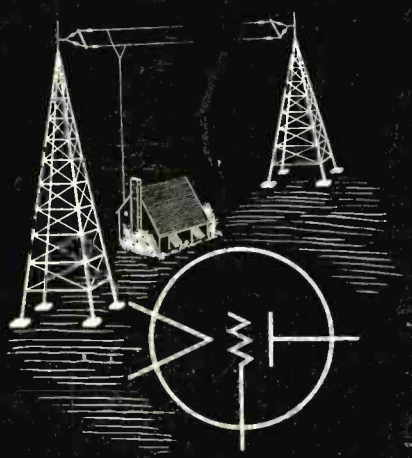
NOVEMBER, 1931

# Radio Engineering



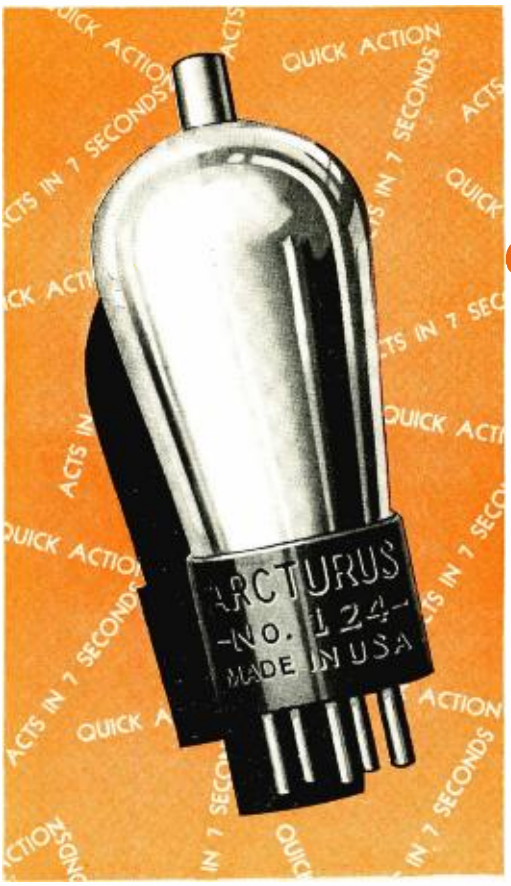
IN THIS ISSUE



ELEVENTH YEAR OF SERVICE

The Journal of The Radio Industries

# Quick Heater RECOGNITION




The quick-acting principle in a.c. tubes is now, more than ever, accorded full appreciation by set and tube manufacturers, jobbers, dealers — and, most important, consumers.

Arcturus pioneered *that* principle over three years ago, in May 1928 — with the famous 7-second action tube.

This Arcturus contribution met with immediate success as users no longer were willing to tolerate the delay in getting reception caused by the old slow-heater. The demand for quick-heaters has become so insistent that the old slow-heater type has now been relegated to an inferior classification and must of necessity be priced appreciably lower. This difference in list price is evidence that the superior merits of the quick-heater are fully appreciated.

A lower price for slow-heaters is unimportant to set users. They will not sacrifice efficiency for price. So they demand quick-acting tubes.

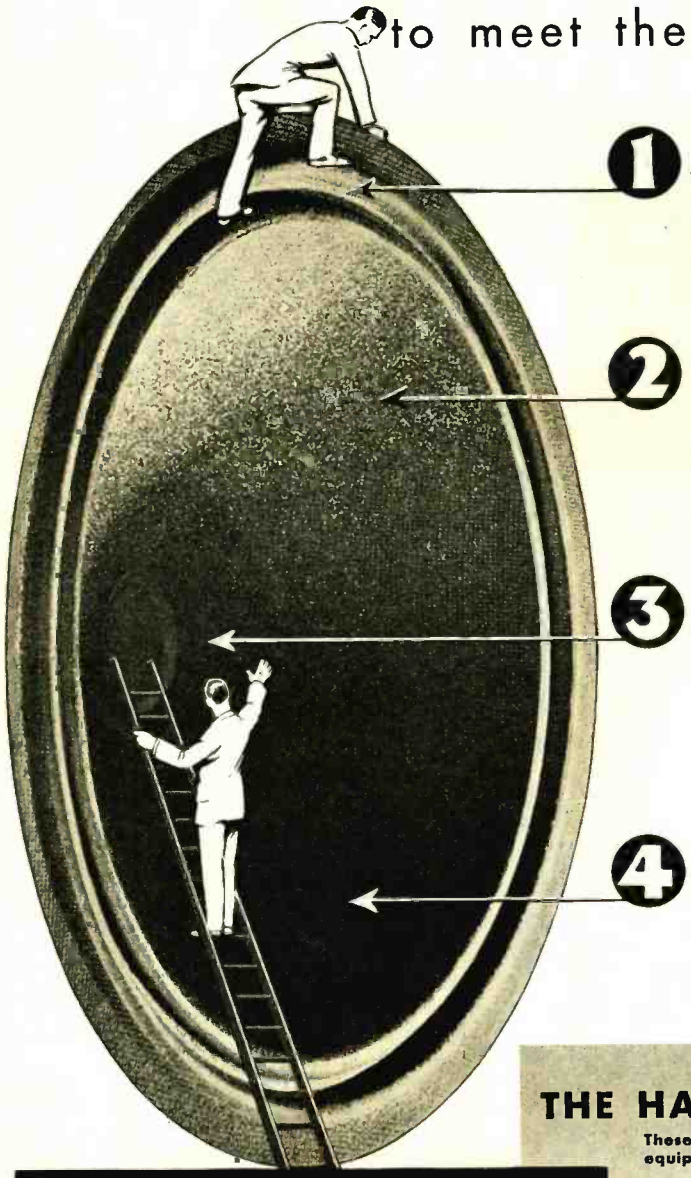
Arcturus *Blue* Tubes are all quick-acting — the same as the original "7-second tube". Arcturus quick-acting tubes are positively not affected by "hum". Arcturus quick-acting tubes have become the standard of the industry.

ARCTURUS RADIO TUBE CO., Newark, N.J.

# ARCTURUS

# Only the Hawley Process

## can produce speaker diaphragms to meet these 4 specifications



### 1 Flexibility

The most critical part of the diaphragm is the flexing ring. The Hawley one-piece moulding process produces a mounting flange, flexing ring, and diaphragm in one piece. Subsequent treatment after moulding provides extreme flexibility in the flexing ring and thus furnishes a support for the diaphragm rim which is so uniformly flexible that perfect tone quality is obtained.

### 2 Light Weight

Hawley diaphragms are moulded by the special Hawley process. The Hawley diaphragm is a marvel of light weight and great strength. The diaphragm is devoid of inherent strains. The usual tonal distortions produced by "pasted-up" diaphragms are eliminated.

### 3 Rigidity

The apex has extreme rigidity in the area surrounding the voice coil. Response to harmonics is improved and greater realism in tone quality is obtained.

### Special Design for Each Speaker

4

Hawley diaphragms are engineered and moulded to individual specifications for each speaker. Hawley acoustic engineers are at your service. Follow the example of world's leading radio manufacturers and standardize on Hawley Moulded Diaphragms. Submit your specifications for a Hawley quotation, today.

## THE HAWLEY HALL OF FAME

**These famous radio set and speaker manufacturers equip their speakers with Hawley Moulded Diaphragms**

| | | |
|---|---|---|
| Magnavox | Jensen | Majestic |
| Utah | Rola | Stromberg-Carlson |
| Stewart-Warner | American Bosch | Crosley |
| Operadio | Trans. Corp. of Am. | Melber (Germany) |
| Lansing | P. Smith Stamping | Sachenwerk (Germany) |
| Colonial | Oxford Radio Products | Feldman (Germany) |
| Northern Engraving | Angsten | Neufeldt & Kuhnke (Germany) |
| Best | Quam-Nichols Co. | Platon Texido (Spain) |

HAWLEY MOULDED DIAPHRAGMS

PRODUCTS AND PROCESSES FULLY COVERED BY PATENTS AND APPLICATIONS

HAWLEY PRODUCTS COMPANY, 201 N. FIRST AVENUE, ST. CHARLES, ILLINOIS

# RADIO ENGINEERING

*Reg. U. S. Patent Office*

Member, Audit Bureau of Circulations

*Western Editor* ULMER G. TURNER

*Editor* DONALD McNICOL

*Managing Editor* F. WALEN

Vol. XI NOVEMBER, 1931 Number 11

## Contents



## Departments



### REDUCTION IN PRICES OF RADIO RECEIVING TUBES

WE wonder how the tube manufacturers can produce these modern dependable tubes for the lowered prices announced in October, but no doubt they know their business.

What there is of sales resistance due to cost of receiving tubes for replacement should melt away in view of the new prices.

RCA Radiotron, Arcturus, Cunningham, Sylvania and other tube manufacturers have reduced prices of receiving set tubes to a point where for $7.00 to $9.00 all of the tubes in an average eight-tube receiver may be replaced.

If an immediate market of one hundred million tubes at a total cost approximately $120,000,000.00 can be sold within the next four months, the reduction in price will probably be a stimulating, constructive move.

BRYAN S. DAVIS *President*

JAS. A. WALKER *Secretary*

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# You Will Find These Important Plus Values Behind Radio Tubes

*Made By*

# Hygrade Sylvania Corporation

## 1. *Production Facilities*

The facilities of Hygrade Sylvania permit the economies of mass production (70,000 tubes a day) without any lowering of quality standards. Efficiency in inventory control assures every purchaser of new fresh tubes.

## 2. *Financial Strength*

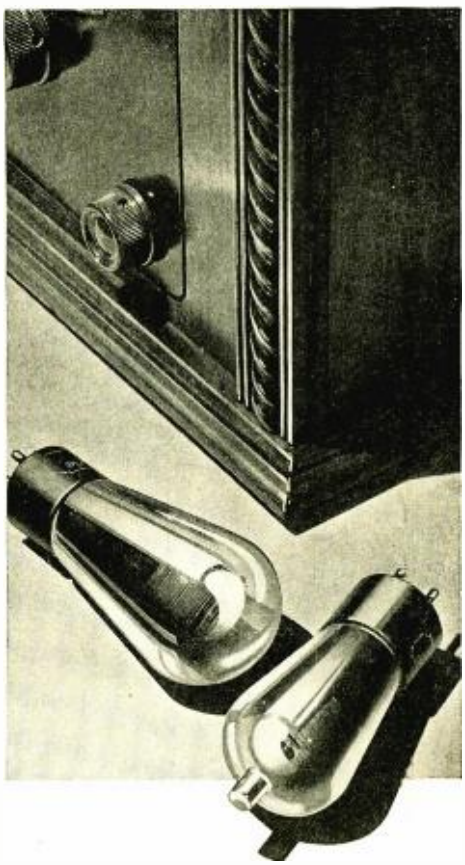
One of the outstanding successes in the tube industry, Hygrade Sylvania offers the assurance of financial strength. There is no danger that economic pressure will effect any let-down in quality or falling off in prestige. This manufacturer is in the business to stay.

## 3. *Engineering Skill*

The success and growth of Hygrade Sylvania have been attended by the development of a large, highly competent engineering staff, abreast of the latest developments and able to handle the growing demands of the set manufacturer.

## 4. *Experience*

Hygrade Sylvania has an enviable background of experience, drawn from years of close co-operation with some of the country's most exacting and successful set manufacturers.



**NO OTHER RADIO TUBE MANUFACTURER IS GEARED SO WELL TO THE REQUIREMENTS OF THE RECEIVING SET MANUFACTURER**

## HYGRADE SYLVANIA CORPORATION

HYGRADE LAMP DIVISION
SALEM, MASS.

SYLVANIA DIVISION
EMPORIUM, PA.

# Editorial

NOVEMBER, 1931

**CHANNELS FOR TELEVISION**

IRVING LANGMUIR, so far as the writer is informed, was the first engineer publicly to propose the utilization of micro rays for communication services. At the annual dinner of the Institute of Radio Engineers, New York, held in January, 1926, Dr. Langmuir in a memorable address boldly suggested a way out of the congestion obtaining at that time in the ether channels employed in broadcast and other communication services.

Little of practical use had been made of wavelengths less than 22 meters, and only wavelengths above 100 meters were employed commercially.

Dr. Langmuir predicted that with further study and experiment it would be found that waves less than a meter in length might be put at work.

The demonstration of March, last, between a station on the Dover cliffs, England, and a station near Calais, France, showed that wavelengths as short as 10 centimeters could be employed for commercial radio communication. The utility of micrometric wavelengths with a radiated power of but one-half watt was demonstrated.

It appears now that by employing ultra short waves the radio spectrum for limited transmitting distances is expanded sufficiently to provide space for the bands required for television. It is reported that the NBC has leased the top of the new 1,250 foot high Empire State Building, New York, for the purposes of television transmission. Ordinary radio waves may be earth waves or sky reflected waves. Ultra short waves are like light rays in that they travel in a straight line. The higher the point of transmission the further away is the limiting horizon.

▲

**EXCLUSIVE DEALERS**

SO long as there are more than a hundred manufacturers of radio receivers, each manufacturer doing what he can to make sales, it is not possible for all dealers in the country to handle the receivers of only one manufacturer. Many dealers handling the products of only one manufacturer are doing good business and are satisfied to handle but one line. The exclusive dealer of the X line may receive a discount of 35 per cent on parts for replacement purposes, while another dealer in the same locality handling the Y line has to purchase parts for any X receivers he may be called upon to service at a price carrying a much smaller discount than 35 per cent.

This is one of these merchandizing situations which has arguments on both sides. In many cases owners of X receivers prefer to have their servicing done by the particular dealer who happens to handle only Y receivers. In these cases the dealer in Y receivers complains that he is penalized when he repairs an X receiver by having to get along with less profit than the X dealer would have from the same job.

It is a noteworthy circumstance that the respective dealers seem to be getting along more amicably than are the respective manufacturers. In an effort to cooperate X dealers and Y dealers are supplying each other with replacement parts on a basis where the charge to the customer is uniform and where the profit is the same, no matter who makes the repair.

Yes, we have heard the other side of the story and have listened to all the harrowing difficulties which beset manufacturers in their search for dependable, go-getter dealers, but there is a strained situation here worthy of business-like consideration.

▲

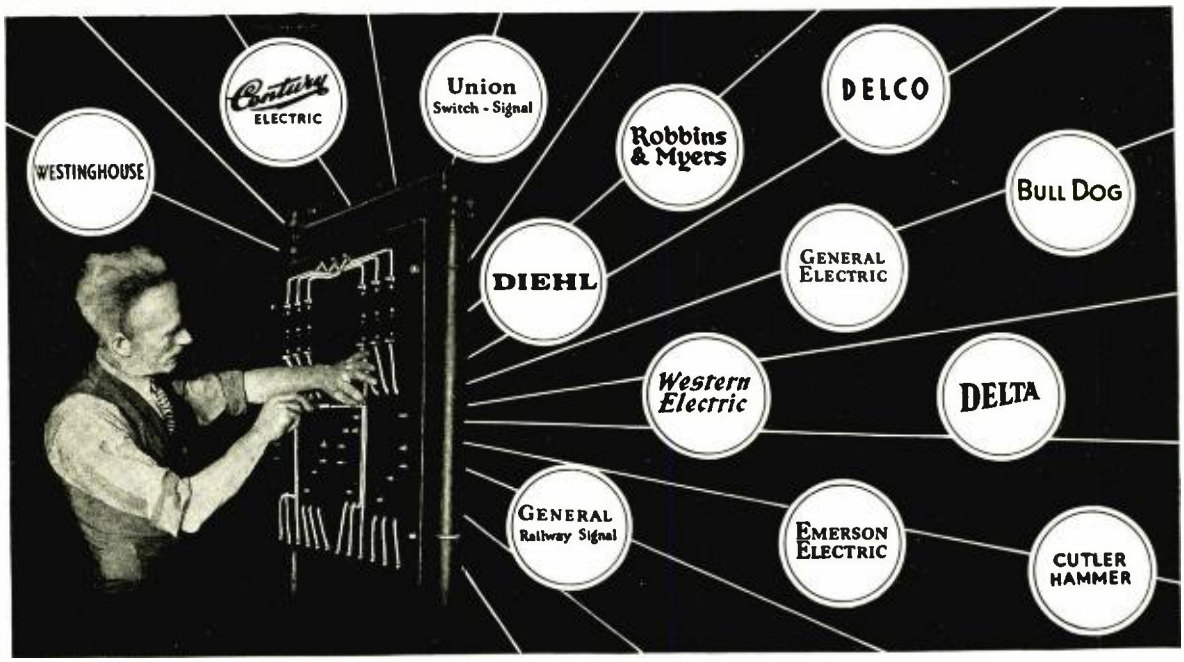
**SHORT WAVES**

BELIEVING the ultra short-wave bands of 5 meters and under offer great possibilities in radio, especially in television, Dr. E. F. W. Alexanderson has arranged for broadcasting one hour programs twice a week over W2XAW, operating on 5 meters. These programs, the same as broadcast by WGY, will be sent out from 5 to 6 o'clock every Tuesday and Thursday afternoon.

Donald McNicol

*Editor*

# MAKERS OF ELECTRICAL EQUIPMENT SAVE IN ASSEMBLING SLATE, EBONY ASBESTOS, BAKELITE, DUREZ, STEEL




## *Make superior fastenings at lower cost with Self-tapping Screws*

Manufacturers who make fastenings to slate, ebony asbestos, Bakelite, Durez and steel can profit by the experience of the leading makers of electrical equipment. For these concerns have solved the problem of making fastenings to such materials securely and economically. They use Hardened Self-tapping Screws and Hardened Metallic Drive Screws.

A cost comparison on a test assembly job, which led to the wide use of Self-tapping Screws by a great concern named above, is sufficient to show the notable economies effected by these Screws. This manufacturer adopted Self-tapping Screws in place of lead anchors and wood screws for the job of fastening cleats and other wiring devices to switchboard panels. Comparison of costs proved that Self-tapping Screws saved $3,120 a year in time, labor and material. A stop watch showed that a workman could make a fastening in 13 seconds less time. Before adopting the Screws for other assemblies, they also subjected them to security tests which demonstrated that Self-tapping Screws actually make stronger as well as cheaper fastenings.

It will pay you to carefully consider Self-tapping Screws for your own fastening jobs. Let our Assembly Engineers tell you whether you can use these Screws to advantage. It costs nothing. Just attach a description of one or more assemblies when you mail the coupon for the booklets below.

**Type "Z" Hardened Self-tapping Sheet Metal Screws**

*For joining and making fastenings to sheet metal up to six gauge; also aluminum, die castings, Bakelite, etc. Simply turn Screw into drilled, pierced or molded hole. It forms a thread in the material as it is turned in. Can be removed and replaced.*

**Type "U" Hardened Metallic Drive Screws**

*This type of Self-tapping Screw is used for making permanent fastenings to iron, brass and aluminum castings, steel, Bakelite, Durez, etc. Just hammer the Screw into a drilled or molded hole. It forms a thread in the material as it is driven.*

## PARKER-KALON *Hardened* Self-tapping Screws

PAT. IN U. S. AND FOREIGN COUNTRIES


← 14 Unbiased Reports on Savings---------- Scientists Explain Fastening Security →

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

Send me free booklets on the Security and Economy of assemblies made with Self-tapping Screws.

Name and Co.----------

Address----------

# Listening habits of radio broadcast audience

WITHIN a radius of 125 miles of Pittsburgh, Penna., the principal KDKA audience zone, there are 5,891,000 people representing 1,450,000 families—4.6 per cent of the total national population.

It is difficult for one, unaccustomed to broadcasting reactions, to visualize the vastness of a radio audience. But the listeners are there, nevertheless. They live quietly until something disturbs their equilibrium. When "Amos 'n' Andy" were changed to seven o'clock eastern standard time, it meant that on the west coast it was four p. m. Did listeners like it? They did not, and, what is more, they wrote in and said so; not by twos and threes, but by the thousands.

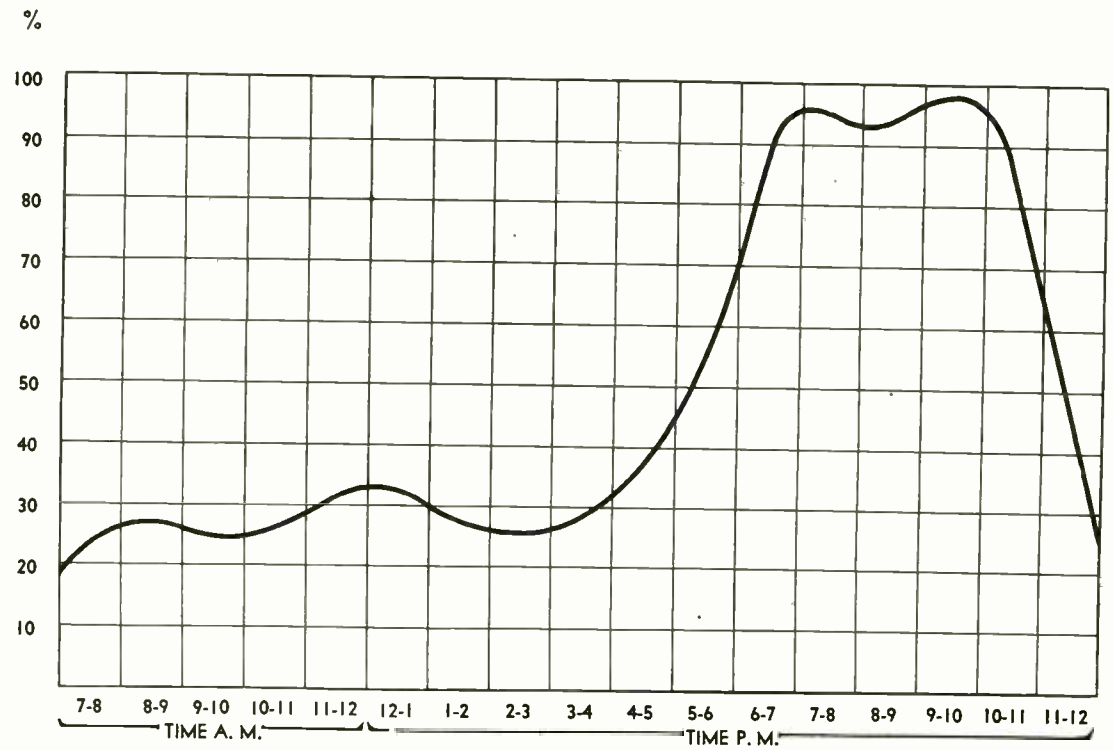
It is this spontaneity of reactions found only in broadcast advertising, which early indicates the likes and dislikes of the listeners for the program and the product. Thus, being able to feel the pulse of the market, as it were, it is possible for the consistent user of broadcast advertising to guide this powerful selling aid to produce the results desired.

SEVERAL things influence the listening habits of the radio audience. Reception, weather conditions, living routine, time of day, season of year, etc., all have a direct bearing, but by far the outstanding influence is the program. *Popular programs will win and hold the audience.* Listeners will switch from one station to another to hear programs they like; they will even inconvenience themselves in order not to miss a favored one. Very popular programs increase the size of the normal audience at a given hour. Not so long ago seven p. m. was considered by advertisers as a low audience time. Since the advent of Amos 'n' Andy the demand for space near this hour exceeds the supply.

With 97.7 per cent of the people interviewed having no choice of days for listening, which is verified by the even distribution of mentions of programs on all days, there appears to be no "best day" of the week.

Because of the limitations imposed by occupational activities which take men and women to places of employment and the children to schools, etc., a program cannot win and hold as large an audience during the daytime hours up to four or five p. m. However, the daytime audience, a great proportion of which is adult females, affords to the advertiser, in many cases, an opportunity to get his message to the group he is trying to reach under very favorable conditions.

The accompanying curve shows the listening habits of the audience in the Primary Zone of Influence of Station KDKA, hour by hour on an average day. It was plotted from the 21,550 program mentions in reply to the question, "What programs did you hear yesterday?"




THIS CURVE INDICATES THE DAILY LISTENING HABITS OF THE AUDIENCE IN THE PRIMARY ZONE OF INFLUENCE OF STATION KDKA

# WHEN HOURS COUNT


In emergency . . . when the unexpected happens . . . when each hour saved in material receipts means an hour gained in production . . . in these emergencies you will find Inca ready to rush your order through at top-speed.

There are times when reliability in delivery is as vital as reliability in the product itself.

Moreover a full and detailed record of each customer's requirements makes possible accurate and prompt interpretation of phone and telegraphic orders.

*"Hail Cuzco, glorious city, I salute thee!" Thus the Inca always greeted his capital city when approaching it from afar.*

# INCA

## MANUFACTURING DIVISION

of NATIONAL ELECTRIC PRODUCTS CORPORATION

FORT WAYNE, INDIANA

*Eastern Office:* 233 Broadway, New York City
*Western Office:* 1547 Venice Blvd., Los Angeles

# CRC presents the "500"* SERIES

## 9 REASONS

**why the latest development of the pioneer socket manufacturer will be preferred by the Radio Industry in 1932.**

**1 BETTER CONTACT**
Eight points of contact on each tube prong.

**2 LASTING TENSION**
Double action contacts provide double tension.

**3 TENACIOUS GRIP**
Easy insertion. Sets may be safely shipped with tubes in place.

**4 BUTTON GUIDE**
Button type guide available if desired.

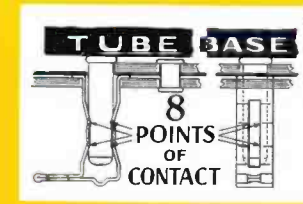
**5 SPEEDIER PRODUCTION**
Rigid, elevated soldering surfaces — heavily cadmium plated.

**6 SPACE ECONOMY**
Elimination of superfluous insulation makes for smaller space requirements and lower costs.

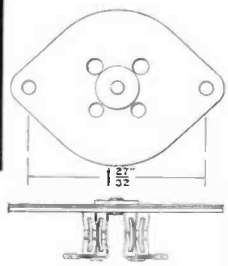
**7 GREATER INSULATION**
The 500 series has more insulation between contacts than any other inserted contact type socket.

**8 TERMINAL CHOICE**
Notched, slotted hole or hook type solder terminals available.

**9 SIZE SELECTION**
About thirty variations of size and contact arrangements with $1\frac{1}{2}''$—$1\frac{11}{16}''$—$1\frac{27}{32}''$ mounting centers. Special mounting centers can be furnished to your specifications.




*Patents pending in U. S. and foreign countries.*



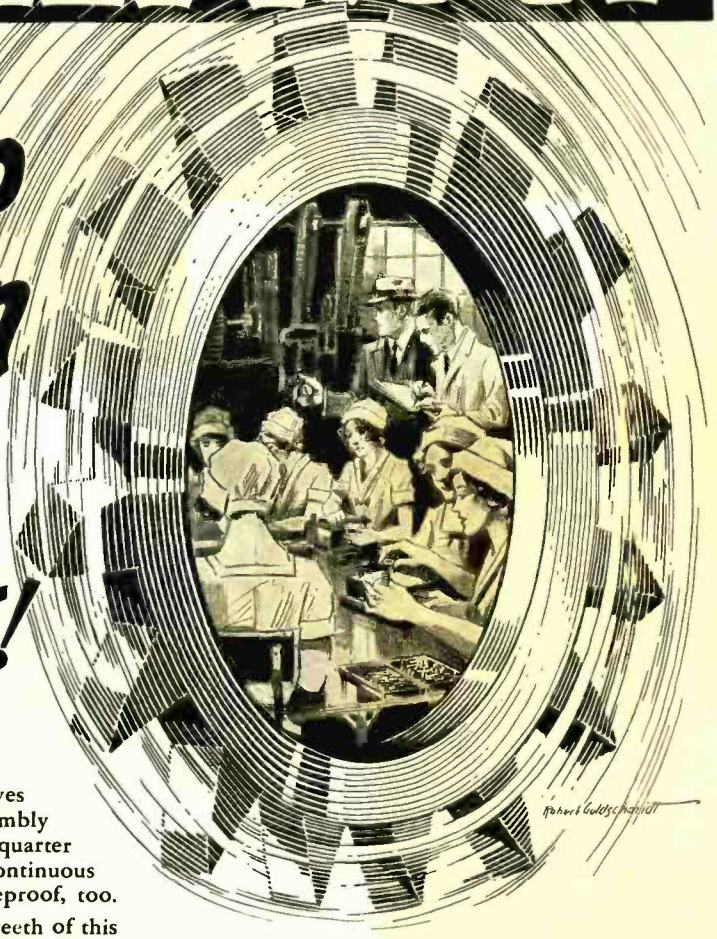

## CENTRAL RADIO CORPORATION

**BELOIT • WISCONSIN**

CRC

# SHAKEPROOF

## Speed Up Production with this Modern Lock Washer!



THE Shakeproof Lock Washer saves many precious minutes on the assembly line. It locks tight with only one quarter turn and because it is made in one continuous circle, it is spreadproof and tangleproof, too. What's more, the patented twisted teeth of this superior locking principle bite into both the nut and work surface. Vibration forces these powerful teeth in deeper and the result is a lock that will not loosen.

Give your product the advantage of Shakeproof protection. It will improve performance and reduce service requirements to a minimum. Send the coupon below for free samples—mail it today!

U. S. Patents
1,419,564
1,604,122
1,697,954
1,782,387
Other patents pending.
Foreign patents.

**SHAKEPROOF**
***Lock Washer Company***
*(Division of Illinois Tool Works)*
2509 North Keeler Avenue, Chicago, Illinois

*"It's the Twisted Teeth that LOCK"*


*Shakeproof representatives are located in the following cities*

New York City, Philadelphia, Boston, Pittsburgh, Schenectady, Cleveland, Detroit, Toledo, Cincinnati, Birmingham, Ala., Dallas, Texas, Milwaukee, Los Angeles, Seattle, San Francisco, Toronto, Ontario, Canada

### COUPON

Gentlemen: We want to test your Shakeproof Lock Washers. Kindly send us samples as indicated.

Type ..... Size .....

Type ..... Size .....

