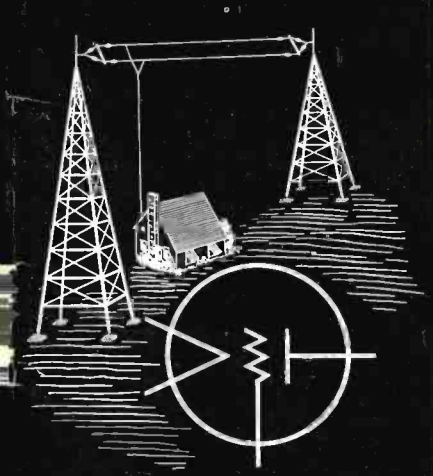
DECEMBER, 1933

Radio Engineering



IN THIS ISSUE

VOL. XIII NO. 12

NRA
WE DO OUR PART

The Journal of the Radio and Allied Industries

illustrations courtesy of RCA RADIOTRON CO., INC.

SVEA METAL is ideal for *Mass Production!*

Quality and economy are the watchwords of modern large scale operations! Great business organizations owe their success and reputation to the fidelity with which they guard the most minute details of method and materials. First come research and design, then precision equipment, carefully executed plans for production and tested raw materials. These insure quality!

For profit there must be efficiency in operation and the uniformity, reliability and adaptability of all basic materials to the processes. Last, but not least, a reasonably low cost is essential and where this can be combined with a product of highest purity and quality, it is ideal.

After design and skilled workmanship, nothing so determines the quality of a radio tube as the materials from which it is made! If the tube is the heart of the set, then the metal in the tube is the heart of the tube.

The best technical talent agrees that shrinkage in production and other tube difficulties are decreased in the same measure as materials of greater purity are used in their fabrication. But purity alone is not enough! The metal must be uniform in structure and temper—it must be gas free—have high heat resistance —excellent conductivity — lightness in weight—ease of forming and welding! It must be dependable—always the same!

Swedish Iron & Steel Corporation

17 Battery Place — New York City

NRA WE DO OUR PART

For more than a quarter of a century suppliers of high grade metals to the foremost electrical equipment manufacturers.

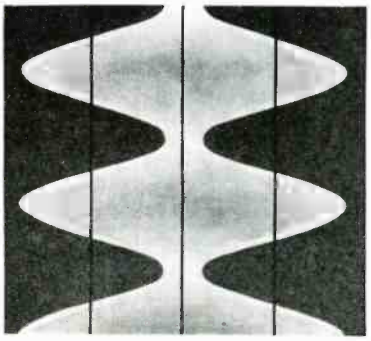
No More Blindfold Broadcasting

★

The 1-D Transmitter Lets You Know What Is Going On

★

These two devices allow you to operate with maximum efficiency and best quality all of the time. They are built-in the RCA Victor 1-D, 1 Kilowatt transmitter.

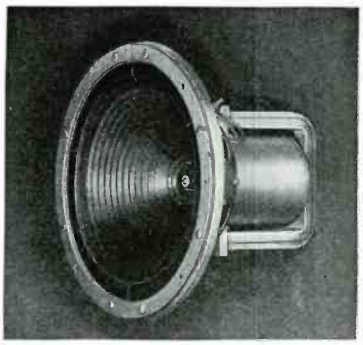


CATHODE RAY MODULATION INDICATOR

A number of broadcasting stations have found that their signals were weak because the percentage of modulation was low. Others had distorted signals due to consistent over modulation. If there is no way to tell, this is likely to happen.

But in the 1-D transmitter, the cathode ray tube indicates continuously and instantly the percentage of modulation. Over-modulation and under-modulation can be easily avoided. Hence the 1-D transmitter will operate at maximum efficiency.

HIGH QUALITY MONITOR SPEAKER



No longer will it be necessary to go to an outside radio set and listen in order to check quality. A new high quality loudspeaker, reproducing the high frequencies, operating from the transmitter output, permits monitoring of the program exactly as it sounds on the air. Distortion shows up instantly.

This high fidelity speaker is built in the 1-D Transmitter and lets the operator know how the radio audience should receive the station. It provides the ultimate check on quality.

RCA VICTOR COMPANY, Inc.

CAMDEN, N. J., U. S. A.

"Radio Headquarters"

New York: 153 E. 24th St. Chicago: 111 N. Canal St. San Francisco: 235 Montgomery St.
Dallas: Santa Fe Bldg. Atlanta: 144 Walton St. N.W.

RADIO ENGINEERING

Reg. U. S. Patent Office

MEMBER AUDIT BUREAU OF CIRCULATIONS

Editor
DONALD MCNICOL

Managing Editor
F. WALEN

Vol. XIII | DECEMBER, 1933 | Number 12

Contents

Departments

STRAIGHT TALK

JUDGE John W. Van Allen, counsel to the RMA, in an address in Chicago recently, said, in part:

"Somehow, we feel that the public does not fully understand the full significance of a properly engineered, properly manufactured, properly serviced receiving set nor the necessity of a fair price therefor nor that high quality and fair priced merchandise is compensated for by the satisfaction it gives in radio reception.

"Doubtless, we have not fulfilled our full responsibility in this respect and are partly at fault about it by emphasizing devices having small effect on quality and performance instead of emphazising the fine things to be heard and enjoyed in music, sports, current events, drama and the like by the greatest talent the country has through the ownership of a fine set.

"We feel that some great act on our part is necessary in the coming year, which shall emphasize quality and performance and service over small price and that satisfactory reception at the proper cost is more to be desired than cheapness. In no other way will the radio listeners be able to fully enjoy the great programs now being delivered over the air by their sponsors."

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

Published Monthly by the
Bryan Davis Publishing Co., Inc.
19 East 47th Street
New York City

SANFORD R. COWAN
Advertising Manager

A. B. CARLSEN
Circulation Manager

Chicago Office—919 N. Michigan Ave.—L. F. McClure, Mgr.
Cleveland Office—10515 Wilbur Ave.—J. C. Munn, Mgr.
Philadelphia Office—1513 N. 13th St.—H. S. Thoenebe, Mgr.
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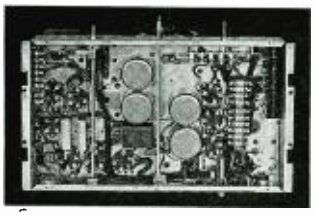
Wellington, New Zealand—Tearo Book Depot.
Melbourne, Australia—McGill's Agency.

Entered as second class matter August 26, 1931, at the Post Office at New York, N. Y., under Act of March 3, 1879. Yearly subscription rate $2.00 in United States. $3.00 in Canada and foreign countries.



Where fastenings are made in hard-to-get-at places

Self-tapping Screws cut time and cost in half

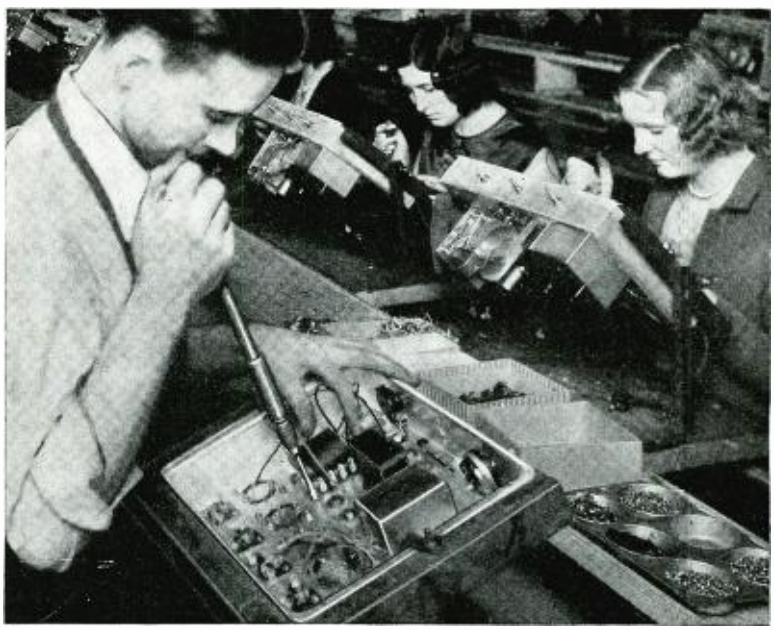
IN making hard-to-get-at fastenings these unique Screws have no equal. Driven like a wood screw . . . forming a thread in the metal as they are turned into a plain hole . . . Parker-Kalon Hardened Self-tapping Sheet Metal Screws offer the only real speedy, simple, cheap way of making sheet metal assemblies in cramped places.

It saves time . . . costs much less to use these famous Screws instead of common devices. You avoid the fumbling and poor fastenings that go with riveting and bolts and nuts. You eliminate the tapping operations, tap plates, stripped and crossed threads and difficult starting involved in the use of machine screws.

Practically all radio manufacturers have gained lower assembly costs by using Parker-Kalon Hardened Self-tapping Sheet Metal Screws for attaching parts to chassis. Among them are — Atwater-Kent, Crosley, Philco, R.C.A.-Victor, Stewart-Warner, Sparton, Stromberg-Carlson, Wurlitzer.

See tight engagement of Self-tapping Screw.

Note loose fit of machine screw in tapped hole.



Stronger Fastenings, too

Under stresses of tension, shear and vibration Self-tapping Screws hold better than the ordinary devices—machine screws and bolts and nuts. It's easy to see why when you look at the microphotographs here. The obviously tighter engagement of a Self-tapping Screw means greater security.

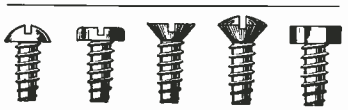
Try Self-tapping Screws, Free

Find out for yourself how much easier, quicker and cheaper it is to make fastenings with these Screws. Use the coupon to get a FREE "Money-Saver Test Bag" of samples with our unbiased recommendations.

Where and How to use them

Parker-Kalon Hardened Self-tapping Screws

For making fastenings to sheet metal up to 6 ga., aluminum, die castings, Bakelite, etc. Turn Screw into drilled, pierced or molded hole. It forms a thread in the material as it turns in. Can be removed and replaced. Available in a full range of diameters and lengths, and 5 styles of heads as shown below.



PARKER-KALON *Hardened* Self-tapping Screws

PAT. IN U. S. AND FOREIGN COUNTRIES

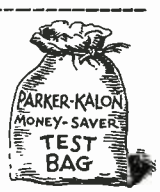
PARKER-KALON CORPORATION, DEPT. L, 190-198 VARICK STREET, NEW YORK, N. Y.

Tell me whether assemblies described on attached sheet can be made cheaper with Self-tapping Screws. I'll make a "Money-Saver Test" if you send samples and recommendations—Free.

Name and Title .....

Company .....

Address .....



Editorial

DECEMBER, 1933

500 KW. AT WLW

IT was inescapable that there should be apprehension anent the impending 500 kilowatts to be impressed upon the supposedly already saturated "ether" by the new WLW. Fear has been expressed that there may be a broadness of signal with consequent blanketing of receiver dials, particularly within a hypothetical "brute force" zone of influence of the station.

The situation is a duplication of what was experienced eight years ago when the 30 k.w. WJZ installation was placed in operation at Bound Brook, New Jersey. At that time a wave of complaints followed immediately upon the opening of the station—from the region within 20 miles or so of the transmitter. Due to the status of the receiver art at that date the operating company found it advisable to take steps to appease the local listeners-in, by devising wave traps suitable for each type of receiver in use in the disturbed area.

This experience with high power did much to center attention upon the feature of selectivity in radio receivers, with early beneficial results.

With the progress that has been made during the past several years in designing transmitters which may be made to function very closely on assigned frequencies, there should be no unanticipated difficulties at WLW.

Incidentally, the increased power of the station will present opportunity to gather practical data with respect to the factors of hysteresis losses, eddy current resistance, and corona loss at the largely increased output power.

◆

THE QUASI-OPTICAL CHANNELS

OSCILLATIONS of a frequency of 10^8 cycles per second and higher, corresponding to wavelengths below ten meters are in their nature quasi-optical, and, disregarding the influence of diffraction, their range is limited to that of visibility between the radiation source and the point of interception. For signaling purposes these oscillations have an advantage not possessed by light rays in that they penetrate fogs and clouds without unit loss.

Notwithstanding that various experimental and commercial radio services now make use of high-frequency channels in this spectrum area, it is plainly suggestive to an habitual listener-in, equipped for wide exploration, that much telephone, telegraph and signal traffic now being handled in bands between 10 kc. and 30,000 kc. could be shifted down to the quasi-optical territory. Fixed or mobile stations which have no occasion to communicate with each other distances in excess of the quasi-optical range, no doubt in time will be sorted out and removed from channels of communication which reach out far beyond the locale of their useful employment.

◆

TUBE ANODE VOLTAGE

UNLESS they have had a considerable amount of experience, designers of radio receiver circuits sometimes wonder why they are able to obtain satisfactory reception results when the anode voltage of a screen-grid tube is not close to the value noted in the characteristics. The unimportance of the discrepancy will be understood when it is noted that in the case of the s-g. tube, and the a-c. pentode, current is controlled almost exclusively by the s-g. voltage.

◆

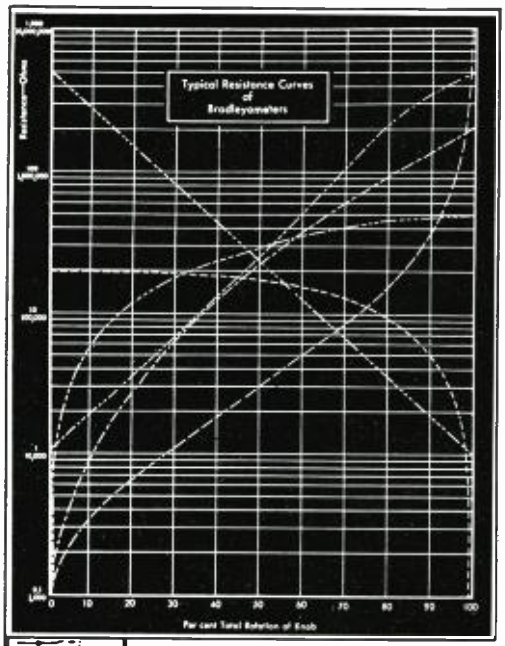
BROADCAST TIME FOR EDUCATION

THERE are broadcast listeners given to the habit of endeavoring to identify the purpose animating particular broadcasts. The Federal Radio Commission and the large broadcasting companies have been generous to a fault in providing preferred time on the air for educational authorities and organizations. much of the content of the broadcasts which may be identified as educational has been favorably received by the public. But, of late there have been various subtly staged round table discussion broadcasts, as well as addresses by national education paid officials loaded to the last syllable with propaganda of the sort sent out by special interest lobbies, which latter have the saving grace of not attempting to hide their identities.

