic. That is, double the voltage and the harmonics are increased as follows:

2nd harmonic varies as E^2 or 4 times
3rd harmonic varies as E^3 or 8 times
4th harmonic varies as E^4 or 16 times

Small wonder, then, that as the output of a receiver is increased, the quality gets bad! Multiply the output ten times and figure out what happens to the sixth harmonic! There usually isn't much 6th harmonic present at low volume, but it doesn't take much multiplied by a million to be a whole lot.

[5] *This is the percentage of the output voltage which is second harmonic. Expressed in relative energy or power, the distortion is* $\frac{K^2}{16}$ *, about 6% for 100% modulation.*

The characteristics of vacuum tubes are such that they are never perfectly linear. If the tubes are properly operated and the applied voltages are small, compared to the degree of asymmetry, little distortion results. As the voltage is increased, the distortion increases. The only remedy is to use larger tubes having a greater length of approximately linear characteristics. This method is well appreciated as is shown by the trend from the –01-A through the –12-and –71-type tubes to the –45-and –50-types.

All of this type of distortion does not occur in the output stage. It may occur in any tube in the set, including the r-f. amplifiers. The effect here is more complex and will await the next section for explanation.

All engineers are familiar with the non-linear magnetic relationships existing in steel and other magnetic materials. Permeance and retentivity exaggerate this non-proportionality between magnetomotive force and resultant flux by producing a hysterisis loop. Calculation (a nasty job) shows the manner and degree by which harmonics are produced in this non-linear system. Certain it is that an audio-amplifying transformer cannot simply be considered as a perfect relay of applied voltage. Many innocent-looking transformers not only transfer voltages but also energy to generate new harmonic frequencies. This is particularly true at low audio frequencies where the flux density runs higher than elsewhere in the musical range. The idea is not new. Transformers, with these non-linear characteristics exaggerated, have often been used to generate harmonic voltages and currents. The effect is a matter of degree only, and our perfect radio receiver can tolerate no transformer harmonic distortion.

Another source of harmonic distortion is quite common, particularly on low frequencies. This is due to the flux distribution and force relationships existing in electrical reproducers. The simple magnetic-type of driving unit, or "motor" as it is often called, introduces a second harmonic distortion inversely proportional to the permanent magnetic field. This is a subject well covered in many telephone treatises. The balanced-type of magnetic unit theoretically cancels this distortion. Actually whenever the armature is "off center" the unit is unbalanced and distortion will occur, although greatly reduced in magnitude.

The dynamic-type of speaker having a moving coil in a magnetic field is a big improvement in theory but may in fact be much worse. A comparison to a D'Arsonval-type meter may be helpful. The movement is proportional to the current in the moving coil and to the magnetic field. If the field is uniform a uniform movement results and the scale is linear. If in a speaker the magnetic field is uniform, a sound proportional to the current results and

good quality is obtained. However, take an extreme case of where the width of the magnetic field is equal to the width of the moving voice coil. It is obvious that any movement of the voice coil will take part of the winding outside of the magnetic field and the resultant driving force will be decreased. Or if the magnetic field is not uniform, the movement will not be proportional to the current. The result of this non-linear characteristic is to produce harmonic distortion. It should be quite apparent that as the width of the magnetic path in the air gap is decreased, the flux density increases and the sensitivity increases likewise. This decreases the permissible movement of the voice coil (assuming no distortion) and means less volume. However, as the necessary movement at those frequencies which determine the apparent volume (300 to 1000 cycles) is small, this is of apparently no consequence. Actually the low notes requiring large movement of the cone, are often badly distorted by this common method of increasing sensitivity. The result is the "synthetic" bass previously mentioned.

The correction of the many faults of harmonic distortion are either perfectly simple or well-nigh impossible as may be well noticed. Low-distortion detection, plenty of power available in all stages, correct design of transformers, speakers, etc., will serve to reduce this type of distortion.

Amplitude Distortion

A third major type of distortion may be termed "amplitude distortion." This is due to the fact that the output sound intensity does not exactly follow that before the transmitting microphone. The sense effect is difficult to describe. Those factors which tend to limit the amplitude and prevent the output from following the peaks also usually introduce harmonic distortion, which is quite observable. When considering that the range in intensity of the sounds producible by the average human voice is about 10,000 to 1, and the average range in intensity of sounds produced by the radio receivers is about 100 to 1, some unusual distortion effects might be expected. In general this results in destroying "climactic" effects. Those dramatic moments so well enacted and produced on the stage fall short in their desired radio effect simply because the range in intensity is not sufficient to portray the relative intensity of human passion and emotion.

The rendition has the impression of flatness and a feeling of being far distant. The reproducer is merely a hole in a wall and the sound source is away behind it. This is one of the major problems of good quality and "distortionless" reception and seems almost insurmountable at the present time.

One of the principal causes of this limitation is traceable to the broadcasting station and its operation. To override static and other noise a certain minimum radiation is maintained so far as possible. Pianissimo passages are amplified; peaks are reduced to prevent overload of the transmitter and consequent shutdown due to opening of the overload control relays. In the hands of a skilled studio director and control room operator the modulation is held between limits which approximate 5% and 100%—a sound intensity range of only 20 to 1. To be sure the instantaneous variation may be five times this amount, or 100 to 1. However, the broadcast station usually manages to maintain its service—over the noise level and below the overload point—and we keep listening through the "hole." They cannot be entirely blamed, however. There is more than one "hole" in the chain.

In a non-linear system, the output is not proportional to the input. Harmonics result as before noted, but this lack of proportionality referred to here relates only to the fundamental frequency. Take the case of vacuum tubes operated on the lower bend. If the applied signal increases, the output will increase a still greater amount. This might tend to offset other limiting factors, but the harmonic distortion is so great and the effect so uncontrollable as to be useless in practice.

When a receiver is so unfortunate as to be operated on this lower bend, the audio peaks will be still further peaked and may overload other portions of the system. If the radio tubes be so operated, perhaps for volume control, the peaks of the modulated signal will come "plopping" through and the signal will be distorted to a greater or less degree.

Or, assume that the tubes are operated on the upper bend. The effect will be reversed and an increased signal will not increase in proportion. This condition is seldom encountered, and is usually apparent only when the source of bias voltage fails.

An asymetrical load impedance is often the cause of amplitude distortion. The output may be proportional to the input until such a time as one or more tubes begin to take grid current. This additional grid load, beyond a certain critical voltage, will prevent the output increasing as rapidly as the input.

As previously noted, a loudspeaker cannot be made to move more than the mechanical design permits, and this limits the sound output, and produces non-proportional reproduction. If the armature is not perfectly centered in the middle of its possible range of travel, the available undistorted power is obviously more limited.

Idiosyncrasies in the audio transformers have been noted. Here's another. The response of an audio transformer depends on the turns ratio and lots of such minor details. The principal factor at low frequencies is the inductance, which in turn depends on the number of primary turns, iron area, length of path, and a-c. permeability. To follow through the house that Jack built, the permeability depends on the kind of steel, its treatment and the flux densities at which it is worked. And the queer part is that up to a certain point (beyond the usual range) the a-c. permeability increases with flux density. That is, the greater will be the flux density, permeability and response! Thus doubling the signal applied at 60 cycles will more than double the output, because of the increased transformer "efficiency" with higher flux densities. Fidelity curves run with different signal amplitudes show that the low-frequency response of the high-amplitude signal is far greater than that of the weaker signal. The effect, however, is of doubtful value as it may aid in producing non-proportional amplitude response.

One more factor tends to increase this amplitude distortion. When acoustic regeneration, or microphonism is present in a cabinet-type receiver, the "feedback" is often non-linear with respect to amplitude. Occasionally when the signal is increased above a critical amplitude, the receiver combination will regenerate or tend to "howl" at certain frequencies. The effect is to still further increase these already too loud frequency components.

Or the situation may be the reverse. With no signal the system will howl. As the signal increases in intensity it may tend to break up the cavity resonance in the cabinet and improve the objectionable condition.

The corrections needed to apply in these cases of amplitude distortion are sometimes hard to find. It is a very fundamental problem and one that prophesies poor quality from any station which is not close enough to over-ride the static level with about 1/10 of 1% of modulation.

Time Distortion

This time distortion seems to be a new idea in radio. It is queer, also, for it is so well appreciated in the telegraph and telephone art. Take the case of ocean cables. Why can't telephone service be used? What limits the transmission speed in telegraph? Although clean-cut dots and dashes are impressed at this end, the other end brings forth an irregular unrecognizable signal. The inductance blocks and slows up the steep wave front; the capacity "lets it down easy" instead of instantly. The result is time distortion, a time lag in rising to maximum amplitude and decreasing again to minimum.

Due to many unforseen losses occuring in a radio receiver, both in the radio- and audio-frequency systems, the decrement is quite high and approximate reproduction is obtained. However, many cases occur where regeneration is present, and the effective decrement is greatly reduced. In such cases time distortion becomes extremely important.

The sense effect of such time distortion is quite obvious. Music loses its clean-cut character and each note seems slurred into the next with a result anything but pleasing. Music containing this defect often can be listened to without great annoyance; it may serve as a rythmic musical background. But nothing can destroy the joy of attentive listening to real "highbrow" renditions like a little "hangover" due to time distortion.

This distortion is usually most apparent at low frequencies. For a given decrement, it takes more cycles and more time for a low-frequency equal amplitude signal to decrease to zero plus. The sense effect is therefore greater and low frequencies appear to suffer more time distortion. If the distorting effect is not noticed, there will appear to be more bass present and a false aural fidelity impression will be given.

The cause of such time distortion is simple to state and hard to find. Any system capable of storing energy may have time distortion. To produce a voltage across such an energy storing system requires a source of power, proper connections and a time long enough to store the desired amount of energy. When it is necessary to reduce this voltage to zero, a load resistance, proper connections and sufficient time must be provided to completely dissipate the stored energy. Time is required to build up the voltage and time is required to reduce it. Increasing the resistance in the system reduces the time distortion and also reduces the efficiency. A common result is plenty of time distortion, especially at low frequencies, where low effective resistance, cabinet resonance and acoustic regeneration combine to defeat the ideals of good quality.

The correction of such time distortion is fairly easy, but the methods necessary are usually not justifiable as based on cost and efficiency. Plenty of resistance losses will help enormously from the distortion standpoint and hurt enormously from any other standpoint.

This type of distortion is beyond question the hardest to measure of all, and considering the variability of the distortion with minor factors, measurement (at present) seems almost valueless. The test methods of correction are usually to "try something" and then ask "does that sound better?" An irresponsible, unreliable method at best but the alternative methods of tests using time recording oscillographs are almost prohibitive. As time goes on in the radio design field, this problem will be better understood and better treated than at present.

Four major kinds of distortion should be sufficient to consider in any radio receiver. Frequency, Harmonic, Amplitude and Time Distortion—a beautiful list comparable only to the Four Horsemen. However, there are some minor ills of more than passing interest and a few words may not be amiss.

Binaural Reception

The first item is binaural reception. For all "natural" sounds, we use both ears. This gives a sense of direction and a reality that no point (almost) sound source can ever approach. The sense of distance is even less accurate than with a one-eyed man—all perspective and relative size is gone—destroyed through an irrational use of the volume control. How can this defect be corrected? Easily—by binaural transmission. (Quoting the experts). Such a binaural transmission test was carried out by WSAI and WLW in Cincinnati in June, 1928. Two microphones were used, one for each station, and were placed some distance apart. Two receivers, one tuned on each station, and two loudspeakers, placed in the same relative positions as the microphones, were used for the test. The idea was simple. The instruments on the left would work the left microphone harder and produce more sound from the left speaker, and vice versa. The apparent position of all instruments could thus be noted with ease. The test worked fine and both stations were flooded with telephone calls, telegrams and mail, all praising the wonderfully improved transmission and quality. And practically every response came from listeners *who had only one receiver!* Those serious-minded tests and observations by engineers gave an absolutely negative result—there was no improvement in quality and no sense of direction or distance. This problem remains on the list of things to do.

Phase Shift

Even the simplest calculations show that high audio frequencies and low audio frequencies get treated far different in this respect in a radio receiver. Considering the vectors, the high frequencies may go round the circle two or three times; the low frequencies may only go once. What's the result of mixing the phase of all the individual frequency components of our complex waves? Repeated tests have shown that in general the ear is not responsive to phase and no tone distortion results. However, distance and direction effects are distinctly a matter of phase, and the explanation of the failure of the binaural transmission experiment is relatively simple. This may prevent us from ever realizing direction and distance effects in radio.

Fading

If at the opera, the lights gradually went out, the orchestra ceased playing and the tenor aria died away until only a distant street-car rumble could be heard—would you buy one? At least you wouldn't attend that opera—you'd listen to a local station. Yet radio will stay in the radio class so long as reception must include those freaks of transmission known as DX and fading.

Static

The mere name brings a shudder. Static eliminators are being sold today. The fact that they won't eliminate doesn't show that static is still desirable. While it's annoying, it's more than that. Those bursts and rumbles and frying noises which we dismiss with a shrug are more than noises. *They destroy the illusion we are trying to produce.* From this view, sensitivity should never be carried to the point where static can be noticed. However, there's KFI on the west and WBZ on the east, and while there are radios there'll be static.

A-C. Hum

This is a bee which we are confidently looking forward to getting out of our bonnet. It's still open season, however, and there's more hunting to be done. Single-stage audio does a lot of good—but often hurts some other way, such as introducing harmonic distortion. Good quality and unannoyed reception mean elimination of this evil.

These defects in our present receiver should not be discouraging. A consideration of the effort and the results obtained in the past shows that these problems will be solved in the future. To an engineer, such a clear statement of our radio deficiencies is not a slur on his ability, but should be a challenge to improve all of the set characteristics. We must work with facts, and the facts tell us that a good fidelity curve alone doesn't begin to tell the story. We are building some mighty fine receivers now but a more complete solution to the difficulties listed above will make them still better. It is encouraging to know that all over the country, big laboratories and little ones are striving to whip those last difficulties in the way of making the perfect quality receiver.

MANUFACTURERS ORGANIZE AUDIO RESEARCH FOUNDATION

AN event of outstanding interest to manufacturers of amplifying apparatus and to the radio industry is the incorporation, under the laws of Illinois, of the Audio Research Foundation, with headquarters in Chicago.

The Foundation was formed by leading manufacturers in the amplification field and in the radio industry. It proposes to bring about cooperation among these manufacturers for the purpose of a comprehensive investigation of the art, as well as of the patents in this field.

Among the outstanding men in this field who have sponsored this movement is Cy Colby, President of the Samson Electric Company.

John R. Howell, of Chicago, was elected Executive Secretary. His office will be at 134 South LaSalle Street. The Washington office is the National Press Building.

Television with Cathode-Ray Tube for Receiver†

Special Tube, Called the Kinescope, Eliminates Usual Scanning and Synchronizing Apparatus and Provides Larger Picture with Better Detail

*By V. Zworykin**

THE problem of television has interested humanity since early times. One of the first pioneers in this field, P. Nipkow, disclosed a patent application in 1884[1] describing a mechanical scheme for television. It involved a scanning of the object and picture, for which purpose the familiar perforated disk was employed. The scanning disk is used even now, almost without alteration, in all practically-developed schemes of television apparatus. However, Nipkow's ingenious invention could not materialize in his day because of the lack of powerful modern aids—the photo-cell and radio amplification. At present, the rotating disk is giving excellent results within the mechanical possibilities of our time.

Out of a number of other methods which have been proposed for the solution of television by various inventors, the author[2] has been attracted by the application of the cathode ray for scanning purposes. This method was proposed for the first time by Boris Rosing, professor of physics in Petrograd, in 1907[3]. The same reasons which handicapped Nipkow prevented Rosing from achieving practical results. Later Belin and Holweck,[4] Douvillier,[5] and Takayanagi[6] were working in the same direction with various degrees of success, striving to develop television reception by means of cathode-ray tubes. The cathode-ray tube presents a number of distinct advantages over all other receiving devices. There is, for example, an absence of moving mechanical parts with consequent noiseless operation, a simplification of synchronization permitting operation even over a single carrier channel, an ample amount of light for plain visibility of the image, and indeed quite a number of other advantages of lesser importance. One very valuable feature of the cathode-ray tube in its application to television is the persistence of fluorescence of the screen, which acts together with persistence of vision of the eye and permits reduction of the number of pictures per second without noticeable flickering. This optical phenomenon allows a greater number of lines and, consequently, better details of the picture without increasing the width of the frequency band.

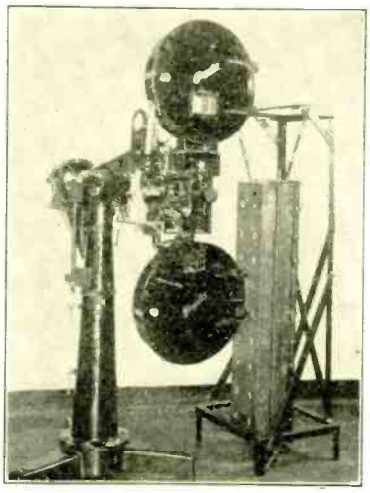


Fig. 4. A general view of the television transmitter.