*Firm Name* .....

*Address* .....

*City* ..... *State* .....

*By* ..... *Title* .....

# Impressions and Expressions

By AUSTIN C. LESCARBOURA

## STANDARDS

IT is interesting to watch the shift in radio standards. Some manufacturers are becoming increasingly conservative in their ratings. Certain resistor manufacturers, for instance, have deliberately decreased their wattage ratings so as to play absolutely safe. Other manufacturers are becoming increasingly rash in their ratings, in trimming costs by the crudest method so as to steal a march on competitors.

The price market which now prevails will stand much watching in the absence of iron-bound standards. Unscrupulous manufacturers are going to cut corners. Radio assemblies stand in danger of unexpected breakdowns because of altered standards.

It will be well for buyers to specify exactly what they want by way of materials and components, and to see that their purchases come within the terms of the specifications. Never before has the radio industry seen so much threatened short-changing in quality as now looms up on the horizon.

▲

## DYNAMIC MICROPHONE

AND now it's the dynamic microphone, following in the footsteps of the condenser microphone, the double carbon button microphone, the electromagnetic microphone (the phonetron of early WJZ history) and the original Bell Telephone microphone of the beginning of broadcasting.

The idea is by no means new, yet the engineers have now worked out remarkably compact designs for the dynamic microphone. Several months ago we were asked to attend an informal demonstration of a dynamic microphone worked out by a very clever young engineer. The microphone proved capable of reproducing the voice and the piano with a naturalness that proved positively uncanny. However, the design was much bulkier than that now being introduced in broadcast studios.

With a choice of microphones, the broadcaster can now make certain of the most desirable pickup technique.

▲

## RCA SETTLES

BY and large, the main news of the past month is the settlement of the long drawn out dispute between RCA and a number of independent tube manufacturers over the so-called Clause 9. Several years ago the DeForest Radio Company, then in receivership, began suit against RCA on the grounds of restraint of trade and unfair competition, based on the contract entered into between RCA and its radio set licensees, Clause 9 of which stipulated that only RCA or RCA licensed tubes were to be used as initial tube equipment in such sets. The DeForest organization and other independents claimed that their respective businesses had been seriously impaired by the Clause 9 practice. After long litigation, the courts ruled that RCA was guilty of restraint of trade and unfair competition, and that the sufferers were entitled to triple damages.

The suits have been settled—and at bargain prices. It is doubtful if RCA could have picked a better time to settle with most of the independents, sorely in need of ready cash at this time. The legal atmosphere is become more and more clarified, and it does begin to look as though radio firms will at last turn to radio manufacturing and merchandising as a means of making money for their stockholders, rather than banking on damages that may never be collected. Certainly the trade and the public will benefit by having manufacturers pay more attention to their business than ever before. Whether or not an all-inclusive patent pool comes out of all this settlement, there can be no denying the general clearing up of what has been a mighty troubled atmosphere.

▲

## TELEVISION

TELEVISION demonstrations are again in season. The latest equipment shown at radio shows bears all the marks of careful engineering, while the results promise sufficient entertainment value to find a place in the average living room. But when do we get some real television production? That's the question just now.

It is positively annoying to note the manner in which television production is being delayed. Perhaps this is the natural reaction from earlier days when crude models were rushed into production on a scale hardly warranted by the engineering status of the struggling art. But today, the latest designs warrant a reasonable production at least to meet the demand which already exists without the aid of real sales promotion.

Our impression is that unless the designers of good television equipment get under way without more delay on a production to at least meet the existing demand, they are going to find themselves displaced by that group of small, snappy, enterprising operators who know a good thing when they see it, and waste no time in exploiting it. Already the small operators are manufacturing kits and complete sets on a scale that is astonishing. While the television leaders are demonstrating, romancing and probably stalling, the little fellows are cleaning up by straightforward production and merchandising methods.

▲

## CABINETS

OF the many impressions gathered at the New York Radio Show, one stands out in bold relief, namely, the striking absence of originality in cabinet designs. At a time when modernistic design is scoring so heavily and when eye value is of greater importance than ever in prying the public away from its money, one would naturally expect some striking innovations in radio cabinets. From this angle at least, the Radio Show has proved a disappointment.

# Give his voice a good send-off!

## ...with tubes that last two and three times their expected life

The No. 242-A . . . a 50 Watt Three Element General Purpose Vacuum Tube. Characteristics:

| | |
|---|---|
| Filament Voltage | 10 volts |
| Filament Current | 3.25 amperes |
| Plate Voltage | 750/1000 volts |
| Plate Current | 49/95 milli-amperes |
| Grid Voltage | 30/60 volts |
| Plate to filament Impedence | 2500/4000 ohms |
| Amplification Constant | 11/13 |

**Leading radio stations safeguard their reputation for quality sound transmission by using only Western Electric vacuum tubes. They know these tubes are backed by 50 years of telephone making—that the name Western Electric assures uniform characteristics and long life! That holds good too for cathode ray**  **oscillograph tubes, vacuum thermocouples and ionization manometers for use in the laboratory—and for photo-electric cells used in Sound Systems in theatres and talking picture studios. For electronic equipment, made to Bell System**  **standards of performance, rely upon the natural leader in sound transmission—Western Electric! Mail the coupon—or write us what kind of electronic equipment you are interested in.**

# Western Electric

## ELECTRONIC EQUIPMENT

*Distributed by* GRAYBAR *Electric Company*

GRAYBAR ELECTRIC CO. RE11-31
Graybar Building, New York, N. Y.
Gentlemen: I would like information on the following electronic equipment: .....

Tubes I am now using are: .....

NAME .....

ADDRESS .....

CITY ..... STATE .....

# Back of Textolite Laminated . . .

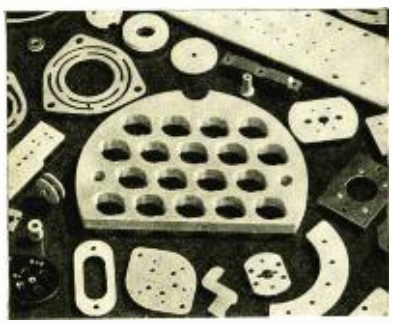
## Years of Research

*Years of insulation research are behind the G-E insulators that protect this G-E experimental "lightning generator" from a 15-foot bolt, 5,000,000-volt artificial lightning discharge*

## and Manufacturing Practice

*Uniform durable insulation is vital to the satisfactory performance of the stationary armature for this G-E 30,000-kw. synchronous condenser*

## are behind Textolite Laminated



*Proved service also characterizes these representative parts made from Textolite laminated*

## more than 40 YEARS Experience with All Types of Insulations

For more than forty years, insulation has been a basic consideration of G-E engineering.

Generators — motors — high-tension cable — vacuum tubes — the reputation of these and every other G-E product would not be maintained without high quality insulation. For this reason, G-E engineers and research men have steadily worked and progressed toward ultimate excellence in insulation.

The long experience and extensive facilities of General Electric are back of Textolite laminated. It is especially appropriate for insulation needs in radio and electronic applications. Ask the G-E office in your vicinity about Textolite laminated, or inquire of the eastern or western fabricators.

**General Fabricating Co.**
37 East 18th St.
New York City

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

831-5

# GENERAL ELECTRIC

# The good old days

By Donald McNicol

IT is one of the paradoxes of life that young men lacking long experience and a profound knowledge of life are as a rule optimists, while older men view the happenings of their times as of direful portent.

This truism has perhaps obtained in all ages. The children in all ages have gamboled and frolicked until, each night, fatigue and darkness overcame them, while older folks at the same time gravely expressed fear that catastrophe was just topping the hill and soon would engulf humanity, making ruin of all.

Most of the apprehensive headwagging going on today is that done by those who have passed the meridian of life's span: youth has no fears for the future and is little disturbed by the colorful happenings of the day.

And youth is right. When those who are now old were young, they were right in accommodating themselves to the constantly and rapidly changing conditions then experienced. As men grow old they look for serenity — for peace and quietness, but the daily press brings to them, seemingly, nothing save accounts of heedless and reckless activities of individuals bent upon rending the fabric of society.

Expressions one often hears emanating from the armchairs around the chimney corner refer to "the good old days." The good old days! When could they have been? Was it the period, say, from the close of the civil war until 1890? In that period there were no Big Four to wield a big stick: there were no Bolsheviks, known as such; there were no soulless corporations, and there was no League of Nations begging for ratification.

But, let us, for a moment, recall some of the events which the newspapers of those days played up in headlines.

Let us start ten years after the civil war closed, to get away from its immediate reconstruction period.

In January, 1874, it required the presence of United States troops in the Louisiana State House at New Orleans to protect the convening of the Legislature. In 1875 the chief clerk of the United States treasury, and the President's secretary were indicted for complicity in whiskey frauds in the west. In 1876 the Secretary of War was arrested for accepting money in consideration of appointments to office. In that same year the Sioux Indians massacred 305 officers and men of General Custer's command. In 1877 eleven "Molly Maguires" were hanged at Pottsville, Pa., for murder; and in that year a railroad strike occurred which necessitated the calling out of State and Federal troops in five states, 200 lives being lost in Pittsburg, 125 locomotives destroyed and 3,500 railroad cars burned. In 1878 a yellow fever epidemic in New Orleans claimed 4,000 lives, and in the same year a big savings bank in New York was robbed by burglars who carried away about $3,000,000. In 1881 an assistant Postmaster General had to resign on account of "Star Route" mail frauds. In 1882 the Government had to take steps to prohibit polygamy, and in the West Jesse James was unloading express cars between stations. In 1884 at Cincinnati, Ohio, there was a three days' reign of mob rule and terror as a result of an unpopular jury decision. The jail and courthouse were wrecked. and after the affair had ended forty-two dead and 120 wounded were counted. In 1885 a mob at Rock Springs, Wyo., massacred fifty Chinamen. In 1888 the Knights of Labor started business and for a time tied up half the railroads of the country; and in Chicago, in that year, it was found necessary to hang eight anarchists.

The foregoing incidents are only a few of the happenings which the daily papers chronicled in "the good old days."

The foregoing paragraphs constituted an editorial written and published by the writer in the year 1920, at which time it was the common view that the ribs or the guy-wires of civilization had given way, and that the people of the world were in for a final drubbing.

It is thought that the matter is worth reprinting now—a decade later.

Industry and civilization came out of the 1920 crash—not quickly nor easily, but warily. Two or three years passed before confidence was restored. During the process of recovery the Western Electric Company, the Standard Oil Companies, the Brooklyn Edison Company and other going concerns had to issue 7 per cent bonds in order to survive and carry on.

Throughout the country at the present time there are some gentlemen who have long memories who believe that the fortunes of the future are being planned today—and that a time will arrive when people will refer to the decade 1931-1941 as The Good Old Days.

RADIO ENGINEERING

Production, Administration, Engineering, Servicing

NOVEMBER, 1931

# The electric condenser †

By R. A. Lane*

**A technical presentation of the subject of condenser design and assembly. The condenser considered is the foil-paper type, such as used in telegraph, telephone, radio and power factor operations.**

In looking into the history of condenser development, we find that the pioneer investigators discovered the ability of a dielectric to store electrical energy, before they understood the principle which governed the apparatus. This is indicated by the name condenser, a misnomer arising from early misconceptions of the electrical principles involved. The more recently applied term "capacitor" is more truly descriptive.

Like many other important developments the first condenser, in the form of the Leyden jar seems to have been arrived at by two investigators at approximately the same time: Dean Von Kleist of the Cathedral of Camin in Germany in October, 1745, and Von Muschenbroek of Leyden in January, 1746. Von Muschenbroek's results were the first to become generally known, hence the name of the apparatus.

The names of Volta, Cavendish and Franklin stand out among the many early investigators of dielectric phenomena. Volta in 1782 observed that when a Leyden jar was discharged and left on open circuit for a time, a charge reappeared. This opened up a field of investigation which has occupied the attention of physicists up to the present time.

†*Delivered before the Radio Club of America, September 16, 1931.*

**Consulting Engineer.*

Cavendish, from the hissing sound he heard just before the discharge of a Leyden jar developed his fluid theory of electricity.

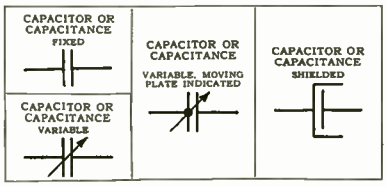
As Americans, we should be particularly proud of Franklin's investigations, which began soon after the discovery of the Leyden jar.

Franklin seems to have been one of the first to put forward the idea that energy was stored in the dielectric. In one of his letters to Peter Collinson, of London, with whom he carried on an extensive correspondence on a variety of subjects, he says: "Thus the whole force of the bottle and power of giving shock is in the glass itself, the non-electrics in contact with the two surfaces serving only to give and receive to and from the several parts of the glass, that is to give on one side and take away on the other."

He later demonstrated this by making a plate condenser out of glass and lead foil, removing the plates after charging the condenser, and discharging with a second set of plates.

Franklin also noted that dry air is a good insulator, but as the amount of moisture increased, the insulating value decreased. He mentions in one of his letters a Leyden jar which held at least a portion of its charge for seven months.

Like most of the investigators of his time, Franklin spent considerable time in working up electrical tricks. He arranged a picture of the King in such a way that anyone who attempted to dislodge the crown would be bowled over by the discharge of a few Leyden jars.




Condenser symbols.

Franklin also was keenly interested in the effect of the "electrical fire" on living things. He found that two large Leyden jars would kill a hen, but turkeys were tough, and while two jars would knock them out, it required five to kill them. He reports that "meat" killed in this way was particularly tender.

Most of the work done by the earlier investigators was of a qualitative nature, but as knowledge was enlarged the more forward looking workers began to seek quantitative results.

Faraday, in particular, appreciated the desirability of this sort of investigation, as shown by the opening paragraph of his paper on "Induction," read before the Royal Society in December, 1837, where he said:

"The science of electricity is in that state in which every part of it requires experimental investigation; not merely for the discovery of new effects, but what is just now of far more importance, the development of the means by which the old effects are produced, and the consequent more accurate determination of the first principles of action of the most extraordinary and universal power in nature."

In his efforts to obtain accurate information Faraday built several pieces of apparatus with which he studied the properties of dielectrics. One of these consisted of two concentric hollow brass spheres, the inner sphere being insulated from the outer with a space of about 5/6 inch between the two. The outer sphere was made up of two hemispheres which could be screwed together. Two of these instruments were made and comparative tests made with

air for insulation in one, and various other materials in the other. From this work Faraday arrived at the idea of specific inductive capacity, and gave values for several different substances. He also observed the phenomena of residual charge, at first finding that all dielectrics, including air, showed it; but finally deciding that the solid insulation used as a support for the inner sphere was responsible for the residual found with the air dielectric.

Maxwell, in 1873, gave out his theory of absorption, which later has been followed by other theories or modifications by Pellat, Boltzman, Van Schweidler, Wagner and others.

During the 125 years between the discovery of the Leyden jar and Maxwell's work on dielectric theory, the condenser was almost exclusively a laboratory device. Progress in the study of insulation had, of course, been made, but there had been no wide technical application of condensers to furnish the incentive for development.

By-pass condenser.

### First Used in Submarine Cabling

This incentive was furnished by the demand for condensers, first for telegraphy and telephony, later for ignition, radio and power factor applications.

The story of condensers is, to some extent, the story of the development of high grade insulation, and the condenser engineer is primarily concerned with the selection of materials and development of processes which will produce the most economical condenser to fit the need at hand.

The necessity for high grade insulation is apparent when the square relation between working stress and volume is considered. Suppose, in making a 200-volt radio by-pass condenser, we used instead of 1 mil of insulation, 10 mils, which can easily be found on other apparatus rated at the same voltage: This by-pass condenser would then be 100 times as large as it is now.

### Properties of Condensers

The electrical properties considered in selecting a condenser dielectric include dielectric constant, insulation resistance, dielectric strength and power factor. Since methods of processing affect most of these properties, process development must be carried on along with materials investigation. When enough information is available to determine probable safe working stress, cost of insulation per joule of energy stored may be determined, and the economic usefulness of the material considered. The ideal dielectric would have a high dielectric constant, negligible leakage and losses, and a high dielectric strength.

No ideal dielectric material has yet been developed, although almost every type of insulation has been tried for condenser dielectric at some time or other. For some, little or no commercial application has been found; others have properties which fit them particularly well for certain applications.

Some of the better known and more widely used dielectric materials are impregnated paper, mica, oil, glass and compressed gas.

The development of impregnated paper insulation is particularly interesting, since condensers insulated with paper impregnated with either wax or oil are widely used for a variety of purposes.

Early wax paper condensers, largely used on low, direct voltages, were, of course, far inferior to present condensers of that type, because neither materials nor processes had been highly developed.

A Bureau of Standards report, published in 1907, gives values of power factor from 1.3 per cent to 14.7 per cent for a number of condensers of various makes. In 1911 another set of tests was made on 13 condensers made by English, French, German, and American manufacturers. The minimum value found was .87 per cent, while most specimens ran many times this value. In 1912 the Bureau made some power factor and insulation resistance tests on paraffine impregnated condensers, some of which used metal foil as conductor and others metallized paper. Tinfoil condensers showed power factors from .4 to 4.1 per cent, Mansbridge type from .9 to 1.9 per cent. Insulation resistance in megohms per microfarad varied between 323,000 and 10 for the tinfoil type and between 74 and 100 for the Mansbridge type. Tests were made at room temperature at 100 cycles. It is interesting to note that the report that gives these values of insulation resistance states that while the values vary widely, even the lowest was satisfactory for the purpose for which the condenser was designed. Apparently the effect of leakage on the circuit in which the condenser was to be used was considered, rather than the leakage as an indication of the life of the condenser.

### The Dielectric

The various types of paper, foil and impregnating compounds used in the manufacture of wax impregnated paper condensers were at first for the most part selected from available materials; later as requirements became better known special materials were developed.

The paper used in present-day condensers is the result of years of development by paper manufacturers in cooperation with condenser manufacturers. These efforts have produced an extremely thin closed sheet, practically neutral chemically, and remarkably free from conducting particles.

Materials in most general use as conductors include tinfoil, aluminum foil and metallized paper. Aluminum and tinfoil are both available in thicknesses of .0003 inch. Tinfoil makes a heavier condenser and is usually more expensive per sq. in. of coverage. Aluminum foil is more difficult to solder and condensers made with it do not press down as readily as those made with tinfoil. Some test results described further on seem to indicate, although perhaps not conclusively, a longer life for condensers wound with aluminum foil.

Metallized paper or Mansbridge condensers have not been used as extensively in this country as abroad. Instead of using a thin sheet of foil, metal is deposited on paper to form a conducting plate. One of the advantages claimed for this type of condenser is that when a failure occurs the metal around the point of failure is so thin it will be vaporized and the fault cleared. The disadvantages include high conductor resistance and difficulty of making a non-inductive winding.

Paraffine, probably the first material used for condenser impregnation, had when first used, widely varying characteristics due to different methods of refining and different places of origin. Characteristics are more closely controlled at present and the material is still quite widely used, either alone, in combination with other waxes such as carnauba, or with a certain amount of mineral oil. Other petroleum derivatives having higher melting points are also available. Most of these have a dielectric constant of 2 to 2.5. Halowax, a synthetic material, is widely used, because it combines good electrical properties with high dielectric constant.

Tubular condenser.

### Assembly

The steps involved in producing a condenser include putting the paper and foil in proper relation, either by winding or stacking, removing moisture from the paper, impregnating, cooling and sealing.

Stacking, that is, building up the

condenser section with sheets of paper and foil cut to size, is very seldom used in making wax impregnated condensers, since the number of sheets of paper between foil is usually small enough to permit winding, which is a much cheaper operation.

Winding may be either inductive or non-inductive. Inductive windings use foil which is ⅜ to ½ inch narrower than the paper. The section is wound up with equal margin on each side and tinned copper strips laid in to enable a connection to be made. The non-inductive winding uses foil the same width as the paper, foils of opposite polarity protruding ¼ inch or so on the opposite ends of the winding. Inductive windings require less weight of foil per microfarad, because all foil used is active. Winding labor is greater because connecting strips must be put in. For certain radio applications, the non-inductive winding is necessary, and it is desirable when the condenser is to be used on alternating current, because this foil arrangement facilitates heat dissipation.

Early methods of processing often did not involve the use of vacuum for removal of moisture from the paper, the sections being placed in the impregnating bath, kept there for a few hours, then removed from the wax and pressed. Sometimes vacuum was used on the impregnating tank, with no previous vacuum treatment of the wound sections. This, of course, made a better condenser than when vacuum was not used at all, probably as much due to the removal of entrapped air as to moisture removal.

One method of pressing was to remove the sections from the wax bath, a few at a time, and press in a hydraulic or compressed air press, in a water cooled die. One objection to this method was the rough treatment the section had to stand. Another was the fact that sections would cool rapidly on the outside, remain hot inside and open up when removed from the press.

In many cases the detrimental effect of exposure to moisture laden air during cooling and assembly was not thoroughly understood, which resulted in a product which was extremely variable in quality.

Details of present practice vary rather widely, due to different materials in use and different production apparatus employed. In general, the wound sections are stacked in clamps, separated by metal spacers. Loaded clamps are then placed in a drying oven, heated and evacuated. Since the amount of moisture drawn off during the first hour or so of pumping is large, two vacuum systems are often employed, one for primary and one for final evacuation.

In some cases wax is run into the vessel in which drying took place and the impregnation completed without handling the loaded clamps. Another method involves moving the clamps from drying oven to impregnating tank. A few systems, after vacuum impregnating for a period of hours finish up by putting the impregnating tank under air pressure of about 50 lbs. per sq. in. for a time.

Cooling starts in the impregnating tank when the heat is cut off. Since it is desirable to cool the condensers out of contact with any moisture laden atmosphere, the cooler they are when removed from the wax the better. Sometimes when steam jacketed impregnating tanks are used, the cooling is hastened by cutting off the steam and running water into the steam jacket.

When removed from the impregnating tank the clamps are cooled off in oil or in air from which the moisture has been removed.

To guard against penetration of moisture during the life of the condenser the section or group of sections is usually dipped in a bath of wax after the leads have been soldered on, and just before placing in the container. After the block is in the container, pitch is poured in to insure complete protection against outside atmospheric conditions.

### Tests

Capacity and over voltage tests are made before assembly is started to eliminate faulty sections before any work is done on them. Preliminary tests of this type are often made at three times rated voltage. After assembly the capacity is rechecked, insulation resistance checked and a final over-voltage test made. On condensers for d-c. service power-factor tests are often not made on total production, tests being made frequently on a few samples selected at random.

The minimum value of insulation resistance specified as acceptable is often set at 1,000 megohms per microfarad at 25° C. Most carefully processed condensers run considerably higher than that.

Even a poorly processed condenser will often stand a 15 second breakdown test at a value far above twice or even three times its rated voltage, so that while the over-potential test will eliminate sections weakened by mechanical defects it is not a good check on process. The insulation resistance test is better in this respect, although by no means infallible. Best results by the manufacturer are obtained by combining routine tests with a very careful check on every step in the process of manufacture; and best results for an organization using condensers but not making them lie in patronizing a manufacturer known to do this.

Long time life tests at two or three times rated voltage are widely used to determine the quality of condensers. They are, of course, useful in the development of processes and materials rather than as a means of controlling production. 1,000 hours is often specified as the minimum time for operation at double rated voltage. There is considerable difference of opinion as to the interpretation of the results of these accelerated life tests. It is sometimes considered that the life of the condenser on d-c. varies as the fourth or fifth power of the voltage applied.

Thus, if a condenser operated at double voltage for 1,000 hours it would operate between 16,000 and 32,000 hours at normal voltage. In drawing conclusions from tests of this kind it must be kept in mind that "normal operation" means operation at varying temperatures, often with an a-c. component, and with the condenser subject to frequent surges.

Such tests are, however, valuable in making comparisons when materials or process have been varied. Some time ago, when working with both aluminum and tinfoil it appeared to me as though aluminum foil sections stood exposure to moist air much better than tinfoil sections. To find out if this was true when conditions were controlled, two sets of sections were made up and impregnated at the same time. Samples of both types were exposed to moist atmosphere at the same time for the same length of time, then assembled in the same way and put on double voltage life test. All the sections made up with aluminum foil remained on test well over 1,000 hours with no failures, while failures started on the tinfoil section in about 10 hours and very few lasted as long as 500 hours. Insulation resistance of the two sets of samples was about the same at the start of test. Unfortunately power-factor tests were not made on either set of sections.

### Oil Impregnated Paper

The use of oil impregnated paper insulation has been largely in condensers for power factor correction, although some have been used in radio work, particularly in broadcasting apparatus.

Oil impregnated paper is superior to wax impregnated for a-c. service, particularly at the higher voltages when insulation is thicker. The combination of oil and paper is a much better conductor of heat than that of wax and paper, so that heat is passed out of the case for dissipation much more rapidly.

Several types of paper have been used in oil impregnated condensers, including Kraft, a combination of wood pulp and cotton and pure linen tissue. Processing must be modified to fit the particular material used, paper containing wood pulp being much more quickly

affected by high temperature than pure linen tissue.

Mineral oil of about the same grade used in transformers is commonly used as an impregnating material. Some vegetable oils having high dielectric constants have been tried.

Process in impregnating paper with oil is similar to that used with wax, drying being completed before admitting the oil, and the oil preheated before being run into the condensers. Care must be taken to get any occluded air out of the oil before it becomes hot enough to damage it by oxidation. In many cases the condenser is assembled completely, then dried out and impregnated in its own container.

Condensers for a-c. service at 1,328 volts and above are tested for 1 minute, at twice rated voltage plus 1,000, sometimes at 2¼ rated voltage plus 2,000.

Dielectric losses are of particular importance in a condenser designed to operate on alternating voltage and must be kept at a low value, usually not so much because of the power cost as to insure long life for the condenser itself. Maximum allowable losses are set from .35 to .5 per cent of the normal operating KVA, measurements being made at 25° C.

### Dielectric Losses

Many methods of measuring dielectric losses have been developed, but most of them require delicate apparatus, which takes considerable time to set up and adjust. A fair idea of losses may be obtained by preparing a dummy container identical outside with the condenser under test but containing a heating element instead of a condenser. By adjusting the input to the heater until the case temperature is the same as that of the condenser under test the condenser losses may be considered equal to the input to the heater.

One method which has proved successful in production testing is the use of an inductance of known losses with which the power factor of the condenser is corrected to approximate unity. Losses in the combination may be measured with an ordinary wattmeter and correction made for the losses in the inductance.

Another method which is an adaptation of laboratory methods for production use has been developed by the Leeds & Northrup Company. This works on the phase defect compensation idea, that is, if the condenser were perfect there would be no phase defect and the dynamometer used as a meter would not be deflected. Since the condenser is not perfect, there is a deflection until a variable inductance in the potential circuit is adjusted to bring the angle between voltage and current to 90°. This variable inductance can be calibrated in power factor, and once the apparatus is set up measurements can be made easily and rapidly.

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# Newest ship radio borrows feature from automobile for increased efficiency

By C. J. Pannill

AN INTERESTING development in shipboard radio transmitters has resulted from successful tests of the latest model vacuum tube transmitter of the Radiomarine Corporation of America on a voyage of the *S.S. Santa Maria.*

Combining several new features making for compactness, convenience of operation and efficiency, the new transmitter is regarded as a distinct step forward in the design of marine radio apparatus.

Among the many innovations in radio design which this new transmitter embodies, perhaps the most important is the feature of using the same vacuum tubes and most of the other apparatus for its operation on two widely separated frequency bands. It performs functions heretofore requiring two separate transmitter installations.

The design and construction of transmitters to operate in the short wavelength band has always been a problem requiring special engineering consideration. Connecting wires must be kept at the minimum length—a necessity which has hampered designers in their efforts to provide the proper spring suspension to enable the apparatus to withstand the vibration and movement of the ship. In Model ET-3674 this difficulty has been met by the ingenious mounting of the entire transmitting panel on four, half-elliptical automobile springs. Thus instead of suspending certain parts within the case on springs, the entire transmitter is made to "float" on automobile springs which insulate all parts against vibration and shock.

For the practical testing of this new transmitter it was installed on the *S.S. Santa Maria,* in addition to her regular radio equipment. This enabled us to make direct comparison of its performance with the regular equipment under exactly the same conditions. The results obtained with the new model are more than gratifying, as the log shows. During the first day's sail from New York on her trip south, the *Santa Maria* was in communication with the station at Portishead, England, as well as San Francisco and Norddeich, Germany. All reported strong signals. Two days later a radio station in Otchishi, Japan, also reported loud signals from the *Santa Maria.* These are but a few of the highlights of the tests, during which the *Santa Maria* was in communication with a score of stations under many different atmospheric conditions.

The principal advantage of being able to employ a single transmitter for both intermediate and short wavelength work is that it makes possible the greatest efficiency of a given power under all conditions. For example, communication over average distances of a few hundred miles is most often best accomplished on the intermediate frequencies. On the other hand, the high frequency or short wavelength band usually proves best on very long distance work as has been demonstrated on many occasions.

# Counteracting acoustic feedback through the tuning condenser

By Zeh Bouck*

THE advent of the console receiver, in which the loudspeaker is mounted in the same cabinet with the tuning apparatus, gave rise to serious problems in acoustic feedback. An initial surge in the speaker fed back to the receiver proper, partially through the chassis supports and partially through the air, setting up the familiar sustained howl. Acoustic feedback was mostly effected through vibration of the audio-frequency tubes—the detector and first a-f. amplifier. Cushioning these tubes, as well as dampening by means of weighted caps and the strengthening of the elements in the heater-cathode designs, have been effective in eliminating this particular species of feedback with all but defective or highly microphonic tubes.

However, with the greater intimacy between the loudspeaker and chassis, occasioned by the increasing popularity of the midget receiver, a new problem arises involving a somewhat more subtle analysis. The feedback in this instance is through the plates of the tuning condensers, the vibrations causing slight variations in capacity which modulate the incoming carrier, are demodulated in the detector circuit, and are passed through the audio system, building up into a howl. Careful cushioning of the entire chassis has been effective to an extent in reducing this acoustic instability, but obviously can have no effect on feedback through the air itself.