Taking advantage of a good thing will not, in the long run, bring desired results.

Donald McNicol

Editor



Quality

• in Flexibility

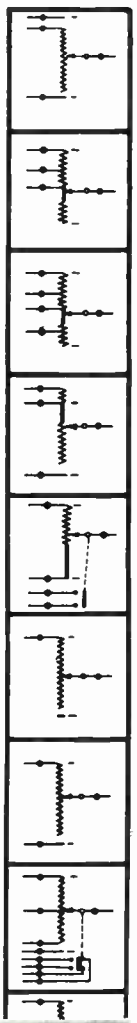
The Bradleyometer, by virtue of its unique resistor element which is not obtainable in any other control, can be supplied with practically any resistance-rotation curve for over 100 different connection combinations.

• in Performance

The design of the resistor element together with the precision manufacturing methods used in its construction result in an output of Bradleyometers of unequaled uniformity. This, in turn, assures a continuous output of radio receivers of optimum performance.

• in Workmanship

Carefully selected raw materials, precision manufacturing methods, and continuous checking of production processes guarantee long life and de luxe performance for all Bradleyometers.

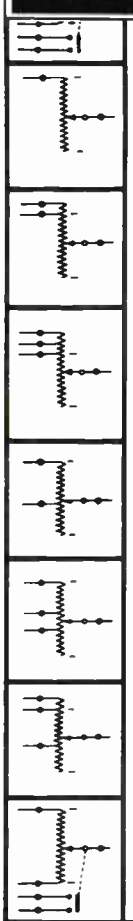


Volume Control De Luxe

The Bradleyometer, now available in over 100 circuit combinations, represents the highest attainment in variable resistors for volume control, tone control, and automatic tone correction with volume control. Allen-Bradley engineers, foremost in the field of rodio resistor design, have pioneered in the development of this volume control de luxe.

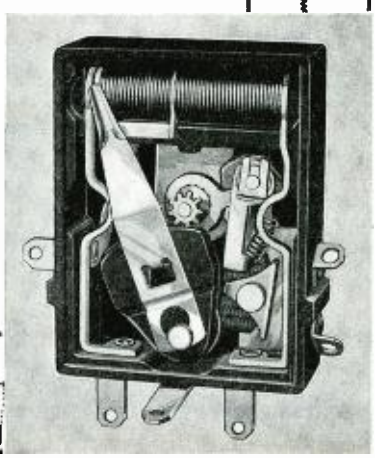
The slight extra cost of the Bradleyometer adds immeasurably to the quality of the receiver. Make your receivers outstonding in performance by using the Bradleyometer—the Volume Control De Luxe. Let Allen-Bradley engineers send you performance data, today.

Allen-Bradley Co., 126 W. Greenfield Ave., Milwaukee, Wis.

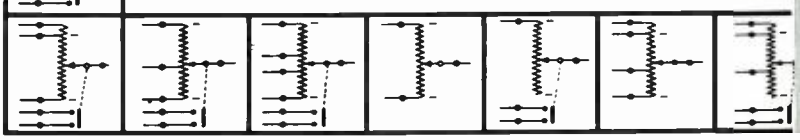


A Quiet A. C. Relay for Remote Control

Allen-Bradley scores another triumph in this new quiet A. C. remote control relay for radio receivers. When operated by remote control, this relay connects or disconnects the main power pack circuit of the receiver. Send for specifications and prices today.



BRADLEYOMETER



RADIO ENGINEERING

FOR DECEMBER, 1933

Of interest to all in the industry

RADIO SHOWS IN 1934

THE show policy for the radio industry was considered at length at the RMA board meeting held in Chicago on November 8, including considerable sentiment for revival of the annual RMA trade show. Instead of a trade show, however, the board decided that the RMA would hold two large public shows, in New York and Chicago, in the fall of 1934. It was decided that the shows would include electrical household apparatus as well as radio. The shows will be timed to stimulate fall buying and will also have events for jobbers and dealers, including meetings of the RMA and other trade organizations.

RMA directors J. Clarke Coit of Chicago, James M. Skinner of Philadelphia, and Bond Geddes, RMA executive vice-president and general manager, were appointed by the board as a committee of arrangements for the association's public shows.

◆

IS THERE TO BE ANOTHER NETWORK?

WHILE Ed Wynn's project of establishing a new broadcast chain languishes, there are reports that George F. McClelland, for some seven years past vice-president of NBC, plans to establish a new chain operating on the mutual principle. The idea is for each member station to be independent, being compensated for its expense in broadcasting chain programs.

It is expected that the name of the system will be announced shortly.

◆

MOBILE RADIO EXPANSION

THE totals of mobile radio receiver requirements for 1934 are likely to be sharply increased in view of expansion movements now afoot. In New York and other cities, in November, taxicab companies experimented with trial installations of receivers in commercial cabs. The innovation appears to have proved so popular that the cab operating companies early discovered that cruising cabs equipped with the radio music boxes were the ones most often hailed to the curbs by prospective passengers.

The lone passenger in a taxicab no longer must remain prisoned with his own thoughts. An uncommunicative taxicab companion no longer need be an embarrassment; the garrulous taxicab companion may henceforth be silenced by a command to "listen."

◆

WHO WOULD BE WITHOUT A RADIO RECEIVER?

IT is stated that arrangements have been made by NBC, through substantial direct money contribution toward the support of the Metropolitan Opera Company, New York, to broadcast from the stage during the fourteen-week opera season.

A pre-season broadcast will go on a network on the afternoon of Christmas Day, when the performance of Hansel and Gretel will be presented.

Mr. O. B. Hanson, manager of technical operations and engineering for NBC, has worked out technical details making possible a high grade of pickup and transmission during performances. Ten microphones will be mounted in the wings, footlight space and on the proscenium arch, so placed as to miss no note or word no matter what the position of the artist may be on the stage.

The pickup control apparatus will be in a parterre box, while the commentator will be in a glass-inclosed ante-room from which position he can view the action, and describe it to the radio listeners.

◆

HIGHER POWER FOR CLEAR CHANNELS

ON the heels of the Federal Radio Commission's recent decision to grant authority for clear channel broadcast stations to employ 50 kilowatt transmitters, come announcements of applications approved.

Clear channel stations authorized to move up into high power company are WGN, Chicago; WBF, Boston; WHAM, Rochester; WBT, Charlotte, and WHAS, Louisville.

Applications are pending from WMAQ, Chicago, and KNX, Hollywood.

In granting the applications for the use of 50 kw. the commission states that in the case of the clear channels the higher powers will result in more efficient use of the assigned frequencies.

At the present there are twenty-two stations entitled to use the maximum power so far sanctioned by the commission, several of them sharing time during night hours.

O. B. HANSON
Manager of NBC Technical Operations and Engineering.

National Broadcasting Company's

NEW STUDIOS IN RADIO CITY, NEW YORK

By O. B. Hanson

IT would be quite in keeping with what follows to begin this with "once upon a time," for the National Broadcasting Company's new home in Radio City is quite as fabulous as any palace ever described by Grimm or Lang, quite as fantastic as any air-castle ever built in day-dreams.

Ten stories, 400,000 square feet of floor space, built especially for radio broadcasting, filled with the newest and most improved devices of their kind—a "world center," for what takes place within these walls is heard round the world, is of interest to you and to me, to our neighbors, our fellow-countrymen and those in other lands, even to those inhabiting the "narrow corners" of the earth!

Radio itself is as fabulous as Prince Housan's magic carpet of Arabian Nights fame—more so as it can fly completely around the world seven times in one second. How it is done, what is necessary for the doing and how these facilities have been provided reads like a fairy tale.

Rockefeller Center is a cultural and entertainment center of unsurpassed size, beauty and grandeur occupying three New York City blocks, from Forty-eighth to Fifty-First Street, and extending from Fifth Avenue to Sixth.

Rising to a height of seventy stories. eight hundred and thirty-six feet, in the midst of this community stands the Central Tower of Radio City, The RCA Building. In this are housed the studios, offices and equipment of the National Broadcasting Company.

The creation of Radio City was magnificently timed. The National Broadcasting Company's activities have been growing as fast as Jack's beanstalk. What seemed spacious accommodations when we started business seven years ago had become uncomfortably cramped. At 711 Fifth Avenue we had ten studios—but for every hour of broadcasting there is now an average of seven hours of rehearsal and there must be time to clear studios of one program and prepare them for the next. There are at least two programs being broadcast simultaneously in our studios from eight a.m. to one a.m., three hundred and sixty-five days in the year. Frequently we broadcast programs of purely metropolitan concern which are of no interest to the stations on our two networks. This means that occasionally we are called upon to broadcast as many as four programs simultaneously. Studios also are demanded for auditions. Ten studios had become far too few. Gladly we welcomed the opportunity to expand, especially since this included the opportunity to build from the ground up just what is required, instead of fitting the service into a structure already built.

The planning of the new headquarters proceeded along four lines: first, designing and constructing a building that would adequately

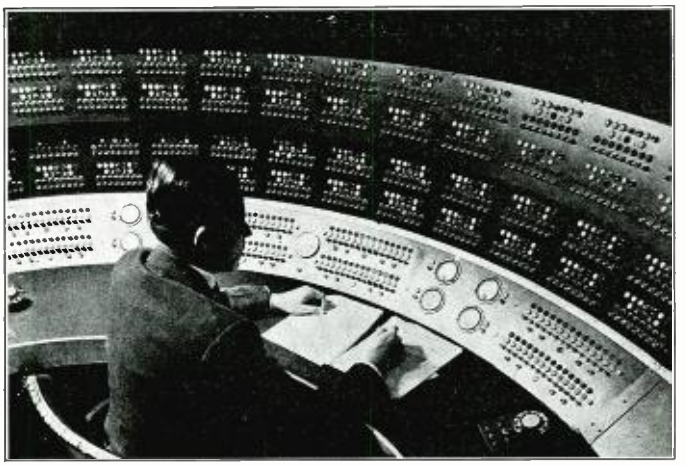
(NBC Photo)

The world's largest broadcasting studio. This photograph was taken from the visitors' gallery of the Auditorium Studio in the National Broadcasting Company's Radio City headquarters in New York.

and comfortably satisfy particular needs, present and future to the extent that we may be able to anticipate these latter; second, designing and installing the special mechanism and apparatus required for extensive activities; third, properly treating studios and other parts of the building in accordance with acoustical requirements for broadcasting, and the lighting and decorating of these interiors in ways that would not conflict therewith; and, fourth, to provide a heating and ventilating system that would serve the peculiar conditions created by acoustical necessity. These four departments of planning dove-tailed in such a way that concurrent co-operation was a necessity.

First, it is quite obvious that the wide spans required for studio construction, thirty-five studios, discouraged any attempt to superimpose a seventy-story tower above them. Accordingly one section of the Central Tower building was roofed at the eleventh story, and in this section are housed the actual broadcasting activities: studios, equipment, both broadcasting and air-conditioning, accommodations for performers, guests and broadcasting staff. Four entire floors of the Central Tower are used to house executive, departmental and clerical offices.

Experience had taught that we needed studios of various sizes for various types of programs, studios both large and small. Certain of these studios would be used for many different kinds of programs. Such must be provided with adjustable acoustics—different voices, different instruments, and different groups of each, and both requiring their individual acoustical background.



A section of the main control desk of the National Broadcasting Company's new headquarters in Radio City. The lights represent the different studios and the 85 stations on the coast-to-coast networks, which the operator controls. *(NBC Photo)*

Acoustical Problems

Acoustical problems are of two kinds: Sounds must be prevented from leaking out of studios and interfering with other broadcasts and general business activities, and we must control the sound that is kept within the studios. The first is a problem of sound-insulation; the second one of sound-manipulation.

As sound hits a wall a portion of it is reflected back as echo, some of it is absorbed by the partition, and the remainder is transmitted through to the other side. Sound will leak out through key-holes, through door-cracks, along steel construction girders. It will escape in various ways and cause all sorts of annoyance. In order to overcome this the studios were built like thermos bottles, bottles within bottles, and doubly corked with two sound-insulating doors separated by an ante-chamber.

The studios are actually rooms within rooms, suspended above the building floors on steel springs padded with felt—concrete floors, covered with linoleum, floating in space. The walls and ceilings of these floating rooms are constructed of special fire-proof sound-insulating material: several inches of rock-wool, with the interior walls and ceilings of "transite" an asbestos-like board material that is perforated in a way that resembles a porus-plaster.

All studios have adjoining control rooms, and most of them also have client's booths and observation galleries from which guests may see and hear (through loud-speakers) what is taking place within the studio. All windows looking into studios from such ante-rooms are made of three different thicknesses of a special quality of plate glass. Most of these panes are too large to be conveniently removed for cleaning, hence, the two intervening air-chambers were hermetically sealed. As atmospheric changes occur within the studios the barometric pressure on these glass surfaces changes—several tons on some of these large windows. To safeguard against inevitable breakage under such conditions, a system of pressure-equalizing air-tubes was designed and installed. These tubes are equipped with fine air-filters which prevent admission of dust or dirt particles. Thus the air pressure inside of these hermetically sealed glass chambers is automatically compensated.

Heating and Ventilating

Since in making the studios sound-tight we were obliged to make them air-tight, some special system of heating and ventilating had to be devised in order to make continuous broadcasting humanly possible. The mammoth air-conditioning plant pumps 20,000,000 cubic feet of air into the establishment hourly. This air is first drawn through cleansing chambers equipped with nozzles which spray 162,000 gallons of water per hour. During the hot season a mechanical refrigerating plant chills this water which both cools and de-humidifies the air. Strange as it may seem, this cold water dries the air. This refrigerating plant can produce 1,800,000 pounds of ice per day—as much ice as 10,000 domestic refrigerating machines can make in the same period. When weather conditions necessitate, we can humidify air to the proper degree. Before being sent on its way the air is filtered through a mesh of finely spun glass fabric, thus insuring "mountain-peak" purity. An elaborate system of ducts distributes this "perfect weather" to all studios and other parts of the building. A similar system of exhaust ducts makes possible a complete change of air in every studio at least once every eight minutes. A total of 1,941 horse power is used by the motors operating the fans which drive the air through this system—at the rate of fifteen miles per hour.

