Eleventh Year of Service

RADIO ENGINEERING

Vol. XI JULY 1931 No. 7

IN THIS ISSUE

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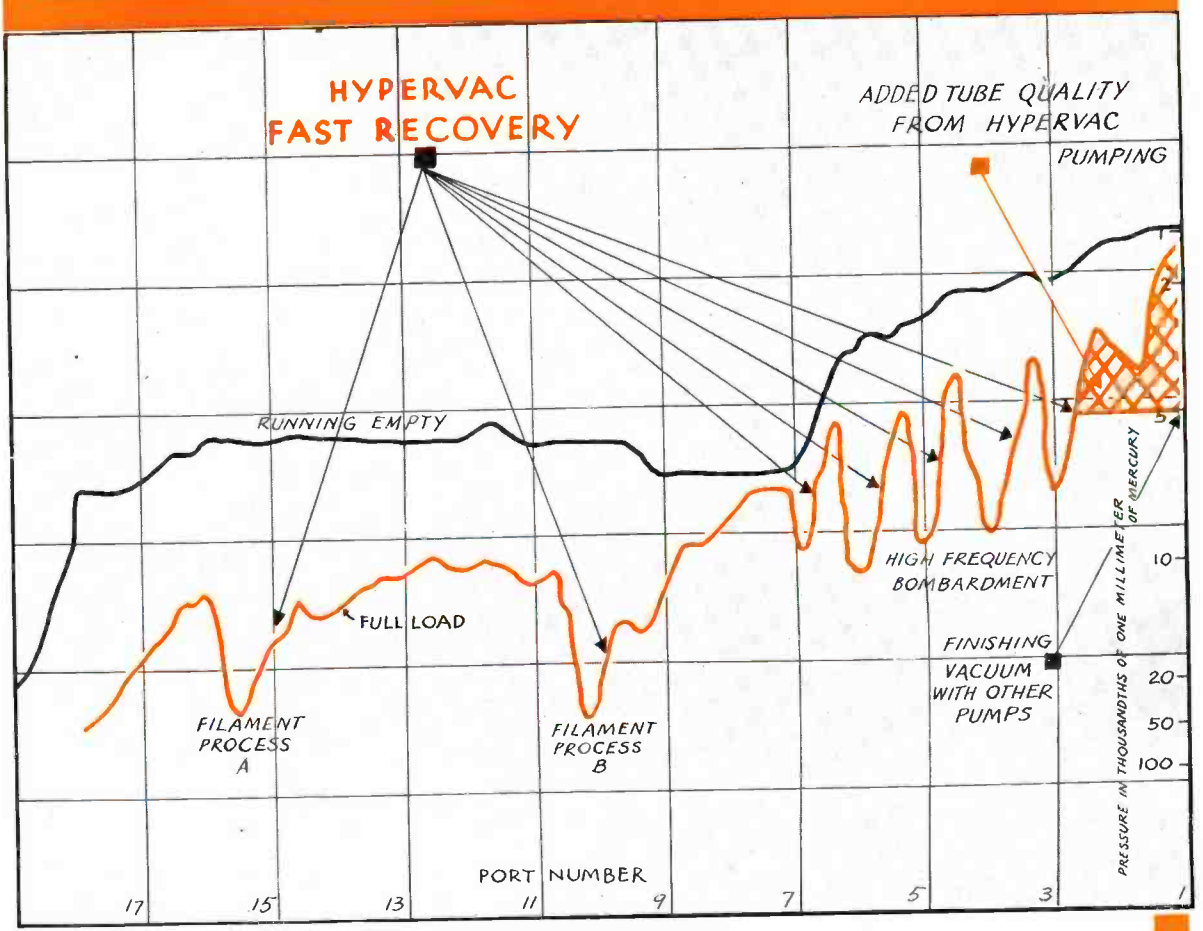
The Journal of the Radio Industry

How Cenco Hypervac Pumps *increase radio tube quality*

AS TOLD BY PRODUCTION CURVES AT ROGERS RADIO LTD.



IN PLANTS where accurate records of process efficiency are maintained, it is possible to identify the exact ways in which Cenco Hypervac pumps improve both product quality and product cost.

These graphs, taken from the records of screen grid tube production at Rogers Radio Limited, represent continuous port to port vacuum measurement, with and without load, on an automatic machine whose last eighteen positions are CENCO HYPERVAC pumped. The unloaded curve marks the best vacuum allowed by the characteristics of the exhaust machine itself. The loaded curve approaches this in proportion to the efficiency with which the pumps remove gases as they are released from the load.

Fast recovery—the key to minimum shrinkage losses—is seen in the sharp and prompt return of the loaded curve to high vacuum, following voluminous gas release by filament processes and high frequency bombardment. This is the factor that reduces unit costs.

As to high finishing vacuum, notice that these tubes are sealed off at one micron, practically equal to the limiting pressure of the empty machine. Other pumping equipment previously used finished off at five microns. Here is a constant integral of finer quality that applies to every tube made in a day's run. Address inquiries to the Central Scientific Company, 460 East Ohio Street, Chicago.

CENTRAL SCIENTIFIC COMPANY

CENCO HIGH VACUUM PUMPS

Hyvac Megavac Super vac Rotovac Hypervac

NEW YORK - BOSTON - CHICAGO - TORONTO - LOS ANGELES

TO PERFECT THE FILTER CIRCUIT

Single hole mounting

One-piece anode

Vent-metal enclosed

Dull Nickel Can

Small Space

High Capacity

High Voltage

Self-Healing

1931 witnesses the definite triumph of the SPRAGUE INVERTED TYPE ELECTROLYTIC CONDENSER which is now specified by most of the leading radio manufacturers, producing the largest volume of radio receivers absorbed by the American public. No other device can compare with the SPRAGUE CONDENSER for efficiency, economy and performance in the perfecting of the Filter Circuit. Produced with absolute uniformity, Sprague condensers are specified by those who seek maximum efficiency.

Write for illustrated booklet, diagrams, etc.
Department

SPRAGUE SPECIALTIES COMPANY
North Adams, Mass.

SPRAGUE
Electrolytic CONDENSERS

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 · **JULY, 1931** · **Number 7**

Contents

THE RADIO CONVENTIONS

THE convention of the Institute of Radio Engineers was held in Chicago in June, the week ahead of the R.M.A. Show. There was advantage to the industry in having the two meetings in the same city during successive weeks. The decision of the engineers this year was to hold their meetings and put on their radio accessories exhibits in advance of the manufacturers' show.

It may be that annual meetings of the two organizations cannot always be arranged in the same city in consecutive weeks, but when this is possible the question arises as to whether the I.R.E. or the R.M.A. should carry on during the first week.

At the windup of the joint sessions in Chicago there was expressed opinion that it would be better for the engineers to begin their meetings following the close of the R.M.A. show.

No doubt this would bring to the I.R.E. gathering a larger number of attendants, and it may be that next year it would be worth trying out.

The number of exhibitors of parts at the I.R.E. convention was gratifying to the Institute management and it appeared that the exhibitors also were satisfied — even though some of them exhibited at both meetings.

At Chicago some thought that three days for each organization would have been sufficient. Others thought that the R.M.A. might have four days and the I.R.E. two.

This subject is important and no doubt during the coming months it will be threshed out conclusively by the officers of the associations concerned.

BRYAN S. DAVIS, *President*

JAS. A. WALKER, *Secretary*

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THE INVERTED TYPE (8Mfd.) ELKON NON-AQUEOUS HI-VOLT CONDENSER

All ELKON Non-Aqueous Hi-Volt Filter Condensers have these outstanding Characteristics:—

1. **Highest Filtering Capacity** *of any electrolytic condenser.*
2. **Working Voltages**—*up to 450 v., d. c.*
3. **Absolutely Dry**—*All free water is eliminated.*
4. **Low Leakage**—*0.1 mil. per mfd., after brief operation.*
5. **Impervious to Low Temperatures**
6. **Long Life**—*in excess of usual set requirements.*
7. **Self Healing**
8. **Compact**—*small cubical volume per microfarad.*
9. **Stability in Operation:** *To guard against variation.*
10. **Low Cost Per Microfarad Per Voltage Rating.**

The new Inverted Type 8 mfd. Elkon condenser meets the standard requirements for a unit to be used on sub-panel wiring jobs. It has the same outstanding characteristics as the other Elkon Non-Aqueous Hi-Volt Condensers which have been adopted as standard equipment by many leading set and instrument manufacturers.

For Production Economy use the Standard Elkon Non-Aqueous Hi-Volt Condenser WITHOUT THE CAN

Many manufacturers have substantially reduced their condenser costs by using Elkon condensers without the can. Mount on bottom of chassis or on top under an inexpensive drawn metal cover.

The metal can is not necessary with Elkon condensers as each unit is enclosed in a sturdy, wax-dipped cardboard container providing ample protection for efficient operation.

Samples of standard Elkon condensers without the can in any capacity or combination of capacities will be sent to all recognized manufacturers.

Send for booklet giving complete technical data and general description.

Small size and efficient operation are the outstanding characteristics of the Elkon Audio By-pass Condensers. They are covered with the same type of sturdy, wax-dipped cardboard carton which is being used so successfully on the standard Elkon Filter Condensers.

The following sizes can be supplied.

Capacity	*Size*	*Voltage*
¼ mfd	½ x ½ x 2	450
½ mfd	½ x ½ x 2	450
1 mfd	¾ x ¾ x 2	450
2 mfd	1 x 1 x 2	450
½ mfd	½ x ½ x 2	up to 150
1 mfd	½ x ½ x 2	up to 150
2 mfd	¾ x ¾ x 2	up to 150
4 mfd	1 x 1 x 2	up to 150
8 mfd	1 x 1 x 2	up to 150

A special mounting band for fastening condensers to the chassis can be supplied if desired.

Now Ready . . .

ELKON AUDIO BY-PASS CONDENSERS

After an extended period of developemental work and exhaustive field tests, the Elkon By-Pass Condenser is now ready for all audio by-pass applications. Small, compact, efficient, economical and with a life-expectancy in excess of the usual set requirements, this latest Elkon Condenser has already been specified by two leading manufacturers for regular production.

Samples will be sent upon request to all recognized manufacturers.

ELKON DIVISION
P. R. Mallory & Co., Incorporated
Indianapolis, Ind.

Editorial

JULY, 1931

TUBE REPLACEMENT

IN A courageous effort to put an end to the tube replacement "racket," several of the vacuum tube manufacturers have announced revised policies covering this element of tube merchandizing.

In general the change means that tube manufacturers will no longer replace any and all types and vintages of tubes purported to be defective.

The DeForest Radio Company will not replace tubes which are more than one year old. Age in this case is determined by code markings known to jobbers.

The Cable Radio Tube Corpn., makers of Speed tubes, on May 1 last adopted the policy now in force by that company.

The Cable Company during a twelve months survey learned that the number of tubes returned totaled 5.87 per cent of sales for the same period. The salvage of good tubes in the returns reduced this to 4.12 per cent.

This company believes that with the high grade tubes now being merchandized returns should not amount to more than 3 per cent. maximum. Cable now has a "no replacement" policy. Instead there is allowed as a safety factor 6 per cent. of the net purchases, deducted from each invoice to cover possible defective goods. This discount seems larger than there is reasonable call for. No doubt it will be reduced as experience warrants.

Other tube manufacturers have reported returns as high as 10 per cent. and have found that 30 per cent. of the tubes returned were still quite serviceable.

It is high time for the adoption of a uniform replacement policy by all tube manufacturers.

▲

RADIO TRANSMISSION

WHEN the name "wireless" originally was given to radio transmission the reason was that there was absent the customary medium —the wire. Those engaged in the radio business avoid the enormous expense of purchasing a medium of transmission at so much per pound-mile: avoid also the expense of maintenance and replacement of the medium.

Avoidance of these costs and expenses is about all radio engineers are agreeable to crediting to the free-for all gift of the medium employed in radio. An uncontrollable, unharnessed medium such as that employed has obvious disadvantages. And, as radio progresses and successive generation of engineers center attention upon investigations having for their object tabulation of the characteristics of the medium, more and more is disclosed in the way of related factors and elements.

It was logical that the astronomers, the astrophysicists, should in time be called upon to bring to this general radio problem the benefits of their accumulated knowledge of what is taking place, and what likely is taking place, in the upper regions of the atmosphere and beyond. There is little doubt that much of what is accomplished in the future toward stabilizing radio transmission will be a result of additional knowledge gained through the eyes of and the reasoning of astronomers.

Recently Dr. Harlan T. Stetson, astronomer at Ohio Wesleyan University, speaking before the astronomical section of the American Association for the Advancement of Science, reported results of measurements of the strength of radio signals originating at station WBBM, Chicago.

It was stated that radio reception conditions improve and deteriorate in irregular fifteen-month cycles. It was observed that the worst disturbances affect radio transmission when Mercury and Venus are in line with the Sun, which occurs approximately once every fifteen months.

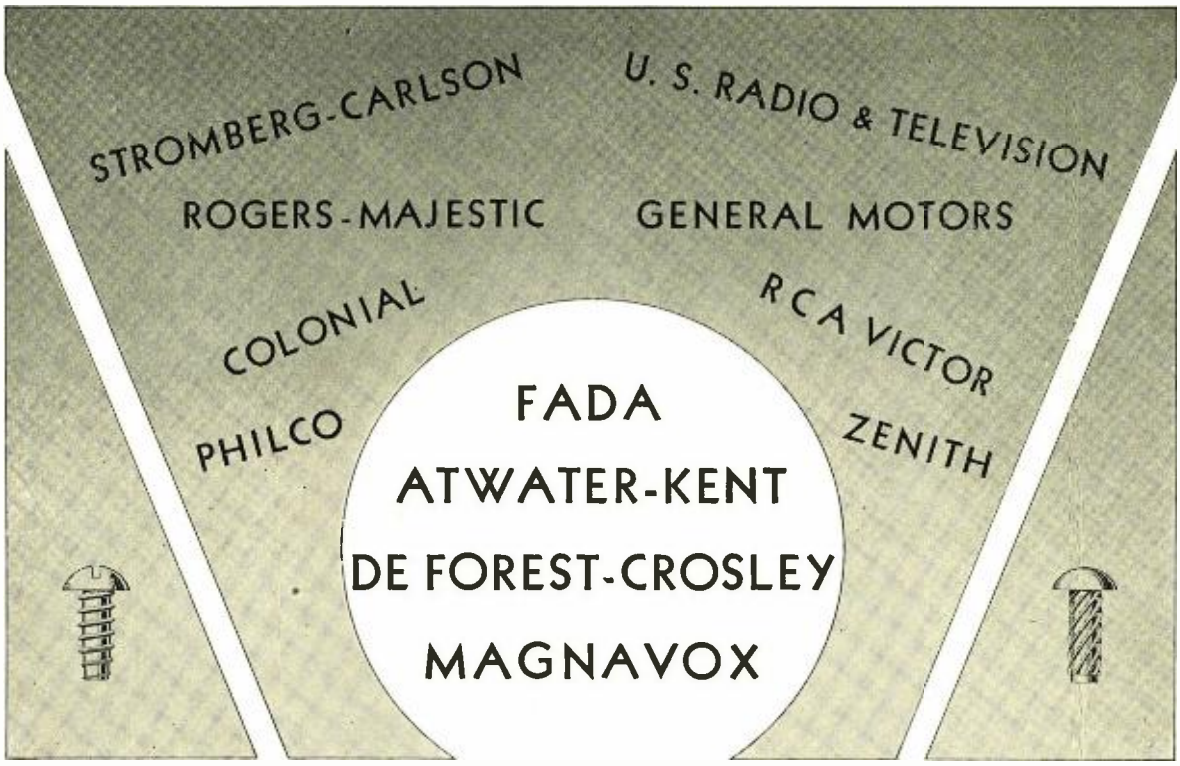
The evidence indicates, according to Dr. Stetson, that Mercury and Venus are both electrified bodies and that they shower the sun with electrons, producing the sun spots or cyclones in the sun's atmosphere. Under the electrical attack of Mercury and Venus the sun in its turn hurls electrical storms at the earth, damaging the "electric ceiling" of the earth which carries and reflects radio.

The moon also is a disturber of radio reception, according to Dr. Stetson. He finds that radio conditions are disturbed when the moon is directly overhead and he believes that the reason is again electrical. The moon is apparently electrified. Its charge is opposite to that of the earth. Therefore, the moon as it travels around the earth carries a sort of tidal wave of electrical disturbance through the radio or electric ceiling of the earth's atmosphere.

A contribution to this subject is contained in the paper prepared by Lieut. Breckel, appearing in this issue of RADIO ENGINEERING. The entire subject is one that will come in for due consideration and discussion in the immediate future.

Donald McNicol

Editor.



4 More Noted Users

Now all leaders assemble the speediest, cheapest way

Smaller manufacturers can have the same advantages by making metal assemblies with Self-tapping Screws.

Proof that Self-tapping Screws offer exceptional assembly advantages to manufacturers of radio receivers and equipment is seen in the list of users given above. All of the leaders have tested and adopted these unique Screws for production. Every adoption has resulted in important savings of assembly time and labor. The makers of Philco receivers eliminate dozens of tapping operations on each unit . . . troublesome operations which had slowed production and increased costs.

Since the use of Self-tapping Screws involves no machinery or changes in design, smaller manufacturers can readily obtain the assembly economies offered by these Screws. In fastening parts to a chassis, assembling speakers, or making any other metallic fastenings, only one simple operation is required to do the job with Self-tapping Screws.

It costs but a two cent stamp to find out what these Screws will do on your own assemblies. Just mail the coupon and we will send two free booklets which contain full information. We will also send the unbiased recommendations of our Assembly Engineers and proper samples for trial, if you will submit a brief description of your assembly.

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

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----------

Three Electric Industries Unite For Public Service

THREE great industries—radio, electrical manufacturing and electric light and power—have united in a joint enterprise of public and industry service. It was announced June 1, that the Radio Manufacturers Association, comprising virtually all prominent radio makers; the National Electric Light Association, embracing the electric light and power interests, and the National Electrical Manufacturers Association had formed a joint coordination committee with the object of furnishing electrical facilities of each type to the public in the most efficient manner.

Improvement of radio reception, nationally and locally, by eliminating or reducing various noises and other interference in radio reception and broadcasting, it was officially announced, is a major effort of the joint industry committee. Coordination of radio with other electrical utilities, with study of many engineering problems involved, to promote harmony in various uses of electricity, is the objective of the committee. This includes design of machines and power systems as well as radio apparatus and the use of electricity for light, heat, power and transportation.

Better radio reception and other electric uses is aim. High power broadcasting urged on Federal Radio Commission.

High Power Broadcasting

The first and important recommendation of the joint committee, which has been transmitted to the Federal Radio Commission at Washington, is a resolution urging high power in broadcasting. It is pointed out that this smothers and greatly reduces radio noises and vastly improves radio reception to the public. The resolution sent to the Commission urges maximum power, consistent with radio development, by broadcast stations as an effective means of improving radio reception. The resolution of the joint committee was endorsed separately by the three organizations, the National Electric Light Association, the National Electrical Manufacturers Association, and the Radio Manufacturers Association.

Representing the Radio Manufacturers Association on the joint industry committee are H. B. Richmond of Cambridge, Mass., former president of the RMA and now director of its Engineering Division; Tobe Deutschmann of Canton, Mass., Chairman of the RMA Interference Committee; Ralph H. Langley of New York, chairman of the RMA Standards Sub-Committee on Receiving Sets; E. M. Hartley of Camden, N. J.; R. F. Herr of Philadelphia; W. K. Fleming of Canton, Mass., and Bond Geddes of New York, executive vice-president of the RMA.

At present the joint coordination committee is gathering statistical data on the present situation of the various uses of electricity. It has begun many important engineering studies and is developing instruments and methods of measurement. Consideration is being given to factors in design of machines in power systems which may affect radio reception and to the characteristics of radio receiver design, as well as shielding, sensitivity, etc.

The resolution on high power broadcasting, which urges the Federal Radio Commission to require high power by broadcast stations using cleared channels, follows:

Whereas, There has been appointed a Joint Coordination Committee on Radio Reception of the National Electric Light Association, National Electrical Manufacturers Association and Radio Manufacturers Association for the purpose of studying methods to improve broadcast reception and in particular to consider the steps necessary to coordinate this newer use of electricity with some of its older uses for light, heat, power and transportation, in order that the growth of each of these various uses may not be restricted by the requirements of the other, and

Whereas, After study of the subject it appears that one of the most effective methods available to attain such improvement promptly is the use in broadcast transmission of high signal field strength, thus obtaining a corresponding increase in signal to noise ratio at the point of reception, at a meeting of the Joint Committee held in New York City, it is by unanimous vote

Resolved, That the reception of radio programs would be served best by the use by broadcasting stations of the maximum power available consistent with the state of development of the art, and

It Is Further Resolved, That the assignment of cleared channels to broadcast stations should require the use by them of adequate amounts of radiated power to utilize properly the facilities afforded by such cleared channels, and therefore in view of the foregoing

It Is Further Resolved, That a copy of these resolutions be transmitted to the Federal Radio Commission with the request that the Commission consider the advisability, as a matter of public interest in promoting the greatest use of electricity in all of its fields of service, as well as improving radio reception, of requiring the uniform use on all cleared channels of the maximum power available consistent with the state of development of the art.

HYGRADE *Sylvania*

Two Great Names *in the* Tube Industry

NOW JOINED TO GIVE GREATER VALUE THAN EVER BEFORE

THE MERGER of the Hygrade Lamp Company of Salem, Mass., and the Sylvania Products Company of Emporium, Pa., unites the forces of two of the most successful radio tube manufacturers in America.

Successful, well financed, and with a background of 30 years' experience in the construction of vacuum products, these two companies offer to the receiving set manufacturer an opportunity to obtain in Hygrade and Sylvania Radio Tubes the advantages of mass production plus high quality, uniformly maintained.

The combined engineering facilities of two thoroughly organized engineering departments, manned by engineers of recognized achievement, plus the skilled man power and the newest types of machinery in two modern manufacturing plants, are at the disposal of the buyer of Sylvania and Hygrade Radio Tubes.

Radio Tubes are supplied to the receiving set manufacturer fresh from production. The factory schedule does not permit accumulation of old tubes of any type.

It pays to buy radio tubes from a strong, progressive company.

FORTIFIED CONSTRUCTION

(patent applied for)

Strong tubes are better tubes. All Hygrade Radio Tubes are made better by the Hygrade method of fortifying (patent applied for) which renders it virtually impossible to break or injure the internal parts unless the bulb itself is smashed.

Jolts and jars, vibration, the rough handling of shipping cannot injure Hygrade Radio Tubes because the elements are held in positive, accurate space relation — fortified against breakage or distortion.

HYGRADE RADIO TUBES

"TUBES YOU CAN TRUST"

A Product of Hygrade Sylvania Corporation :: Hygrade Lamp Division, Salem, Mass.

SHAKEPROOF

Greater Locking Power thanks to the Patented Twisted Teeth!

1 This shows the position of each tooth when the nut is first tightened down. Note the powerful leverage that is automatically set up against any movement of the nut.

2 When vibration tends to loosen the nut, the spring action of the twisted tooth acts instantly and the sharp edges are forced deeper into both the work and the nut. This action is only possible with Shakeproof's patented twisted teeth.

3 As vibration becomes more intense, the teeth bite in still deeper—always exerting that powerful leverage against any movement of the nut. At the same time, the spring action of the tooth keeps the threads of the nut tight against the threads of the bolt—thus creating a friction that makes the lock absolutely secure.

WHEN a nut or screw is turned down on a Shakeproof Lock Washer, it can't work loose. The patented twisted teeth prevent any movement and as vibration increases the teeth bite in deeper—thus, assuring absolutely tight connections.

This practical locking method has proved its superiority on thousands of products in hundreds of industries. Shakeproof Lock Washers are adding years of extra performance to Automobiles—Radios—Electrical Appliances—Stoves—etc. In fact, practically every leading manufacturer today is using Shakeproof to protect his product from the damaging action of vibration.

Be sure to test this powerful locking method in your own shop. See for yourself how it improves performance and reduces customer complaints. Free samples will be gladly sent on request—mail the coupon, 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 N. Keeler Avenue, Chicago, Ill.

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.....

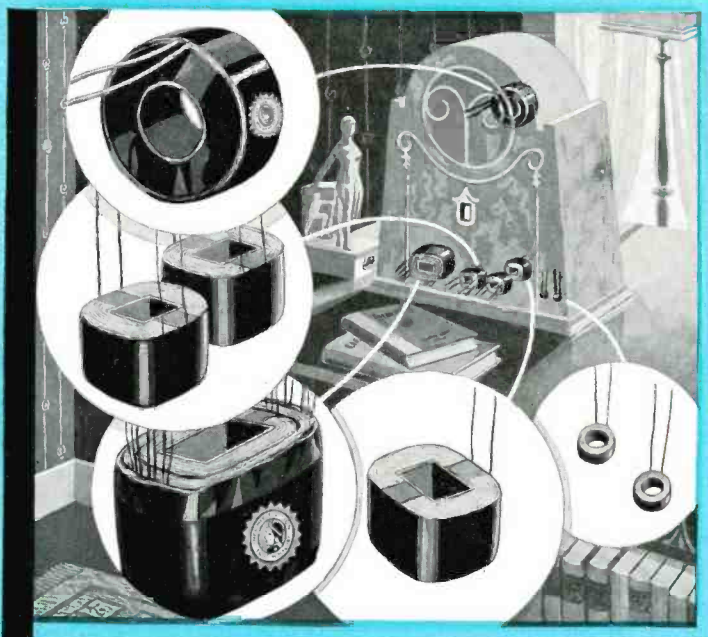
Firm Name.....

Address.....

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

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

The Incas were born musicians, their favorite instrument being the quena or Inca flute. Inca music still exists, having been handed down from generation to generation by their descendants, who play these curious instruments entirely by ear.



COMPACTNESS

★ THE KEYNOTE OF RADIO THIS YEAR

Economy . . . Of course, but compactness means economy when it comes to radio. More and more exacting every day are the requirements of the radio engineer. But Inca is ready. Inca engineers have anticipated these changing coil demands . . . and stand ready to meet the most rigid specifications for compactness, performance, economy, and delivery.

Inca enameled magnet wire makes well designed coils still better . . . because no coil can be better than the wire in its windings.

INCA MANUFACTURING DIVISION

of NATIONAL ELECTRIC PRODUCTS CORPORATION
FORT WAYNE, INDIANA

Symbolic of the best in copper wire products.

Eastern Office: 233 Broadway, New York, N. Y.