A consideration of the manner in which capacity varies with spacing suggests several modes of attack of varying degrees of practicability. The capacity of a variable air condenser having a certain number of plates of a definite area, and at any given dial setting, can be expressed by

$$C = K / D \qquad (1)$$

where D is the spacing between the plates.

By differentiating, we get an expression for the rate change of capacity with spacing

$$dC / dD = -K / D^2 \qquad (2)$$

This expression indicates that, for small variations in spacing, the change in capacity will be inversely proportional to the square of the original spacing. In other words, as the spacing in a tuning condenser is decreased, the effect of vibrations on the capacity increases by practically a square law. In an effort to conserve space in small receivers, such as the midgets, by using fewer plates and closer spacing, the results of such vibration have necessarily been pronounced to a considerable degree. One solution of the problem, as obvious as its impracticability if compactness is to be maintained, is to increase the spacing between the plates, with larger plate areas, more plates, or both.

If it were possible to maintain the same amplitude and phase of vibration in both the stator and rotor plates, modulation effects would not ensue. This condition, however, in view of size difference and manner of staking, may be passed by as a physical impossibility, though, as will be pointed out later, some effort might be made in this direction. For the sake of our argument we are justified in assuming that one set of plates remains stationary (the stators) while the rotors are free to vibrate in accordance with the audio frequency impulses impinging upon them.

Delving further into the capacity equation (1), the resultant capacity with a reduction in spacing may be expressed by

$$C + \triangle C_1 = K / D - \triangle D$$

and similarly the capacity with an increase in spacing by

$$C - \triangle C_2 = K / D + \triangle D$$

Rearranging these equations to define explicitly the changes in capacity, and combining with equation (1)

$$\triangle C_1 = K / D - \triangle D - K / D = K \triangle D / D (D - \triangle D) \qquad (3)$$

and

$$\triangle C_2 = K / D - K / D + \triangle D = K \triangle D / D (D + \triangle D) \qquad (4)$$

Obviously

$$\triangle C_1 > \triangle C_2$$

In other words, the change in capacity for a given decrease in spacing is greater than the change in capacity for the same increase in spacing.

However, if the amplitude of vibration is slight—if $\Delta D$ is made small enough $\Delta C_1$ and $\Delta C_2$ approach a common limit, dC, and for practical purposes $\Delta C_1 = \Delta C_2 = \Delta C = dC$. The total change in capacity may then be expressed by

$\Delta C - \Delta C + \Delta C - \Delta C \ldots$ to n terms, n being the number of dielectric spaces. The $\Delta C$'s cancel, and the net change in capacity is zero. One way in which this condition can be attained is by reducing the amplitude of vibration to such an extent that the gain in capacity as the plates move toward the stators on, say the right side, is equivalent to the capacity lost in moving away from the plates on the left side. This condition may be obtained by using heavier plates of a material that is acoustically sluggish. It is reasonably certain that an alloy can be developed which will be more satisfactory for condenser plates than the metals used today.

### Improvement Possible

However, it is still possible to improve matters without varying the design of our present-day condensers—even the closely spaced midget type. While we have assumed, in the case of the ideal condenser described above, that $\Delta C_1 = \Delta C_2$, outside of an infinitely small vibration this, mathematically, is,

*Chief engineer, DeJur-Amsco Corporation.

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**Reduction of condenser dimensions, and of plate spacing, for the modern midget receiver, introduces distortion. This article by Mr. Bouck points to a practical solution of the difficulties.**

ot course, not the case. $\Delta C_1$ will always be greater than $\Delta C_2$, and the summation $\Sigma\Delta C_1 + \Delta C_1 + \Delta C_1 + \Delta C_1 \ldots >$ $\Sigma\Delta C_2 + \Delta C_2 + \Delta C_2 + \Delta C_2 \ldots$

Any vibration will result in a net increase in capacity, though the amplitude may be kept sufficiently low to prevent more than a negligible modulation, by the use of heavier plates, as already suggested, or by the *very careful centering of the rotor plates.*

If we substitute $D_1$ for D in (3) and $D_2$ for D in (4), and make $D_2$ larger than $D_1$, it is apparent that $\Delta C_1$ will become still greater than $\Delta C_2$. This is the condition existing when the rotor plates are not exactly centered between the stator plates.

When the plates are exactly centered the same increase in capacity will be occasioned by a right-hand shift as by a left-hand shift of the plates. Therefore, the modulation frequency will be the second harmonic of the audio frequency, and, aside from asymmetrical variations caused by simultaneous vibrations of both rotors and stators (dissimilar in respect to phase and amplitude) there will be no tendency to regenerate. (In completing one cycle of audio-frequency response, the vibrating plates will move from the center position to the left, with a capacity increase, back to the center and over to the right with another capacity increase and back to center, giving double frequency modulation.) However, when the plates are not centered, a movement in one direction will cause a greater capacity increment than the movement in the opposite direction, resulting in modulation at the fundamental frequency, with ensuing regeneration.

It should be possible, therefore, to reduce acoustic feedback through the tuning condenser by more rigorous production methods effecting the following improvements.

1. More perfect paralleling of the plates.

2. The centering of plates by mechanical rather than visual spacing.

An approach toward perfection in these two considerations would reduce the amount of bending of the outer plates necessary to secure alignment, which process, on inspection of the foregoing discussion, evidently tends in itself to promote the conditions essential to feedback.

Probably additional staking of the rotor plates along the unmeshing edges, with less staking of the stators, would be attended with a more uniform vibratory period in both sections and a reduction of capacity.

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# An amplification of ten quadrillion times

A DEVICE which amplifies an electric current ten quadrillion times was exhibited by E. S. Darlington of the vacuum tube engineering department of the General Electric Company at the radio and electric show of the Electric League of Washington, D. C., which opened September 21. The device is a low-grid-current tube, which in conjunction with a Thyratron tube is capable of utilizing 0.00000000000000001 ($10^{-17}$) ampere to control 0.1 ampere—or 100 milliamperes—directly. The grid cap or terminal of the tube which picks up these minute charges from space is smaller than an ordinary thimble.

As a means of demonstrating the remarkable sensitivey of the low grid-current tube, Mr. Darlington utilized the relatively small amount of current generated by rubbing an amber rod with a piece of paper to turn on and off an incandescent lamp, with the amber rod at varying distances of from 5 to 15 feet from the small box on which the sensitive tube was mounted. On the front of the box was a meter which showed plainly to what degree the tube was being affected by positive and negative charges obtained by rubbing the rod. Connected to the box was another one, on top of which were mounted a Thyratron tube and an incandescent lamp. Current was supplied to the lamp by the Thryatron tube; and the minute charge from the amber rod was amplified by the low-grid-current tube sufficiently to operate the Thyratron tube and turn the lamp on or off according to whether the charge was positive or negative. A current of $10^{-17}$ ampere thus directly controlled the 0.1 ampere used by the lamp.

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### The Edison Polar Relay

The invention of the Edison polar relay was covered in patents taken out by Mr. Edison in 1873 and 1874, for duplex and quadruplex systems of telegraph. His first duplex patent was No. 147,917, issued April 23, 1873, Patent 150,846 of April 23, 1873, referred to the relay. The seven patents issued to Mr. Edison in August, 1874, covered the duplex and quadruplex as finally completed. The patent numbers were: 178,221, 178,222, 178,223, 180,858, 207,723, 207,724 and 480,567.

### Electrolysis

Electrolysis is the name given to the action which takes place when electric currents from street-car tracks or other foreign sources are allowed to flow through the lead sheaths of underground cables. At the point where the current leaves the lead sheath and reenters the earth on its way back to the power-station, electrolytic action takes place which destroys the sheath in spots, permitting moisture to enter in and short-circuit or lower the insulation of the cable conductors.

▲

### Ohmic Equivalent of Back E. M. F.

The ohmic equivalent of back electromotive force E; that is, resistance R which is added to the circuit when the motor is prevented from turning its armature, causing the current I, flowing in the circuit, to remain unaltered, is

$$R = \frac{E}{I}$$

▲ ▲ ▲

# Short-wave radio for Alberta (Canada) police

**Calgary headquarters of the Alberta Provincial Police has recently been equipped with short-wave radio apparatus. Broadcasting and receiving sets are being installed in all divisional headquarters throughout the province, following the one year experiment carried out successfully in British Columbia. The set operates on a low wavelength, with the call letters CGS. In the future, the service will be extended to radio equipped cars permitting provincial police patrols to keep in constant touch with headquarters.**

# Details of Radio City are revealed

BIDS have been received from general contractors for the construction of three of the most important units in the colossal mid-town building project, popularly known as Radio City, which will transform the three blocks between Fifth and Sixth Avenues, from Forty-eighth to Fifty-first streets, New York City, into the world's greatest entertainment, office and shop center under one ownership.

Approximately one-quarter of the space in the entire development, which is being built by the John D. Rockefeller, Jr., interests, will be leased as offices, studios. and theatres by Radio Corporation of America, the National Broadcasting Company, RCA Photophone. Inc., and Radio-Keith-Orpheum Corporation. RKO offices will be in the 31-story building on the Sixth Avenue side of the block between Fiftieth and Fifty-first streets.

The largest of the three units will be a 66-story office building with a 16-story wing. This structure will have a floor space, of 2,500,000 square feet, nearly half a million square feet in excess of the gross area of any other office building in the world today. It will occupy more than half of the middle block. This is the structure which will house the executive offices of RCA, the NBC general offices and studios and, in the 16-story wing, the RCA Photophone offices and studios.

A second unit is the International Music Hall of RKO, world's largest theatre, to be located on the west half of the block between Fiftieth and Fifty-first streets, and flanked on the Sixth Avenue side by a 31-story office building, where the offices of RKO will be. Similarly situated in the block between Forty-eighth and Forty-ninth streets will be a capacious RKO sound motion picture theatre, completing the triumvirate.

Excavation work has been in progress for several weeks on the sites of the three structures. Their actual construction will start some time in the autumn. The theatres will be completed by October 1, 1932, and the office building by May 1, 1933.

The plans, slightly changed in detail from the preliminary ones announced some months ago, show a radical innovation in architectural city planning. The lower roofs and setbacks of the building in the three blocks will be turned into a modern and much magnified Hanging Gardens of Babylon. Seven acres of intensive landscaping will be devoted to waterfalls, fountains, reflecting pools, trees, shrubbery, formal flower beds, multi-colored tile walks, grass plots, and statuary. Plans for covering the outer walls of the buildings with a heavy network of living ivy are also a tentative part of the scenic picture.

An acre of ground space, visible from the street, will be devoted to a Sunken Plaza, studded with a central 30-foot fountain, smaller fountains, statuary, grass, flowers and mosaic pavements. In following out this plan, more than $17,500,000 worth of open land area will be devoted to beautification for the public's benefit. without any revenue to the owners of the development. Between a quarter million and a half million dollars will be spent on the general landscaping.

Forty feet above the roof of the 16-story wing in the center block. a curved waterfall, a miniature of the famous horseshoe falls of Niagara, will send a tumbling torrent through a series of cascades to end at the roof level in a reflecting pool, from 80 to 100 feet long and 25 or 30 feet wide. The waterfall will have 50 feet of spillway, with approximately a 30-foot radius between the ends of the arch. The water from the spillway will drop about 20 feet into a ribbon pool, thence about 10 feet into another ribbon pool, from which it will spill into the large reflecting pool at the roof level. Fountains will play at each end of the lower pool.

Thirty-foot trees, shrubbery, grass, flowers, and multichromatic walks will furnish a general background for the water effects.

There will be two levels of landscaping above the studios of the National Broadcasting Company, in the lower roof area between the main building and the main east wall of the 16-story wing. These areas will be at the thirteenth and eleventh floor levels and connected by stairways. They will have terraces, formal flower gardens, benches and geometric grass plots, with at least two small fountains. The general appearance will be that of a formal garden.

Sunken plaza with view of entrance to world's largest office building in floor area.

## Canada has 452,879 receiving sets licensed

**Figures on privately owned radio receiving sets issued recently show a total of 452,879 radio sets licensed in Canada on August 1. Toronto leads the list with a total of 68,034, Montreal second with 56,072 and Vancouver third with 23,196.**

# A neon tube audio-frequency oscillator

By Dale Pollack

ONE of the most important pieces of apparatus in the radio laboratory is the audio-frequency oscillator, which has a multitude of applications in the testing and design of receivers. So long as the desired audio-frequency is fixed, the problem of obtaining a suitable current supply is not a difficult one, and may usually be satisfied by means of a simple vacuum tube oscillator, such as the one diagrammed in Fig. 1; the strong dynatron characteristic of the screen-grid tube has also been used recently to this end in circuits similar to that shown in Fig. 2.

However, the problem of securing a satisfactory audio-frequency supply, which is continuously variable to both extremes of the audio spectrum, preferably with single dial control frequency, is not a simple one. It is not practicable to construct a vacuum tube oscillator to generate frequencies variable from, for example, 50 to 5,000 cycles per second and still control the oscillation frequency with only one dial. If circuits similar to Fig. 1 and Fig. 2 are employed, the necessary changes in the inductance or capacity in the oscillator circuit would be much too great, and render their use infeasible with ordinary apparatus.

The search for an oscillator which could be controlled over the wide range necessary for the audio oscillator has led to the development of the beat oscillator. In this type of instrument, two similar vacuum tube high-frequency oscillators are interconnected in such a way to a third tube that, if the frequency of one of the oscillators is made to differ from that of the other, a beat note will be produced whose frequency is equal to the difference in frequency between the two oscillators, the beat being made audible in the third "mixer" tube.

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**Description of a little known audio oscillator circuit.**

A variation in capacity of .0001 mfd. in the circuit of a tube oscillating at 500 cycles would produce a negligible effect on the oscillation frequency, but a similar change in capacity in the circuit of an oscillator operating at 50 kc. would produce perhaps a one thousand cycle variation in its frequency. Large changes in the beat frequency may thus be made with only small changes in the circuit constants. In this manner the beat oscillator considerably simplifies the problem of single dial control of an audio-frequency source. Unfortunately, however, a satisfactory beat oscillator is difficult to make, because of certain intricacies which arise in its design, and, hence, its construction very often is complicated. For this reason a beat oscillator is an expensive apparatus, and, when several oscillators are needed, their purchase is often prohibitive. Were it not for its prohibitive cost and complex construction, there is no doubt that the beat oscillator would be superior to any other type of variable audio-frequency generator, but a simpler and less expensive instrument must be sought.

It is the purpose of this article to present the use of a little-known oscillating circuit employing a neon tube in the rôle of an audio-frequency oscillator. It has almost escaped notice that the neon lamp, of television and advertising fame, may be caused to oscillate in a simple circuit. If a neon lamp is connected as in the diagram, Fig. 3, and a voltage of sufficiently high potential is applied, the lamp will flash intermittently, and an accompanying oscillatory current will be generated across the terminals of the tube.

It is not difficult to explain the cause of this oscillation phenomenon. If the voltage applied to the terminals of the circuit is gradually increased from zero, the lamp will not glow until after a certain critical voltage, the ignition voltage is surpassed. However, once the ignition potential has been exceeded, the voltage may be reduced and the tube will not be extinguished, even after the applied voltage has fallen short of the ignition voltage, until the voltage reaches another critical voltage, the extinction potential, after which the lamp finally goes out. Now, if the tube is connected in the oscillatory circuit of Fig. 3, and a battery potential higher than the ignition voltage is applied, the condenser will begin to charge, creating a voltage drop across the resistor. As the condenser charge builds up, the drop across the resistor diminishes until the voltage across the condenser finally exceeds the ignition voltage, when the lamp lights. Since the lamp in this condition is a far better conductor than when dark, the condenser discharges through it, and the voltage soon drops below the extinction voltage, darkening the lamp. The cycle is then repeated at a frequency determined by the constants of the neon tube, the applied voltage, and the values of the condenser and resistor.

Pearson and Anson[1] have shown that the frequency of oscillation of a neon tube is inversely proportional to the products of the resistance and capacity in that circuit. Frequencies varying from one cycle in five minutes to 95,000 per second have been obtained from this type of oscillator.

The neon tube oscillator may be conveniently substituted for the beat frequency oscillator in many of its applications, in fact, in any position where a sinusoidal waveform is not essential. Its characteristics are such that the audio-frequency range may be completely covered with a condenser of

[1] *S. O. Pearson and H. St. G. Anson, Proceedings, Physical Society, (London), 34, 204, (1922).*

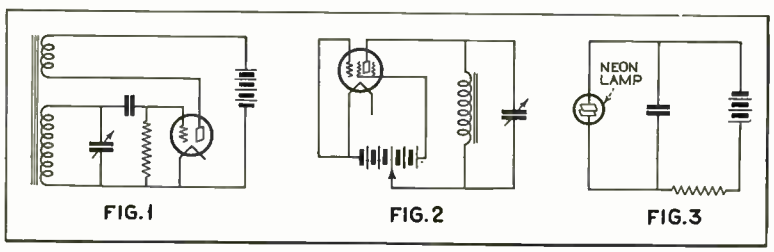


Fig. 1. Audio oscillator for fixed frequency use.
Fig. 2. Screen-grid tube used as dynatron audio oscillator.
Fig. 3. Neon tube oscillator circuit.

reasonable dimensions. The circuit of the neon tube oscillator, in conjunction with an amplifier, is given in Fig. 4. Additional stages of amplification may, of course, be added in the usual manner, if desired, but, with one tube, as shown, a loudspeaker is actuated at a comfortable level. Where a large output is necessary, a type '45 tube should be substituted for the '27 and the voltage should be increased to 300, if it is desired to preserve the original waveform.

The operation of the oscillator is very simple, as the positions of $R_1$ and $R_2$ are not critical. $R_2$ should be adjusted until the vacuum tube draws its normal plate current, which, with the type '27 tube, is 5 milliamperes. The value of $R_1$ is gradually increased from zero, until the neon tube begins to oscillate. It should be noted that the tube will not oscillate until the value of the resistor exceeds a critical minimum. Variation of the oscillation frequency is then obtained by means of the variable condenser; with a 1,000 mmfd. condenser as shown, a frequency range approximately from 5,000 to 35 cycles will be covered. A satisfactory neon lamp for use in this circuit is the Cooper-Hewitt G-10, which may be purchased at small expense, but any other lamp which may be available will operate equally well. If frequency stability is a necessary feature, the lamp should be operated in the oscillating condition for ten minutes to permit the lamp parts to reach their normal operating temperature, before any precise measurements are made.

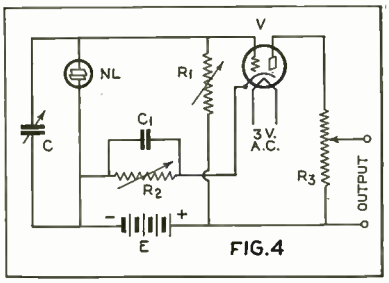


Fig. 4. Variable neon tube audio oscillator and amplifier.
C—.001 variable condenser.
C1—2 mfd. by-pass condenser.
R1—0-5 megohm, variable resistor.
R2—0-25000 ohm, variable resistor.
R3—10000 ohm output potentiometer.
NL—Neon lamp.
E—200 volt potential source; may be either battery or "eliminator."
V—Type '27 vacuum tube.

The wave shape of the voltage across a neon tube oscillator is of the form shown in Fig. 5. The voltage, as is shown, varies between the two critical voltages of the lamp. Reich[2] has used the peculiar saw-tooth characteristic to advantage in the measurement of frequency discrimination in audio-frequency amplifiers and in detectors. He found that the amount of curvature which occurs in the positive branch of each saw-tooth, as observed in an oscillograph, after having passed through the amplifier being tested, is a measure of the amount of distortion taking place. In this manner any inequalities in amplification at different frequencies may easily be made evident.

[2]*H. J. Reich, Proceedings, Institute of Radio Engineers,* 19, 401, (1931).

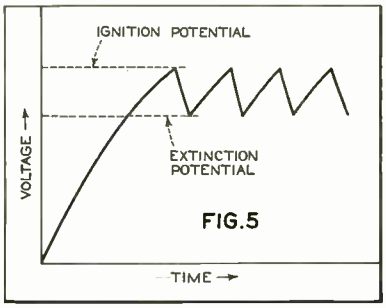


Fig. 5. Waveform produced by neon tube oscillator.

The neon tube oscillator is ideally suited for modulating radio-frequency oscillators used in the production and service testing of radio receivers. Its superiority in the matter of portability makes it particularly valuable.

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# Attenuation measurements on telephone and telegraph lines

By J. W. Horton*

In its most elementary form the measurement of the attenuation of a telephone or telegraph circuit consists of measuring the power delivered to the line at the transmitting end and of measuring the power delivered by the line at the receiving end. The attenuation-frequency characteristic of a line is obtained by repeating these measurements at a suitable number of known frequencies.

In making these measurements, the impedance of the load to which the line delivers energy is generally made equal to, or matched to, the characteristic impedance of the line, which can usually be considered as a pure resistance without appreciable error. If this matching condition is met, the power delivered by the source of energy to the line is identical with the power which the same source would deliver to the load, were the latter connected to the source in place of the line. Furthermore, when the line is connected between the source and the load, the voltage across its input terminals and the voltage across the load terminals may be used as an indication of the power received and delivered, inasmuch as these voltages are impressed upon circuits of equal impedance.

In practice, therefore, the measurement of line attenuation is effected by terminating the line in a suitable load impedance, and in measuring the voltages across its input and output terminals. From the ratio of these two voltages, the attenuation of the line, in transmission units, is obtained by the following equation:

$$N = 20 \log_{10} \frac{V_{in}}{V_{out}} \text{ decibels.}$$

In practice, the voltage at the receiving end of the line generally has a magnitude so small that it cannot be

*Chief Engineer, General Radio Company.

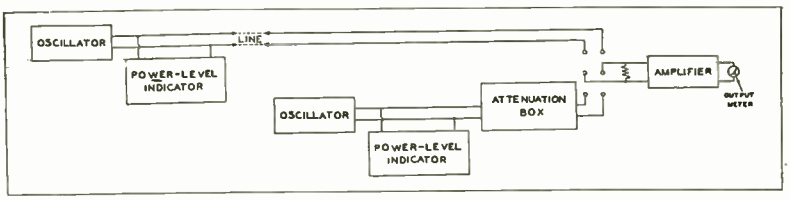


Fig. 1. Apparatus and connections for measuring line attenuation by the modification of the standard method described in the accompanying article.

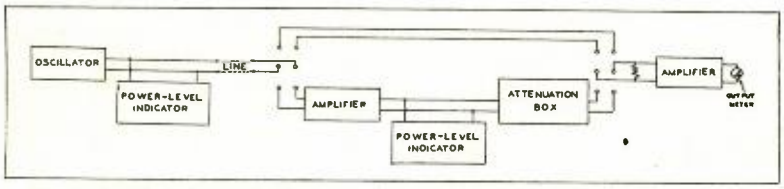


Fig. 2. A method of measuring line attenuation like that of Fig. 1, except that an amplifier replaces the oscillator at the receiving end of the line.

measured by any available calibrated instrument. It is customary, therefore, to resort to a substitution method in which a calibrated attenuator, having the same impedance characteristic as the line, is used at the receiving terminal. The arrangement of circuits is shown in Fig. 1.

The attenuator receives energy from a source similar to that connected to the transmitting end of the line. The voltage across the input terminals of the attenuator is adjusted to be equal to the voltage across the input terminals of the line; hence, as the impedances are equal, the power delivered is the same in each case. An amplifier having an input impedance equal to the characteristic line impedance, and therefore suitable for use as a load, is connected alternately to the line and the calibrated attenuator, and the latter adjusted until the output of the amplifier as indicated by any suitable instrument is the same for both connections. When this condition is reached, the voltage set up across the load by the line is equal to the known voltage set up across the same load by the calibrated attenuator. For convenience, the latter is calibrated in transmission units—generally in decibels—and, hence, the attenuation of the line is indicated directly by the setting of the attenuator.

As has already been noted, the calibrated attenuator must have the same characteristic impedance as the line. This condition applies only to the input terminals of the attenuator, and it is imposed in order that equal voltages across the input to the line and the input to the attenuator shall indicate equal amounts of power. When this condition is met, it is apparent that the calibrated attenuator presents the same impedance to the secondary source as would the load, were the secondary source and the load connected directly together.

Provided that the input impedance of the attenuator is the same as the load impedance, it is unnecessary for the output impedance of the attenuator to match the load impedance, inasmuch as the indicated attenuation for any setting refers to the actual ratio between the power supplied to the attenuator and the power delivered by the attenuator to the load. In other words, in those attenuation networks which present a constant impedance to the source only (i. e., L-type networks) the loss due to the impedance mismatch on the load side is included in the calibration.

In making the measurement outlined in the preceding discussion it is, of course, necessary to be sure that the frequency of the current supplied to the line and the frequency of the current supplied to the calibrated attenuator are identical. In order to avoid the necessity for repeatedly making this adjustment, and also to permit the measurement to be made in cases where a duplicate source may not be available at the receiving end, it is possible to carry out the measurement as indicated in Fig. 2. In this figure it will be noted that the oscillator of Fig. 1 is replaced by an amplifier which may be connected to the line whenever the load is connected to the output of the calibrated attenuator. The amplification of this secondary source amplifier is adjusted until the voltage across the input end of the attenuator at the receiving terminal is the same as the voltage across the input end of the line at the transmitting terminal. In this case, it is apparent that the frequency of the current delivered to the attenuator must be identical with the frequency delivered to the line. One objection to this method lies in the fact that the wave supplied to the attenuator may fail to duplicate exactly the wave supplied to the line, due to the presence of interference picked up by the latter.

It should be noted, in connection with the alternative source of local current just described, that it is unnecessary for the input impedance of the secondary source amplifier to match the line impedance, inasmuch as the efficiency of this connection plays no part in the measurement. It should further be pointed out that it is quite unnecessary to know the gain or amplification of the source amplifier, or of the load amplifier used in making the voltage comparison; the frequency characteristics of these amplifiers are, consequently, of no importance in connection with the attenuation measurement, provided that the gain is adequate at all frequencies.

To summarize the requirements imposed on the measuring equipment, therefore, we note that the calibrated attenuator must be designed so as to have the same input impedance as the line with which it is to be compared, and that the impedance of the voltage-indicating amplifier, which is connected alternately to the line and to the calibrated attenuator, must match this characteristic impedance.

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## MARINE RADIO STATION TO BE ERECTED IN INDIA

THE first wireless station for ship-to-shore communication in India is to be erected at Bedi Port, Nawanagar State, according to a recent report. The station will be equipped with a tube transmitter capable of reaching vessels 800 to 1,000 miles at sea and its reception apparatus will have a range of 10,000 to 20,000 meters. The reception service is expected to include daily news bulletins from the station at Rugby (England) and other powerful stations throughout the world. The aerials are to be supported on lattice steel towers similar to those employed by the Bombay Broadcasting station at Worli, Bombay. The station is scheduled to commence operation about October 1, 1931. (*Assistant Trade Commissioner Paul L. Hopper, Calcutta, India.*)

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## BUENOS AIRES POLICE DEPT. PLANS RADIO AND TELEPHONE COMMUNICATION SYSTEM

LIEUTENANT-COL. CARLOS H. RODRIGUEZ, in a statement to the press on June 8, made an appeal to the public of Buenos Aires, through the Prefecture of Police, to interest themselves and support the scheme for the introduction of a radio and telephone service for use exclusively as a guarantee of public safety, according to the Buenos Aires Herald, June 9, 1931. Colonel Rodriguez, in giving a brief résumé of the measures for the better security of the public which will be adopted when sufficient funds have been collected, gave as an example what is known as the "police circuit," which consists mainly of the linking up by direct telephones of police stations, points where policemen are on duty, banking premises, public and private buildings, with the Prefecture-General of Police. To complement the telephone service a wireless transmission station would be installed at the Central Department, which would use special short wave. The patrol cars would be equipped with receiving sets, permanently tuned in on the transmission station in such a way that interference or interruption through other stations would be impossible.

# A new television system

By R. W. Tanner

**A system of television is here described which has possibilities in throwing the received picture directly upon a screen, without employing a lens.**

IT is a well understood fact among television engineers that, if television is to become popular in the home, the entire apparatus must be small enough to be installed within a console of reasonable size. The tendency at the present time is to employ a very small scanning disc (one manufacturer has reduced the size of the disc to 6 inches in diameter) with a crater type neon lamp and project the picture on a screen located a few feet from the source of light.

This method can never be very satisfactory. By making the disc small, the size of the holes must be extremely small, reducing the amount of light passing through the holes to a very low percentage of that available. Again illumination is further reduced by the use of a projection lens which necessitates placing the screen at a considerable distance from the disc.

It would seem far better to employ some system using a scanner which would throw the picture directly on a screen without the use of a projection lens. In this case the loss of light would be less since the distance between screen and scanner would be decreased. Assuming a desired picture size approximately 15 inches by 18 inches, the dot elements would have to be about ¼ inch square. A disc having holes of this size would require a diameter of at least 28 feet, certainly a size not very desirable for public use.

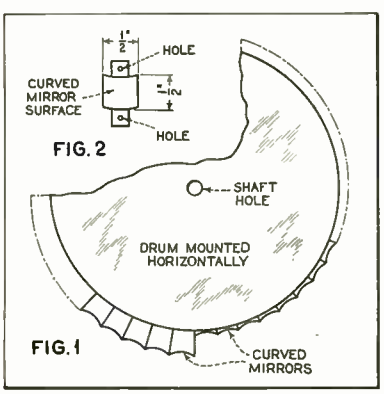


Fig. 1. Exaggerated sketch of the mirror drum.

Fig. 2. Curved mirror surface.

## Small Scanner

A new system has been developed which employs a small scanner, approximately 9.5 inches in diameter, and which throws a picture on a screen 15 inches by 18 inches. The scanner is located only 12 inches from the screen, making use of the available illumination to the fullest extent. The exaggerated sketch in Fig. 1 shows details of this scanner.