Such a rushing of air would create sound itself, and these feed and exhaust ducts would bring sounds into and out of studios. To overcome this. all ventilating

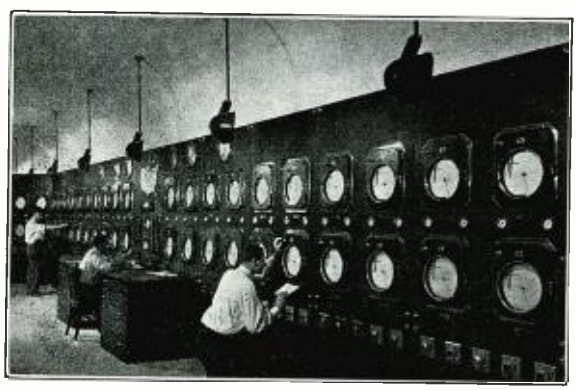
ducts were lined with rockwool and covered with a thickness of the same material, thus absorbing all transient sounds before they travel many feet. To prevent transmission of sounds from the metal work of these ducts to the floating walls of studios another precaution was taken: studio intakes and outlets were connected with the ducts imbedded in the building walls by a "hose" of canvass, also wrapped with rockwool.

Reverberation

So much for sound-insulation and air-conditioning. The control of the sound kept within studios is another and separate matter. Excessive reverberation in broadcasting studios must be eliminated. One does not want to hear the same program several times per second. Prolonged reverberations blur—similarly to playing the piano with the "loud" pedal kept down. The sound-absorbing materials used for sound-insulation helped to solve this problem in degree. Remember, the walls and ceilings are made of a perforated asbestos-like board. Papering such surfaces would defeat their purpose. Painting them would not relieve their unsightly appearance. All decoration, therefore, resolved itself into the application of porus textile fabrics to all studio walls and ceilings, the floors being covered with linoleum. Thus the insides of these "thermos bottles" have been treated in such a way as to absorb excessive reverberations and all echoes.

Now programs vary in type considerably: different instrumental ensembles, different size groups, different voices, speaking voices, singing voices, sound effects of different qualities and of different intensities, each of which requires its own degree of resonance support, its individual acoustical setting. To meet these requirements studios have been provided in great number, varying in dimensions from the great Auditorium Studio, 78 feet by 132 feet and three stories high, down to the little studios designed solely for an individual speaker. Each has its acoustic treatment so applied to walls and ceilings as to provide the best acoustical background for the broadcast program.

Certain of these studios designed to accommodate general and therefore widely varied types of broadcasting are so equipped that the reverberations or resonance can be altered at the will of the engineer in charge simply by pressing a button in the adjacent control room. This, in part, is accomplished by acoustic panels mounted on overhead tracks around studio walls, controlled by small electric motors. When these panels are slid into wall pockets, they expose a hard plaster surface which reflects sounds, increasing the resonance of the room. These exposed plaster surfaces are not flat but "corrugated" in wide, shallow, wavey surfaces that deflect rather than reflect sound waves, dispersing sounds in such a way as to prevent disagreeable echos.



(NBC Photo)

The largest air conditioning system in the world has been installed in the NBC section of Radio City. Shown above is the control panel, for regulation of temperatures in all parts of the studio building.

In the construction and decorating of our studios we have used 500,000 pounds (eleven carloads) of rockwool; 153,000 square feet of that asbestos-like perforated wall and ceiling board; 8,500 square feet of plate glass; 175,000 linear feet (four and a half carloads) of fine woods for panellings, etc., fifteen different kinds; 244,908 square yards of textile fabrics for wall and ceiling coverings. More than 6,000 textile samples were examined for this use. Each was subjected to rigid acoustical tests, with the result that ninety per cent of the fabrics finally chosen were woven to specification both as to material and weave, color and design.

With reference to the special mechanical equipment designed and installed for picking programs out of studios and sending them out through space for entertainment; this, of course, is the very latest and most improved broadcasting equipment yet devised by radio science.

Studio Electrical Equipment

Starting in the studios, where programs originate, we use the most improved condenser microphones and the new high fidelity "ribbon" microphones. In the 35 studios when all are completed there will be 250 microphone outlets. The sound waves, converted into electrical energy, pass through a maze of wires, tubes and electrical apparatus, nursed along in the various ways necessary, and then shot into that intricate maze of wires that represent the two networks, carrying this electrical energy to the local broadcasting stations where it is sent out on the ether waves to be picked up by the antennas of receiving sets and reconverted into sound as it pours through loudspeakers.

For this conglomeration of apparatus we used 1,250 miles of wire, just within our new building; 89 miles of cable, some of it containing forty wire strands, some twenty and some ten. These were cut in lengths varying from a few inches to stretches of 400 feet. It is estimated that these miles and miles of wire were cut into 10,000,000 pieces, necessitating 20,000,000 wire connections! We employed 600 especially trained union electricians working two shifts a day to complete this installation.

With this new equipment we can present multiple-point programs switching back and forth to different broadcasting points and keeping each point constantly informed as to what is taking place at the other points.

Each executive office and the offices of those whose business it is to keep in touch with broadcasting activities is equipped with a loudspeaker operated through a dial control similar to a dial telephone, making it possible for each of these loudspeakers to contact 42 different programs, rehearsals, broadcasts, or any special long-or-short-wave program that may be piped into the system by the central control board. Offices have been wired in such a way that one may cut into the floor within two feet of any given point and locate conduits that contain monitor wires, telephone or light wires.

The Control Central

The central control of this system is located on the fifth floor, midway between the several floors of broadcasting studios. An observation gallery permits visitors

(*Concluded on page* 18)

A Radio Market That Caught the Manufacturers Napping

NOTHWITHSTANDING that more than half a million radio receivers for automobile use have been sold during the present year, the additional market for about 250,000 receivers for taxicab use has not, except in a few isolated spots, been developed. Strange as it may seem the taxicab companies have had to take the initiative. In several of the large cities commercial cab companies have installed receivers in their cars, or in a portion of them.

Recently the technical staff of RADIO ENGINEERING was called upon by large taxicab interests to make a complete report on the availability of present automobile receivers for taxicab use, and to make detailed suggestions for design and alteration to meet the needs of passenger car service.

Examination of various receivers intended for private automobiles disclosed that there is being marketed a number of excellent sets for this use. In these installations the receiver proper, the loudspeaker and controls are mounted in front of the driver's seat. This for the easy access of the person who is to operate the receiver.

Public Cab Requirements Different

For taxicab use the receiver is for the entertainment of the passenger traveling in the cab. Properly, the control of operation of the receiver must be in the hands of the passenger, if he is to have a choice of programs. There are many objections to imposing this responsibility upon the driver. Further, when space is available there are reasons for mounting the receiver on the partition separating the driver's compartment from that of the passenger, the receiver and the controls within reach of the passenger.

In one installation in New York City, the "flag" on the taxi meter is employed to control the operation of the radio receiver. When the driver drops the flag upon taking in a passenger, this action closes a contact which starts the radio. When the passenger arrives at his destination and the flag is raised, this disconnects the radio.

Among the objections to this arrangement is the one that drivers soon discover how to close the starting contact without the meter flag being placed in the pay position.

Taxicab companies are experimenting with contacts to be closed when the passenger sits down on the cushion of the rear seat—automatically opening when the passenger alights.

In some cities police departments have banned taxicab radios. It will be for time to determine whether taxicab radio is to be universal or permitted only in the less densely populated areas.

Driver Should Not Control

The taxicab companies are of the opinion that the radio service should be a feature to be availed of by the passenger at will; that is, a service with which the driver has nothing to do. The fact that the automobile receivers now being marketed have neat, serviceable control dials does not mean that these present dials meet the needs of taxicab service. In this one particular it is plain that the radio manufacturers have not sensed the particular needs of cab radio. There is opportunity for the exercise of ingenuity in designing dials which will measure up to this new requirement. A cab dial need not be of miniature dimensions. There is room for a dial considerably larger than that now affixed to steering posts. The cab dial should carry directions lettering large enough to be read three feet away, where the light is not good. The control knobs should be rugged, to withstand hard usage. The dial functions of station selection and volume control should be simple and easy to manipulate. The dial legends should invite the passenger to make use of the radio, rather than to discourage him.

Taxicab Companies Have Their Own Shops

Taxicab companies maintain extensive construction and repair shops where staffs of competent mechanics and electricians are regularly employed. Where a cab company operates hundreds of radio receivers the view they have is that they best can install the radio equipment, and possibly also maintain it. Commercial radio servicing organizations probably would be employed to make the more difficult repairs and to re-condition receivers which have had considerable use.

It may develop later that placing the receiver on the back of the cab partition was the first adopted method only because the present car receivers are of such shape that they would not fit in other areas within the cab. Some of the taxicab executives believe that the receiver should be of such shape that it would fit in the space beneath the right arm rest, beside the rear seat, with self-contained loudspeaker and controls. Or, there is opportunity for a remote control unit to be mounted above the arm rest, where a control transmission system is used that will operate over a distance of 8 to 10 feet.

In observing the present activity on the part of the taxicab companies and radio engineers to make up for lost time in this matter it is noteworthy that there are some excellent manufactured products with which many engineers are not familiar. An instance is where antenna lead wire was installed which invited disturbances to reception, while at the same time there is available an excellent wire product for this purpose. It is a case of inadequate marketing on the part of the wire manufacturer.

What is being learned at the moment about radios suitable for taxicabs will be helpful in improving auto radio for long-distance bus, and larger family car use.

Examination and test of numerous auto receivers discloses that not in all cases are the best parts being used. Taxicab service will demand betterment of parts, of parts mounting, of accessibility, of freedom from vibration loosenings, and of assembly generally.

With a potential market for an additional quarter of a million radio receivers, in a service where the life of the set will be short compared with that of the home receiver, it is worth while devoting considerable thought and effort toward its development. Taxi radio must meet unusual requirements, not the least of which is the objection to their use on the part of officials in some communities. Entertainment for the passenger must not become distraction for the driver.

CORRELATION OF THEORETICAL AND EXPERIMENTAL DATA ON CLASS C OPERATION OF RADIO-FREQUENCY AMPLIFIERS†

By R. J. Davis and W. J. Cahill*

THE post-war decade witnessed the initial development of thermionic tubes of large power capacity for use in radio transmitters. The first years were necessarily spent in design improvements in the tubes themselves with principal emphasis upon large radio-frequency power output. The operating efficiency of the tube circuits, and the optimum cascading of the successive amplifier stages were usually treated as of secondary importance. The opening up of transmitter manufacture as a competitive industry, and the development of plate structures permitting considerably greater anode dissipation than the older types, has forced the question of tube and circuit efficiency into a position of primary importance in transmitter design, especially with reference to Class C operation with very high positive grid swings. While limitations due to the necessity of modulation fidelity prevent the full exploitation of these new developments in broadcast and telephonic transmission generally, code transmitters can be designed today having overall efficiencies from 20 to 25% greater than those in common use only a few years ago. It is with this type of circuit that the present paper is concerned.

Our work has not progressed to the point where complete data can be presented, but the preliminary computations will be described and illustrated with curves, a complete method of attack outlined, and a brief critique attempted of other work in the field.

It is essential that complete static characteristics of the tube considered be at hand. To get these data in the region of positive grid swing is difficult on account of the emission of secondary electrons from the grid at high positive potentials. It is believed that on account of the short period of time during which high grid current passes in a r-f. cycle under Class C operation, this effect is small for all tubes except the high power water-cooled types. In order to avoid secondary emission when taking data, the grid must be placed at the desired positive potential just long enough for an oscillograph element to record the swing of current. By utilizing several elements, the instantaneous values of plate voltage and current, as well as grid voltage and current may be read on the same film. A detailed technique for this procedure has been given by Kozanowski and Mouromtseff[1]. The desirability of simultaneous records is evidenced by the fact that all practicable plate and grid voltage supplies will show considerable regulation when called on to supply the increment of current involved in switching the grid from zero volts to a high positive value. It is also necessary to allow the grid to retain its positive potential long enough to permit all transients in the voltage supply circuits to die down. Kozanowski and Mouromtseff have covered these factors very well in their technique.

†*Presented before the Radio Club of America, October* 11, 1933.
*Hygrade Sylvania Corp.

Assuming that a satisfactory set of characteristic curves are at hand, the next step is to compute data following the method of Prince and Vogdes[2] which results in an ensemble of optimum conditions illustrated in Fig. 1. The details of the computations for *one* point on *one* curve are given in the appendix. It should be emphasized that the efficiencies given here refer simply to the ratio of r-f. power available to the input to the tube, taking account of both grid and plate losses, but without consideration of the transfer of fundamental frequency energy into a given plate tank impedance. To solve this problem, we have recourse to a procedure similar to that described by Fay[3]. Unfortunately, the method of Fay is open to considerable error when applied to Class C operation over angles of 50-60°, because of the fluctuation of the cut-off voltage with the instantaneous plate voltage. The method may be followed, however, provided the assumed data include the *angle of operation* as well as the *maximum positive grid swing*. This means in turn that the maximum grid swing

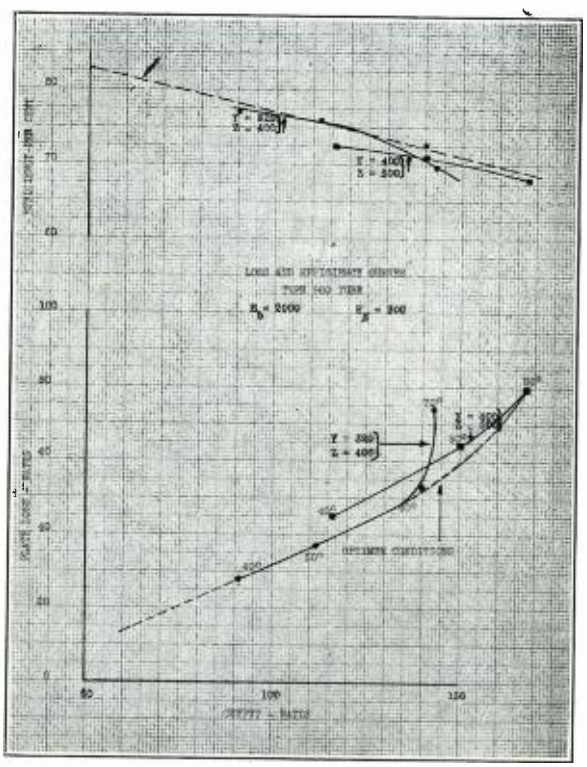


Fig. 1—Loss and Efficiency Curves.

must be adjusted to the value corresponding to the point selected by varying the excitation received from the preceding tube. We may now determine the value of plate impedance which will give maximum power output at the fundamental frequency by utilizing Equation (12) of Fay's article, viz:

$$R_o = \frac{r_p}{K} \quad \ldots\ldots (1)$$

K is defined by the equation $K = \frac{\text{I fundamental max.}}{I_p \text{ max.}}$