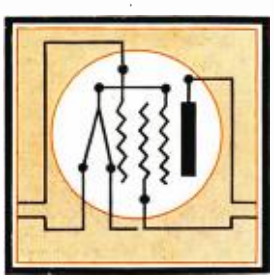
Western Office: 1547 Venice Blvd., Los Angeles, Calif.

For these NEW TUBES

-for ALL TUBES-

FANSTEEL

Rare Metal Wire and Sheet



In your new 1931 tubes, don't try to work with uncertain metals and alloys. Standardize on Fansteel Molybdenum, Tungsten and Tantalum, elementary metals refined from ores and basic salts, finished to accurate dimensions, uniform, dependable. Alloys of these rare metals are available too, and close laboratory check on production makes certain that exact specifications are uniformly maintained.

Given such materials to work with, you can not only make better tubes, but also cut production costs through reduction of shrinkage, waste and spoilage. Reduction of costs isn't all, however. There's more at stake than that. The new tubes must be "right"—must win public favor through their performance because for *profits* you need the steady repeat business which only better-than average tubes will provide. If the tubes are to be "standard equipment" on a well-known set, importance of trouble-free performance can scarcely be overestimated.

Obviously it's a poor time to take chances or cut corners. The very best of materials are only just barely good enough this year. To help manufacturers find the one best metal or alloy for their purposes, Fansteel offers the assistance of its scientific staff on development problems.

Fansteel's ample stock assures prompt shipments. Special cooperation given tube engineers desiring small lots for experimental use.

Write for Samples and Prices

FANSTEEL PRODUCTS COMPANY, Inc.
North Chicago, Ill.

TANTALUM · TUNGSTEN · MOLYBDENUM · RARE METAL ALLOYS

NEW SCOVILL 4-GANG MIDGET CONDENSER WITH LOW SHIELDS

THE diagram at right gives the mechanical specifications and electrical characteristics of the new Scovill four-gang midget condenser with low shields.

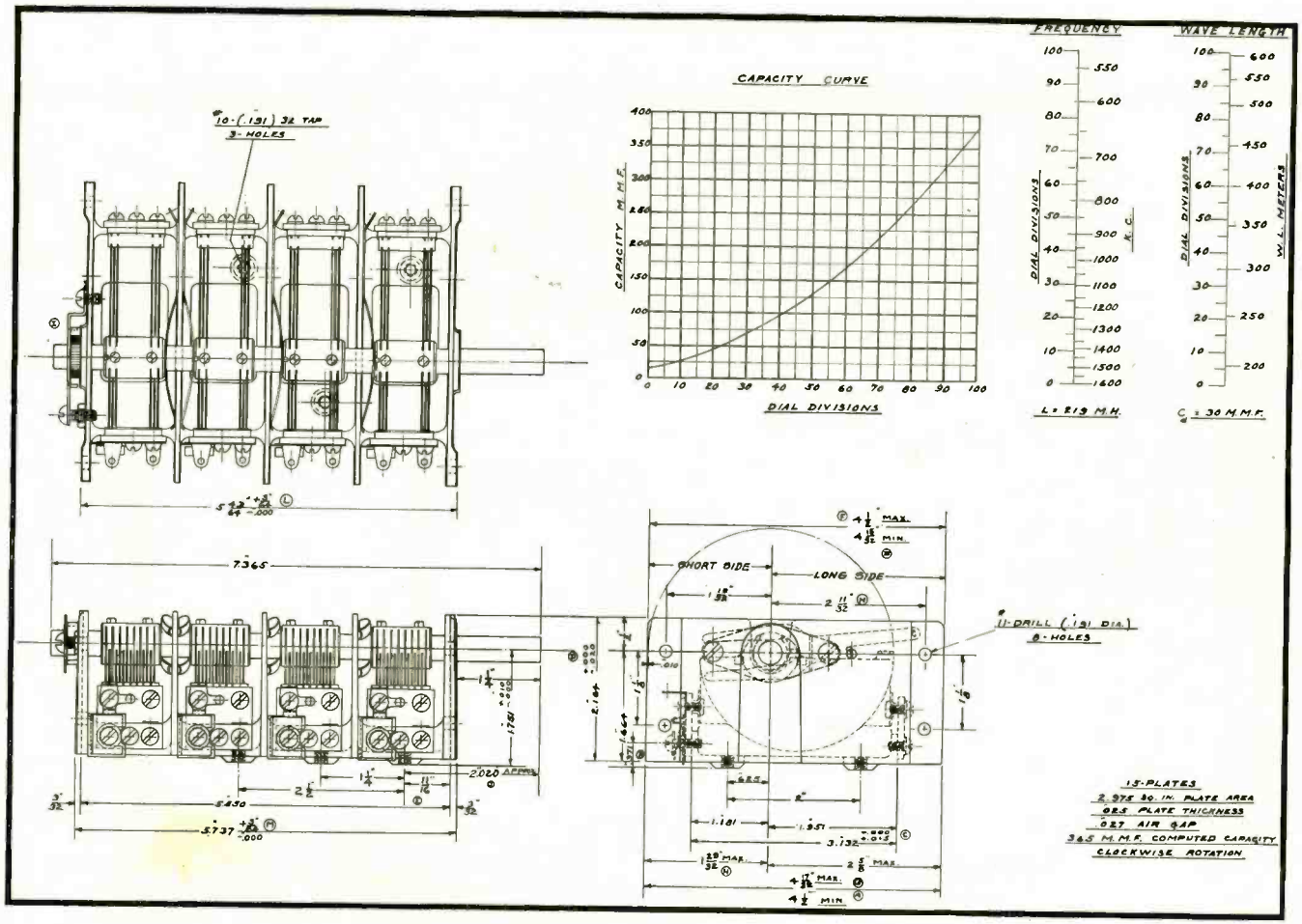
This condenser can also be supplied with high shields, and as a three-gang unit with either high or low shields.

For the heterodyne circuit these condensers can be furnished with a special section for tuning the oscillator.

Available in any quantity at moderate prices.

●

Compactness . . . unusual rigidity without added weight . . . freedom from end play.



JULY, 1931

Scovill

SCOVILL MANUFACTURING COMPANY, WATERBURY, CONNECTICUT
New York Philadelphia Boston Providence Chicago Syracuse Detroit Akron Cincinnati Atlanta San Francisco Los Angeles In Europe: *The Hague, Holland*

RADIO ENGINEERING

Production, Administration, Engineering, Servicing

JULY, 1931

The Radio Conventions at Chicago

I. R. E., June 4-6; R. M. A., June 8-16

BECAUSE the I. R. E. Convention and the R. M. A. Show were held in the same city during consecutive weeks, these two important radio events of 1931 may sensibly be viewed as one undertaking. The important thing is the overall result attained. The economic depression which it is hoped is at an end, placed a heavy burden of responsibility upon the men who planned and carried through this year's industrial gatherings. To look back only one year it may be said that the 1931 radio conventions, to a much greater extent than was the case in 1930, sent thousands of radio jobbers and dealers home to widely scattered localities in an optimistic frame of mind.

A reason for optimism was that each dealer felt that he had gotten the complete sales picture for the 1931-32 season. What he saw at the show was a reasonably trustworthy display of what the factories are at work upon. The undercurrent of distrust in evidence at Atlantic City a year ago was not apparent at Chicago. That this is so is a distinct credit to the management of the R. M. A. and to the individual radio manufacturers.

However, to review the highlights of the meetings as these developed, it is in order to consider first the events of the I. R. E. sessions.

The Technical Papers

Captain S. C. Hooper, of the U. S. Navy radio delivered an inspiring address at the first session in which he dwelt upon the status of the engineer in all of the development which has taken place in radio during the past years. It is Captain Hooper's view that if engineers would take a closer interest in the commercial and governmental phases of radio that this would be greatly to the advantage of the business.

Thyratron Tubes

J. C. Warner, of the General Electric Company, read an interesting paper

Television emerges from the laboratory.

▲

dealing with characteristics of the thyratron tube.

E. B. Patterson, of the RCA-Victor Company presented a paper on the subject of "Music in Color."

Hans Roder, of the General Electric Co., read a paper on "Amplitude, Phase and Frequency Modulation."

Other technical papers presented during the meeting included: "Some Developments in Common Frequency Broadcasting," by G. D. Gillett, Bell Telephone Laboratories; "On the Use of Field Intensity Measurements for the Determination of Broadcast Station Coverage," by C. M. Jansky, Jr. and S. L. Bailey; "New Method of Frequency Control Employing Long Lines," by J. W. Conklin, J. L. Finch, and C. W. Hansell, RCA Communications; "Low Power High-Frequency Aircraft Transmitter," by A. P. Bock, Westinghouse Electric and Manufacturing Company; "Some Observations of the Behavior of Earth Currents and Their Correlation with Magnetic Disturbances and Radio Transmission," by Isabel S. Bemis, American Telephone and Telegraph Company; "Technique of Loud Speaker Sound Measurements," by Stuart Ballantine, Boonton Research Corporation; "Some Acoustical Problems of Sound Picture Engineering," by W. A. Mac Nair, Bell Telephone Laboratories; "Rochelle Salt Crystals as Electrical Reproducers and Microphones," by C. B. Sawyer, Brush Laboratories; "High Audio Output From Relatively Small Tubes," by L. E. Barton, RCA-Victor; "Electron Tubes as High-Frequency Alternators," by E. D. McArthur and E. E. Spitzer, General Electric Company; "Development of Directive Transmitting Antennas by RCA Communications," by P. S. Carter, C. W. Hansell, and N. Lindenblad, RCA Communications; "Developments in Short-Wave Directive Antennas, by E. Bruce, Bell Telephone Laboratories.

The Parts Exhibits

Once more the I. R. E. put on a radio receiver parts exhibit. It was the opinion of the engineers who attended the convention that the exhibits displayed by parts manufacturers constituted a valuable and highly educational element of the meeting. Manufacturers who had products at the show included:

Allen-Bradley Co.; Carter Radio Mfg. Co.; Caswell Runyan Co.; Central Radio Labs.; Condenser Corporation of America; Continental Carbon, Inc.; Chicago Telephone Supply Co. (H. H. Frost Division); Cornish Wire Company; Crowe Nameplate Mfg. Co.; DeJur-Amsco Corp.; Duovac Radio Tube Corp.; Eddie Manufacturing Co.; Electrical Insulation Co.; General Industries Co.; General Instrument Co.; General Manufacturing Co.; International Resistance Co.; Jensen Manufacturing Co.; Jewell Electrical Instrument Co.; Johns-Manville Corp.; Johnson Laboratories, Inc.; Kellogg Switchboard and Supply Co.; Kester Solder Co.; La Crosse Manufacturing Corp.; Magnavox Company; P. R. Mallory & Company (Elkon Division); Meissner Electric Mfg. Co.; National Electric Products Co. (Inca Division); Ohmite Manufacturing Co.; Parker-Kalon Corp.; R C A Victor Company, Inc.; Radio Coil and Wire Corp.; Rola Company; Shallcross Manufacturing Co.; Scovill Manufacturing Co.; Shakeproof Lockwasher Co.; Soreng-Manegold Co.; Sound Engineering Co.; Sprague Specialties Co.; Stenode Corporation of America; Sylvania Products Co.; Thordarson Electric Manufacturing Co.; Tung-Sol Company; Utah Radio Products Co.; Weston Electrical Instrument Co.; Yaxley Manufacturing Co.

Stuart Ballantine Receives Award

Each year the Institute makes two awards to radio investigators in recognition of meritorious inventions or other developments in radio technique.

The Morris Liebmann Memorial Prize of five hundred dollars is awarded to that member of the Institute who, in the opinion of the Board of Direction shall have made the most important contributions to the radio art during the preceding year. This year the Leibmann Memorial Prize was awarded to Stuart Ballantine of the Boonton Research Corporation for his outstanding theoretical and experimental investigations of numerous radio and acoustic devices. Among the recent important developments for which Mr. Ballantine is responsible is the variable-mu tetrode.

For 1931 the Institute Medal of Honor was awarded to General G. A. Ferrie of Paris for his pioneer work in the building up of radio communication in France, his long continued leadership in the field of communications, and his outstanding contributions to the organization of international cooperation in radio.

The Committees

Institute members who organized and carried through the excellent arrangements for the technical sessions, the entertainment and the exhibits were: Byron B. Minnium, S. E. Adair, R. M. Arnold, A. J. Carter, J. F. Church, A. C. Forbes, J. N. Golten, K. A. Hathaway, J. B. Hoag, A. J. McMaster, L. F. Muter, H. M. Dodge, W. S. McClintock, Jr., Edward Bradshaw, L. C. McCarthy, Riley Sutherland, A. A. Woods, V. J. Andrew, J. H. Miller, S. I. Cole, H. C. Forster, S. A. Jacobs, Arthur Moss, H. L. Oleson, W. F. Osler, R. T. Pierson, R. E. Smiley, R. F. Sparrow, R. W. Augustine, J. B. Hawley, J. W. Million, F. W. Kranz, H. A. Wheeler, H. W. Armstrong, J. Callanan, G. S. Holly, H. E. Kranz, J. J. O'Callaghan, E. Kauer, H. C. Tittle, T. A. White and A. T. Haugh.

Much credit is due also to President R. H. Manson and Secretary H. P. Westman, from headquarters, New York, for the success of the convention.

Past-presidents of the I. R. E. who attended the convention were R. H. Marriott, Fulton Cutting, Donald McNicol and J. V. L. Hogan.

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The R. M. A. Show

ATTENDANCE at the show was normal under existing conditions and passed the 22,300 mark at noon on Friday, June 12, a few hours before the show closed.

While the attendance was smaller, as expected, than the peak radio year of 1929 and the Association's show last summer at Atlantic City, actual business transacted was reported generally to be better. The net result was a smaller attendance but better business. The trade show visitors this year came for business and not pleasure. Business was the keynote of the entire show week and actual orders totaling several millions of dollars were reported.

The 24,000 feet of floor space used for the display of 1931–32 radio receivers and accessories presented the industry's answer to the question: What are the manufacturers doing?

An inspection of the radio receivers, tubes and radio apparatus emphasized the truth of President Metcalf's early prediction that this year's trade show would go down in history as one of the most important ever held. Actually there was more new radio apparatus of all kinds than has ever been shown before in any one year.

Many Superheterodynes

Judged solely on the basis of the number of superheterodyne receivers shown, superheterodynes will be a feature, though tuned radio-frequency receivers were present in both inexpensive and costly models.

Sets Offer Greater Values

Consumer prices of new models continue to reflect manufacturing economics. Two or three years ago labor was one of the largest radio costs, with an assembly cost frequently higher than that of the radio apparatus. Today, brought about by the development of shielding, the parts of radio sets can be so arranged as to eliminate much of the costly wiring expense. Newly invented machinery also contributes to lower costs.

New Tubes Introduced This Year

This year saw the introduction of the variable-mu tube in radio-frequency stages and the pentode tube in the output stage of radio receivers. The use of these new tubes is considered by the industry, not at all revolutionary, but a normal development such as can be expected when research men labor diligently to advance the art.

The variable-mu tube has as its principal contribution the elimination of cross-talk; whereas the pentode is designed for a greater output with a smaller audio system. Pentodes are being used in sets designed for a single output tube or a push-pull stage depending largely upon the space available in the chassis design.

"Auto' Tubes Important Development

The automobile series of tubes constitutes another outstanding tube development of the year. While designed to reduce the drain on the automobile battery, when installed in auto-radio, they lend themselves for use in sets designed for rural trade, far beyond the extension of power lines. Here, low drain is just as important to the consumer as it is to the automobile owner.

Circuit Design Governs Choice of Tubes

Screen-grid tubes continue to be manufactured and used in large quantities. They are not displaced by the variable-mu because this latter tube is used only in circuits designed for it. The variable-mu does, however, assume the position formerly taken by the screen grid.

Auto-Radio Increasing

The number of auto-radio receivers already known to have been installed this year indicates a growing popularity for this type of set. Advances incorporated in auto-radio receivers permit excellent results both as to sensitivity and tone.

Short-Wave Receivers Gain in Popularity

Undoubtedly stimulated by foreign broadcasts by American networks, enthusiasts of the radio public are eager to listen to trans-oceanic broadcasts, direct, through the medium of a short-wave receiver in their homes. As a consequence the construction of factory made short-wave receivers is sharply upward.

Introduce New Circuit

A new circuit is the Stenode. It is designed to provide a maximum of selectivity through the use of a special circuit in which is introduced a mechanical oscillator in the form of a quartz crystal.

The radio signal in passing through the Stenode circuit undergoes definite changes. The wave is literally "forced through an exceedingly narrow aperture," and then reconstructed by means of what is known as a corrective circuit placed in the audio system.

Election of Officers

At the annual election of officers J. Clark Coit, Chicago, president of United States Radio & Television

Corp., was elected president for the 1931–32 term.

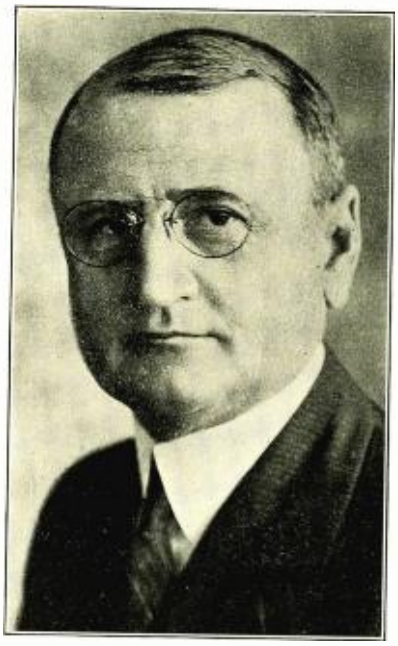
Two other Chicagoans were elected to office, A. S. Wells, president, The Gulbransen Company, first vice-president, and Leslie F. Muter, president of The Muter Company, treasurer.

Fred D. Williams, New York City, manager radio tube division, National Carbon Co., Inc., and N. P. Bloom, president, Adler Mfg. Company, Louisville, Ky., were elected, respectively, second and third vice-president.

Directors elected for a three-year term were: W. J. Barkley, Passaic, N. J., sales manager, DeForest Radio Company; Harry A. Beach, Rochester, N. Y., radio sales manager, Stromberg-Carlson Telephone Mfg. Co.; N. P. Bloom, Louisville, Ky., president, Adler Mfg. Co.; E. R. Farney, Chicago, Ill., president, All-American Mohawk Corp.; E. V. Hughes, Peru, Ind., sales manager, Wasmuth-Goodrich Co.; F. E. Johnston, Cincinnati, Ohio, director of engineering, The Crosley Radio Corp.; Arthur Moss, New York, N. Y., president, Electrad, Inc., and A. S. Wells, Chicago, Ill., president, The Gulbransen Company.

President Coit

J. Clarke Coit, the new president of the Radio Manufacturers' Association, has, in the space of some twenty months, become one of the prominent figures of the radio industry. In September of 1929, Mr. Coit was made president of the United States Radio & Television Corporation with manufacturing plant in Marion, Ind., and under his guidance the corporation, in spite of the general economic recession, has maintained a high record of production and sales.



J. CLARKE COIT,
President R. M. A.

Mr. Coit was born in Missouri Valley, Iowa, in 1872, the son of a country doctor. His business career started in 1890 when he joined the Lee, Clark, Andreeson Company, wholesale hardware dealers of Omaha, Neb. Early in his career Mr. Coit sensed the important part played in merchandising, and devoted himself to study of this phase of business.

So successful were the merchandising practices applied by Mr. Coit that in 1913 he was made vice-president and general manager and the name of the firm was changed to the Lee, Coit, Andreeson Company, and four years later he was elected president of the concern.

Mr. Coit's reputation as a successful merchandiser attracted wide attention and in 1924 he accepted an invitation to become president of the nationally known Simmons Hardware Company, doing a business of some $30,000,000 a year. At the same time he was made a trustee of Associated Simmons Hardware and vice-president of Winchester Simmons Company. These offices were held until September of 1929 when the call came for him to accept the presidency of the United States Radio & Television Corporation.

Mr. Coit is a vigorous, restless, driving personality of apparently inexhaustible energy; a leader who works shoulder to shoulder with his men, who spends most of his time on the road.

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Television

AN outstanding accomplishment of the R. M. A. show was the launching of television on its way to everyday use. Not the television of the future but the television of today, such as it is. During the past two years there has been enough of explanation and description so that many persons have learned just what to expect in the way of pictures.

Television receiving sets attracted wide interest at the show. For the first time in the history of the annual event visual receiving apparatus was displayed by more than six manufacturers of such equipment. Receivers ranged from elaborate consoles, capable of reproducing images several inches square, to small midget designs, which gave images of usual proportions of two inches square.

In a number of instances manufacturers exhibited and demonstrated their television apparatus for the first time.

Among some of the exhibitors of television apparatus were the Western Television Corporation, of Chicago; the Short Wave and Television Corporation, of Boston; the Jenkins Television Corporation, of Passaic, N. J.; the Insuline Corporation of America and the Freed-Eisemann Radio Corporation, of New York.

Forthcoming Events

There is but little doubt that during the Fall and Winter months coming there will be noteworthy advances in the technique of television and in the television receivers offered for sale.

Manufacturers, jobbers, dealers and the public realize that the present types of broadcast sound receivers will continue to be sold as at present. The television receivers will for some time to come be devices apart and in addition to the usual broadcast receiver.

As during the past two years RADIO ENGINEERING proposes to keep abreast of the engineering of television transmission and reception. In the monthly columns of this journal will be published up-to-the-minute, dependable and useful information on this comparatively new development in radio.

Following the recent activity in television development the Federal Radio Commission has granted a permit to Don Lee, Inc., Los Angeles, for an experimental television station to use 2,100 to 2,200 and 2,850 to 2,950 kc., with 500 watts power.

For portable television station 2XBT, the National Broadcasting Company has been granted a renewal of the following frequencies: 43,000 to 46,000, 48,500 to 50,300, 60,000 to 80,000 kc., at 750 watts.

R. C. A.-Victor at Camden, N. J., has been granted a permit for an additional transmission for experimental television.

Radio Pictures, Inc., Long Island City, N. Y., has been granted three permits, two for new transmitters and one for an additional transmitter.

The General Electric Company's station W2XAF at Schenectady, N. Y., also may be used for television signals up to 60-line scanning at twenty pictures per second.

Component Parts of a Television Receiver

As a guide to manufacturers of radio parts and accessories we give herewith

(*Concluded on page* 38)

The superheterodyne receiver

By R. R. BATCHER

Its Tuning System and Operating Adjustment

ONE of the important technical problems which is encountered in superheterodyne receiver design is that of a satisfactory "match" between the tuning circuit elements and the oscillator. It is likewise important that the factory testing personnel and servicemen know what is necessary to do to obtain the correct correlation of these circuits, or else a wide variation in signal gain will be noticed at different signal frequencies. Many field servicemen have difficulty in making readjustment so that set operation is satisfactory. Most certainly the practice of servicing a superheterodyne receiver by readjusting the intermediate stage transformers to 175 kc. exactly without additional checks, might do more harm in some cases than good.

For various reasons, many manufacturers have elected to use an intermediate frequency of 175 kc. or thereabouts. In nearly all cases the i-f. transformers are adjustable and can be set at exactly that frequency or one near it. The adjustment of these stages is not difficult and requires no special apparatus other than an output meter and an incoming signal, if the radio-frequency circuits are in proper alignment. An intermediate-frequency oscillator is of no value in making tests on the latter circuits.

S.L.F. Condensers

It has been shown that the only tuning condenser shape that will tune both the radio-frequency stages and the oscillator at the same operation is the straight-line frequency shape. In this case one rotor is shifted around the shaft an amount equivalent to the required frequency difference. The writer knows of very few instances where condensers of this type were accurately enough designed to be used for this purpose without additional compensation. The reason being that the shape of the plates is such that a large radius is required at one end, so that a rather bulky condenser results when true s.l.f. plates are designed, as indicated in Fig. 2.

In some cases a special section is designed in the gang condenser for the oscillator circuit, the manufacturer shaping the plates empirically so that the required frequency difference is obtained. In general the condenser plates in such cases follow no definite mathematical law, so that an analysis of the effect of variations cannot be definitely anticipated. It is not the purpose of this paper to advocate any particular condenser shape, however.

The following facts are probably not very well known to those who have not studied the problem. Similar condensers cannot be used to tune the two circuits with any simple tuning circuit, even though the inductance in one circuit is changed to cover a slightly different range. This will be seen from Fig. 1 in which the frequency difference is plotted against the signal frequency, assuming that the inductance of the oscillator circuit was changed. It will be seen that the band of wavelengths over which efficient operation takes place is very small indeed. The higher the value of intermediate frequency selected the greater will be the difference in the tuning circuit constants, and the greater the accuracy requirements. Manufacturing difficulties of this nature are not unsurmountable and the advantages of a high intermediate frequency need not be abandoned for such a reason.

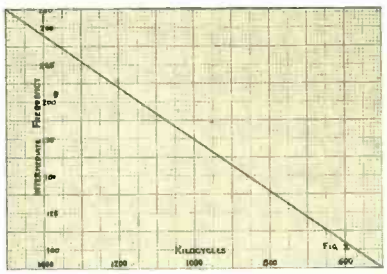

Fig. 1.

Circuit Constants

Much of the difficulty can be solved with the proper selection of the circuit constants in the first place. Arbitrarily assuming an i-f. of 175 kc., the relative values of the capacities at any setting may be determined from the relation

$$\frac{C_2}{C_1} = \frac{f_o^2 f_x^2}{f_o^2 - f_x^2}\left[\frac{1}{(f_x + 175)^2} - \frac{1}{(f_o + 175)^2}\right] \quad (1)$$

where f_o is the maximum signal frequency required (herein assumed to be 1500 kc.) and f_x the signal frequency at any setting X. This relation holds as long as the adjusting condensers that regulate the capacity in the circuit at the minimum wavelength have the relation:

$$\frac{C'_1}{C'_2} = \frac{(f_o + 175)^2}{f_o^2} \quad (2)$$

The values of C_2 and C_1 in (1) do not include the zero capacity of the condenser itself, so that the value of the condenser stray capacity (of the order of 5 mmf. must be subtracted from the actual capacity at any setting to obtain C_1 or C_2. In order to select an oscillator circuit we must get a picture of what formula (1) is all about, so curve 1 in Fig. 3 is plotted from this relation, for the frequency range 1500 kc. to 500 kc.

It will be seen that when the inductances in the two circuits are equal that the oscillator tuning condenser should have approximately two-thirds of the capacity of the signal stage condensers. Furthermore the capacity increment should follow a different law, else the curve 1 would be a horizontal line. A change in the relative inductance values in the circuit will compensate for the condition that a smaller capacity is required but will not compensate for the condition that the required capacity curve is neither flat nor straight.