This paper will be limited to a description of an apparatus developed in Westinghouse Research Laboratories for transmission by radio of moving pictures using the cathode-ray tube for reception.

In the author's opinion, if a receiver is to be developed for practical use in private homes, it should be designed

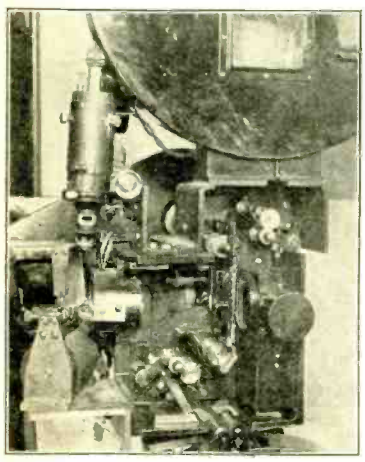


Fig. 3. A view of the projector, showing the vibrating mirror.

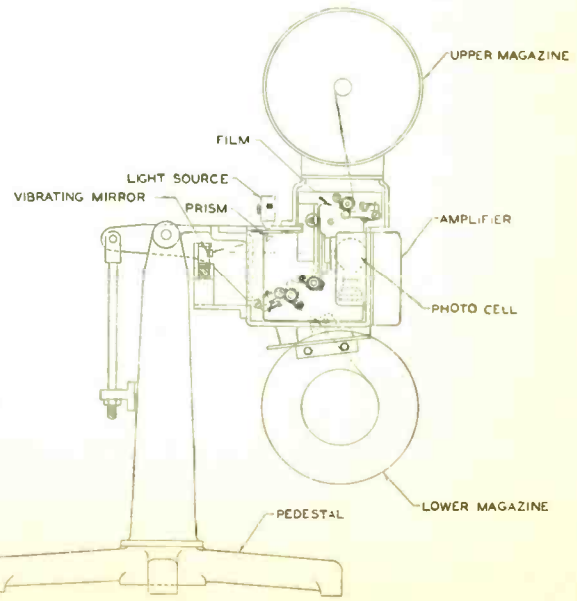


Fig. 1. Details of the modified standard moving-picture projector — a part of the television transmitter — showing the location of the photo-cell, light source and vibrating mirror.

† *Preprinted from a forthcoming issue of the Proceedings of the Institute of Radio Engineers.*

* *Engineering Department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.*

[1] *P. Nipkow, English patent No. 30.105, January 6, 1884*

[2] *U. S. Patent application, March 17, 1924. U. S. Patent No. 1,691,324, July 13, 1925.*

[3] *English Patent No. 27,270, December 13, 1907.*

[4] *Belin et Holweck, Bull. No. 243 de la "Société Fyancaise de Physique," p. 35, 8, March 1927.*

[5] *A. Douvillier, "Revue General de L'Electricite," p. 5, January 7, 1928.*

[6] *K. Takayanagi, "Jour. I. E. E.," Japan No. 482, pp. 932, Sept. 1928*

without any mechanically moving parts. The operation of such a receiver should not require great mechanical skill. This does not apply to the transmitter, since there is no commercial difficulty in providing a highly trained operator for handling the transmitter at a broadcasting station.

The Transmitter

The transmitter consists of a modified standard moving-picture projector. The intermittent motion device, the optical system, and the light source are dismantled. The film is caused to move with a constant speed downward, this motion providing the vertical component of scanning.

The construction of the transmitter is shown in Fig. 1. A light source is provided by an ordinary 6-volt automobile lamp. The light is focussed by a condensing lens *L* upon a diaphragm *D* with a small orifice. From there the beam of light emerging through the orifice is reflected from a vibrating mirror *M* and focussed into a sharply-defined spot on the moving film *F*. With the mirror vibrating at a

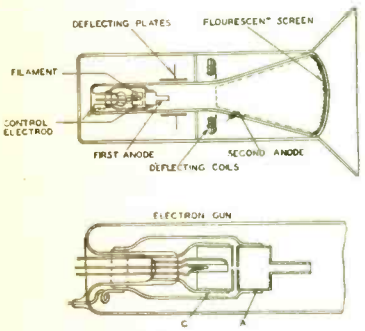


Fig. 5. Details of the special cathode-ray tube described in this article.

frequency of 480 cycles about a vertical axis, the light spot sweeps the film horizontally. This vibration of the mirror combined with the downward movement of the film causes the light spot to explore the whole surface of the pictures as shown in Fig. 2. After passing the film, the light enters a photoelectric cell *C* which transforms the variations of optical density in the film into a variable electric current.

The vibrating mirror is shown in Fig. 3. It consists of a small steel rod with a vane placed between the poles of an electromagnet. The poles are U-shaped and each leg is provided with a coil. An oscillating current of the same frequency as the natural frequency of the rod is supplied to the coils, thus causing the rod and the mirror to oscillate about the axis of the rod. In order not to depend upon the uniformity of sensitivity over the cathode area of the photo-cell, an additional lens L_2 is provided between the film and photo-cell. This lens is so situated that the mirror and sensitive surface are at conjugate foci.

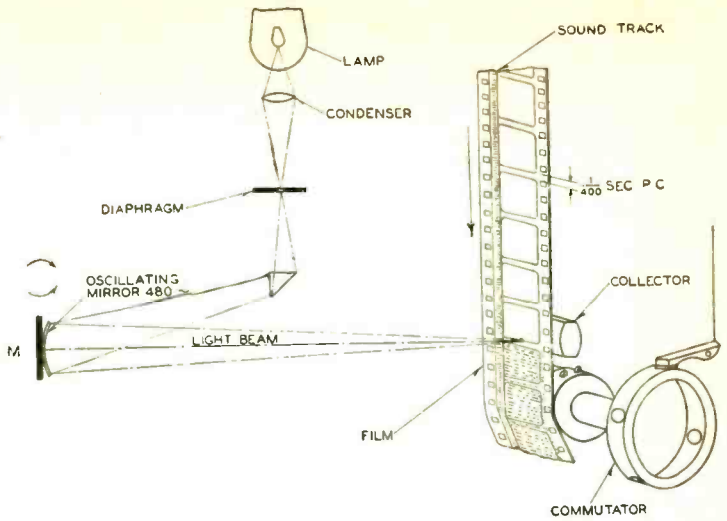


Fig. 2. Showing the manner in which the whole surface of the picture is explored by the light reflected from the vibrating mirror.

Thus, the scanning beam is always focussed upon a stationary spot in the cell.

From the fact that the horizontal scanning is produced by a sinusoidal current, it follows that the velocity of the beam across the picture is not uniform. The velocity in the center is about 57 per cent higher than that of a spot scanning at uniform rate a picture the same width. Before work was started on the machine, it was anticipated that the feature would be found objectionable and correction by optical filter was planned. Practical tests, however, indicate that the non-uniform distribution of light across the picture is not readily apparent to the eye, and, therefore, no precautions are now used. A general view of the transmitter is shown in Fig. 4.

The Receiver

The receiver consists of a cathode-ray tube especially designed for the purpose. The principles of the cathode-ray tube are well-known from their application for oscillographs. In their ordinary form, however, they cannot be used for picture reception, because although they have scanning arrangement in two dimensions they do not have means for varying the intensity of the picture. Moreover, neither of the main types of oscillographs is suited for television purposes. The high potential type which would give a sufficiently brilliant spot, is always operated in connection with a vacuum pump. Such a pump is impractical for a home television receiver. The low potential type of cathode-ray oscillographs is of the sealed-off type but the amount of light available from the screen is far too small. In order to give sufficient brilliancy for the picture of 5-in. size, the tube should operate at least at 3000 volts. For larger pictures still higher voltage is required, since the brightness increases with the accelerating voltage. According to these requirements, a new type of cathode-ray tube was developed. This is shown in Figs. 5 and 6. An oxide-coated filament is mounted within a controlling electrode *C*. The cathode beam passes through a small hole in the front part of the controlling element and then again through a hole in the first anode *A*. The first anode accelerates the electrons to a velocity of 300 to 400 volts. There is also a second anode consisting of a metallic coating on the inside of the glass bulb. This second anode gives to the electrons a further acceleration up to 3000 or 4000 volts. The velocity of the electrons at this voltage is about one-tenth that of light. An important function of this second anode is also

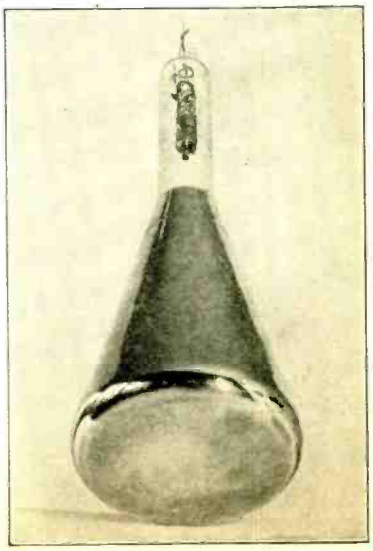


Fig. 6. The special cathode-ray tube, or Kinescope, as it is called.

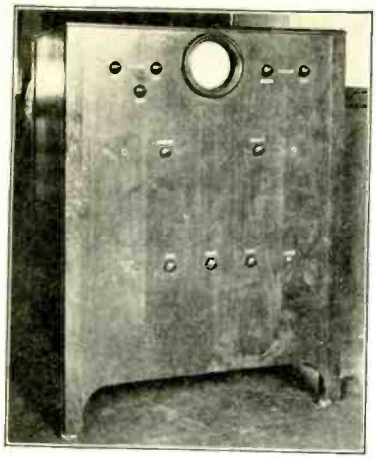


Fig. 7. A view of one of the laboratory television receivers.

to focus electrostatically the beam into a sharp spot on the screen. The target wall of the bulb is about 7 in. in diameter and is covered with a fluorescent material such as willemite prepared by a special process so as to make it slightly conductive. Conductivity is required to remove the electrical charges from the screen supplied by the electron beam. This tube will be referred to hereafter in this paper as the kinescope.

The beam of electrons can easily be moved across the screen either by an electrostatic or an electromagnetic field, leaving a bright fluorescent line as it passes. For this purpose a set of deflecting plates and a set of deflecting coils are mounted on the neck of the kinescope, outside the tube. The plates and coils are adjusted in the same plane, so as to give vertical and horizontal deflection at right angles to each other. As a result of the location of the deflecting elements between first and second anode, the deflecting field is acting on comparatively slowly moving electrons. Hence the field strength required is much less than that which would ordinarily be used to deflect the beam under the full acceleration of the second anode voltage.

The brightness of the line can be controlled to any desired extent by a negative bias on the controlling element. The bias controls the mean intensity of the picture whose lights and shadows are superimposed upon this mean intensity. It is evident that if we apply to this controlling electrode the amplified impulses from the transmitter and at the same time deflect the beam to synchronism with the motion of the light beam across the picture on the film, the picture will be reproduced on the fluorescent screen. Figs. 7 and 8 show a general view of two types of receivers.

Synchronization

If separate channels are available for each of the synchronizing signals, the problem of synchronization of the receiver with the transmitter is very simple. For horizontal scanning, it is necessary only to transmit the scanning frequency, operating the mirror as a sinusoidal voltage and to impress it on the deflecting coils of the kinescope. The cathode beam will follow exactly the movement of the light beam across the film.

For the framing or picture frequency, a voltage is generated at the receiving end and merely controlled by signals from the transmitter. A condenser is charged at constant current through a current limiting device, such as a two-electrode tube, so that the voltage at the condenser rises linearly. The deflecting plates of the kinescope are connected in parallel to this condenser, and, therefore, when the condenser is charging, this cathode beam is deflected gradually from the bottom to the top of the fluorescent screen at constant speed. This speed is regulated by the temperature of the filament of the charging tube to duplicate the downward movement of the film. An impulse is sent from the transmitter between pictures, which discharges the condenser, quickly returning the beam to the bottom position, ready to start upward and reproduce the next picture.

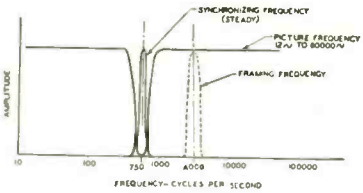


Fig. 10. The spectrum used to modulate the radio-frequency carrier.

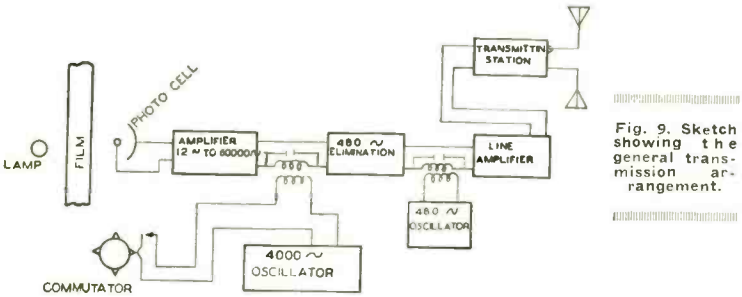


Fig. 9. Sketch showing the general transmission arrangement.

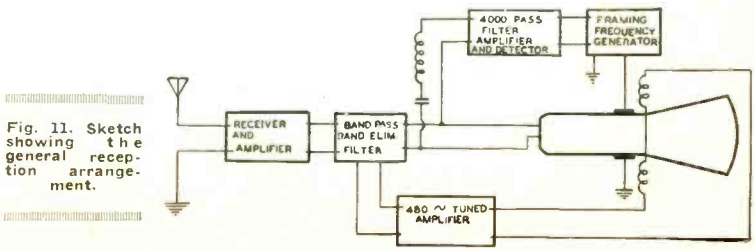


Fig. 11. Sketch showing the general reception arrangement.

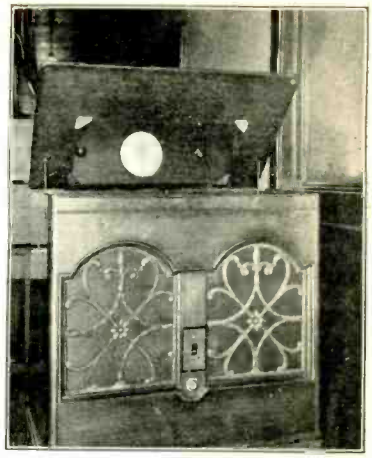


Fig. 8. The television receiver built into a Radiola cabinet.

For transmission of the complete picture, three sets of signals are therefore required: picture signals, horizontal scanning frequency, and impulses for framing. It was found that it is possible to combine all of these sets of signals into one channel. In this case the photo-cell voltage of the transmitter is first amplified to a level sufficiently high for transmission. There is then superimposed upon the series of high audio-frequency impulses lasting a few cycles only and occurring when the light beam passes the interval between the pictures. (Fig. 9.)

The picture frequencies together with the framing frequencies are then passed through a band-eliminating filter, which removes the picture component of the same frequency as that of horizontal scanning. Following this, a portion of the voltage which drives the transmitter vibrator is impressed upon the signals, passed through the filter, and the entire spectrum is used to modulate the radio-frequency carrier. (Fig. 10.)

At the receiving station the output of the local radio receiver is amplified

and divided by a band-pass band-elimination filter into two parts; one the synchronizing frequency, and the second the picture frequency plus the framing frequency. The synchronizing frequency is amplified by a tuned amplifier which supplies current to the deflecting coils of the kinescope. (Fig. 11.)

The picture and framing frequencies are applied directly to the control electrode of the kinescope.

The same voltage which modulates the light is impressed upon a band-pass filter, which is tuned to the frequency of the a-c. voltage used for the framing impulses. The output of this filter is amplified, rectified, and used to unbias a discharging triode which is normally biased to zero plate current, and which takes its plate voltage from the condenser which provides the vertical scanning voltage.

Thus, the picture signals and both synchronizing and framing frequencies are transmitted on one channel, and fully automatic synchronization is obtained.

The amplification problem in this case does not differ from that of the amplifier for mechanical television of the same picture frequency. The frequency band for which the amplifier should be constructed is much lower for the same number of lines due to the smaller number of pictures per second.

Conclusion

Those who are accustomed to the conventional scanning disk type of television notice a number of differences in the appearance of the picture as viewed on the end of the cathode-ray tube. The picture is green, rather than red (as when a neon glow tube is used). It is visible to a large number of people at once, for an enlargement by means of lenses is unnecessary. There are no moving parts, consequently, no noise. The framing of the picture is automatic; and it is brilliant enough to be seen in a moderately-lighted room.

Technically, the kinescope type of receiver presents added advantages. The high-frequency motor for synchronization, together with its power amplifier, is not required. The power required to operate the grid of a kinescope is no more than that for an ordinary vacuum tube.