K is a numerical factor uniquely determined by the angle of operation, r_p is the plate resistance of the tube at the point where I_p max. flows, and R_o is the equivalent resistance of the plate tank when tuned to resonance with the fundamental frequency. Referring to Fig. 2, we get a reasonable approximation to r_p by taking

$$r_p = \left(\frac{\Delta E_p}{\Delta I_p}\right)_{E_c = 300} = 6400^{w} \quad \ldots\ldots (2) \text{ \& } (3)$$

$$R_o = \frac{6400}{.35} = 18000^{w} \quad \ldots\ldots (4)$$

Going back to our tube conditions, we find e_{pm}, the minimum plate voltage by Prince and Vogdes' criterion that $e_{g\ max.}$ shall not be greater than 80 per cent of e_{pm}. Hence we know e_{pm}. The max. plate swing $= E_b - e_{pm}$. $\frac{E_b - e_{pm}}{\sqrt{2}}$ gives the r.m.s. fundamental voltage impressed across the plate tank. The power output

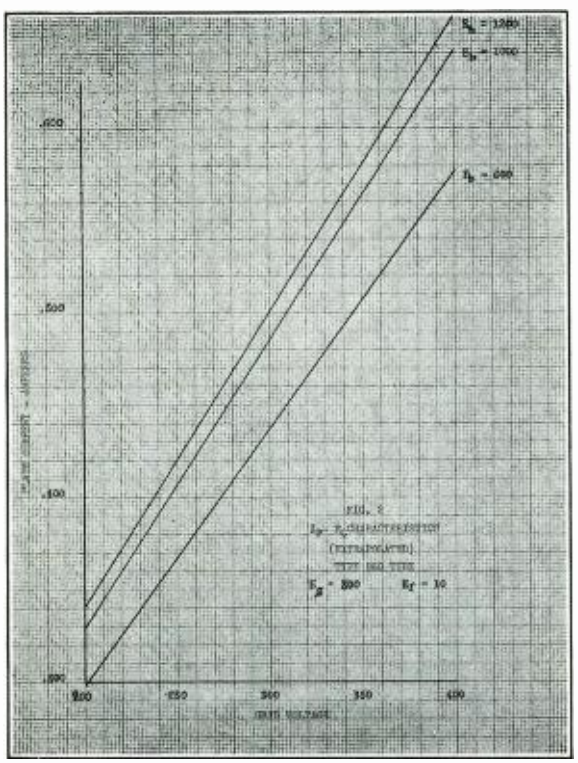


Fig. 2.

into the plate tank at fundamental frequency is given by the equation:

$$W_o = \frac{(E_b - e_{pm})^2}{2R_o} \quad \ldots\ldots (5)$$

This power will be delivered with the tube operating at maximum efficiency for its assumed output. The result comes out

$$W_o = \frac{(15000)^2}{(2 \times 18000)} = 63 \text{ watts} \quad \ldots\ldots (6)$$

This does not agree with the value calculated further on, because the value of r_p picked off the extrapolated i_p—e_g curves is subject to considerable error. More exact numerical check of the above analysis follows:

$$E_b - e_{pm} = 2000 - 500 = 1500 \text{ volts} \quad \ldots\ldots (7)$$

$$\frac{E_b - e_{pm}}{\sqrt{2}} = 1060 \text{ volts r. m. s.} \quad \ldots\ldots (8)$$

$$W_o = \frac{E_b - e_{pm}}{2} K I_p \quad \ldots\ldots (9)$$

(I_p max = .576 amp.)

$$W_o = (750)\ (.35)\ (.576) = 152 \text{ watts} \quad \ldots\ldots (9a)$$

The actual measured power in the antenna for two tubes in parallel was 306 watts. Losses in the tank and antenna tuning circuit were estimated at 15.0 watts per tube giving a total output per tube of 168 watts. The difference in the measured and calculated powers is 10%, and is probably due to an incorrect value of the constant K, as this is sensitive to changes in the assumed shape of the tip of the plate current curve. The value of K used here is the value given by Fay for a 3/2-power curve. If the shape of the plate current curve is taken as slightly flattened (probably a closer approximation on account of filament saturation), the value of K for 60 deg. operation comes out to be about .37. Substituting this in the above equation, we get

$$W_o = (750)\ (.37)\ (.576) = 160 \text{ watts} \quad \ldots\ldots (10)$$

This gives a closer check.

In designing the plate circuit, the values of L and C are usually chosen with a primary view to stability. It is customary to assume a ratio of K.V.A./Watts in the amplifier tank circuit of about 20/1 to 30/1. This is in accordance with ideas developed in Prince and Vogdes' book which show that this ratio should be at least 12.6/1 for stable operation. The theoretical minimum is usually doubled to allow a factor of safety. A value of C is assumed, the circulating current through it at a given frequency determined with an r.m.s. voltage $\frac{E_b - e_{pm}}{\sqrt{2}}$ across it, and the value of R necessary to dissipate the power output with this circulating current through it found. L is determined from tuning considerations. The value of $\frac{L}{CR}$ is then computed and compared with the value of R_o obtained from the equation:

$$\frac{(KI_p)^2 R_o}{2} = 152 \quad \ldots\ldots (11)$$

$$K = \frac{I_1}{I_p} = \frac{\text{Peak Fund Current}}{\text{Peak Plate Current}}$$

$$R_o = \frac{152 \times 2}{(.35)^2\ (.576)^2} = 7500^{w} \quad \ldots\ldots (11a)$$

If the value of $\frac{L}{CR}$ differs markedly from this, a new value of C is selected, and the computation repeated until fair agreement is obtained.

The constants on the tank used in the experimental work are known, so that it is possible to check this theory also. The measurement was made at a frequency of 2400 kilocycles/sec. The low frequency L of the tank by computation was 30 microhenrys. The C necessary to tune this to 2400 k.c. is 148 mmf. Of this, 92 mmf. was in the tank condenser, and 56 mmf. in the coil and circuit wiring as distributed capacity. With an r. m. s. voltage of $\frac{2000-500}{\sqrt{2}}$ or 1060 volts across the tank, the capacity current will be

$$I_c = \frac{1060}{X_c} = \frac{1060}{450} = 2.35 \text{ amp.} \quad \ldots\ldots\ldots\ldots (12)$$

In order to dissipate 168 watts, this current must traverse an equivalent resistance R given by the equation:

$$(2.35)^2 R = 168 \quad \ldots\ldots\ldots\ldots (13)$$

$$R = 30.2 \text{ ohms} \quad \ldots\ldots\ldots\ldots (13a)$$

This R includes the resistance of the tank coil itself together with the resistance reflected into the tank from the antenna circuit. The equivalent resistance of the tank R_o at fundamental frequency is then given by the equation

$$R_o = \frac{L}{CR} = \frac{30 \times 10^{-6}}{148 \times 10^{-12} \times 30.2} = 6700 \text{ ohms} \quad \ldots\ldots (14)$$

This is in fair agreement with the value (7500 ohms) deduced in equation (11a) above.

While the foregoing analysis may seem laborious, it can be attacked systematically, and the optimum values found very quickly. It should be noticed, furthermore, that the data so obtained are of use in designing circuits at any frequency and furnish a record of permanent value for the engineering files.

ADDENDUM

It should be noted that the power output of a tube computed by the method of Prince and Vogdes includes the *total* power available for transfer into a load, i.e. fundamental power and harmonic power. Fay's procedure leads to a value of *fundamental* power only. We should expect that the two values of computed power would differ, therefore by an amount equal to the *harmonic* power. For small angle Class C operation, this harmonic power is very small, so that close correlation between the available power outputs computed by the two methods should exist. The method of power measurement in the experimental work did not permit a sharp discrimination against the harmonic frequency power, so that part of the discrepancy between the measured and computed values may be explained as due to this fact.

REFERENCES

[1]Kozanowski and Mouromtseff: "Vacuum Tube Characteristics in the Positive Grid Region: Proc. I. R. E., August, 1933; p. 1082.

[2]Prince and Vogdes: "Vacuum Tubes as Oscillation Generators": G. E. Company, July, 1929.

[3]C. E. Fay: "Operation of Vacuum Tubes as Class B and Class C Amplifiers": Proc. I. R. E. March, 1932; p. 548.

APPENDIX

Tube: 860
60 deg. operation

D. C. plate volts X = 2000
Max. grid volts Y = 400
Min. plate volts = 500

		0°	10°	20°	30°	40°	50°	60°
A	1-cos Θ	0	.0152	.0603	.1340	.2340	.3572	.5000
B	(X-Z) (1—cos Θ)	0	22.8	90.5	201.0	351.0	536.0	750.0
C	e_p	500	522.8	590.5	701.0	851.0	1036.0	1250.0
D	e_p/u	60	60	60	60	65	65	65
F	Y plus e_p/u	460	460	460	460	460	460	460
G	1-cos Θ	0	.015	.060	.134	.234	.357	.500
H	Max. grid swing (G)	—	—	7650	3440	1990	1300	930
J	A-C comp. of E_g	—	—	5420	2440	1410	920	660
K	Bias	—	—	—	3040	1590	900	530
L	1-cos Θ	0	.015	.060	.134	.234	.357	.500
M	G (1-cos Θ)	0	14	56	125	218	332	465
N	e_g	400	386	344	275	182	68	—65
P	i_p	.576	.560	.525	.440	.290	.124	0
Q	i_g	.082	.080	.070	.043	.028	.012	0
R	Plate loss	288	295	310	310	246	129	0
S	Grid Loss	32	32	21	11	5		

$I_p = .124$
$I_g = .015$
Grid Loss = 4 watts
$R_g = 35{,}400^{\omega}$
R_g loss = 8 watts
Total grid loss = 12 watts

Plate loss = 80 watts
Input = 248
Output = 168
Efficiency = 67.6%

◆ ◆ ◆

RADIO IN RUSSIA EXPANDS

It has been stated that at the beginning of the present year the U. S. S. R. held a foremost place in the world in the power of its broadcasting stations. The number of radio-telegraph-telephone transmitting sets increased from 49 in 1928 to 73 in 1932, and their capacity from 328 k.w. to 933 k.w.; receiving sets increased from 348,000 to 2.3 million at the end of 1932. Prior to the Revolution the communication services were completely dependent upon imported equipment. The gross output of the electro-technical industry of low current increased from 37.3 million rubles in 1927-28 to 272 million rubles in 1932. Television and telegraphic transmission of images has also been organized, and extensive experiments have been conducted in the field of ultra-short wave lengths.

Recording of Patterns and Waves Applied to Cathode Ray Tube by Camera

By Allen B. DuMont

THE methods commonly in use to record phenomena occurring on the fluorescent screen of the cathode ray tube consist of either using an ordinary camera to record stationary patterns or recurrent waveforms or a moving film camera with the voltage to be recorded impressed across one set of deflection plates as a means of recording recurrent or particularly non-recurrent phenomena.

Both of these methods are useful for certain purposes but a third method namely using a motion picture camera to record wave forms or patterns has some advantages for certain uses over the first two methods mentioned. This last method however has only recently been made possible by the increased intensity of the fluorescent screen of the cathode ray tube and the increased sensitivity of the photographic film available.

A number of films are shown on this page which were taken with a standard home motion picture camera equipped with an F3.5 lens. Eastman super-sensitive panchromatic film was used. This film is put through a double developing process and acts as both negative and positive so that when prints are made of the film the recording shows up as a black trace on a white background. The cathode ray tube used utilized a special high intensity time delay screen on a three-inch diameter blank the tube being of a standard type equipped with two sets of deflection plates. The potential applied to the accelerating electrode was 1500 volts. A type 127 sweep circuit was used to supply the time axis in the films showing waveform.

Fig. 1 shows the motion of the spot by means of a magnet. The first part of the film was taken in a darkened room and the second with a 40-watt lamp about a foot above the cathode ray tube. It will be noticed that the spot is not sharp due to halation of the film. This can be done away with by reducing the voltage to the accelerating electrode when the spot is moving at slow speeds.

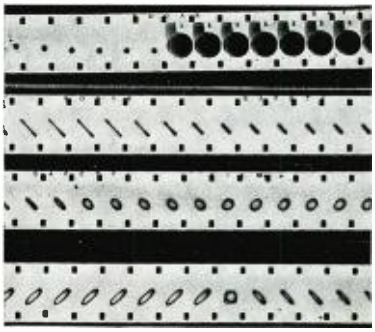
The next strip, Fig. 2, shows a line (which is at right angles to one set of deflection plates) which varies in amplitude as the a-c. voltage across the one pair of deflection plates is varied.

In Fig. 3 an out-of-phase voltage is applied to the second set of plates and then both voltages increased. Fig. 4, also showing out-of-phase voltages, is interesting in that it shows the effect of rapid shifting of the pattern. On the camera used each picture is stationary for 5/120 of a second. As a 60-cycle source was used on the deflection plates to form the patterns and waves, two and one-half circular traces may be seen. A very light trace of the preceding figure may also be seen on the frame due to the afterglow of the screen and lighter traces on the two frames following.

Fig. 5 was taken of a 60-cycle wave with the sweep circuit adjusted to 12 cycles. It will be noticed that when the camera was started the shutter was open and the picture stationary for five complete cycles and in the following frames the picture was stationary and the shutter open for 5/120 of a second enabling two and one-half cycles to be seen on each frame. Fig. 6 is of a 60-cycle wave with a 20-cycle sweep. Here again we see two and one-half waves one-half of a wave being missing on each frame due to the time the shutter is open.

In Fig. 7 is shown the trace of a 60-cycle wave when using a 30-cycle sweep. Here the entire wave is shown as only 4/120 of a second is required to trace the wave

(*Continued on page* 18)



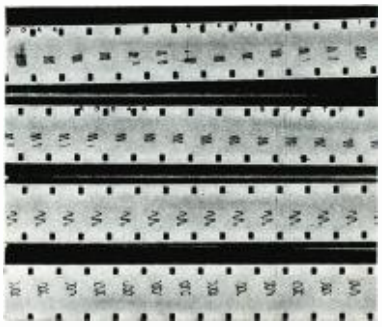
Left:

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.



Right:

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

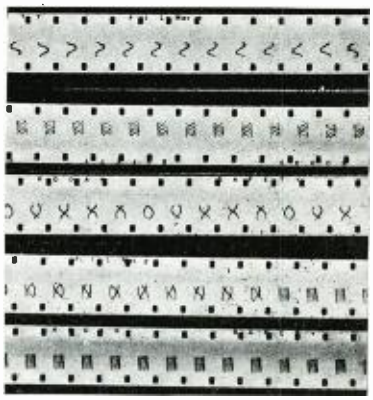


Fig. 9

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Police Radio Service

Information of Value to Municipalities Operating Police Radio Systems, and Those Contemplating Such Service

THE manifold advantages to be derived from the use of radio in connection with the administration of a police department has been appreciated by all who have been issued licenses to operate stations in the police radio service. The record of growth of the number of stations shows a steady increase in these facilities.

The Federal Radio Commission has attempted to work out an allocation of frequencies and to adopt regulations that will make this service fit in with many others and at the same time give an efficient service to the police.