Some idea of the magnitude of the error introduced is gained from the curve in Fig. 1, which represents the introduction of an inductance in the oscillator circuit of 60 per cent of the signal frequency circuit value.

Adjusting Capacity

One way of correcting the capacity curve is to connect a condenser in series with the oscillator condenser. The combined capacity will then be, according to well known laws:

$$C = \frac{C_2 C_3}{C_2 + C_3} \quad (3)$$

Now, referring to curve 1 it will be seen that the capacity ratio varies over the range shown, by a value $\frac{52.0}{71.0} =$ 73.0 per cent. These values were taken from each end of the curve. If we were to introduce a series condenser having a value that would reduce the effective capacity of C_2 at its maximum value to 73.0 per cent a curve will be obtained as per Fig. 3, curve 2. It will be noticed that the capacity curve now has a similar shape but is somewhat

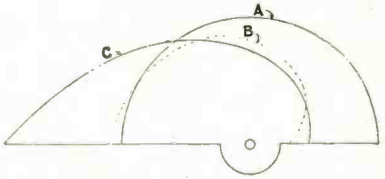

Fig. 2.

displaced as to its absolute value. We can now apply the principle that a change in the inductance value will change the requirements of the absolute values of capacity required. It would seem that the inductance value will have to be dropped to 70 per cent in the oscillator circuit. (This figure was found by the average of the ratio of the heights of the two curves.)

The revised circuit is now indicated in Fig. 4, where C_1 and C_2 represent two sections of a gang condenser of similar shape and capacity. The other values are as follows: C_1' has any convenient value, such as might have been obtained after alignment of this stage with other signal frequency stages in the circuit if present. This setting is best made before attempting to align the oscillator.

$C_2' = \frac{1}{.7} \frac{f_o^2 C_1'}{(f_o + 175)^2} = 1.147\ C_1'$ (assuming $f_o = 1500$ kc.)

$C_3 = 2.70\ C_2$ (maximum value) obtained from (3).

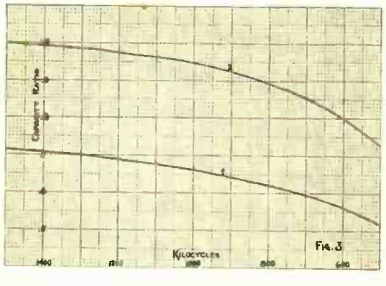

Fig. 3.

Introducing these values in the previous formulas gives the relation:

$$\left[\frac{f_x}{f_x + IF}\right]^2 = \left[\frac{15.92\,(R + 1.089)}{(R + 21.6)\,(R + 1)}\right]$$ where $R = \frac{C_1}{C_1'}$

This gives the error at any setting, and gives results represented in Fig. 1. It may be said that although this scheme is only approximate excellent results are obtained if theoretical values are closely adhered to.

In the application of this circuit to a receiver several items must be considered. For instance, every condenser has a minimum inherent capacity. In the case of C_1' it is considered to be a part of C_1, and in the case of C_2' to be a part of C_2. In the latter case it is actually in series with a condenser approximately 21 times as large, so that the equivalent value is nearly the same as C_2' itself.

Rotor Shifting

In this system the shape of the condenser plates has no effect on the results. Care should be taken that the rotor of any one of the condensers is not shifted slightly on the shaft, as this will introduce an effect not readily compensated for. For an analysis of the effect of slight variation of the circuit elements from the required values, the circuit Fig. 4 will be used as a basis for computations. The intermediate-frequency signal frequency type of curve gives the best indication of these effects. Since all effects are relative the variations in the oscillator circuit constants need to be considered only. Major items can be listed as follows:

1. Variation in the inductance L_2. This may be due to a number of causes: effect of the shielding can, effect of the coupling of the feedback coil, error in the turns or changes in the spacing of the wire, or variations in the diameter of the winding support.

2. Variation in the fixed capacity C_2', due to shielding changes, effect of coupling for feedback or for the introduction of the frequency to the detector, or from the variations in the tubes.

3. Variation in the value of the series capacity C_3.

4. Variation in the maximum capacity of the condenser, with the capacity at intermediate points proportionally in error. This may be due to unequal spacing in the plates, variation in the thickness of the metal in the plates, or to a shift in the whole rotor on the shaft.

In order to show the effects in each case an error has been assumed in each

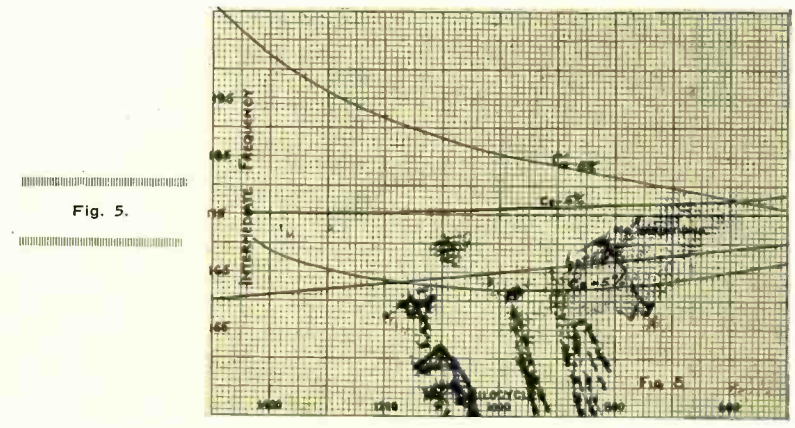

Fig. 5.

instance, and that the other items were correct. Fig. 5 indicates the approximate frequency difference with the indicated circuit error in each instance.

In the application of the above theoretical values of inductance some experimental work is necessary, due to the effect of the shield can. As is generally the case, if all coils are put in similar aluminum or copper cans, say from 2-inch to 3-inch in diameter, the percentage reduction in inductance will be the same in both cases.

This is especially true if the oscillator coil is wound with a larger sized wire so that the total winding length is the same as the signal circuit coils. This may be explained by the fact that the coefficient of coupling between the coil and the shield (which acts as a large short-circuited turn) is dependent upon the physical dimensions of the coil only, and not upon the number of turns. However, it is not difficult to determine experimentally the required value of the inductance with the shield in place.

In making these measurements, care should be taken that the distributed capacity of the coil does not affect the measurements. If the measurements are made at a frequency somewhat removed from the natural period of the coil no trouble will be experienced from this cause. The inductance required is the true inductance and not the apparent value sometimes found in measurements in which the distributed capacity affects the results.

It will not be necessary to include the data used to obtain the curves, Fig. 5, since the curves are self-explanatory. They will enable one to estimate the cause of the trouble from the resulting frequency error.

Testing Receivers

Methods for testing and servicing superheterodyne receivers have been receiving considerable attention. Several intermediate-frequency oscillators have appeared on the market and their

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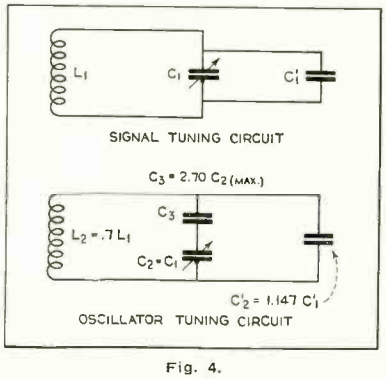
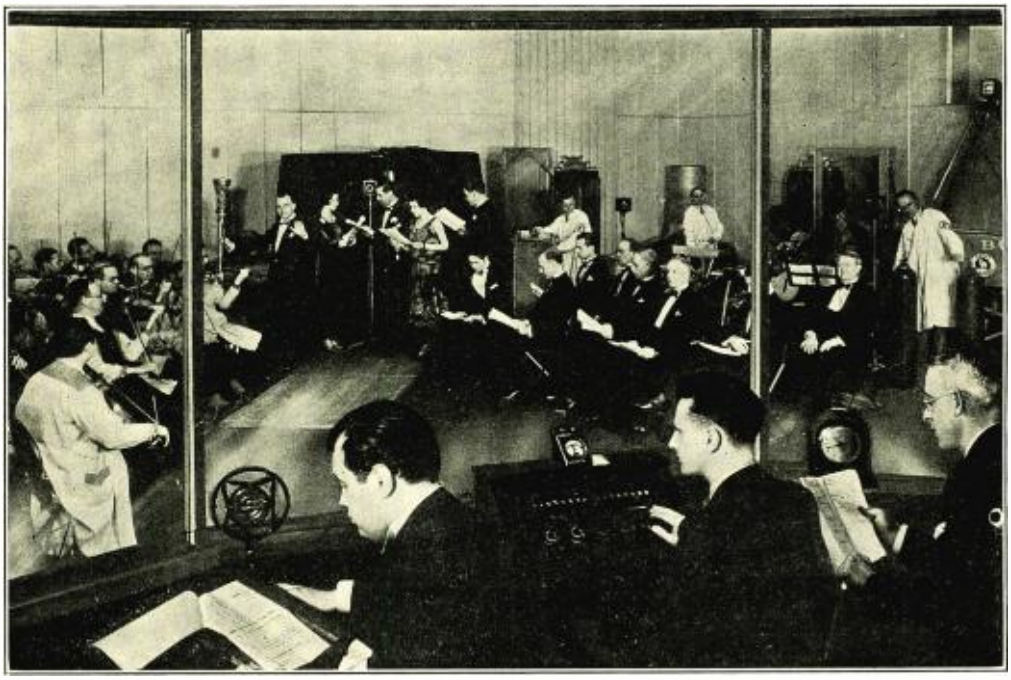


Fig. 4.



This unusual photograph taken during an Empire Builder dramatic presentation shows how radio drama is produced at present—a procedure that will have to be completely revolutionized when television arrives. Five microphones feed various parts of the program into a loudspeaker in the sound-proof control room, where the studio engineer manipulates volume controls on the "mixing panel" in very much the same way a radio listener would have to do if he were getting parts of a radio program from five different stations over five different receiving sets.

How Chain Features are Broadcast

SOME idea of the drastic changes television will necessitate in the presentation of radio drama can be gained from the studio scene from "Empire Builders," herewith shown.

It is Monday night, and "Empire Builders" is on the air. The listener can all but see the "Old Timer," featured player in the Great Northern Railway's half hour dramas, settled comfortably in the observation car, reeling off stories of the romantic early west as singing wheels beneath reel off the countless miles. The radio in the observation car is playing softly, a sort of accompaniment to the rythmic clickety-click of the heavy rails. The ting-a-ling of crossing bells is heard as the train whisks through a town. A puffing freight passes with its familiar swh-s-s-sh.

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All will be changed when television is employed

But if there were a television attachment to your radio and an optic "mike" in the glassed-in, sound-proof control room in the broadcasting studio, you would see just what is shown in the photograph.

The three busy individuals in the foreground are Don Bernard, the director; Ralph Davis, the studio engineer; and Harold M. Sims, the Great Northern representative who supervises every detail of the railway's radio plays.

Before them are the orchestra, dramatic cast, sound effects paraphernalia and four microphones which feed their pickups of sound into the control room over the loudspeaker shown in the photograph at the left. A fifth microphone on the roof picks up the locomotive whistles, bells, and other effects which require an out-of-doors atmosphere to meet the demands of realism.

Drama, music and sound effects are all directed from the control room by means of light signals and motions, while the nimble fingers of the studio engineer must manipulate five different "faders," or volume controls from the different "mikes," as well as watch a flock of other dials, gauges and signal lights on the board before him.

As a train approaches from a distance the "fader" which controls the sound volume from the "mike" on the roof, where the steam whistles and bells are located, must gradually be increased in volume, always in proper relation to the other sounds.

The machine which reproduces the clicking of the rails and the roar of the train is seen at the left of the picture, with its "mike" at the apex of the megaphone arrangement.

The sound of steam is obtained from compressed air tanks, shown on the right, and the puffing of the locomotive is imitated by an ingenious drum arrangement. All of the train effects were developed by the Great Northern railway, and are used exclusively on its program.

From thirty to fifty hours of rehearsal are required to perfect and synchronize an "Empire Builders" program, and to time it so that it will fit exactly into a half hour period.

A study in radio transmission

By H. F. BRECKEL*

THAT we still have much to learn about the basic causes and effects bearing on the theories of radio wave propagation incidental to radio transmission and reception, is quite obvious to those engaged in this field. This is particularly true with respect to the reactive effects of solar and lunar influences on the behavior of the so-called Kennelly-Heaviside layer which has important bearing on radio wave propagation.

Various criterions based on tests and observations during the past years, and universally accepted as to their relation to the behavior of high, low and intermediate frequencies, now seem inadequate and due to be discarded in part, or added to, to determine just what factors have been overlooked in affording basic theories applicable over longer periods of time than is the case at present. That certain factors have been overlooked is apparent. All the data on theories of the behavior of various frequencies have been upset as it were. They have been found wanting in explanation of the erratic behavior of certain frequencies, the performance of which has not been similar when compared to criterions afforded during the past, especially in the direction of skip distance effects, signal level and consistent performance of particularly the higher frequencies.

Lunar Influences

The author has long felt that other influences besides the accepted solar effects on the Kennelly-Heaviside layer have been present. Also, that certain of these solar effects have been overlooked. It has been his opinion that reactive effects of lunar influences have been overlooked and the results of observations taken with respect to this influence will be set forth in this article.

Theorizing on the matter of the Kennelly-Heaviside layer from the author's viewpoint, it has long been his belief that this so-called ionized strata above the surface of the earth, is, in reality, a thick layer of negative electrons variable in density away from its center; being greater in density toward the sun, the emitting source, and lighter in density toward the earth's surface—on approach to which it thins out progressively.

This layer of electrons is thrown off by the incandescent mass of the sun throughout the vacuum of space in a manner largely analogous to that of the filament of the vacuum tube, and comprises tiny conducting particles, the conducting ability of which is proportional to their density and mass. This being true, the reflecting and ionizing effects on radio frequencies exerted on them by the Heaviside layer, are likewise dependent on the density and height of the layer of electrons comprising it. Thus, we see that the reactive effects of the layer on the behavior of radio frequencies will of necessity be variable in nature, as its density and height will be dependent on the varied periods of greatest or least solar activity, which govern the reactive effects of lunar influences.

It is the theory of the author that this layer of electrons comprising the Kennelly-Heaviside layer is held in suspension above the earth's surface by reason of the repellent action of the earth's negative charge characteristics and is also influenced in this respect, i. e., height and uniformity of the suspension, by the deflecting characteristics of the earth's magnetic field. Further, the density, height and uniformity of the layer differs on each half of the earth's sphere, being more dense and closer to the earth on the daylight side, and less dense and farther away on the dark side. Likewise, the layer is more uniform both as to density and contour on the daylight side, due to this side being in the direct path of the emitting source, the sun, while on the dark side the layer is not so uniform either as to density or contour with respect to the earth's surface.

By way of comparison the reactive effects of the negative repulsion and the magnetic deflection characteristics of the earth and the recently arrived at lunar reactive effects of similar nature on the layer electrons supplied by the sun may be likened to the well-known theory involved in the vacuum tube, wherein a negative grid interposed in the path of the filament emission tends to hold these electrons in suspension by reason of its repellent action. Likewise, a permanent magnet brought into adjacent relationship to an electron stream causes a deflection of the electrons comprising it. The latter theories are well-known and universally accepted.

Periods of Light and Darkness

During the daylight cycle on either half of the earth's sphere this half is subjected to a heavy bombardment of electronic energy by the sun, consequently bringing about a heavier ionization of the Kennelly-Heaviside layer, increasing its density and conductivity, also causing it to take up a position closer to the earth's surface. This results in greater reactive effect being exerted on the angular reflection of the higher frequencies (sky waves) and also on the absorption characteristics reacting on the lower or intermediate frequencies. The layer being less dense and farther from the surface on the dark side, these reactive effects, particularly as to absorption and skip distance, are less in magnitude and the reverse of the daylight effects with, of course, some variation. This analogy would seem definitely to clear up the reasons why the higher frequencies possess greater daylight range in contrast to the decreased ranges of lower or intermediate frequencies and in reverse perspective; why the lower or intermediate frequencies have greater range on the dark side of the earth.

It may also be considered that the dark side of the earth not being the recipient of any direct bombardment from the sun, the condition of the layer above it would be considerably less in density and consequently in conductivity. It would also tend to take up a position higher above the earth's surface, this being brought about by the increased effects of the earth's negative charge characteristics and the deflecting values of its magnetic field, in that this total effect would be greater by reason of the reduced ionization or density of the electrons making up the layer.

Factors Determining Layer Condition

Reactive effects of the layer would also be variable in nature, being dependent on the periods of greater or lesser solar activity as well as the relative position of the moon during its different phases. These effects will be in the nature of increased density, or a decrease, and likewise, periods of depression or raising of the layer above

* *Lieutenant U.S.N.R.*

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Solar and Lunar Reactive Effect on Radio Waves

the earth as well as change of its contour with respect to the surface of the earth. These effects in addition to the known effects brought about by seasonal solar changes, conditions of temperature, and the position of the sun and moon with respect to their bearing above or away from certain parts of the earth's surface. All of these factors have the property of changing the behavior of the various frequencies, these reactive values being proportional to the sum total of the solar, lunar and earth effective reactive characteristics mentioned.

Touching on the lunar reactive effects on the layer, this body has the effect of depressing the layer thereby causing it to take a position closer to the surface on either the dark or light side dependent on the different phases of the moon with consequent reaction on wave propagation in the matters of absorption and angle of skip (in the case of higher frequencies). This lunar effect is brought about by the negative repellent characteristic of the lunar mass. We may also consider that the same reflects and deflects an additive quantity of the sun's emission, which though undoubtedly very low in quantitative value, would nevertheless have some effect on the density of the layer, changing both its density and absorption qualities as well as reflection characteristics. In the main, however, we may consider that the negative repellent characteristics of the lunar mass are responsible for the reactive effects on the layer which bring about the effects on wave propagation which have been noted.

Solar and Lunar Influences

Practically all of the present-day criterions on the behavior of high and low radio frequencies are based on the solar reactive effects on the Kennelly-Heaviside layer which theories have been adopted and which in the main, we believe govern the properties of reflection and absorption.

Why lunar reactive effects have not likewise been accorded consideration before now constitutes one of those unexplainable happenings which occasionally appear.

Doubtless, little or no thought has been given the matter of possible lunar reactive effects, either on radio wave propagation, or on the Kennelly-Heaviside layer. Likewise, in connection with the influence or effects of the earth's magnetic field on the layer with the consequent result of changing deflective characteristics of that force on the electrons comprising the layer bringing about a change of its density, height and reflective and absorptive qualities. That lunar reactive effects do exist, has been definitely verified by the author, who, in connection with studying the apparently unaccountable behavior of erratic performance of the 4045 kilocycle channel used in connection with the work of training the naval volunteer communication reserve operators learned that the moon's position with respect to the earth had much to do with the matter of that frequency's behavior with respect to skip distance effect. This was brought to attention as a result of a study conducted to determine the reasons involved. Observations were conducted over a period of five months, the results of which indicate conclusively that during periods when the moon was below the horizon, i. e., no moonlight over the intervening territory between the observed station, the signal strength and skip distance effects were very erratic, with bad fading as well.

In contrast, during periods when the moon was in various stages of fullness over the intervening territory, signal level was high as well as stability, with no fading due to skip effect being present. The strength of the signal level was also observed to be proportional to the various stages of fullness of the moon, being greatest when the moon was full and less in the first and successive quarters.

The observations were taken at station W8EB, the sectional control radio station of the U. S. Naval Communication Reserve, located at Cincinnati, O., and the observed station was NDS, the ninth naval district master control station, located at Chicago, which transmitted on a frequency of 4045 kilocycles, using a 500-watt crystal controlled transmitter. Unquestionably the skip distance effects which influenced the signals from NDS during periods of non-moonlight were not present during periods when the moon was in position above the intervening territory, and neither cloudiness, rain, snow nor temperature changes appeared to have any effect on the reliability of this observation, the signal level being high and skip effect negligible when the moon was in various stages of fullness approximating maximum, even though at times it was very cloudy.

Although the observation was conducted on this particular frequency (4045 kc.), there is no doubt that a similar reactive effect takes place on other frequencies, either high or low, differing of course with the value of the frequencies involved and the power used, as to the amplitude of such lunar reactive effects, just as is the case in considering the known solar reactions.

The foregoing theories are advanced by the author with the thought that it seems highly desirable for those interested in the subject to conduct further studies on the subject and observe the reactions of other frequencies to lunar effects, in order that the picture may be completed to the ultimate benefit of the art involved as well as in the interests of the commercial application of such frequencies to commercial radio communication.

Conclusion

It is interesting to note that subsequent to the observations by the author, Dr. Harlan T. Stetson, Perkins Observatory, Ohio Wesleyan University, read a paper before a joint meeting of the American Institute of Electrical Engineers and the New York Electrical Society in which he set forth the results of observations which he made over a period of more than a year on the signals of broadcasting station WBBM, of Chicago. He announced that he had analyzed the strengths of signals between Chicago and Boston and discovered that they were 100 per cent stronger when the moon was below the horizon. He believes this effect is caused by the negative electrical charge on the moon. The author contributes to this belief in that in the foregoing article it is pointed out that the Kennelly-Heaviside layer would be of less density and higher above the earth's surface with the result that the ionization absorption effects would be greatly diminished for the frequency used by WBBM, hence the signal level would be higher. The reverse would hold true for periods of moonlight, thus accounting for the diminished signal strength during such times.

Another corroborative observation which has come to the author's attention as this article goes to press is the result of experiments conducted at the U. S. Army radio laboratory at Wilbur Wright Field, Dayton, O., where results have been computed on the 3500 kilocycle frequency showing conclusively that skip effects and signal level are least when transmission is conducted during the first and last quarters of the moon's phases. As pointed out, the lunar reactive effects will be governed dependent upon the frequency used for the study, but the total results indicate that lower or intermediate frequencies perform best in the dark of the moon, and the higher frequencies perform best in the light of the moon.

Vacuum tube life tests

By J. N. FULLER† and PAUL W. CHARTON*

THE keen competition which has developed in recent years in many industries has been the greatest factor in the creation and rapid development by various industrials of a particular form of investigation on mechanical or electrical products. This varies in form dependent on the nature of the industry. In the manufacture of tubes this investigation takes the form of rigid life testing. The reason why we say investigation rather than measurement, rating or checking, will be made plain hereafter, and is due to the fact that the original purpose of life testing is but one of many functions pertaining to a well organized modern life-test department. Although life testing is applied to widely different products we shall limit ourselves to vacuum tubes.

What is a life test? It is a test conducted to determine the life span of the product in question, i. e., it consists of subjecting the product to continuous operation simulating actual usage conditions until it wears off and becomes unsatisfactory. For a vacuum tube this means until one or more of its characteristics varies beyond specified limits. Then three original and essential functions of this test become at once evident:

(a) providing uninterrupted operation under normal conditions for a number of samples of the given product;

(b) taking periodic measurements on the samples under test in order to determine the variations of their characteristics;

(c) averaging, comparing and interpreting results, and eventually setting up standard limits, or ratings, of the product.

Systematic Tests

Because the quality of a product is liable to vary according to the conditions of manufacture, the operators and the lots of original materials, etc., a regular and systematic test of samples coming from various lots is necessary, and a check on daily production is generally adopted as a matter of routine. The number of tubes picked out depends upon the production and the uniformity of the product. It is customary in the life test department of the Arcturus Radio Tube Company to pick out tubes in such a way that each lot, each machine, is represented by a certain number of samples. The tubes are carefully labelled, dated and numbered, so that in case of defect the trouble can easily be traced back to its origin. This provides for a constant check on the life of the product put on the market.

Since the characteristics of the tubes are measured systematically at definite intervals of time, life testing, ipsofacto, becomes also a very direct and handy source of information on the behavior of tubes once in the hands of the consumer. Curves are drawn showing the variations in their characteristics after a specified period of time and can serve as a basis for definite investigations in view of further improvements in manufacturing processes, or for theoretical research. Moreover, causes of sudden inoperation can be detected on the spot, and the development of shorts, open connections, etc., followed easily.

Modern Vacuum Tube Manufacture is Founded Upon Continuous Examination of the Output

This facility, inherent in life testing, is the real cause of the "emancipation" of the life test department, for, indeed, the interpretation of the results means necessarily an analysis of the behavior of the tubes, and analysis is soon associated with verification and experimentation. If, for instance, the emission of some tubes is found to drop too soon, and upon examination one suspects that the oxide coating of the filament does not stand the operating temperature as it should, tests are immediately run both at higher and at lower filament voltages, in order to determine more definitely the effect of temperature on the life and emission of that particular coating. If it is a matter of adhesion to the metal core, and the oxide is found to crack one way or the other, due to the expansion of the filament, tests are made with frequent interruptions of the filament supply so that successive expansions and contractions of the core accelerate the cracking and falling off of the coating.

Thus life testing instead of remaining purely a matter of routine broadens its own field, and what was originally a side line becomes its most important function. To the three fundamental functions of this department can then be added:

(d) the careful examination of the tubes at the end of,—and often during,—their life;

(e) special tests.

Microscopic Inspection

The examination of the samples not only comprises the microscopic inspection, the mensuration of the parts so as to determine the amount of distortion, if any, the inspection of the welds, etc.,—but their microscopic study as well. Most important of all is the study of filament and cathode coatings, by which much knowledge can be gained of the value of the coating from the form and direction of cracks and crevices, the

Fig. 1. Life testing racks.

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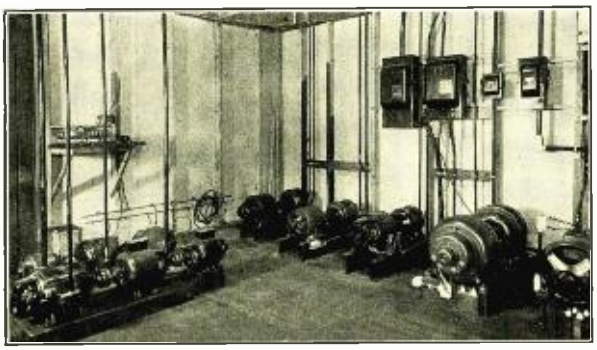

Fig. 2. Power supply for tube life test department.

presence of craters, the dull or glossy nature of its surface, its color, etc. Microscopic examination of possible deposits on other parts is also occasionally done and supplemented by simple chemical tests.

Special tests are often very enlightening as to the mechanical effects of expansion and contraction of the parts. Supports sometimes act as a wedge between two parts, welds are loosened, parts are bent and grids distorted by repeated expansion and contraction under the alternate action of heating and cooling.