The Projection Osiso

A Device Permitting a Musician to See as Well as Hear His Own Music

Rudolph Ganz at the piano making a sound wave record.

BY means of a new device, known as the Projection Osiso, it is now possible for singers, speakers, actors, pianists, violinists, and other vocal and instrumental artists to see the sound waves they produce dance visibly across a screen, just as they dance invisibly through the air to the ears of their audience.

This device was developed by C. Anderson, engineer of the Westinghouse Electric and Manufacturing Company, Newark, N. J., in collaboration with William Braid White, acoustic engineer of the American Steel and Wire Company, a subsidiary of the U. S. Steel Corporation, who is using it in a series of studies of musical sounds at Steinway Hall with the cooperation of Messrs. Steinway and Sons. It consists of several different parts. The sound waves are caught by a microphone, which can be placed in any convenient location, and are conveyed electrically to an osiso, which consists essentially of a delicately suspended mirror that is oscillated in unison with the received sound waves. A beam of light, directed on this mirror, is reflected by it to a system of revolving mirrors, which, in turn, project it upon a screen where it can be viewed by any number of people.

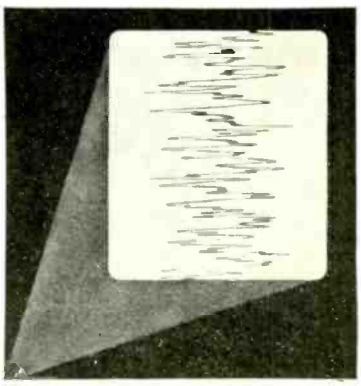
When all is quiet around the microphone, a long white line is seen on the screen, but as soon as any kind of a sound reaches the sensitive electrical ear, the white line on the screen is thrown into waves, much as a clothes line is thrown into waves when its end is shaken. The form of these waves varies with the sounds producing them, and they range from gentle ripples, produced by low pure tones, to the most intricate of patterns produced by loud complex chords and noises.

"Two practical investigations are now being carried on with the aid of the projection osiso," stated Mr. White, "although its possibilities seem almost endless.

"We are using it to study the construction of pianos and other musical instruments in order to improve them. Another application of this instrument," continued Mr. White, "is to help the student improve his technique."

The osiso in its older form, which is suitable for photographing waves and for scientific work, has been used extensively in a wide variey of electrical and acoustical investigations. It is, for example, the instrument used by Byrd's radio experts on the Antarctic Continent in their study of the behavior of radio waves, and it is also being employed by Dr. Max Goldstein for instructing the totally deaf to speak correctly. The present development, by magnifying the wave forms to any desired extent, enlarges its range of usefulness, especially in the educational field.

Permanent records of the wave patterns produced by such distinguished musicians as Harold Bauer, Rudolph Ganz, Ernest Schelling, Josef Lhevinne, Mischa Levitski, Olga Smaroff, John Powell, and others have been made by means of the older photographic type of Osiso in the acoustical laboratory of the American Steel & Wire Company at Chicago, and, with these before him, the student can endeavor to reproduce them on the screen of the Projection Osiso. It seems certain that improvement can be attained in this way, but it also seems certain that no amount of effort will transform a good clerk into a great artist, for one of the things that the Osiso has demonstrated is that each artist produces patterns as individual as his signature, and though others may be able to imitate these patterns fairly well, as a good forger can imitate a signature, apparently no one can reproduce them exactly.



A large picture of a sound wave taken by the Projection Osiso as it would appear through a screen from a slide. This is a tracing of a sound wave made by Rudolph Ganz at the piano in the acoustic laboratory of the American Steel and Wire Company.

Radio Production and Over-Production

A Survey of the Industry Discloses a General Understanding of the Need for Accurate Sales Information and Production Control

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

A SHORT time ago a survey was sent to radio manufacturers, asking their opinions on the production situations in their own concerns. We had an idea that over-production was rife. Unlike automobiles, radio receivers have few wearing parts. There is no reason why the purchaser of a 1929 model receiver should be in the market for another set much before 1935. The saturation point, though not yet reached, is coming into view. So we sent the questionnaire.

Perhaps such topics as over-production are not proper for investigation. Perhaps it is a subject spoken of behind closed doors of executive offices. Perhaps it is not to be countenanced. Over-production? Never heard of the animal. That seems to be the essence of the replies we received. The manufacturer will admit of no such thing as over-production. That was immediately before the late market crash. Unfortunately, all the answers were received before the downfall of Wall Street. Perhaps the manufacturers are not now so optimistic.

Our own personal opinion is that while manufacturers had planned their 1929 production with a view to having twice the demand of 1928, they have found their needs only slightly greater than last year. Their expectations have not altogether come true. Instead of an exhorbitant increase over 1928 production, their increase is normal. A let-down from the expected, but an increase over the previous year. And since manufacturers are not producing in the enormous quantities predicted a year ago, they do not consider themselves as over-producing. And yet the current advertising in metropolitan newspapers points to a market flooded with receivers, although this should be the season when prices are high and the demand in excess of the supply. A few dealers and manufacturers are cutting their prices, almost by a third. Most of them are stressing the point that they will not cut prices, as though to cut them in this period of over-production would be only natural. Of course, in this pre-Christmas season the opposite is true.

Cancellations

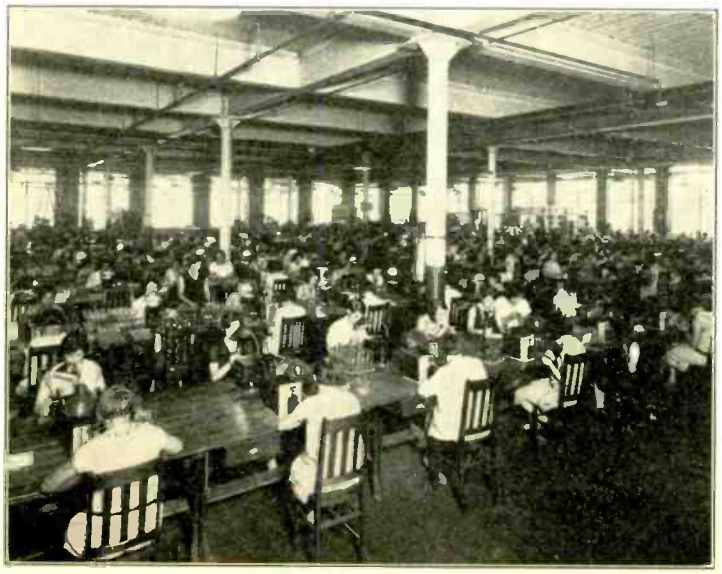
The experience of one particular equipment manufacturer is perhaps typical. In the early part of the year he determined to take orders for only as much as he could safely produce. By the middle of June he had received orders covering the maximum output of his plant. But since the end of September customers have been cancelling their orders to as much as 20 and 25 per cent of their original commitments. These customers represent the largest manufacturers, the most substantial leaders in the radio industry. The problem is even deeper. Not only has over-production flooded the market at the season when prices should be high, but even after a more normal demand for initial installations has been met and production has been scaled to meet demand, there will be an excess production capacity, which, from present indications, will remain idle.

Another house, manufacturing specialties for radio manufacturers, makes purchase commitments for raw materials following the receipt of orders, keeping a limited supply of materials on hand, just enough to cover elapsed time between ordering material and the time of delivery. This firm has also received cancellations recently, but has been able to forestall shipments of materials, consequently avoiding tied-up capital. This concern also carries, for consumer business, a minimum of finished goods on its shelves, besides material in several sub-assembly forms, which may be combined for almost immediate delivery in case the finished stock is suddenly rushed off the shelves.

A flexible production procedure which does not interfere with proper factory administration, coupled to sources of supply chosen in part for their flexibility, makes for a combination that can be suited to the changing production needs with the minimum of waste and the maximum of speed.

Harnessing Production

Another method of keeping production in check, and one followed by at least one firm, is to map a production schedule at the beginning of the season of not more than 50 per cent in excess of actual orders, and gradually decreasing production as the season progresses to a point where it is only 10 per cent in excess of actual released orders. One manufacturer sells on a merchandise rather than on a price basis. Using the latter basis, the product is dependent on the amount of merchandise necessary to obtain price. This, of course, is basically unsound. A careful watch must be kept at all times, not only at the beginning of the season, on orders and estimates, production, and sales; and sound judgment and common sense used in interpreting these trends, fitting them into the production schedule.



A section of the Arcturus plant given over to the production of —80 type rectifier tubes.

All manufacturers should check their sales, regularly, at as many points as possible, and in relation to production. This is most important now, to gauge accurately the probable need for the next year as well as for the immediate future. This can be done in a number of ways. Jobbers' surveys, either territorially, or on a time basis, furnish the requirements of the nearest outlet of the manufacturer. Direct representatives may be able to make better surveys, due to their broader vision of the field. This can be done territorially. Distributors should furnish weekly sales reports, showing the amount of merchandise sold, to whom it was sold, and the stock on hand. Consumer surveys by direct representatives are often revealing, as are monthly sales analyses and dealer surveys. One firm, selling to large department stores and chain dealers, checks its daily and weekly sales against its production during the same period. One vacuum tube manufacturer keeps a graph in the form of a curve statement whereby daily sales are posted on the same sheet with anticipated sales. Besides, the manufacturer receives daily reports from each of twenty salesmen regarding dealer reactions as to changes in the market.

Checking Trade-ins

Another aid to the control of production is checking trade-ins. Radio is following the automobile industry in this respect. The manufacturer should know not only how many repeat orders he gets, but also how many of his products, when they are turned in, are replaced by other makes. It might be well for the manufacturer to examine his old sets that have been turned in for new ones, with a view to finding weaknesses or flaws, which can be overcome in production. And while he is at it, the manufacturer should take the turned-in sets of other makes, which have been exchanged for his, and likewise, examine them.

Now that the greatest potential sales have been turned into actual sales, and merchandising is growing rapidly more difficult, the first added incentive to new set purchasing—an allowance for the old one—has somewhat demoralized the market and a new policy is being followed by some companies. Instead of suggesting the trading-in of the old set, they suggest, (as do General Motors among the automobile manufacturers) that the purchaser of a new set keep his old one for supplementary use in dining room, nursery, maid's room, or den. Manufacturers are beginning to feel that if a vogue for more than one set to the home can be created, as it has in the realm of automobiles, an outlet may be found for their products, and their huge plants will not have to be kept idle. It will mean more servicing and parts outlets, tubes, sockets, etc., and tend to create a positive desire for more than one set, so that in time, instead of using the old set in the den, people will deliberately set out to buy a second or a third set. This is one way to meet the over-production problem over a period of years.

Checking Theoretical Life

Checking the life of the product might give the manufacturer a good picture of his probable sales and consequent production. Radio has grown so rapidly that the life of the average radio receiver and its component parts has been very short. Obsolescence, while it has cost the manufacturer plenty in the way of patents, machinery, and manufactured products which have been distributed to jobbers and dealers but cannot be sold, has by the same token been a boom, for it has meant the scrapping of old sets in favor of newer and better models on the part of the consumer. Surely, the public has in the past been more than keen to get the bigger and better, the newer, the greater Radio Receiver. Manufacturers have played this ever-improving market, this rapid obsolescence, to the limit. The profits have far outweighed the expense. But now the time has come when sets have been so improved that obsolescence is no longer rapid. Sets are longer-lived. The public is not so willing to turn in last year's set for a new one. Wait a few years! What is wrong with what we have? This seems to be the reaction of the public toward advertisements of the newest model. Intrinsic improvements, though not finished for all time, are being developed more slowly, too slowly to act as sales points every few months. Proof of this fact is seen by the purely superficial and unimportant sidelines that are being stressed by radio manufacturers as selling features. An arrangement by which all the wavelengths and numbers are visible and one tunes in by moving a dial across the numbers. This in the Victor models. Lightomatic tuning by which each station, as it is perfectly tuned, lights a small bulb. This is the feature of the new Edison. Each station in the form of a button. Press a button and the station which it represents is automatically tuned. The new Zenith. Fine, all these features, but not important.

Better looking cabinets. The radio as a piece of furniture, an appeal to the feminine taste, besides the masculine appeal of a fine piece of mechanism. All are proofs of the slowing down of fundamental improvements.

Manufacturers can test the life of their products, partly by keeping track of the age of the old sets exchanged for new. In case of parts like tubes, by life test racks. Such tests are used generally to influence design. They have not been used to influence production. They should. If a manufacturer sees that his product lasts, without any undue lessening in efficiency for, say, five years, it means that aside from developments in cabinet and other superficialities, no repeats can be expected for that length of time—provided of course, that some new and radical fundamental improvement does not appear overnight. The longer the life of the product the more elapsed time between repeats. And yet research must continue to lengthen the life of the product in order to sell at all. One redeeming factor is the steadying influence and the knowledge that costly machinery for production will not have to be scrapped after a short time. With the slower obsolescence, life tests become more important to production. One vacuum tube company operates a complete life test department, receiving the attention of four engineers, and considered one of the most important activities of the organization.

Assessments of Territories

Following the example of other industries, radio manufacturers should assess territories for sales possibilities. This will aid selling, distribution, and merchandising as well as in judging production. It would also bear on location of plants in case a company thinks of moving. And, bearing upon transportation costs, such assessments would determine costs. Manufacturers might base their assessments on per capita wealth of the community, number of homes, number and age of sets, broadcasting stations and programs available, etc. Salesmen in different territories could then be allotted quotas, based on these surveys. And since such surveys would aid all radio and radio parts manufacturers alike, we believe that a disinterested organization, such as the Carnegie Foundation or a bureau formed for the purpose by an organization of radio manufacturers, should be given funds by the manufacturers to make and keep up to date such surveys and similar indexes of importance to the industry. At present, territories are being assessed by only a few firms, chiefly in terms of the Crowell and Curtis index.

Looking at Production

Looking at production from the factory standpoint, it is only natural to scale production according to present material, labor, and transportation costs, depreciation of plant, overhead; generally on the basis of unit cost. This means the largest possible production, but only the largest possible profit if all the production can be moved. Because this is not Utopia but, rather, an overfed and lately-coming-to-its-senses America, production should also be scaled according to probable sales. As one company puts it, while production is theoretically based on materials, cost, and equipment, in reality it is regulated by the probable sales of the season. Unfor-

tunately, many manufacturers take the opposite view: the greatest possible output at the smallest unit cost. Then if it is found that the company has over-produced, it can always sell the surplus at reduced prices, the small unit cost covering the difference between that and the originally computed price. Such a system, however, tends to demoralize the industry. The firm that acts accordingly to such theory will find it doubly difficult to raise its prices to normal, once it has resorted to price-cutting practices. And the fact that it can live through such price-cutting indicates either that inferior materials, labor and inspection have gone into the manufacture of the product, or that at the original price, too high a margin of profit was being made. In other words, the consumer is not getting enough for his money.

A concern running on a flexible plan, such as outlined above, can produce according to probable sales very easily. One firm, even though it has produced on probable sales in the past, has found itself so far over-produced, due to pre-season optimism, that it intends in the future to produce according to actual sales only. It is only well to anticipate sales at the beginning of the season, or in preparation of stocks for the rush season. Of course, costs must be taken into consideration. Also the past performance and proven ability of sales outlets.

Percentage of Sets Unsold

Still another survey which might aid production, concerns the percentage of manufactured sets or parts each year that remained unsold to the jobber, dealer, and consumer. Practically none of the manufacturers seems to keep figures on this subject. From those that do, it is found that in 1926 about 5 per cent remained unsold, in 1927 about 17 per cent, the following year again 5 per cent and since then none. These figures comprise only a very small portion of all the manufacturers in the country. Without being unduly pessimistic, we feel that this year will see the figure rise again. Perhaps by keeping such statistics manufacturers could see where they erred in figuring the probable sales and the consequent safe production. Otherwise they are liable to make the same mistakes in judging production year after year. This survey would act as a check on those made before production.

The incorporation of improvements in receivers as soon as they were proved worthy, without waiting for yearly models or radio shows, would tend to solve the obsolescense problem and make possible the sale of old sets even after the new season was under way. That is, there would be no break, no distinct line between some sets and others, necessitating the scrapping of the old.

As to feasible methods of measuring probable sales for new models, they must be found by each manufacturer to meet his own needs. The surveys mentioned above should be of great value, especially the territorial assessment survey. The manufacturer should also watch very closely the field results of the early shipments, the success of his larger outlets, market conditions, competing products, price comparison, and distributor commitments. It is not necessary to produce only on orders. The cost of this would be exhorbitant, and the delay in meeting shipping specifications would be so great as to lose many customers. Neither should the manufacturer go full-blast at the beginning of the season with the idea that he can always cut down at the end of the year. Full-blast production means greater unit cost in overtime, a slackening of inspection, and the employment of more operators, lowering the average efficiency. And at the other end of the year it means laying off help, not only the extras, the night shift, but some of the regulars too, men whom the manufacturer has trained to be of value and who will leave and find work elsewhere, probably for his competitor. Training operators for one's competitors is no way to make money. Also, during the slow period at the end of the year, due to over-production in the early season, the unit cost will rise. Better to take the middle of the road all along, so cutting the unit cost, keeping the plant going, and maintaining uniform quality.

