and it is MAGNETO-INDUCTIVE ... most important wide range development since the advent of pick-ups in 1926 ... a system capable of reproducing in all its fine detail exactly what the microphone delivered at the original performance. For years Radio-Music has striven toward this ideal. How appropriate ... that AUDAX, pioneer in electro-acoustical evolution, should cap its brilliant record with this epochal forward stride! Skip technical data for the present ... just listen to absolute fac-simile reproduction ... a revelation to engineers and laymen alike. Truly, your conception of pick-up performance will be entirely revamped when you have heard MICRODYNE.

AUDAX COMPANY, 500 Fifth Avenue, New York.
"Creators of High Grade Electrical and Acoustical Apparatus Since 1915"

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COVER: Steeplejacks erecting unique radiator on top of Empire State Building in preparation for RCA television field tests. Photo made from McGraw-Hill building through 25-power telescope at a distance of over one half mile.

FCC Reviews U-H-F Region
Reporting the June 15th hearings, at which the needs of various services for assignments below ten meters were heard

3-Meter Facsimile
RCA Communications institutes service between New York and Philadelphia in first commercial use of frequencies of the order of 100 megacycles

Photometering Raw Silk
How electron tubes are being used to measure the "evenness" of silk for stockings, an Electronics experience story

Broadcast Transmitter Adjustments
Efficient transfer of energy, freedom from harmonic radiation result when tank circuits, and transmission lines are properly engineered.

Loud Speaker Testing
Second in a series of articles on loud speakers. The first appeared in February Electronics and dealt with the design of loud speakers.

1937 Radio Receivers
Fall lines of merchandise are replete with new technical features. Automatic tuning control, static limiter, high-fidelity phonograph, better dial systems, etc., etc.

Emporium's "Summer Seminar"
A two-day get-together by technical papers, and all the fun.

Radiation Counting
by Bernard H. Po
Cosmic rays, alpha particles, are counted at high grid-controlled rectifiers

Feedback Amplifier
The Bell Telephone Laboratories are working to eliminate the degeneration. Now it will cast, transmitters, in home.

Photo Transmission
W. G. Flinch demonstrates transmission system using telephone lines

Band-Pass Characteristic
by H. W. Jaderho
Text and chart showing by plotting are related to band-pass circuit Q's

Departments
Crosstalk
Reference Sheet
Tubes At Work
Electron Art
Manufacturing Review

McGraw-Hill Publishing
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99-129 North Broadway, New York

James H. McGraw, Jr., President
Howard Ehrlich, Vice-President

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WHERE SPACE IS AT A PREMIUM

USE STACKPOLE NEW SUPER MIDGET TONE CONTROL

APPROXIMATELY 2½ TIMES ACTUAL SIZE

WRITE for your sample Super Midget Control and Engineering data. One to four point tone switches are also available in the super midget size.

STACKPOLE CARBON CO.
ST. MARYS, PENNA.
Manufacturers of quality resistors, suppressors, switches, controls and tone switches

July 1936 — ELECTRONICS
THE "LOOP TEST"
Take a 3-foot or longer length of shaft. Hold it at the ends as shown with the loop resting on desk or table. Then rotate it with the fingers in either direction.

The "Loop Test" tells the tale
. . . brings out an invisible art
S. S. WHITE REMOTE CONTROL FLEX

1 LOW INTERNAL FRICTION
2 MINIMUM TORSIONAL DEFLECTION
3 EQUAL DEFLECTION FOR EITHER DIRECTION OF ROTATION

This test shows that the shafts for auto radios, turn curved, without any trouble, with LOW INTERNAL FRICTION, MINIMUM TORSIONAL DEFLECTION, and EQUAL DEFLECTION OF ROTATION is a characteristic a flexible shaft suitable for auto radios, and like the other two, of the shaft. To combine all three in the one shaft is a real problem. In S. S. WHITE Remote Control Shaft, we can provide correct balance.