This consideration has led to the general adoption of intermittent life test, in which the tubes are in continuous operation for one hour or two, then switched off long enough for all parts to get cold, and automatically switched on again, and so forth. This method presents the additional advantage of simulating more exactly the actual use of tubes in sets.

Other special tests are meant to study the effect of abnormal conditions, irregularities in voltages, surges and over-voltages on the filament, heat, excessive vibration, etc. Tubes are here tested at low bias voltage, high plate or screen potential, at high filament current, in a tight enclosure, on a vibrating rack, or under any condition which may give significant results for a definite problem in view. For instance if an insulation coating on a heater wire shows signs of wear at places where it touches the cathode a test may be conducted in which the heater supply is turned on and off at very short intervals, with or without potential on the other elements, until a heavy leakage or a short-circuit develops between heater and cathode, due to the friction between these parts while expanding and contracting. The time elapsed is then noted. If there is leakage increasing gradually before a short occurs, the amount of leakage may be plotted against the time, or against the number of interruptions if an automatic counter is provided. In fact there can be as many special tests as there are ideas in an intelligent man's brains!

Coordination

In this light, life testing becomes indeed more than a pure routine check, and can be classed as a highly definite and distinct form of investigation. The life test department has one leg in the factory, next to the specification-check and the quality-check departments, and the other leg in the research division, with the experimental shop and the chemical laboratory. With one arm it makes progressive reports, tabulated characteristics and life curves on the regular tests of production tubes; and with the other arm it reaches the engineering laboratories with detailed reports on the examination of life-tested tubes, with a suggestive account of observations and tentative interpretations. It works hand in hand with the development section in special tests, and tests on newly designed or modified tubes.

This handling of data and reports constitutes the two minor, although still important, duties of this remarkable department, which can be finally noted as:

(f) collecting and tabulating data, drawing curves of the characteristics versus time, and sending out to the interested parties progressive reports on the tubes under test, until the test is completed;

(g) making full reports on the results of the examination of tubes and the special tests, with complete descriptions of the alterations found in the tubes.

The equipment necessary to carry out to full efficiency a program of this sort is, outside of the racks themselves and their power supply, relatively simple. Ordinary vacuum tube bridges for all types of tubes, emission and gas test boards, and back-current testers for rectifier tubes are all that is required for the routine measurements of the characteristics. Special tests on leakage, hum, gain or interelectrode capacitance can be carried out in the engineering laboratory. A complete set of tools for surgical operations and mensurations on the tubes examined, one or two good magnifying glasses and microscopes with photographic equipment, or at least drawing facilities, correspond to the other phase of the work and are an indispensable help to the proper study of the tested tubes. The use of X-rays for the inspection of the parts and the detection of mechanical distortion while the tubes are still on test proves to be of great assistance, and is more and more resorted to.

The life racks themselves are generally so designed that every part is easily accessible, the switching and adjusting arrangements are simple, and the protecting devices, fuses or relays, allow a quick identification of the cause of trouble.

The Arcturus Radio Tube Company provides for each type of tube its individual life rack or racks. For the sake of uniformity and economy they are all made as near the same size and shape as possible. Fig. 1 shows some of the life racks of this company, installed in front of the main switchboard. Note in the back the special enclosures on a type 124 life rack. Tubes have been removed from some of the shelves in order to give a better view of the layout. For convenience each rack is divided into four sections controlled by four independent sets of switches installed in the front of each rack.

The life test department has its own power supply installed in the back of the main switchboard, and regulated to suit the requirements of the department (see Fig. 2).

On intermittent tests sign-flashers are used to open and close the primary circuit of the filament transformers, and if so required, all supplies on any rack. They can be designed and adjusted for any speed and any schedule desired.

The size and the number of racks to be used varies with the manufacturer and depends upon the length of the test and the number of tubes taken every day. If the test lasts 45 days, which corresponds to 1080 hours, and only twenty tubes of one type are taken every day, room must be provided for at least 900 tubes of that type, to which must be added enough room for experimental purposes. If ten different types of tubes are on test at the same time and the same rate, this means 9000 tubes in constant operation, plus those under study in special tests, and the tubes in course of development. This alone pictures the importance of the life-test department, particularly when one remembers the continual measurements and examinations made on these tubes.

Accelerated Testing

This is why many manufacturers advocate the general use of *accelerated* life test, in which the tubes are operated at voltages higher than normal, especially on the heater or the filament, with the idea of crowding the 1000

hours of life into a much shorter period. This would of course require less room on the one hand, and on the other would give results much quicker. But what results? The tubes are tested under conditions more severe than normal, the temperature of the emitter and the elements is higher, the parts expand more than usual, the distortion is possibly greater than it would ever be otherwise, and the actual significance of any observation made is lost so far as its meaning is concerned when the tube is in normal use. The conditions are altogether different and a considerable amount of evidence is still to be collected to give us the right to say that if a tube stands 400 or 500 hours of accelerated life test it will stand 1000 hours of normal use. As to the hope of learning anything definite about the behavior of the tubes once in the hands of the consumer, it is to be abandoned.

Definite Information

Assuming a perfectly efficient life test department, its object is attained only as far as its reports have the desired effect. They must be short, clear and incisive. Columns of figures are good only for precise reference and computations; they do not tell much to the reader except at the cost of time and decided attention. This is why, besides this kind of report, the Arcturus Radio Tube Company uses systematically broken curves drawn on a stencil or a tracing, and duplicated as many times as necessary. The curves do not need to be redrawn every time a new measurement is made on the same lot, for the same tracing is used up to the end of the test, and the line is only extended to the new point corresponding to the last reading taken. A glance at a bunch of curves tells more than minutes spent on a page covered with figures. This saves time and means efficiency in work and in effect. Actual figures and precise data, though, are by no means neglected, but are recorded in a way that allows also easy duplication.

Whenever a special report is written, extensive use of diagrams and drawings is made, and samples of filaments, coatings, insulations, etc., are attached to the report. The purpose of special tests, their operating conditions, and a detailed account of the results, with tentative conclusions and recommendations is the usual content of such reports.

This case illustrates how unexpected results can be derived from a mere necessity, and how the growth of a department depends upon carrying to to full efficiency the simple work which it is meant to perform at first. The prime object necessitates a minimum equipment and a definite type of work, for a specific purpose. The equipment and data being there, one derives the greatest benefit from it when one uses it to capacity, that is, when it is made to give all that it can give: a maximum of work and a maximum of information. This maximum work or information is practically always far beyond what was implied in the original purpose. Then small additions are soon found to increase the results tenfold, and finally the reaping proves to be worth many times the sowing.

Thus, if the immediate value of life testing resides in the constant checking of the lasting qualities of a product and the "signaling" of accidents as soon as they are detected, its potential value is immeasurable and depends only upon the intelligence with which such tests are conducted.

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Federal radio commission on carrier power

THE Federal Radio Commission at its May 25, 1931, session issued General Order No. 115, amending General Order No. 91, as follows:

Section 1. The maximum rated carrier power of all broadcast transmitters installed after this date shall be determined by the authorized power as given in Table I of this Section. The maximum rated carrier power shall be determined as provided in Section 2 of this General Order.

TABLE I

Authorized Power	Maximum Rated Carrier Power Allowed to be Installed
(a)	
5 to 100 watts	100 watts
100 watts night and 250 watts day	250 watts
(b)	
250 to 1000 watts	1000 watts
2500 to 5000 watts	5000 watts
(c)	

The maximum rated carrier power of transmitters hereafter installed in stations with an authorized power of over 5000 watts shall be not more than twice the authorized power.

Applicants requesting power from 5 to 50 watts, or from 250 to 500 watts, inclusive, may be allowed to install transmitters of the same maximum rated carrier power as the authorized power.

Section 2. The maximum rated carrier power of all broadcast transmitters shall be determined by the installed vacuum tube capacity of the last radio stage (i.e., oscillator or radio frequency power amplifier which supplies power to the antenna), depending on the system of modulation employed.

(a) The maximum rated carrier power of transmitters employing high-level modulation shall be considered the same as the total installed tube power capacity of the last radio stage as determined by Table II.

(b) The maximum rated carrier power of transmitters employing low-level modulation shall be considered as one-fourth the total installed tube power capacity of the last radio stage as determined by Table II.

(c) The maximum rated carrier power of transmitters employing grid bias modulation on the last radio stage shall be considered the same as the total installed tube power capacity of the last radio stage.

(d) If the methods of rating in paragraphs (a), (b) and (c) of this Section do not give an even power rating, the nearest rating recognized in the Commission's plan of allocation will be accepted.

(e) The power capacity of standard vacuum tubes commonly used in broadcast transmitters having a power rating of 50 watts and above as oscillators, Class 3 or Class C amplifiers, is fixed and approved as set out in Table II hereafter set out in this Section. Any vacuum tube of a type number and power rating not listed in Table II may be specified and accepted on an application to the Commission, provided the manufacturer's complete maximum and normal operating constants as oscillator or Class 3 or Class C amplifier and for class of service for which vacuum tube is specified in the application and complete curves which are considered necessary to determine the complete characteristics of the vacuum tube are submitted to and approved by the Commission.

Section 3. No licensee shall change the number of vacuum tubes or change to vacuum tubes of different power rating in the last radio stage, or change the system of modulation except upon authority from the Commission.

Section 4. The operating carrier power of broadcast stations shall be determined from the antenna input power either (a) by direct measurement or, (b) by indirect measurement

TABLE II

Power rating Watts	De Forest Type No.	RCA-Radiotron Type No.
50	503-A	UV-203-A
	511	UV-211
	545	UV-845
75	552	UX-852
	560	UX-860
250	504	UV-204-A
	504-A	
350	549	UV-849
500	561	UV-861
1000	—	UV-851
5000	520-B	RCA-1652
	520-M	
	521	
10000	507	UV-207
	548	UV-848
	563	UV-863
20000	—	UV-858
35000	—	—
100000	—	UV-862

by means of the plate input power of the last radio stage.

(a) The antenna input power determined by direct measurement is the square of the antenna current times the antenna resistance at the place where the current is measured and at the operating frequency. The direct measurement of the antenna input power will be accepted as operating power provided the data on the antenna resistance measurements are submitted under oath, giving detailed description of the method used and the data taken. The antenna current shall be measured by an ammeter of accepted accuracy. This data must be submitted to and approved by the Commission before any licensee will be authorized to operate by this method of power determination.

Any licensee authorized by the Commission to determine the operating power by direct measurement of antenna input power shall not make any changes in the antenna system except upon authority from the Commission.

(b) The antenna input power shall be determined by indirect measurement from the plate input power of the last radio stage by multiplying plate voltage by the total plate current of the last radio stage and by the proper percentage given in Tables IV, V, or VI, in accordance with the power and system of modulation used.

The operating power of transmitters employing high-level modulation shall be computed from the maximum rated carrier power of the transmitter as determined by Section 2 of this Order and the plate input power in accordance with Table IV.

TABLE IV

Maximum rated carrier power of transmitters as determined by Section 2	The operating power shall be this per cent of the total plate input
5 to 100 watts	50 per cent
250 to 1000 watts	60 per cent
2500 to 50000 watts	65 per cent

The operating power of transmitters employing low-level modulation shall be computed from the maximum percentage of satisfactory modulation and the total plate input power in accordance with Table V. No distinction will be recognized between transmitters of different powers.

TABLE V

Maximum Percentage of Satisfactory Modulation	The Operating Power shall be this Per Cent of the Total Plate Input
100 to 86 per cent	33⅓ per cent
85 to 75 per cent	40 per cent

The operating power of transmitters employing grid bias modulation in the last radio stage shall be computed from the maximum percentage of satisfactory modulation and the total plate input power in accordance with Table VI. No distinction will be recognized between transmitters of different powers.

TABLE VI

Maximum Percentage of Satisfactory Modulation	The Operating Power shall be this Per Cent of the Total Plate Input
100 to 86 per cent	22½ per cent
85 to 75 per cent	27 per cent

In computing the operating power of stations by indirect measurement, the above percentages shall apply in all cases and no distinction will be recognized due to the operating power being less than the maximum rated carrier power.

Section 5. The operating power of broadcast stations determined by the radiated power computed from field intensity measurements may be accepted in lieu of antenna input power, provided a sufficient number of measurements are taken to insure accuracy and an analysis of the antenna system is submitted indicating the relative distribution of the radiation (i.e., ground and sky wave radiation). The data on the antenna resistance, complete description of the antenna system with dimensions and method of taking field intensity measurements and of relating these measurements to the operating power shall be submitted to and approved by the Commission before any licensee will be authorized to operate by this method of power determination.

Any licensee authorized by the Commission to determine the operating power from radiated power shall not make any changes in the antenna system except upon the authority from the Commission.

Section 6. All broadcast stations shall be required to maintain their operating power in exact accordance with their licensed power at all times during the broadcast day and no departure from the licensed power will be permitted in any case except upon specific authorization from the Commission.

Section 7. Unless specifically authorized by the Commission to do otherwise, all broadcast licensees shall compute their operating power by the antenna input indirect measurement, and any broadcast licensee which has at any time been authorized by the Commission to compute its operating power by any other method (i.e., antenna input direct measurement or radiated power measurement) shall upon making any change in its antenna system or in the antenna current measuring instruments, revert to the use of the antenna input indirect measurement until further order of the Commission.

Section 8. (a) All broadcast stations shall be equipped with indicating instruments of accepted accuracy to measure the antenna current, direct plate circuit voltage, and the direct plate circuit current on the last radio stage.

(b) These indicating instruments shall not be changed or replaced except upon authority from the Commission.

Definition of Technical Terms Used in General Order No. 115

The following definitions apply to the terms used in General Order No. 115, adopted May 25, 1931:

(1) *Authorized or licensed power*: the power assigned by the Commission and specified in the instrument of authorization.

(2) *Maximum rated carrier power*: determined by the design of the transmitter and orders of the Commission and is independent of operating power except that generally it is the greatest power at which the transmitter can be satisfactorily operated.

(3) *Operating power*: the power that is actually transmitted by the station. It must be determined by one of of the several methods set out in General Order No. 115 and must agree with the authorized or licensed power.

(4) *Plate input power*: the product of the direct plate voltage applied to the tubes in the last radio stage and the total direct plate current of these tubes, measured under conditions of no modulation.

(5) *Radiated power*: the total power radiated from the antenna at all angles. In the absence of actual measurements, it is considered to be 50 per cent of

(*Concluded on page* 38)

Short-wave interference with broadcast reception

By VERNE V. GUNSOLLEY

"HOW do you fix your receiver to pick up the police transmissions?" asks one eagerly.

"How can I get rid of the police transmitter interference nuisance?" asks another.

And from a third: "Why do 85 meter radiophone transmissions interfere with programs mostly on 1060 kc.? All texts teach us that harmonics go up in frequency; not down. Some say this is re-radiation. But how or in what part of the circuit? If choke coils will effect a remedy, what kind should be used; how made; and where placed?"

Naturally the answers to such questions are not simple since in each case so much depends upon the design, condition and location of the receiver. However, the fundamentals are well known and the application is not difficult, though each problem requires special consideration.

The Broadcast Receiver Antenna

In general, the broadcast receiver is equipped with a single wire antenna of from 50 to 100 feet in length. One end is free and the other end is connected to ground through the primary of a radio-frequency transformer. The whole is equivalent to a simple vertical quarter-wave antenna with loading coil, Fig. 1.

The antenna thus grounded, but with coil removed, would have a natural wavelength, or, be resonant without tuning, to any wavelength equal to 4L, 4/3 L, 4/5 L, 4/7 L, etc.; where L is the length of the antenna. That is, the antenna will oscillate not only at its fundamental frequency but on all odd harmonics as well. Thus, an antenna 21 meters long has a natural wavelength of about 85 meters corresponding to a frequency of 3530 kc. It can also be made to oscillate on the third, fifth, seventh, etc., harmonics of this frequency.

Since 21 meters are closely 70 feet, and since 70 feet is the average effective length of the common receiving antenna it is quite reasonable to assume that reception conditions on an 85 meter wave are very favorable for most broadcast receivers which have the slightest weakness towards either cross modulation or self-oscillation.

The effect of adding the primary coil is to increase the natural wavelength slightly so that many a 30 to 60 foot antenna is boosted in natural wavelength so as to be resonant close to 85 meters, or 3530 kc.

Cross Modulation

When powerful signals, as from a local broadcasting station or nearby police transmitter, overwhelm an antenna, it is excited into forced oscillation whether resonant or not. The interfering signal will then get to the first radio-frequency stage whether tuned in or not. The result will be cross modulation on any carrier wave within the broadcast band which may be going through the amplifier. This is no function of a harmonic since the interfering station will ride in on any broadcast carrier.

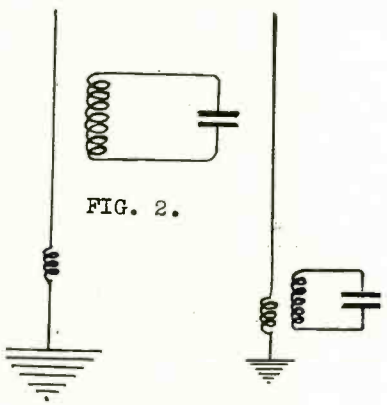
Generally the interference will disappear with the disappearance of the broadcast carrier, or with the setting of the dial to some point where no carrier is coming in. If the interference comes in at various points on the dial or all over the dial, then the radio-frequency of the interfering wave is being by-passed to the detector through the various stages by means of the distributed capacity between the elements of the circuits. The latter case is not cross modulation.

The first requirement of cross modulation is a powerful signal. At increased distances, and thus for decreased signal intensity, the cross modulation can occur generally only on receivers on which the antenna length is such as to produce resonance to the interfering short wave. It is evident that in this case only with a resonant aerial can the signal intensity be strong enough to cause cross modulation, and, even then, the signal must spot down quite heavily in the vicinity of the aerial.

Modes of Oscillation

If the impressed frequency is the same as the natural frequency of the circuit, or antenna, the mode of oscillation will be the same as that of the impressed frequency. However, if the impressed frequency is modulated, the modes of oscillation will be all of those of which the resonant system is capable; namely, all the odd harmonics for the antenna in question, and both even and odd harmonics for the common resonant circuit, Fig. 2. The sharper the modulation the more powerful and the higher the order of harmonics emitted.

In the average broadcast receiver we have the condition in Fig. 3, which, it will be noted, constitutes an antenna tuning around 85 meters as in Fig. 1, and, a coil-condenser combination, as in Fig. 2, tuning to the broadcast band. It becomes at once evident that this system is ideal for the conditions required for cross modulation, or for harmonic reception. If the condenser is set to 1177 kc. the third harmonic of the resonant circuit will be 3530 kc. which is near the fundamental of the antenna. When strong modulated signals impinge on the antenna at a frequency of 3530 kc. the response is very great, causing a maximum of excitation of the resonant circuit on its third harmonic. This causes the resonant circuit to emit all its modes of vibration which will be the weaker the farther they are away from the impressed frequency. There is some excitation at the fundamental



Figs. 1, 2, 3.

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The "interference" difficulties herein described and discussed understandingly are met with daily. Remedies are presented.

1177 kc.. therefore, and in modern high gain amplifiers this may be sufficient to become audible or to cross modulate any carrier on that wavelength.

Heterodyning

The foregoing is not always the case whenever such interference occurs. There are ways in which the radio frequency may step up or down through harmonics, heterodyne with oscillations within the receiver and appear on the dial as cross modulation or straight interference.

By heterodyning two frequencies, a third may be obtained provided the heterodyne modulation is rectified into a pulsating direct current, and this converted into alternating current through the medium of a radio-frequency transformer. Such a procedure requires detection, therefore, but this is generally not wanting in the average screen-grid amplifier not employing multi-mu tubes. The three-stage amplifier is lucky if it is not already a three-stage detector.

As an example of how heterodyning may possibly combine with harmonic reception, take the following: Suppose the dial set to 1160 kc. on a superheterodyne receiver having an intermediate frequency of 175 kc. The oscillator is then radiating in the region of the initial stages at a frequency of 985 kc. The third harmonic of 985 kc. is 2955 kc. If very pronounced, this harmonic may beat with 3530 kc. to give 575 kc. The response to 575 kc. may be very weak within the receiver, but to its second harmonic, 1150 kc., the response can be maximum since the dial is set to 1160 kc. Thus by slightly readjusting the dial the response can be made a maximum for all the conditions within the receiver favorable to reception in this manner. With 175 kc. supers, therefore, it is probable that reception on 85 meters will be had at dial settings of 1160 kc. or thereabouts, provided the antenna length is favorable, and the location of the receiver is in the vicinity of fair signal strength for the interfering wave.

With tuned radio-frequency receivers, if the volume control is turned up to the point of oscillation, the oscillations, or their harmonics, may beat with the incoming interfering short waves to form frequencies within the tuning range of the receiver. It may be found that such interference is had at several points on the dial, exact multiples of some frequency apart.

Heterodyne Beats

Another example of heterodyning is of common occurrence. Police transmitters have a frequency assignment of 2416 kc. This frequency may beat with a local broadcast carrier, or, in fact, any strong carrier on the broadcast band or otherwise that may be in the receiver along with the powerful police carrier. If the beat frequency falls within the broadcast band it may be tuned in at that point and both stations will be heard provided both use a high percentage of modulation. In case one station has very low modulation it may not be heard although its carrier is strong enough to produce a strong beat frequency with the police transmitter. To give a special case, a local station of 1460 kc. employing an average of 25 per cent modulation but a carrier of 10.000 watts beat with the police transmitter during police broadcasts to give a difference frequency of 956 kc. and this frequency could always be tuned in on that point of the broadcast band. The local station was not audible. Some time later the local station increased its percentage of modulation to nearly 100 per cent with the result that both stations are heard simultaneously during police broadcasts, but both disappear with the police transmissions. Another interesting point is that the frequency of 956 kc. beats with 950 kc. to form a 4 kc. heterodyne note during reception of the broadcasting on 95 kc.

Parasitic Oscillations

When a receiver is well by-passed, shielded and trimmed its circuits are quite complex, though they may be reduced to simple resonant circuits with lumped constants, for purposes of analysis. In other words, the constants are really quite well distributed, especially to short waves or high frequencies. While it is true, therefore, that the receiver tunes as a whole as if its constants were lumped, it may oftentimes happen that the receiver does not oscillate at its fundamental alone, but also at overtones not necessarily of exact multiple order, due to pockets formed in the circuits by distributed inductance and capacity. These parasitic oscillations may be compared to the overtones in music which are called partials. Since there is no prescribed method of distribution of constants these partials are not necessarily in arithmetic relation to the fundamental.

Such outlaw frequencies are not uncommonly found in high power radio-frequency amplifiers such as are used in large transmitters, and steps must always be taken to prevent them. Such frequencies can also be present in the modern high-gain receiving amplifier and when present can beat with short waves to form frequencies which, or the harmonics of which, will fall within the normal tuning range, though to all appearances the receiver is not oscillating at all so far as reception on the broadcast band is concerned. This is particularly liable to be the case with amplifiers which work the tubes at full gain and control volume by dissipation of the signal input.

Remedies

From an analysis of the causes, the remedies are self-evident.

The length of the antenna may be changed to some other value. This can be done mechanically or electrically. Electrically the antenna is shortened by the addition of a condenser in series, and if it is variable, it may be set at a point where the interference is eliminated. The antenna is lengthened electrically by adding more inductance in the form of any kind of a radio-frequency choke; a few inductively wound turns of wire often being all that is necessary. However, if the signal strength is overpowering, these methods fail.

With overpowering signal strength, it is necessary to resort to the more effective wave-trap. The applications are numerous and generally well known and will not be given here. It is only necessary to obtain a coil-condenser combination that will tune to the frequency to be eliminated and place this as close to the antenna post of the receiver as possible.

If the receiver is not well shielded; has open wiring, or, is picking up considerable signal strength through the house lighting circuits, even the wave trap may not be all that is necessary. In this case, shielding will need to be improved, and it will be necessary to bypass all signals to ground that may be coming through the house lighting circuit; as can be done by installing an ordinary line interference filter.

When these methods are effectively applied, and the receiver is still affected, it will be necessary to carefully stabilize all circuits to the point of no possible oscillation.

These methods all failing, the circuits should be changed to employ multi-mu tubes, after which it is hardly possible that any further trouble will be experienced.

Usually the trouble is corrected with very small expenditure of effort. The application of a very low resistance wave-trap usually stops the interference at the very first attempt. This can be made with a high quality variable condenser of low losses and an inductance having well spaced turns of large diameter wire. Shielding the wave-trap sometimes is desirable if the signal is powerful.

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COMMERCIAL RADIO COMMUNICATION

The Federal Radio Commission on June 17 granted to the American Radio News Corporation, Carlstadt, New Jersey, the following frequencies for press messages, news dispatches, advertising, etc.: 7625, 7640, 9230, 9390, 10090 kc. The station operates on 5 kw.

Gain and loss in communication circuits

By CHARLES FELSTEAD*

In this article Mr. Felstead presents the subject of gain and loss in communication and audio amplifier circuits in easily understood terms

MANY engineering students and technicians are confused by the expressions "gain" and "loss" in the sense in which they are used in electrical transmission work. In the first place, these two quantities are usually measured in terms of the decibel, or db. "Zero level" in decibels, which represents a static condition of neither gain nor loss, has been given the arbitrary power value of 0.006 watt, or six milliwatts. This is known as the standard reference level of power. It is usually referred to as the electrical power level in decibels relative to 0.006 watt, and is written "db./0.006 watt." This is a necessary distinction, because this unit, the decibel, which is one-tenth of the Bel, is employed likewise to measure the amount of gain (increase) or loss (decrease) of power in an amplifier or attenuator without respect to any particular level of power; as well as to measure the "level" of the power with regard to this arbitrary quantity known as zero level, either before or after the amplification or attenuation of the electrical energy.

Values in db. above zero level are marked with the plus sign; and db. quantities below zero level are written as negative values. It is like saying that the perpendicular distance from the base to the summit of a mountain is one mile. That tells us the size of the mountain; but does not teach us the elevation of the summit with relation to sea level, which in this analogy can be compared to zero level in db. The height of the mountain may be one mile; but the height of the mountain summit above sea level naturally depends on the elevation of the base with respect to sea level. If it were not customary to measure all elevations relative to sea level, it would be necessary to write "height/sea level," as is done with the decibel. It might be well to explain that in addition to being a measure of electrical energy in watts, this unit is also used as a measure of voltage or current gain or loss in transmission circuits, because the voltage and current are both, naturally, functions of the power.