Radio frequencies are scarce and new ones cannot be provided in the present state of development of the radio art. The very high frequencies (above 30,000 kc.) offer a possible solution of the shortage of frequencies, but these bands are still in the experimental stage of development, and will not be opened for any commercial use until more specific information with regard to their possibilities has been obtained.

The number of frequencies suitable for municipal or state police radio service is limited to a relatively small portion of the radio spectrum. Frequencies beginning at 3000 kc. are useful for long-distance communication. The higher frequencies above 5000 kc. possess skip distance characteristics which render them useless for short-range communication. The lower frequency bands below 1500 kc. are now used to full capacity by Government stations, ship and aircraft stations, broadcast stations, as well as many other classes. As the area of interference incident to the use of any frequency is vast, both domestic and international considerations must be given proper weight in their allocation.

Emergency police radio service is a mobile service and the frequencies which may be used by police stations are allocated from the mobile bands.

Frequency Allocations

In North America the band of frequencies between 1500 and 6000 kc. is allocated to services as between nations by special agreement commonly known as the North American Agreement. The frequencies suitable for municipal and state police radio service fall within the band 1500 and 3000 kc., which, under this treaty, is allocated for use by maritime and aviation stations, amateurs, experimental visual broadcasting stations, and finally a general allocation for any stations in the mobile service. These service bands from which the police allocations are made are further subdivided for use also by maritime, aviation and geophysical stations.

A 400-watt Western Electric transmitter in New York's police radio-telephone system. This one is located in Brooklyn; another identical one is located in the Bronx. The policeman, attached to the radio branch of the Telegraph Bureau, is broadcasting a message.

The specific frequencies available for use by police radio stations are set out in the Commission's Rules and Regulations (Rule 332). As there are only eight frequencies available, the Commission is confronted with the necessity of providing for their greatest possible use. After considerable study it was decided that the entire country should be divided into zones and that all cities within a zone should share the use of the same frequency. In this way it is possible to duplicate frequencies in distant zones and at the same time provide for an efficient system of operation within each zone.

There is a belief on the part of some police administrations that a separate frequency should be assigned to each municipality. It is pointed out that with only eight frequencies available, such a system could not possibly be as efficient as the zone system of allocation. For example, in one metropolitan area, there are 19 cities located in 80 districts, nearly all of which are within twenty miles of the center of the district. Therefore, if different frequencies were assigned to each municipality, the adjacent police departments would lose the advantage of being notified of crimes committed in neighboring cities, with a consequent delay in the apprehension of criminals who succeeded in making their escape from one city to another.

Districts

Cities in areas such as that referred to above are encouraged to organize the metropolitan district type of radio service. To do this, it is necessary for some one city in the area to take the initiative and impress upon the police departments the necessity of all cities cooperating in the establishment of a single system. Without cooperation the system cannot be efficient as there would be no way to trace the criminal from one city to another. The metropolitan area type of service may be established in several ways. All the cities within an area may enter into contracts providing for mutual use and support of one radio station, the various cities involved could enter into a partnership and designate one licensee who would be responsible for the operation of as many radio stations as may be required to properly serve the entire area or two or more of the cities may each establish independent stations to give primary service to specific portions of the metropolitan area and enter into an agreement as to the rendering of cooperative service over the whole area and as to priority in the handling of calls originating in the various districts.

It is important that if a metropolitan area type of service is contemplated, the city making application to the Commission for authority to erect a station forward with the application certified copies of the contracts involved in the establishment of the system. The agreement should show that the applicant is required to furnish police radio service to all subscribing municipalities without discrimination and that these municipalities agree to accept the service and not request the Commission to grant them independent transmitting facilities.

Interference

In the interest of reduction of interference an allocation of power based on population was selected in preference to an allocation based on the area to be served. Municipalities having large population need more power than those of less populous areas because of the greater attenuation of the radiated energy due to building construction. It

has been determined after careful study that most of the small municipalities which occupy greater geographical dimensions than some of the larger cities are not handicapped with the transmission difficulties usually present in the more populous districts.

The amount of power that may be licensed is specified in Rule 329. Where two or more cities desire to cooperate the power is computed on the basis of the population of the entire area to be served.

In many cases, cities desire to install a police transmitter capable of serving the metropolitan area and to make the installation at once with a view to ultimately furnishing service to mobile units in contiguous municipalities. The construction of such a station may be authorized, pending a conclusion of arrangements between the applicant and the police officials in surrounding municipalities. However, a license to use power above that which may be authorized on the basis of the applicant's city will not be granted until satisfactory arrangements have been concluded and the Commission has been furnished with copies of contracts entered into by all cities subscribing to the system.

In the event that the amount of power allocated is insufficient to afford reliable coverage over the desired area, the Commission will, upon proper showing being made, authorize the use of additional transmitters of the same or less power. The City of Chicago, for example, now operates three 400-watt transmitters. The City of New York, one 500-watt and two 400-watt transmitters, and the City of Detroit, two 500-watt transmitters. In each case it is possible to provide efficient communication and at the same time limit the power on the particular frequency so that it can be duplicated for use in other zones. Where more than one transmitter is installed, only one transmitter is required for local alarms and two or more transmitters in turn when the alarm is general in nature.

Administration

It may be of interest to outline briefly a typical system of police radio administration. In such a system, one or more transmitters are located in strategic places in the city. Radio-equipped patrol cars are arranged throughout the city by precincts and each precinct is divided into patrol districts covered by a single car. The patrol districts are chosen with the following points in mind:

1. Density of population.
2. Crime record of the territory considered.
3. The traffic problem.
   a. Density of traffic.
   b. Congested points.
   c. Obstruction, such as railroads, etc.
4. The existence of other types of police protection.

In addition to the precinct cars usually termed "scouts," there are often other types of cars equipped with radio, termed "cruisers." These cruisers may be heavy, high-powered cars carrying a number of men equipped with riot guns, tear gas bombs, etc., designed to assist scout cars in handling the more serious crimes, or another type of cruiser may be equipped with photographic apparatus, brake-testing equipment, etc., for the purpose of making permanent record of the conditions surrounding traffic accidents. This latter type of cruiser often inspects traffic lights, signs, etc., during periods when it is not on a definite run.

The transmitter is operated in most cases from a central control point. This is usually in police headquarters and is often in the same room with the telephone switchboard. An officer is detailed at the control point who is termed the "dispatcher." He may perform other duties in addition to dispatching cars, such as operating the telephone switchboard.

Except under certain conditions set forth specifically in Rule 213, it is necessary for a licensed operator to be on duty at the actual transmitter location at all times during which the transmitter is operated. Under the special conditions referred to, the Commission may, upon application, grant authority to operate the transmitter with a licensed operator at the control point only, in which case he may act as dispatcher as well as operator.

Courtesy Eveready Raytheon Company

Automobile radio receiving sets used by the New York police department are simple in construction but sturdy and durable, built to withstand 24-hour service under all weather conditions.

It is usual to provide both a talking circuit and an order circuit between the control room and the transmitter location. The talking circuit is for the purpose of permitting communication between the dispatcher and the transmitter operator, and the order circuit being connected directly into the transmitter for the transmission of orders to police cars. A signal system is arranged so that the dispatcher may call for the transmitter with the least possible delay. Provision is often made for the switching of incoming calls to the radio operator instead of the dispatcher in order that the radio operator may act as a relief and dispatch cars during the absence of the regular dispatcher.

In addition to the equipment actually necessary for the dispatching of police cars, most cities provide for the placing of receivers in precinct station houses, various locations in police headquarters, sometimes at fire stations, and in mobile fire units.

Secrecy Systems

Some licensees believe that secrecy systems have possibilities if they can be made mechanical, rather than of the code book type. However, the majority believe that secrecy systems are unnecessary and that the number of times that the transmissions are used for improper purposes is far outweighed by the salutory effect due to reception by the general public. One licensee, with reference to a secrecy system, states that it is his belief that any criminal organization having the ability to install and operate an intercept system for the protection of criminals against the police would be able to duplicate mechanical devices installed for secrecy purposes and render such a system ineffective.

In addition to the operation of thousands of short-wave receivers at fixed locations there are many portable and mobile short-wave receivers which cover the police bands and also the bands used by the following services: aviation, experimental, geophysical, ship, forest patrol, emergency (marine, fire and special emergency stations), temporary service, including broadcast pickup stations and motion picture stations, and amateur. Furthermore, many thousand broadcast receivers are being used in automobiles which have a tuning range that includes the 1712-kilocycle police frequency.

In this connection Section 27 of the Radio Act reads in part as follows:

"No person receiving or assisting in receiving any radio communication shall divulge or publish the contents,

substance, purport, effect, or meaning thereof except through authorized channels of transmission or reception to any person other than the addressee . . .; and no person not being authorized by the sender shall intercept any message and divulge or publish the contents, substance, purpose, effect, or meaning of such intercepted message to any person; and no person not being entitled thereto shall receive or assist in receiving any radio communication and use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto; and no person having received such intercepted radio communication . . . , knowing that such information was so obtained, shall divulge or publish the contents . . .; or use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto: Provided: That this section shall not apply to the receiving, divulging, publishing, or utilizing the contents of any radio communication broadcasted or transmitted by amateurs or others for the use of the general public or relating to ships in distress."

The Commission does not expect to issue any regulations of a restrictive nature that can possibly be avoided and there is no present intention of prescribing the type of announcement that shall be used for police service. However, in view of the existence of interzone interference, licensees should use the utmost discretion in limiting their time on the air. Even though the modulation of a police transmitter may be unheard, the presence of a heterodyne is extremely annoying if not a source of serious interference. Cases have been observed in which a city in one zone which transmits its call six times commenced transmission prior to the beginning of an announcement in a second zone and this second announcer utilizing the contents of any radio ment was completed before the first city was through with the initial transmission.

The same high quality speech transmission should not be expected of police radio as of broadcasting. In some seasons of the year and during certain times of the day, particularly at night, police announcements from municipalities in one zone may be heard at a location where the frequency is used in another zone. It has been found that this does not lead to confusion, but in fact gives the officer in the car constant assurance that his receiver is operating properly.

◆

Early Police Radio

What was said to be the first police radio installation in the United States was that put in for the state police at Harrisburgh, Penn., by the Westinghouse Company. This was a 500 watt radio telephone transmitter designed for point-to-point service.

The New York police department had a radio system in use as early as 1916, but this was employed only for patrol boat service in New York harbor. The transmitting station had the call letters KUVS.

The city of Detroit was a pioneer in police radio use, having a limited installation as early as 1921. The first installation was used only a short time. In 1929 Detroit again took up police radio and started the general movement for this modern service.

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NEW STUDIOS IN RADIO CITY

(*Concluded from page* 10)

to view the central control board which governs and registers the activities of the networks and studios.

There is also an observation gallery from which visitors may view the central control board of the air-conditioning plant on the tenth floor. This plant is built in sixty-four units, each self-controlling its thermodynamic purpose. Dials indicate and register the variations of temperature and humidity in each studio and different sections of the building, and these are automatically rectified and controlled by a thermostatic device. The entire plant is self-operating, requiring only starting and stopping. It works continuously from 6 a.m. to 1 a.m.

Television? Yes, we have tried to anticipate its advent. There has been laid a special and separate system of cables from studios to the central control plant, not knowing when or in what guise television will make its appearance. This, however, we do know; television will require light, a super-abundance of light, and we have provided for this in the specially devised lighting system. All lights are imbedded in the ceilings of studios and along walls of corridors. These are covered and controlled by a scientifically designed lens which diffuses this flood of light in such a way as to eliminate shadow. If and when necessary we can further supplement this normal lighting system with a system of flood and spolights that rivals the Summer daylight.

One set of studios, too, was designed with experimental television in mind. Four studios are built around one control room, the control apparatus of which is built on a circular track, making it possible to pick up sight or sound from one studio and switch immediately to the next, allowing for changes of scenery, set-up, etc. In the mean time this set of studios will conveniently serve those radio programs which present a variety of features.

RECORDING PATTERNS AND WAVES APPLIED TO CATHODE RAY TUBE BY CAMERA

(*Concluded from page* 15)

and the shutter is open 5/120 of a second allowing a 25 per cent retrace. Fig. 8 shows the trace obtained when the sweep frequency is not an even multiple of the observed wave (60-cycle). The sweep frequency in this case was 40-cycles and it is apparent that in 1/40 of a second one and one-half waves would be traced at the end of which time the wave would be retraced in phase with the first trace but of the opposite sign. As this double trace would require 6/120 of a second and the shutter is open only 5/120 of a second, one-half cycle is lost.

Fig. 9 shows a 60-cycle wave as observed when a 60-cycle sweep is used. Fig. 10 is with an 80-cycle sweep. Fig. 11 is with a 120-cycle sweep.

Figs. 12 and 13 show the traces obtained as the sweep frequency is increased up to 5000 cycles per second.

No particular attempt was made during the taking of this film to keep the patterns or waves stationary except while the 30-cycle sweep was being used the pattern was locked in step by means of the synchronizing adjustment which applies part of the observed wave to the grid of the mercury vapor discharge tube.

In showing a film of patterns or waves from the cathode ray tube in a motion picture projector the picture viewed appears exactly as seen on the tube except when a very slow speed sweep or timing axis is used in which case the wave has not time to complete a cycle on an individual frame. Under these conditions the wave appears, but a black bar seems to be moving in front of the trace the width of which increases as the sweep frequency is lowered.

Radio Testing Instruments†

From the Engineering Viewpoint

By J. H. MILLER*

THE problem of adequate service on broadcast receivers is demanding increasing attention from the radio engineer. There are now in the hands of the public entirely too many receivers functioning well below par because of minor faults. Such sets do not result in new sales, but tend to convey the impression, in each individual case, that broadcasting as a whole is not advancing.

It is believed that equipment to enable the servicemen to resuscitate such sets easily, quickly and economically is a real requirement of the industry. If the old set can be brought to at least its normal condition, confidence can be restored and the way paved for modern equipment.

While the method of analysis of current and voltage in the tube socket is well known, it merely serves to point out the stage in trouble and give a general picture of what may be the specific difficulty. Modern radio sets, however, are becoming increasingly complex as to circuits and abnormal voltage or current readings may frequently be caused by a number of defects which can not be analyzed from such readings only.

In a single receiver we may have several times as many resistors as we have tubes; potentials, both direct current and radio frequency, are broken up into sections by resistance networks, and direct and intermediate and radio frequency currents are segregated by means of capacitors. The requirement for devices to more accurately measure these resistance and capacity units is, therefore, a growing one.

In the endeavor to reduce obsolescence in test equipment of various kinds, unit panels have been made available. Fig. 1 shows five such panels in a carrying case intended for the serviceman. This gives him sufficient equipment to run down even major troubles in most any instance.