The S. S. WHITE Den
INDUSTRIAL DIV.
10 East 40th St., Room 2310E, New York

ELECTRONICS — July 1936
Save Chassis Material Cost with MALLORY Standard Dry Electrolytic Capacitors

Regardless of your present capacitor specifications, a Mallory unit will meet your production and performance requirements with greater satisfaction and at less expense! This is possible through a new method of standardization which substantially lowers production costs.

Save Production Time!
In most cases, a single Mallory Capacitor, in round metal can or cardboard tube, completes your electrolytic capacitor requirements. No need for several individual capacitors; punching extra chassis holes; buying or making extra mounting brackets. Mallory Capacitors are available in correct voltage and capacity combinations to fit your circuit.

Save Chassis Space!
When you specify new, compact Mallory standard combination capacitors, chassis space originally required for several individual capacitors may be otherwise utilized—or the chassis size may be reduced.

With standard Mallory Capacitors, extra cathode bypass capacities may be included at slight additional cost—providing added savings and reducing chassis space.

Mallory engineers will gladly cooperate in the selection of the capacitor that best meets your needs.

MALLORY DRY ELECTROLYTIC CAPACITORS

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA

Cable Address — PELMALLO

July 1936 — ELECTRONICS
Crosstalk

ARGUS . . . Candid photos made at the IRE Cleveland Convention were presented in Electronics last month. Several of these shots were made by Dick Purinton of Raytheon using an Argus camera; others were made by the editors with a Leica camera. The Argus is made by the International Research Corporation in Ann Arbor, a subsidiary of the International Radio Corporation, and marks the beginning of a new line of radio camera and marking the entry of the Research Corporation into the field of radio research.

Several shots were made by the IRE editors with a Leica camera. The photographer was Leica. The effort was not a success, and was not intended to be. The IRE editors were not interested in using a Leica camera, but were interested in using a radio camera. The Argus camera was intended to be used for photography, not for radio research.

HOME WIRED RADIO . . . At the recent distributors’ meeting of United American Bosch, held in New York, Chief Engineer L. F. Curtis described a method by which programs can be piped into one’s home. The program voltages on this wire and the BX grounded covering will now be picked up by any outlet in the house.

PATENT EVALUATION . . . When the inventor wants to patent his invention, the manufacturer offers him only a thousand, how can equitable price be determined?

For example, assuming an annual royalty of $1000 and a useful life of 4 years, the price, in round numbers, would be $3,470.

But if the invention is divided by two, three or four (in some instances), a price can be reached that should be satisfactory to both patentee and manufacturer. At least it offers a solid basis for negotiation.

THAD. R. GOLDSBOROUGH

100 YEARS OLD . . . Speaking of patents, July 4 this year marks the hundredth anniversary of the present patent system.

LIFE EXPECTANCY . . . Industrial users of tubes, actual or potential, are greatly interested in the life that may be expected from these electron devices. One manufacturer of electrical equipment, enthusiastic about his experience with electronic equipment, states that “if electronic tubes can be guaranteed for a minimum life of 5000 hours, then...”
HIGH . . . WIDE . . . HANDSOME

High in frequency, wide in bandwidth, handsome in design, this seven-meter power amplifier constructed by Safar of Milan supplies 1400 watts of television signal for Italian experimenters.
Informal hearings held before Communications Commission to determine needs of various services in ultra-high spectrum. New standard broadcasting and facsimile proposed

On June 15th there began what is probably the most comprehensive statement of evidence ever presented on the ultra-high radio frequency spectrum. The region above 30 megacycles (below ten meters) was thought only five years ago to be barren ground by everyone except a few pioneering amateurs. Now these frequencies have assumed front rank importance, and the number of uses for them has increased to the point where commercial, governmental and educational groups are demanding permanent allocations. In this region, as well as on the lower frequencies, it appears that there are far too few frequencies to supply the demand, despite the fact that “below ten meters” was once thought to be a limitless territory in which all those interested could find room. The situation has reached a point, in fact, where a thorough review of the conflicting demands is necessary; this fact has prompted the Federal Communications Commission to hold a series of informal hearings in which all interested parties could present testimony relative to the needs of their services. The hearings, held in Washington before the FCC, began June 15th and continued for nearly two weeks thereafter.