This is a mirror drum scanner similar to types used in Europe, but greatly improved. Mirrors, one for each pictorial line, are placed around the periphery of a hard rubber drum approximately 1 inch thick. Each mirror is placed at a slightly different angle, with respect to the axis of rotation, to give the vertical scanning. Horizontal scanning is accomplished by the horizontal rotation of the drum. The individual mirrors, instead of being plane mirrors, are slightly curved in order to provide a wider angle of reflection. If plane mirrors are used the picture size cannot be greater than 5 inches or 6 inches wide when the drum is located 12 inches from the screen. It is readily apparent then that the curved mirrors are a great improvement over the plane type. Fig. 2 shows details of the mirrors. The mirrors may be of monel or other metal.

Due to the light weight of the scanning drum, a motor of 1/25 h.p. is more than sufficient, making it easy to synchronize by means of a phonic wheel excited by the hole frequency in the signal.

The source of light may be a crator neon if desired. In the system here described a mercury arc tube is used. This tube contains a filament which heats a small pool of mercury. After mercury vapor is formed, an arc is created between two electrodes, having a very high intensity. Details of this tube are shown in Fig. 3.

## Source of Light

Generally the source of light is connected directly in the plate circuit of the power audio amplifier. This functions satisfactorily with neon and some other types of glow lamps. With mercury arcs there is danger that a dark strata may occur inside the positive column of light due to the direct current excitation. In this new system, stratification is avoided by lighting the arc by means of a radio frequency oscillator which is modulated by the power audio amplifier.

The oscillator is a 210 tube and the audio power amplifier a 250, resulting in an available power (to the mercury arc) of approximately 5 watts, depending upon the plate voltages. The 100 per cent modulation system is employed which increases the power to 20 watts on the modulation peaks. It should be understood, however, that it is never possible to fully realize the

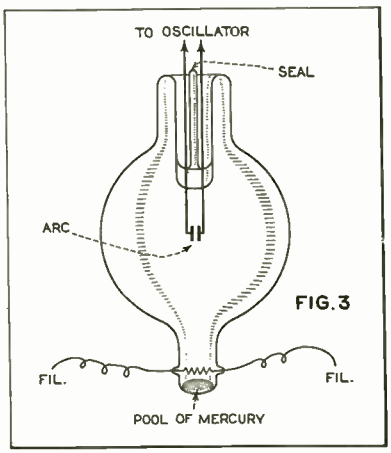


Fig. 3. Details of the mercury arc tube used in Tanner system for illumination.

full 20 watts in illumination from the arc tube due to the losses encountered in the transfer of the energy from oscillator to arc and within the tube itself.

In the first experiments with this system the light from the arc was thrown on the scanning mirror drum through a conical tube, large at the end towards the arc and ¼ inch square at the drum end. This cone was made from a piece of highly polished metal and rolled into a cone. Condensing lenses cannot be used, since, if the beam of light is focused to a small point on

the mirror, the rays spread to 3 inches at the screen.

While the polished metal cone produces very satisfactory results, a new device has been developed. This is merely a solid glass cone, preferably of quartz, ¼ inch square at the small end and increasing to 2 inches at the large end. The end facing the arc is concave as shown in Fig. 4. The entire glass is painted with a substance to render it opaque except the concave end and the small end.

### The Dark Box

The arc tubes and concentrating glass are inclosed within a "dark box" with only the small end of the glass showing. This box is then placed at the proper distance from the scanning drum and at the proper angle to the drum. Fig. 5 shows a sketch of the "dark box."

For a console job, the scanner, arc tube, etc., would be mounted within and having a ground glass screen in the front, throwing the light rays on the back of the screen. The audience would then observe the picture from the front. It is advisable and very desirable to mount the scanning drum so as to rotate exactly horizontally with the "dark box" at a slight angle throwing the rays up on to the scanner. The screen would then be mounted also at an angle with the top slanting inward. This is only a suggestion, however.

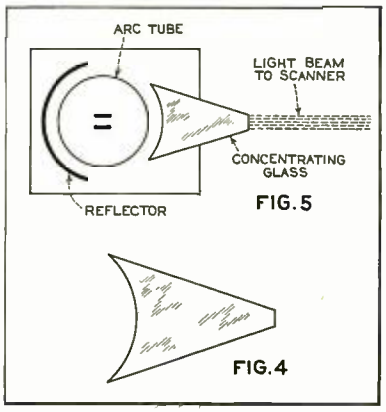


Fig. 4. Concentrating glass.

Fig. 5. Showing the arc tube, concentrating glass and reflector in the "dark box."

The Tanner television system has a great advantage over other systems employing discs in that all of the available light (not considering losses) from the arc is used for each pictorial element. With a disc, the light beam is focused to cover the entire space of the picture, each element then utilizing only 1/4320 part of the total light.

A new tube of the mercury-argon type is now under development for use with this new system. It is hoped that this tube will give still greater illumination than a plain mercury arc.

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# Some radio questions answered

IT is interesting to learn the nature of the questions forwarded to the offices of vacuum tube manufacturers.

Herewith are nine questions received by and answered by the engineers of E. T. Cunningham, Inc.:

Q.—Would it be practical to substitute a C-347 power output pentode in a receiver designed for a -345 power amplifier?

A.—No. This substitution would require considerable alteration in the circuit of the receiver. Also, it would be necessary to replace the output transformer with one designed for use with the C-347; furthermore, the loudspeaker might not operate efficiently due to the different characteristics of the pentode.

Q.—What causes dimming and brightening of the heating element of cathode-heater types of tubes?

A.—Varying line voltages sometimes cause this peculiarity, but more often it is due to expansion of the filament (heater). As the filament heats it expands and touches the insulator which encloses it. This cools the filament slightly, causing it to dim and, at the same time, to shrink. The shrinkage draws the filament away from the insulator and it goes back to the higher temperature and becomes brighter. This variation of heater temperature does not impair the efficiency of the tube, however.

Q.—How many different types of tubes are employed in the present-day a-c. radio receiver?

A.—Types extensively employed are the C-327, C-324, the CX-345 for output and the CX-380 rectifier. Some set manufacturers, however, have substituted the super-control C-335 in place of the -24, and the power output pentode C-347 in place of the CX-345.

Q.—I have a receiver which generally reproduces very well, but at times it loses volume and the tone becomes distorted. Can you explain this action and how it can be remedied?

A.—This would seem to indicate a tube in the set which has an intermittent short or open circuit, or it might be caused by a loose connection in the set. A swinging aerial also causes the same action at times. Suggest you have a serviceman inspect the tubes, circuit connections, and aerial.

Q.—What tubes are commonly employed in present-day sets using automatic volume control?

A.—The C-327 and C-324 have been used to very good advantage. Among the more recent types used for this purpose is the C-335.

Q.—What is a "ballast" tube and how is it employed?

A.—This tube is a device used for maintaining constant input voltage to a radio receiver by equalizing the line voltage variations.

Q.—Are the same type tubes employed with short-wave receivers as with broadcast receivers?

A.—Yes. The chief difference between the two types of receivers lies in the circuit design.

Q.—In what respect does the construction of the pentode differ from other screen-grid tubes?

A.—The pentode, in addition to having the control and screen-grids, also has a third grid, known as the suppressor. This latter grid is connected inside the tube to the cathode and serves to eliminate the secondary emission effects which limit the output of four-electrode screen-grid types.

Q.—We would appreciate a description of a simple circuit for finding the emission current of a tube.

A.—For this test, the grid and plate are connected and 50-volts applied across the terminal of this connection and the negative filament connection. A 0-200 milliammeter and switch are placed in series with this voltage supply. When the switch is closed the emission current is read from the ammeter. The switch should be closed only long enough to make the reading, otherwise the tube may be damaged.

### NEW TUBES FOR BROADCAST STATIONS

*In the December issue of* RADIO ENGINEERING *will appear a special technical article describing and illustrating the new high-power tubes being introduced in modern broadcast stations. A study of this important paper will bring radio engineers up to date in this subject.*

# Broadcast station coverage surveys

By V. V. GUNSOLLEY

**Radio stations dependent upon commercial support must employ dependable methods of determining their regular listener audiences.**

THE public has come to take radio for granted. The public no longer is largely responsive except to the most unusual programs and these are very few and far between. The more programs of the unusual type the public is given, the less unusual programs become and the more difficult it becomes to stand the public on its ear, so to speak.

The station that can command the most attention is the one making the most money, provided it is otherwise well managed. But there is also one other besides the public whom the station must attract, if it is going to make any money at all, and that is Mr. Advertiser. While he is really a part of the public, yet he sees the radio broadcast from an entirely different viewpoint, and stations with an eye for business are beginning to cultivate him industriously. In this respect about the best cultivating tool is a "bang-up" station survey that gives all the "facts" about the station in easily digestible form; graphs, color charts, maps, testimonials, etc.

So the holiday is over. The responsibility of management is increasing. The day is past when any former "ham" can manage a broadcasting station. The need for business principles is paramount as in other intricate businesses. It is very detailed and complex, requiring minute attention to a multitude of small but exceptionally important items. It combines at once the exactness of engineering with the uncertainty of the show business. It requires both cold, logical engineering and hot, gambling showmanship; two most incompatible elements, and lucky indeed is the organization that has solved the problem of delegating responsibility so that none of the gambling is done in the engineering, and that none of the engineering is done in the gambling. Programs can no more be built by cold plan and logic than can popular song hits. There is no accounting for tastes, and the sooner planning boards discover this the sooner some of them will be disbanded. It takes intuitive genius to pick and plan programs just as it does to pick Broadway hits, and no such foresight seems to exist on any planning commission.

There is one reliable guide, however. It is the station survey. It gives no information in advance, but it tells how well the program gets along. It is like theatre applause. It tells nothing of the mechanics or structure of the program, but tells in a general way what "works." It mirrors public preference but does not account for it. For some unknown reason a second program, like the first in principle, may fall flat. But unless a survey is made the program director is serenely ignorant of the fact notwithstanding that all the while the public suffers and station popularity unaccountably wanes. Thus there is need for constant sounding of public preference. It is the function of the survey to do this.

Some are in the broadcasting business for the fun they get out of it, much like any other hobby. They subsidize their station with the earnings of some other more profitable business in which they are engaged. It is a satisfaction to their pride and vanity to be able to have a broadcasting station for a plaything and as long as they are having a good time and getting publicity out of it, it matters little whether both ends meet or not. However, in the more general case, the only object of business is to secure a maximum of return for a minimum of investment, and, the whole study of business has the motive to determine what the minimum is in relation to the reasonable maximum. To find this relation in broadcasting, private opinion must give way to demonstrated public preference. A survey tells what this preference is but cannot always do away with private opinion. The station which is governed by the know-it-all, egotistical type of manager who is still coasting on the results of three years ago; or even three months ago, has a manager who is not trading in his car as often as he used to and this may not be because of the "depression." It is because his preference regulates, so far as his audience is concerned.

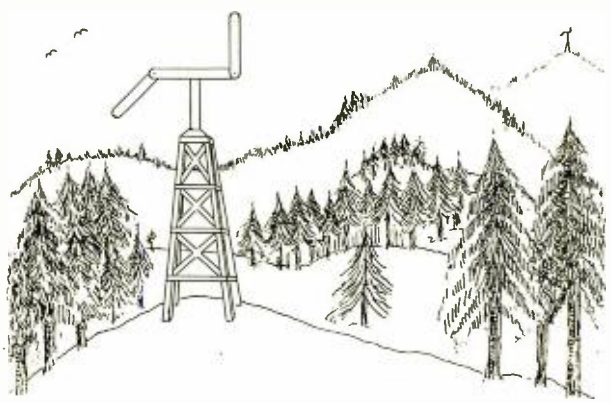
### Various Forms of Surveys

Station surveys take on various forms all of which may be divided into three classes, generally. They are:

1. Commercial analysis.
2. Listener analysis.
3. Field strength analysis.

Some surveys are a combination of all three forms; some well classified and others not so well defined.

The commercial analysis has two justifications. First, there are some stations that know only too well that they have no chance in a popularity race and that they could not make a very good showing therefore on the basis of public preference. They have little to present to the advertiser on which to base service charges. The commercial analysis then becomes a sort of a racket to draw the advertiser's mind away from the real issue



When distance communication was by means of visual, daylight semaphore signaling, coverage was not difficult to determine.

by filling him up with a lot of booster talk about all the opportunities there are for business in the territory served by the broadcasting station. It does not say how well the station serves, but depends for the most part on the advertiser's gullibility. An outline of a commercial analysis looks something like this.

### Commercial Analysis

(a) Number of and counties served with Class A, B, and C signal.

(b) Number of receivers by counties for both city and farm.

(c) Potential audience. (Without regard to time of season, day or hour and without regard for competing stations.)

(d) Number of commodity users in total and by counties for each principal commodity (automobiles, homes, farm implements, groceries, hardware, furniture, clothing, guns, boats, tobacco, etc., etc.)

(e) Bank deposits and postal savings, in counties served.

(f) Estimated value of all physical property.

(g) Life insurance in force.

(h) Internal revenue receipts.

(i) Value of all farm property.

(j) Cash income from crops and live stock.

(k) Value of manufactured products.

(l) Value of mineral products.

(m) Earnings of railroads.

(n) Breakdown of station rates based on potential audience.

It may readily be appreciated that the wise advertising salesman can take such an array of facts and impress the credulous advertisers. No doubt in time the advertiser will learn that such optimistic conclusions as may be drawn from the figures, are no guarantee of results on his investment. However, if the station is honest and bases its rates upon its actual service rather than on the commercial analysis, the advertising will pay, and the station will have another satisfied customer. There is no reason why one should not advertise over a station of small coverage any more than in a paper of small circulation, provided the rates are reasonable for the service rendered.

### The Survey

The second function of the commercial analysis is in combination with the listener analysis. These two analyses in combination form what is ordinarily termed a survey. In this respect it gives the prospective advertiser a statistical service that is helpful to him in deciding whether or not to advertise. The large advertiser or agency has all this information on file so that for him such an analysis is unnecessary. However, it is always desirable to round out a survey with a fair commercial analysis. It gives more plausibility to the main message the station has to drive home.

The listener analysis gives the station information as to who the listener is, what he does, and what he prefers. It shows what programs are liked best and gives some indication of how well any type of program is likely to be received. To the advertiser it gives valuable information as to what proportion of the listeners are likely to be in the market for his wares; that is, just what proportion is usable circulation. Not so many persons are in the market for roofing, harness or paint as there are for toothpaste, shoes or cigarettes. The advertiser whose product has a large proportion of usable circulation can be quite careless about what the proportion is. The advertiser with a patent poultry feed especially beneficial to chicks will choose the season for his message with some wisdom. The manufacturer of steam shovels and the builder of suspension bridges probably could not be convinced that there was enough usable circulation in proportion to the rates charged for time on the air.

### WESTINGHOUSE WILL RETAIN RADIO STATIONS

*"Certain rumors, which have been brought to my attention," states F. A. Merrick, president of the Westinghouse Electric and Manufacturing Company, "have been to the effect that this company is contemplating disposing of its interest in radio stations KDKA in Pittsburgh, WBZ in Boston, WBZA in Springfield, Mass., and KYW in Chicago.*

*"The Westinghouse Electric and Manufacturing Company has no intention of divesting itself of ownership, operation or control of its broadcasting stations."*

While to the station an hour must be productive of so much in revenue regardless of the message, to the advertiser the value of the hour depends upon the proportion of usable circulation. This means that the most valuable hours of the day will most likely be crowded with programs sponsored by advertisers whose products require a large percentage of usable circulation. These are some of the complications that make it difficult for advertisers and executives to understand the basis for station rates. The listener survey makes it less difficult to base station rates and gives a better understanding of what is going on in the minds of the listeners. The following outline gives some idea of the scope of such a survey.

### Listener Analysis

(a) Potential audience in different seasons, and on different days and hours.

1. City.

2. Country.

(b) Measure of effectiveness.

1. Percentage of potential audience actually listening for each of the various hours.

2. Percentage of usable circulation for the various commodities also by hours.

(c) Test of good-will.

1. Type of program liked best.

2. Best length of program to choose.

3. Relative appeal of the various types of program.

4. The tastes of the different divisions of the radio audience and how they vary from time to time.

5. Attitude toward record and transcription broadcasts.

6. Attitude toward chain broadcasting.

7. Attitude toward local programs.

(d) Results of the broadcast.

1. How sponsors obtain the highest efficiency from radio broadcasting.

2. The actual results obtained.

3. Coordination with other forms of advertising; adjustment to the advertising campaign.

4. How to convert the favorable impression into sales.

(e) Choosing the station.

1. Building arguments for the station using pertinent facts obtained from the survey.

2. How the station compares with others, both local and distant.

(f) Description of the average audience.

Comparison of the sexes, different ages, city versus farm, the different financial levels, etc.

(g) Basis of rates.

1. Comparison with costs for other stations and mediums.

2. Breakdown of station rates on basis of usable circulation for the various commodities.

Needless to say, the labor involved in securing timely information to fill out such an outline in great detail is very great. If the survey is to be completed before it is already out of date, a large corps of investigators and statisticians is required. This makes any attempt on the part of the station itself to turn out a survey very likely to be unsuccessful or at most very amateurish.

It is not an uncommon thing for a station naturally biased about its own importance to use information years out of date, and to use notions in place of facts regarding its coverage and popularity. Some stations have the idea that power is a basis for coverage and

map out a circle within which all listeners are supposed to give undivided attention to its programs. No thought is given to the matter of competing interest in the programs of other stations. One station formed its ideas of its own importance during its first birthday party during which interest was new and everybody who wired or wrote in received some kind of a prize. It now has the least popularity and the lowest usable circulation, naturally, but is unaware of the fact despite the difficulty it has in selling the advertiser its service. The depression gets all the blame.

The survey should be an honest disclosure of the facts since no wise executive will desire to deceive himself. He must be willing therefore to go to great pains and expense to find the facts. It will be least expensive in the end.

To find the facts! That is the question. How may they be discovered? Several methods are at once obvious.

1. House to house canvassers.
2. Mail questionnaires.
3. Telephone canvass.
4. Fan mail.
5. Actual results to advertisers.
6. Distress the program.
7. Keying the program.
8. Contests.
9. Requests for particular broadcasts.
10. Field measurements, or tests.

Sending out canvassers is the most expensive and the slowest but the most reliable and useful where detailed information is to be obtained. When done by a station in its own interests, likely it will not be reliably done for there is too strong a tendency to ask leading questions. If the lady of the house knows who the canvasser represents, she will not likely condemn the station as freely as she would if she thought the census taker were unbiased, and condemnation is likely to be the most valuable part of any census. The canvasser should be distinterested in any particular station. Whether he is or not will be disclosed by comparing his results with those of other canvassers and if his results are biased they will not run true to form. This may be suavely brought out by skillful conversation with the canvasser and if guilty he should be discharged. Herein lies the value of the station itself not making the survey. If an independent concern makes the survey, the canvasser need not know who is interested.

2. The second method is not very reliable since it must nearly always be addressed to a select list and therefore cannot reach a typical cross-section of the audience. The names must be obtained from some kind of a directory and no directory is complete. Furthermore, only those reply who are enough interested or who feel intelligent enough to do so, while those who do not reply listen to the radio and buy the advertiser's products just the same. Prizes are sometimes offered to stimulate interest in returning such questionnaires, but there is still much indifference on the part of those who nevertheless are good buyers and good listeners. Filling out a large questionnaire reminds one too much of the income tax statement, and any small questionnaire likely does not request enough valuable information to justify sending it out. However, the mail is very useful in obtaining a general response; to see how well some particular program is liked.

The third method, of using a telephone canvass, is in some cases very convenient, fast and quite reliable. It has the disadvantage that it is a selected list, but some advertisers feel that any one who has not a telephone is likely not the most desirable for their class of business, anyway, and actually value this form of survey the more. Of course, we know that this is not strictly true, but in general, the person with a telephone has more money with which to buy; uses the telephone to buy oftener since it is so convenient to order.

### Fan Mail

Fourth, fan mail is a very reliable index of the relative response to one program compared with another provided it is really applause mail and not something cultivated by the advertiser. In general, however, fan mail is a very unreliable guide and should be used with great caution when forming important decisions involving great expenditures.

The fifth method is to actually investigate the results obtained by the advertiser. Obviously this method can be used only after all the advertiser's results are in. If his is an emergency appeal in which the cry is to buy now, or where the customer has to buy in season, then up-to-date results may be obtained. In the case of the long-circuit appeal; the buy-the-next-time-you-need-it appeal, then it is seldom that such fact finding is of any value. Some businesses have had to greatly enlarge their production facilities as a result of consistent radio broadcasting and even though the appeal may be of the long-circuit type, it may well be pointed out as an example of the value of radio advertising as an investment.

### Interrupted Broadcasts

Sixth: Some advertisers actually have had their program interrupted at a crucial part where interest should be highest in order that the general flood of complaints may serve as an index to listener interest. This is dangerous since it has a negative effect on both the program and the station. When the distress is genuine, and unavoidable, the advertiser should not lose sight of this opportunity to observe coverage.

In the seventh method sometimes a program is keyed so that the advertiser knows how to trace his results. He then is enabled to find which program types produce the best results and use those types of program with greater frequency.

By the eighth method, which is that of using contests, interest is stimulated only for the duration of the contest, and results therefrom cannot be used as a general index.

A very reliable way of gauging how many are listening to a given program is to call for requests. The results are somewhat affected by the popularity of the program at the moment and many may be listening who are not interested enough either to send in a request or to re-dial. However, when the results are numerous, they are quite reliable as an index to listener interest.

### Engineering Inquiry

By the tenth method, that of field measurement, the station can get an engineering measure of its signal strength over its useful signal range. It is generally conceded that, other things being equal, the station with the greatest signal strength has the greater coverage. This conclusion has but little value, however, for it is seldom that other things are equal. A man will listen with headphones on, if necessary, to get a program he wants and can get nowhere else, while powerful local signals go to waste. The station with the greatest signal strength may prove to be only a greater nuisance than it would be with less signal strength. A 1,000-watt station can easily take the play away from a 10,000-watt station especially during the day time since both have closely the same range, and at night the more powerful station has so much competition with outside stations that even locally often it is "just another station." At fifty miles few stations enjoy a monopoly.

Since the listener does not usually understand the meaning of the term "microvolts-per-meter" it is hardly necessary to go to the expense of such a survey. It is practically as well to go to his home and make a test on his receiver. Then the broadcaster and the listener understand each other on the same terms. As soon as the broadcaster lays down a signal at the receiver that is free from interference in general, it matters not whether his signal is as strong as that of other stations or not, especially in the case of receivers having automatic volume control. When the slightest turn of the

(*Concluded on page* 38)

# Grid circuit linear detection

By James R. Nelson

THIS article will discuss briefly the operation of the screen-grid tube used as a grid circuit detector. This type of detector will be compared with the several types of detectors in common use in order to show its marked superiority as regards sensitivity under practical operating conditions.

Fig. 1 shows the $I_g$-$E_g$ curves of an ER-224 tube taken with 200 volts on the plate and 45 volts on the screen grid. The curves are taken with various a-c. input voltages on the grid. If the grid is returned to the cathode or the point of zero potential through a resistor R the d-c. potential for any input voltage may be found from the intersection of the curve for that input voltage and the load line drawn from the point of zero potential with a slope equal to 1/R. A one megohm load line is shown drawn in on Fig. 1. It can be easily seen that as R is increased the load line approaches the horizontal axis so that the change of d-c. voltage will be equal to the peak a-c. voltage applied to the grid provided the resistor R is by-passed for the carrier voltage. If the resistor R is not by-passed, all the a-c. voltage is not impressed on the grid and the change of d-c. voltage is correspondingly reduced. The resistor R is usually by-passed so that the following equation is approximately true with the value of R at least one megohm.

$$V = E \qquad (1)$$

where V is the rectifier voltage, E is the peak value of a-c. input voltage.

The method of operation is quite obvious from the curves. If an a-c. input voltage of E volts is applied, the grid will assume the d-c. potential given by the intersection of the load line, or the line drawn with the slope 1/R, and $I_g$-$E_g$ curve for that input voltage. If the modulation is 100 per cent, the d-c. voltage will vary between that given for 2 E and O, while if the modulation is any other percentage, M, the d-c. voltage, will vary at the modulation frequency between E + ME and E — ME. This a-c. voltage of modulation frequency thus developed in the grid circuit is amplified by the tube in the usual manner.

The audio output could be calculated in the usual manner knowing the Mu, $r_p$ and $R_p$ external. There are, however, several factors which are not taken into account in this method. The carrier frequency is also applied to the grid and the resultant carrier frequency current developed in the plate circuit limits the audio-frequency output. The Mu and $r_p$ of the screen-grid tube are also far from constant over the wide range of grid and plate voltages involved.

It is much better to determine the plate current-plate voltage characteristics directly, thus automatically taking into account the above factors. Fig. 2 shows the $I_p$-$E_p$ curves for 45 volts on the screen grid taken with various a-c. input voltages in the control grid. A 60-cycle input voltage was used, which was introduced with a megohm grid leak shunted by a 1 mfd. condenser in series with the tube, the 1 mfd. condenser having the same impedance at 60 cycles as a 100 mmfd. condenser at 600 kc. There was no a-c. impedance in the plate so that the conditions simulate those with the detector output by-passed for radio frequency. The audio-frequency output is found in the same manner as described above for the grid circuit.

A load line of 90,000 ohms is shown drawn in from 300 volts. The rectified voltage curve is shown plotted in Fig. 3-B for the 90,000 ohm load line. Rectification curves for 62.5 volts and 22.5 volts on the screen grid are shown in Fig. 3 A and C. The load line should be chosen to fit the battery conditions as a study of Figs. 2 and 3 will show.

The problem of finding the best external load may be explained physically by means of the curves shown in Fig. 2. For example, with 300 volts plate supply, the problem is to draw in a load line from this voltage intersecting the $I_p$-$E_p$ curve for zero carrier as far to the left as the curved portion will allow.

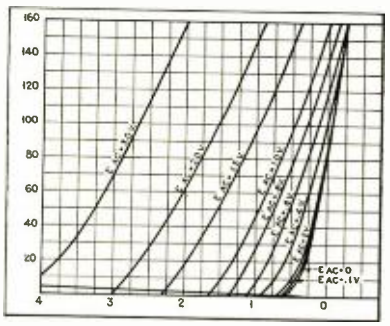



Fig. 1. Ig—Eg curves ER224 tube. Ep=200 volts. Esg=45 volts.

The load line drawn for 109,000 ohms, which is too large a value of resistance, illustrates this point. The rectified voltage output curve is drawn in Fig. 3-D for this case. The curve is fairly flat up to about 0.5 volt carrier. If a 0.5 volt carrier modulated 100 per cent were used, the audio-frequency voltage would swing from 9 to 0 volts and 9 to 47.5 or 9 volts on one side and 38.5 volts on the other, resulting in very bad distortion.

The rectification curve for 90,000 ohms is fairly good. The curve is about as linear as it is for bias rectification with considerably higher voltages. Lower values of resistance will also give fairly linear output curves. If a tube having a higher plate current is used, the load line remains stationary and the $I_p$-$E_p$ curves are shifted up. Thus for good results with all tubes the load resistance should be reduced somewhat from that found best for the average tube. It was found that a 10 or 15 per cent reduction from the optimum resistance found for an average tube would take care of the plate cur-

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**The study of the possibility of using a grid circuit linear detector to work directly into the power output stage has been somewhat neglected. The grid bias detector has worked well enough for practical purposes although it requires a large input voltage to obtain fairly linear rectification. This large input voltage imposes rather severe shielding and filtering problems on the amplifier design so that if the same results as are obtained with present detectors could be obtained by less radio-frequency voltage, a cheaper radio-frequency amplifier could be used.**

rent variations found in the ER-224 tubes.

### Sensitivity Comparisons

There is no standard method of comparing detectors. Sensitivity or dV/dE where dV is the small change of rectified output caused by a small dE of the carrier voltage expressed in peak value is one method which might be used and will be satisfactory here. The sensitivity is really the slope of the rectification curve and should be constant for an ideal rectifier.

In a previous article it was shown that the sensitivity of a C bias detector as the input voltage is increased approaches the value

$$S = \frac{\mu}{\pi} \frac{R_p}{r_p} \qquad (2)$$

where $R_p$ is the external resistance and $r_p$ is the internal resistance.

In the case of a triode, the ratio of $R_r/r_p$ may be made equal to two or three. The ratio of $\mu/\pi$ is also greater than one with the usual triode so that with a typical *227* tube, for instance, the sensitivity with fairly high plate voltages may be about 7. Curve A of Fig. 4 shows the sensitivity for a typical case.

In the case of an automatic bias detector the internal resistance is high so that the sensitivity is reduced considerably. Curve B of Fig. 4 shows that the sensitivity of a *227* tube used in a typical automatic bias detector circuit is only about 3.5 or one-half that obtained when used as a C bias or a fixed bias detector due to the large $r_p$ when used as an automatic bias detector. The reason for the increase of internal resistance is that the drop across the bias resistor is impressed on the grid which voltage opposes the effect of the plate voltage, thus increasing the resistance. The $I_p$-$E_p$ curves are much flatter and

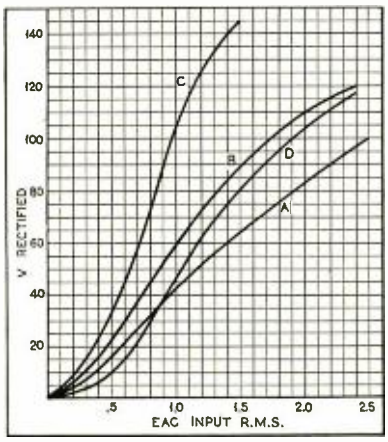


Fig. 3. Rectification characteristics, average ER 224 tube. Ep=300 volts.