Conclusion

In conclusion let us turn once more to the surveys mentioned in this article. We feel very strongly on the matter. Few of the manufacturers questioned take full advantage of the knowledge such surveys would furnish, perhaps because of the cost of obtaining such information. Those surveys that are made probably favor the firms under whose auspices they are compiled. How much better it would be if the radio industry would combine to support an unbiased, disinterested survey of the radio situation in all its aspects, carried on by an outside organization, or by a specially appointed committee from the leading manufacturers.

A Laboratory in the Clouds

Radio Receiver Manufacturer Builds Laboratory Almost One Mile Straight Up.

WHEN C. R. Leutz, Inc., moved to Altoona, Pa., some time ago, they decided to build a laboratory that would be especially adaptable to long-distance radio reception tests. The close proximity of the Alleghany mountains suggested this locality as an ideal spot for such a purpose. Accordingly, preliminary reception tests were made and it was found that this was indeed a DX fan's paradise.

Laboratory Facilities Offered

While Altoona itself is around 1200 feet above sea level, certain spots in the Alleghany mountains, just to the south, rise to 3000 and more feet in height. These peaks are, in fact, the highest points in the state of Pennsylvania. A spot was chosen that was remarkably free from any sort of local disturbance; so free, indeed, that the most powerful radio receiver in the world may be operated at full amplification with an absolute minimum of background noise. A building is being erected on this site, to house a complete laboratory equipped for both long- and short-wave reception tests over great distances. The building is of cinder block and stucco, and contains a receiving room, a transmitting room, and a general laboratory. In addition to carrying on experiments for the Leutz organization, the facilities of the laboratory are offered to other manufacturers.

While the total absence of power lines for miles around makes this an ideal spot for quality reception, it also means that there will be no electric current available. Accordingly, a small power plant is being erected.

The possibilities for unusual aerial combinations in this desolate locality, are unlimited. For short-wave, long-distance reception, a wave aerial one mile long is being erected. This may be used equally well for long-wave transoceanic reception.

Short-Wave Relay Transmitter

A short-wave relay transmitter will be installed, for one thing, but will not only transmit programs originating in the station, but will also relay the programs of station WFBG of Altoona. Provision is being made for extensive television work, in the new laboratory. As short-wave signals travel over great distances, it is hoped that this station, with its extraordinary location, will be a powerful factor in long-distance television work between countries and continents.

Design Mistakes

Looking at the Radio Sets Through the Eyes of the Generally Dumb Public

*By Evans E. Plummer, Western Editor**

IT is a known fact that the best way to learn of our mistakes is to ask someone else: if we knew that we had been wrong in the first place, we probably wouldn't have made the error. By the same token, not knowing that we have made mistakes, we make very poor critics of ourselves.

A well-known piano manufacturer called conference upon conference and planned the ultimate in player pianos. The case was designed by the best artists and made by expert cabinetmakers. The piano and player movements were the last word—on paper.

After every official had torn the plans apart and suggested countless little changes, the first few pianos of that design were turned out in production. They were shipped. A dealer in a small town got one of the lot.

By means of telegrams and long distance messages that dealer immediately informed the great piano factory and its engineers that some very comical design mistakes and omissions had been made.

There you are.

Everybody makes mistakes. Therefore, we have rubber on pencils, accident insurance and divorces. Radio manufacturers, despite the safeguards such as field and proving tests, make mistakes. And, if too many are made by a manufacturer, he loses his reputation and his selling costs rise to the inevitable receivership or bankruptcy.

The "generally dumb public," as I have chosen to call the great army of consumers in the title to this article, are a queer bunch of birds. The only way to outguess them is to take them into account very carefully in your plans.

In my eight years of experience as a radio editor, first for five years with a magazine and for the next three with a newspaper, I learned to appreciate the dumb public. While they are without exception almost totally ignorant of the technical details of radio design and construction, they know what they want.

They cast their ballot by means of the dollar. They will often pay much more for a set giving them what they want than for a more reasonably priced receiver embodying pet ideas of the radio engineer which were not so highly prized by the public. And sometimes the laboratory curves of the unpopular set are much superior to the popular make!

**Mr. Plummer is also Radio Editor of The Chicago Herald and Examiner.*

MR. PLUMMER, new Western Editor of RADIO ENGINEERING, *felt the first pulse of the public in* 1910 *when his quarter K.W. transmitter,* 9LL *in Indianapolis, pulled down the lights in the neighborhood with every dot and dash. Then he went to Purdue, war, and back to Purdue for a degree, only to finish in* 1921 *in time to become Editor of Radio Digest, a fan magazine with its first issue. If you don't think he knows his "dumb public," you don't know how to figure inductance.*

—The Editor.

Figure that one out on your slide rule.

Humless Sets

Before suggesting a means of acquiring the public perspective, let us consider some of the more glaring examples of general design mistakes. I must avoid, however, mentioning specific names.

Poor power packs have put many a manufacturer in a panic. The public expects the power supply of a set to hold up. That is reasonable. If it doesn't, the owner blames the maker of the set. If the tubes in a set burn out through high line voltage fluctuations, the public seldom blames the tube maker. The set manufacturer gets it again.

Nearly every one of the first a-c. sets had a bad hum except several of the cheaper makes which had audio transformers in them that didn't pass a note lower than 130 cycles.

Did the public know that the cheap sets had cheap transformers in them? No! It wanted a set without hum, and so awarded the laurel wreaths to the boys whose sets couldn't help themselves from being humless.

Now I've read oodles, reams and volumes of yarns about tone quality selling sets, and that good reproduction was the basis by which the public measured its radio-buying dollar. I think this should be modified. I don't believe it as it stands.

Adjustable Pitch

John Doe is an individual. His ears are different from Bill Smith's. Mary Brown, too, has her likes, and they don't coincide with Helen White's. If we were all alike, we would all love the same kind of girl, and there wouldn't be enough Miss Utopias to go around to all of us.

John Doe, Bill Smith, Mary Brown and Helen White might get together and select the type of reproducer, and its pitch, so that all four would be satisfied, but my experience has been that only three out of four, at the best, would get together.

A year and a half ago the boom-boom dynamic sold well. Yet at that time there were hundreds of thousands of sets sold with magnetic cone-speakers in which the tweet-tweet predominated to the utter loss of the boom-boom.

Now, the pendulum swings back to more natural, a less boom-boom or tweet-tweet distorted reproduction. Those of the public which had boom speakers got tired of them. Those which had tweet speakers now want a little more boom.

So I'll amend that tone quality sales point to say that the public expects good tone quality "of the kind it likes."

The best stunt or design trick I've seen to please the public ear is the dynamicspeaker fitted with a tapped input transformer to please the high, medium or low ear.

The Set With a Sock

What next does the public want? Well, I think that "sock," as I choose to call it, is very important. A radio set without punch or sock is like a washed-out personality. You've known many a person with a negative reaction, haven't you? Did you like them?

But how about the "wildcats" with too much personality? They bore you, or perhaps you run and hide when you see them coming. I know, from feeling the public pulse, that sets with too much sock or uncontrollable r-f. gain, are also in bad grace.

The dumb public wants a set with ample r-f. gain to go out and get distance with a wallop even though local stations are the only kind ever listened to.

Plenty of people buy an 80-mile an hour motor-car and never drive it faster than the speed limit in the city. But they want to *know* that it *will* go 80 miles an hour. That is the way many purchasers feel about *dx*.

In getting this so-called sock, it is never wise to make a set so selective that the average fan cannot locate his station. Since the advent of the socket-power, single-control set, the tuning intelligence of the general public has suffered a great letdown. In the early days, from five to eight years ago, every listener was an expert tuner.

He had to be!

But simple sets have opened the

market of the simple public, and they, the great uninformed, know little or nothing about tuning. The engineer must make a compromise. He must design his set to be selective enough to separate local stations without perhaps more than twenty kilocycles spread on the dial, yet broad enough that the unskilled owner can tune without difficulty.

Calibrated Dials

At this point, I'd like to throw a harpoon at "calibrated" dials. The general public has learned by experience, magazine and newspaper articles and hearsay that each station has a wave-length and "kilocycles." Few know the relation of one to the other or what either of them represents. They only think of this or the other number as a sort of telephone number or combination by which they can bring in this or that station.

Imagine their chagrin when they purchase a set "calibrated" in meters, kilocycles, or both, and find the graduations correct only on about 30 per cent of the dial.

I say that a manufacturer attempting to market a set with a calibrated dial should also attempt to have his calibrations within one per cent of accuracy over the entire scale of the dial. *Then*, by means of an operation manual, he should make the fact plain that production problems make it impossible to turn out a set precisely calibrated, and that the graduations will be found to be *slightly* in error; that the calibrations are approximated in order to guide him *close* to the broadcasting channel he is seeking.

The only other honest alternative open to the set maker who does not wish to build up consumer dissatisfaction, is to number his dial from zero to one hundred. His manual then can give approximate settings at which the principal wave channels can be located.

Cabinet Style

How can you please the public with a cabinet? I've heard a great usage of the term "eye value" in this connection. I think it means that a successful cabinet from the manufacturer's viewpoint is one which looks like a great deal more, for the price, than any other in the field, and, I might add parenthetically, like a great deal more than it actually is.

All right, go after eye value. But get a practical cabinet. After artists, furniture experts and cabinetmakers have had their fling at the designs, give a jury of about twenty-five wives (not wives of factory employes if possible) the final say. They will feel flattered to have a say, and you'll be surprized to learn what they do say. Needless to emphasize, the wife's "say" is more important than the husband's when it comes to selecting the cabinet style and finish.

In all my experience I have heard only two general complaints of radio cabinets. One was in regard to that type of console which has half doors which swing out into the room—you know—and don't have anywhere to go after they get there. They don't fold back against the sides of the console. The other general kick has been that the finish of certain sets looked "too cheap." Some certainly have!

While not under the topic under discussion—design mistakes from the public's angle—I would like to relate one crucial incident in cabinet choice that hurt one large manufacturer this year. The cabinet was selected to please the public. It was a good choice. But the chassis wouldn't fit in it without a "shoe-horn."

So production speed was cut tremendously until the problem was solved by changing the chassis design somewhat. I think the radio and production engineers should have final say in regard to cabinet size when only a matter of several inches are at stake. Changing chassis designs to fit cabinets is not sound engineering.

The Operation Manual

Now, how about the operation manual? You get one with your automobile (and probably scan over it the first day, then promptly throw it under the seat and forget about it until you trade your car in), but you don't always get one with a radio set.

I know they are important to radio fans. They should be fastened in some kind of a tin or leather holder in an accessible spot in the cabinet. The dealer should be instructed to tell each purchaser where the manual is, and to read it over carefully once or more, and always to glance at it first when some type of trouble makes itself apparent.

An operation manual should contain considerable information compiled so that a child of twelve[1] can understand it. It should hastily, perhaps by analogy, sketch what radio is and how broadcasting is done. It should explain wavelength, frequency and tuning. It should describe how various electrical interferences sound and how one can determine that such noises originate without rather than within the set.

It should explain that a long aerial acts like a scoop-shovel and picks up more broadcast energy along with more interference and static, and that a short antenna is like a pitchfork and picks up less signal strength and *less extraneous noises*.

The Importance of Good Tubes

It should emphasize the importance of good tubes; how often they should be tested; and that they wear out after so many hours just like rubber tires do after so many miles, but that the fact that they light means nothing as to their efficiency.

Entirely too many fans keep using the same set of tubes two or more years and feel they are cheating the tube maker while the only persons they are cheating are themselves. Ask them to borrow a new set of tubes after a year and prove to themselves that they need new ones.

The buzzer-like noise of defective heater tubes should be described, and a simple method of substitution outlined whereby the buzzing tube can be spotted and eliminated. The click interference of houselighting switches should be pictured in words, and remedies, such as a proper filter (with names and addresses of manufacturers) suggested if the clicking proves bothersome.

Some manufacturers don't bother to tell the purchaser (and many dealers and servicemen don't *know*) that reversing the receptacle plug sometimes cuts the residual hum of an a-c. set.

Speaking of hum, if there is some present in the set (of course, *no* sets hum these days), admit it. Otherwise, the buyer feels he has a defective set and will annoy your dealer to death or send the set back.

A service manual should overlook no bets. It should tell everything imaginable in primer language and be well-illustrated. How to get strong reception in remote localities, selectivity in congested broadcasting centers, anything at all in steel apartment buildings; all these should be told.

Simple first aids will eliminate many wild-goose service calls upon dealers and increase their profits as well as improve their opinion of your brand of set. Some enterprising manufacturer, breaking down the rural and small town markets, might even go farther with a "supplementary" manual which would go into even more intimate details regarding self-service. This is a good plan, for servicemen; good ones are hard enough to find in the city, let alone the country.

Now that the dumb public has been helped a bit along the thorny path of radio, how is the manufacturer going to get the viewpoint of the said generally dumb public in regards to his product?

Field Tests

Field tests can be made in many ways. Typical listeners in *all* parts of the country in which the set is being sold can be questioned. Radio editors of newspapers can be asked for frank, honest destructive and constructive criticism (and they are close, generally, to the local situation). Radio dealers are generally to be depended upon.

Experience records will show that different kinds of trouble are prevalent in different parts of the United States due to localized conditions, such as fluctuating of high line voltages, climatic extremes, inadequate or congested broadcasting facilities, etc. The wise engineer will get the public's reaction at these outposts and watch it closely. Average conditions will take care of themselves.

The big idea is to seek out the very dumb public in order to obtain the wisest criticisms and suggestions.

[1] *To be taken literally—Ed.*

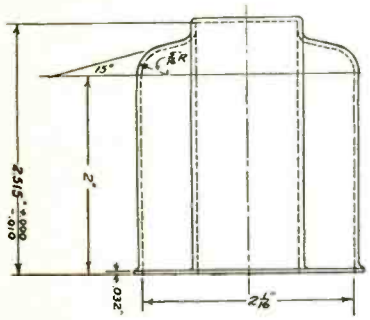
Special Steel for Deep-Drawn Transformer Housings*

Use of a Special Forged Steel Cuts Time Loss, Reduces Spoilage and Increases Production

SPECIAL forged steel sheets are making a remarkable showing at the plant of Paul & Beekman Manufacturing Company. Radio transformer housings of this steel are costing at least $13.61 less per thousand than with the best competing steel available for such work due to the fact that the sheets used permit faster press operation, reduce die maintenance by about 85 per cent and cut spoilage losses 85 per cent. The total saving creditable to the use of this steel is about $3,400 per year and the exclusive use of this special material—at the rate of more than 90,000 pounds annually for transformer housings alone—appears soundly justified in view of the results obtained.

Drawing Operations

The drawing of the transformer housing is considered the most difficult job of its kind ever handled by the Paul & Beekman Company. A sketch of the finished piece, shown in Fig 1, clearly indicates the nature of the problem. The specifications call for absolutely flat surfaces, free from alligator marks or orange-peel effect,



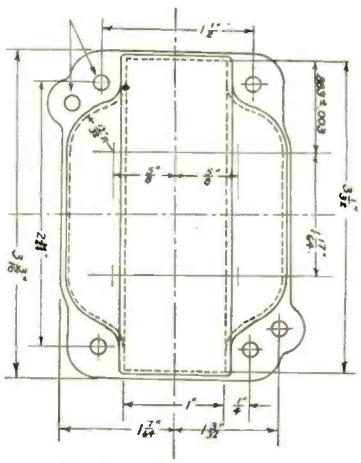
important dimensions within .003-inch of those shown, and inside corners of the rectangular central section absolutely square.

The stock used for this housing is of 22 gauge (.032-in.) It is supplied to the presses in strips 6½ inches wide and 6 to 10 feet long. The drawing lubricant, a 1:2 mixture of Refrigerant Base and Draw Easy compound (Fidelity Chemical Company), is applied with a brush prior to each of the first three operations.

The first operation requires a 70-ton double-acting press. The product is a straight-sided elliptical cup about 3x 3¾ inches in plan and 2½ inches in maximum depth. The outlines of what is to be the rectangular central section are clearly defined at this stage and the cup bottom is turned up at an angle of approximately 30 degrees on either side of this section.

The second operation changes the ellipse to an eight-sided figure, deepens the cup slightly and begins the formation of the flanges. This requires a 50-ton single-acting press.

The third operation merely notches the shell at the ends to permit flattening the flange along the sides. This portion of the work could have been



Specifications of deep-drawn transformer housing referred to.

handled as a part of the second operation, reducing the total from six operations to five, if the second dies had a suitable cutting ring.

The fourth operation gives the third actual drawing on a 40-ton single-acting press. This leaves the housing close to its final form with flanges considerably pressed out but not yet flat.