Chairman Prall states purposes

The purposes of the hearings, to quote the FCC Chairman, Anning C. Prall, were five: “(1) To determine the present and future needs of the various classes of service for frequencies above 30,000 kc., with a view toward ultimately assigning such frequencies to services; (2) to secure for the public and the Commission a keener insight into the conflicting problems which confront the industry and the regulatory body in the application of the new frequencies to the service of the public; (3) to guide experimentation along more definite lines as may be justified from the evidence presented at the hearings; (4) to review present frequency allocations to services in the radio spectrum below 30,000 kc.; and (5) to assist the government in its preparation for the International Telecommunications Conference in Cairo in 1938.

The whole spirit of the investigation can be summed up in Chairman Prall’s words “We are, and we believe everyone else is, tremendously interested in intelligent estimates of the future of radio.” As such, the great mass of testimony presented is of extraordinary interest to everyone even remotely connected with the electronics industries, especially since further extension of vacuum tube technique in radio will undoubtedly come in the ultra-high frequency region.

A truly staggering amount of evidence was presented. The agenda of the hearings listed 15 items and 75 separate presentations of testimony by nearly a hundred different individuals. Nearly 250 of the country’s foremost radio engineers and executives registered as attending the hearings. From such a group of conflicting opinions and “facts” it is, of course very difficult to make many generalizations. In fact, no one anticipated how many different uses for the frequencies were being actively developed by commercial and governmental groups. In addition to the well-publicized needs of television, there appeared an “apex” broadcasting, facsimile broadcasting, frequency modulation broadcasting, maritime telegraph and telephone, airport and aircraft service, point-to-point telegraph and telephone, civil and military government services, police radio, relaying service, and the amateur requirements. Many highly specialized services were also represented, such as the public utility (light and power) industry, forestry fire service, equipment for movement of equipment finders, aviation, with concurrent demand found, to be several by decision presented which could be built.

Chairman Prall concludes

Fully 50 per cent of the proposed projects involve engineers in individual groups being considered. “The demand for frequencies has increased from 20,000 to 500,000.”

Forty-eight percent of the spectrum is intended for ultra-wide bands available about 75,000 to 100,000 kc.; and (5) the last group being considered, radio telegraphy, are to 500,000 kc. of which about 500,000 kc. is allocated to us in a manner not to exceed the limits set by the regulations. It appears that we are being able to use the new frequencies to produce an industry of national importance.
vised by the Interdepartment Radio Advisory Board, and those for all other uses, which rest in the hands of the FCC. The two bodies are in close touch with each other; working together this summer, the recommendations to be made both to the President and by the FCC will be worked out by both groups. Commander Craven stated, "Your Engineering Department feels that the industry as a whole has sufficient knowledge of a general character with respect to a new portion of the spectrum to proceed cautiously, and we see no valid reason for holding up progress along this line."

Dr. J. H. Dellinger of the National Bureau of Standards was then called to present the requirements of the government services. The suggested division of the spectrum for this purpose is given in one of the figures. The spectrum between 30 and 200 mc. is treated on the basis of channels having 0.1 per cent bandwidth (corresponding to 30 kc. bandwidth at 30 mc.). Between 30 and 200 mc. there are 1907 0.1 per cent channels. Of these the government requests the use of 1012 channels, leaving 895 for all other uses. In view of the demands of the commercial interests it appears that these remaining channels are not sufficient for all the non-government services, and it is hoped that a revision of the government request will be made. Among the uses to which the projected government channels would be put are: law enforcement, aids to air and water navigation, military applications for both Army and Navy, forest fire protection, weather predicting, general short-distance communication, and radio meteorography. Said Dr. Dellinger, "The government agencies will learn with interest of the requirements of the several non-government services as they may be indicated in the present hearing. That information will be fully considered by the Interdepartment Radio Advisory Committee in eventual collaboration with the Commission to work out a definitive system of allocation for this part of the frequency spectrum."