A—Esg=67.5 V. Rp= 46,500 ohms.
B—Esg=45.0 V. Rp= 90,000 ohms.
C—Esg=22.5 V. Rp=256,000 ohms.
D—Esg=45.0 V. Rp=109,000 ohms.

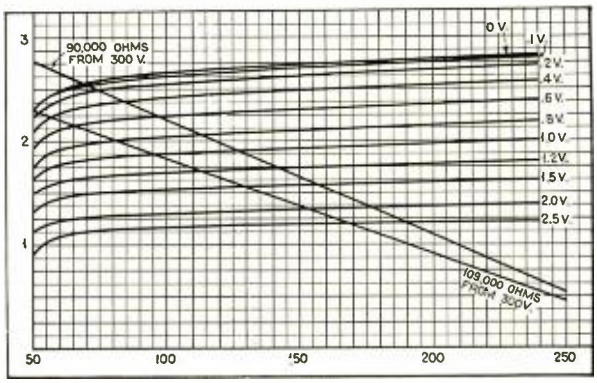


Fig. 2. Ip—Ep curves average ER 224 tubes. Esg = 45 volts, various a-c voltages. f=60 cycles, Rg=1 megohm, Cg=1 mfd.

do not cut off sharply as they do with a fixed bias.

It was shown in equation (1) that the value of V approaches E so that the sensitivity in the grid circuit above approaches unity. The rectified voltage developed in the grid circuit is also amplified in the usual manner so that the total sensitivity of a grid circuit detector may be written from analogy with the amplifier equation as

$$S = \mu \frac{R_p}{r_p + R_p} \qquad (3)$$

Thus it is seen that the sensitivity is less than the $\mu$ of the tube. It is necessary to keep $R_p$ one or two times $r_p$ in a three-element tube so that the total sensitivity may be only about ½ to ⅔ of the mu of the tube. This is illustrated in Fig. 4-C.

In practice it is difficult to make the ratio of $R_p/r_p$ greater than $\pi$ even for the case of a C bias detector. The grid circuit detector sensitivity approaches $\mu$ as a limit so that we would expect that the sensitivity of the C bias detector and the grid circuit detector would be about the same in the case of three-element tubes. It should be noted, however, that a large input voltage is necessary to obtain the maximum sensitivity in the case of the C bias detector while the maximum sensitivity is obtained with a small input voltage in the case of the grid circuit detector.

In all electric receivers, however, a self-bias detector is used and a study of curves B and C of Fig. 4 shows that the sensitivity of the grid circuit detector is almost twice as great and more linear than that of a self-bias automatic bias detector. It is better to use a *227* grid circuit detector rather than an automatic bias detector provided that the output voltage is sufficient for the purpose. Typical output results were given for the ER-*227* tube in another paper[1] and will not be repeated here.

Equation (2) holds also for the case of the 224 tube used as automatic bias detector. The ratio of $R_p$ to $r_p$ must necessarily be made small because of audio quality considerations. A typical sensitivity curve is shown in Fig. 4-D. Thus we would expect to find that a *224* automatic bias detector would be slightly more sensitive than a *227* automatic bias detector, and from the curves, we find that it is about twice as sensitive. It is to be noted, however, that the *227* grid circuit detector up to its output limitations is a much more linear detector and slightly more sensitive than the *224* automatic bias detector.

Equation (3) holds also in the case of a *224* grid circuit detector. The values of dV/dE found from Fig. 3 are plotted in Fig. 4-D. There is a large increase in sensitivity over any other type of detector discussed here. The difference is striking when compared with the case of automatic or C bias detectors for input voltages of less than one volt. The region of voltages less than .1 volt is that used in small signal detection and does not concern us in this study, as the audio amplification is such that the power ouput level delivered by the small signal, .1 volt or less, is very low.

It is to be noted, however, that although the change in grid voltage is as linear as with a *227*, the change in rectified plate voltage is not as linear. This is due to the variation of mu and $r_p$ in the screen grid tube. The output, however, provided that the input is .2 volt or more, will be fairly linear and about as linear as that of the *227* automatic bias detector with 4 or more volts input voltage.

### Grid Circuit Impedance Considerations

An examination of Fig. 1 shows that the larger $R_g$ the more linear the rectified grid input voltage will be. From the standpoint of by-passing $R_g$ so that the voltage drop across $R_g$ and $C_g$ will be small the condenser $C_g$ should be large. The larger $R_g$ the less the resistance added to the tuned circuit both from $R_g$ and the grid resistance of the tube. Audio quality considera-

[1] *J. R. Nelson—Grid Circuit Power Rectification, Proceedings I. R. E., March,* 1931.

tions, however, require that $T_g$ be made not too large and $C_g$ be made rather small. Due to the enormous gain in sensitivity some loss in input voltage will not be much of a factor. Taking all the above factors in consideration, a resistance $R_g$ of one megohm with the grid condenser of 50 to 100 mmfd. will be good compromise values.

### Output Limitations

An examination of Fig. 3 shows that about 100 volts rectified is all that may be realized with 300 volts on the plate fed through a resistance. This means that the 224 grid circuit detector resistance coupled would work a single 245 on 100 per cent modulation. There is ample output, however, to work a new power pentode such as the ER-247 on about 30 per cent modulation. A study of impedance coupling is beyond the scope of this article. It was found, however, that a push-pull 245 stage could be worked on full output with 25 per cent. modulation by using a one to one transformer, such as is used in some of the present day receivers with 45 or 67.5 volts applied to the screen grid of the 224 grid circuit detector. The plate of the 224 grid circuit detector was connected to either 250 or 300 volts directly through the primary of the transformer.

Rectification curves taken with 135 volts B-voltage showed that the screen grid detector using grid circuit rectification would not quite work the new 6.3 volt pentode output tube (ER-236) with resistance coupling. There was ample output voltage, however, using the correct choke coupling with Eb as low as 100 volts so that an intermediate audio tube is not necessary.

It must be emphasized again, however, that the plate circuit impedance must not be too high. In three element tubes a high impedance is desirable, but due to the different shape of the $I_p$-$E_p$ curves of a screen grid detector using grid circuit rectification, too high an impedance causes bad distortion for the same reason that too high a resistance does. The best method in insuring that the impedance is not too high is to insert a resistor in parallel with the choke or transformer. The approximate range of voltage swings may be found by assuming that impedance has only the d-c. resistance of the choke and drawing in the load line through the operating point for the carrier voltage so that it acts only as an a-c. impedance and assuming that the $I_p$-$E_p$ curves will follow along a line having a slope equal to $1/R_p$ instead of following along a distorted ellipse. If the choke impedance is equal to the resistance of the shunting resistor at some fairly low frequency, say 60-cycles, this will give approximate results.

Before using impedance or a transformer coupler it is suggested that the receiver be tested with high percentages of modulation or that the $I_p$-$E_p$ characteristic diagram be studied carefully. If either of the above studies are made, the possibility of the receiver distorting badly on high percentage modulation will be eliminated.

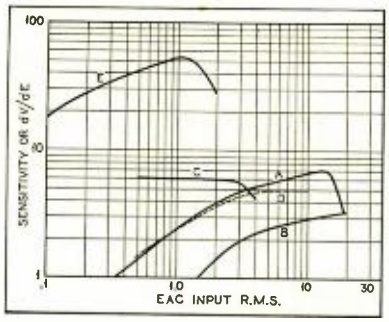


Fig. 4. Sensitivity or dV/dE curves for various detectors.

A—227 C bias detector Ecg=18. Ep=270. Rp=200,000 ohms.
B—227 automatic bias detector R Cathode=35,000 ohms. Ep=180 v. Rp=180,000 ohms.
C—227 grid circuit detector Rg=1 megohm. Ep=300. Rp=25,000 ohms.
D—224 automatic bias detector R cathode=20,000 ohms. Rp=200,000. Ep=300 V. Esg=40 v.
E—224 grid circuit detector Rg=1 megohm. Rp=90,000 ohms. Ep=300 v. Esg=40 v.

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# Cannot Refuse Wired Music

UNDER its legally filed tariffs, the Public Service Commission of New York, in a decision announced August 29, held that the New York Telephone Company can not refuse, in the exercise of its managerial discretion, to furnish leased lines for the transmission of musical programs from a central point to hotels, restaurants and private residences. It directs the telephone company to furnish certain facilities to Wired Music, with headquarters at 351 West Forty-second Street, New York.

Wired Music, an association of persons doing business under that name, applied to the telephone company for the leasing of private lines for transmission purposes, with the ultimate intention, if the project is successful, to extend the service to other cities and sections which are served by the telephone company. The latter refused the request on the advice of its counsel, stating that "the company is not willing to undertake to furnish a system of network of circuits for such purpose." Wired Music made complaint to the commission, and public hearing was held by it.

It was shown in the record that the telephone company now leases wires over which speeches, musical programs, convention proceedings and other events of general interest are carried from the actual locality to one or more broadcasting radio stations where they are released on the air to be picked up and amplified and reproduced by private or public radio receiving sets.

Exactly the same service, it was shown, was asked by Wired Music so that programs could be sent over leased wires. No equipment is to be supplied by the telephone company at either end and it was also shown that the same service is now given burglar alarm companies, stock exchanges and news tickers and will serve television when commercially used.

The company alleged that the service was not regular telephone communication and therefore not under the jurisdiction of the commission; that although certain facilities are now furnished over leased wires, such service is from surplus facilities and not immediately needed for telephonic communication; that the use of such surplus facilities is in the managerial discretion of the telephone company, and that it has the right to decide how much surplus facilities shall be used.

It was also shown in the evidence that the telephone company is now using about 200 circuits for radio broadcasting and its witness stated that there does not seem to be any probable increase over that number. This number, it was contended, was no problem from the standpoint of spare facilities. Wired music, it was claimed, has possibilities of extending to many thousands. The company did not produce any evidence as to the extent of its surplus facilities, stating that they vary in different exchanges.

Commissioner George R. Van Namee, in a memorandum approved by the commission, said in part:

"The question presented goes far beyond reasonable rules and regulations. It goes to the very essence of the business and to the question of who shall be served by the company. In effect, the company claims the right to say what part of its business it will elect to do. If the company has no right to do a 'leased wire' business it must stop doing such business with those who have already applied and to whom it has granted these facilities. If this is a legal part of its business it must come under regulation and the company must serve all who apply under proper conditions for the service."

# Radio reception from distant stations, with receiver located close to powerful transmitter

By C. H. W. Nason

THERE are certain locations in which the reception of broadcasts from distant transmitters is impossible due to the close proximity of a local station. A new device has made its appearance in Germany which bids fair to enable the poor fellow residing under the antenna of a local to find some enjoyment in his old receiver. It seems that for some years past at each annual radio exposition the German Broadcasting Company has posted a cash award for any device which will permit the reception of distant signals through the nearby locals. Until this year no device of sufficient merit to warrant the award has appeared. This year, however, a device offered by one Theodor Eckert not only merited the posted award, but was of such worth as to receive the Silver Medal of the Heinrich Hertz Institute, which has been withheld for the past three years because of the fact that no obviously worthy recipient has been in evidence.

A normal four-tube receiver was operated within sight of the Berlin transmitter. Operating alone, the receiver was unable to bring in transmitters a hundred kc. or more removed from the local, the blanketing was so great. With the Eckert device a distant transmitter but 9 kc. removed could be brought in with no difficulty whatever. From the circuit arrangement shown in Fig. 1 it will be seen that a small portion of the signal from the interfering station was fed back into the antenna system of the receiver in reverse phase. The input to the receiver of the desired signal frequency is obtained from a tuned circuit and is fed through a variable, non-inductive resistance into the antenna terminals of the receiver proper. This resistance it is claimed reduces interferences due to impact such as from electro-medical devices, X-rays, etc. No data is available concerning the efficacy of this portion of the device.

The tuning of the first tuned circuit which is tuned to the interfering carrier is said to be quite critical—a slight detuning being sufficient to permit interference to result. The second tuned circuit is tuned to the frequency of the desired signal and could be dispensed with were the arrangement incorporated in a receiver directly and not as a secondary bit of equipment. In its present form the writer would suggest that a dummy antenna replacing the variable resistance might add to the efficiency of the arrangement.

The necessary parts for constructing the unit are available here in America without danger of losing efficiency through the substitution. The antenna coupling coils can be Hammarlund HQC-29 units tuned by MC-M midget condensers. The coupling coils can be of twenty turns each on a 2-inch form, care being taken that the proper polarity is observed.

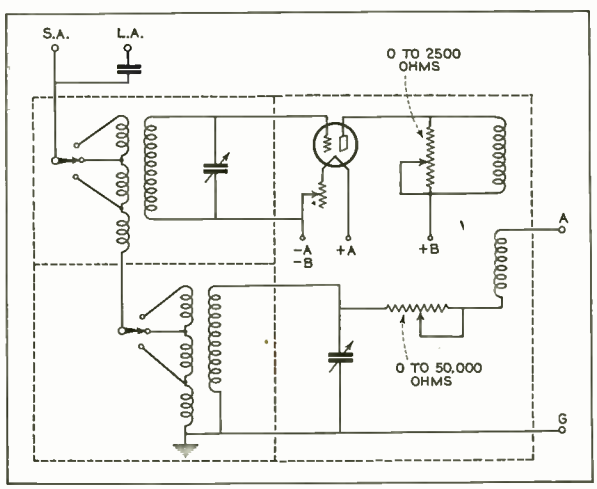


Fig. 1.

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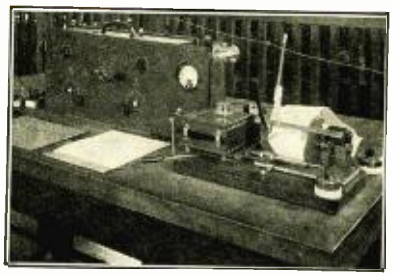
## Mechanics' Measurements

To find the number of square yards in a floor or wall, multiply the length in feet by the width or height in feet, and divide the product by nine.

Board Measure—If the board is one inch or less in thickness, the number of feet of lumber is found by dividing the length in feet times the width in inches by twelve. If the board is more than one inch thick, the number of feet, lumber measurement, is found by dividing the length times the width times the thickness by twelve.

These questions are not electrical, but the answers are published because engineers frequently find it necessary to make these space measurements, and it is well to have the data in pocket note books.

# Recording characteristics of radio signals and static



View of the three-in-one instrument—a device that records station fading, and denotes field intensity of transmitting station.

By S. R. Winters

LIKE a certain brand of oil in its consolidation of units, a three-in-one instrument, developed by the Radio Laboratory of the Bureau of Standards, measures the strength of broadcasting stations, denotes fading of radio signals, and records static. Formerly requiring individual units for each of the three services, the merger of three devices into one piece of apparatus likewise effects a three-fold performance of functions—only slight modifications or additions being necessary to convert the instrument from a static recorder to a device for measuring the fluctuations of signals or to change it to equipment for determining the field intensities of radio transmitting stations.

Instruments for measuring and recording the vagaries of radio waves as well as determining the strength of transmitting stations are of increasing value because of their diversified uses. A mere recital of the different services performed by measuring and recording devices would fill the pages of a catalogue. Among the noteworthy uses are: Measuring the field intensities of 600 broadcasting stations, 16,000 amateur stations, in addition to ship and commercial wireless stations; for denoting the direction and strength of static in its relationship to storms and weather conditions as a means of forecasting hurricanes for the benifit of ships; harnessing fading in order that it may be analyzed with the possible view of designing satisfactory automatic volume boosters in our 10,000,000 receiving sets when music or speech waxes and wanes; recording and studying both static and fading in conjunction with trans-Atlantic radio-telephone and international broadcasting; investigating radio phenomena along the 30,000 miles of civil airways; obtaining charts for analyzing the effects of sunspots and the aurora borealis on radio reception; and recording weather maps on board ships and airplanes.

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**100-acre laboratory for radio transmission research, established.**

### Autographs of Fading and Static

The three-in-one instrument, devised by T. Parkinson of the Radio Laboratory of the Bureau of Standards, for making autographs of static and fading as well as measuring the strength of signals from broadcast stations consists of three essential units: the receiving set, the indicating device, and the means of converting indicated variations in static or fading into graphic records—word pictures, as it were. Charts showing the fading of signals from a broadcast station are likewise records of the relative field intensity of that station; therefore, with the inclusion of a calibrating unit with a fading recorder the field intensities of broadcast stations may be translated into absolute values. The intensity and source of static are the primary two-fold object of investigations into atmospheric disturbances. These functions may be accomplished by a revolving loop or coil antenna, the only necessary addition to the fading recorder or field-intensity-measuring apparatus.

### Type of Antenna

The kind of antenna employed with the new measuring and recording apparatus is a variable factor—depending upon the object of investigation. For example, Dr. L. W. Austin, in his measurements of the strength of signals and static from long-wave European transmitting stations, uses a hybrid type of antenna—combination of a loop or coil of wire within the laboratory with a towering overhead aerial—thus giving an uni-directorial effect. Contrary to this system, no overhead antenna is to be used at the new 100-acre open-air radio laboratory of the Bureau of Standards. Instead of elaborate out door pickup systems, direction-finding coils and loops and a vertical rod, 55 feet high, will be employed.

A design of direction-finder, known as the Adcock antenna, will be used. It obviates the pickup of the horizantal component of a radio wave and thus, in direction-finding, the night-shift effects are elimated. This 100-acre outdoor radio laboratory—10 miles beyond Fairfax, Va., and 30 miles from the Bureau of Standards, was selected because of its freedom from trees and the earth mounds. The ground acts as a mirror in the reflection of radio waves and in the study of the vagaries of wave propagation a rolling area would tend to complicate results. This novel laboratory is dedicated to a study of wave propagation phenomena.

In general, however, any type of antenna is suitable for use with this three-in-one measuring and recording instrument in observing the fluctuations of radio signals, although the characteristics of fading may vary appreciably between the use of a directrional and non-directional pickup system. Of the directional designs of antennae are the coil or loop of wire and the inverted L aerial, when the latter is low and relatively long. While investigators are without positive knowledge as to the percentage of fading due to lateral and vertical directions-shifts in the received signal and the amout due to absorption and interference phenomena, the directional antenna should be avoided if the effect of horizontal direction-shifts is to be eliminated from the fading records. Therefore, the choice of pick-up systems for fading observations is narrowed down to the vertical antenna—the T-tvpe—or an inverted L that is relatively high.

### Coil Antenna

The coil antenna, with a grounded center tap for securing balance, is desirable for use in measuring the relative strength of broadcasting stations. This

choice is dictated by the two-fold reason of the portability of a coil or loop of wire and because its electrical constants are readily subject to measurements and calibration. The ease with which the electrical constants are determined renders it possible to match the voltage induced in the coil by the received signal with a local signal. The overhead type of antenna lends itself to this matching of signals but the process of measuremnt and calculation is the indirect or long-way-home route.

Coil or loop antenna systems are employed by radio inspectors of the United States Department of Commerce, on the radio-equipped trucks, for trailing down man-made interference with radio reception and for determining the field intensities of broadcasting and amateur stations; loop or directional aerials are used by the United States Navy Department and commercial laboratories for studying wave propogation phenomena in connection with ship and aircraft radio; and coils of wire are being increasingly used by millions of broadcast listeners because of their directional properties and virtue of reducing static when these loops are pointed in certain directions.

The hybrid antenna—combination of loop and overhead aerial—is preferable when the direction of static or of lateral shift in radio signals is to be determined. When a coil of wire and a towering aerial are in harness, working together, the minimum signal—by which the direction of static or signals is most sharply determined—occurs at only one point of the compass. However, when a coil aerial functions alone minimum points may be found at two opposite positions of the coil. When the overhead antenna and loop are joined together inductively a composite product of the signals received by the two pickup systems is received in the radio set. A resistance unit is inserted in the tuned circuit of the overhead antenna and by virtue of this the signal is reduced until it is approximately equal to the maximum signal received in the coil alone, when the latter is normal to the wave-front of the received signals. The combined signal from the two aerials, with the coil in the above-mentioned position, will be double that of either singly if the voltage phases of the two are identical, but will be zero if the phases are opposite. As the coil is revolved there is always a maximum point of signal strength, when one side of the antenna points in the direction of the received signal and a minimum of signal strength when the position of the coil is reversed. The direction in which the latter side points, therefore, determines the signal direction. The coil antenna may be revolved at a specified speed by mechanical or electrical means—for instance, the Laboratory for Special Radio Transmission Research of the Bureau of Standards employs an electrical motor, the normal speed of which has been reduced by use of suitable reducing gearing.

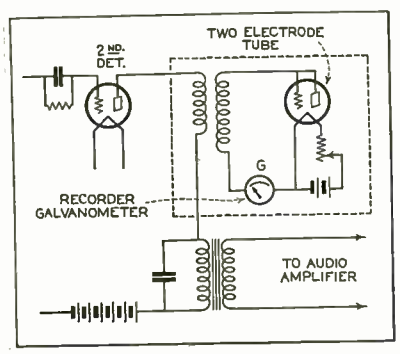


**Fig. 1.**
Circuit connections of receiver unit to superheterodyne. Circuit of recorder unit within broken lines.

## Type of Receiver

In the selection of the radio receiver proper for use with the three-in-one measuring and recording instrument the choice is likewise a variable factor—governed by the elements of dependability and simplicity. The first-named requisite automatically eliminates the crystal detector, since the latter offers no assurance of constant sensitivity for appreciable periods of time. The well-known regenerative detector qualifies because of its simple nature and reasonable sensitivity. The circuit is so tuned that a beat note is produced between the locally generated signal and the incoming signal. This beat note, necessarily, is of the same frequency, if results are to be comparable, since no receiving circuit is equally sensitive to all frequencies—despite claims of some radio manufacturers. Experiments conducted by the Bureau of Standards have lodged four disadvantages against this particular beat-note system of recording signals and static: (1) It is well-nigh impossible to repeat adjustments, especially in securing the same amount of regeneration; (2) it distorts modulation so as to render monitoring disagreeable; (3) it virtually renders necessary continuous calibration by some method of matching the antenna signal directly by a measured signal; (4) the circuit does not qualify as sufficiently selective.

Of the radio-frequency amplifiers, of the familarly known neutrodyne circuit, used with this three-in-one measuring and recording system, there was noted a net gain in dependability but a sacrifice of simplicity. The Bureau of Standards summarizes the advantage of the neutrodyne receiving set as a recorder of field intensities and vagaries of radio

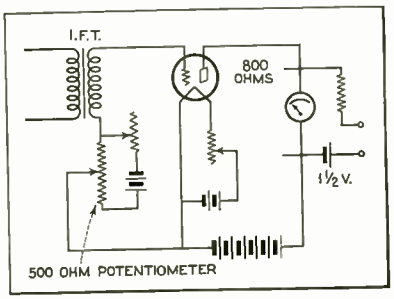


**Fig. 2.**
Circuit diagram for potentiometer type recorder.

waves as follows: (1) Selectivity is improved by employing extra tuned circuits; (2) because regeneration is avoided it is feasible to duplicate tuning and amplilcation; (3) calibration of the amplification of the set for any specified frequency is feasible. Among the disadvantages lodged against the neutrodyne circuit for this special purpose are: (1) Too many tuning controls, although the present almost universal trend toward uni-control will largely eliminate this objection; (2) any amplification control, such as a variable resistance, will have a varying effect for signals of different frequencies, thus necessitating its complete calibration over the entire wavelength range of the receiver.

## Superhet Preferred

The superheterodyne circuit, after repeated tests, was endorsed as the receiving set likely to yield most satisfactory results when acting as an integral part of a radio measuring and recording system. Mr. Parkinson, of the Radio Laboratory lists its commendable qualities as follows: (1) Beyond the first detector the frequency is always the same and, therefore, the amplification is uniform, regardless of the frequency of the received signal; (2) for any specified frequency the amplification of the signal before reaching the intermediate-frequency amplifier remains the same so that a calibration showing relative sensitivities of this portion of the circuit-system to the different frequencies can be used to correct any measurements made at the output of the receiver; (3) the fixed intermediate or beat-frequency, to say 40 kilocycles, which for practical purposes is now the carrier, can easily be isolated from modulation effects by means of a transformer tuned to this frequency and coupled to a rectifier and indicating device; (4) one calibration of the amplification control serves for all input frequencies, since this control affects only the amplifier and following stages, where the same beat-frequency is always involved; (5) a calibrating unit is required only from time to time for verifying and checking purposes and, therefore, one such unit

can serve for several receiving sets, and the size of the measuring outfit can be reduced for service afield.

### Modifications

Slight changes are necessary to adapt the superheterodyne receiving set to recording uses, and these modifications are illustrated in Fig. 1. The auxiliary equipment consists of a two-electrode tube-rectifier, an intermediate-frequency transformer, and a recording galvanometer. These auxiliary units may be incorporated in the cabinet of the receiving set or permitted to constitute an individual unit. A rewiring of the superheterodyne receiver is necessary only to the extent of opening the plate circuit of the second detector or of the last intermediate-frequency amplifier and inserting lead wires to the primary winding of the extra transformer. Substituting for the aforementioned two-electrode tube-rectifier, a three-electrode type may be employed, with the plate current balanced out of the indicating device. This arrangement would involve the use of such additional units as a B battery, a balancing battery, and resistance units. Voltmeters or ammeters are necessary in either arrangement, these being required in the A and B battery circuits to keep tab on the constancy of the power supply. A variable-resistance unit or potential divider, shunted across the primary winding of the first intermediate-frequency transformer, is recommended by the Bureau of Standards as a stable means of controlling the filament current, whereas adjustment of this current from a tube by an individual rheostat is lacking in stable calibration.

### Indicators

The static or signal intensity indicating devices used with this three-in-one measuring instrument and recorder are not prescribed with rigid conformity to a certain type of indicator, although certain requirements are outlined. For instance, in the measurement of low frequencies or long wavelengths there is the comparator method. This conforms to the general class of indicating devices using sound intensity which, in this instance, requires matching of pitches and intensities with those of some known values. Continuous waves or interrupted continuous waves, for example, are interrupted by keying sufficiently to cause variable errors in galvanometer records. A 1,000-cycle tuning-fork produces the constant pitch; the regenerative receiver is tuned to convert the incoming signal to a beat-frequency of one thousand cycles. The comparator current is then adjusted by manipulation of a potentiometer until the two signals are of equal intensity in the head-telephone set. Having knowledge of the amount of current in the headset, the amplification of the receiving circuit, and the antenna constants, it is feasible to calculate the strength of field intensities of the transmitting stations. This type of indicator, however, is useless for measuring modulated and rapid fluctuating signals from broadcast stations or from the high frequencies of amateur stations.

In contradistinction to sound-intensity indicating instruments, there are the so-called visual indicators which, as the term implies, parades the records of static or signals before the eyes. Of this type, the direct-current galvanometer uses the rectified carrier-current and affords deflections proportional to the squares of the strength or field intensities of the transmitting stations. The Radio Laboratory outlines the following advantages favoring use of the direct-current galvanometer type of visual indicator: (1) It makes continuous records possible; (2) it integrates the audio-frequency changes, thus isolating the carrier from modulation effects, which is necessary for measurements of broadcast transmissions. The disadvantages against this design of visual indicator are: (1) Extra analysis is required to translate the ordinates of a record from square-law to straight-line relationships; (2) the square-law effect reduces seriously the galvanometer range for field changes. thus necessitating frequent readjustment of receiver-set amplification to keep the galvanometer pointer on the scale, and thus adding complications to the analysis work.

The potentiometer method of visual indication of records functions in response to the slide-back principle. With a specified signal, a deflection is produced in the galvanometer. By virtue of an opposing current, extending through the galvanometer, the deflection is curtailed to an arbitrary zero at the center of the galvanometer scale. Since the deflection points to an increase in signal strength, the potentiometer is readjusted so as to neutralize the increased positive charge on the grid of the detector by an equal negative potential. This swings the galvanometer deflection back to its central position. When the signal fades, the negative potential on the grid is likewise reduced by the opposite potentiometer adjustment and again the pointer retreats to zero position. Virtues of this type of visual indicator, are: (1) It makes it possible to record with ordinates directly proportional to antenna currents; (2) it can be made to control the entire amplification system beyond the first detector, thus preventing possible saturation of amplifier tubes. "With this latter arrangement, however," points out Mr. Parkinson of the Radio Laboratory, "there is an inverse relationship between deflections and antenna currents." Among the disadvantages of this type of indicator, the Bureau enumerates the following: (1) It is difficult to keep the deflection even approximately constant by manual control of the potentiometer; (2) the inertia of the recording system in automatic apparatus restricts its usefulness for studying the character of rapid fading.

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## BROADCAST STATION COVERAGE SURVEYS

(*Concluded from page* 31)

knob will equalize two fairly unequal stations, the weaker station has little to worry about if it has its programs gauged to public interests. The writer has seen a 10,000-watt station unable to cover a radius of 18 miles city area when a 1,000-watt station of practically the same frequency cut through with flying colors. The larger station is actually in need of more power or an improved location. There are times truly when the question of signal intensity is important, but too often it is made the sole concern and criterion by the management.

In the foregoing we have confined ourselves to what may be called the major survey. There is another classification into which surveys may fall. It is the minor survey. Minor surveys are those made from day to day or from week to week merely to test out how well any given program is received. Naturally the expense of these surveys is much less and they are more quickly made. Their value, however, may be more immediately useful than the major survey. They are more up to date and, like theatre applause, give a quick and reliable indication of the value of the program as an advertising medium.

In conclusion, a station survey takes the place of theatre applause and enables the advertiser to visualize the nature and needs, likes and dislikes of an audience. It is the only means nowadays by which the live and aggressive radio station may stay at the top. The station that is not constantly sounding public preference is probably on the bottom without knowing it.

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## INDEX NOTATION

The small figure to the right of a number signifies the number of noughts contained in the whole number intended: $10^6$ equals 1,000,000.