The three lower units are an analyzer of conventional type, a self-modulated oscillator covering the broadcast and intermediate bands and a tube checking device.

Because of the rather bulky assembly of the several units, they have been made removable as individual testing devices and are enclosed in small steel boxes as shown in Fig. 2. This allows for the removal of any of these units where it may be particularly required and also allows for the transportation of only such test units as are needed in a particular call.

The Volt-Ohmmeter

The upper two units in Fig. 1 are the recently developed volt-ohmmeter at the left and capacity meter at the right. The volt-ohmmeter panel is shown in greater detail in Fig. 3. The scale on the instrument is shown in Fig. 4. The switch positions are such that the scale reads directly in ohms on the next to the right hand switch position. In the right hand position the indications are divided by 5 and the first division to the right is 0.2 ohm.

Decimal multipliers are used for the higher values and the highest is R × 10,000; the last division at the left is marked 1,000 on the scale so that this becomes 10 megohms, directly readable with a truly portable device.

The details of the circuit have been worked out so that this rather wide range is obtainable through the use of a maximum of 15 volts of battery. A

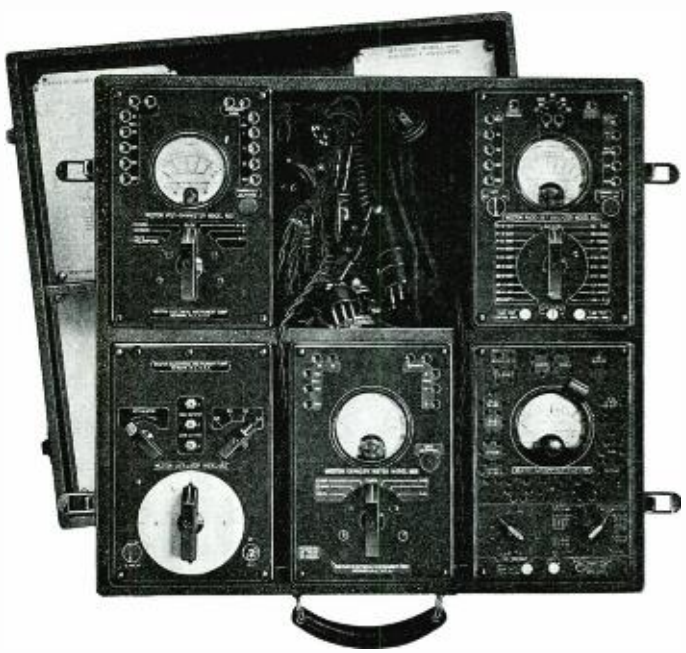


Fig. 1.

† *Presented before the Radio Club of America, May 10, 1933.*

* *In charge of Radio Engineering Division, Weston Electrical Instrument Corporation, Newark, N. J.*

single No. 2 unit cell is used for all but the highest resistance. To this is added three of the smallest 3-cell "C" batteries for the highest range.

In order to obtain this wide range in values it has been necessary to use the very latest developments in instrument construction and a discussion of the ohmmeter theory will indicate the general angle of attack on the problem.

The series type ohmmeter, of which this is an example, may be analyzed directly by Ohm's Law. Consider first the current flowing through the instrument

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

In this case E is the open circuit voltage of the battery being used and R the total resistance of the circuit including that of the instrument, the battery and connecting leads.

Taking the second case where an external resistance is connected in series, we have for the new value of current,

$$I' = \frac{E}{R + X},$$

where X is the external resistance which has been added to the circuit.

In order to get the reading on the instrument scale, let us consider the deflection in terms of full scale deflection; that is, let us arrange matters so that the result will be in per cent of full scale. We then have

$$\frac{I'}{I} = \frac{\frac{E}{R + X}}{\frac{E}{R}}.$$

The first member is per cent of full scale deflection and the second member may be reduced to

$$\frac{R}{R + X}.$$

This shows that the series type of ohmmeter is essentially a resistance comparator and if the resistance of the instrument circuit is known, the voltage of the battery and the current which flows may be completely dropped out of the picture. To be sure, there must be a sufficient amount of current to get a good readable indication on the instrument and in order that the scale may be of good length the potential and internal resistance must be so proportioned as to give sufficient current for full scale deflection with zero external resistance. But once these have been satisfied, they completely drop out of the picture and the readings in per cent of full scale are purely a matter of resistance proportion.

However, if we fix the resistance, the battery voltage will vary as the battery gets old and accordingly we must compensate the instrument sensitivity so that with a definite and fixed internal resistance full scale is always indicated. This may be done in any one of several ways.

Battery Compensation

A magnetic shunt is perhaps one of the most satisfactory methods of compensating for battery variation, but requires special construction in the instrument itself. A certain amount of scale distortion will also be present with different positions of the magnetic shunt simply because the flux distribution in the air-gap will change with the position of the shunt itself. While not of great importance in a small instrument it is definitely a factor, although the mechanical difficulties perhaps are of greater importance.

Another method of adjustment for battery voltage is to provide a variable shunt for the instrument movement itself. Since the resistance of the instrument movement is rarely more than 6 or 7 per cent of the total circuit resistance, shunting it down a matter of another 10 per cent will change the total circuit resistance by the order of considerably less than 1 per cent. The method is very simple to apply, simply requiring a small rheostat of suitable value. Practical ratios seem to indicate that the rheostat should have a maximum resistance of from ten to twenty times that of the instrument. In series with the rheostat is a fixed resistance to prevent the instrument from being completely short-circuited and this is usually from two and one-half to three times the resistance of the instrument movement.

This method, therefore, allows for the adjustment of the current sensitivity of the instrument to match the variation in the applied voltage and at the same time maintains the circuit resistance constant to within better than 1 per cent. If adjustments have been made at the center of the resistance variation, then the adjustment is good to considerably better than ½ of 1 per cent.

Making the analysis in this way, and considering the instrument as a resistance comparator, it will be seen that methods of adjustment using series resistance are inherently wrong in that they change the value R in the foregoing equations. It has been assumed by some that the change in effective battery voltage was not a change in open circuit potential, but rather a change in the internal battery resistance and that a series external resistance would compensate. This is not the case, however. The battery voltage drops even on absolute open circuit, as measured on a potentiometer, and the resistance increase is in general a very great deal smaller in terms of the circuit as a whole than the true drop in voltage.

Fig. 2.

Fig. 3. Model 663.

Fig. 7. Model 664.

Ranges

The resistance ranges supplied are largely the result of a study of the requirements. Ten (10) megohms seems to be the maximum which it would be necessary to measure; 5 megohm units are fairly common, but very few units of over 10 megohms in value are found in commercial receivers. In the design of a series type ohmmeter the left end of the scale is always infinity on any range. The practical top of the scale, however, is considered arbitrarily after the first division and this is 2½ per cent of the scale length. We may then allocate 10 megohms at this point.

In a series type ohmmeter, where the pointer indicates full scale on zero external resistance, the center scale point is equal to the resistance of the instrument circuit including all necessary series resistance. If, therefore, we consider the maximum reading as 2½ per cent of full scale, center scale is 1/40 of this value or 250,000 ohms. If the instrument resistance on the highest range is to be 250,000 ohms, we must

get an instrument of sufficient sensitivity so that it will give full scale deflection with this resistance as a part of its circuit on whatever battery used.

Microammeters

Recent developments in the design and construction of direct-current instruments have made available microammeters with ranges very considerably lower than have been heretofore available and in the present instance an instrument with a full scale sensitivity of 50 microamperes has been used. It is not very many years since 1 milliampere was considered as maximum full scale sensitivity on a small instrument and it will be seen that the present sensitivity of twenty times the older value is a very marked gain and has been made over the last decade. Magnets of special alloy steels of large cross section, coils wound from wire considerably finer than the human hair have both contributed to the increased sensitivity now available. Incidentally this sensitivity is by no means the maximum since in the present instance an instrument with a reasonably high torque was required; by reducing the torque as may be done for laboratory work, full scale currents of considerably less than 50 microamperes can be had.

With a sensitivity of 50 microamperes and a resistance of 250,000 ohms the battery voltage works out to be 12.5. It seemed in order to use a lower voltage for the lower resistance measurements and of course the lowest battery voltage is a nominal 1.5. A decimal ratio would, therefore, indicate 15 volts as the higher voltage. This fits very nicely and will allow for the 15-volt battery dropping in voltage a reasonable amount and will also allow for a slight increase in current due to that shunted by the rheostat for adjusting purposes.

For the next lower range in resistance the same current sensitivity is maintained with a single dry cell of 1.5 volts, the next lower range is obtained by shunting to 500 microamperes, the next by shunting to 5 milliamperes, then 50 milliamperes and for the lowest range the instrument is shunted to 250 milliamperes. This last value is considered as the maximum which can be taken from one of the larger unit cells

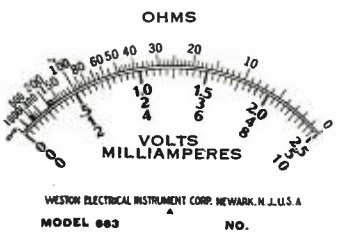
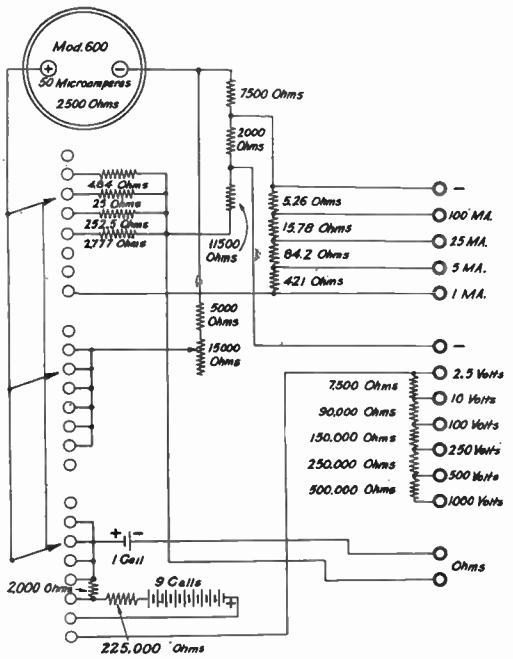


Fig. 4. Model 663 scale.

Fig. 5.



and as a matter of fact the battery resistance is a very definite factor in this range and must be considered in setting up the network. It is probable that the accuracy over the full scale is somewhat reduced on this low range because of the change in battery resistance over its useful life. This range, however, is used only for the very low resistances which are read at the extreme right of the scale adjacent to the point where the initial adjustment is made and the error is, therefore, small. For readings of over a few ohms the next range is selected.

This completes the electrical design with the selection of the instrument, its current and voltage values and the type of adjustment. The wiring diagram is shown in Fig. 5 in schematic form and it will be noted that a 3-pole 8-position switch is used, one blade of which selects the shunts to change the current drain of the instrument. Another blade throws in the battery adjusting rheostat and a third blade throws in the extra battery and resistance on the high range.

The center blade would not have been necessary except for the fact that the instrument is also supplied with four current ranges and six voltage ranges to increase its utilitarian value and it is necessary to remove the adjusting rheostat where absolute values are to be taken. As a voltmeter the instrument is shunted to 1 milliampere full scale; as a milliammeter its drop is several hundred millivolts because of the rather high resistance coil, but this is usually quite satisfactory where plate currents are to be measured.

While originally developed for radio servicing, the wide range of usefulness of this assembly has made it one of the most popular instruments in the plant. Wherever a department must determine possible troubles in an assembly, this particular combination volt-ohmmeter seems to be the best single unit. While not possessing the accuracy of a bridge in the measurement of resistance, it will nevertheless segregate resistance errors and will even read leakage values where these exist to spoil the functioning of an assembly. It is believed, therefore, that with its multiplicity of ranges, this instrument will find an increasing range of usefulness.

The Capacity Meter

A capacity measuring device can be built along the same general lines as the ohmmeter, using alternating current of a definite frequency and a sensitive alternating current instrument. The equations are somewhat more complex because the reactance of the condenser must be considered as such and instead of the somewhat simple equation we get,

$$\% \text{ deflection} = \frac{R}{\sqrt{R^2 + X_c^2}}$$

Converting this into a form wherein the capacity is shown directly in microfarads we have,

$$\% \text{ deflection} = \frac{R}{\sqrt{R^2 + \frac{10^{12}}{4\pi^2 f^2 c^2}}}$$

This may be further simplified to bring it into the form,

$$\% \text{ deflection} = \frac{R \times 2\pi f c}{\sqrt{R^2 (4\pi^2 f^2 c^2) + 10^{12}}}$$

Again it will be noted that voltage and current are not in the picture, but that the per cent deflection is purely a function of the resistance of the circuit, the capacity in series and the frequency. But most lines are today carefully controlled and we must thank the makers of electric clocks that we now have a sufficiently constant frequency to make reliable capacity measurements simply and directly.

The instrument used is adjusted to 250 microamperes full scale and is of the rectifier type. Adjustments for variation in line voltage are made by a variable shunt across the instrument movement itself where the resistance is relatively low and this in turn keeps the change of total circuit resistance to a small value.

The instrument is first connected in series with suitable resistance to bring it to 4 volts full scale; it is then shunted as required for the higher ranges. For measuring electrolytic condensers up to 200 microfarads, the instrument is adjusted to 100 milliamperes and functions at 4 volts tapped from a small transformer. This low value of voltage does not seem to do any damage to electrolytic condensers and no polarizing voltage is apparently needed. The scale is shown in Fig. 6 and will be seen to be remarkably uniform over a good portion of its length. The high range to 200 microfarads is obtained by switching as shown in Fig. 7 to a position marked × 10; the direct position adjusts the instrument to 10 milliamperes full scale. The position marked ÷ 10 calibrates the instrument to 1 milliampere still maintaining the 4 volts. The position marked ÷ 100 removes the shunts so that the instrument functions at ¼ milliampere sensitivity and the 10-volt transformer tap is brought into play. The position ÷ 1,000 is the highest sensitivity of ¼ milliampere and 100 volts. This is used only for small fixed condensers and no difficulty has been had with breakdown. With this range it will be noted that the center point on the scale is 0.004 mf. The first main division is 0.001 mf. or 1,000 micromicrofarads. This is divided into 10 parts so that the first small division is 100 micromicrofarads. An ordinary 23-plate tuning condenser gives a nice indication. It is somewhat surprising to many engineers to see a sufficient amount of 60-cycle energy pass across the air-gap of an ordinary tuning condenser to give a readable indication on a commercially obtainable instrument.

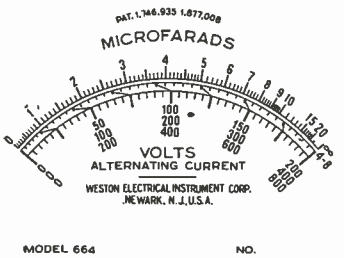


Fig. 6. Model 664 scale.