The fifth and sixth operations give the finishing touches, flattening the flanges, trimming the corner lugs to final shape and punching the mounting holes. The fifth operation requires a 40- and the sixth a 25-ton single-acting press.

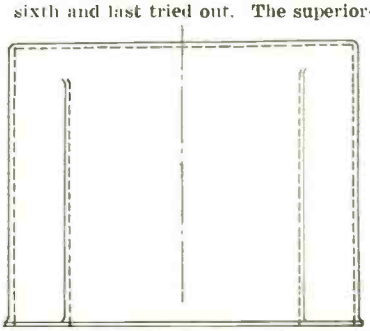
Experience With Various Steels

The selection of the steel for this housing climaxed two months of careful experiment with sheet stock of five other kinds. Three brands of cold rolled strip and one brand of cold rolled sheet gave approximately the same result. It seemed impossible to avoid breaking out at the corners and about 50 per cent of the housings were spoiled in this way before they got through the second operation. It was found necessary to provide a surplus of material throughout the preliminary drawing operations in order that the final form might show a sufficient excess of stock to produce a smooth effect. Even this failed to give the desired results, however, and it was evident that the trial must be carried further.

The fifth material tried was a lamp body stock and results were considerably bettered. Spoilage sometimes reached 40 per cent but was usually not much over 25 per cent and it would have been possible to produce the housings from this steel if no better material was found. The principal reason for continuing the search was the fact that steel shavings gathered on the dies and caused serious scoring of subsequent pieces. Projections begun in this way built up rapidly on the dies, as more shavings adhered at the same spot, and ultimately formed warts which began to ruin housings at every stroke of the presses.

Results Obtained

The special steel sheets were the sixth and last tried out. The superior-



ity of the material was evidenced at once in several ways and the results obtained fully justify the wide use of this steel at the present time.

Production was immediately increased on the first, fourth and sixth operations. The following tabulation shows the average outputs now obtained with the special steel in comparison with the corresponding figures for a comparable run on the lamp body stock formerly used (See page 48).

Total press time was thus reduced from 19.04 to 17.27 hours per thousand completed housings, a saving of 1.77 press hours per thousand (9.3%) which is worth not less than $3.54 at this company's average press labor and equipment cost of $2.00 per hour.

Die maintenance was markedly reduced by the introduction of the

**A survey made by the A. C. Nielsen Co., Engineers, of Draworite forged steel sheets furnished by Follansbee Brothers Co., of Pittsburgh.*

Operation	Press	Output—Pieces per Hour Lamp Body Stock	Special Steel	Increases
First	70-ton DA	500	700	40%
Second	50-ton SA	335	335	.....
Third	15-ton SA	305	305	.....
Fourth	40-ton SA	355	400	12.7%
Fifth	40-ton SA	325	325	.....
Sixth	25-ton SA	205	250	22%

special steel. The stoning of dies to remove projecting accumulations of shavings on the first three sets now requires a ½-hour shut-down after each 3,000 impressions. The work is not difficult and is done satisfactorily by the regular press operators. The same operation was required after each 500 impressions with the lamp body stock formerly used. The time loss for die work has thus been cut from 1 hour to 1/6 hour per thousand housings (83%) on each of the first three presses. The total saving is 2.5 press hours per thousand and there is no longer any danger of costly production tieups.

Spoilage has been greatly reduced. The minimum loss during the few runs with the lamp body stock was 25% of the good pieces produced whereas the average figure now is 3.75 per cent. The use of the special steel has thus cut spoilage 85 per cent.

Savings Effected

The lamp body stock was not in service long enough to establish its production, die upkeep and spoilage figures to a high degree of accuracy. The work was under fairly close observation, however, and the table shown herewith may be taken as a good approximation of the savings effected by the use of the special steel.

The saving of labor and press time has already been mentioned— .57-hour per thousand housings. On the first operation, .32-hour on the fourth and .88-hour on the sixth—a total of 1.77 press hours worth not less than $3.54 per thousand.

The reduction of time loss for die stoning is figured on the same unit basis—$2.00 per press hour to cover the operator's labor and the idle time on the equipment. The net gain on this item is shown as $5.01 per thousand housings.

The net loss on spoiled housings is figured at the average rate of $23.79 per thousand. The reduction of spoilage from 250 to 37.5 pieces per thousand produced is thus worth $5.06.

The total of these items is $13.61 per thousand housings. It takes 370 pounds of the steel for each thousand housings now turned out and the unit saving is thus $3.68 per hundred pounds of steel. This company's annual output of transformer housings averages 250,000 and the total saving is $3,402.50.

Fast Heater *versus* Slow Heater Cathode

Objections to Fast Heaters Removed by Special Design

*By C. F. Stromeyer**

ANYTHING new or somewhat radical in design always goes through a very trying stage of rebuff issued from those who are prone to dogma. Certainly fast heating cathodes used in -27 and -24's are having their share. To ascertain the validity of this criticism compare in detail both slow and fast heaters.

Slow Heaters

Slow heaters can be defined as those having a heater surrounded by a full-sleeve insulator which heats conductively the thermionic emitting base. It is immaterial whether coil or hairpin heaters are employed. The indirect heating method produces a large time lag—thus slow heaters. The insulators and heaters, both in manufacturing process and operating conditions, reach dangerous fusing temperatures. Fusing troubles are attributed to many of last year's -27 burn-out complaints, for the two constituents have different expansion coefficients. Something must give! The tungsten splits, opens, and finally renders the tube useless. Also, at the fusing points, the insulators become fair electrical conductors wherein a-c. leakage is impressed on the coated sleeve, considerably raising the hum and noise level. Hot insulators extended from the ends of the cathodes still further increase the noise level by discharging stray static charges, which they periodically assume.

Although slow heaters have been improved to some extent by using better insulating material and full length metal sleeves which totally shield the insulators, they are not, without question, better than fast heaters.

Fast Heaters

Cathodes whose emitting bases are directly heated by heater radiation can be classed as fast heaters. Some employ centering plug insulators at each end, but this in no way defeats radiation. If designed properly, the plugs operate comparatively cool—consequently, no fusing or static discharges are possible. Coil heaters, even at their low operating frequency, can inductively introduce a-c. on the coated sleeve; but if the coil diameter is kept small compared to the metal sleeve, this effect becomes negligible.

On the other hand, the hairpin type is free from this effect: but because of its geometric proximity, the heater must be coated with an insulating material to prevent heater-to-cathode shorts. This material is in the neighborhood of a few thousandths of an inch. No burn-out difficulties, as previously mentioned, are encountered, but hum conditions remain. If a heater does lay up against a metal sleeve, there is grave danger of an insulation breakdown, especially when the heater becomes excessively hot or a high potential difference exists between the two. In producing coated heaters, a production short test does not reveal the story. Tubes may go to the consumer with heaters completely out of alignment. Even with these difficulties, one manufacturer is successfully making a hairpin type, but he uses a special low-temperature heater.

All metals under certain conditions emit electrons. The current flow from heater to sleeve is objectionable. Common practice balances this out by biasing the metal sleeve. Fast heaters in this respect are on a par with their opponents.

Life Span

By what reasoning should anyone conclude that fast heaters' life span are less when the same type of emission coating can be used on both types? The sensitivity of the coating is not effected—so no increase in temperature is necessary. The nickel base may remain the same. They can without question stand more heater voltage overload. The mechanical constructions are not necessarily weaker because the insulators are removed, for the sleeve may be supported in some other way. It may be well to mention that fast heaters do not heat instantaneously as stated in some advertisements. It is ambiguous to state their heating time without setting some standardization of measuring the lag. However, they average about twelve seconds for optimum volume under normal conditions.

* *Chief Engineer, Cable Radio Tube Corp.*

Refinement

THE many processes involved in the manufacture of Thordarson transformers show refinement such that the completed unit is more than mere copper and steel. The steel housing of a power transformer is an example of this. An uninteresting piece of flat steel is drawn with perfect precision into an intricate graceful unit of assembly. A battery of powerful presses combined with a corps of skilled mechanicians change a drab metal slab into a beautiful specimen of modern handicraft — a fit housing for the excellence of transformers by Thordarson.

THORDARSON

Transformer Specialists Since 1895

THORDARSON ELECTRIC MANUFACTURING CO.

Huron, Kingsbury and Larabee Streets, Chicago, Ill., U. S. A.

The Trend of Invention

By RICHARDS & GEIER

PATENT AND TRADE MARK ATTORNEYS 274 MADISON AVE NEW YORK CITY

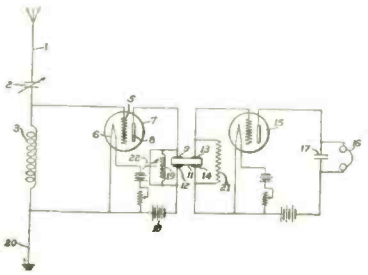
Wireless Receiving System

Max C. Batsel, of Wilkinsburg, Pennsylvania, assignor to Westinghouse Electric & Manufacturing Company, a Corporation of Pennsylvania. U. S. Patent No. 1,732,710. (*Issued October* 22, 1929.)

THIS invention relates to systems for receiving radio signals and particularly to the coupling means used for connecting successive circuits in such systems.

It is an object of this invention to make use of the characteristics of a piezo electric crystal to secure a sharply tuned coupling between such circuits.

A signal-receiving system comprising a circuit, a second circuit including an in-

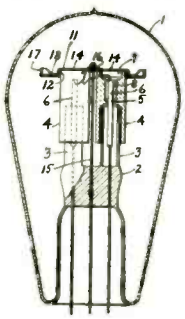


dicating device, and a coupling between said circuits, and coupling consisting solely of a piezo-electric crystal having a greater selectivity than that either of said circuits, whereby the frequency to which the receiving system will respond is determined by said coupling.

Electric Discharge Device

Louis C. Billotte, of Evreux, and Edward Lipson, of Chelsea, Massachusetts. U. S. Patent No. 1,727,956. (*Issued September* 10, 1929.)

This invention relates to electrical discharge devices of the type employing

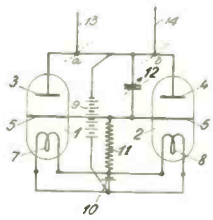


ionized gas, and more particularly to rectifiers for alternating-current.

Short-Wave Wireless Signaling

Abraham Esau, of Jena, Germany. U. S. Patent No. 1,732,556. (*Issued October* 22, 1929.)

This invention relates to an arrangement for short-wave wireless signaling comprising in combination two three-electrode vacuum tubes having anodes, controlling grid-electrodes and incandescent cathodes, leads connecting each pair of corresponding electrodes, a variable capacity interposed between points of two of said connecting leads and forming two oscillatory circuits of different natural wavelengths containing each an inherent inter-electrode capacity in series with said variable capacity and the self-inductance of the connecting leads thereof, and means to impart the generated

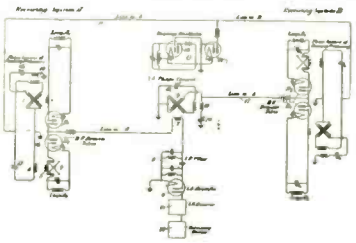


oscillations to antenna systems for the simultaneous radiation of signals on two different wavelengths.

Radio Receiving System

Augustus E. Harper, of Belfast, Maine, Assignor to American Telephone and Telegraph Company, a Corporation of New York. U. S. Patent No. 1,724,019. (*Issued August* 13, 1929.)

This invention relates to radio receiv-

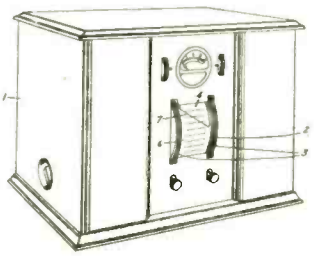


ing systems and particularly to means for improving the directional selectivity of such systems.

Indicating Device

Ralph G. Langley, of Schenectady, New York, assignor to General Electric Company, a corporation of New York. U. S. Patent No. 1,731,141. (*Issued October* 8, 1929.)

This present invention relates to indicating devices suitable for use in connection with signal receiving apparatus, and more particularly to devices which are especially



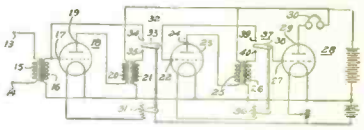
adapted for use in connection with apparatus intended for the reception of broadcast radio signals.

Amplifier System

Walter John Brown, of Eversley, England, assignor, by Mesne Assignments, to Associated Electrical Industries Limited, a British Joint-Stock Company. U. S. Patent No. 1,729,983. (*Issued October* 1, 1929.)

This invention relates to signal amplifying systems and particularly to amplifier systems having means for adjusting the degree of amplification.

In an amplifying system, a plurality of three-electrode vacuum tubes in cascade relation, cathode-rheostats, one for each tube, switches, one controlled by each rheostat and each moved to a characteristic position by the movement of the corresponding rheostat to cut-off position and connec-

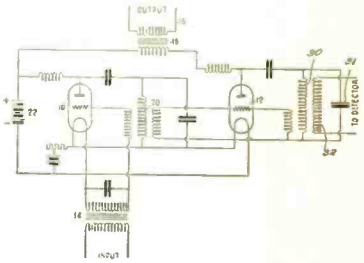


tions established by the said characteristic position of each switch between an electrode of the deenergized tube and a like electrode of another tube.

Arrangement For Audio-Frequency Amplification

Walter Schaffer, of Berlin, Germany, assignor to Gesellschaft Fur Drahtlose Telegraphie M. B. H., of Berlin, Germany, a corporation of Germany. U. S. Patent No. 1,732,031. (*Issued October* 15, 1929.)

The present invention relates to an improved arrangement for audio-frequency amplification. It comprises vacuum tubes arranged in cascade and has the important advantage that only the first and last trans-

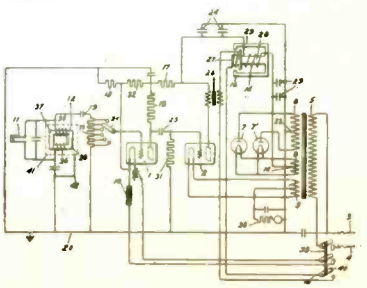


formers of the arrangement are iron core transformers, the vacuum tubes being coupled to each other by high-frequency transformers.

Amplifying System

Chester W. Rice and Edward W. Kellogg, of Schenectady, New York, assignors to General Electric Company, a Corporation of New York. U. S. Patent No. 1,728,879. (*Issued September* 17, 1929.)

The present invention relates to thermionic amplifying apparatus, and especially to an apparatus which is particularly adapted to furnish an appreciable amount of power for the operation of sound-producing apparatus.



NEWS OF THE INDUSTRY

EDISON DISCONTINUES RECORD MANUFACTURE

Because of the many rumors and certain incorrect quotations which have been given publicity as a result of the decision of Thomas A. Edison, Inc., to discontinue commercial record manufacture, the following statement from Arthur L. Walsh, Vice President of Thomas A. Edison, Inc., Orange, N. J., is of particular interest.

Mr. Walsh's statement is as follows:

"Thomas A. Edison, Inc., has discontinued the manufacture of commercial phonograph records (including both diamond disc and needle types) in order to make available additional factories for the manufacture of radio and radio-phonograph combinations on a greatly augmented scale. This decision is the outgrowth of the unprecedented volume of orders for Edison Light-O-Matic Radios, which is more than three times our present radio manufacturing facilities.

"Mechanical phonographs, of the portable type, will continue to be manufactured and sold as heretofore.

"Naturally our withdrawal from the commercial record field is due in a large measure to the definite trend toward radio as the home entertainer. In devoting our energies to augmented radio manufacture, we call attention to the fact that the record buyer will be well served by other competent manufacturers."

ADDITION TO INCA PLANT

The construction of a large addition to the new factory of the Inca Manufacturing Corporation at Fort Wayne, Indiana, was announced recently by officials of the company. The new unit will treble the capacity of the present plant.

The general contract for the construction of the building has already been let and work is well under way. The structure will be completed shortly after the first of the year.

The new building will be 300 feet long and 200 feet wide, exactly the size of the present plant recently completed. However, the production capacity will be greatly in excess of that allowed by present facilities for the reason that considerable space is occupied by the general offices of the corporation in the first unit.

The new factory structure is being added to the eastern extremity of the present unit. The two buildings will form an architectural "whole" and give the appearance of one great building.

TRANSMITTER FOR DE FOREST RESEARCH

The DeForest Radio Company of Jersey City, N. J., has just received a license from the Federal Radio Commission for the installation of a 5-kilowatt transmitter at its Passaic plant and engineering laboratories. The transmitter will be arranged to operate on C. W., I. C. W. and 'phone. The assigned frequencies are 1604, 2398, 3256, 4795, 6425, 8650, 12850, and 17300 kilocycles, covering a very considerable range of wavelengths from the lower end of the short-wave spectrum to the top end almost within reach of the broadcast waveband.