*Executives Present the Commercial Picture*

The general testimony of the hearing opened with a statement by David Sarnoff, President of the Radio Corporation of America. After reviewing the size and importance of the radio industry in the United States, quoting Professor Alport of Harvard to the effect that the American people spend a billion hours a week listening to the radio, Mr. Sarnoff gave his attention to television, which was by all odds the subject of greatest commercial interest throughout the hearing. He said, "Technically television is an accomplished fact, although it is not yet ready commercially... most foreign nations (in developing television) have been working with public funds. No such government subsidies of course have been available in the United States. None has been asked... And when television comes, it is my hope that despite the greater expense of its far more complicated program productions, there will be no need for a license charge for television receivers." Facsimile transmission was also looked upon as a development worthy of speedy introduction. Mr. Sarnoff concluded with seven specific suggestions to the Commission, which advocated advance reservations for future services, suggested that no allocations, except for experimental purposes, be made to individual applicants until a public service is possible, that multiple use of frequencies be made by duplicated channels wherever possible, stressing the primary importance of services on the basis of their value to the public at large. One recommendation is of special significance: "In time of war, or other emergency, all the equipment and resources of the radio industry are by law placed at the disposal of the nation. The government departments interested in our national defense should, therefore, cooperate in making possible the greatest peacetime development of radio by limiting the number of frequencies requested for exclusive government use."

William S. Paley, president of the Columbia Broadcasting System, in his statement made a strong plea for the continuation of the competitive, economically self-sufficient nature of the industry, in all phases of ultra-high frequency development. Mr. Paley, also, stressed the great eco-
The economic problems faced in television development, stating that if television transmitters costing $500,000 each were to be feasible, the economic structure of the broadcasting industry must be sound. The danger of setting up standards for television too early and thereby freezing the art within those limitations, was pointed out.

Recommendations of the RMA on Television

The Radio Manufacturers Association was represented by three men, James M. Skinner, President of Philco, and A. F. Murray, for the RMA Television Committee, and L. C. F. Horle, consulting engineer, who outlined the recommendations of the RMA on Facsimile and High Frequency Broadcasting.

Mr. Skinner outlined a five-point program for the development of television as a public service, as follows: “1. One single set of television standards for the United States, so that all receivers can receive the signals of all transmitters within range. 2. A high definition picture approaching ultimately the definition obtainable in home movies. 3. A service giving as near nationwide coverage as possible. 4. A selection of programs, that is, simultaneous broadcasting of more than one television program in as many localities as possible. 5. The lowest possible receiver cost and the easiest possible tuning, both of which are best achieved by allocating for television as nearly a continuous band in the radio spectrum as possible.” These points were developed at length, and it was made clear that television could be born “full grown” if the industry and the public are to be protected from the dangers of rapid obsolescence of transmitting and receiving equipment. To the end of promoting orderly growth the RMA proposed a tentative group of standards for television similar in scope to those adopted by the British Broadcasting Corporation, but containing important differences from the English standards.

The standards, which are highly significant as a milestone in television progress, grew out of meetings of a sub-committee composed of nine

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L. C. F. Horie presented for RMA the recommendation that a band between 37 and 42 mc. be allocated to broadcast service, both for aural and facsimile service. Assignments in the region of 26 mc., which were contemplated in the Order No. 14 of the FCC, were not recommended for assignment to aural broadcasting. The communication bandwidth suggested for the 37 to 42 mc. band is 30 kc. (i.e., an audio band of 15 kc.) together with a guard band of 5 kc. on either side of each channel, making a total channel width of 40 kc. The frequency separation between such stations in the same geographical area is recommended to be 200 kc.