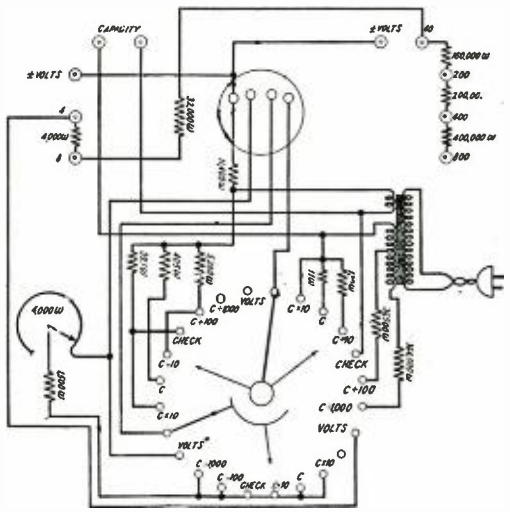


Fig. 8. Connections of capacity meter.

The diagram, Fig. 8, is somewhat similar to the ohmmeter in that a multiple blade switch is used which picks up the shunts, the series resistance and transformer taps and throws in the adjusting shunt. A position is arranged for a series of voltage readings to extend the usefulness of the instrument.

While the rectifier type of instrument somewhat limits the accuracy of a device of this sort, its very wide range of usefulness from air dielectric tuning condensers up to larger electrolytics makes it a most desirable unit for checking capacities. It is being used not only in the radio laboratory, but in many plants manufacturing other equipment where condensers constitute a part of the apparatus.

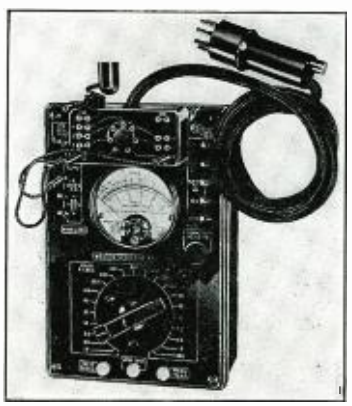


Fig. 9. Model 665 showing Model 666 unit mounted thereon.

The Selective Analyzer

A new method of attack on the general problem of analyzing a radio set for the location of trouble has been presented within the last few weeks.

Fig. 10. Model 666 unit.

The general problem in taking voltage, current, resistance and capacity readings in a radio set through the medium of a cord and plug from some tube socket has been that if switching arrangements were supplied to take the necessary measurements across and in each required circuit, such switching arrangements would today be entirely too complex and elaborate to be worth while. This is largely because of the fact that recent tubes may place their several electrodes on any pin and measurements of any range whatever may be required across any pins or in any circuit. This should be contrasted with the situation a year or two ago where the plate, and a single plate at that, was always associated with a definite pin position; the same held true of the cathode and the control grid.

To give sufficient flexibility a pin jack arrangement with small patch cords has been selected. Furthermore, the units into which these patch cords are plugged have been made separable from the instrument unit. This latter feature is of

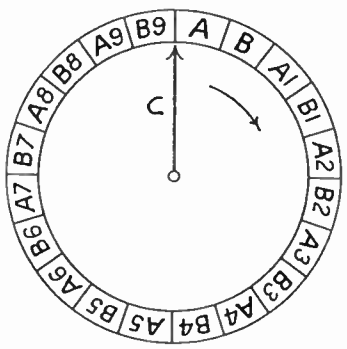
(*Concluded on page 23*)

PAIRED BROADCASTS

IS the line distributor employed for half a century or thereabouts by Baudot, Delany, and others for multiplex telegraphy, Morse and printing telegraphs, by wire, to be applied in radio broadcasting to double the number of transmissions over a single carrier wave? It would seem so from experiments being made in Holland.

Paired transmission as it is called in Europe is based on the use of a mechanical distributor, which, rotating continuously, connects the r.f. output of two transmitters, successively to the antenna system, at such time sequences as not to interrupt the outgoing matter from either transmitter.

At the transmitting end it is stated that in the experiments under way the two programs are switched in and out by means of a local oscillator tube, which applies or removes a paralyzing



grid bias from two separate amplifier tubes, coupled to the same modulator.

At the receiver two input tubes are used. A weak oscillator synchronized with that at the transmitter serves to bring one or the other of the two input tubes into operation at proper intervals.

At the transmitter, suppose that a contact arm C, Fig. 1, is by means of a motor caused to rotate rapidly over the separated contacts A, A_1, B, B_1, etc., and that the A segments are connected to one microphone while the B segments are connected to a second microphone. Then if the contact arm is connected to a single antenna system the two studio outputs will for practical purposes each be continuous and uninterrupted.

In radio engineering circles in the United States the possibility of applying this principle to radio transmission has occasionally been discussed in past years, particularly with respect to code signaling.

The experiments in Holland will be watched with interest.

◆ ◆ ◆

BROADCASTERS EXPECT BUSINESS EXPANSION

AFTER conferences with licensees of radio broadcasting stations in Illinois and Wisconsin, held recently in Chicago Federal Radio Commissioner James H. Hanley, of the Fourth Radio Zone, is convinced that there is a healthy up-turn in business. He found the station licensees most optimistic over the trade outlook. He added:

"They are militant in their demands for more time and more power, so as to increase their service areas. They are convinced that we are on the verge of a big trade revival and are anxious to be prepared to take care of expected increased demands for radio facilities on the part of manufacturers and distributors of the necessities and luxuries of life."

While sympathetic to their pleas, Commissioner Hanley pointed out that unless and until radio engineers provided more radio channels for use in the United States, it is physically impossible to grant these requests.

Commissioner Hanley reported that he received little or no encouragement when he suggested that the smaller stations get together and pool their radio facilities. He explained:

"Such mergers, in many instances, in my judgment, would solve the problem of many of the smaller stations. Such consolidations would not conflict in any way with the federal anti-trust laws or violate the anti-monopoly clause in the radio act.

"But the licensees turned a deaf ear to my suggestion as they are convinced all radio stations face a bright future."

Commissioner Hanley received many complaints while in the Middle West regarding the broadcasts from Dr. John R. Brinkley's station now located in Mexico.

"The people resent having reception from their favorite stations in the United States spoiled by interference from a station ruled off the air by the Radio Commission. I told the protestants that while I was not a member of the Commission when Brinkley, Rev. Bob Shuler, and Norman Baker were taken off the air, I am in thorough sympathy with that action, which was upheld by the Court of Appeals of the District of Columbia.

"Progress is being made through diplomatic channels in clearing up the intolerable interference to our stations caused by stations established in Mexico by discredited broadcasters from this country. The American delegation, headed by Judge E. O. Sykes, Chairman of the Federal Radio Commission, laid the foundation for an amicable adjustment. As a respected and reputable nation, Mexico, when she learns all the facts, will no longer offer succor and a refuge to such outlaws."

◆ ◆ ◆

RADIO TESTING INSTRUMENTS FROM THE ENGINEERING VIEWPOINT

(*Concluded from page 22*)

great value since the arrival of new tube basing arrangements as may be had for 8, 9 or 10 pins will simply require the acquisition of another one of the small units; the instrument itself will not be changed in the least since it is simply a combination voltmeter, milliammeter and ohmmeter.

In Figs. 9 and 10 are shown the several units, there being a separate plug, cord and socket arrangement for each 4, 5, 6 and 7 prong base. These fit mechanically, by means of a pair of pins and jacks on the instrument proper. The ranges of the instrument are 1, 2.5, 5, 10, 25, 50, 100, 250, 500 and 1000 volts, both d-c. and a-c. (rectifier type). Current ranges are 1, 2.5, 5, 10, 25, 50, 100, 250 and 500 ma. d-c. Four ranges of resistance measurements are supplied, the low range reading to 1 ohm for the first division and the highest range going up to 1 megohm. Potential is also available for shifting the grid 4.5 or 13.5 volts and this potential in turn can be placed on any of the several grids selectively by use of the patch cords.

While this development is relatively recent, it is believed that its very great flexibility will reduce obsolescence in equipment of this sort and when used in conjunction with auxiliary instruments such as the capacity meter and the ohmmeter of wide coverage described in the first part of this paper, will give a set of laboratory apparatus with which the serviceman can be prepared to take care of all his several requirements for many years to come.

A chronological history of electrical communication —telegraph, telephone and radio

◆

This history began with the January 1, 1932, issue of RADIO ENGINEERING. The items are numbered chronologically, beginning at 2000 B.C., and will be continued down to modern times. The history records important dates, discoveries, inventions, necrology and statistics, with numerous contemporary chronological tie-in references to events in associated scientific development. The material was compiled by Donald McNicol.

◆

Part XXIV

1899 (*Continued*)

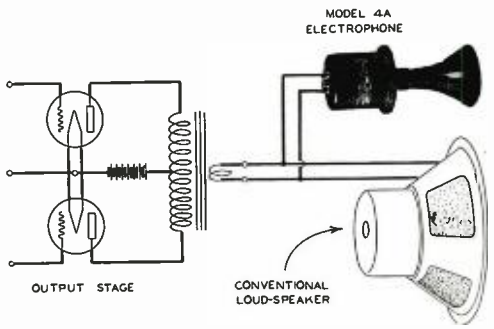
(949) Wireless telegraph communication is established across the Strait of Dover between Wimereux, France, and the South Foreland Lighthouse, England.
(950) In July, British warships are equipped with Marconi apparatus. A distance of eighty-five miles is bridged by wireless.
(951) A paper-insulated power cable is installed between Minneapolis, Minn., and St. Paul, Minn., a distance of ten miles. The cable was tested at 120,000 volts.
(952) Electrical Standardization Rules, prepared by an Institute Committee, are adopted by the A.I.E.E.
(953) Reginald A. Fessenden, of Washington, D. C., develops improvements in methods of wireless telegraph signaling.
(954) Hayes, in New York, transmits music over a beam of light.
(955) The Pollak-Virag system of telegraphy is tried out on lines in the United States.
(956) Robert W. Bunsen dies. (Born in Germany, 1811.)
(957) In Italy a Centennial Congress is held in honor of Volta. Delegates attend from the telegraph administrations of all large countries. Hon. Walter C. Burton, New York, represents the telegraphers of the United States.
(958) During the International Yacht races between the *Columbia* and the *Shamrock* off New York harbor, September, the New York *Herald* uses wireless telegraphy to report the progress of the race.
(959) United States war vessels make trials of Marconi's wireless telegraph system. The cruiser *New York* and the battleship *Massachusetts* are equipped with apparatus.
(960) The British war office sends six Marconi electricians to South Africa with wireless telegraph apparatus for use by the army and navy in the British-Boer war.
(961) The American Telephone and Telegraph Company Company takes over (December 11) the American Bell Telephone Company.
(962) Electrically driven automobiles are used in light truck service.
(963) George O. Squier reads a paper before the A.I.E.E., New York, on the subject of An American Pacific Cable.
(964) Warren De La Rue dies. (Born in France 1815.)
(965) The first turbine electric generators used in America are installed in the power house of the Westinghouse Electric and Mfg. Co., at Wilmerding, Pa.

1900 (966) Wireless telegraph apparatus is installed on the German ship *Kaiser William Der Grosse.* (March.)
(967) The Marconi International Marine Communication Company, organized, April 25, in London.
(968) Carl Hering is elected president of the A.I.E.E.
(969) M. I. Pupin perfects the Pupin loading cell for telephone circuits.
(970) At Purdue University a 60-cycle, 210,000-volt transformer is built.
(971) Dudell, in England, discovers that a direct-current arc shunted with a condenser in series with a self-inductance coil will, under certain conditions, give out a musical note, and transform part of the direct-into alternating-current with constant amplitude.
(972) A German-American transatlantic cable is laid from Emden, Germany, to New York, by way of Fayal. Completed August 30.
(973) The Rocky Mountain Telegraph Company, in Montana and Utah, is absorbed by the Postal Telegraph-Cable Company.
(974) The Donald Murray printing telegraph system is tried out in the United States.
(975) T. A. Edison begins experiments on a new type of storage cell.
(976) Alcock procures a United States patent (648,677) covering the invention of an animated electric sign.
(977) Joseph Sachs is granted (October 23) a United States patent (No. 660,341) for an improvement in inclosed fuses.
(978) Dr. S. S. Wheeler, of New York, purchases the Latimer Clark collection of electrical books and pamphlets in London and presents these to the American Institute of Electrical Engineers, New York.
(979) The Driver-Harris Wire Company organized, at Newark, N. J.
(980) Upon completion of the German-American Cable the German Emperor conferred upon George G. Ward, vice-president of the Commercial Cable Company, New York, the order of the Royal Prussian Crown of the second class.
(981) David E. Hughes dies. (Born in United States 1831.)

1901 (982) Marconi wireless telegraph service is inaugurated between islands of the Hawaiian group, March 1.
(983) The Canadian Government orders two Marconi telegraph sets for use at coast points along the strait of Belle Isle.
(984) The lines of the Western Union Telegraph Company along the Pennsylvania Railroad, New York to Pittsburgh, are removed by the railroad company (May) and a contract is made with the Postal Telegraph-Cable Company providing that the latter company build lines to replace the ones removed.
(985) Important improvements are made in telegraph main line switchboards by J. F. Skirrow, New York.
(986) The American Telephone and Telegraph Company acquires the use of Pupin's loading coil inventions.
(987) A transpacific submarine telegraph cable is planned and authorized by Great Britain, including Canada and Australia.
(988) James D. Reid dies. (Born in Scotland 1819.)
(989) The Commercial Pacific Cable Company, a Mackay enterprise, is incorporated, September 23.
(990) An additional transatlantic cable is laid by the Commercial Cable Company, between Canso, Nova Scotia, and Waterville, Ireland, by way of the Azores.
(991) The telephone is used for train dispatching purposes in Australia.
(992) Charles P. Steinmetz is elected president of the A.I.E.E.

(To be continued)

High-Fidelity Sound Reproduction



Now Simply Obtained by Adding the New Model 4A High-Frequency Electrophone to Existing Equipment

The range of sound reproduction may be considerably extended at the high-frequency end by connecting a Model 4A Electrophone unit across your present loud speaker as shown by the diagram. This unit is of the piezoelectric type and is scientifically designed for the efficient and distortionless reproduction of the higher audio frequencies. Its frequency response characteristic complements that of the average loud-speaker.

No Filters or Field Supply Required

Due to the parallel combination of capacitive reactance of the piezo-electric diaphragm employed in this unit and the inductive reactance of the low-frequency speaker the power divides naturally between the two units. This connection also improves the power-factor of the output circuit. No field excitation required. This results in a simplicity and saving of cost not possible with other types.