The transmitter will be employed for research and test purposes, in keeping with the growing activities of the DeForest organization in the radio transmitting field.

NEW ADDITION TO BOSCH PLANT

Increases in sales of both radio products and precision automotive electrical products of the American Bosch Magneto Corporation of Springfield, Mass., over previous years have made necessary the erection of a substantial addition to the present plant "A" on North Main Street.

The concrete foundation has been laid, and steel work is fast shaping the new structure.

The new building is partly of saw-tooth type and partly of regular two-story construction and when completed will house the most modern of heat-treating and hardening rooms, a new sand-blasting room, a department for scrap reclaiming, store rooms for maintenance supplies, and sundry production supplies, a store room for packing and shipping materials, as well as one of the most complete and modern shipping departments in the city.

Railroad track is being laid from the Boston & Maine tracks, into the yard and up to a modern loading platform adjacent to the new shipping room. Space for a considerable number of freight cars is provided.

The building is modern to the last word, with steel frame work fabricated in Springfield, walls of yellow brick, and Fenestra steel window sash, and fireproof tar and gravel roof. Modern unit type heaters take the place of radiators and provide uniform heat, and increase the health factor. The interior of the building is to be finished in mill white and an abundance of natural daylight will be augmented when necessary by the latest type of electric lighting. Modern ventilating system will insure a constant change of air.

Another new and smaller building has just been completed by Bosch to house oil and paint supplies.

Both new buildings have been laid out and planned in detail by Bosch engineers.

It is expected that the new building will be ready for occupancy before the end of the present year.

"Listen here, United Electric, my radio is for alternating current—do you know you're supplying me with direct current!"

(From an Illustration by Alan Dunn in "The New Yorker")

STROMBERG-CARLSON EXTENDS OLD LEASE

The large volume of business that is flowing to the Stromberg-Carlson Telephone Mfg. Co., at Rochester, New York, has necessitated the postponement of the relinquishment of the old plant and a lease on the property for another year has been signed.

The purchase of fifteen additional acres of land, adjoining the new plant, has been announced by officials of Stromberg-Carlson Company. This addition is west of the new plant and is ideally situated, as it is along the side track of the New York Central Railroad, which serves Stromberg-Carlson. The purchase of this land brings the total number of acres owned by Stromberg-Carlson to 43, all of which are located at the new factory.

At present the company is using the new plant, which measures 625 x 460 feet and covers approximately 360,000 square feet of floor space and also the old factory which covers 100,000 square feet.

F. GOAT CO. EXPANDS

The Fred Goat Co., Inc., Brooklyn, who have been manufacturing standard and special radio tube parts for the past year or so, have experienced such an increase in this portion of the business that, although the present factory on Dean Street has a capacity of eighty men, it has become necessary to expand.

Accordingly, a new manufacturing plant has been established at the Bush Terminal, where the production of tube parts is being concentrated. Also, a new company has been formed for this portion of the business, under the name of Goat Radio Tube Parts, Inc.

The success of the Goat concern is due to a combination of business men, production engineers, toolmakers and other mechanics who for many years have specialized in the design and production of stamped and formed parts, and which enables them to attain a degree of accuracy and uniformity that was welcomed by radio tube manufacturers.

Mr. Edward F. Staver, Secretary of the new company, says the establishment of the new plant has been accomplished without the slightest interruption in production. Indeed, he attributes the rapid growth of this business in large part to his company's ability to meet promptly the heaviest and most sudden demands for tube parts.

VAN HORNE OPENS CHICAGO OFFICE

In order to serve their trade to better advantage, the pioneer firm of Van Horne Tube Company has opened an office and warehouse in Chicago, from which point all adjoining territory will be served. This will permit 24-hour service to all the important markets of the United States, eastern accounts being shipped from Franklin, Ohio, and the western from Chicago.

The Chicago address will be at 108 West Lake Street. Telephones, Franklin 9708-9709.

H. L. CROWLEY & CO. IN NEW PLANT

Henry L. Crowley & Company, manufacturers of Crolite, an insulating material widely employed in the radio and electrical field, announce the purchase of a new plant located at 1 Central Avenue, West Orange, N. J. The old plant in East Orange is being dismantled, and the new one will be in operation by December 1st, 1929, according to Henry L. Crowley, President of the company. There are 32,000 square feet of space at the West Orange factory, which will accommodate the offices, laboratory, shipping department and production plant proper, all under one roof.

A new note has been struck in factory interior decoration in the Crowley plant. The main part of the building, where the female employees work, has been entirely finished in tile. The floor is of flat red, and the walls of glazed white tile. This, in addition to the numerous skylights, and entire upper sidewalls of glass, makes an exceedingly cheerful and hygienic place to work. All of the dust-producing activities incidental to the manufacture of Crolite, have been confined to another room in the building.

MARVIN UNIFICATION PLAN AIMS AT CENTRALIZED CONTROL

Appreciating the fact that lack of co-ordination is the bane of mergers, the Marvin Radio Tube Corporation, of Irvington, N. J., has undertaken a program of unification with a view to maintaining complete control of all company activities at the key plant in Irvington, N. J.

"When the merger of six independent companies was consummated some time ago, and the Marvin Radio Tube Corporation came into being," states F. A. LaBaw, General Sales Manager, "it was planned gradually to concentrate all production facilities under one roof. The demand for tubes was so great at that time, however, that it was found impossible to effect any change without serious loss. Consequently, the six plants, located in Newark, Irvington and Chicago, were kept in operation. This necessitated the establishment of an independent laboratory for the benefit of all six plants, as well as an independent sales organization. The loss of efficiency entailed by such an arrangement will be readily appreciated.

"With the recent return to normalcy of the radio production situation, radio manufacturers everywhere are now finding time to do the long neglected things that were sidetracked during the production field-day," continues Mr. LaBaw, "and the Marvin organization has been able to start its unification program. The sales offices, previously at 225 Broadway, New York City, as well as the independent laboratory, have been moved to the Irvington plant, 76 Coit St., Irvington, N. J. This is being followed by the concentration at all manufacturing facilities, which will eventually be assembled here in Irvington."

SPEED NOW OPERATES FIVE COMPLETE PLANTS

The Cable Radio Tube Corporation, with offices and main factory building at 84-90 N. Ninth St., Brooklyn, N. Y., has had to expand into four more factories in order to keep production at the same high peak as sales.

The main Speed Tube factory is still located in the Greenpoint section of Brooklyn, and is operating at capacity; across the street at 9th St. & Wythe Avenue is located Plant No. 2; a new plant has been set up at North Ninth & Roebling Streets; Plant No. 4 is the Wyckoff Corporation; in Newark, N. J., is the 5th plant, formerly the Tubecraft Corporation.

This unparalleled expansion is not over yet. Speed executives letting fall a hint that further news of a "growth" nature would be forthcoming shortly.

ANOTHER NEW SYLVANIA FACTORY

Another new plant—in step with the constantly growing demand for the product—has been completed at Sylvania's home town, Emporium, Pennsylvania, and is in full operation for Sylvania Radio Tubes.

The newest factory building of concrete, brick and steel, to be known as Number One, dwarfs the other members of Sylvania's productive family, being more than three times the size of the huge Sylvania Screen Grid plant at Lock Haven.

Three stories in height, with over 100,000 square feet of space, this latest physical adjunct of the Production Department houses a thousand employees. Begun only in June of this year, the plant today is complete, and manufacturing 45,000 tubes a day.

There is not a post in the working space of any of the three floors. The newest of production and test equipment has been installed, many of them developments of Sylvania's own engineering division.

An ingenious conveyor system has been devised, an employees' restaurant included, and a fully equipped hospital bay provided for.

High ceilings, wide steel windows, and a new type ventilating-heating system assure maximum comfort for the army of Sylvania employees.

NEW WESTERN DISTRIBUTOR AND FABRICATOR OF LAMINATED TEXTOLITE

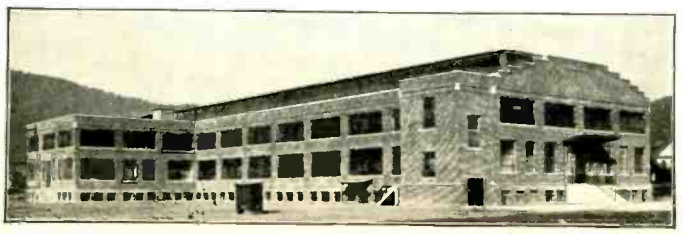
The Electrical Insulation Corporation announces through its General Manager, Mr. E. W. Patterson, that it has been appointed western distributors and fabricators of Laminated Textolite, the well-known General Electric product. For the convenience of electrical manufacturers and engineers of the west, their offices are located at Chicago, 308 W. Washington Street, with main fabricating plant at Crystal Lake, Illinois.

E. W. PATTERSON
General Manager, Electrical Insulation Corp.

Their insulating product, Laminated Textolite, is used primarily for its remarkably high dielectric strength, coupled with its resistance to acid, its non-absorptive qualities, and the pleasing appearance with which it machines. Made with either base of selected paper, or with a special fabric base, it comes in standard sheet, rod and tube form, facilitating use by manufacturers. Special sizes and shapes are supplied on short notice.

The company has a well-manned staff, expert in the insulating material field. Their president, Mr. E. F. Bessey, is a veteran with many years of manufacturing experience. He has a thorough knowledge of the handling of all types of punch presses and screw machines, especially with relation to the machining of composition materials.

The general management of this enterprise is in the hands of Mr. E. W. Patterson, Vice-President of the Electrical Insulation Corporation. He is an old-timer in middle west electrical enterprise, having represented several important manufacturers in the laminated insulation field.



The new Sylvania factory, at Emporium, Pa.

NATIONAL UNION TUBE SCHOOL

The National Union Radio Corporation is sponsoring a free course of instruction in the principles, construction and operation of radio tubes to be given in a series of Friday night lectures in the New York offices of the Company, 400 Madison Ave., beginning December 6th, according to an announcement received.

Professor E. Gordon Taylor, of the Physics Department of the City College of New York, and Chief Consultant Physicist of the National Union Radio Corporation, will conduct the course which is open to radio servicemen, set engineers, technical school students, and others.

"This course has been instituted because the heads of the National Union Radio Corporation believe that those who work with radio tubes should have a complete first-hand knowledge regarding them which has heretofore been unavailable in a comprehensive form such as we are now presenting it," said Nathan Chirelstein, president.

"The course will include lectures on such subjects as: The Elementary Laws of Electrostatics and Magnetism; Electric Currents and Methods of Producing Them; Electron Emission from Various Types of Filaments; Ionization of Gases and Electrolytes; Discharge of Electricity Through a Vacuum Tube; Rectifying Tubes and Circuits for Same; Servicemen's Difficulties.

"It is believed that these lectures, together with question periods and general discussions, will give those who enroll a comprehensive picture of radio tube principles and operation which will combine both the theoretical and practical viewpoints."

ELTZ JOINS STERLING

George J. Eltz, Jr., who has been appointed manager of the radio division of the Sterling Manufacturing Co., is a real radio pioneer. He became interested in radio as early as 1904 and in 1907 founded the Radio Club of America.

In 1914 Eltz was appointed research engineer of the Western Electric Co., devoting his time to the company's transatlantic telephone experiments from New York to Paris. During the World War he was in charge of naval aircraft radio in the United States and England and also served on Admiral Sims' staff in England. After the war he returned to the Western Electric.

ABBOTT WITH PHILCO

Curtiss Abbott, formerly General Sales Manager of the Eveready Radio Corp., is en route to California to assume his new duties as Manager of the Pacific Northwest territory for Philco. Mr. Abbott is well known on the Pacific Coast and his addition to the Philco staff has been most favorably commented upon by the established Philco representatives in that section.

TEMPLE RETAINS BROWNING

The Temple Corporation of Chicago has retained Glen Browning, of the firm of Browing-Drake, to work on special problems relating to future radio development, according to an announcement by Paul G. Andres, vice-president in charge of engineering.

The Temple Corporation, under the direction of Prof. Andres as chief engineer, has nineteen college graduate engineers in the permanent staff of its development and research department as well as a number of other men of outstanding ability on its consulting staff.

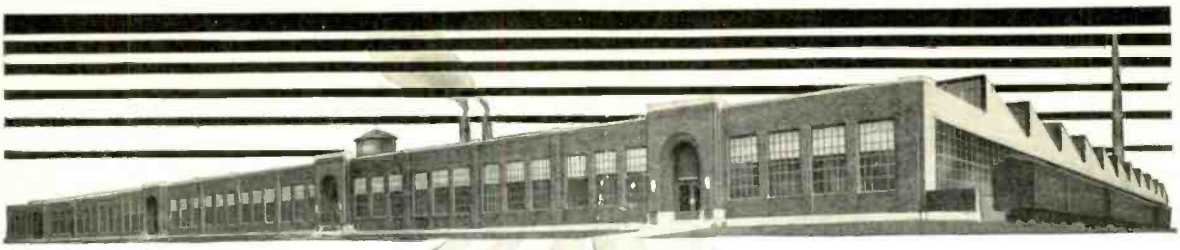
POLYMET EARNINGS

The Polymet Manufacturing Corporation, of 829 East 134th St., New York City, Easton, Pa., and Winstead, Ct., announce earnings of $2.02 per share for the first quarter on the outstanding 180,000 shares capital stock of the company.

This compares with 50 cents per share earned in the corresponding quarter of the last fiscal year, Nov. 1st, 1927 to Oct. 31st, 1928.

Net sales for the last quarter, August 1st to October 31st, were $1,739,352.86; profits before deduction of taxes and depreciation were $423,179.10; net profits after deduction of all taxes and depreciation were $363,019.18.

These figures place Polymet in new high ground, quadrupling net profits for the previous fiscal year, which were $89,659.34 after deduction for taxes and depreciation.



Large addition trebling plant capacity under construction

INCA

A REMARKABLE RECORD!

GREAT FACTORY COMPLETED
PRODUCTION AT FULL SPEED
EXPANSION NOW UNDER WAY
WILL TREBLE PLANT CAPACITY

A MAMMOTH plant under full power of production. New machinery and equipment built exclusively for the specialized needs of the industry. Copper wire products for the radio, electrical and automotive fields manufactured with consummate skill — under management and engineering seasoned by years of experience.

That's the story of INCA — just 80 days after the first shovel of dirt was turned for the new factory. It is likely that this record, indicating as it does, matchless ability of performance, is unexcelled in industrial history.

And now comes the announcement of the construction of an addition to the factory, giving floor space and facilities that will treble INCA'S capacity of output! This tremendous expansion is possible because of the exacting and courteous service already given those who have placed their confidence in INCA — growth which competently invites the increasing demands of the trade.

Founded by GEO. A. JACOBS *and Associates*

INCA

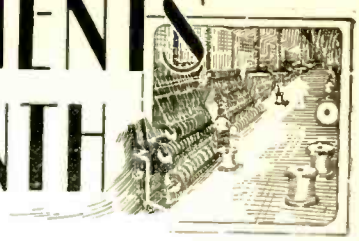
INCA: *Symbolic of the best in the copper wire industry*

INCA MANUFACTURING CORPORATION

COPPER WIRE PRODUCTS
FORT WAYNE, INDIANA

EASTERN OFFICE: NEWARK, NEW JERSEY + INDUSTRIAL OFFICE BLDG.

NEW DEVELOPMENTS OF THE MONTH



WESTINGHOUSE PRODUCTION TESTING INSTRUMENTS

The manufacture of electrical apparatus and in fact manufacturing processes in general carried out on a production basis often involved the necessity for accurate measurements of the electrical quantities involved.

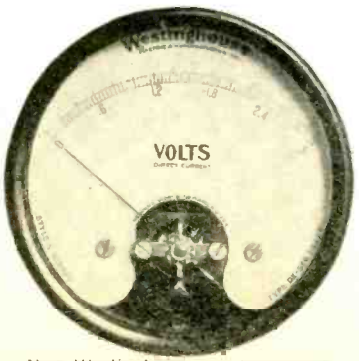
An example of this is the manufacture of radio vacuum tubes of different kinds.

The accuracy required for such measurements is in general much higher than that obtainable with ordinary panel or switchboard type instruments. For example it is well known that a slight error in the setting of the grid voltage in the testing of radio tubes will result in a very large difference in the plate current. Therefore if sufficiently close test limits are set on plate currents to assure in this respect a satisfactory tube characteristic many good tubes will be rejected in testing and many defective tubes will be accepted due to lack of sufficient instrument accuracy. Similarly a higher order of accuracy is needed for many of the other production measurements in many manufacturing processes aside from radio tubes.

Switchboard instruments are not primarily intended for close measurement work. Their principal field of application is for operating or control. The pointers are furnished with large index ends to facilitate reading at a distance and for the same reasons the division lines are made very heavy. The calibration accuracy of switchboard instruments is generally of the order of 1 to 3% allowable error. Many of the smaller types of switchboard instruments are furnished with etched printed dials resulting in variable accuracy at different scale points.