* *Sound Engineer, Universal Pictures Corporation.*

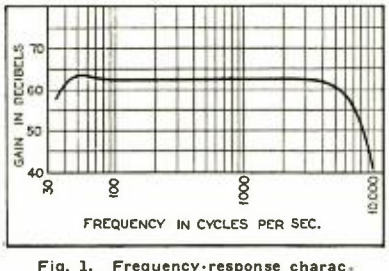


Fig. 1. Frequency-response characteristic of an amplifier.

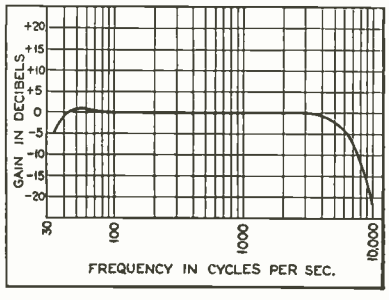


Fig. 2. Frequency-response characteristic of an amplifier.

Gain and Amplification

Gain is another word for amplification and represents an increase in electrical energy. This term is usually applied to an *active network*, such as an amplifier, because in an active network there is an internal source of power which operates the device, and that tends to augment the incoming energy and send it out at a greater electrical power level than the level at which it entered the network. In fact, any circuit or instrument that puts a higher electrical level into the "sink" which it feeds than it receives from the "source" that supplies it with energy is said to have gain. The gain may be, and usually is, of different amplitudes at various points in the audio-frequency spectrum. A measure of the response of an amplifier at different frequencies is generally termed the gain-frequency, or frequency response, characteristics of the amplifier, and is a comparison of the amounts of gain in decibels or other units obtained at all of the frequencies employed in communication circuits, which in high-quality sound transmission takes in a frequency band that extends roughly from about thirty-five to 10,000 cycles per second. Incidentally, this measure of frequency, cycles per second, is also written c.p.s. and ∽/sec. The results obtained from a gain-frequency run on an amplifier are usually plotted on semi-logarithmic, three-cycle graph paper, using values of gain in db. for ordinates and frequencies in c.p.s. for the abscissae, as shown in the graph given in Fig. 1, which is that of an amplifier widely employed for sound amplification. Semi-logarithmic graph paper is used because it tends to spread out the readings obtained in the important low-frequency band. Sometimes, however, the amount of gain in an amplifier is plotted relative to the mean speech frequency of 1000 c.p.s. A curve of this latter type is shown in Fig. 2, which represents the same curve as that in Fig. 1. The gain at 1000 cycles is marked on the graph sheet as a point opposite about the center of the ordinate line of the graph, and the values of gain in db. at all other frequencies are marked on the graph as so many db. plus or minus with respect to the mean value of 1000 c.p.s. Gain in an amplifier is not usually measured relative to zero level; but the output power level or

(*Concluded on page 32*)

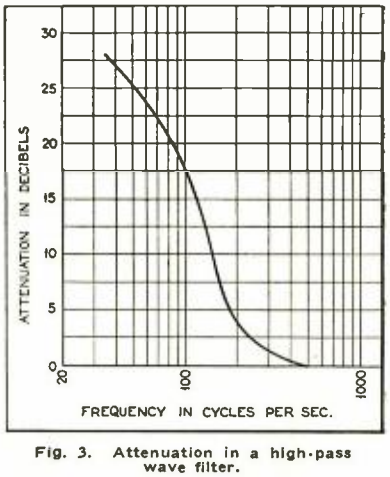


Fig. 3. Attenuation in a high-pass wave filter.

A new 100-watt radio broadcasting transmitter

Herewith is an outline description of a new low-power radio broadcast transmitter which meets all standard requirements and regulations

THE latest and most refined developments in radio broadcasting have heretofore only been available in high power equipments and as a result small station owners have found themselves at a disadvantage as compared to the larger stations from the standpoints of both quality of transmission and operating technique. Operators of low power stations have often found that their equipments did not satisfy the regulations of the Federal Radio Commission which have become more rigid as the art of broadcasting has advanced.

The 100-watt radio broadcasting transmitter herein described brings within the reach of the local broadcaster apparatus capable of meeting the exacting performance standards which are typical of the best regional and cleared channel stations, together with certain special facilities peculiarly adapted to low power equipments.

In the design of this transmitter extreme simplicity both in electrical and mechanical design has been attained.

General Description

The transmitter and the power supply are housed in a special metal cabinet. Four hinged-doors are provided in the front. The doors are paneled with grilled ironwork which provides both visibility to the vacuum tubes and adequate ventilation. All meters are arranged in a row across the top of the cabinet behind a glass plate. Indirect illumination of these meters permits easy, accurate readings at all times. This cabinet design is a complete innovation in the construction of radio transmitters.

The transmitter itself consists of a quartz crystal-controlled oscillator, two buffer stages of radio-frequency amplification, and an output stage in which modulation is effected. Modulation is accomplished without the use of audio amplifiers, sufficient audio-frequency level being obtained directly from the speech input equipment.

Simplification has been the keynote of the design of the 100-watt transmitter.

Some of the outstanding points of the transmitter are:

1. Complete absence of all rotating machinery.
2. Single unit mounting.
3. Simplified control system.
4. A thorough protection for operating personnel.
5. Complete (100 per cent) modulation.
6. Unusual frequency stability.
7. Crystal controlled oscillator.
8. Fidelity of transmission.
9. Suppression of harmonic frequencies.
10. Reduced number of vacuum tubes.
11. Low operating cost.
12. Adaptability to common frequency broadcasting.
13. Adaptability to increased power requirements.

Complete Absence of Rotating Machinery

All necessary d-c. power is supplied by rectifiers so that the entire transmitter is energized directly from the commercial a-c. power supply. By thus doing away with rotating machinery, has been made possible a very compact installation for broadcasting at this power. The complete equipment occupies little space and the use of rectifiers is considerably more advantageous than that of motor-generator sets from the standpoints of installation and maintenance.

Single Unit Mounting

The entire transmitter and power equipment are mounted in a single unit 36 inches wide, 25 inches deep and 6 feet 6 inches high. The total weight of the equipment, less tubes, is approximately 1,500 pounds. The shipping weight, less tubes and the two heaviest transformers which are packed separately, is approximately 2,000 pounds. The net weight of the two transformers is 180 pounds.

The unit is completely factory wired with the exception of the connections to the two transformers that are shipped separately. The unique new cabinet type structure has made compactness possible without sacrificing accessibility to all parts of the equipment. Due to the fact that all apparatus is accessible from the front, no aisle or space is necessary in the rear of the transmitter. The special cabinet design also does away with a great deal of routine cleaning and dusting of the apparatus.

Simplified Control System

The simplicity of the apparatus is reflected in the control system. There are but two major radio controls and one power control for the entire transmitter. If the transmitter has been previously in operation, it is necessary only to push the master "starting button" in order to go "on the air." An automatic control system applies the voltages in their proper sequence by means of time delay relays.

Protection for Operating Personnel

Thorough protection against contact with high voltages is provided for operating personnel. The surface of the cabinet containing the equipment is all "dead front" and the doors in the front of the cabinet are provided with circuit breakers which close down the transmitter when the doors are open.

100 Per Cent Modulation

Complete or 100 per cent modulation is another salient feature of this transmitter. Under a system of 100 per cent modulation, a broadcasting transmitter requires quadruple power to satisfy peak loads. This power is actual and the vacuum tube equipment transmitter is capable of supplying this power for instantaneous demand. Modulation is effected with a small amount of audio frequency power, an input at only +10 db. level being required. This eliminates the necessity of amplifying the audio frequency to a high power in the transmitter and is a step further in the development of low level modulation which has for some time been standard practice in radio broadcasting. Modulation is one of the most vital functions of a radio broadcasting transmitter.

Unusual Frequency Stability

The latest and most efficient methods of controlling the frequency of a radio transmitter are employed in the equipment. A degree of stability is attained which practically insures maintenance of the frequency within 50 cycles of the assigned value without any adjustment over a considerable period of time.

Crystal Controlled Oscillator

The unusual frequency stability of this transmitter is the result of a crystal controlled oscillator which is an improvement in broadcasting equipments. A mercury thermostat is employed to control the temperature of the quartz crystal. The quartz crystal, its associated thermostat, and the oscillator circuit are mounted as a unit and are adjusted and calibrated as such. This insures a high precision of calibration as well as permanence of adjustment. The apparatus is similar to that which has been successfully used for common frequency broadcasting and is of proved reliability.

Fidelity of Transmission

High quality broadcasting requires that every note be transmitted at its true and normal value. The transmitter herein described will transmit a range of 30 to 10,000 cycles with a maximum deviation of less than 2 db.

Suppression of Harmonics

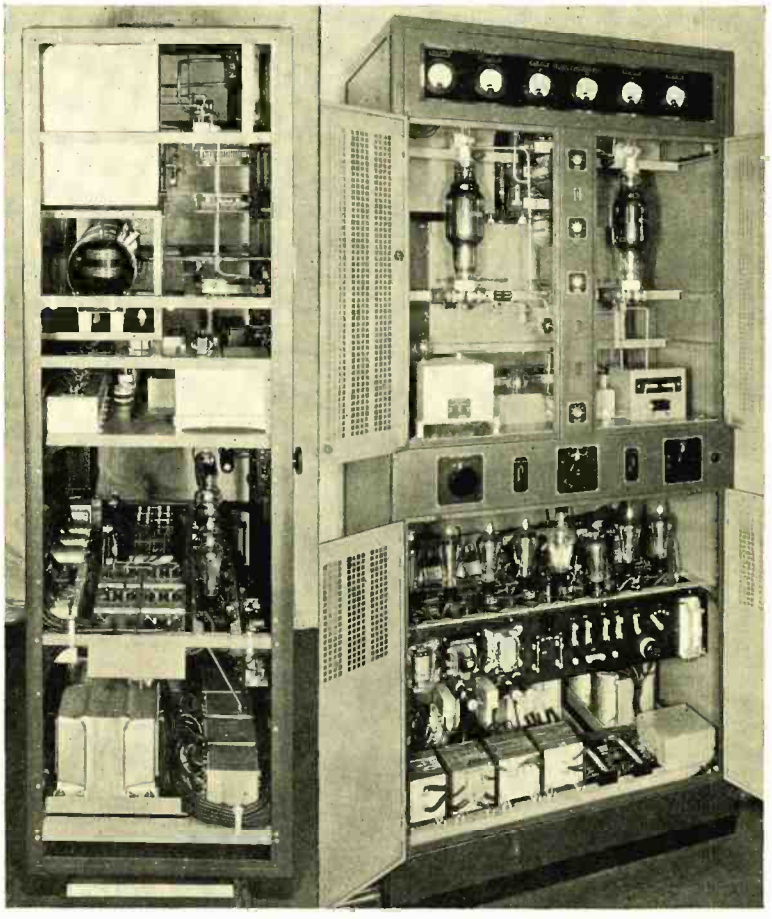
Particular care has been taken to insure against the radiation of harmonic frequencies. The radio-frequency circuits in the transmitter are thoroughly shielded, and the output circuit is specially arranged to suppress the harmonics and prevent them from reaching the antenna. By these means, the radiation at harmonic frequencies either from the antenna or from the circuits within the transmitter itself is reduced to a negligible amount. This feature becomes increasingly important as greater use is made of the higher radio frequencies in the broadcasting band and the still higher frequencies which are employed for other purposes.

Reduced Number of Vacuum Tubes

Only five vacuum tubes are used in the circuits of the transmitter, all other tubes in the unit being rectifiers which are used in the power supply circuits. This achievement of reducing the number of vacuum tubes to five in a highly stabilized, crystal controlled, 100-watt transmitter has been made possible by employing a circuit arrangement which permits elimination of the audio amplifiers ordinarily required ahead of the modulating stage. This is done without sacrificing power or quality and requires only a +10 db. level of audio-frequency input to the transmitter.

Low Operating Cost

The employment of a small number of tubes minimizes the expense for tube replacements, and this same feature, together with that of operation direct from a-c. power supply, reduces the cost of power for operating the transmitter to a minimum.



End view of assembled 100-watt broadcast transmitter.
Front view of assembled 100-watt broadcast transmitter.

Adaptability

Adaptability is one of the important features of the transmitter. In providing this feature, an underlying thought of the designing engineers has been to protect the owner against early obsolescence of his equipment.

This type of transmitter is easily adaptable to common frequency broadcasting which promises to be an important development in the radio field. The possibility of covering considerable areas by means of a number of properly distributed small transmitters makes this development very significant to low power stations.

If, at some later date, the owner of a transmitter of this type wishes to expand the power of his station to 250 or 1000 watts, he may do so by purchasing an additional amplifier which is designed along the same lines as the transmitter itself. Through anticipation of this possibility, the designers have made this increase in power a simple matter.

Speech Input Equipment

A very compact and efficient single rack speech input equipment has been designed for use with this radio transmitter. It includes high quality a-c. amplifiers, complete microphone mixing and switching facilities, master gain control and mercury-vapor rectifiers for plate supply.

The 100-watt radio broadcast transmitter herein described is a product of the Western Electric Company, marketed by the Graybar Electric Company.

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UNSATISFACTORY VOLUME OF TELEPHOTO BUSINESS IN JAPAN

A telephoto service has been in operation between Tokyo and Osaka since August 31, 1930. The largest item of business handled has been press pictures followed by business catalogs, specimen copies and original telegrams. The amount of business has been unsatisfactory inasmuch as there have been an average of only seven messages per day between the two cities. In November tests were made of a radio service between Nagoya and Bangkok, Siam. The direct transmission of radiograms was reported to be entirely successful. (*Vice Consul Hiram Bingham, Jr., Tokyo, Japan, 3/28/31.*)

A new method of measuring vacuum tube characteristics

By J. R. BARNHART*

THE method described herein of determining the three principal characteristics of the vacuum tube was evolved mathematically from a consideration of the properties of the self-biased tube. Actual magnitudes of currents and voltages do not enter into the calculations involved. It is, of course, necessary to apply sources of current suitable to the tube being measured.

The equipment used consists of a source of filament current, a source of plate current, a galvanometer and suitable resistances which will be described as the method is explained. The galvanometer need not be calibrated in any system of units but must be capable of carrying the plate current of the tube. A low resistance shunt built on the Ayrton principle is advised when using a sensitive galvanometer. The galvanometer must respond to small changes in current flow.

A testing set, enabling rapid measurement of all three quantities, g_m, μ and r_p, can be constructed.

By manipulation of suitable keys the circuits shown in Figs. 2, 3 and 4 may be selectively chosen. The arrangement is selective in the sense that any one of the three quantities can be determined independently of the other two. In the following measurements it will be noted that when evaluating $\frac{\Delta ip}{\Delta eg}$, E_p is held constant; when evaluating $\frac{\Delta ep}{\Delta eg}$, I_p is held constant and when evaluating $\frac{\Delta ep}{\Delta ip}$ E_g is held constant. The quantities found are the "dynamic" characteristics.

Mutual Conductance

Mutual conductance is defined as the ratio of plate current change to grid voltage change. Referring to Fig. 1, which represents the E_g, I_p curve of a vacuum tube, it is seen that the mutual conductance of the tube at the operating point, O, is the slope of the tangent T, T'. This may be expressed by

$$g_m = \frac{di_p}{de_g}$$

It is not possible to find this tangent with commercial measuring instruments, so if a chord C, C' be drawn through two points P, Q, on each side of the operating point, O, on the curve S, S', this chord can be made as nearly parallel to the tangent T, T' as desired. Mutual conductance may then be expressed,

$$g_m = \frac{\Delta ip}{\Delta eg}$$

The method of measuring mutual conductance may now be explained by referring to Fig. 2.

With switch, S, in position 1 and key, K, open, the initial current registered by the meter, M, is I. If switch, S, is now shifted to position 2, the grid will become less negative, and the plate current will increase. This grid change corresponds to the increment P', Q', in Fig. 1. Then, if key, K, is closed and R is adjusted until the meter, M, reads the same as initially, the following condition exists:

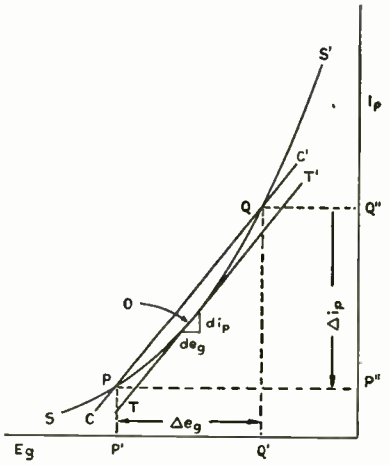

Fig. 1. Graphical representation of mutual conductance.

Because the current, I, in branch r, r_1 has been held constant, shifting the switch, S, from point 1 to point 2 changes the grid voltage by an amount rI. This causes a change, Δip, in plate current equal to rIg_m. This current change corresponds to the increment P", Q", in Fig. 1. The current, I, flows through the branch r_1, r, while the increment Δip flows through the branch R.

The potential drop from the cathode, C, to the point, O, is equal to (r_1+r) I. From Ohm's law, the current, Δip, flowing through R is $\frac{(r_1+r)\,I}{R}$.

But $rIg_m = \Delta ip$, therefore, $rIg_m = \frac{(r_1+r)\,I}{R}$

whence $g_m = \frac{(r_1+r)\,I}{rIR}$, which simplifies to $g_m = \frac{(r_1+r)}{(r)} \cdot \frac{1}{R}$

If the resistances, r_1, r, be made variable and controlled by a single knob, and if, further, the resistance elements be so constructed that the ratio $\frac{r_1}{r}$ is constant at all settings of the knob, the expression $\frac{r_1+r}{r}$ becomes a constant, b.

The equation for mutual conductance then becomes $g_m = \frac{b}{R}$.

The variable feature makes possible the adjustment of "C" bias for different types of tubes. The dial associated with the resistance, R, can be calibrated to read directly in micromhos.

The incremental distances P O, OQ (Fig. 1) can be made as small as desired, thus making the chord C, C' approach very nearly the tangent T, T'.

It is thus seen that the precision attainable by this method is limited only by the quality of the equipment used.

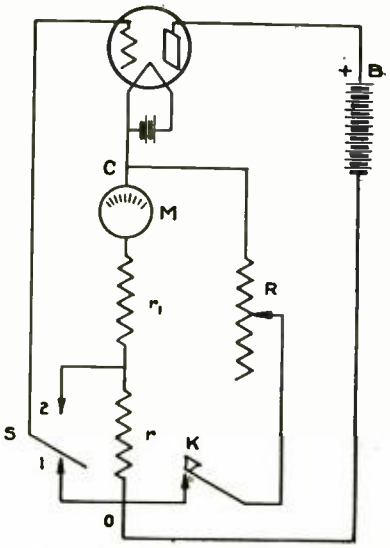

Fig. 2. Circuit arrangement used in measuring mutual conductances.

*Engineer, The Sterling Mfg. Co.

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Determination of Dynamic Mutual Conductance, Amplification Factor and Plate Resistance

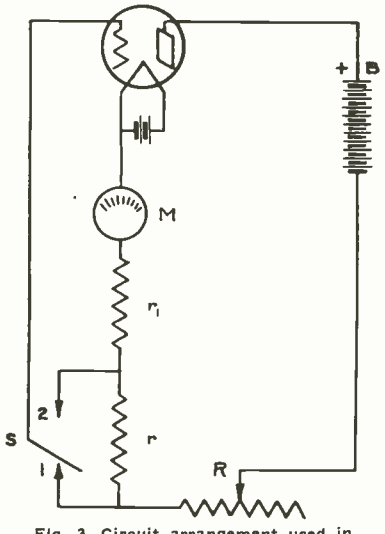

Fig. 3. Circuit arrangement used in determining amplification factor.

Amplification Factor

The amplification factor of the tube is determined by means of the circuit connections shown in Fig. 3.

With the switch, S, in position 1, and R at zero resistance, the initial current registered by the meter, M, is I. If the switch, S, is now shifted to position 2, the plate current will be increased. Adjusting R until the meter, M, reads the same as initially, the following condition exists:

Because the current, I, has been held constant, shifting switch, S, from point 1 to point 2, causes an effective increase in plate voltage, μrI, which is balanced by the plate voltage decrease, RI.

Then $\mu rI = RI$

whence $\mu = \frac{R}{r}$

Plate Resistance

The plate resistance of the tube is measured by means of the connections shown in Fig. 4.

With the keys, K and K_1, open, the initial current registered by the meter, M, is I. If the key, K, is now closed, the plate voltage will be increased, causing an increase in plate current. Then, closing K_1 and adjusting R until the meter, M, reads the same as initially, the following condition exists:

Because the current, I, in the branch, r_1, r, has been held constant, the plate voltage change upon closing the key, K, is rI. The increment of plate current, Δip, flows through the branch R. The voltage drop between the cathode, C, and the point, O, is $r_1 I$. From Ohm's laws it follows that

$$\frac{r_1 I}{R} = \Delta ip.$$

but $$\frac{\text{Plate voltage change}}{\text{Plate resistance}} = \Delta ip$$

therefore $$\frac{rI}{r_p} = \frac{r_1 I}{R}$$

whence $$r_p = \frac{(r)}{(r_1)} c\, R$$

It will be noted that it is not necessary to first find μ in this method of measuring plate resistance. This is very convenient.

It is interesting to check the relation

$$g_m = \frac{\mu}{r_p}$$

from the values found independently by the above method.

Either d-c. or a-c. current can be used. I have found, by means of the oscillograph, that sine wave of e.m.f., when applied to a self-biased tube, produces substantially half sine wave of output.

When using a-c. source of current the meter, M, will indicate the average value integrated over the complete cycle. During the positive half cycle the current is of sine wave form. During the negative half cycle the current is zero. The area under the sine curve for the positive half cycle is $\int_0^{\pi} \sin\alpha = \cos\alpha \Big]_0^{\pi} = 2$. The average value is $\frac{2}{\pi}$ peak value. The average for the complete cycle is $\frac{2}{2\pi}$ peak value.

Because the plate current is substantially proportional to the voltage of the plate current source, the d-c. equivalent of the a-c. plate voltage is the average value, or $\frac{9}{10}$ r.m.s. value. For example, if 200 volts r.m.s. is used as a source of plate supply, the meter, M, will indicate $\frac{1}{2}$ the value of current it would indicate if 180 volts d-c. were applied.

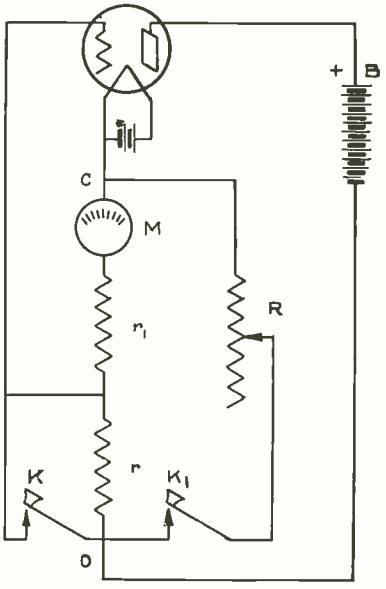

Fig. 4. Circuit arrangement used in measuring plate resistance.

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THE SUPERHETERODYNE RECEIVER

(*Concluded from page 17*)

use will facilitate making adjustments on the i-f. transformers when it is known at what frequency the set is nearest in alignment. Some sets while nominally adjusted to a 175 kc. band might actually have an oscillator frequency difference of say 170 kc. so that readjusting the i-f. would be useless.

The writer has found that the essential piece of equipment for testing and servicing superheterodyne receivers is a frequency meter capable of reading the normal values of these frequencies in the 175 kc. range. Fig. 6 represents a type of direct reading frequency meter developed for such work although any type may be used in which measurements are quickly made. A direct reading meter is necessary where speed counts, as in production tests.

To eliminate manual adjustments, a single sweep of the tuning control gives the operator a mental picture of the data similar to that given in the curves, Fig. 5. Experience will tell him which adjustments he can make to affect certain parts of the band, or in extreme cases he can warp or bend the end plates of the oscillator condenser, adjusting to that frequency that appears to extend over the greatest portion of the scale, whether or not it is exactly at 175 kc.

Making the final adjustments on the i-f. transformers is then a simple matter, since a single reading on an output meter connected across the speaker will indicate their adjustment.

BRITISH DEVELOPMENTS IN OVERSEAS TELEPHONY

Considerable interest has been aroused in Great Britain by the recent remarkable developments in overseas telephony. In the early part of March a demonstration which attracted extensive notice in the British press was held at the London overseas trunk exchange. A telephone operator, sitting before a switchboard measuring only 20 inches by 6 inches, talked to more than 20 European cities in less than a minute. This "continental tour" included cities as far apart as Paris and Berlin, Vienna and Copenhagen, Madrid and Prague, Boulogne and Geneva. In each case courtesies were exchanged with the foreign operators at the other ends.

Tube life measurements

By VERNE V. GUNSOLLEY

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The Watthour Meter Method of Determining Tube Life

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THE need is sometimes felt for a simple means of registering tube life, and, to the individual or firm interested in making such records, the following means may prove to be a valuable suggestion.

The first step necessary is to procure a 110 volt 5 ampere watthour meter. The cost is a small item compared to the cost of a good receiver, being only nine dollars or so, and a used meter may be obtained for less.

The meter is then provided with terminals supplied with standard extension cord fittings so that it may be plugged into the standard flush plate receptacle and the set attachment plug plugged into the meter. This places the meter in the receiver line so as to meter the receiver load. The meter may by hung on the inside of the cabinet, and the cords neatly knotted to take up slack and tucked in out of the way.

After installing, turn on the receiver, and, with the aid of a watch time the revolutions of the disc over a period of two minutes or more keeping accurate account of both time and the revolutions.

Next examine the face of the meter for a letter K_h or K_s. K_h is the number of watthours per revolution of the disc, while if K_s is given it is the number of wattseconds. That is K_s is 3600 times K_h since there are 3600 seconds per hour.

If R is the number of revolutions; S the time in seconds for R revolutions and P the watts required by the receiver, then, with the foregoing information at hand

$$P = \frac{K_h \times R \times 3600}{S}$$

$$= \frac{K_s \times R}{S}$$

Suppose the meter upon examination is found to have a mark: $K_h = 1/3$ Further assume R to be 22 and S to be 234, then

$$P = \frac{1/3 \times 22 \times 3600}{234}$$

$$= 112.8 \text{ watthours}$$

That is, the receiver draws as much power as a 113 watt lamp if such were available. Its rate of power consumption is, therefore, 0.1128 kilowatthour per hour. It follows that the difference between any two readings of the meter, when divided by the constant 0.1128, will give the number of hours the receiver, and thus its tubes, has been operating.