The RMA urged that facsimile broadcasting should be permitted as a midnight-to-morning adjunct on all frequency assignments to aural broadcast stations. Channels for exclusive facsimile service, on a twenty-four hour basis, were also requested in the 37 to 42 mc. band, but it was asked that such exclusive assignments be limited to the lower end of the band (say between 37 and 38 mc.), and not be interleaved with the aural assignments.

Baldwin and Aiken Disclose Broadcaster’s Needs

Two men represented the National Association of Broadcasters. James W. Baldwin, managing director of NAB, presented a strong case for the broadcast industry, showing its present position in the public favor by saying, “the possession of radio receiving sets is more widespread than any other commonly accepted standard of living factor in American life.” The detailed proposals of the NAB for allocation of frequencies were made by Dr. Charles B. Aiken, head of the communications courses at Purdue University, who acted as technical consultant.

A considerable portion of Dr. Aiken’s statement was taken up with proposals for a low-frequency broadcast band, 180 to 210 kc., following the European practice of using wavelengths in the neighborhood of 1500 meters for high-power broadcast use. The purpose of such frequency assignments would be wide coverage of rural areas which now receive little if any service. A map was shown on which five 1000 kw. stations operating in this frequency range could cover virtually the whole United States with a 1 millivolt signal. It was admitted that static conditions in this frequency region are severe, especially in the southern portions of the country, but the high signal levels contemplated were expected to overcome the noise level. During the cross-examination by Commander Craven, it appeared that the frequencies requested were now already assigned to military and other interests which it would be very difficult, and perhaps genuinely unwise, to displace.

The proposals for the ultra-high frequencies above 30 mc. made by the NAB are in general in line with the recommendations of the RMA with certain minor differences, as will be seen in the figures. For aural broadcasting and facsimile NAB suggests 36 to 38 mc., as against 37 to 42 mc. requested by RMA. The most important difference between the two, however, is the plan of the NAB for an aural and facsimile band from 62 to 64 mc. Dr. Aiken argued that, since the amateurs should be allowed to retain their 56 to 60 mc. band, a continuous television band from 40 to 90 mc. was not possible in any event, and that aural broadcasting, if permitted near 60 mc., would certainly be much freer of long distance interference than it would be on 37 mc. The reasons for permitting the amateurs to keep their five-meter band were given by Dr. Aiken not only in recognition of their value and service but also taking into account the fact that the five-meter band would be of little use to any one else because of the presence of harmonics on it from the other amateur bands, particularly those from 28 to 30 mc.

Demands of Other Services

In addition to the three major groups, government, RMA and NAB, the requests of many scores of other smaller interests were presented. Perhaps the most important individual, from a technical viewpoint at least, to present his request was Major E. H. Armstrong who gave a complete demonstration of his frequency modulation system, for which definite assignments were already made available by the FCC Order No. 14 (see Electrons, June 1936, pages 31 and 32). Regarding receivers for frequency-modulated waves, Major Armstrong said, “Without sacrifice of performance it is possible to construct them with fewer tubes than are now being used in some of the standard broadcasting sets on the market.” He also stated that because of the increased service areas of f-m transmitters and the fact that they are relatively free from interference with one another, the same amount of service can be obtained from a given portion of the spectrum with the f-m system as with amplitude modulation, with the additional advantage of noise-free operation.

Samuel E. Darby, Jr., prominent radio lawyer, caused something of a sensation by demanding in the name of 11 radio set manufacturers, which have made 75 per cent of the sets now in use, that the television field be kept free of the patent monopoly which has allegedly plagued the radio set industry for the past five years.

J. W. Studebaker, U. S. Commissioner of Education, made the interesting suggestion that “2 or preferably 4 mc. next below those assigned to commercial broadcasting be allotted for the exclusive use of agencies organized for educational purposes,” supposedly to provide individual wavelengths for the 127,000 local school districts and agencies in the country. Albert L. Colston, of Brooklyn Technical High School, recommended that one television channel be reserved for his school! One company wanted wavelengths for an inter-office typewriter service.