The accuracy considered essential and acceptable for switchboard instruments can be obtained without exceptional care in balancing the movement. The design of the bearings, pointers, and other parts are intended to withstand the overloads and rough usage of operating or control work rather than carrying the delicacy required for high accuracy work.

Portable instruments, however, are designed for use where greater accuracy is required. The preferable position for the use of portable instruments is horizontal and this involves practical difficulties in their application to permanent testing benches designed for speedy production testing such as in radio tubes or similar modern manufacture. It is generally the practice to mount the test sockets on the top surface of the test bench together with the switches and other controls and mount the test instruments on vertical panels at the rear of the bench in a position easily read by the operator making a self-contained outfit. This enables quick readings to be taken.



New Westinghouse panel standard d-c. voltmeter.

With large production it is desirable to specialize the test positions or benches for testing of each piece of apparatus only, therefore simplifying the connections and controls and avoiding multi-range scales on the instruments. This means that in any manufacturing plant there will be many different test outfits as there are different varieties of apparatus to be tested.

New Westinghouse panel standard milliammeter.

Unfortunately in the past there has been, as indicated above, a conflict between such test requirements and the use of switchboard type instruments which do not have sufficient accuracy for test purposes.

In order to provide a line of instruments especially intended for this class of service, instrument engineers have carefully studied the problems of testing measurements in production for large quantity production work as regards to measuring instruments and this has resulted in the design of the so-called "panel standard instruments." These were orignally intended for mass production work on vacuum tubes but are of course equally applicable to all kinds of manufacture where quick high accuracy inspection readings or tests are necessary.

Briefly the "panel standard instruments" consist of the combination of a panel or switchboard type cases and mountings into which are placed high-accuracy portable instrument mechanisms. The dial markings are hand calibrated of the fine line type enabling close readings to be taken and the calibration is performed with the same painstaking care and by the same experts that perform the calibration on the high grade portable instruments.

Therefore these instruments possess so far as possible the accuracy and qualifications of the corresponding portable types. The reservation "as far as possible" in the above statement is introduced because due to the horizontal position of the pivot in the bearings of panel mounted instruments there must of necessity be somewhat more pivot friction than in the bearings of portable instruments which are normally vertical in position. This is due to the fact that with a vertical shaft arrangement the contact between the pivot and the jewel is at the center line of the pivot, and therefore the friction works at a much shorter radius than in the case of the horizontal shaft. In horizontal shafts the end play requirement is such that the contact point between the pivot and the jewel is at the side of the pivot and therefore at a point where the effective radius is greater. Consequently, there is more friction effect.

Figures 1 and 2 clearly show the scales and pointers in two of these panel standard instruments. The scales are almost 4" long and very clearly divided. The cases however are only 4⅜" in diameter and therefore the instruments are very compact indeed, taking up the least possible space on the panel. The cases are made of heavy, soft-drawn steel, which shields the movement from external magnetic fields. A large amount of experience particularly in actual production of radio tubes has shown that this size of instrument is the best suited for general production testing purposes.

The scales are long enough to make accurate readings on the lower parts which is often necessary and yet the pointers are not too long, which would cause instability or variations in balancing due to moisture or other causes.

The happy combination of portable instrument movements and scales with switchboard cases and mountings is thought to be entirely novel and should find a large application in all kinds of testing work where the otherwise preferable horizontal position of portable instruments cannot be employed.

The general designation of "panel standard instruments" has been chosen as being both descriptive of this new type distinguishing it from "portable standard instruments" and also from the usual switchboard or panel instruments.

CECO IMPROVED TYPE 227 TUBE

The engineering department of CeCo Manufacturing Company, has just announced the CeCo 227 to replace the N27—a high vacuum detector-amplifier tube.

Its features include:

Two mica spacing members, the upper one much larger than usual.

A grid built around two supporting bars instead of the usual single bar.

Short cathode.

Shortened distance from glass stem to electrode.

Longer glass stem.

The larger upper mica separator holds both cathode and grid in positions concentric to the plate and yet permits expansion when the tube heats, without strain to cause warping. Fastened loosely at one end, its inertia has the effect of damping vibrations of the electrodes. This prevents any prolonged howl in a receiving set. Also, it limits the distance through which the support wires can bend in case the tube receives a severe shock. The two pieces of mica work together to hold electrical characteristics to a higher degree of uniformity than any previously attained.

The doubly supported grid also helps to maintain tube uniformity. The supports prevent movement of the grid in any direction. Special treatment of the grid stops electron emission, thus correcting a common cause of tone distortion.

Other improvements noted insure increased resistance to shock, longer life through cooler operation and prevention of oscillation in the average receiver.

CeCo engineers state that the tube is not offered as one of the quick heater variety.

The engineering bulletin describing the new tube further states:

"The CeCo 227 tube operates with 2.5 volts applied to the heater. The cathode sleeve should have a negative bias from 7.5 to 9 volts with respect to the heater. When used as an amplifier the grid bias should be 13.5 volts negative to the cathode and the plate voltage, 180 volts positive.

"In the detector position the tube will operate with the usual condenser and leak. Also, it will be satisfactory as a grid bias or power detector with 200 volts on the plate and 16 volts negative on the grid."

Front view of Electro-Acoustic microphone input panel.

ELECTRO-ACOUSTIC MICROPHONE INPUT PANEL

To fill the demand for microphone mixing panels, the Electro-Acoustic Products Company, 55 E. Wacker Drive, Chicago, has developed a very efficient unit which is being standardized, and is now on the market. The microphone input panel illustrated in the photograph is particularly designed for recording studios, but can also be used for public address work or wherever more than one microphone is employed in an amplifying circuit.

The microphone panel CM-4 incorporates four individual faders or mixers for four condenser microphones so that any number up to four microphones may be controlled separately or mixed together at will. Included also is a very novel feature which has proven invaluable in the case of recording studios. This is a volume indicator meter which is operated from the main amplifier volume indicator tube. By means of this meter which has a 5-inch scale, the operator can accurately control the input, and at the same time watch his talent in the studio, also making it possible to install the control apparatus remotely from the amplifying equipment.

Rear view of the microphone input panel, showing the shielding.

The unit is thoroughly shielded, the parts being mounted on a steel panel and covered by a steel can. This is absolutely essential where high amplification is used, and noiseless results are expected. Mixing controls mounted on bakelite panels frequently pick up alternating-current noise, and generator brush noises.

The mixing panel CM-4 is designed for 200-ohm input and 200-ohm output. The output impedance of the unit is always constant at 200 ohms regardless where the controls are set.

NEW DYNAMIC ON MARKET

What might well be termed a super-dynamic speaker, has just appeared on the market under the Powerizer trade mark. This new speaker, manufactured by the Radio Receptor Company of New York City, has a frequency range of from 40 to 8,000 cycles, with an effective frequency response of from 40 to 6,000 cycles, it is said. In addition to this unusual frequency range, the new speaker is guaranteed to handle 10 watts undistorted output in constant use, which guarantee is considered conservative, since the speaker has been operated with as high as 30 watts undistorted output, without signs of distress.

A NEW INSULATOR FOR A-C. TUBES

In pure magnesia, extruded from dies for the proper crossection and cut to the desired length while in the plastic state, followed by firing at a temperature 700 degrees Fahrenheit, higher than has ever been applied before to this kind of material, the tube industry has found a new and satisfactory insulator. This new Crolite formula, developed by Henry L. Crowley & Company of West Orange, N. J., is now utilized in the form of heater tubing by certain radio tube manufacturers, with excellent results. For instance, tubes with pure magnesia tubing withstand an overload of 8 volts on the filament, without disasterous results. With six volts on the filament, tubes have operated for 25 hours. Tubes operated at 4 volts instead of the usual 2½ have enjoyed a life in excess of 500 hours. These overloaded or accelerated life tests indicate that tubes with the magnesia insulator should last for several thousand hours, and even beyond 5000 hours.

A characteristic of the pure magnesia insulator is that it will positively not fuse with the filament wire, regardless of applied voltage or heat. The average a-c. tube at present has an insulator body which combines with the filament, through fusion, and, when the insulator and filament cool off and contract at different rates, the filament wire is snapped, causing a premature burnout.

DE FOREST ANNOUNCES TRANSMITTING TUBES

In addition to the complete line of audions for every broadcast reception purpose, the DeForest Radio Company of Jersey City, N. J., now announces a comprehensive line of transmitting audions as follows:

		Price
Type 510	15-watt Oscillator	$9.00
503A	50-watt Oscillator	40.00
511	50-watt Modulator	40.00
545	50-watt Amplifier	40.00
500	500-watt Oscillator	130.00
520B	5-kilowatt water-cooled tube	250.00

Other transmitting audions are being placed in production, such as higher-power oscillators and mercury rectifiers, as well as various sizes of screen-grid, general-purpose audions.

The DeForest transmitting audions are sold by the factory to consumer direct, and at the above net prices.

NEW MICROPHONE AMPLIFIERS

The Radio Receptor Company of 106 Seventh Avenue, New York City, has just introduced a new microphone amplifier for portable or stationary use in public address and similar systems. This amplifier is being produced in two types, namely, one for a-c. operation, and the other for battery operation. The battery type employs two tubes, and has an output of approximately .35 watt. The a-c. amplifier employs two -27 tubes and an -80 rectifier, with an output of approximately .45 watt. The amplifier is built as a single, independent unit, but is so constructed as to permit of rack mounting, if so desired.

STEVENS-SIBLEY ELECTRIC PHONOGRAPH MOTOR

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

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

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

STEVENS PORTABLE A-C. AND BATTERY PHONOGRAPH

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

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

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

AN ALL-PURPOSE AMPLIFIER PANEL FOR SCHOOLS

The requirements of the educational institution differ radically from those of other public places when it comes to sound-reproducing installations, according to Ludwig Arnson, Vice-President of the Radio Receptor Company of New York. Whereas the restaurant, dance hall, stadium and other applications continually reproduce the same type of program and generally from the same source, the school reproduces a variety of subjects from many different parts of the building. For this reason, the school or educational installation must be far more flexible than the usual installation, if it is to prove of maximum worth.

The Radio Receptor Company has just perfected an all-purpose amplifier panel, especially designed for school and similar educational applications. The panel board includes a radio set, a three-position microphone and mixer, a switch panel, a volume control panel, a microphone amplifier, and two power amplifier panels. This installation makes it possible for the principal of the school to address the entire school. Visiting speakers may likewise be heard throughout the building as well as in the auditorium. Educational and similar features may be picked up by radio. Recorded music is available by means of a phonograph pickup. The switching panel makes it possible to employ all three mediums simultaneously, changing from one to the other by means of a single three-position switch.

NEW RADIO RECEPTOR MICROPHONES

The Radio Receptor Company of 106 Seventh Avenue, New York City, announces a new line of microphones for public-address and sound reproduction purposes. These microphones have been designed primarily for use in conjunction with Powerizer sound amplifying systems. The possibilities of their universal use have been fully appreciated, however, and they have, therefore, been placed on the market.

There are three types of microphones in this new line, namely, a 3½-inch, a 6-inch and a hand microphone for portable use. The hand microphone is enclosed in a bronze case with bakelite handle. These microphones have been developed especially for public-address purposes, and incorporate a number of features that make them particularly desirable in this field. The construction includes a special alloy diaphragm that has no fundamental period of its own. There is also a special composition carbon button that positively cannot "pack." This feature is particularly desirable in public-address apparatus where the microphones are generally located far from the home "Lab," and must consequently perform satisfactorily over long periods of time without attention.

Televocal
Quality Tubes

QUICK HEATING

Instantaneous — no — but close to it. And the programs come in clear as a bell, and free from all hum, crackle or buzz. Tremendous undistorted volume — more than you need — producing an unequalled fidelity of tone, even under a full load.

Incredible sensitivity with hair-line selectivity, giving accurate and natural reproductions of programs from stations never heard before.

Sturdy and rugged construction, built to withstand the shocks and knocks of every-day use.

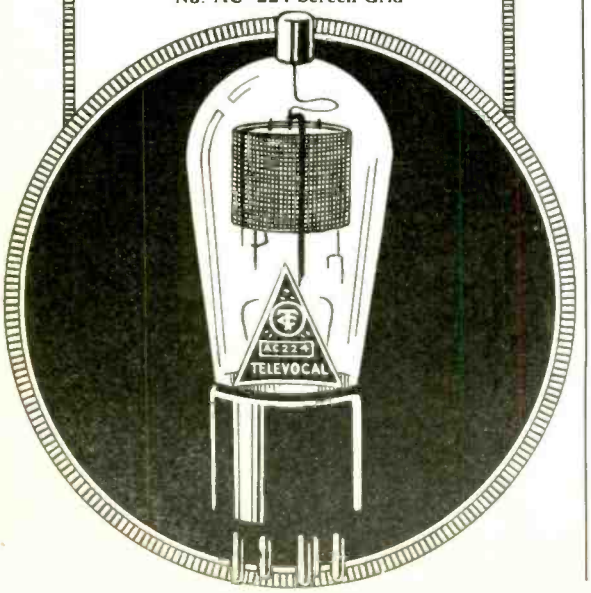
Televocal Tubes are standard equipment with many leading set manufacturers, and progressive dealers have learned that sales are quicker and easier with Televocals in their sets.

All Televocals are absolutely uniform. Endless tests and inspections insure their high standard of quality and make them all twins.

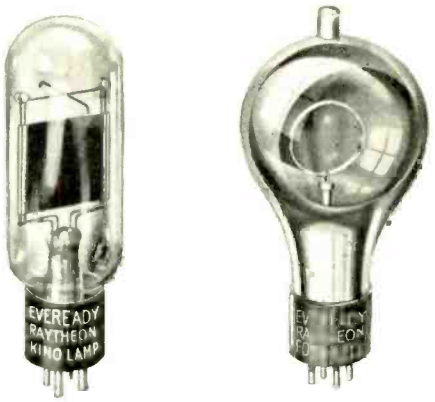
Televocal Tubes are made in all standard types.

National Union Radio Corporation
Televocal Division, Dept C-1
400 Madison Ave., New York City

No. AC 224 Screen Grid



HIGH-QUALITY, DEPENDABLE TUBES FOR
TALKING PICTURES AND TELEVISION



EVEREADY Raytheon Television Tubes are the result of our extensive research and experience in this new science. Their construction is along the same advanced lines which give all Eveready Raytheon Tubes their well-known superior performance.

The Eveready Raytheon Foto-Cell is a long-life, sensitive, quick-response transmitting tube for talking pictures. Used also in television. It is made in several types for different requirements. Foto-Cells to special specifications will be made at reasonable prices.

The Eveready Raytheon Kino-Lamp for television reception is the first tube developed commercially which will work with all systems. Uniform glow over the entire plate, perfect reproductive qualities without the need of mirrors or ground glass, tested performance . . . are features which make this tube outstanding.

Correspondence is invited from every one interested in television and talking pictures.

NATIONAL CARBON COMPANY, INC.
General Offices: New York, N. Y.
Unit of Union Carbide UCC *and Carbon Corporation*

EVEREADY RAYTHEON
Trade-marks

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 74

ADAPTERS:
Lynch, Arthur H., Inc.

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

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

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

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

ARRESTERS, LIGHTNING:
Jewell Elec. Inst. Co.

BASES, VACUUM TUBE:
Formica Insulation Co.
General Electric Co.
General Plastics Co.
National Vulcanized Fibre Co.
Synthane Corp.

BAFFLES:
Wright-DeCoster, Inc.

BATTERY COMPOUNDS:
Mitchell Rand Mfg. Co.

BEARINGS, RADIALL:
Chicago Gear Works

BENCHES, STEEL WORK:
Standard Pressed Steel Co.

BINDING POSTS:
General Radio Co.

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

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

BROADCAST STATION EQUIPT:
Cardwell, Allen D., Mfg. Co.
Ferranti, Inc.
General Radio Co.
Jenkins & Adair, Inc.

BUTTS:
Scovill Mfg. Co.

CABINETS, METAL:
Aluminum Co. of America

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

CEMENT, LOUD SPEAKER:
Maas & Waldstein Co.

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

CHARGERS:
Elkon Co.

CHASSES
Aluminum Co. of America
United Scientific Laboratories, Inc.

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

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

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

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

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

COIL FORMS:
General Radio Co.

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

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

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

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

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

COILS, RADIO FREQUENCY:
General Mfg. Co.

COILS, RETARD:
Hammarlund Mfg. Co.

COILS, SCREEN GRID:
General Mfg. Co.

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

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

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

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

CONDENSERS, EQUALIZING:
Hammarlund Mfg. Co., Inc.

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.
Leslie F. Muter Co.
Polymet Mfg. Corp.
Potter Co., The
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.
Leslie F. Muter Co.
Polymet Mfg. Corp.
Potter Co., The
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:
Hammarlund Mfg. Co., Inc.
Polymet Mfg. Corp.