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### Frequency-Wavelength Conversion

$$WL = \frac{300{,}000{,}000}{f}$$

# Modern fabrication of radio receivers and other like assemblies

By Austin C. Lescarboura

**This article describes and illustrates how Stromberg-Carlson, Crosley, Philco, General Motors, Pilot, Electrad, General Radio, Kennedy, Wurlitzer, The Transformer Corpn., Zenith, and other radio manufacturers effect cost reduction and improve their products by employing modern methods.**

IT is of significant note that in the improvement of radio receivers during the past year outstanding has been the advance made in the refinement of mechanical design. Coming at a time when the industry is confronted with the problem of reducing production costs without prospects of an immediate increase in production, any development which will aid in accomplishing this seeming paradox is of decided interest.

It was at one time considered that metal parts not incorporated in the electrical circuits of radio sets were detrimental to performance, but now it is rare indeed that any other material, with the exception of insulating parts, is used. With this accepted type of construction, the assembly methods of a year ago must needs be revised. Therefore, it was necessary to develop an entirely new means of assembly. Probably one of the most influencing factors that led to this change of design was the introduction of self-tapping screws to the radio industry. One of the most astounding facts is that these screws have been able to effect assemblies economically in this industry to which all the opportunities of quantity production and distribution of tooling-up costs in output running into thousands of units per day, were at hand; yet their application is responsible for the same percentage of economy on a single unit per day as on volume production. Relatively speaking, an even greater reduction in assembly costs is obtained in small production operations because they do not necessitate investment in equipment, nor in special skill. Not only do they directly replace more costly fabricating operations using machine screws, bolts and nuts, welding, etc., in difficult and inaccessible locations, but by their nature make possible a simplicity of design that is impossible with any other means of fabrication.

Oftentimes, costly metal flanges, welded on metal tap strips, forming operations, etc., are eliminated by the use of the single simple procedure of fastening the component parts with self-tapping screws. However, it must not be assumed that these screws are advocated in every possible fastening operation in radio assemblies. They find their greatest use when fastenings must be made in places that are hard to get at with rivets or bolts and nuts and where it is not practical to tap holes for machine screws because the metal is too thin to give satisfactory results by this method of assembly.


Fig. 2. Various forms of Type "Z" screws which can be produced.

Fig. 4. Type "U" hardened metallic drive screw.

Fig. 1. Type "Z" hardened self-tapping sheet metal screw.

In fact, there are so many applications wherein these screws are used with marked assembly economies that any generalization as to their applicability would be inadequate.

Aside from the savings of time and labor that these screws effect, the fastenings they make are found to be better than those made with machine screws, bolts and nuts. A series of laboratory tests recently made at the College of Engineering, New York University, show that they stand up better under tension . . . under shear stresses . . . under vibration.

There are two types of self-tapping screws that are used almost exclusively in the radio industry—Type "Z" hardened self-tapping sheet metal screws and Type "U" hardened metallic drive screws.

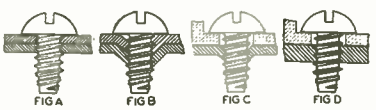



Fig. 3. Methods of applying Type "Z" screws under various conditions. Figs. A & B. When joining two thicknesses of light gauge sheet metal the holes may be drilled or clean-punched the same size in both sheets as shown in Fig. A; or both sheets may be pierced together so that the burrs are nested, as shown in Fig. B. The latter form naturally results in a stronger fastening. Figs. C and D: When fastening a part in which clearance holes are provided and the sheet metal is of a light gauge, it is desirable to make the holes in the sheet metal with a burr, as shown in Fig. C, thus presenting a greater cross-sectional surface for the screw to engage. In heavy gauges of sheet metal or where it is not practical to pierce the holes as shown in Fig. C, the holes should be drilled or clean-punched as shown in Fig. D. Fig. E: When making a fastening to a solid section of aluminum or die castings, Bakelite, slate or the like, clearance holes should be provided in the part to be fastened as shown in Fig. E, so as to permit of drawing the parts tightly together.


## Type "Z" Hardened Self-Tapping Sheet Metal Screws

These are used for joining and making fastenings to sheet metal from 28-gauge (.015") up to 6 gauge (.203"). They are also used for making fastenings to aluminum and die castings, Bakelite, Durez, ebony asbestos, and similar insulating materials.

The unique structure of the threads of these screws and the hardening treatment to which they are subjected make them capable of forming a thread in the material as they are turned in with a screwdriver. They can be removed when necessary and used over again

in the same holes without impairing the security of the fastening. By thus eliminating the tapping operation, with its breakage of taps, maintenance of tapping equipment, losses from scrapped parts due to crossed threads and mistapped holes, etc., the screws save from 15% to 50% of the cost of radio assemblies.

Another advantage in radio assemblies, especially where they are used for joining two sections of sheet metal or making fastenings to light gauges of sheet metal, is that their hardened threads will not strip nor will they strip the threads they form in the material. This happens frequently when machine screws are used on the assembly line and often stops production until the unit is doctored up.

### How Type "Z" Screws Are Used

The material in which the screws are to be used is first drilled with a hole slightly smaller than the outside diameter of the screw. The self-tapping screw is then turned into the metal, forming its own thread. The screw can be driven with any type of screwdriver, plain, spiral, portable electric, pneumatic or with automatic-feed machines where production warrants it.

This type of screw is furnished for stock with round and countersunk flat heads. However, they can be made to order with various shapes of heads and also with a pointed pilot shown in Fig. 2 as style 13.

Fig. 3 illustrates the method of applying Type "Z" hardened self-tapping sheet metal screws under various conditions.

### Type "U" Hardened Metallic Drive Screws

The Type "U" hardened metallic drive screws, Fig. 4, are for making permanent fastenings to iron, brass and aluminum castings, steel, Bakelite, Durez, etc. They function in a manner somewhat differently than the Type "Z" screws. They are driven in with a hammer. As the screw is hammered in its hardened spiral thread cuts into the material like a tap. The unthreaded portion, or pilot, at the tip holds the screw in place before it is driven in and also guides it so that it will go in straight. Furthermore, the diameter of the pilot, being somewhat larger than the root diameter of the screw and slightly smaller than the outside diameter, the material that is displaced when the screw is hammered in is forced between the threads and the pilot, thereby anchoring the fastening at the base. These screws make fastenings that are stronger and hold better than those made with machine screws, escutcheon pins, rivets, etc. Once driven in, they stay in. Because they cannot easily be removed, these screws are recommended only for assemblies that do not have to be disassembled. Like the Type "Z" screws, they eliminate the slow and expensive tapping operation. This saves the cost of taps, maintenance of tapping equipment and losses due to scrapped parts resulting from mistapped and crossed threads.

The various forms of Type "U" screws that can be obtained are shown in Fig. 5.

### How Type "U" Screws Are Used

As when any other fastening device is used, in order to obtain the best results, the holes for the drive screws must be made the proper size. Here again the size of the hole depends upon certain variable factors, such as the kind of material, its degree of hardness, uniformity, etc. Suggested methods of application are shown in Fig. 6.

### Structural Tests

An extensive series of tests on both the Type "Z" and Type "U" hardened self-tapping screws were conducted in the College of Engineering Laboratories of New York University, and Columbia, to determine the strength of the fastenings made with the screws under shear and tension stresses, and their dependability under vibration. A brief resume of these investigations are here given.

### Shear Tests—Type "Z" Screws

Fig. 7 graphically shows the superior holding power of Type "Z" screws in comparison with machine screws under shear loads. Fifteen specimen assemblies made with self-tapping screws and a like number made with machine screws of corresponding sizes were tested. The results shown are based on the minimum values obtained.

### Tension Tests—Type "Z" Screws

Fig. 8 shows a comparison of the tension values of the Type "Z" screws and machine screws. The loads were applied to the screws through a straight pull on a lap joint. Fifteen each of hardened self-tapping sheet metal screws and machine screws of equivalent sizes were used in this series of tests. As graphically shown, the tension strength of the fastenings made with self-tapping screws far exceeds that of fastenings made with machine screws.


Fig. 5. Various forms of Type "U" screws which can be produced.


Fig. 6. Methods of applying Parker-Kalon Type "U" hardened metallic drive screws under various conditions. A & B: When the screws are used to make a fastening to sheet metal or to join two thicknesses of sheet metal (see note below), the holes in the part to be attached, or in the upper section, may be clearance holes as shown in Fig. A. It is, however, advisable when possible to make the holes the same size in both sections, as shown in Fig. B. This will greatly increase the strength of the fastening and also prevent the screws from loosening.
Fig. C: When using the screws for making a fastening to a solid section of steel, cast iron, aluminum, Bakelite, etc., the upper part should have a clearance hole, as shown in Fig. C so as to permit of drawing the parts tightly together.
Note: Drive screws are recommended for use only in material that is thick enough to permit of a sufficient engagement of threads in the material to assure a satisfactory fastening. Generally speaking, the thickness of the material should be equivalent to not less than the outside body diameter of the screw being used.

### Shear Tests—Type "U" Screws

A graphic comparison of the holding power of Type "U" drive screws and machine screws when subjected to shear stresses are illustrated in Fig. 9. Fifteen each of metallic drive screws and machine screws of equivalent sizes were tested in this series. The loads were applied to the screws through a straight pull on a lap joint. As shown in the curve, the shear strength of fastenings made with Type "U" screws greatly exceeds that of fastenings made with machine screws.

### Tension Tests—Type "U" Screws

Tension tests were also conducted on the Type "U" screws in comparison with machine screws. Fig. 10 shows the results secured from testing fifteen typical assemblies made with drive screws and corresponding sizes of machine screws. The faired curve shows that in every case the fastenings made with drive screws are stronger under tension than those made with machine screws.

### Vibration Tests

Perhaps the most important factor regarding fastenings that the radio industry is concerned with is the ability of the fastenings to stand up under vibration that the sets are subjected to from the time they are assembled until they are obsolete. First, the fastenings must be secure to withstand the stresses imposed when the receiver is in transit. Then, after it is installed, resonance vibration from the loudspeaker frequently sets up synchronized waves in the various sub-assemblies. Therefore, every component comprising the set must be fastened rigidly in place as the slightest movement of condensers, chokes,

etc., frequently results in distorting the tone or the receptive qualities of the set.

To prove that Type "Z" hardened self-tapping screws made fastenings that were as secure as those made with machine screws, bolts and nuts, split rivets, etc., an extensive series of vibration tests were conducted. The first part was devoted to typical assemblies simulating conditions where two sections of sheet metal were fastened together with machine screws and hardened self-tapping screws. So severe was the vibration that some of the machine screws began to loosen after 8 hours but there was no sign of loosening of the Type "Z" screws although the tests were conducted some 24 hours after the last machine screw had fallen out.

In addition to these tests and numerous tests which various radio manufacturers made in their own laboratories, a stock model receiver, in the assembly of which 44 self-tapping screws had been used, was submitted to the Columbia University Testing Laboratories for an impartial investigation. To carry out the test a specially designed vibrating machine was developed. The action of this machine simulated the conditions that would be encountered if the set was enroute to its destination in a freight car having a flat wheel moving at a high rate of speed. The vibration was so intense that many of the sheet metal parts of the set were twisted and broken. Six assemblies made with machine screws in the unit could not stand such a jolting. They quickly fell out yet not one of the 44 fastenings made with self-tapping screws loosened.

### Uses in Radio Production

First is that of fastening the various units to the chassis such as shield plates, power chokes, condenser braces, power transformers, power condensers, transformers, etc. They also find extensive application for fastening speaker pots to the frame, wire clamps, neutralizing condensers, name, escutcheon and instruction plates and for the final assembly of fastening the receiver in the cabinet. Some of the specific applications for which the screws are being used by leading manufacturers in the industry and the benefits which have resulted follow:

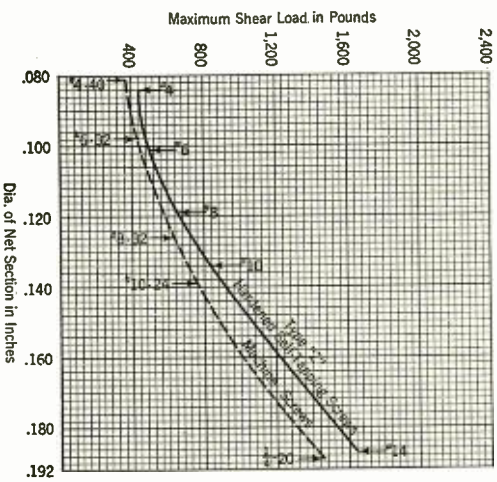



Fig. 7. Comparative shear strength Type "Z" screws versus machine screws.

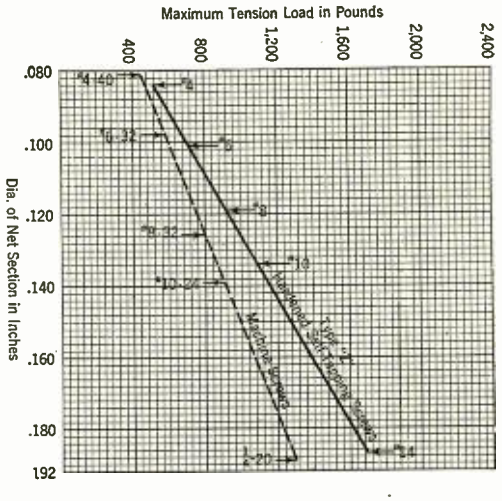



Fig. 8. Comparative tension strength type "Z" screws versus machine screws.

### Crosley Radio Corporation

In assemblies where nuts are hard to start, due to mechanical location, or where the metal is too thin to use an ordinary tapped thread, engineers of the Crosley Radio Corporation say "Type 'Z' hardened self-tapping sheet metal screws with hexagon heads have a decided advantage over ordinary machine screws. Type 'Z' screws are being used for mounting brackets, transformers, drives for variable condensers, etc., to the sheet steel chassis. They are also employed for mounting the chassis to the cabinet. In all of these assemblies they have displaced machine screws, bolts and nuts and lock-washers resulting in savings ranging from 20% to 30% over the former methods of making assemblies."

### Electrad Corporation

The assembly of this company's Truvolt Divider involves the fastening of four resistance core brackets to a Bakelite case and the resistant cores which are of composition lava must in turn be mounted on these brackets. Electrad, Inc., makers of this unique device, originally used machine screws for attaching the brackets, necessitating the molding of inserts in the Bakelite, a costly proposition. Then in mounting the lava composition insulation, they used a long bolt and nut running through the core from bracket to bracket, a means that frequently resulted in trouble by causing short circuits. By adopting self-tapping screws for this assembly the expensive inserts were dispensed with and the product was mechanically improved because now the screws are turned into holes molded in the Bakelite and the composition lava.

### General Motors Radio Corp.

There are approximately 49 self-tapping sheet metal screws used in the assembly of each G. M. Radio receiver for fastening the various units to a .062" steel chassis. Not only have the screws eliminated the time necessary for the tapping operation but fumbling with nuts on machine screws, etc., and the production was increased to some extent. Furthermore, it was found that the use of these screws eliminated the necessity of using lock washers and other auxiliary locking devices.

### General Radio Co.

This organization used round head Type "Z" screws for fastening name

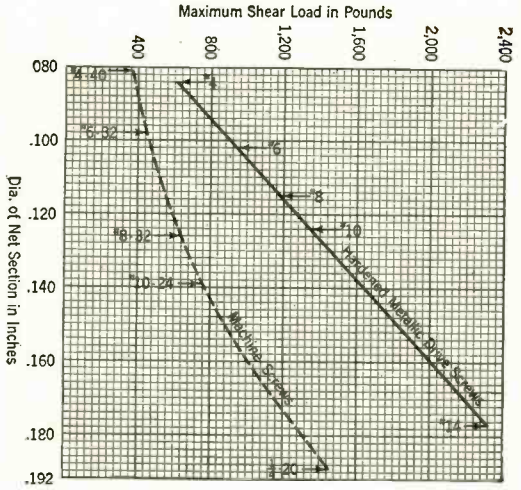



Fig. 9. Comparative shear strength Type "U" screws versus machine screws.

plates to a Bakelite control panel. The Engineering Department says that the ordinary method would have been to use machine screws and tap the Bakelite. However, self-tapping screws obviate the necessity of tapping and provide a more reliable fastening considering the nature of the Bakelite and the threads made by the self-tapping screw therein.

### Colin B. Kennedy Corp.

The Colin B. Kennedy Corp. have devised a very interesting means of fastening a condenser housing to a 16-gauge sheet steel chassis. On account of the weight of the housing it was at one time thought necessary to use machine screws and nuts, but they encountered difficulty due to the fact that the fastenings frequently loosened when the set was in transit. It was considered impractical to tap the holes in the 16-gauge sheet steel. Therefore, it was suggested that self-tapping screws be tried out. After a little experimenting the screws were adopted with a decided saving in time over the former methods with the added advantage that the assembly was absolutely secure. On other units such as holding the sub-base to the chassis they are likewise giving the same results.

### Philadelphia Storage Battery Co.

One of the most outstanding examples of the extensive and well planned use of self-tapping sheet screws in the radio industry is their application in Philco radios. In the past two seasons this company used over 75,000,000 of the screws for fastening various units comprising several series of sets to the chassis members. A detailed study involving this application was conducted by a time study engineer of the A. C. Nielsen Co. and it was found that through the use of the self-tapping screws savings running into tens of thousands of dollars a year were being made by eliminating the costly tapping operation and other difficulties incident to this work. A study of the Philco Balanced Unit Receiver shows that there are approximately 50 fastenings made with these screws to each chassis. They include such sub-assemblies as fastening shield plates, padding condenser, condenser braces, power chokes, power transformer, power condenser, push-pull transformer, wire clamps, by-pass condenser, r.f. transformers, neutralizing condensers, etc. Almost without exception all of the self-tapping screws that were used in these assemblies are with hexagon heads, the assemblies being made with electric or pneumatic power tools.

One assembly that is quite interesting is where the speaker pot is fastened to a cast-iron frame by the means of Type "U" screws. This assembly is subjected to considerable resonance vibration, hence it must be made as secure and as rigid as possible. Machine screws and then a patented pin were tried out with indifferent results. The machine screws loosened readily and the pin quickly lost its holding power, causing a distortion in reproduced sounds. It was then found that metallic drive screws were an ideal means of making this fastening. The hardened metallic drive screws are forced into the frame by the means of a pneumatic press.

Another interesting assembly in this same unit is fastening the cone to the pressed steel housing. Machine screws were formerly used for making this assembly, but as the use of these screws necessitated tapping, they were abandoned in favor of self-tapping screws, which had demonstrated on other assemblies remarkable fabricating economies.

Philco engineers say that by the adoption of self-tapping screws they have avoided entirely all the troubles they frequently encountered when machine screws and other fastening devices loosened under vibration. And aside from this mechanical improvement in the design of their product, assembly production, often running into 50,000 sets in thirty days, has been maintained.

### Pilot Radio and Tube Corporation

The design of the receiver manufactured by this company in so far as fastening the various parts of the chassis is concerned, was predicated on the use of hardened self-tapping sheet metal screws because it was evident through the extensive use of the screws in well known sets that they offered a number of advantages that are not possessed by other means of assembly. The screws are used for fastening by-pass and filter condensers to the bottom side of the chassis made of .062" sheet metal. They are also extensively used for other sub-assemblies.

(*Concluded on page* 45)

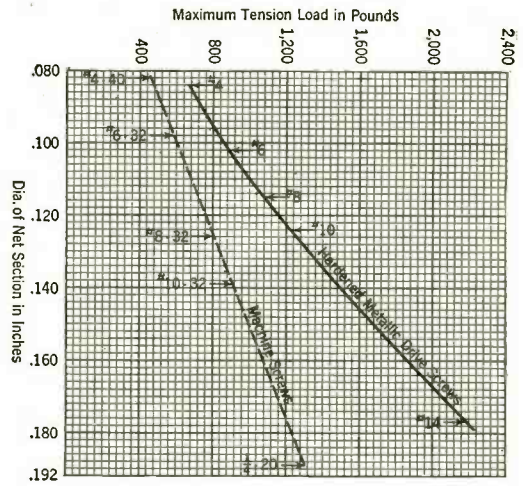
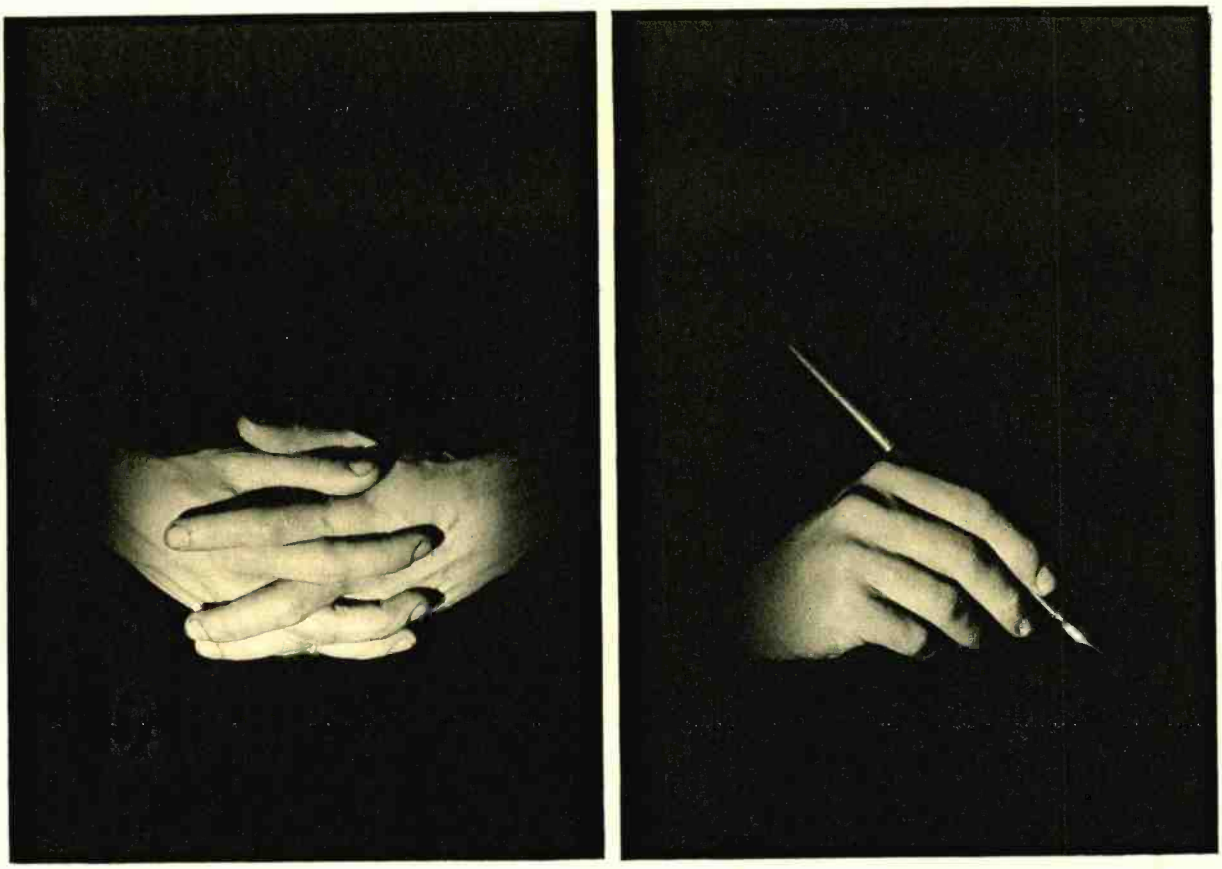



Fig. 10. Comparative tension strength Type "U" screws versus machine screws.



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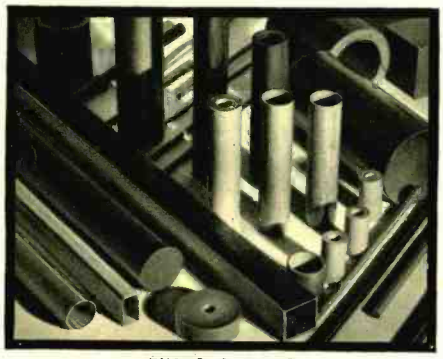
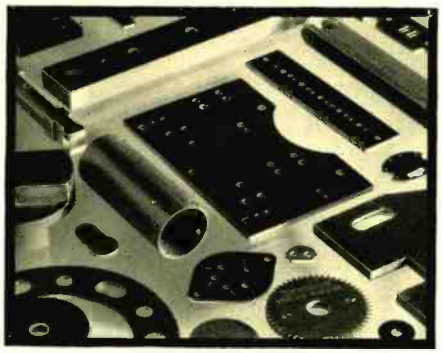


TUBES & RODS



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Special grades made at no additional cost. All standard grades of Synthane, listed according to N. E. M. A. standards, are ready for immediate shipment.

GRADE X. For General Use where low moisture absorption and good machining and electrical properties are required. Paper base. Will punch up to 1/32" cold, and when heated, to greater thicknesses. Machines readily. See "Sheets", "Tubes".

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SHEETS. Size—36" square. Thickness—.010" upwards to 8". Color—Natural, Chocolate Brown and Black. Finish—Dull, High Gloss. Grades—X, XX, XXX, XP, C, L. Special as required.

TUBES. Length—36". Diameter—Inside diameter from 1/8" upwards. Outside diameter as required. Color—Natural and Black. Finish—Dull, High Gloss. Stocks—Round, Square, Rectangular. Grades—Wrapped X, C, L; Molded X, XX, C, L. Special as required.

RODS. Length—36". Diameter—1/8" upward. Color—Natural, Black. Finish—Dull, High Gloss. Stocks—Round, Square. Grades—Molded XX, C, L.

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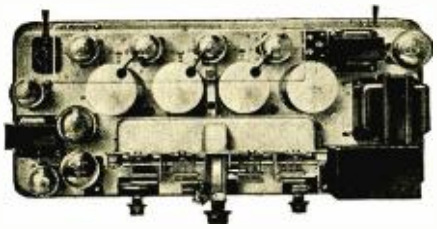

Fig. 11. Philco balanced unit receiver.

As in contemporary construction, the parts to be fastened are provided with clearance holes, the screws being turned into the engagement material by means of power driven socket wrenches.

### Stromberg Carlson

In No. 20 SC superheterodyne receiver (Fig. 12) 29 self-tapping sheet metal screws are used for fastening the capacitor, power chokes, condensers, shield plates, transformer shields, etc., to the chassis. The former method of making these assemblies was by means of machine screws and nuts or machine screws and tapped holes. This means was, however, found undesirable because with machine screws and nuts there was considerable fumbling with the nuts, especially in inaccessible places which frequently resulted in slowing production. Then, when the sets were in transit the nuts would be apt to loosen and fall off. To overcome this, lock washers were resorted to but these increased the cost of the assembly and also slowed up the assembly operation.

The abandonment of the machine screws eliminated the tapping operation as well as the expense of maintenance of tapping equipment, cost of taps and losses due to crossed threads, mistapped holes, etc.

### Transformer Corporation of America

One of the most unique methods of fastening chassis end plates to the chassis proper is that which is employed by the Transformer Corporation of America in their Clarion radios. The former method of making this assembly was by the means of spot welding. However, this was not practical because it was costly and also took too much time. The screws were then tried on a test assembly and a check up showed a saving of about 22% over the cost of the former method and the production was speeded up about 12%.

### Rudolph Wurlitzer Manufacturing Co.

In sheet metal of comparatively light gauges it is impractical to tap holes for machine screws for making fastenings that will hold with any degree of security. Therefore, it is necessary to provide some means of obtaining a greater area of engagement for the screws. This is especially the case where it is impossible to use bolts and nuts. Therefore, the expedient of extruded holes was resorted to. This mechanical compromise was not satisfactory because it added unduly to the cost of the assembly. The Rudolph Wurlitzer Manufacturing Co. was confronted with a problem of this kind and it was solved quite simply by the means of self-tapping screws. Formerly, extruded holes were formed in the chassis pan and then tapped for mounting audio input and r.f. transformers, bypass condensers, variable condensers, shields and fastening bottom covers. Now, plain holes are substituted for extruded holes and self-tapping metal screws for machine screws. This seemingly unimportant assembly change has been responsible for a number of marked economies. It has reduced tool and die costs. It has eliminated 90% of the tapping operation formerly required besides saving taps, scrapped parts and rejected assemblies. Besides, lock washers formerly used with the machine screws have been eliminated.

### Zenith Radio Corporation

Here again the adoption of self-tapping screws has led to important savings in the fabrication of a well-known set. Zenith formerly used machine screws for fastening shields, brackets and covers. The change to self-tapping screws on these assemblies resulted in the elimination of tapping equipment, breakage of taps, etc. In addition the space formerly occupied by the tapping equipment is being put to other uses. Moreover, the labor of extra men necessary to move the parts to the tapping machines and bring them back to the assembly line has been saved.

### Future Uses

While many other similar applications might be cited, it is felt that they would add but little to the purpose of this paper which is primarily to suggest new possibilities for these hardened self-tapping screws in radio, sound reproduction equipment, etc. That the self-tapping screw has pointed the way to a new era of fabrication of radio and allied equipment appears well established. The hardened self-tapping screws herein described are manufactured by the Parker-Kalon Corporation, New York.

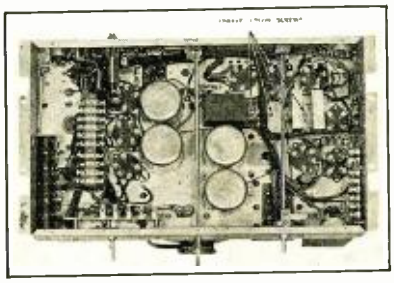

Fig. 12. Stromberg-Carlson receiver chassis.

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## COST OF TRAIN TELEPHONY IN CANADA

IN reply to the query made recently in the Canadian House of Commons at Ottawa, Ont., Canada, it was stated that the cost of telephone installation on Canadian National Railway trains was $37,156.70. This amount together with miscellaneous expenditures and expenses in connection with experimental work, brought the total outlay to $83,-333.21. The average monthly revenue for the 12 months ended April 30, 1931 was $73.43.