To log the tube life, it is only necessary to label the tube with the meter reading when first put into service, and then at any time subtract this reading from the later reading. The difference divided by the constant for the set in question (in this case 0.1128) will give the hours service to date.

Using this means, it is possible to plot curves of any desired tube characteristic against tube life in hours by the simple means of testing the tubes from time to time and tabulating the readings against the hours of time. In this way some very interesting studies of tube performance may be made.

When Accuracy Desired

The foregoing considerations assume constant voltage regulation, constant meter accuracy, and constant load. If extreme accuracy is desired, the voltage should be checked several times a day and the mean value of the watts load taken. If a new tube is placed in the set, the load should be rechecked to see that it is the same. If any sharp or extreme variations of conditions occur, corrections will need to be made. Ordinarily such accuracy is not necessary so that if the load is checked once every two or three months and the average taken the results will be all that is desired.

Does the tube retain normal strength for a long time and then drop off in emission suddenly? Does the tube test high at the beginning and suddenly drop off in emission and have a long life of comparatively weak emission? Or, does the tube taper off in strength with increase of life? How long is it advisable to run a tube after it shows the first signs of weakness? All these are questions that such a method of checking will answer. The trends of some curves are very interesting and instructive; with the various brands of tubes.

In addition, the meter gives very interesting information on the cost of operating a receiver. In fact it is possible that it opens up a new field for the sale of electric meters to set owners interested in keeping a record of tube performance.

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GAIN AND LOSS IN COMMUNICATION CIRCUITS

(*Concluded from page 27*)

carrying capacity of the amplifier is always measured in that way.

Loss

Loss has been termed negative gain because it represents a condition of more than absence of gain. Any network in which there is no increase of energy, and which is known as a *passive network* for that reason, introduces a loss in the communication circuit in which it is inserted. That is, the input energy to the network is greater than the energy in the output of the network. If the passive network is a simple attenuation network, or attenuator, made up entirely of non-inductive resistances, the attenuation, or loss, is considered for all practical purposes as to be constant at all frequencies in the audio-frequency band. However, if the network is composed of an audio transformer or wave filter of any type, the amount of loss is usually dependent on frequency. In such cases, it is possible to measure and make a graph, or "curve" as it is popularly called, of the attenuation of the network at different frequencies. The measurement of the "insertion loss" caused by introducing a passive network into a transmission line is customarily accomplished by connecting an amplifier having a greater gain than the network has loss in series with it. The frequency response of the amplifier and network together can then be measured and subtracted from the frequency response obtained with the amplifier alone. That gives the attenuation provided by the network.

The attenuation in db. can be plotted against frequency, as shown in Fig. 3; or if the amplifier and passive network are to be used together in the circuit, the overall gain-frequency characteristic of the combination can be plotted in the same manner that gain alone was graphed in Figs. 1 and 2. These values of gain and loss are sometimes given in terms of voltage or current ratios of amplification and attenuation, as well as in wattage ratios, but since the decibel, which used to be known as the transmission unit, is a logarithmic quantity and permits gain and loss as measured in decibels to be directly added and subtracted, instead of having to be multiplied or divided, it is the preferred unit to use for these measurements.

The practical operation of a complete television system‡

By ALLEN B. DUMONT*

Here is an authoritative technical description of a system of television now in operation

MANY writers and philosophers have envisaged the day when it would be possible for people to look into a magic crystal and see events taking place in some other part of the world. Today, thanks to the many technical advances that have taken place, it is not only possible to *see* events at a distance but to *hear* them as well.

For the past fifty years, one system after the other has been introduced for transmitting pictures from point to point. Some of the systems attempt only to transmit still images such as photographs, drawings or written messages, recording them at the receiving point in facsimile form. Other systems aim to transmit simultaneously the actual events taking place, in animated form, utilizing suitable apparatus at a remote point to receive and reconstruct such events so that they may be seen by a group of persons. Both classes of systems may employ either wire lines or the radio ether as the transmission medium. That class of systems in which the events are transmitted instantaneously over the air is the one which holds the greatest fascination and likewise represents the more difficult problems. Commonly known as television, and more specifically as radiovision when employing the radio transmission medium, this class is of particular interest today when a new entertainment vehicle is now in the making.

In this paper a practical system for accomplishing radio television or radiovision will be described as well as demonstrated. Before going into details, however, it might be well to state the general problems and to give a brief résumé of the inventions which have made a practical television system possible.

The Nipkow Disc

To start with, we must have a suitable method of analyzing the event to be transmitted. The most satisfactory method for this purpose at present makes use of the Nipkow disc, invented by Nipkow in 1884. This consists of a disc in which a number of holes are punched to form a spiral. The disc is mounted on the shaft of a motor. For picking up outdoor events where the intensity of illumination is considerable, the image is usually focused on the disc by means of lenses, so that it may be analyzed in its reduced form. Fig. 1 shows the Jenkins outdoor pickup camera in which this principle is employed. For studio pickups, however, it is generally advantageous to reverse this process. Instead of focusing the image on the disc, a powerful beam of light, properly guided by the disc, is projected on the subject to be analyzed. An example of this system is shown in Fig. 2, which depicts the Jenkins flying spot pickup. The lenses in front of the disc may be shifted to take care of a larger or smaller field, while the adjustable mirrors in front of the lenses permit of shifting the light beam up or down for any desired height of subject. After the event has been analyzed, it is necessary to translate the varying light waves picked up, into varying electrical impulses. This translation is accomplished by means of a light sensitive or photoelectric cell. As the light waves fall on the cell, the current passing through the cell is proportionately varied.

Going back a bit in television history, it is interesting to note that only as recently as the past five years have suitable photoelectric cells been available. For television work, the photoelectric cells must be sufficiently sensitive and possess a satisfactory frequency response. Prior to five years ago, the available photoelectric cells were either too sluggish to transform faithfully the high-frequency light variations into corresponding electric variations, or lacked the necessary sensitivity. At present the potassium hydride cell and the caesium sub-oxide cell are available for this work, and, while by no means the ultimate cells, they are successfully employed with proper associated apparatus. We are now employing the DeForest type 668 photoelectric cells of the caesium sub-oxide type in our work.

The Amplifier

Having obtained weak electrical variations as the result of the light translation process, it is now necessary to amplify those variations several million times without distortion. This step is accomplished by a carefully designed resistance-coupled amplifier employing a number of Audions. After the electrical variations are amplified, they are put to work modulating or regulating a radio transmitter similar to the usual broadcast transmitter but designed to pass the far wider band of frequencies required for good pictorial detail in television work.

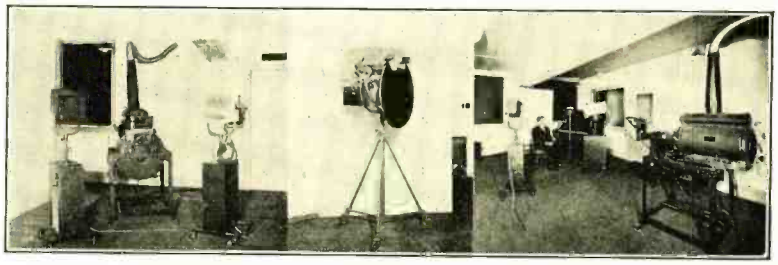

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Jenkins outdoor pickup camera. Fig. 2. Jenkins flying spot pickup. Fig. 3. Direct pickup studio.

‡ *Presented before the Radio Club of America, April 8, 1931*

* *Vice-President and Chief Engineer, DeForest Radio Company*

We have, so far, briefly discussed the method employed in picking up the event and starting it on its way through the ether. No mention has been made of the voice or sound pickup apparatus, frequently employed in combination with television programs, but since such apparatus is quite similar to that employed in sound broadcasting work, no further mention is required.

In order to visualize the layout of a sight and sound television transmitter, we refer to Fig. 3, depicting the direct pickup studio, Fig. 4 showing the film and synchronized sound apparatus.

In the station studio a reception room is provided for artists who are to appear before the direct pickup camera. In this room a radiovisor or "looking-in" device is provided so that the artists may see for themselves the programs on the air and how they are being received. Looking through a window on one side of the reception room, the artists and studio visitors may see the other artists as they are being televised. A loudspeaker is also installed in this room, operated by the voice transmitter.

Pickup Studio

Adjoining the reception room is the direct pickup studio. As the voice as well as the actions of the artists must be picked up in this studio, the treatment is along the same acoustic lines as that of a modern sound broadcasting studio. The flying spot pickup apparatus as well as the two photoelectric cell units are much in evidence. Each photocell unit comprises four photoelectric cells mounted on cushioned supports and placed at the focal point of individual spherical mirrors that collect and concentrate the reflected light from the subject. As an integral part of the unit, there is the head amplifier which amplifies the current from the photoelectric cells and feeds it to the main picture amplifier. The main purpose of the head amplifier is to raise the level of the current from the photocells sufficiently so that the ratio between this current and any extraneous or parasitic currents will be such as to overcome any streaks or lines in the picture. The photocell pickup units are mounted on rubber-tired wheels so that they may be moved about readily. Also, the mounting is such that they may be raised or lowered to follow the motions of the artist. The photocells are screened electrically to prevent any feedback from the transmitter. It might be well to state at this point that extreme care must be taken in the layout of the unit to prevent microphonics. We have found that in addition to the cushioned supports of the photocell, sound-absorbing material behind the photocell mounting helps considerably. If only the picture is being transmitted, without sounds to contend with, no difficulty is experienced with microphonics.

The flying spot pickup makes use of a 3.7 kw. arc mounted on a movable stand, together with the scanning disc and motor. As already mentioned, several lenses make possible the televising of either closeup or long shots. Mirrors in front of the lenses enable the operator to shift the scanning beam up or down in following the artist in a close-up shot. The studio includes a radiovisor so that an artist or the pickup operator may occasionally "look in" and check up on the program being transmitted.

Sound Pickup

Next to the direct pickup studio is the mechanical pickup room, containing the film-pickup apparatus and the synchronized sound accompaniment. A non-synchronous sound pickup is also provided and is employed when films without their own sound are being transmitted. The main picture amplifier is also in this room. This amplifier takes the signal either from the direct pickup head amplifiers or the film pickup amplifiers and increases it so as to feed directly into the modulator tube of the transmitter. The head and main amplifiers have a practically flat characteristic from 15 to 100,000 cycles. The main picture amplifier increases the voltage of the incoming signal approximately 2,000,000 times.

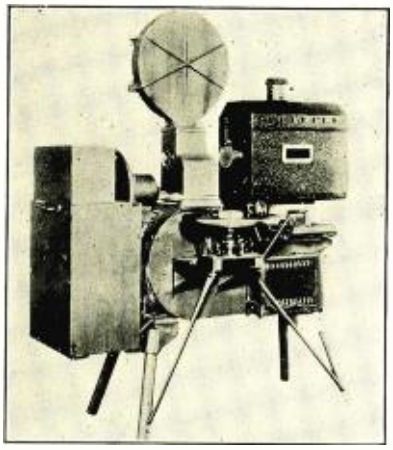

Fig. 4. Film and synchronized sound apparatus.

In the film pickup apparatus, the film feeds through continuously or without the intermittent motion of the usual motion picture projector. The holes in the scanning disc are arranged in the form of a circle rather than as a spiral. At present we are employing sound on disc, but a film pickup has been designed and is being built, which will permit us to employ either sound-on-film or sound-on-disc presentations. Also, at the present time, it is necessary to employ special records, because all records available are for 24 pictures a second, whereas we are transmitting only 15 pictures per second. Our new pickup is so designed that standard 24 pictures per second recordings can be run through at any desired speed for perfectly synchronized sight and sound presentations.

The voice and the picture transmitters are contained in a separate room adjacent to the film pickup room. Special precautions have been taken to prevent modulation of the voice transmitter by the picture transmitter, or vice versa. The picture transmitter operates on a frequency of 2035 kc.. and the voice transmitter on a frequency of 1604 kc.

Control Room

The control room is so located as to face the three rooms already mentioned, namely, the direct pickup studio, the film pickup room, and the transmitter room. Windows are provided so that the control room operator can see into each room at all times.

In front of the control room operator is a control board. Before describing the apparatus in this room, it might be well to point out the greater number of details to be watched in the radiovision station, as compared with the usual sound broadcaster. Following are the duties of the various operators at Station W2XCD.

Control Operator

1. Monitor picture over line for quality.
2. Keep picture level constant.
3. Synchronize film and direct pickup.
4. See that film and sounds are synchronized.
5. Monitor pictures over air for quality.
6. Monitor sound or voice for quality.
7. Keep sound or voice level constant.
8. Shift from films to direct pickup.
9. Shift from microphone to phonograph or synchronous phonograph turntable.

Radio and Film Pickup Operator

1. Check operation of picture transmitter.
2. Check operation of voice transmitter.
3. Operate film pickup.
4. Change phonograph records.
5. Operate synchronous record drive.
6. Keep film pickup in focus.

Direct Pickup Operator

1. Keep artists in field of direct pickup.
2. Keep direct pickup in focus.
3. Keep photocell units adjusted.
4. Check arc and change carbons.

Announcer and Studio Director

1. Make announcements.
2. Instruct artists.
3. Locate artists and instruments.

Fig. 5. Fig. 6. Fig. 7.
Fig. 5. Radio receiver. Fig. 6. The radioviser. Fig. 7. Scanning drum and mechanical shutter radiovisor.

4. Have acts ready to go on.
5. Shift properties.

It will be noted that there are twenty-four duties listed. Nine of these duties are necessary in sound broadcast operation, namely: Monitor voice for quality; keep voice level constant; check operation of voice transmitter; change phonograph records; make announcements; instruct artists; locate artists and instruments; have acts ready to go on; and shift properties. It will also be noted that the control operator must keep the other operators informed as to what is going on and what is desired so that the program may move along without a hitch.

The control panel consists of two televisors employed as monitors for both the picture on the line and the picture on the air. Beneath the line monitor is a level indicator and beneath this is a level control for the picture over the line. By varying the level control the signal to the modulator tubes is varied. Beneath the air monitor are switches to turn on or off the televisor. Between the air and line monitors is a frame control which is simply a switch controlling the scanning motor on the film drive. In order that the "lookers-in" may only have to frame the picture once, we start the direct pickup scanning apparatus before the program starts and allow it to run throughout the program. The air and line monitors are then framed by snapping on and off the switches under the air monitor until they are in frame. We now have both monitors in synchronization with the direct pickup scanner, and they are bound to stay in step until the station is closed down following the completion of the program.

Pickup

When we shift from direct pickup to films, the frame control between air and line monitors is turned on and off until the picture is framed, before the picture is put on the air. This calls for one adjustment at the studio instead of an individual adjustment at each receiving location.

Beneath the frame control is the voice level indicator, and beneath this is the voice level control. To the left of the central panel just described is the voice control panel. The four divisions vertically are, in turn, the order control, the main control, the order lamps and the answer lamps. The same arrangement also applies to the picture control which is to the right of the central panel. With regard to the voice controls, the four divisions horizontally are, in turn, the voice carrier, the studio microphone, the non-synchronous pickup, and the synchronous pickup. On the picture controls the three divisions are, in turn, the picture carrier, the flying spot pickup, and the film pickup. This control arrangement enables the control operator to direct and to monitor the programs. He can indicate to the various operators what is desired, and he is notified when the order has been carried out. Signal lights in the three rooms notify the operators what is desired and also what is going on.

While further improvements are being made in the control room, the arrangement referred to has proved satisfactory in maintaining a smooth flow of program features.

Reception

To receive the radiovision programs, we have developed several models of radiovisors and also several models of television receivers. Without going to details, it may be stated in a general way that the receiving problem is practically the reverse of the transmitting problem. The modulated radio wave is received on a radio receiver of a sensitivity of about 10 microvolts per meter, capable of passing frequencies of from 15 to 100,000 cycles with fairly flat characteristics. In this regard, we have developed an inexpensive receiver that can be assembled by the average experimenter. It is of the tuned r-f. type with a resistance-coupled audio amplifier including a power tube, and also a self-containing power pack for a-c. operation.

Really good half-tone pictures may be obtained with this receiver when employed in conjunction with one of the several models of radiovisors which we are producing. The receiver appears in Fig. 5. We have also developed a radiovision receiver of the superheterodyne type which has somewhat better characteristics but is considerably more expensive to produce.

It might be interesting to note at this point that the proper receiver has been a minor problem. At no time have we been unable to duplicate the results obtained in the studio.

The Radiovisor

The radiovisors employed in combination with the television receivers, all operate with the DeForest type 601 neon glow lamp. The small model radiovisor is sold assembled and unassembled, being in stripped form or without an enclosing cabinet. It provides a two-inch square picture. See Fig. 6. The motive force of this radiovisor is furnished by an eddy current motor comprising four electromagnets acting on a copper disc fastened to the scanning disc which is mounted on a ball-bearing shaft. Synchronism is obtained by means of a toothed rotor that rotates between a pair of magnets energized by the 60-cycle current. The radiovisor will keep in step only with stations on the same power system. However, due to the close regulation of frequency which is maintained today on power systems, it is feasible to maintain approximate synchronism on signals from a station outside the power system employed. Where fully automatic synchronization is desired on signals from stations outside the power system zone, a simple synchronizing device is added. This unit comprises a laminated 60-tooth rotor which fits on the motor shaft, together with an elec-

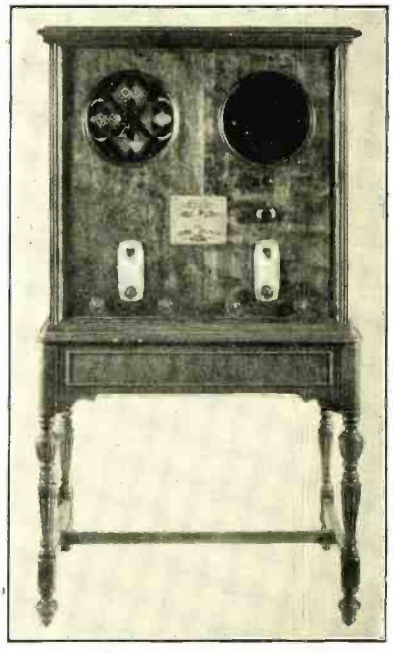

Fig. 8. Combination sound and picture receiver.

tromagnet fed by the 1200-cycle component filtered out of the intercepted carrier wave. The 1200-cycle is a dominant frequency in the present 60-line 20 pictures per second signal (60 x 20=1200). The receiver is provided with an additional tube to amplify the 1200-cycle component so as to feed the automatic synchronizer. It will be noted that while the usual 60-cycle current is used to keep the radiovisor approximately in step with the intercepted signal, the 1200-cycle synchronizer adds the necessary acceleration or braking effect so as to complete the synchronization. With this automatic synchronizer, it is possible to hold the signals from stations several hundred miles distant in perfect step for an entire evening.

A larger radiovisor providing either a 4 x 4 or an 8 x 8 picture, depending upon the lenses employed, is also being manufactured. This model does not employ a scanning disc. Instead, it makes use of a scanning drum and a mechanical shutter, permitting a relatively large picture to be obtained from an 8-inch drum. At present, this model is made up with a synchronous motor (see Fig. 7). Another model now in production contains practically the same mechanism as the stripped radiovisor models already referred to, with automatic synchronizer. Still another model, shown in Fig. 8, provides the highly desirable combination of voice receiver with loudspeaker and picture receiver with radiovisor.

The radiovisors just described are no more difficult to operate than the present-day broadcast receiver. They are intended for home use. For theatre purposes, where a larger picture must be thrown on a screen so as to be seen by a large group of people, several experimental models have been made up. One model employs a lens disc and a crater lamp, while another employs a lens disc and a Kerr cell.

The programs now on the air which can be received in the New York metropolitan area are as follows:

Station	Location	Programs	L.P.P.	P.P.S.
W2XCD	Passaic, N. J.,	syn. films and direct pickup	60	20
W2XCR	New York City,	syn. films and direct pickup	60	20
W3XK	Washington, D. C.,	syn. films and direct pickup	60	20
W1XAV	Boston, Mass.,	direct pickup	60	20
W2XR	New York City,	silhouette films	60	20
W2XBS	New York City,	call letters of station	60	20

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Essential Don'ts for Radio Stations

By CARL H. BUTMAN

DON'T fail to have your station managers and operators read the Federal Radio Commission General Orders, as well as the Radio Act of 1927; keep a complete file of General Orders up to date and available for ready reference.

Don't build, install, rebuild or move your main or auxiliary transmitter unless so authorized by the Commission; Radio Act, Section 21.

Don't install frequency control devices without written authority from the Commission; General Order 77.

Don't buy or sell transmitter equipment unless in possession of construction permit covering same; General Order 91, Section 3, and Radio Act, Section 21.

Don't test after construction without first advising Commission and your supervisor, and don't operate until authorized; General Order 45 and new supplement to construction permit.

Don't operate without a station license and only on the frequency, with the power, and during the time specified in your license; Radio Act, Sections 1, 9, 10 and 11.

Don't operate your transmitter except when a licensed operator is on watch; Radio Act, Sections 5, 9 and 20.

Don't fail to announce call letters and location of station every fifteen minutes; General Order 8.

Don't change your call letters without permission of the Radio Division of the Department of Commerce; Radio Act, Section 8.

Don't fail to announce mechanical reproductions and records as prescribed in General Order 78.

Don't move main studio without authority; General Order 28 and Radio Act, Section 9, as amended on March 28, 1928.

Don't let your transmitter deviate over 500 cycles; keep a continuous check on your frequency; General Orders 7, 75 and 77.

Don't fail to comply with supervisor's request for report within three days if you are notified of violations; General Order 75.

Don't increase the power of your transmitter at any time without authority; General Orders 10, 48, 53 and 91.

Don't fail to read General Order 91 when calculating carrier power or rating your transmitter.

Don't seek power in excess of 25 kw. without studying General Orders 42 as amended, 91 and 92.

Don't apply for a new frequency or more power without consulting General Orders 40, 91, 92 and explanation thereof.

Dont' operate a daytime, limited time or local sunset station without understanding General Orders, 10, 41, 48 and 53.

Don't operate daylight saving time without following General Order 61.

Don't fail to close down your station if required when an SOS is heard or officially requested; General Orders 66, and Radio Act, Sections 22, 23 and 28.

Don't fail to file renewal applications with supervisor thirty days prior to expiration date; General Order 89.

Don't fail to file all applications through supervisor of radio (who acts for the Secretary of Commerce) for your district; Radio Act, Section 10.

Don't fail to post station and operator licenses conspicuously in transmitter room; General Order 90.

Don't assign, lease or relinquish control of your station without consent of the Commission; General Order 95, and Radio Act. Sections 11 and 12.

Don't put an alien on your Board of Directors, or permit aliens to own more than one-fifth of stock; Radio Act, Section 12.

Don't participate in a hearing without reading General Order 93 and Radio Act, Sections 4, 5, 11, 14, 15 and 16.

Don't grant one candidate for public office the privilege of using your transmitter and deny it to another similar candidate; give equal privilege to all; General Order 31, Radio Act, Section 18.

Don't permit use of obscene, indecent or profane language, or broadcast anything not in public interest, convenience or necessity; Radio Act, Section 29.

Don't fail to announce sponsored programs; Radio Act, Section 19.

Don't rebroadcast programs without authority of the originating station; Radio Act, Section 28.

Don't fail to keep a station log; Radio Act, Section 4.

Don't fail to read penalties under Radio Act for violations; Radio Act. Sections 32 and 33.

A new modulation tube for television

By HENRI F. DALPAYRAT

THE progress of television has been greatly hindered by the lack of certain necessities; to numerous limitations, so far only partly solved, and the obstinacy of many experimenters in working along beaten paths.

Although there is a very great variety of television schemes, patented or described in publications, most of them are far from promising a bright future for this new industry, but rather foretell a complicated commercial situation which will be difficult to untangle. Meanwhile the television enthusiasts will be offered inferior and inefficient systems at various prices. Which of these will ever be popular and outlast the others? Undoubtedly the one which will be so designed as to give the best results and which will be sold at the lowest price. This calls for extreme simplicity and superior results which can only be produced when the problems of illumination, scanning and projection are solved.

The writer believes that the new arc tube described herein will be an important step toward popularizing the reception of television signals by producing a new source of light of intense brilliancy which will make possible the design of a more efficient televisor.

Fig. 1 shows the new arc tube connected to the output of a radio receiver. In the diagram, 1 is an evacuated glass bulb, the outside surface of which is rendered opaque by total shielding or by painting it black; 2 is a part of the bulb which is silver plated and is to act as a reflector; 3 is a small, square clear glass opening through which the light is projected outside the bulb: 4 are two long, wide metallic electrodes facing each other and shaped as shown; 5 are portions of electrodes 4 which are made of high resistance metal; 6 are two rod electrodes placed in spaced relations near and between the lower ends of electrodes 4; 7 is a filament which heats a small amount of mercury 8; 9 is a source of high d-c. voltage which is applied on electrodes 4; 10 is a radio receiver which supplies the signal voltage variations to electrodes 6.

Operation

The mode of operation is as follows: When switch 14 is turned on, the filament 7 draws current from battery 13, and becoming incandescent heats the mercury, 8. Mercury vapors fill the tube and the space between the upper ends and the lower ends of electrodes 4 becomes electrically conductive and arcs are formed at points A-B-C-D. The distance between B-C-D is adjusted so that when electrodes 6 do not carry any signals, the distance at the upper ends of 4 has a lower resistance at point A and a strong arc is formed there. Now when a signal is applied on electrodes 6 an arc is established between them which varies in intensity according to the signal variations. The space between electrodes 6 varies in resistance with the signal and decreases the total resistance between the lower ends of electrodes 4. Current is then drawn at those points from source 9. However, most of this current is dissipated under the form of heat going through resistances 5, to prevent the distance between 6 from becoming short circuited by passing too heavy current. The arc taking place between the lower ends of 4 and going through electrodes 6 may be called the primary arc. The arc formed at the upper ends of 4 may be called the secondary arc. From the above description it may be easily seen that the primary arc acts as a variable resistance for the secondary arc. When this secondary arc is decreased, it sinks down between electrodes and in so doing decreases the amount of light reaching the reflector 2 and the light projected through the clear glass at point 3. Once the secondary arc is formed, the current from source 9 passing through the magnetic relay 12 opens the circuit of the heating filament 7. This circuit stays open so long as the tube is in operation, as the heat of the arcs themselves is enough to maintain the temperature of the mercury vapors.

Modulation

It has been roughly calculated that this tube could safely modulate a current of half an ampere at 200 volts. An average of 100 watts can be consumed at this voltage by this new arc tube, although higher values may be reached with electrodes able to stand higher temperature.