CONDENSERS TRANSMITTING:
Dubilier Condenser Mfg. Co.

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

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

CONNECTORS:
Scovill Mfg. Co.

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

CONTROLS, ILLUMINATED:
Hammarlund Mfg. Co.

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

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

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

COPPER:
Baltimore Brass Co.
Scovill Mfg. Co.

COPPER WIRE, BARE:
Spargo Wire Company

COPPER WIRE TINNED:
Spargo Wire Company

CORD CONNECTORS:
Rodale Mfg. Co.

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

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

CURRENT CONTROLS, AUTOMATIC:
Radiall Co.

CUSHIONS, SPEAKERS:
Western Felt Co.

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

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

DIE-CASTINGS:
Allied Die-Casting Corp.

DIES:
Willor Mfg. Corp.

DYNAMOTORS:
Electric Specialty Co

ENGINEERS, CONSULTING:
Allied Engineering Institute

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

EXPORT:
Ad. Auriema, Inc.

FELT, ACOUSTICAL:
Western Felt Co.

FELT, PACKING:
Western Felt Co.

FILAMENTS:
Callite Products Co., Inc.
Fansteel Products Co., Inc.
Gilby Wire Co.
National-Harris Wire Co.
Radio Prod. Corp.

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

FOIL, ALUMINUM:
Aluminum Co. of America

FOIL, ZINC:
Lehmaier, Schwartz & Co.

FRICTION TAPES:
Mitchell Rand Mfg. Co.

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

GEARS:
Chicago Gear Works

GENERATORS:
Electric Specialty Co.
Janette Mfg. Co.

GETTER MATERIAL:
Gilby Wire Co.
National-Harris Wire Co.
Radio Products Corp.

GRID LEAKS:
Aerovox Wireless Corpn.
Allen-Bradley Co.
DeJur-Amsco Co.
Electrad, Inc.
Electro Motive Eng. Co.
Hardwick, Hindle, Inc.
International Resistance Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Shallcross Mfg. Co.
Ward Leonard Elec. Co.

HEADPHONES:
Amplion Co. of Amer.

HINGES:
Scovill Mfg. Co.

HORNS:
Amplion Co. of Amer.
Best Mfg Co.
Magnavox Co.
Oxford Radio Corp.

INDUCTANCES, TRANSMITTING:
General Radio Co.

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

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

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

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

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

JACKS, TIP:
Carter Radio Co.

KITS, BROADCAST:
Hammarlund Mfg. Co., Inc.

KITS SHORT WAVE:
Hammarlund Mfg. Co., Inc.
Lynch Mfg. Co., Inc.

KITS, TELEVISION:
Lynch Mfg. Co., Inc.

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

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

LACQUER, WOOD:
Maas & Waldstein Co.

LACQUER, METAL:
Maas & Waldstein Co.

LACQUER, ENAMEL:
Maas & Waldstein Co.

LAMINATIONS:
Lamination Stamping Co.
Willor Mfg. Corp.

LAMPS, MINIATURE:
National Carbon Co., Inc.

LAMPS, PANEL:
National Carbon Co., Inc.

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

LEAD-INS:
Electrad, Inc.

LOCK WASHERS:
Shakeproof Lock Washer Co

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

MACHINERY, COIL WINDING:
American Safety Table Co.

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

MACHINES, SPECIAL
Willor Mfg. Corp.

MAGNESIUM:
Aluminum Co. of America.

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

MERCURY SWITCHES:
(See Switches)

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

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

MOLDING MATERIALS
Bakelite Corp.
Formica Insulation Co.
General Electric Co.
General Plastics Co.
National Vulcanized Fibre Co.
Synthane Corp.

MOTORS:
Electric Specialty Co.

MOTOR-GENERATORS:
Electric Specialty Co.

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

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

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

NUTS:
Shakeproof Lock Washer Co.

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

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

OSCILLOSCOPE:
The Beltone Corp., Ltd.

PACKING PADS, CABINET:
Western Felt Co.

PACKING MATERIAL:
Holed-Tite Packing, Inc.

PANELS, COMPOSITION:
Electrical Insulation Corp.
Formica Insulation Co.
Synthane Corp.

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

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

PAPER, CONE SPEAKER:
Seymour Co.

PARTS, SCREW MACHINE:
Standard Pressed Steel Co.

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

PHONOGRAPH MOTORS:
(See Motors)

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

PHOTOELECTRIC CELLS:
(See Cells)

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

PLATES, OUTLET:
Carter Radio Co

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

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

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

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

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

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

Kodel Radio Corp.
Lynch, Arthur H., Inc.
National Co., Inc.
Nelson, I. R., Co.
Polymet Mfg. Corp.
Powrad, Inc.
Thordarson Electric Mfg. Co.
Transformer Co. of Amer.

PRESSINGS:
Scovill Mfg. Co.

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

PULLEYS:
Chicago Gear Works

PUMPS, HIGH VACUUM:
Arrow Mfg. & Machine Co., Inc.
Central Scientific Co.
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Kodel Elec. & Mfg. Co.

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

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

REPRODUCERS, TALKING MOTION PICTURES:
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RESISTANCES, FIXED:
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Central Radio Laboratories
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DeJur-Amsco Co.
Electrad, Inc.
Electro-Motive Co
Ferranti, Inc.
Frost, Herbert H.
General Electric Co.
Hardwick, Hindle Inc.
International Resistance Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.

RESISTANCES, VARIABLE:
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Clarostat Mfg. Co.
Electrad, Inc.
Electro-Motive Co.
Frost, Herbert H.
General Electric Co.
Hardwick, Hindle, Inc.
International Resistance Co.
Lynch, Arthur H., Inc.
Polymet Mfg. Corp.
Shallcross Mfg. Co.

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Central Radio Laboratories
DeJur-Amsco Co.
Electrad, Inc.
Electro-Motive Co.
Frost, Herbert H.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories

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Standard Pressed Steel Co.
Synthane Corp.

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Mitchell Rand Mfg. Co.

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Hammarlund Mfg. Co., Inc.

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Radio Products Corp.

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General Radio Co.
Hammarlund Mfg. Co., Inc.
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Lynch, Arthur H., Inc.
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Chicago Solder Co.

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Jensen Radio Mfg. Co.
Oxford Radio Corp.
Rola Co., The

SPAGHETTI:
(See Wire, Spaghetti).

SPEAKERS:
Amplion Corp. of Amer.
Electro-Acoustic Prod. Co.
Best Mfg. Co.
Jensen Radio Mfg. Co.
Magnavox Co.
Leslie F. Muter Co.
Oxford Radio Corp.
Potter Co., The
Rola Co., The
Transformer Co. of Amer.
Wright-DeCoster, Inc.

SPROCKETS:
Chicago Gear Works

STAMPINGS, METAL:
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Scovill Mfg. Co.

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General Radio Co.
National Vulcanized Fibre Co.

SWITCHES:
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Ferranti, Inc.
Rodale Mfg. Co.

SWITCHES, MERCURY:
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TABLES, STEEL WORK:
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TANTALUM:
Fansteel Products Co., Inc.

TAPES, FRICTION:
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TELEVISION PARTS:
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Clarostat Co., Inc.
Lynch, Arthur H., Inc.
Shallcross Mfg. Co.

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General Radio Co.
Jewell Electrical Inst. Co.

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

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

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

TESTING LABORATORIES:
Electrical Testing Labs.

TIN COATED METAL:
Baltimore Brass Co.

TOOL STANDS:
Standard Pressed Steel Co.

TOOLS:
Willor Mfg. Corp.

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

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

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

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

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

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

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

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

TUBE MACHINERY:
See (Machinery, Tube.)

TUBE, PACKING:
Holed-Tite Packing, Inc.

TUBE PARTS:
(See Parts, Tube.)

TUBE TESTERS:
(See Testers, Tube)

TUBES, A.C.:
Allan Mfg. Co.
Arcturus Radio Co.
Armstrong Elec. Co.
Cable Radio Tube Co.
De Forest Radio Co.
Dilco Radio Corp.
Duovac Radio Tube Co.
Gibraltar Radio Supply Co.
Hyvac Radio Tube Co.
Marvin Radio Tube Corp.
National Carbon Co., Inc.
Nat'l Union Radio Corp.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.
Triad Mfg. Co.

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Armstrong Elec. Co.
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De Forest Radio Co.
Dilco Radio Corp.
Duovac Radio Tube Co.
Gibraltar Radio Supply Co.
Hyvac Radio Tube Co.
National Carbon Co., Inc.
Nat'l Union Radio Corp.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.
Triad Mfg. Co.

TUBES, SCREEN GRID:
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Arcturus Radio Co.
Armstrong Elec. Co.
Cable Radio Tube Co.
De Forest Radio Co.
Dilco Radio Corp.
Duovac Radio Tube Co.
Gibraltar Radio Supply Co.
Hyvac Radio Tube Co.
National Carbon Co., Inc.
Nat'l Union Radio Corp.
Perryman Electric Co.
Sylvania Products Co.
Televocal Corp.
Triad Mfg. Co.

TUBES, TELEVISION
See (Cells, Photoelectric.)

TUBING, NICKEL:
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TUBING, REFRACTORY:
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TUBING, VARNISHED:
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Mitchell Rand Mfg. Co.

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

UNIVERSAL JOINTS:
Chicago Gear Works

VARNISH:
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Mitchell Rand Mfg. Co.

VOLTAGE REGULATORS:
(See Regulators)

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

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

WASHERS:
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Electrical Insulation Corp.
Scovill Mfg. Co.
Shakeproof Lock Washer Co.
Synthane Corp.

WAXES, IMPREGNATING:
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Mitchell Rand Mfg. Co.

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

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

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

WIRE BALLAST:
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Radio Wire Corp.

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

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

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

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

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

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

WIRE, MAGNET:
Acme Wire Co.
Dudlo Mfg. Corp.
Rome Wire Co.

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

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

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

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

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

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

ZINC:
St. Joseph Lead Co.

INDEX OF ADVERTISERS

The Straight and Narrow Path

YES, there is a terrible sermon to preach in radio, just as there is in affairs of religion. And the radio sermon today, with socket-power operation, is simply this:

Keep within the straight and narrow path — the 5% plus or minus limits set by tube manufacturers for the safe and sane operation of their A-C tubes. After all, tubes are made to operate with specific filament, plate and grid-bias voltages. But electric light and power companies, unfortunately, do not place much stock in such facts, and therefore, allow their line voltages to meander anywhere from 95 to 135 volts as proved by a country-wide survey. The results of straying away from the straight and narrow path of 110 volts, plus or minus 5% leeway at the utmost, are briefly as follows:

With excessively low voltage, it is virtually impossible to provide a satisfactory demonstration of a socket-power radio set. The filament, heater, plate and grid-biasing voltages are sub-normal, and the results are progressively so. Hence many sales are lost in the very territories — suburban and rural — where your enterprising dealer today is making his biggest play for business. Why kill your best markets?

With excessively high voltage, the demonstrations are brilliant, but so are the tubes which soon lose their emission, characteristics, and even their life. One of the greatest causes of bad will, bad name and bad business these days is excessive line voltage operation, which means excessive tube replacements, service calls, and general dissatisfaction. You cannot afford to take a chance on bad will, can you?

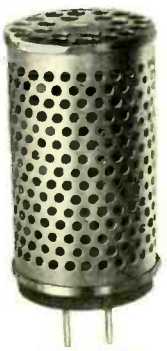
And so we urge you, as set designer, set manufacturer, or set service man, to keep within the straight and narrow path — within that 5% plus or minus voltage specified by tube manufacturers. All of which is simple enough, if you make use of the

CLAROSTAT LINE BALLAST

The perfected and inexpensive method of regulating line voltage automatically, now employed in the better type socket-power radio sets. It costs little, but saves much.

The Line Ballast Clarostat is, as above all, foolproof. There are no chemicals to spill or wear out, no glass bulb to break, no delicate filaments, nothing to play with. Simply a sturdy metal cartridge which plugs into receptacle provided in chassis. Internal details comprise sturdy brass and mica framework holding non-oxidizing wire winding. Each cartridge is designed for a specific power transformer, providing ideal automatic regulation. The device maintains a constant voltage on the primary, even though the line voltage may fluctuate between the limits of 95 and 135 volts, with the secondary voltages held to within the plus or minus 5% specified by tube manufacturers.

Compare the Line Ballast Clarostat with all other ballasts now being offered! Better still, make comparative tests! It is in a class by itself!



½ Actual Size

WRITE for technical data regarding the Line Ballast Clarostat, the improved Volume Control Clarostats, and other Clarostat radio aids. If you are a radio manufacturer or designing engineer, send us a sample power transformer, together with complete data as to primary and secondary voltages and loads, and we shall gladly submit a matched ballast for your tests.

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MEMBER RMA

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Looking Ahead in Radio Design

While your production line is turning out sets or amplifiers for this season's market your engineers are looking ahead. Decided improvements in Transformer design for the season to come is already an accomplished fact. Engineers in the Dongan Laboratories have developed innovations and refinements during the past six months which will unquestionably be accepted for the new models.

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New designs and engineering cooperation for the new models are available to any manufacturer.

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Use these Approved Parts with 245 Tubes. Send check or money order for immediate delivery.

No. 994—Power Amplifier Transformer	$12.00
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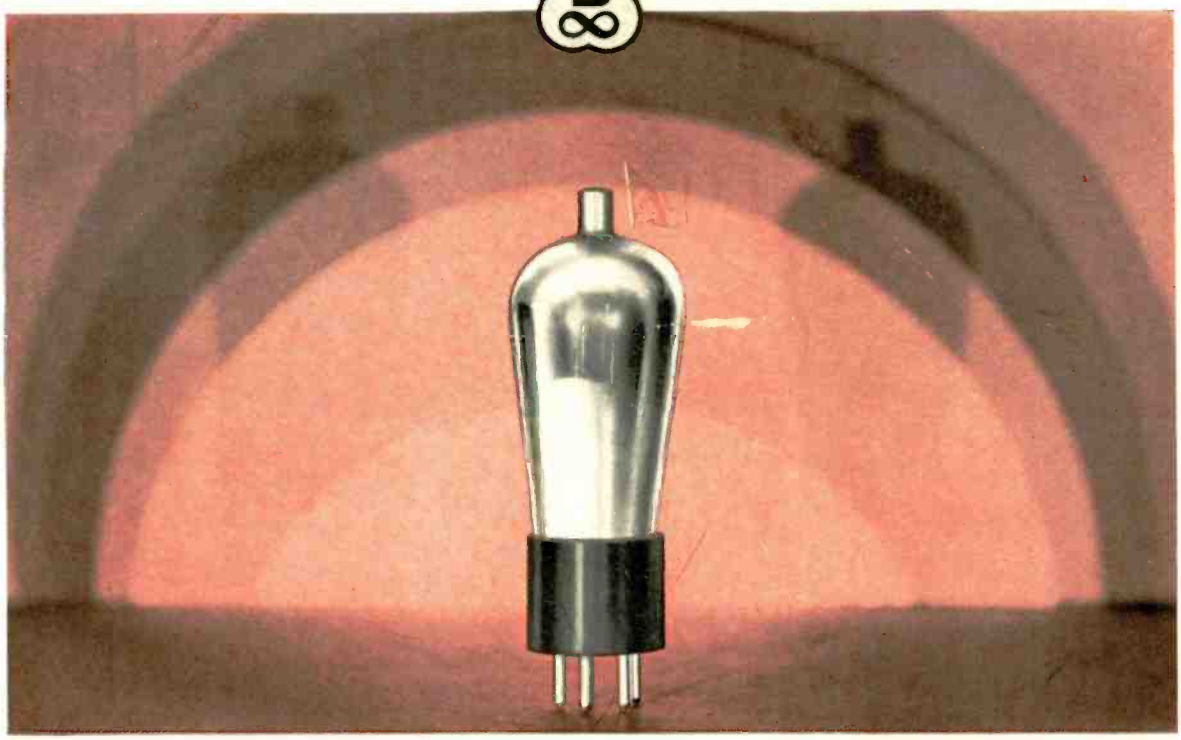

Screen grid tube, with Bakelite Molded base, made by The Sonatron Tube Co., Chicago

Bakelite Molded bases are superior for screen grid tubes too

IT IS probable that no other industry ever developed as rapidly as radio has during the past few years. Practices, and even materials, that were in common use only a few years ago are now obsolete. Bakelite Molded, however, is an exception, for it is employed in connection with practically every advance in radio design. The modern screen grid tube is an example. Bakelite Molded tube bases replaced brass and porcelain for battery tubes some years ago. When A. C. tubes, and later screen grid tubes were developed, Bakelite Molded proved equal to the need of these higher powered tubes—and continues to be the standard for tube bases. Bakelite Materials—Molded, Laminated and Varnish—have become the accepted insulations of the radio industry.

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

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