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## DIRECT WIRELESS TELEPHONE COMMUNICATION BETWEEN FRANCE AND ALGERIA

RADIO telephone service between Paris and Algeria is expected to be available by the end of the year. At both Paris and Algiers there will be two transmitting sets capable of allowing four conversations and two telegraph messages to be transmitted simultaneonsly during 16 hours of the day. During 7 hours the line will be available for two telephone and one telegraph message, the remaining hour of the 24 being devoted to testing and the adjustment of the apparatus. (*The Electrical Review, London.*)

# Mr. Edison as a telegrapher

THE passing of Thomas A. Edison at the age of eighty-four years brought forth a mass of biographical material which is going the rounds of the press. Numerous references have been made to the great inventor's start in life, when he worked as a newsboy and later as a telegraph operator. Some of the material published is misleading and inaccurate.

Mr. Edison became a telegrapher when he was sixteen years of age. The Civil War had just gotten well into swing at that time, and although the young telegrapher was employed in Canada, the demand for telegraphers in the United States, because of so many telegraphers leaving the commercial telegraph service to take up war telegraph duties, created openings which were filled by boys.

"Al" Edison, as he was called by his telegraph contemporaries, worked as a telegrapher from 1863 until 1868. During this time he was employed in important offices such as Cincinnati, Ohio, Louisville, Ky., and Memphis, Tenn., where at times he worked the heaviest wires. In these offices his telegraph duties required that he apply himself for long hours in the sending and receiving of telegrams. In these offices he developed the legible rapid penmanship for which he was later noted.

In 1868 he was employed in the Boston office of one of the telegraph companies, coming there at the suggestion of a friend, Milton F. Adams, with whom he had previously worked in Cincinnati. There is in existence a 125-word section of a press report copied by Edison while he worked in Boston.

Telegraphers who were contemporaries of Mr. Edison's and who are still alive include S. E. Barton, R. U. Johnston, E. C. Boileau, John Morison and John Lonergan. Of the telegraphers who first tried out Edison's quadruple telegraph in New York in 1872—R. B. Lown, Fred. Catlin, Walter P. Phillips, Fred. Seibert and E. C. Boileau—only Mr. Boileau is alive.

Although Mr. Edison's days at the telegraph key terminated in 1868 (he came from Boston to New York in 1869), his inventions in telegraphy for several years thereafter kept him in close touch with the business and its personnel. Indeed, throughout his entire lifetime he retained a keen interest in telegraph development and maintained continuous personal contact with his old-time acquaintances and with men who later became prominent in the telegraph business.

Because of deafness the great inventor found his knowledge of the Morse code of great use to him throughout the last quarter century. Many occasions developed where he made almost daily use of this means of communication.

▲ ▲ ▲

# The Fess Radio Bill

By JOHN DUNSHEATH

THE proposed Fess bill would set aside 15 per cent of all radio channels for the uses of "educational institutions."

If any one is in doubt as to what the result of this would be we would suggest that the inquirer post himself on what Governor Roosevelt, of New York, discovered about the intrenched position of the education lobby in his state when, recently, he sought cooperation in devising ways of reducing tax burdens.

During the years of prosperity when the taxpayers of the country were devoting all of their time to earning good incomes—and spending them, the education lobbies in all states were industrious in getting on the statute books laws that now leave education costs a subject practically beyond the control of taxpayers whose incomes have been decimated. Within the past two or three years as incomes declined and taxes continued to mount, men in public office discovered that more than one-third of all state income is being spent in so-called education. In New Jersey more than one-half of all tax money in many municipalities is given up to school authorities.

Education lobbies have spent millions of dollars of tax money fabricating a mantle of sacredness around the idea of "free education." Free at a cost of $150 per year per pupil!

There are advantages possible in educational systems by making proper use of radio and modern sound amplification systems, but the public will be satisfied only with applications which will be economical substitution for and not in addition to facilities which now cost too much and which are far from efficacious in turning out a school product qualified to cope with the actualities of life.

The Fess bill should be consigned to limbo.

# Radio transmitting hazard

By K. W. KEENE*

FOLLOWING the example of progress in so many other branches of engineering, development of the field of radio communication has recently disclosed a fire hazard which has as yet received little attention. Fortunately, it is a hazard which may easily be eliminated by careful planning.

While operating a transmitter at a private radio transmitting station, continuous extraneous sparkings, during operating periods, were noticed in rooms containing and adjacent to the transmitter apparatus. The sparks were characteristic of high frequency, small energy discharges, and were occurring between sprinkler piping and unused service piping and between steel electrical conduit and a roof leader. All pipes were grounded. The ceilings in the vicinity of the transmitting apparatus were well covered with conduit and sprinkler piping, and close to this piping the antenna lead-in passed.

To eliminate the fire hazard caused by the sparking, unused piping was removed; and a copper, non-magnetic grounding system was provided for all remaining piping. The main grounding conductor, which led to the basement and ground, consisted of copper straps more than one inch wide, and the branch conductors, connecting frequently to the piping systems, consisted of smaller copper straps.

As an explanation of the sparking, it has been found, and can be shown mathematically that, if metal structural work of a building, water or sprinkler piping or electrical conduit is located close to a transmitter, there can be induced in any of these conducting materials sufficient high-frequency electrical energy to cause sparking to other nearby conductors, even though both conductors between which the spark exists are grounded at a distant point. In installing radio circuits in transmitting stations, therefore, it will be well to remember that such circuits should be kept well away from nearby conducting materials, or else these materials should be grounded via a low impedance path. The fire hazard of sparking will then be eliminated.

*Extract from article "Extraneous Sparking from Radio Transmitters," in May issue of "Laboratories Data," published by Underwriters' Laboratories.

# Resistor Products

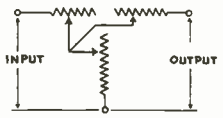
## ALLEN-BRADLEY RADIO RESISTORS

With reference to the radio resistor situation the engineering department of The Allen-Bradley Company, 126 West Greenfield Ave., Milwaukee, Wis., state:

"The quality angle is one which should receive a great deal of attention. Very few set manufacturers appreciate the importance of quality in resistors. Many of them pass over resistors with hardly a thought, and that situation is one with which we are primarily concerned at the present time. Many set manufacturers unquestionably believe that any one of several makes is perfectly satisfactory to use and that the performances are equivalent. This, of course, is not true. It can be argued, of course, that in an application where the requirements are not strict, a mediocre resistor may be satisfactory and it might not be good commercial engineering to spend more money for a better resistor, but certainly, price being equal, the better resistor is the best one to use always. The present problem, however, is not the result of such situations but is due more from the set manufacturer's lack of appreciation of the importance of tightening up his requirements.

Type Triple A Bradleyohm.

TYPE AAA




"We note particularly that the set manufacturers with the best facilities and the most capable engineering departments generally have the most rigid and carefully drawn specifications. We should do everything possible to get the customer to give serious consideration to the resistor problem and to the tightening of the specifications to protect himself."

▲

## CANDOHMS

The Muter Company, 1255 South Michigan Avenue, Chicago, manufactures the well known line of Candohm resistors.

The units are delivered in two general sizes. The smaller, Type G, is rated at one watt for each inch (of length). The larger, Type F, is rated similarly at two watts.

They are specified and delivered in all lengths from one inch to eleven inches, the length, in most cases, being determined by the watt dissipation required.

The universal practice is to rivet Candohms directly to the chassis. For customer convenience, mounting hole diameters are supplied for all usual production rivet sizes.

The resistance range, per inch, is often as low as a fraction of one ohm and as high as eighteen thousand ohms per inch. The design lends itself readily to the assembly of single resistance sections; series sections, or several resistance sections isolated from each other, all within one housing. In addition, the company often supplies additional insulated terminals built into the unit for the production convenience of customers. In further addition; they "ground" any designated terminal by soldering the particular terminal to the outer protective steel casing.

The d-c breakdown point, between resistor and steel casing, is in excess of 3,000 volts; ample assurance that line surges or defective tubes will not cause resistor failures.

▲

## CLAROSTAT FLEXIBLE RESISTORS

Clarostat flexible type fixed resistors are finding many new applications in radio and sound equipment. Their particular advantage is that they are very easily assembled, take the place of connecting wires are flexible enough to wrap around interfering objects, are protected by insulating sleeving, and maintain their normal resistance under mechanical and electrical stress.

The woven flexible sleeving which protects the actual winding is made in colors and with colored bands, in accordance with the RMA resistor color code. The core is composed of a flexible material which not only maintains a space between each turn of wire, but is of an inactive material which does not oxidize or otherwise attack the winding.

One of the largest radio manufacturers has put a number of these resistors through a thorough test and has reported 100 per cent acceptance. The test consisted of five steps as follows:

Six resistors were selected at random from a production lot shipped to the factory and their resistance was measured and found to be in every case well within the 10 per cent plus or minus specified limits, only one of the resistors showing a plus variation as high as 7 per cent. After a 24 hour test at rated load the resistors were again tested and found that none of them had changed more than .01 ohms. The resistors were then subjected to bending and twisting, while in the circuit no change in resistance could be detected. These resistors were then subject to a 100 hour humidity test and showed a change in resistance of less than one half of one per cent. The resistors were then subjected to a pull test of two pounds and all of them maintained their resistance within limits of one half of one per cent.

These tests indicated the unusual durability of these apparently delicate devices which are made up to such exact requirements.

▲

## LYNCH RESISTORS

The Lynch Manufacturing, 1775 Broadway, New York, in producing their line of precision wire wound resistors do the winding on a winding form of non-hygroscopic ceramic having high insulation qualities, mechanical strength and low coefficient of expansion. Sectional construction permits winding sections in opposite directions giving a non-inductive resistor with low distributed capacity. There is no breaking of the insulation for testing purposes.

Alloy wire of the highest grade and largest size consistent with resistance value is accurately gauged and specially enamelled to meet a rigid insulation test. The winding is impregnated with a special compound which hardens with high temperatures instead of softening as is the case with wax-impregnated units.

Contact is insured by the same general method employed in the manufacture of Lynch metallized dynohmic resistors. A molded metal end cap cuts down contact resistance and avoids the weakness encountered in a soldered or welded connection. It also provides a seal against moisture and assures noiseless operation.

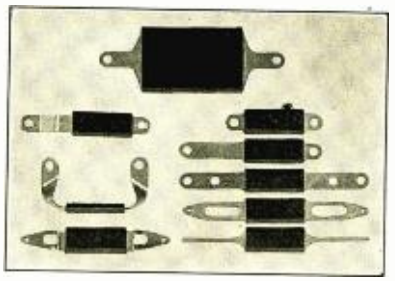
▲

## HIGH-RESISTANCE UNITS

The S. S. White Dental Mfg. Co., 152 West 42nd Street, New York, advises that due to the frequent requests from laboratories and manufacturers of sensitive vacuum tube equipment, S. S. White molded resistors can now be supplied on special order in practically any values from 10 megohms to $10^{12}$ ohms.

These high value resistors have now been used over a year and have been found very satisfactory and stable. They are particularly desirable in values from 10 megohms to 1,000 megohms for photo electric cell equipment, and condenser microphone amplifiers.

The original designs of some of the types of S. S. White Molded Resistors are



such that they are readily adapted to midget sets or any equipment in which the space is limited.

The Industrial Division of the S. S. White Company is interested in the development of any special resistor requirements and would be pleased to cooperate with engineers on their resistor problems.

▲

## AKRA-OHM RESISTORS

The Shallcross Manufacturing Company, 700 Parker Avenue, Collingdale, Pa., manufacture the type RM Akra-Ohm wire wound resistors, especially designed for heavy duty, and ideal for employment in instruments and high grade electrical apparatus where high current is necessary in a small, accurately calibrated wire wound resistor.

Many unusual mechanical and electrical

(*Concluded on page 52*)

# Condenser Products

## VARIABLE AIR CONDENSERS

The Radio Condenser Company, Camden, N. J., has not introduced any new models so far this year. Last fall this company pioneered the gang condenser for superheterodynes carrying a specially shaped rotor plate for the oscillator tuning unit. This design permits the receiver designer to effect a saving in materials and assures him of uniform dial calibration because these condensers are all calibrated to a uniform capacity curve. This special condenser is gaining wider acceptance every day and the company feels confident that within a short time this type of condenser will be used almost exclusively in superheterodynes.

Gang condensers are available in two models, the No. 10 which is the large size and the smaller No. 11. The model No. 10's are available in single units and in two, three, four and five gang. The model No. 11 condensers are available in two, three and four gang.

This season the efforts of the company have been largely directed toward furnishing a superior condenser, both mechanically and electrically, at very nominal prices. They have developed a new bakelite insulating material which allows their condensers to have a lower power-factor and consequently a lower equivalent series resistance. Receivers using these condensers show greatly improved selectivity at the higher frequencies, especially those of the t. r. f. type.

▲

## SIEMENS AND HALSKE CONDENSERS

The well known Siemens and Halske condensers are handled by Morrill and Morrill, 30 Church Street, New York.

These condensers embody long years of development and experience. They are exceptionally well built. The finest materials, repeatedly subjected to the most exacting tests, are used in their construction. They are rated on an extremely conservative basis and assure the maximum in reliability. They occupy a minimum of space and present a remarkably neat appearance.

The high voltage transmitter type from one to four microfarads and with operating voltages from 1,000 to 3,000 volts direct current.

▲

## AEROVOX HI-FARAD DRY ELECTROLYTIC

The Aerovox Wireless Corporation, 70-82 Washington Street, Brooklyn, N. Y., have the following to say about their new product:

"When the electrolytic condensers first began to show promise of providing dependable, low cost substitutes for wax paper condensers in radio circuits, exhaustive tests were made by Aerovox engineers on all available commercial and laboratory units.

"These first electrolytic condensers for radio circuits were far from being satisfactory for use in place of wax paper condensers. This was due to certain disadvantages and weaknesses such as the use of a liquid electrolyte with its leakage, spilling, drying up and freezing characteristics, high power factor, poor filtering action, the difficulty of obtaining high voltage units and the tendency of the electrolyte to attack the electrodes.

"After three years of intensive research, we are pleased to announce the Aerovox Hi-Farad DRY electrolytic condenser, a low cost, high capacity, compact, self-healing, dry electrolytic condenser for filter and audio bypass use that has a voltage rating of 500 volts peak."

▲

## DUBILIER CAPACITORS

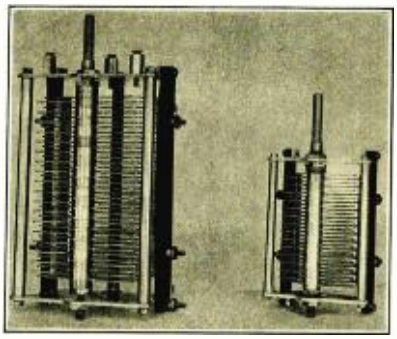
The Dubilier Condenser Corporation, New York, has, during the past few months brought out an entirely new line of high grade capacitors. Those interested in transmitting condensers should write to the company for a copy of the bulletin illustrating and describing Types 50, 51, 52, 53 and 670.

▲

## CARDWELL TRANSMITTING CONDENSER

The Allen D. Cardwell Mfg. Corp., 91 Prospect St., Brooklyn, N. Y., make transmitting condensers for high, medium and low power, as well as a wide line of variable receiving condensers.

The transmitter condenser illustrated (on the right) is of 150 mmf., .070 inch



air gap, and weighs 6 oz., and of 3000 volts breakdown. Another type (on the left) has a capacity of 440 mmf., and a gap of .070 inch, weight 27 oz.

▲

## POLYMET ELECTROLYTIC CONDENSER

A bulletin issued by the Polymet Manufacturing Corporation, 829-839 East 134th Street, New York, referring to the Corporation's electrolytic condenser, says:

"The electrolytic condenser of the type manufactured by Polymet consists of a formed aluminum anode, an aqueous solution and a metal container. The operation of the device is based upon the asymmetrical conductivity of aluminum in contact with a suitable electrolyte. This effect was mentioned in a paper by Wheatstone before the Royal Society as long ago as 1855, during an investigation of the position of aluminum in the electro-motive series. This discovery was followed by considerable research in all parts of the world, and led finally to the commercial development of rectifiers, lightning arresters and condensers using this principle.

"In common with many other devices, the development and application of the electrolytic condenser has been accelerated by a demand for cost reduction. Filter condensers in the power supply of the radio receiver represent a sizable part of the total chassis cost and, therefore, reductions in cost on this item are of extreme importance, especially in view of the keen economic competition now existing in industrial markets.

"The 'E' condenser, however, has other qualities in addition to price to recommend it. An 'E' condenser, equal in capacity and working voltage to a paper condenser, can be made smaller physically, and the 'E' condenser is able to recover completely from the effects of over-voltage of considerable duration as soon as normal voltages are restored.

"The 'E' condenser may be applied wherever paper condensers are used, subject to the following limitations:

"1. The 'E' condenser must be used on direct current only, and the formed anode must be maintained positive with respect to the can or cathode.

"2. The condenser unit must be used in a position with the vent on top (but may be shipped or stored in any position).

"3. Power factor is higher than that of paper condensers.

"4. Insulation resistance is lower than that of paper condensers.

"In the average radio receiver, and in many other electrical applications, none of the above mentioned limitations are objectionable and, in fact, may be very desirable."

▲

## SURGEPROOF CONDENSERS

The Tobe Deutschmann Corporation, Canton, Mass., says in reference to their new surgeproof condenser:

"Experience has shown that absorbed moisture lowers condenser resistance and shortens condenser life.

"Moisture may enter an uncased condenser in three ways: the first, is through air bubbles or pin holes left in the wax at the ends of a condenser dipped in the usual manner; the second is around the leads, which are easily pulled away from the wax; the third is through cracks which develop if the condenser is handled at all roughly. Moisture cannot enter the new Tobe surgeproof condenser in any of these three ways.

"The Double End Seal (patented) leaves no air bubbles or pin-holes; it holds the leads firmly in place so that they cannot pull away from the wax; it protects the edges of the condenser and thus avoids cracking of body wax."

▲

## DE JUR-AMSCO CONDENSERS

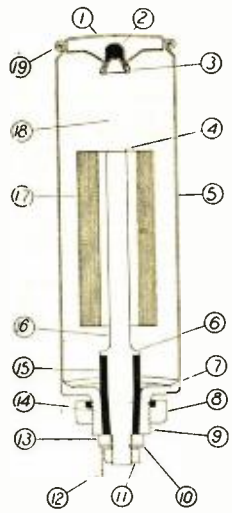
The De Jur-Amsco Corporation, 95 Morton St., New York, says in regard to that company's superheterodyne ganged, tuning and oscillator tracking condensers:

"The inevitable and natural trend of broadcast receivers requires that a commercially successful superheterodyne be single control as far as the resonance adjustment is concerned. This makes necessary the co-axial mounting of the

(*Concluded on page 52*)

# ACRACON

## Electrolytic Condensers




***Are Now Specified By Over 30 Leading Radio Manufacturers***

No other condenser offers all these features in electrical design and mechanical construction:

1. Metal cover for protection and appearance.
2. Live rubber nipple.
3. Nipple spun into aluminum shell. Absolutely leak-proof.
4. Anode spiral cold welded into anode, giving rigid construction.
5. One-piece extruded aluminum container.
6. Retaining flange for rubber gasket.
7. Tapered anode stem for snug fit.
8. Large cadmium-plated steel mounting nut, concave to insure tight connection.
9. ¾" 16-thread neck for mounting.
10. Metal washer.
11. Anode nut.
12. Anode soldering tab.
13. Large size insulating washer.
14. Tapered hole to take tapered anode.
15. Special live rubber insulating gasket, free from impurities.
16. Heavy, rigid anode stem of high purity aluminum.
17. High purity anode, spiral, so wound as to eliminate the necessity of insulating liner between anode and container.
18. Special, high, critical voltage electrolyte, well over anode to insure long life.
19. Leak-proof rolled seam as used in canning industry.

Acracon Electrolytic units are now available in capacities up to 16 microfarads at either 440 or 475 volt peak in the single anode type.

Follow the leaders of the industry. Specify Acracon Electrolytic Condensers. Also By-Pass, Wax Impregnated, Oil Impregnated, Power and Transmitting types. Write today, enclosing specifications.

**Acracon Features Are Protected by Patents Pending*

**Condenser Corp. of America**

259-271 Cornelison Ave., Jersey City, N. J.

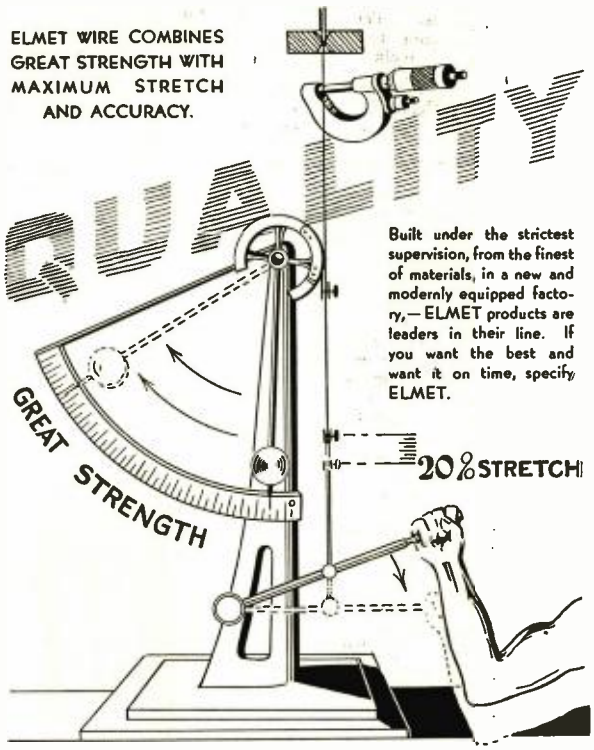
*Factory Representatives In:*

CHICAGO ST. LOUIS CINCINNATI SAN FRANCISCO LOS ANGELES TORONTO

And Other Principal Cities

# ELMET

## MOLYBDENUM PRODUCTS




One trial will prove to you that the difficulties in your grid department will be eliminated by using ELMET Molybdenum Grid Wire, in connection with our Technical Service.

There is no substitute for ELMET Molybdenum Wire. It is backed by eighteen years of actual experience in this field.

ELMET Molybdenum Wire is made not only for use in radio tubes but to your individual requirements for various types of grid machines.

Specify ELMET and get uniformity, accuracy, purity, and prompt service.

DO NOT DELAY! ORDER ELMET MOLYBDENUM WIRE NOW!

ELIMINATE YOUR SHRINKAGE, CUT YOUR PRODUCTION COST!

*For samples and prices write Dept. R-3*

**AMERICAN ELECTRO METAL CORP.**

**LEWISTON MAINE**

# RESISTOR PRODUCTS

(Concluded from page 48)

features are incorporated in these resistors. The wire is single layer wound on a strong Isolantite tube that will not break in handling. Insulated wire is used and then covered with a special insulating protecting coating that will expand and contract with the wire as it changes temperature under load.

Tolerance 2 per cent single layer wound.

Brass caps fit standard 5 amp. fuse clips. Terminal studs cadmium plated permit easy soldering. Resistor length 2¼ inches. Studs—¼ inch, overall 2¾ inches.

The type RM resistors can be made in resistances not listed within the range of the stock values, also special alloys can be employed when specified.

▲

## WIDE LINE OF RESISTORS

Electrad, Inc., 175 Varick Street, New York, manufactures a wide line of resistors for radio and associated industries.

Truvolt all-wire resistors are recommended for all purposes where heavy currents are to be handled, such as eliminators and power packs, bias resistors for power tubes, etc.

Truvolt Resistors are "double-wound" —a patented method of construction exclusively used by Electrad. First, Nichrome resistance wire is wound on an asbestos covered copper core. This is then wound around a grooved fire-clay base.

Electrad also makes Vitmonel Vitreous resistors of the highest grade resistance wire, space-wound on a fire-clay refractory tube and coated with a specially developed vitreous enamel which protects the resistance wire against moisture and oxidation and also guards the wire against possible mechanical injury.

In addition, Electrad manufactures small space replacement resistors. These resistors are wire wound on flexible core and covered with impregnated fabric. Pigtail terminals are provided at each end. By reason of their design, these are adaptable to replacement. The values of stock sizes have been selected to fill practically all replacements where a resistor of less than twelve thousand ohms may be used in a radio set.

▲

## ERIE RESISTORS

Unit resistors from 15 ohms to 10 megohms are manufactured by the Erie Resistor Corporation, Erie, Pa. These units are painted standard RMA color code. The resistors are made in six sizes: 1/5, 1/3, 1/2, 1, 3 and 5 watts.

The Corporation records show that less than one-half of one per cent of their units supplied to manufacturers have been found to be under standard.

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## OHMITE RESISTORS

The Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, make a wide variety of vitreous enameled resistor units which are manufactured on order. These are for transmitting radio stations, communication work and for industrial applications.

The company recently organized a radio resistor department for the manufacture of Wirohm Red Devil type of unit, which is a small, compact wire-wound unit of high wattage capacity. These units are used in all places in the chassis where some wattage has to be dissipated, and they are proving popular with manufacturers of sets at the present time.

In addition to these units the company also manufactures a line of carbon resistors known by the trade name of Carbohm. These are at present made in the 1 watt and ½ watt sizes in all resistance values.

▲

## CENTRALAB FIXED RESISTORS

The Central Radio Laboratories, Milwaukee, Wis., have issued a new bulletin which announces that Centralab fixed resistors look like stone, and are as permanent. Carefully calibrated resistance material is forced under tons of pressure through double dies in conjunction with a paste-like ceramic. This is baked for hours in huge ovens, and then fired at over 2,500 deg. Fahrenheit. After such a baptism of fire, no ordinary service or overload temperatures can damage the resistor. The material is entirely surrounded by a dense ceramic, hard as stone. No moisture can possibly penetrate, so age cannot change the resistance value. Great mechanical strength eliminates any chance of accidental breakage in handling. A heavy metal spray of brass makes contact to the resistance material. Wire leads are looped and soldered to this sprayed metal, making a very solid connection. This is further assurance of permanent noiselessness. Resistance values read approximately the same at any normal voltage—most important when resistors are purchased for service work.

The small ⅛ x ⅝ inch size is particularly suited to repair jobs. It has ample load capacity for most radio circuit locations, and is much easier to install than a larger size. It will actually withstand more current on accidental overload, without permanent change, than the ¼ inch size of many other makes.

### USEFUL INFORMATION COMING

*IN the December and January issues of* RADIO ENGINEERING *will appear authoritative educational engineering articles dealing with Class "A" and Class "B" broadcast amplifiers; new data on the multi-mu tubes and studies of broadcast channel betterment.*

▲

## GANGED METALLIZED RESISTORS EXTENSIVELY USED

For compactness together with economy and practicability, the ganged metallized resistors are proving popular, particularly in the small radio sets or midgets. There are two forms of ganged metallized resistor assemblies, namely, the Bakelite gang assembly and the molded gang assembly. In the former, the metallized resistors are provided with tips integral with the molded ends, said tips slipping into holes in a bakelite sheet and serving to rivet the resistor in place, together with a soldering lug, on the reverse side of the sheet. The molded gang assembly is made up of metallized resistor units having a cast metal center section with a hole through which is slipped a tie rod. A number of resistors can thus be grouped together and held by a tie rod, the threaded ends of which take the nuts that bind the assembly together. The International Resistance Company of Philadelphia reports a brisk demand for both types of gang assemblies.

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## DAVEN RESISTORS

The Daven Company, 158 Summit Street, Newark, N. J., manufactures a dependable line of precision resistors, resistance boxes and attenuators. The company also announces a new line of volume controls in all standard sections.

▲

# CONDENSER PRODUCTS

(Concluded from page 50)

condensers tuning the oscillator, preselector and first detector stages, with the composite tuning arrangement so arranged that the oscillator will track at a given frequency above the preselector and first detector circuits at a frequency equal to the resonant frequency of the i-f amplifier—in present day broadcast receivers 175 kilocycles.

"Successful superheterodynes have been designed using condensers with identical tuning curves in the preselector and oscillator section by means of the so-called "padding" arrangements. Such circuits require extra fixed and semi-variable condensers and, in some designs, two additional resistors. These accessories add to the material cost of the receiver, while the extra adjustment contributes another charge to the production bill.

"Moreover, padding arrangements are, in many instances, a compromise and an approximation, the discrepancy between the desirable and actual capacities being more than ten micromicrofarads. This discrepancy varies at different dial positions, resulting in a distorted sensitivity curve and poor reception at certain points.

"Appreciating that the combination of a standard condenser (or condensers, depending upon the number of preselector stages) and a special rotor tuning the oscillator coil in accordance with the frequency difference requirement, would greatly simplify the problem, our type OT (oscillator tracking) 320 (approximate maximum capacity in mmf) was developed in the DeJur-Amsco laboratories. Such a condenser makes the adjustment of the oscillator section as simple as that of the selector circuits, with exactly the same degree of accuracy readily obtained in a t-r-f receiver."

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## HAMMARLUND CONDENSERS

The Hammarlund Manufacturing Company, 424 W. 33d Street, New York City, manufactures a complete line of variable air condensers, also a wide variety of adjustable, or semi-variable condensers using mica as the dielectric.

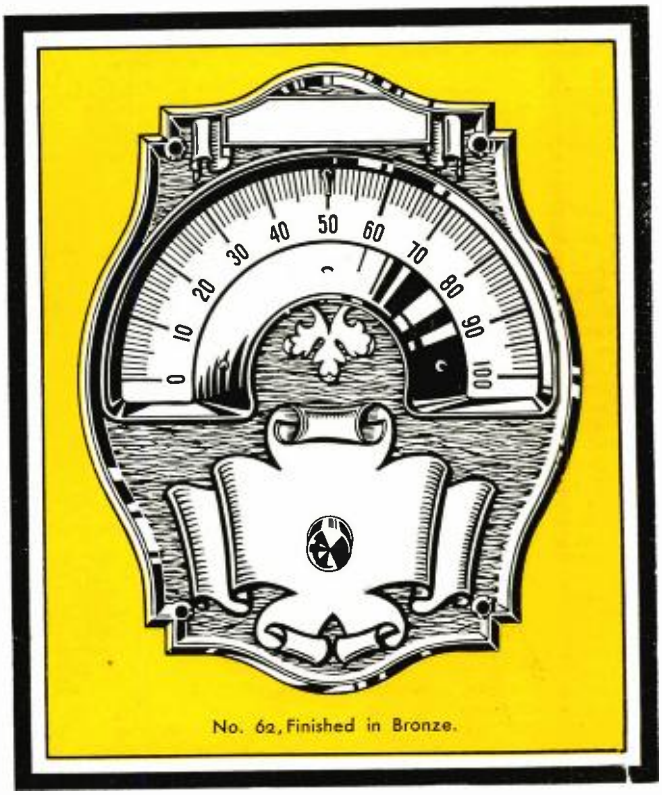
Isolantite is used in most cases where insulating supports are necessary. The remarkably low power factor of this material aids in holding the total losses in the various types of condensers to an almost irreducible minimum. Even in cases where extremely low power factor is unnecessary its use is often justified by its great mechanical stability.