Active work in television development on the West Coast was revealed by the DeForest and Don Lee interests. The letter, represented by Harry R. Lubeck, reported that a public television service, on 300 lines, 24 frames, is now in daily operation in Los Angeles.

The 45,000 licensed amateurs in the country were well represented through the A.R.R.L. by Paul M. Segal, their attorney, and by Secretary Warner, Communications Manager Handy, and Ross Hull, associate editor of QST. They recommended extension of the present band on 40 meters to include 7300 to 7500 kc., a band from 4000 to 4500 kc. and an extension of the harmonic amateur band series to include 112-120 mc., 224-240 mc., 448-480 mc., and 896-960 mc.

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RCA Communications demonstrated its new 3-meter relayed facsimile circuit from New York to Philadelphia to newspaper men on June 11, in what is undoubtedly the first important commercial use of wavelengths of that order. Power output at New York was of the order of 75 watts, signals were relayed at W2XBM, 90 mc. at New Brunswick, 30 miles from New York and at Arney's Mount, W3XAP, 104 mc., 36 miles and thence 25 miles to Philadelphia, W3XAO, 89.5 mc. Northbound W3XAP and W2XBM operate at 94.5 and 99.5 mc. respectively. In this demonstration voice and pictures were transmitted. New Brunswick and Arney's Mount stations are turned on by remote control from either end, the receiver being on continuous operation. Resonant line transmitters are employed; the receivers use Acorn tubes in preliminary stages.

Receiving equipment. Said Mr. Sar

noff, describing the 3-meter circuit, “Of course radio wants its share of telegraph traffic, but it looks also on the much bulkier mail bags”

Left, scanning mechanism at transm automatic typewriters, one telegraph in each direction simultaneously, or per minute if traffic demanded. Abo

miting equipment. The high freq

ment are in the cylindrical co
WHEN a man looks at a pair of smooth, even-toned, sheer silk stockings he probably thinks of the maid that wears them rather than the man that made them. But we will have to reverse the process here, for this story is mainly concerned with a photo tube and how it is becoming useful in selecting the most suitable raw silk for hosiery.

And you should know that testing raw silk is not as easy as testing a vacuum tube.

To begin with, raw silk varies considerably in most of its characteristics, especially in one of its most important qualities, evenness. This is quite understandable when we consider how silk is made. Silk worms eject a fine stream of organic matter (the silk filament) which they manipulate around until they have spun their cocoons. Later, the cocoons are softened in water and unwound. But, because the silk filament is so fine, four or five or more cocoon ends are combined and unreeled at once. The reeled cocoon ends form a thread which passes through guides and onto a reel that runs continuously.

As one or more cocoons break or run out, others must be added to keep the diameter of the raw silk thread as uniform as possible. This lack of uniformity of the thread diameter is called unevenness. Obviously, it affects many other physical characteristics of the thread too, but mainly it is important because poor evenness causes light and dark stripes, rings and mismatches in sheer silk stockings.

The manufacturer who wants to make fine hosiery must be sure he has selected the most even silk available. And to assist and insure him of this, many experts trained eyes examine samples of the raw silk wound on a black board. Estimations are made of its apparent evenness qualities, estimations of the deviation from the normal diameter—which is about two-thousandths of an inch.

Is it any wonder that the well-known electric-eye has been harnessed for this job? No, it was inevitable. Through the cooperation of F. H. Shepard, of RCA Radiotron, electronic circuits have been engineered to perform a complete series of mathematical operations. Now, deviations in the silk thread are measured by the “electric eye” and passed on to amplifiers of different characteristics. There, they are juggled around until the final result, punched out on a chart, is an accurate, logical measure of the percentage of unevenness—the percentage of defects to expect in the finished hosiery. But this is getting ahead of the story. Let us go back a few years to the days when phototubes were few and far between; and good ones were scarcer still.