This new tube is now being experimented with and the reports are very promising. An intense white brilliant light is produced and the arc is easily modulated without any appreciable lag. The problem of flickering which is so bothersome with arcs exposed to the air, does not create difficulties with this tube. The ends of electrodes 4 are specially shaped to prevent the arc from dancing.

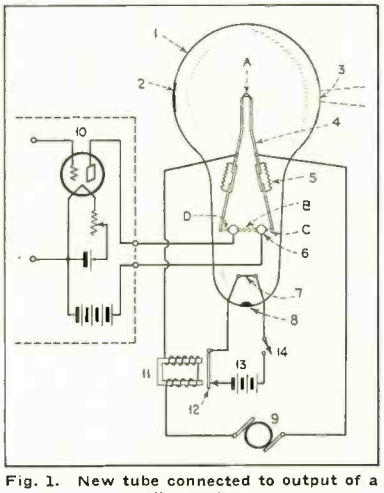


Fig. 1. New tube connected to output of a radio receiver.

The electrodes also are covered with a thin coat of porous porcelain, thus protecting the metal itself from wearing out. This unusual feature was found to greatly increase the stability of the arc as well as to prolong the life of the tube. The applications of an intense brilliant modulated light are numerous, television, talking pictures, recording, etc., to predict a great usefulness as well as a wide use for this remarkable invention.

▲

This new mercury vapor arc tube has a very large output of modulated light and shows great possibilities

TELEVISION

(*Concluded from page 15*)

a list of the parts which go into a typical television receiver:

1 .000365 mfd. variable condenser
1 .0002 mfd. variable condenser
1 .0001 mfd. fixed condenser
1 .1 mfd. fixed condenser
1 .001 mfd. fixed condenser
3 .25 mfd. fixed condenser
1 1. mfd. fixed condenser
6 2. mfd. fixed condenser
2 1. mfd. fixed condenser
2 8. mfd. electrolytic c'ndenser
1 16. mfd. electrolytic c'ndenser
3 4. mfd. by-pass condenser
1 volume control
2 140 mfd. varitors
19 resistors, various values
4 grid resistors
1 power switch
2 shielded r-f. transformer
1 power transformer
1 double filter choke (2, 30 henry)
1 roll hook-up wire
8 sockets
3 tube shields
5 screen-grid tubes
1 output tube
1 rectifier tube
1 neon lamp
1 milliammeter
1 aluminum chassis
2 vernier dials
1 lens assembly
1 radiovisor kit
1 shielded antenna

TELEVISION TIME-TABLE

Station	Lines per Frame	Call Signal	Frequency in Kilocycles, Meters in Parentheses	Power (watts)	Owner
Illinois: Chicago	48	W9XAA	2,000 (150) to 2,100 (142.9), 2,750 (109.1) to 2,850 (105.3)	500	Chicago Federation of Labor.
" "	45	W9XAO	2.000 (150) to 2,100 (142.9)	500	Western Television Corp., 6312 Bway.
" "	45	W9XAP	2,750 (109.1) to 2,850 (105.3), 2,100 (142.9) to 2,200 (136.4)	1,000	Chicago Daily News.
Downers Grove	24	W9XR	2,850 (105.3) to 2,950 (101.7)	5,000	Great Lakes Broadcasting Co., 72 W. Adams St., Chicago.
Indiana: West Lafayette	—	W9XG	2,750 (109.1) to 2,850 (105.3)	1,500	Purdue University, 400-500 Northwestern Ave., West Lafayette, Ind.
Iowa: Iowa City	—	W9XAZ	2,000 (150) to 2,100 (142.9)	500	State University of Iowa
Maryland: Silver Springs	48	W3XK	2,000 (150) to 2,100 (142.9) 2,850 (105.3) to 2,950 (101.7)	5,000	Jenkins Laboratories, 1519 Connecticut Ave., Washington, D. C.
Massachusetts: Boston	48	W1XAV	2,850 (105.3) to 2.950 (101.7)	500	Shortwave and Television Laboratory (Inc.)
New Jersey: Allwood	—	W2XCP	2,000 (150) to 2,100 (142.9), 2,850 (105.3) to 2,950 (101.7)	2,000	Freed Eisemann Radio Corp., Junius St. & Liberty Ave., Brooklyn, N. Y.
Camden	60	W3XAD	2,100 (142.9) to 2,200 (136.4), 43,000 (6.97) to 46,000 (6.52), 48,500 (6.18) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	500	R. C. A. Victor Company (Inc.)
Passaic	60	W2XAP	2,750 (109.1) to 2,850 (105.3), 2,000 (150) to 2,100 (142.9)	250	Jenkins Television Corp. (Portable.)
"	60	W2XCD	2,000 (150) to 2,100 (142.9)	5,000	De Forest Radio Co.
New York: Beacon	48	W2XBU	2,000 (150) to 2.100 (142.9)	100	Harold E. Smith.
Long Island City	—	W2XBO	2,750 (109.1) to 2.850 (105.3)	500	United Research Corp., 39-41 Van Pelt Ave.
" " "	48	W2XAR	2,100 (142.9) to 2,200 (136.4), 2,850 (105.3) to 2,950 (101.69)	500	Radio Pictures, Inc. 3104 Northern Blvd.
New York	60	W2XAB	2,750 (109.1) to 2,850 (105.3)	500	Atlantic Broadcasting Corp., 485 Madison Ave.
" "	60	W2XCR	2,000 (150) to 2,100 (142.9), 2,750 (109.1) to 2,850 (105.3)	5,000	Jenkins Television Corp., 655 5th Ave., New York City.
Ossining	—	W2XX	2,000 (150) to 2,100 (142.9)	100	Robert F. Gowen.
Schenectady	—	W2XCW	2,100 (142.9) to 2,200 (136.4)	20,000	General Electric Co.
Pennsylvania: East Pittsburgh.	60	W8XAV	2,100 (142.9) to 2,200 (136.4)	20,000	Westinghouse Electric & Mfg. Co.
" "	60	W8XT	660 (455)	25,000	Westinghouse Electric & Mfg. Co.
Wisconsin: Milwaukee	—	W9XD	43,000 (6.97) to 44,000 (6.81)	500	The Journal Co. (Milwaukee Journal).
PORTABLE					
New Jersey: Bound Brook	60	W3XAK	2,100 (142.9) to 2,200 (136.4)	5,000	National Broadcasting Co., Inc.
New York: New York	60	W2XBS	2,000 (150) to 2,100 (142.9) 2,100 (142.9) to 2,200 (130.4)	5,000	National Broadcasting Co., Inc.

▲ ▲ ▲

FEDERAL RADIO COMMISSION ON CARRIER POWER

(*Concluded from page 24*)

the antenna input power for all computations.

(6) *Antenna input power or antenna power*: product of the total antenna resistance and the square of the antenna current.

(7) *Last radio stage*: the oscillator or radio frequency power amplifier stage which supplies the power to the antenna.

(8) *Modulation*: the superimposing of audio-frequency power on radio-frequency power resulting in the generation of sidebands or varying the peak amplitude of the output current and voltage. May be accomplished by several methods.

(9) *System of modulation*: determined by stage modulated, the method, and subsequent amplification.

(10) *Modulator*: the last audio-frequency amplifier stage which modulates a radio stage by plate modulation or otherwise.

(11) *Modulated stage*: the radio-frequency amplifier stage which is coupled to the modulator and is modulated by one of the several methods.

(12) *Percentage of modulation*: the ratio of the amplitude of the difference between the maximum or minimum rectified antenna current during modulation and the rectified carrier under conditions of no modulation to the rectified carrier under conditions of no modulation, multiplied by 100. If the positive and negative modulation are of different percentages, the one giving the lesser percentage is considered as determining.

(13) *Maximum percentage of satisfactory modulation*: defined as the greatest percentage that may be obtained by supplying sound energy to the station microphone without over 10 per cent combined audio harmonics in the output being generated by the entire transmitter.

(14) *High level modulation*: the plate circuit of the last radio stage is modulated.

(15) *Low level modulation*: a stage before the last radio stage is modulated and the last stage operates only as a linear power amplifier.

(16) *Grid bias modulation in the last radio stage*: the grid bias voltage of the stage which supplies power to the antenna is controlled at audio frequency. If such modulation is employed in other than the last radio stage, it is low level modulation.

(17) *Antenna resistance*: the total resistance of the antenna system at the operating frequency and at the place of measuring the antenna current.

(18) *Antenna current*: the radio-frequency current at the operating frequency under conditions of no modulation.

NEWS OF THE INDUSTRY

DINION EXECUTIVE VICE-PRESIDENT U. S. MAGNETIC PRODUCTS

N. L. Dinion has joined the U. S. Magnetic Products Corp., Lock Haven, Pa., and has been elected executive vice-president. Mr. Dinion has been identified with the electrical industry for over twenty years. He has conducted many laboratory tests for Charles R. Underhill—and has designed solenoids and electromagnets for special and standard machinery in which are included such magnetic actions as the photomaton machine, Craig printing demagnetizer apparatus, stage lighting apparatus and ignition.

Recognized as an authority, Mr. Dinion has delivered several lectures on the subject of coil winding and solenoids—and has added to many of the most recent developments in the coil industry, in addition to compiling valuable wire data.

Years ago Mr. Dinion was connected with the engineering staff of the Acme Wire Co. In 1923 he formed the Easton Coil Co., and until his recent resignation, served as president and general manager of that company.

In his new connection Mr. Dinion already has a big expansion program well under way. A factory has been acquired in Lock Haven, providing over 35,000 square feet of floor space to meet production needs.

Plans also call for the immediate installation of modern machinery for coil winding and for the manufacturing of electromagnets, solenoids, various types of small transformers and magnetic specialties.

▲

D. J. QUAMMEN APPOINTED BY CUTLER-HAMMER

D. J. Quammen has been appointed manager of the Philadelphia district office of Cutler-Hammer, Inc.—manufacturers of electric motor control and allied apparatus—whose headquarters are at Milwaukee, Wis. Mr. Quammen succeeds F. J. Burd, who has been made assistant manager of the Chicago Office of Cutler-Hammer. Mr. Burd will have charge of industrial sales in the Chicago district, and of the C-H (Harland) paper machine drive, throughout the country. Mr. Quammen has been connected with the Philadelphia office of Cutler-Hammer for the past five years.

▲

ALPHA WIRE MOVES

The Alpha Wire Corporation has recently moved to larger quarters at 50 Howard Street, New York. Main offices will be located at that address.

The larger New York quarters will permit exceptional service in all types of wire desired by the radio and allied industries. Most types are available in stock for immediate delivery.

Sales offices will be continued as in the past at Boston, Philadelphia. Cleveland, Chicago, Charlotte, N. C., Atlanta, Ga., Kansas City, Seattle, Los Angeles and Oklahoma City.

▲

A. S. WELLS NEW HEAD OF GULBRANSEN COMPANY

At a special meeting of the board of directors of the Gulbransen Company, piano and radio manufacturers, A. S. Wells, well known in the radio field since the commercial inception of the industry, was elected president of the company. A. G. Gulbransen, the retiring president, was elected chairman of the board.

Other officers elected were G. M. Gardner, vice-president; George McDermott, vice-president; Frank Dillbahner, treasurer and Edward B. Healy, secretary. In addition to the above, the board of directors will consist of W. L. Peterson, C. Gulbransen, Frank Christopher, G. J. Peters and E. Q. Kruchten.

▲

SERGE DESIGNS NEW SPEAKER

Mr. I. B. Serge, whose likeness is here presented has designed a new loudspeaker for radio receivers which is meeting with wide favor.

Mr. Serge has been in radio since 1913. He spent four and one-half years as designing engineer in the Radio Department of General Electric Company, where he devoted his time to the study of manufacturing and designing loudspeakers; later he became factory manager and designing engineer of United Reproducers, manufacturers of the Peerless speakers; after that he became chief engineer of Valley Appliance, Inc., manufacturers of the Symington speaker.

I. BOBROVSKY SERGE

This new speaker product of Peter Smith Stamping Company is a result of the manufacturing skill of the Peter Smith Stamping Company plus the engineering experience of Mr. Serge.

The Serge-Smith electrodynamic reproducer is a result of extensive study of acoustical as well as mechanical problems of sound reproduction required by radio set manufacturers at the present time.

▲

CRYSTALS FOR RADIO

Additional cutting and grinding machinery is being installed by the Precision Crystal Laboratories of Springfield, Mass., to take care of the demand for crystals being used in the production of Stenode receivers. Due to the proposed rulings of the Federal Radio Commission for a 50 cycle accuracy of assigned frequency, many broadcasting stations have already changed their present crystals for those having 50 cycle limits.

▲

ZAPON HEADQUARTERS

Headquarters of the New England sales division of The Zapon Company has been moved from New Haven, Conn., to Stamford, Conn., to better facilitate deliveries and render more efficient service.

The New Haven office had been opened when The Zapon Company's executive sales offices were located in New York City. Now, with the executive offices in Stamford, a closer contact with factory and laboratory is effected and at least one day is saved in deliveries.

Mr. Oberender will continue in charge of the New England division.

▲

WILLIAM DUBILIER RESUMES PRESIDENCY OF DUBILIER CONDENSER CORP.

After an absence of several years from the organization which he created and developed, William Dubilier has resumed the presidency of the Dubilier Condenser Corporation of New York City. Recently asked to take charge of the condenser manufacturing organization by its board of directors in order that his extensive experience in the condenser and allied arts might once more be made available for the further development of the industry, Mr. Dubilier has finally accepted the appointment.

"I am glad to return to the condenser field," stated Mr. Dubilier when interviewed. "The rapid advances in the radio and electrical arts have greatly enlarged the scope of the condenser industry. However, there is need for original research and engineering development as never before. Also, there is need for acceptable and definite standards whereby to gauge the performance and service life of condensers. Again, there is need for closer co-operation between those requiring condensers and those who build them.

"In accepting the presidency of the Dubilier Condenser Corporation, I am not unmindful of the seriousness of the task that lies before me. It is my plan to restore the Dubilier research and engineering laboratories to their former high standards. We are already developing new condensers. Our plant is being reorganized for the most economical production consistent with Dubilier quality. The results will shortly speak for themselves."

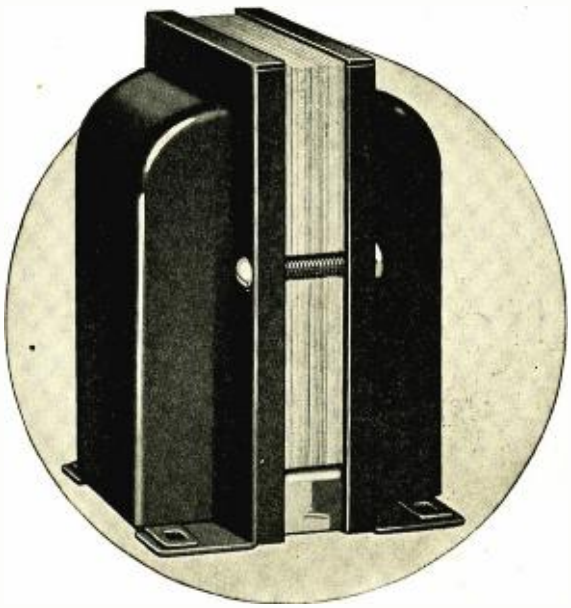
▲

ARCTURUS ESTABLISHES WESTERN DIVISION OFFICE

Arcturus Radio Tube Company, Newark, New Jersey, manufacturers of radio tubes and photoelectric cells, announces the opening of its western division office located at 1855 Industrial Street, Los Angeles, in charge of L. P. Naylor.

Mr. Naylor was formerly sales manager of Arcturus. In his new capacity Mr. Naylor will supervise the business of Arcturus products in the far western territory. By establishing this western division office, manufacturers, jobbers and dealers are assured of direct factory service.

Draw on this store of transformer knowledge *As You Need It*



Look upon the Jefferson Service as a store you can draw upon at any time . . . . whether for the solution of a troublesome design problem . . . . or for the prompt delivery of ANY quantity of radio transformers needed.

Jefferson's fund of transformer knowledge has been piling up ever since the birth of radio. Jefferson specialized engineers have been the pioneers,—in the front rank of radio-transformer development in the past; they are now engaged in developments which are scheduled to write history in the future. And YOUR Jefferson Transformer is the sum total of this huge experience and knowledge.

The crying need of the times is: the most business in return for the smallest investment. And exactly here, Jefferson can help you best. When times are booming, Jefferson Electric is YOUR transformer department, geared exactly to your needs, —as large or small as you want. Yet when production slows up there is no overhanging penalty of frozen assets or burdensome overhead. Submit your requirements and specifications—without obligation.

JEFFERSON ELECTRIC COMPANY
1599 S. Laflin St.
Chicago, Ill.

JEFFERSON TRANSFORMERS

All-weather Performance

• • •

● International offers, in the type "B" Condenser Transmitter, the result of three years of intensive research —combined with methods of manufacture which are a radical departure.

● This unit, being unaffected by extreme changes in temperature or humidity, will function perfectly under the most exacting conditions. Its rugged construction permits of much rougher usage than the ordinary microphone will stand—and for a slight additional cost it can be completely waterproofed — thus assuring perfect performance in the heaviest downpour. Its output is considerably higher than similar Condenser Transmitters.

● The low price is made possible by efficient manufacturing methods — the materials used are of a quality comparable with those in much higher priced products. An unqualified guarantee against mechanical or electrical failure for one year is a condition of every sale.

● Folder "B3" will provide you with some interesting information on up-to-the-minute speech input equipment.

● Write for it—TODAY.

Type "B" Condenser Transmitter
Type "3-B" Microphone Amplifier

PRICES

Complete	$110.00
Type B. Transmitter only	75.00
Type 3-B. Amplifier only	35.00

Net F.O.B. Chicago

(Prices quoted include 25 foot cord, plugs and wall plate.)

●

International Broadcasting Equipment Company

3112 West 51st St., Chicago, Ill.

Manufacturers of a complete line of speech input equipment.

"OILDAG" AS A RADIO PARTS LUBRICANT

The moving parts of a radio receiving set are not provided with cups or ducts for the admission of lubricants.

In the assembly of the receiver, these parts are usually treated with a light oil or grease, thus providing the only lubrication the set receives.

The parts requiring lubrication such as variometers, variable condensers, and the automatic tuning mechanism are subjected to the elevated temperature usually existing within a receiver resulting from the heat generated by the vacuum tubes and resistances.

With constant use of these parts under such conditions, the lubricant is soon consumed. The controls cease to function smoothly and the resulting wear produces clearances which are undesirable and avoidable.

Concentrated "Oildag" manufactured by the Acheson Oildag Company, Port Huron, Mich., may be applied to the bearings, shafts, etc., either before or after assembly of the device. While most manufacturers prefer to apply "Oildag" to the parts with the aid of a brush during assembly, application may be made upon completion of the device by means of a squirt can equipped with a very fine nozzle.

It is recommended that the material be used in the concentration in which it is sold, although it may be blended with a neutral grade of mineral oil if a lubricant of different viscosity or lower graphite content is desired.

▲

NEW DUBILIER CATALOG

The largest and most elaborate catalog yet issued by the Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City, has just come off the press. Known as General Catalog 120, this interesting piece of literature covers the Dubilier line of mica and paper condensers for general radio and electrical purposes, ranging from the modest requirements of the receiving circuits to the giant units for radio transmitters and industrial applications. General purpose paper condensers, filter circuit condenser blocks, high-voltage paper condensers, paper transmitting condensers, replacement blocks, bare condenser sections, electrolytic condensers, mica condensers, r-f. transformers, light socket aerials, by-pass condensers, dry A condensers, mica transmitting condensers and interference prevention devices are described and listed in this catalog.

▲

HIGH GAIN I-F. UNITS NOW AVAILABLE

The DeJur-Amsco Corpn., 95 Morton St., New York, announces the production of an intermediate frequency amplifying transformer—the "Transitor"—for which a high order of electrical efficiency is claimed. The Transitor is made in three standard broadcast types, the variations being in the order of selectivity, and include a sharply tuned filter stage, a standard type and a very broadly tuned unit especially engineered for use in Stenode receivers. The Transitor is said to be characterized by an unusually high gain, and is the result of considerable laboratory research.

Under average circuit conditions the units may be peaked, by means of small semi-fixed condensers anywhere from 167 to 183 kilocycles. Literature describing the Transitor, containing curves and engineering data, may be obtained, upon request, from the manufacturer.

▲

PUBLIC-ADDRESS ON NEW SHIPS

The six new steamships of the United Fruit Company are to be equipped with modern sound distribution and public-address systems.

The installations will be engineered by C. A. McKee, communication engineer. The amplifier racks will be those of the Samson Electric Company.

CABLE EXECUTIVE OFFICES MOVE

In order to allow increased facilities for production at their plant located at 84-90 N. 9th Street, Brooklyn, N. Y., the Cable Radio Tube Company, have removed their executive offices to 230-242 N. Ninth St., Brooklyn, New York.

▲

R. C. SPRAGUE

President of Sprague Specialities Companies, Quincy, Mass., manufacturers of a high grade line of electrolytic condensers and of the Visavox Home Talking Moving Picture Machine.

A. B. AYERS

General manager of the Sprague Specialties Company, Quincy, Mass.

NEW POCKET SIZE REPLACEMENT GUIDE

Due to the increased demand for the serviceman's replacement guide put out this past year by the International Resistance Company, a second edition with additional pages has been placed on the market, but in a pocket size with a leatherette cover.

This new guide at the present time contains a few hundred circuits of radio sets manufactured in the past few years and is of considerable assistance to the servicemen in determining the proper resistor to use for replacement purposes. This guide will be sent free of charge with an order for 10 resistors, or can be bought for $1.00. This offer includes the cost of additionaal sheets and service helps which will be mailed to all owners of the guide each month.

The International Resistance Company is also giving away a R.M.A. color code chart with every order for a new replacement guide. This color code chart automatically gives the proper resistance value of any resistor that is colored in accordance with the R.M.A. Color Code, by rotating the necessary discs.

▲

ARCTURUS ANNOUNCES NEW LIST PRICES ON 3 TUBES

Announcement is made by Arcturus Radio Tube Company, Newark, New Jersey, that prices on the types 127, 551 variable-mu and PZ pentode tubes had been reduced. The new list prices on these tubes are Type 127, $1.25; Type 551, $2.20; Type PZ, $1.90.

"As promised in our price announcement of April 20," says C. E. Stahl, general manager, "we are reducing the pentode and variable-mu prices now when it is demonstrated that such reduction will not sacrifice quality. In introducing a new tube, the users's interest must be safeguarded through costly processing until all possible hazards in manufacture are determined and conquered.

"This latest action left the type 127 as the only tube not conforming with universal lists. Although this tube was individualized by its special features, it was still thought advisable to reduce the list price, so that it is now available at competitive prices."

▲

PERPETUAL RADIO REFERENCE DATA

Technical men and technical organizations are displaying a great deal of interest in a new addition to the vast amount of radio literature available upon the market. This latest work is by John F. Rider.

There has been a definite need among technical men and technical schools and libraries for a coordinated compilation of radio receiver data, starting with the time when radio receivers became popular. The closest equivalent to this book by Mr. Rider is the compilation of ignition systems in the automotive industry. Perpetual Radio Reference Data is a compilation of radio receiver circuits encompassing the popular radio receivers and associated devices produced by the prominent radio manufacturers of this country. In fact it is a sort of a technical history of the radio receiver industry. At the same time it is a volume which includes all data of value in connection with any one particular radio receiver.

The conventional schematic wiring diagrams are accompanied by associated data such as chassis layouts, electrical values of the various parts, color coding, arrangement of the sockets, voltage data, etc. Recognizing that a number of accessories are part and parcel of the radio receiver industry, the author has included and treated in similar fashion, battery eliminators, power units, power amplifiers, testing equipment related to radio receivers and kit receivers.

A copy of this work should find a point of vantage in every technical library and in the file of every radio technician and engineer.

The book is of loose leaf character, bound in a stiff imitation binder.

Coils made to fit production schedules

When inventories are held to a minimum against fluctuating sales, there are times when you will want coils *in a hurry.*

Nevertheless, you will want each one to be as perfect as modern coil manufacture can make it.

Under such circumstances, as well as for all normal requirements, General Cable can serve you to great advantage. The extensive coil manufacturing facilities of Dudlo and Rome combined; the experience gained in the manufacture of millions of radio coils; the unlimited source of magnet wire enables General Cable to accelerate production rapidly—by means of turning more productive capacity—trained operatives, machines, materials—into coil production for *you.*

Equal to the capacity to wind coils is General Cable's capacity to inspect and test them. General Cable Coils measure up to General Cable standards, irrespective of the quantity being produced.

Coil service like that—dependable, flexible, fast—favors profitable operation on your part.

●

GENERAL CABLE CORPORATION

EXECUTIVE OFFICES: 420 LEXINGTON AVENUE, NEW YORK • OFFICES IN PRINCIPAL CITIES

"Projection Engineering"

The Journal of the "Sound" Industries

Published monthly, and dealing with the manufacture, engineering, service, installation and operation of public address systems, centralized radio, theatre talkies, home talkies. Covering the subjects of design, production, materials, acoustics and the practical problems encountered by field engineers, contractors, installation men and service men.

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PAID
CIRCULATION
OVER 9,000
in the
Electronic
or
"Sound" Industries

A PRESENT MARKET OF PROVEN AVAILABILITY

Public Address
Sound Amplifiers
Sound Recording
Sound Pictures
Home Talkies
Visual Projection
Sound Reproducers
Acoustic Engineering
Automatic Music
Photo Tubes
Amplifier Tubes
Industrial Sound Applications
Industrial Visual Applications

Projection Engineering, with a paid A.B.C. Circulation of over 9,000 engineers, executives, technicians, contractors, service and installation men and projectionists, has the largest paid circulation of any publication among the *new*, radio associated, electronic or "sound," industries.

The editorial staff is headed by Donald McNicol, past president of the I. R. E.

The subscription rate is $2.00 a year (no newsstand circulation)—$3.00 for 2 years. ($3.00 yearly in foreign countries.)

Published by the

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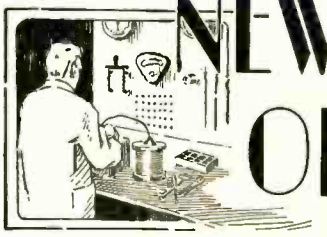
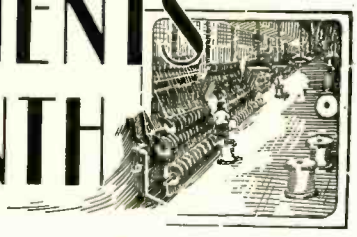


NEW DEVELOPMENTS OF THE MONTH



RIBBON METAL CUTTER FOR SOLID RIBBON OR MESH

Cutting thickness—from .001" to .025", Cutting widths—from 1/16" to 1¼", Cutting lengths—adjustable 1/64" to 3¼", Production—75 to 150 per minute, depending on length.