▲

## VARIABLE CONDENSER

The Premier Electric Company, 1802 Grace Street, Chicago, announces the Premier Low-min Variable Condenser. The condenser has a low of .000013 mf., and a high of .00035 mf.

# Introducing THE COMPACT "62"



No. 62, Finished in Bronze.

The New Wedge Drive 62 Tuning Unit, complete with escutcheon as shown above, is designed as a low priced unit for midget or console sets in which space is limited. The 62 occupies less space than any of the friction drive units, requiring only one hole, $2\frac{11}{16}$" in diameter in the panel for mounting. The escutcheon is generous in size, adequately concealing the aperture.

A ratio of 6-1 gives the 62 unusual smoothness and power. The scale is riveted to the back of the escutcheon and slopes backward at a 25° angle. The pointer is in an overhead position and travels through a 180° arc. This unit, under another number, will soon be available with a travelling light.


No. 2388

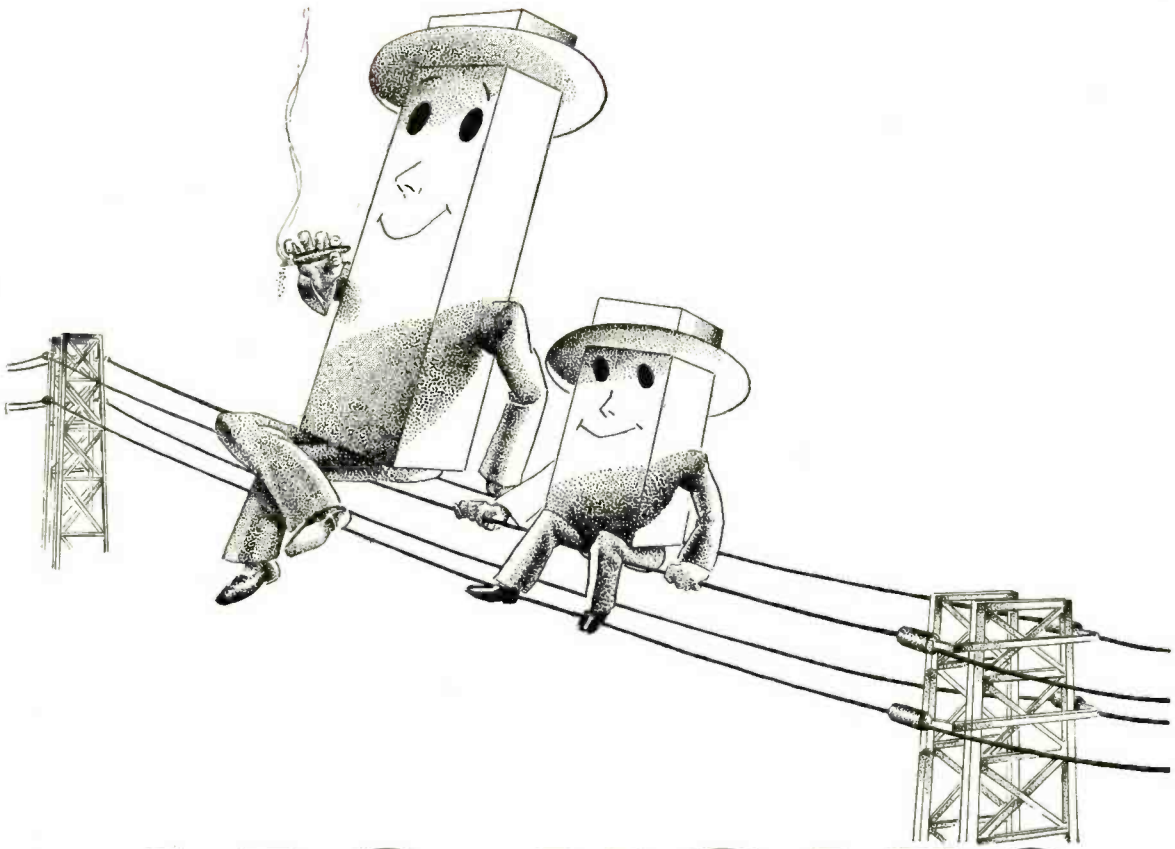
The Tuning Meter Escutcheon shown at the left is a stock pattern, for general use.

Write or wire for samples and prices.

## CROWE

**NAME PLATE & MANUFACTURING CO.**

1739 Grace St. CHICAGO ILLINOIS



# 450 VOLTS

## *Also Lower Voltages at Lower Prices*

THE Elkon electrolytic water-free* condenser has a working range up to 450 volts—and withstands without injury transient peaks in excess of 575 volts. The highest capacity of any condenser of equal size! Because it is free from water it can be mounted at any angle, will withstand extreme winter cold, yet it is stable, has high filtering capacity and extremely low leakage. Furthermore Elkon has practically the same characteristics as paper condensers—but is lower in cost and much less bulky . . . and here's news—all of the above characteristics apply to our new By-pass condensers. 73 leading set manufacturers have standardized on Elkon. A request today will bring you your sample tomorrow. Complete information will be sent to all members of your technical staff. Just send their names.

*—water of crystallization, of course—but no *free* water.

*Elkon Division of* P. R. MALLORY & CO., Inc., Indianapolis, Ind.

*Sales Offices:* New York · Cleveland · Detroit · Chicago · Los Angeles

**ELKON CONDENSERS**

**COST LESS TO BUY AND LESS TO INSTALL**

# NEWS OF THE INDUSTRY

### RADIO TUBE MANUFACTURE

The Chamber of Commerce of Lewiston, Me., in reporting on the industrial situation in that locality states that in the metal manufacturing line the production of the American Electro Metal Co., was recorded as greater for each month of 1931 than in the corresponding months of 1930. 1930 production was larger than that of 1929.

The American Electro Metal Co., manufactures Elmet wire for hooks and grids and Elmet sheet for plates of radio tubes.

▲

### R. F. SHEA IN CONSULTING WORK

Richard F. Shea, formerly chief engineer of Pilot Radio and Tube Mfg. Co., has gone into radio consulting work, with offices at 24 Dewey Street, Lawrence, Mass. Mr. Shea is specializing in manufacturers' production and engineering problems, such as condenser and transformer design and manufacture, and receiver and testing equipment design, in all of which lines he has had considerable experience with many of the leading radio manufacturers. In particular, Mr. Shea is expert on short wave converter design, having worked out several commercial jobs, including the new Pilot All Wave.

▲

### TUBE PRICE REDUCTIONS

E. T. Cunningham, president of the RCA Radiotron Company, Inc., announced on October 17 substantial list price reductions on RCA Radiotrons and Cunningham radio tubes, ranging up to 40%, and affecting the popular type tubes which make up 82% of the tube demand. This is the fourth price reduction on tubes since 1930, making today's price about 50% under those existing before July of last year.

The types affected and the reduction on each type follows:

| Type | Old Price | New Price |
|---|---|---|
| UX-171-A | $1.40 | $0.90 |
| UX-201-A | 1.10 | .75 |
| UY-224 | 1.50 | 1.00 |
| UY-224-A | 2.00 | 1.60 |
| UX-226 | 1.25 | .80 |
| UY-227 | 1.25 | 1.00 |
| RCA-235 | 2.20 | 1.60 |
| UX-245 | 1.40 | 1.10 |
| RCA-247 | 1.90 | 1.55 |
| UX-280 | 1.40 | 1.00 |

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### EISLER ELECTRIC SPEED SPOT WELDING MACHINES

The Eisler Electric Corporation of 740-772 South Thirteenth St., Newark, N. J., have expanded their line of speed spot welders which they have been manufacturing for the past twelve years.

The range now covers ½ to 35 K.V.A. with machines of the following capacities: ½, 1, 3, 5, 10, 20 and 35 K.V.A. capable of handling from .0005-inch to 5/8-inch combined thickness of steel, made foot and motor drive.

Speed welding machines are extensively employed in the manufacture of radio tubes, automotive and electrical appliances.

Speed welders' principal advantages are speed in production—produces uniform welds—positive and smooth in action—simplicity of construction—few working parts—rugged and compact—wide range of heating steps—low maintenance cost.

A few of the metals that can be welded to each other are aluminum, ascoloy, brass, copper, galvanized iron, lead, monel, nickel, nichrome, tin plate, zinc, phosphor bronze, nickel silver and many others. Most of these materials will also weld to each other.

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### NEW PRESIDENT OF DE FOREST AND JENKINS

The DeForest Radio Company and the Jenkins Television Corporation of Passaic, N. J., announce the resignation of Charles G. Munn as president of both companies, and his election as chairman of the executive committee of both companies. Leslie S. Gordon, who has been identified with banking and manufacturing activities in Chicago, succeeds Mr. Munn as president of the DeForest and Jenkins companies. The personnel of both organizations remains the same.

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### POWER TRANSFORMERS

The Halldorsen Company, 4500 Ravenswood Avenue, Chicago, report that in the production of power transformers their engineers have constantly stressed the importance of designing the product so that it will operate at the highest efficiency, and insulating it so that it will hold up under all conditions. The original designs are tested under actual operating load before being submitted, so that their operation may be observed and checked before they are submitted to customers.

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### JEFFERSON NEW ELECTRIC PLANT

Announcement was made recently of what is claimed to be the largest industrial development in the Chicago area during 1931. Jefferson Electric Company purchased a 19-acre tract in Bellwood, a western suburb, on which it will erect at once a $550,000 manufacturing plant. This will house in one building their two Chicago plants now at 15th and Laflin Streets and at Congress and Green Streets, and will care for their entire business with the exception of the Canadian subsidiary in Toronto. The company now employs approximately 1,800 and the new plant will have facilities for 3,000 workers.

The property fronts 700 feet on 25th Avenue and 1,000 feet on Madison Street, extending from Madison Street 1,278 feet along the Indiana Harbor Belt Railway to Jackson Street. In addition to being served by the Belt Railway, the new plant will have the Chicago, Aurora and Elgin Railroad, the Chicago and Great Western and a freight line of the Chicago and Northwestern Railroad.

Jefferson Electric Company, of which J. A. Bennan is president, J. C. Daley, vice-president and treasurer, and A. E. Tregenza, vice-president and general sales manager, was established twenty years ago and merged fifteen years later with the Chicago Fuse Manufacturing Company, which had been organized more than four decades ago. They have paid dividends every year without interruption since organization, it is stated.

The chief products manufactured include transformers such as are used for bells, signal systems, electrical toys, oil burners, radio receivers, and neon signs, as well as electrical fuses, automobile ignition coils, outlet boxes, switch boxes, and miscellaneous electrical products. The annual business approximates $5,000,000.

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### KINGSTON TRANSFORMERS

The Kingston Products Corporation, Kokomo, Ind., manufacture a high-grade line of radio power transformers. The corporation has issued a new booklet listing various types of transformer to meet the requirements of radio manufacturers.

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### THE JEWELL PROFESSIONAL COMBINATION

There is a rapidly growing percentage of radio servicemen who consider their work in the light of a profession. The whole industry is indebted to them for the superior service methods they have evolved.

These men demand complete radio service equipment that is adequate for making all tests and adjustments on any receiver. To meet their needs most conveniently the Jewell Electrical Instrument Company, 1650 Walnut Street, Chicago, has developed a single compact unit that provides all necessary servicing functions.

The Pattern 531 Professional Combination includes a Jewell Pattern 444 Set Analyzer, the new Jewell Compact Oscillator similar to the Pat. 563 and a power unit that supplies power for testing all tubes independently of a receiving set.

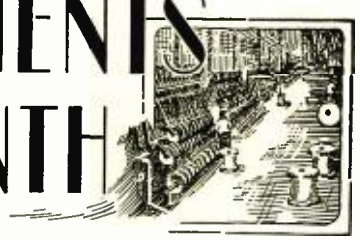
The analyzer and oscillator may be removed from the carrying case for convenient use in the shop or in the customer's home.

▲

### CHARLES GILBERT NOW WITH DUBILIER CONDENSER CORPORATION

Since July 1st, 1931, Charles Gilbert has been with the Dubilier Condenser Corporation of New York City as assistant to the president, William Dubilier. Mr. Gilbert has long been identified with the radio industry as one of its pioneers and builders. He served as president and treasurer of the DeForest organization from 1915 till 1924. He was vice-president of the Brandes-Kolster organization for four years. More recently, he was executive vice-president of the Pilot Radio & Tube Corporation. Mr. Gilbert has specialized in the financial, merchandising and material control phases of radio manufacturing, bringing to the Dubilier organization a wealth of experience and knowledge.

# NEW DEVELOPMENTS OF THE MONTH



## DAYRAD DIRECT READING TUBE TESTER

With base dimensions of 9" x 17" and with the back panel 12" high, the Type 360 DayraD direct reading tube tester is the ideal instrument for stores and departments where space is limited, but where tube sales are an important part of the merchandising.

This instrument is all a-c. operated. Tubes are tested at voltages sufficiently high and appropriate to make the readings reliable and accurate.

A separate tube socket is provided for each type of tube. Similar tubes are grouped and each group of sockets is of colored bakelite in contrast to the adjacent group.

The large meter scale is divided into three sections, Good, Weak, and Poor. Tests are made for quality, shorts and opens.

The cabinet is finished in instrument black and is of hardwood.

▲

## SPECIAL IMPEDANCE MATCHING TRANSFORMERS

Ferranti, Inc., 130 West 42nd St., New York, in addition to their standard audio and output transformers, are specializing in the manufacture of special impedance matching transformers giving a particularly flat curve from 30 to 8,000 cycles. This type of transformer is exceptionally well suited for broadcast stations, sound studios, communication engineering and various types of special vacuum tube work. The accompanying curve is a typical line-to-line transformer which shows a drop of less than one-half of 1 db. from 30 to 8,000 cycles.

These transformers are wound to suit customers' requirements, a few of the usual types being microphone to line, tube to line, line to line, tube to speaker, line to speaker and line to tube. Due to the special type of construction used in these transformers the leakage reactance and self and mutual capacities have been reduced to a minimum, thus obtaining the flat curve along with a high transfer of energy.

Literature will be sent on request.

## BURGESS VACUUM CONTACT MOUNTING

To facilitate the application of the Burgess Vacuum Contact to relays and other actuating mechanisms, a conveniently mounted unit has been developed by the Burgess Battery Company, New York City. The unit consists of a C-shaped metal casing to protect the glass vacuum contact held in a pair of clips, a connecting link for coupling the actuating mechanism to the extension stem of the vacuum contact, and a pair of screw binding posts. An adjustment screw with lock nut permits of applying counter pressure to the connecting link in offsetting the inherent spring tension that normally keeps the vacuum contact close, when operating as an open circuit device. By rotating the vacuum contact one-half turn in its spring clips, it may be operated as a closed circuit device after adjusting the connecting link.

The Burgess Vacuum Contact Mounting

is especially applicable to the standard type telephone relay. It may also be applied to any mechanical, manual or thermostatic form of actuation. An actuating force of 6 to 10 ounces, with a movement of but .02 inch, is sufficient to operate the vacuum contact which in turn controls up to 6 amperes continuously or 8 amperes intermittently, at potentials up to 220 volts.

## A. C. AUDIO OSCILLATOR

Audio oscillator Model No. 304 is intended for use in places where operation from the 110-volt a-c. line, and where audio output voltages in the neighborhood of 100 volts is desired. The frequency range is continuously variable between 40 and 10,000 cycles per second. Two 224-type tubes are used as oscillators, a 227-type tube serves as the mixer tube, while

the amplification is accomplished by a 224 and two 245-type tubes. A 280 tube acts as the power pack rectifier which is built into a separate compact unit.

An output voltage meter is included in the device and reads "output volts" directly. No hum can be heard in the output even when using sensitive ear-phones. The oscillator is supplied with a calibration curve covering the entire range.

The harmonic content of the output wave is approximately 5% above and 10% below 100 c.p.s. (percentages are in relation to fundamental voltage).

The output voltage is between 100 and 160 volts between 60 and 10,000 cycles per second and can be varied continuously between zero and maximum by means of the volume control.

It is manufactured by Wireless Egert Engineering, Inc., 179 Varick St., New York City.

▲

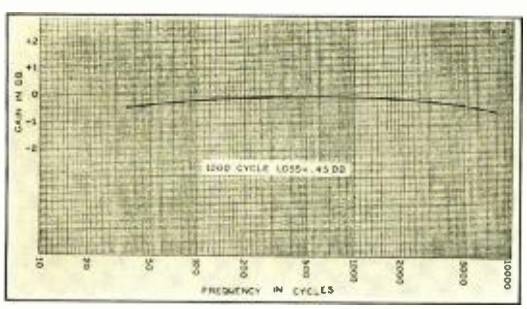
## F. W. SICKLES COMPANY

The F. W. Sickles Company of Springfield, Mass., pioneer radio-frequency coil manufacturers, have recently developed a series of standard coil units, both shielded in attractive aluminum cans and the conventional unshielded coil. These coils are single layer space wound solenoids and bank wound Litz coils, with high efficiency.

Intermediate frequency transformers, of unique designs, enable the manufacturer to obtain any desired band-width and "gain." Of special interest is the new type intermediate with close coupled primary and secondary, requiring a trimmer condenser on one side only. This offers a saving for midget supers.

This company is also specializing in short-wave coils for converters and television receivers and manufacturers are requested to write regarding their requirements in this field.

The F. W. Sickles Company maintains a fully equipped radio-frequency measuring laboratory and will be glad to assist manufacturers and coil engineers in developing special items.




Curve of 500 ohm line-to-line Ferranti transformer.

### VISUAL TEST SET

#### Type TMS-36

This new visual test set, the result of more than ten years of research and development, offers to both the engineer and manufacturer a most rapid and accurate means for adjusting intermediate frequency amplifiers and their component parts. The operation is extremely simple as an image of the resonance curve is projected on a screen, and it is only necessary for the operator to adjust the device under test to give the required resonance curve. The screen may be calibrated, both as to band

width and amplification. An attenuator system is included for adjusting the signal to the proper level for the various stages when cascade amplifiers are being tested. An impedance matching unit is included, eliminating the use of an additional tube when individual transformers are being tested.

This instrument contains a variable frequency oscillator, and attenuator, an impedance matching unit, a combination amplifier or detector unit, and a single element oscillograph. The output frequency of the oscillator is varied over a predetermined range by a sweep condenser. The signal thus generated, after being properly attenuated, is impressed on the input of the device under test. The output voltage is then fed through the amplifier and detector unit to the galvanometer of the oscillograph. The oscillograph mirror rotating in synchronism with the sweep condenser produces a standing image of the resonance curve which is projected on the screen.

For testing small inductors and capacitors, an additional unit can be supplied for mounting in the lower center section of the cabinet.

The Visual Test Set, Type TMS-36, is supplied, either in a cabinet of walnut finish or black duco, as specified by the customer. The visual test set is manufactured by the RCA-Victor Company, Camden, N. J.

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### NEON LAMP CABLE FOR INDOOR USE

An indoor-type neon sign cable announced by the General Electric Company is available in ratings of 5,000, 10,000 and 15,000 volts. The cable for 5,000-volt service is a No. 14, 19-strand, single conductor covered with a special high-tension rubber compound, a single braid of hard-finish cotton, and 12 individual coats of high-tension lacquer. The cable is slightly less than ¼ inch in overall diameter, and its weight about 50 pounds per thousand feet.

The 10,000-volt cable is similar except for a heavier coating of rubber. Its overall diameter is 0.350 inch, and its weight about 75 pounds per thousand feet.

The 15,000-volt cable is a No. 14, 19-strand, single conductor of tinned copper, with an even heavier covering of the special high-tension rubber compound. Over this is applied a single braid of cotton put through a flame-resisting finish, a single braid of glazed cotton, and 12 individual coats of high-tension lacquer. The overall diameter is slightly less than ½ inch, and the weight approximately 115 pounds per thousand feet.

The standard color of the finish is brown, but special colors such as black, etc., can be furnished at additional cost.

▲

### NEW TUBE CHECKER

The Cable Radio Tube Corp., 230 North 9th St., Brooklyn, N. Y., has introduced the Speed Tube Checker. Fitted with an easily readable, flush-mounted meter, seven inches in diameter, and located so that the customers can see for themselves how the tubes test. Reading limits for each type are plainly shown, permitting visible comparisons to be made by the customer—establishing an impressive demonstration.

Assembled in a beautiful walnut-finished cabinet, twenty-five inches wide, twenty-two inches deep and twenty-four inches high. (Table to match, thirty-one inches high, supplied if desired.)

▲

### H. F. CONVERTER

The LEPEL Type "D" High Frequency Converter illustrated herein is of the tungsten quenched gap type, having a variable primary high frequency exciter circuit tunable to a free swinging high frequency load circuit. The coupling between these


circuits is arranged to utilize the *entire "L"* value of the secondary or load circuits without the use of external tapping points and other complications or losses. This feature with other refinements make the unit ideal as a source of high frequency energy for bombarding of radio tubes on automatic exhaust, trolley or metallurgical research where heating or melting metals by high frequency induction are desired.

Manufactured by the Lepel High Frequency Laboratories, 39 West 60th St., New York.

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### POWER SUPPLY FOR RADIO TRANSMITTERS AND SOUND SYSTEMS

The type 30-A power supply was originally developed for testing aircraft radio telephone transmitters. Because of its compact design and portability, it is useful in many other applications. It will supply plate power for 50-watt radio telephone installations, sound trucks equipped with high power audio amplifiers and public-address systems, and is particularly valuable in laboratories where a source of high voltage direct current is required.

The unit consists of a single-phase full-wave mercury vapor rectifier, filter system and automatic switching and protective circuits, including a time-delay relay and overload circuit breaker. Two receptacles at the rear of the frame make it possible to use either 110 or 220 volt supply at will. The output leads are brought through rubber bushings at the side. It is completely enclosed in a perforated metal frame. The top is hinged to provide access to the rectifier tubes and

is equipped with a door switch to prevent application of the high voltage while the frame is open.

The unit has a maximum rated output of .5 ampere at 1000 volts and will deliver .4 ampere at this voltage continuously.

In addition to the portable model shown, this unit is also furnished for mounting in a standard relay rack. The 30-A power supply is one of a complete line of radio telephone transmitters and allied equipment manufactured by R. C. Powell & Co., Inc., of New York City.

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### BROADCAST STATION OUTPUT

A circular from the General Radio Company, Cambridge, Mass., reads as follows:

"Ten per cent as the maximum harmonic content of a broadcast station output is the subject of a Federal Radio Commission order. While the measurement of harmonic content may be made by an oscillograph, such records are inconvenient to take and, in addition, do not give reliable quantitative data on distortion of this magnitude.

"A direct reading instrument is required, and one which may be used not only to determine the harmonic content of the station output, but also to check through the amplifier in order to determine the source of the distortion. Not over a minute should be required to take a reading. Such an instrument is now available in our Type 536-A distortion-factor meter.

"The use of this meter in the output of a station requires, in addition, a carefully designed linear rectifier. Such a rectifier is contained in our Type 457-A modulation meter. The combination of these two meters, which give direct readings in percentage modulation and distortion, is an essential factor in keeping the station within the requirements of the Radio Commission and in reaching a larger listener audience."

# RADIO NEEDS BETTER AUDIO SYSTEMS


Modern radio must deliver *better reception* to match the tremendous improvements in broadcasting, in talent, in programs.

It costs the manufacturer little more to give his sets the superior performance advantage that Mershon Electrolytic Condensers confer—lifetime perfection of noiseless service, never interfering with the listener's enjoyment.

Equip your sets with the original puncture-proof electrolytic condenser—the Mershon—with exclusive quality features that have made this unit the choice of leading engineers for the majority of America's finest radio sets.

*Magnavox Company Ltd.*

*Executive and Sales Offices:*
155 East Ohio St., Chicago, Ill.

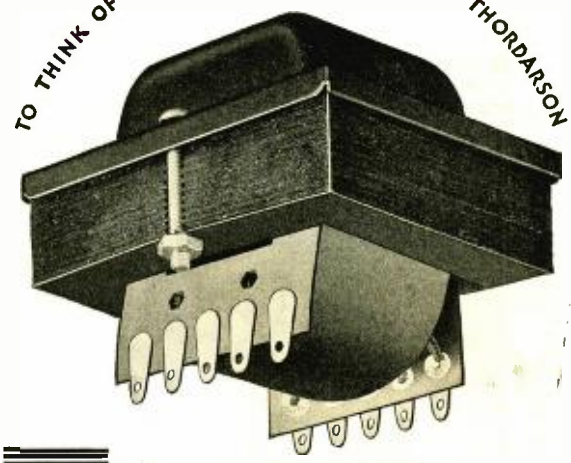
*Factories:*
Fort Wayne, Ind.

*Subsidiaries:*
The Magnavox Company
Electro Formation, Inc.
Magnavox (Great Britain) Ltd.
Magnavox (Australia) Ltd.

## MERSHON
ELECTROLYTIC CONDENSERS

AVAILABLE IN A WIDE RANGE OF CAPACITIES TO SATISFY THE REQUIREMENTS OF EVERY MAKE OF RADIO. SEND FOR ENGINEERING DATA

TO THINK OF TRANSFORMERS IS TO THINK OF THORDARSON



## NEW PRICES *set* NEW LOW-COST RECORDS

You can now use Thordarson Transformers with actual saving . . . so attractive are the new prices at which this quality product is offered. Yet Thordarson Transformers are designed and built for those radio manufacturers who insist upon the outstanding performance of their product.

The "Pentran" (Power for the Pentode), illustrated above, is but one development in line with engineering progress in the radio field. Intensive and continuous research keeps our Engineers right in step with your requirements. Let us work with you. The experience of nearly 40 years' leadership in quality transformer production is at your service.

Thordarson Electric Mfg. Company
500 W. Huron St., Chicago, Illinois

## THORDARSON
Reg. U. S. Pat. Off.
TRANSFORMER SPECIALISTS SINCE 1895 . . .

# INDEX OF ADVERTISERS

# Good News for Tube Makers

## FANSTEEL Moly Wire "G"

1. Greater uniformity . . . . .
2. Less hardening when bent and heated

The past few months have been especially fruitful for Fansteel in perfecting ways and means for improved working of Molybdenum into ductile, workable form for use as grid wire. Two *very* important objectives have been attained:

1. Much better uniformity in elongation, strength and surface now assured by Fansteel's Molybdenum "G." As a result, there is far less tendency for the wire to break in grid winding, or when finished grids are being stretched to shape.

2. The tendency of Molybdenum wire to harden where it is bent or welded has been almost entirely overcome in this improved Fansteel product. Brittle, weakened or broken grids are no longer a necessary evil.

Fansteel Moly "G" is especially recommended for flat grids, such as the '45 type, where wire must be bent at sharp angles, welded, rolled, stretched and fired. Giving Fansteel Molybdenum "G" wire a try out in this severe service has shown many manufacturers that spoilage can be largely eliminated with life of tubes increased.

Great pains are taken to make this Fansteel Moly "G" the best, most dependable tube material ever offered. There is frequent laboratory check on uniformity of the metal. Closer tolerances as to roundness and diameter are maintained than ever before. Samples are taken for test from each individual spool of wire before it is shipped or placed in stock. Yet it is not high priced.

**GET A SAMPLE AND TRY IT!**

Test Fansteel Molybdenum "G" in your regular tubes—watch it pay for itself in lowered shrinkage. See if those tubes don't stand up better in hard use.

## FANSTEEL PRODUCTS COMPANY, Inc.

North Chicago, Ill.

tantalum · tungsten · molybdenum · caesium

*Bakelite Molded back plate and spools used in electric pick-up, made by Webster Electric Co., Racine, Wisc.*

# Guarding the vital spots

## *with Bakelite Molded parts*

"Beauty is only skin deep" is a saying that hardly can be applied to the new Webster electric pick-up. For, the same attention to fine design that led to the adoption of the beautiful modernistic bronze exterior, is plainly evident in the choice of Bakelite Molded for the needle-carrying block and wire spools in the interior of this device.

The Bakelite Molded needle-carrying block is formed in one piece with square and round holes, three metal inserts and sharply defined raised lettering, all formed in the one molding operation, eliminating machining, finishing and assembling. The use of this material for these vital spots assures freedom from short circuits and metallic vibration, and helps make the tone of the pick-up as beautiful as its appearance.

Bakelite Materials, Molded, Laminated, and Varnish have long played an important part in the manufacture of efficient electronic devices. Applications range from small spools and bushings to complete radio cabinets. Write for Booklets 38M, "Bakelite Molded", 38L, "Bakelite Laminated", and 38V, "Bakelite Varnish". You will find them full of valuable suggestions and authentic technical information.

*Bakelite Engineering Service*—We manufacture a wide variety of Bakelite resinoid molding materials, varnishes, lacquers, enamels, cements, and other products. Twenty-one years experience in the development of these materials for electrical and other uses, provides a valuable background for the cooperation offered by our engineers and laboratories.

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

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

# BAKELITE

REGISTERED U. S. PAT. OFF.

The registered trade marks shown above distinguish materials manufactured by Bakelite Corporation. Under the capital "B" is the numerical sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products.

THE MATERIAL OF A THOUSAND USES