Built in accordance with designed specifications of Boonton Research Corporation (see article by Stuart Ballantine, "Proceedings of the Institute of Radio Engineers," October 1933, and article by W. G. Ellis, "Radio Engineering," October 1933).

Send for free Technical Bulletin 1H.

ELECTROPHONE CORPORATION

2019H Rittenhouse Square **Philadelphia, Penna.**

Licensed under patents and applications of
Boonton Research Corporation and Brush Development Company.

TUBE DATA IN HANDY FORM

Taking into account the multiplicity of tubes during the past year, the Hygrade Sylvania Corporation of Emporium, Pa., has issued a bulletin containing tube data required by the engineer. The bulletin divides the existing standard tubes into various groups, such as the 6.3 volt group for a-c. or d-c. operation, the 2.5 volt group for a-c. or d-c. operation, the 2.0 volt group for battery operation, special tubes including many of the former popular types which have now disappeared from current radio sets and amplifiers, and finally the rectifiers.. The data includes type number, use, base, bulb size and design, cathode description, filament amperes, maximum plate voltage, maximum screen grid voltage, working plate voltage, negative grid voltage, screen voltage, plate current, plate resistance, mutual conductance, amplification factor, ohms for stated power output, and undistorted power output. The bulletin includes a bottom view of the bases of all standard tubes, indicating the elements connecting with the various prongs, as well as top cap. There is also a diagram of the various glass bulbs together with dimensions, for the convenience of those designing or building compact assemblies and tube shields. The latest tubes are described at length. The bulletin will be sent to any one on request.

◆

SHIELD PATENT GRANTED GOAT RADIO TUBE PARTS, INC.

Goat Radio Tube Parts, Inc., of Brooklyn, N. Y., announce the issuance to them of patent No. 1,933,109 covering the assembled shield for screen-grid tubes, developed by them.

This invention covers the assembled outer screen grid or shield, consisting of a cylinder of mesh or perforated nickel, to which the top disc is securely crimped, forming an ideal mechanical and electrical connection.

It is stated that Goat Radio Tube Parts, Inc., developed this improved assembly shortly after the introduction of the screen-grid tubes. At that time the tube manufacturers were welding separate pieces of mesh and discs together.

◆

TRANSMITTERS FOR POLICE RADIO

Transmitters with a nominal rating of 250 watts, designed to give economical operation on powers as low as 50 watts, are being developed by the Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa. These sets have base dimensions of 45 by 22½ inches and stand 72 inches high. Inside, there are two vertical racks, each containing individual panels. Each panel is an individual unit of the transmitter and may be removed for inspection or replacement. The circuit is of fixed frequency.

CATHODE RAY TUBES

The Allen B. DuMont Laboratories, Upper Montclair, N. J., announce a reduction in price on two of the most popular tubes in their line, the Type 34 with a 3-inch screen and the Type 54 with a 5-inch screen.

This has been made possible due to the fact that the increased sales of these types has made it economical to tool up to manufacture them on a semi-production basis and the savings thus made are being passed on to customers.

The prices on the other tubes remain the same as before. As soon as the demand is sufficient, however, on these types to effect savings, they will be passed on to the consumer.

No sacrifice has been made in quality and the guarantee of 350 hours of operation, or six months, which ever comes first, still applies on all types when used in DuMont equipment.

◆

POLICE RADIO TO HIGHER FREQUENCIES

The continuously increasing number of applications to the Federal Radio Commission from municipal police departments for wave length assignments has caused anxiety as to cluttering up the 1500-1600 kc. territory in the spectrum.

In this respect relief is in sight as grants are being made in the nine-meter band for police work. One good result of this shift to shorter waves is that eavesdropping on the part of broadcast listeners whose sets tune beyond the upper limit of the program band, will be less prevalent. Police officials naturally are opposed to these communications being intercepted by persons merely curious, and those who seek advantage in learning of police car movements.

◆

TRANSFORMERS AND CHOKES

Ferranti Incorporated, of 130 West 42nd Street, New York, N. Y., have just published a new 1934 catalog covering transformers and chokes for use in the communication field.

This catalog covers up-to-date precision transformers for use with the more commonly used types of vacuum tubes.

The Ferranti Company have extended their New York laboratory and engineering facilities, and are now specializing in the production of iron core products.

A copy of this catalog may be obtained by writing to the above address.

◆

COURT APPOINTS MAJESTIC RECEIVERS

On December 5, the United States District Court ordered the appointment of Le Roi J. Williams and Thomas L. Marshall as permanent receivers for the Grigsby-Grunow Company, manufacturers of Majestic radios, refrigerators and tubes. Broad powers have been granted the receivers by the court order, and they have been authorized to carry on the business and properties as a going concern.

"This order," stated Mr. Williams, "places Majestic in a position where we can continue and consummate our manufacturing, merchandising and advertising plans for the coming refrigeration and radio seasons. This is definite recognition of the fact that Majestic has a splendid future and that nothing should be done to retard or handicap the company in any manner whatsoever. It is further proof that our operations will be carried on for the promotion and the sale of Majestic products on a sound business basis, and that Majestic will continue to maintain its high position in the radio and refrigeration industries."

Figures released during the past several months show that sales of Majestic products, since Mr. Williams became general manager last March, have not been equaled since 1930 for a like period. More than 300,000 Majestic radios have been shipped in the current year, which far exceeds the previous two years.

◆

HEARING AID DEVICE

The month's blueprint service from Universal Microphone Co., Inglewood, Cal., includes one for its hearing aid device model HA1.

It shows a recommended circuit when using a multiple headphone outlet. The volume control should be set at a maximum, and volume controls at each outlet should be adjusted by the individual user.

The use of the Universal device, originally adapted as a home set, has now become available for use in churches, theaters, lodge rooms and other places where several hard-of-hearing people are congregated.

◆

BOOKLET ABOUT RADIO TELEPHONY

Robert S. Kruse, of North Guilford, Conn., has issued a little book entitled "Kruse's Radiophone Guide," which contains a carefully selected list of papers dealing with radio telephony. The material is of real value to broadcast operators and to those using voice equipment.

◆

NEW GENERAL TRANSFORMER CATALOG

The General Transformer Corporation, 500 S. Throop Street, Chicago, announce their new 1934 catalog of power-supply replacement units, input and output transformers, chokes, and special filament and power transformers.

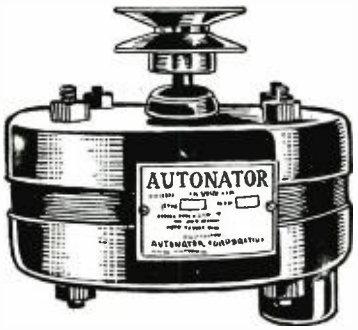
This new catalog is very complete—all data necessary to the Service Man being included. General Transformer Corporation will send you one gratis. Just drop them a line.

NEW DEVELOPMENTS OF THE MONTH

AUTONATOR POWER SUPPLY

The Autonator Laboratories, Inc., 8440 South Chicago Ave., Chicago, Ill., have developed a simplified generator without brushes, collector rings, commutator or wire-wound armature to require service, for furnishing 110 volts a-c in automobiles. The unit is actually an alternator.

This device, called the Autonator, is made to work directly off the fan belt of any motor vehicle, or by direct coupling to a stationary engine. Provision is made for the regulation of voltage at all speeds. It is claimed that the Autonator cannot be burned out or overloaded.



It is particularly applicable to the operation in passenger cars or trucks of a-c radio sets or public-address equipment.

The Autonator is available in six sizes —50, 100, 150, 250, 350 and 400 watts. Each size is sold complete with armored cables, double outlet, switch, and mounting brackets.

◆

REACTANCE METER

The Premier Crystal Laboratories, Inc., 53-63 Park Row, New York, announce a reactance meter Type 165, for capacity and inductance measurements. In principle the zero beat method for capacity and inductance comparison has been extended to cover a wide range of values by the use of a specially designed ratio coil and a sensitive method of zero beat indication.

Further information will be forwarded upon request to the laboratories.

◆

BROADCAST TRANSMITTER IMPROVEMENT

The Western Electric Company has produced a set of conversion parts for its 6 types (1 kilowatt) radio broadcast transmitters. This equipment, in addition to eliminating motor-generators, will increase the modulation capability of transmitters of this type to 100 per cent by increasing the plate voltage applied to the last radio-frequency power amplifier from 4,000 volts to 5,000 volts.

The essential unit in the set is a 5,000 volt mercury vapor rectifier which replaces the existing 2,000/4,000 volt motor-generator. The 5,000 volt supply permits operation of the final power amplifier tube of the transmitter at that part of its characteristic which allows full use of its capacity to pass all the power required for 100 per cent modulation, with an attending audio harmonic content well within the requirements of the Federal Radio Commission. Eliminating the generator also increases dependability and ease of maintenance.

The conversion requires only minor changes in the transmitter. Operation remains virtually unchanged. Stations operating not more than 17 hours per day can be converted in about three days without time off the air.

The 6 type transmitter was first put on the market about seven years ago. More than 100 are in use at present. While the fundamental design remains standard, two previous conversions have been made available. The first offered a quartz crystal controlled oscillator capable of maintaining the carrier frequency well within the Federal Radio Commission's requirement of ± 500 cycles and the outstanding development of deep modulation. The second of these conversions made available extremely stable crystal oscillators for meeting the Federal Radio Commission's requirement of ± 50 cycle control of the carrier.

◆

ARCTURUS DEVELOPS QUICK-HEATER 43 TUBE

A new development in radio—a quick-heater type 43 power pentode tube, that operates in 13 seconds—has been announced by the Arcturus Radio Tube Company, Newark, N. J.

Besides enabling quicker reception, this

development also lengthens the life of other tubes in the set, particularly in series-operated a-c.—d-c. receivers.

◆

STAND OFF INSULATORS

The Birnbach Radio Co., Inc., 145 Hudson St., New York, is marketing a stand-off insulator having unique design and novel features. The body is made of a good grade of porcelain, glazed with smooth finish suitable for high-frequency work. These insulators are supplied in several sizes ranging from ⅝ in. to 1¼ in.

high and come complete with nickel plated brass hardware. The ⅞ in. and 1¼ in. sizes are supplied with jacks, desirable for plug-in coils, chokes and all types of high voltage apparatus.

◆

A GENERAL PURPOSE TUBE

Type F-100-A vacuum tube being marketed by the Federal Telegraph Company, 200 Mount Pleasant Avenue, Newark, N. J., is a general purpose tube of real usefulness.

This tube is of rugged construction, high interelectrode insulation and unusually broad frequency range. The efficiencies range from 30 to 40 per cent, on wave lengths lower than five meters. It is a 3-electrode tube with a tungsten filament. The plate current is 175 milliamperes, the amplification factor 14, plate resistance 7000 ohms and the mutual conductance 2000 micromhos.

The operating limits are:
Maximum plate voltage, 5000 volts.
Maximum d-c. plate current, .500 ampere.
Maximum plate dissipation, 500 watts.
Maximum r-f. grid current, 30 amperes.
Maximum d-c. grid current, .100 ampere.
The overall dimensions are:
Maximum length, 15⅝ inches.
Maximum radius, 5⅝ inches.
Minimum length, 15⅜ inches.

◆

NEW DYNAMIC MICROPHONE FOR SOUND SYSTEMS

The Lifetime Corporation, 1306 Dorr Street, Toledo, Ohio, announces a new dynamic microphone for sound systems. This instrument is of the permanent magnet type—35 per cent cobalt. It has a .001 inch diaphragm with aluminum coil attached. The microphone is 3 inches in diameter, 3 inches deep and measures 8 inches high with deck stand.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS
OF MARCH 3, 1933, OF RADIO ENGINEERING
Published monthly at New York, N. Y., for October 1, 1933.

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

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 19 East 47th Street, New York. Editor, Donald McNicol, Roselle Park, N. J.; managing editor, F. Walen, Union City, N. J.; Business Manager, B. S. Davis, Scarsdale, N. Y. 2. That the owners are: Bryan Davis Pub. Co., Inc.; B. S. Davis, Scarsdale, N. Y.; Roy T. Atwood, Albany, N. Y.; G. R. Bacon, Douglaston, N. Y.; J. C. Munn, Cleveland, O.; J. A. Walker, Richmond Hill, N. Y.; A. B. Goodenough, New Rochelle, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also, that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

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

Sworn to and subscribed before me this 1st day of October, 1933.
(Seal) J. A. WALKER, Notary Public.

Queens Co. Clk's No. 2982, Reg. No. 7176
New York Co. Clk's No. 655. Reg. No. 5-W-424.
Commission expires March 30, 1935.

INDEX TO ADVERTISERS

"WE CANCELED OUR FACTORY INSPECTION AND RELY ON ERIE'S OWN TESTS"

Because resistors furnished by us over a period of years have so consistently been well within their specified resistance tolerances, several leading radio manufacturers have eliminated their factory inspection of Erie Resistors.

Modern manufacturing methods on machinery of our own design, plus triple inspection of each resistor, guarantees a finished product that satisfies the most rigid specification.

Every radio manufacturer can cut production costs by specifying Erie Resistors and eliminating factory tests. Why not take advantage of this large saving through the use of precision-tested Erie Resistors?

Top: An automatic machine of our own design that electrically tests and sorts Erie Resistors according to their tolerances.

Above: Finished resistors being checked by a skilled operator.

NRA

ERIE RESISTOR CORPORATION

ERIE, PA.

Factories in ERIE, PA.-TORONTO, CANADA - LONDON, ENG.

BROAD-BAND

The Mark Of A Superior Line Of Wide-Range High-Fidelity Reproducers

ELECTRO-DYNAMIC HIGH FREQUENCY LOUD SPEAKER

This precision-built loudspeaker is designed to faithfully reproduce all components present in the audio source from 3000 to 12000 cycles, uniformly, without peakiness, shrillness or over-accentuation. The construction, while maintaining characteristic high-sensitivity, is rugged and durable. The loudspeaker may be subjected to temporary overloads at operating intervals without permanent serious injury to the driving system. In operation, the loudspeaker is free from temperature and other atmospheric effects and can be operated under all climatic conditions.

Supplied with horn, in one assembly, as illustrated. Six volt or 110 volt field ratings. Voice coil impedance 15 ohms at 3000 cycles. Weight 3 lbs.

For large theatre and public auditorium installation, the use of the RACON TWO-BAND Filter Network is recommended. This accessory gives predictable and controllable sound projection. It aids in eliminating echo and reflection and makes practical a sound distribution, in balance with the architectural features of the auditorium. Such control is difficult with filterless devices.

Send for Data Sheet RE 12

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52 EAST 19th STREET NEW YORK CITY

LONDON, ENGLAND TORONTO, CANADA

Sales Offices in Principal Cities