MACHINE NO. 110-H F

H. P. ¼, 1750 r.p.m. with reduction gear drive, net weight—300 lbs., gross weight—425 lbs., crated, boxed for export weight—575 lbs., box dimension—52" x 36" x 25". This cutter is manufactured by The Eisler Electric Corpn., 744 S. 13th St., Newark, N. J.

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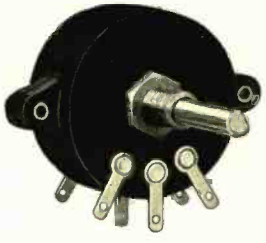
CENTRALAB CONTROLS

The Central Radio Laboratories, 900 Keefe Ave., Milwaukee, Wis., are marketing Junior Controls with 110 volt switch attached. The Centralab Twin Junior has



two resistances completely insulated from each other and from the shaft and bushing.

▲

CONDENSER TRANSMITTER

Jenkins and Adair, Inc., Chicago, Ill., announce for broadcasting, recording, announcing and sound measurement work, condenser transmitter Type D. This is a dependable instrument with no background noise, no blasting, and of low upkeep.

A DEPENDABLE RHEOSTAT

The Superpower Clarostat Variable resistor here illustrated and manufactured by

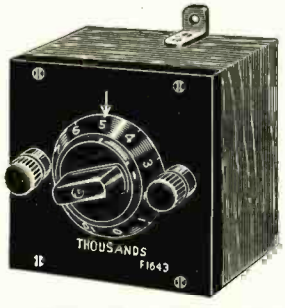
the Clarostat Company, has a high current carrying capacity. It is employed as a line voltage control, filament and plate control for transmitters, and speed control for motors up to ¼ h.p.

▲

PRECISION RESISTANCE BOXES

Herewith is illustrated a standard resistance box for testing and laboratory uses and for communication terminal office purposes.

The coils are from 10,000 ohms to 1 ohm inclusive and non-inductively wound on insulated metal tubes. One-tenth and one-one-hundredth units consist of ribbon bent



back on itself. The resistance wire and ribbon used is double silk covered manganin which has a negligible temperature coefficient. All units are properly aged, treated in bakelite varnish and finally adjusted for accuracy.

This practical and accurate resistance box is manufactured by J. H. Bunnell & Co., 215 Fulton Street, New York.

▲

PLATE RESISTANCE AND MUTUAL CONDUCTANCE METER

This instrument, Type VE8, has been designed to measure the important static and dynamic characteristics of all present types of receiver tubes including pentodes. It embodies the important feature of permitting a rapid and accurate means of measuring directly the plate resistance, as well as the mutual conductance of screen-grid tubes. The instrument contains provisions for obtaining tube characteristics with known adjustable voltages to all elements, with known current to all elements, and with a variable external load. Tubes may be measured with a plate supply up to 500 volts at 100 milliamperes, and with a filament supply up to 7.5 volts at 3 amperes. An added feature is that this instrument may be readily used to accurately determine the impedance of choke coils with a known amount of d-c. in the winding and also to measure the a-c. resistance of resistors.

Mutual conductance can be measured quickly and accurately from 5 to 10,000 micromhos, and plate resistance up to 5 megohms. Mutual conductance is read directly from a meter and the plate resistance from a decade resistance box. The accuracy of calibration is within 2 per cent. A standard signal is provided for checking

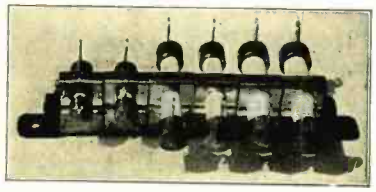
and adjusting calibration. Binding posts are provided for using external meters to measure the voltage and current supplied to the tube under test. This instrument is enclosed in a walnut finished cabinet 32½ inches x 11 inches x 17½ inches.

This instrument is being marketed by the RCA-Victor Company, Camden, N. J.

▲

MOULDED GANG RESISTOR

Simplicity, convenience and low cost, together with compactness, mark the rather novel type of gang resistor just introduced by the International Resistor Company of Philadelphia, Pa. Briefly, the usual metallized resistor with ceramic body and cast metal ends including soldering lugs, is provided with a special cast metal center support so that the resistor may be mounted, along with any other combination of resistors, to form a gang resistor. Each unit is separate. The units are placed side by side and a rod is slipped through the aligned holes. End brackets and nuts on the rod complete the assembly. Any desired combination of resistors may



be assembled, with a choice of ½-watt, 1-watt and 2-watt units of any resistance value required. Thus the resistance network costs very little more than the total of the individual resistors, since the center support is cast at the same time as the cast metal ends.

TUBE CHECKER

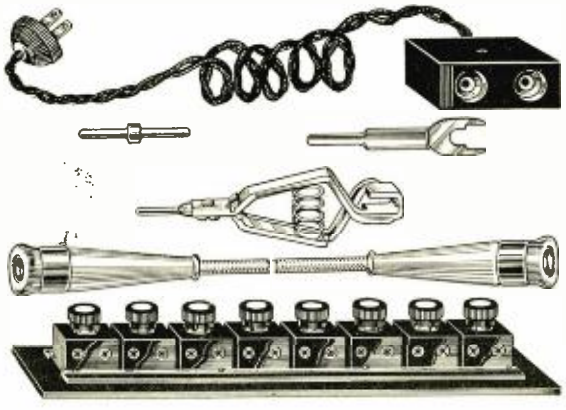
The Radio Products Company, Dayton, Ohio, is first on the market with a compact tube checker which will test all new types of tubes including the pentode, new 2-volt, new 6-volt, newer types of screen grid, as well as all other current types of radio receiving tubes. Six sockets are arranged, and are all conveniently marked so the dealer can quickly test tubes either at the store, or, since the instrument is small, and compact, at the user's home. Tests are made by means of four different colored test buttons. All technical language has been avoided. As was the case with previous DayraD tube checkers the new Type L DayraD self-biasing tube checker tests for end of life. short circuits. open circuits, etc. Dealer's price on this instrument is $27.60.

▲

LABORATORY RAPID WIRING SET

The electrical connecting equipment illustrated has been used for several years. Its practical utility has been proven. Many hours of time may be saved by its use, and in place of a jungled confusion of all kinds of wires, your laboratory will always have an orderly appearance.

Test cables have sockets at each end. Three lengths: 9, 18, and 36 inches. Coupling terminals make any socket a plug, or join two test cables together. Spade terminals permit coupling of instruments, etc., to test cables. Clip terminals permit coupling of wires, or irregular surfaces where other means are inconvenient. Junction blocks. One voltage brought to the block may be taken out in four test cables. Voltage may be printed on head of binding post and erased. Junction rack accommodates eight junction blocks. Test rack—Used for testing resistances, capacities, etc. Service cord —For 110 volt service current. Manufactured by the Howard B. Jones Company. Chicago, Ill.



Rapid wiring set.

NEW INVERTIBLE TYPE CONDENSER

The Elkon Division of P. R. Mallory & Co., Inc., announces the release of a new inverted type 8 mfd. condenser. This new type has all the outstanding features of the regular Elkon non-aqueous hi-volt condensers and differs only in that it conforms to the standard dimensions of the inverted round 8 mfd. type.

Elkon condensers have many features which appeal to the set manufacturer. As implied by the term "non-aqueous", they contain no free water; they can meet any d-c. operating voltage requirements up to 450 v. d-c.; low temperatures are not injurious; they can withstand without injury peak voltage of all properly designed sets; they are stable in operation to guard against electrical and mechanical variations that would affect the action of the circuit, and they have an extremely low normal rated leakage.

With the addition of the new inverted type 8 mfd. condensers, Elkon non-aqueous hi-volt condensers are now adaptable to all mounting arrangements in use by the set manufacturers.

▲

DONGAN ANNOUNCES SHORT-WAVE CONVERTER POWER TRANSFORMERS

Of interest to manufacturers who are planning to build short-wave converter receivers for the coming season is the announcement of a new type transformer designed and built by the Dongan Electric Manufacturing Company of Detroit.

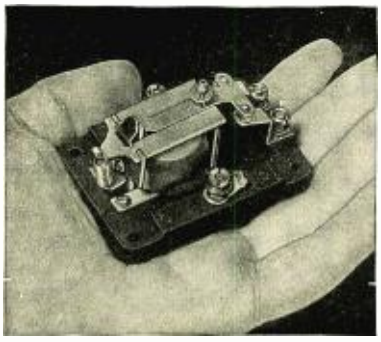
This company, huilders of transformers exclusively, has perfected a power transformer for use in short-wave converter receivers. A filter choke can be supplied where the design makes one necessary.

This new transformer is a small, compact unit, easy to attach and free of service troubles. Quite a number of these new transformers are already in operation and giving splendid service.

▲

STRUTHERS-DUNN ANNOUNCE LINE OF DUNCO MID-GETT RELAYS

The new Dunco line of miniature relays, to be known as "Mid-gett" is being made in eight contact arrangements by Struthers-Dunn, Inc., 142 N. Juniper St., Philadelphia.



They are on standard bases, and measure 1⅞ inches x 2¾ inches, and follow in detail the design of regular type Dunco relays, having the three-legged stool principle of construction, form-wound, moisture-proof coils, renewable contacts, accessible terminals, with moulded bases having a high dielectric.

They operate on from 6 to 120 volts a-c., or 24 volts d-c., depending upon the coil used.

These Dunco Mid-gett relays will be of particular interest to electrical manufacturers building equipment, as well as general remote control equipment where space is a factor.

▲

NEW JEWELL TUBE TEST PANELS

Accurate tube testing equipment that also combines attractive display value is offered the radio dealer in two new tube-sellers, announced at the R. M. A. Show, by the Jewell Electrical Instrument Company of 1642-U Walnut Street, Chicago, Illinois. Dealers all over the country have found that increases in tube sales can be secured by installing tube testing equipment which builds customer confidence. The Pattern 535 tube-seller has a black panel 30 inches high by 28 inches wide, on which are mounted an 8½-inch meter for indicating tube test readings. a smaller meter to show when the line voltage adjustment is properly set, preheater and short check sockets and short indicating lights, and a separate test socket for each type of tube.

The Pattern 535 tube-seller is suited for wall mounting.

SMALL METERS

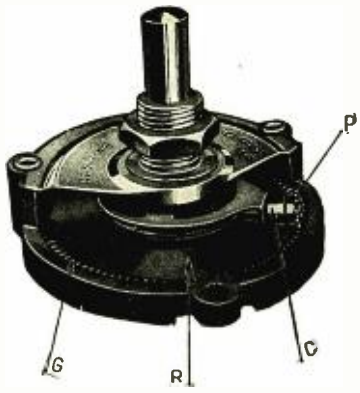
The General Electric Co. has recently announced a new line of small size portable instruments types AS3 and DS3. The small dimensions 5¼-inches x 3½-inches x 1⅞-inches permit the instruments to be easily carried in a coat pocket. They are particularly adapted to general testing and checking work where portability is an essential requirement. The case is of moulded compound with hinged cover and snap lock, finished in brownish red or black with nickel trimmings. Direct-current instruments operate on the D'Arsonval principle and alternating-current instruments on the

repulsion vane principle. Instruments with copper oxide rectifiers are also supplied for a-c. and d-c. service. The copper oxide rectifier instrument has the advantage of being a high resistance instrument for use on a-c.

▲

VOLUME CONTROLS

The Clarostat Manufacturing Company, Inc., 285 N. 6th Street, Brooklyn, N. Y., offers a graphite unit which includes a positive rolling contact. A rotating movement is given to the roller contact (c) by means of a small pinion (p) attached to the contact roller, engaging gear track (g)



moulded in the periphery of resistance element (r). Turning the knob imparts a rotary motion to the contact arm. A smooth, positive contact is assured over the length of the resistance surface.

▲

TOOTHPICK TYPE TRANSMITTING CONDENSER

The popularity enjoyed by the metal-clamped toothpick mica condenser as met in certain superheterodyne and tuned r-f. receiving circuits, has resulted in the development of a larger version for use in transmitting and other high-voltage circuits. The Dubilier Condenser Corporation of New York City now announces the Type 704 or large sized toothpick condenser for radio telegraph and telephone transmitters, carrier current work, Tesla coil high-frequency circuits, and electro-therapeutic applications.

The Dubilier Type 704 condenser is of the mica dielectric type, rigidly and permanently held by a brass clamp casing. The design assures a predetermined pressure or definite capacity, constantly maintained, even over an extremely long temperature range. The unit will handle 2 amperes at 140 meters, and has an effective a-c. voltage rating of 2000. It is exceedingly compact and neat, the protruding tinned plate tabs permitting of soldered connections. The unit measures 2½ inches long by 17/32 inches wide by 21/64 inches thick. The design permits of vastly improved characteristics over the usual moulded condenser of equivalent voltage rating. The production cost is low, being reflected in attractive low prices for quantity lots.

▲

NEW AUDIO BY-PASS CONDENSERS

Elkon audio by-pass condensers are the latest development of the Elkon Division of P. R. Mallory & Co., Inc., Indianapolis, Ind. The outstanding features of these new audio by-pass condensers are small size, compactness and efficient operation with a range of capacities and voltages from ½ mfd. to 8 mfd. up to 150 volts and ¼ mfd. to 2 mfd. up to 450 volts. Outside dimensions of the condensers range from ½" x ½" x 2" to 1" x 1" x 2". The outer covering consists of the same type of sturdy, wax-dipped cardboard carton which is being used so successfully on the regular Elkon non-aqueous hi-volt filter condensers. Special mounting

bands are available for manufacturers who wish to mount the by-pass condensers on the chassis.

Although the Elkon audio by-pass condensers have just been officially announced, Elkon reports that two of the leading set manufacturers have already completed their tests and are specifying these condensers for regular production.

▲

SPECIAL TRACKING CONDENSER FOR SUPERHETERODYNES

A ganged condenser combination designed to eliminate padding arrangements and from two to five extra parts in superheterodyne construction has recently been produced by the DeJur-Amsco Corporation, 95 Morton St., New York. A still further economy is claimed, resulting from the relative ease with which the oscillator circuit in the completed receiver may be adjusted.

The condensers are available in two, three and four gang units, comprising one special oscillator section and standard tuning sections. In utilizing this combination it is essential that 240 microhenry coils be employed in the preselector and first detector circuits and a 144 microhenry coil in the oscillator circuit. When properly and simply adjusted it is claimed that the tuning and oscillator circuits will track consistently 175 kc. apart.

▲

SMALL SIZE HAMMARLUND INTERMEDIATE CONDENSERS NOW AVAILABLE

A small size, double intermediate tuning condenser for use in intermediate transformer units in midget superheterodynes, has just been developed by the Hammarlund Manufacturing Company, 424 West 33rd Street, New York City. It measures only 1 15/16 inches in diameter and is available in capacity ranges of from 10 mmf. to 70 mmf.; 70 mmf. to 140 mmf., and 140 mmf. to 220 mmf. It is known as the MICD type.

The same unique constructional features embodied in the larger types are incorporated in this model. Treated isolantite bases, insuring moisture-proof characteristics, are used. Scleroscope tested phosphor bronze, selected mica films, solder dipped terminals, fibre "shock pad," and cut thread screws are among the features of this new condenser. They have ample space for coil mounting with excellent provision for capacity adjustment.

▲

CATHODE RAY OSCILLOGRAPH

The cathode-ray oscillograph is a well-known and justly popular laboratory tool for the observation and recording of phenomena, especially where high frequencies and very short time intervals are involved.

Because the "moving element" is a beam of cathode rays or electrons, it is inherently more suitable for most purposes than oscillographs of the string or moving-coil types. Distortions due to inertia and resonance effects encountered in vibrating mechanical elements are absent and, since the rays are usually deflected by electrostatic means, the power sensitivity is much higher.

This useful instrument is being marketed by The General Radio Company, Cambridge, Mass.

▲

AUTO-RADIO CONTROLS

The Premier Electric Company, 1802 Grace St., Chicago, is marketing a satisfactory automobile radio receiver control unit for attachment to steering columns. This new device is meeting with wide acceptance.

▲

JENSEN INTRODUCES NEW PERMANENT MAGNET SPEAKER

A permanent magnet speaker, to be known as the Jensen Model PM-1, and the first of a new series of electrodynamic speakers, designated as the Jensen Model J-1, were shown for the first time during the R.M.A. Trade Show by the Jensen Radio Manufacturing Company, Chicago, Ill.

The permanent magnet speaker, which, according ot Peter L. Jensen, president of the company, is electrodynamic in its tone quality and has the ability to handle great volume, is the result of eighteen months research and development work.

The design of the magnet is such that the entire speaker assembly is exceedingly compact, requiring little more space than an electrodynamic speaker of equal cone size. Its weight is considerably less than that of speakers of this type which have been offered to the manufacturers and trade up to the present time. The cone and moving coil structure follows that employed in the new Jensen electrodynamic speakers and is exceedingly sensitive. The Tym-Flex one piece molded cone, also of exclusive Jensen design and material, is used with the new Jensen PM-1 speaker.

According to Mr. Jensen, the executives of the company look for a large sale for this type of speaker in connection with battery operated receivers.

In reference to this sales possibility he said, "There are literally hundreds of thousands of people in the country who do not have electric current in their home but who would like to have a good radio receiver.

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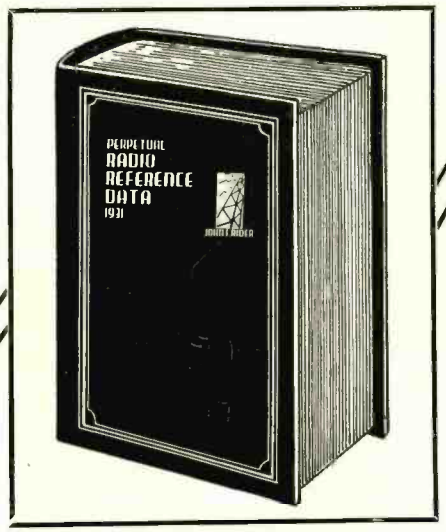

950 *Pages of* RADIO CIRCUIT DATA

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RADIO SCHOOLS

An idea of the contents can be had from this listing of the manufacturers represented in the various classifications. This list does not include the entire contents of the volume.

BROADCAST RECEIVERS (Amer.)

A. C. Dayton, Acme Apparatus, Acme Elec. Mfg. Co., Aero Products, All-American Mohawk, American Bosch, Amrad Corp., Andrea (Fada), Argus Radio Corp., Atwater-Kent, Audiola, Automatic Radio, Atchison Radio, Baldwin, Balkite, Brandes, Bremer-Tully, Browning-Drake, Brunswick, Buckingham, Bush-Lane, Case, Cleartone, Colonial, Columbia Phono, Columbia Radio, Continental Radio, Crosley, De-Forest, Delco-Remy, Earl, Edison, Electrical Research Labs, Emerson, Everready, Fansteel, Federal, Freed-Eisemann, General Electric, General Motors, Dayfan, Gilfallan, Graybar, Grebe, Grigsby-Grunow, Grimes, Gulbransan, Hammarlund-Roberts, H-F-L, Howard, Jesse French, Kellogg, Kennedy, King, Kolster, Lang, Leutz, Lincoln Radio, Magnavox, McMillan Radio, Montgomery-Ward, Murdock, Norden-Hauck, Operadio, Ozarka, Philco, Pilot, R.C.A., Reese-Mace, Silver-Marshall, Sonora, Sparks-Withington, Splitdorf, Standard, Steinite, Sterling, Stewart-Warner, Story and Clark, Stromberg-Carlson, Temple, Transformer Corp. of Amer., Trav-ler, United Air Cleaner, United Reproducers, U. S. Elect., U. S. Radio and Telev., Victor, Wells-Gardner, Westinghouse, Wholesale Radio Service, Wurlitzer, Zenith.

BROADCAST RECEIVERS (Can.)

Canadian Marconi, Canadian Westinghouse.

TEST EQUIPMENT

Weston, Jewell, Supreme, General Radio, Radio Products, Readrite, Sterling, Hickock.

POWER AMPLIFIERS

Amertran, Electrad, Ferranti, General Radio, Grebe, Jenkins and Adair, Kolster, Major Labs, Pilot, R.C.A.-Victor, R.C.A. Photophone, Samson, Silver-Marshall, Thordarson, Western Electric.

ELIMINATORS AND POWER UNITS

Abox, Acme Apparatus, Airex, All-American Mohawk, American-Bosch, Amertran, Amrad, Fada, Balkite, Farrand, Freshman, Freed-Eisemann, General Motors, (Dayfan), Grebe, Grigsby-Grunow, General Radio, Jefferson Elec., Mayo Labs., Philco, Pilot, R.C.A.-Victor, Silver-Marshall, Thordarson, Todd, Valley.

SHORT WAVE and KIT RECEIVERS

Aero Prod., Browning-Drake, Deforest, Experimenters Information Service, Fenway, Grebe, Gray and Danielson, Hammarlund, Hatry and Young, H-F-L, Karas Elec., Lacault, Leutz, Madison-Moore, Magnaformer, National Co., Pilot, Radiart Labs, Radio Engineering Labs, Raytheon, Remler, Rim Radio, Scott Transformer Co., Short Wave and Television, Silver-Marshall, Sleeper, Tyrman, Walker (Victoreen).

John F. Rider's **PERPETUAL RADIO REFERENCE DATA** is a loose leaf library of radio receiver circuits encompassing practically ALL commercial broadcast receivers manufactured since the popularization of radio. This volume has been adjudged the *greatest compilation* of radio receiver data ever presented to the radio industry.

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This is not a book covering the theory of radio. It is the greatest library of radio circuits ever published and is used as a reference book by many radio schools, manufacturers, engineers, research laboratories, technical libraries, colleges, vocational schools, etc. It has been found of inestimable value because this vital data is available under one cover. The simple, quick index makes it possible to locate data concerning any one receiver with minimum waste of time and effort. No more searching through ever mounting piles of magazines.

A panorama of its users covers the entire radio field from the student in a radio school to the legal department of the manufacturer. If you have any interest in radio receiver design past or present, this loose leaf volume should be in your library. It is a technical history of radio receivers. The pages are 8½ by 11 inches. The drawings are clear. Everything is legible.

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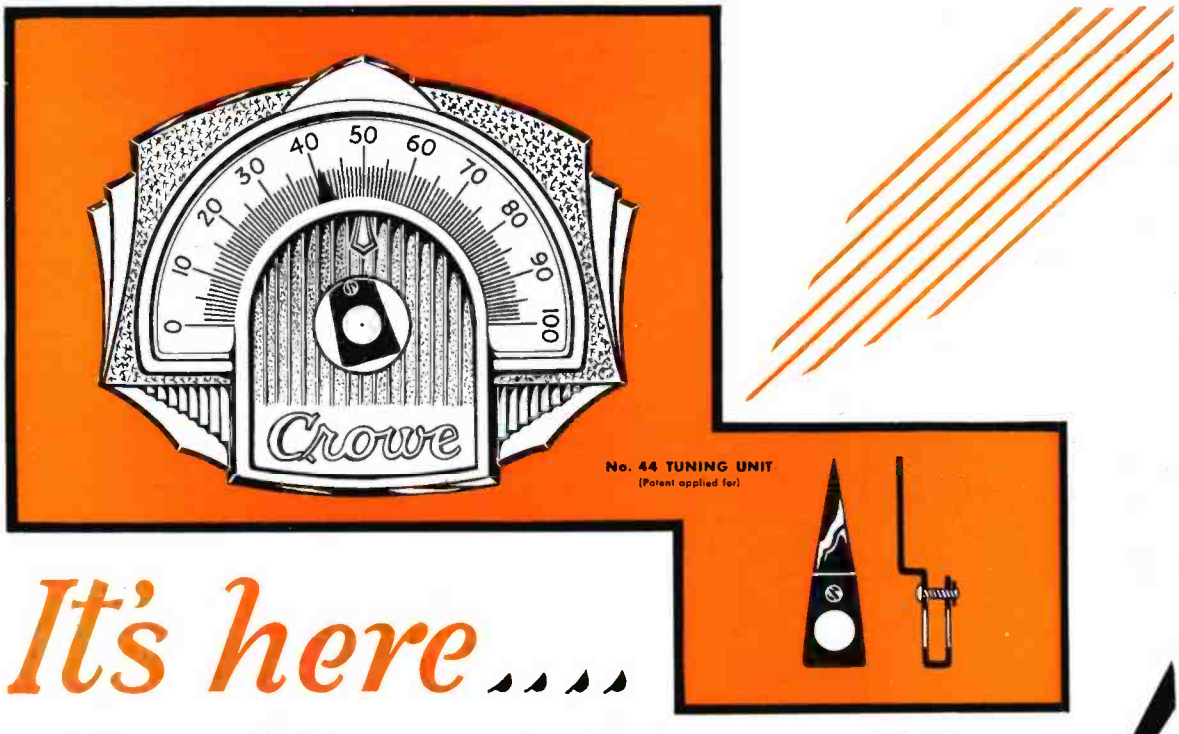

No. 44 TUNING UNIT
(Patent applied for)

It's here....

the No. 44 Tuning Unit!

FULL VISION—DIRECT DRIVE.

The No. 44 Full Vision Direct Drive Tuning Unit shown above is the popular-priced answer to an immediate and pressing need in the Radio Industry. Although only a few have seen it, yet their enthusiasm for its trim design indicates that it is a "winner" and will enjoy great popularity. • • • • Only three pieces—a bronze escutcheon, a pyralin scale, and a metal pointer—make up the No. 44. The pyralin scale may be had in either ivory or tan, with scale running in either direction. The pointer (illustrated directly above) is furnished to fit either one-fourth or three-eighths inch shaft. An enlarged hole around the shaft provides for reflected lighting if so desired. The back of the unit may be coated with white for lighting efficiency at a slight extra cost. • • • • Many of the name dies used in 1930 can be used on the No. 44 escutcheon. Other styles of this type unit are available . . . samples on request.

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Bakelite Molded panel used on the Radio Set Analyzer made by Jewell Electrical Company, Chicago, Ill.

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from attractive Bakelite Molded

Panels similar to the one used on the Jewell radio set analyzer present difficult problems of design and manufacture. Efficient electrical insulation is a primary requirement, but the real difficulties lie in the intricacies of the design and necessity for accuracy. Fine appearance is likewise of considerable importance and often has a favorable effect on the salability of the device.

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