Early in 1927, after returning from the Orient where he had been carrying on silk improvement work for the United States Testing Company, Inc., C. J. Huber became very much entangled in the ever puzzling evenness problem. A new test had just been officially recognized, but the results were far from repeatable. Briefly, the test consisted of a visual comparison of panels of closely wound raw silk with photographs depicting various light and shade effects which were arbitrarily graded in ten evenness degrees. The limitation of the human eye and the human element in general played such a great and yet questionable part in the test that Mr. Huber decided to experiment. Several attempts to use a photometer proved impracticable. Then he hit on the idea of using a photo cell to replace the human eye. The problem was discussed with Dr. Gibson at the Bureau of Standards; much correspondence was carried on with many companies; finally, Mr. Deschler in the Research Department of General Electric was contacted. He set up mirror boards of silk and actually measured the variation in stripes in a panel with a galvanometer.

The variations were measured in two ways. One way was by the reflection method. Coarse threads re-
...ected more light on the photo cell than fine threads did. But the level of intensity was low and affected by the color of the silk. The other way consisted of measuring the transmission between threads by cutting a hole in the board. This method has consistently been found to be the more practical.

Shortly, Mr. Huber took the post of Director of Research at Cheney Bros., where he had available the well-known radio engineer, John Reinartz, who rolled up his sleeves and went to work. A machine was built to pass a slotted board of silk panels between a light and a gas filled phototube; and a sensitive circuit with an elaborate amplifier was worked out. The amplifier operated an ordinary watt-hour meter, which rotated in one direction when the silk thread was coarse and in the other when it was fine, remaining stationary when the thread was of the proper size. This evenness indicator both demonstrated the possibilities and pointed the way toward improvements necessary for reliable test results.

So the development went on. More experiments ensued; new circuits were tried. In 1932 the apparatus and equipment were removed from Cheney Bros. to the United States Testing Company and many changes followed. Vacuum phototubes were adopted; instead of one, two phototubes were used with a balanced amplifier circuit; and a printing magnetic counter was used to add up and record the sum of the fluctuations caused by unevenness. However, this device was very complicated and relatively slow, its speed being limited by the time required to operate the magnets in the counter. Moreover, it lacked a sound mathematical basis for evaluating the unevenness.

Up to this time, all that had been angled for was an accurate linear measurement of the deviations in the thread diameters. But it was most desirable to express the final result as an important statistical function of the dispersion, namely the standard deviation. This called for squaring the deviation currents before making the summation; and naturally it meant different tube characteristics, and more circuit rearrangements, too. But, how? which? where?

An S.O.S. was sent out to RCA and after several trips to the Radio- gramon Company in 1933, Frank H. Shepard, Jr., was contacted. Then the clouds started to roll away. Not only was the squared deviation problem worked out, but the entire circuit was revamped. In place of the balanced amplifier, a simple pre-amplifier was substituted and the balancing was done directly with the phototubes. Besides eliminating troublesome and unnecessary frills, the phototube bridge circuit offered an additional advantage. Being balanced by light from the same source, bridge balance was independent of fluctuations in both the lamp and supply voltage. Then the complicated magnetic counter and printer went overboard. In its place came a condenser to accumulate the electric charge rather than count it; and a recording vacuum tube voltmeter indicated the charge on the condenser.

Mr. Shepard's broad experience with problems of this nature and his continued cooperation with the writer during the past year and a half have made it possible to proceed, with hardly a hitch, to the final calibration of a precision photometer for measuring raw silk unevenness.

The block diagram should give one a good idea of what goes on electrically. It will be noticed that fundamentally the Evenometer, as the device is called, consists of six units. No. 1 is the phototube bridge circuit where \( R = R' \). The bridge is brought to balance by adjusting the light valve \( V \) until the same amount of light falls on the cathode of phototube 2 as is passed through the transmission standard \( F \) to phototube 1. In taking measurements, the samples of silk threads are substi-
or No. 4, and the value is taken off the condenser by the triode in No. 6, whose output is indicated on a sensitive recording watt-second meter. Thus, a series of bridge unbalances occurring during a time interval can be totaled and recorded by the Evenometer.

Then, if we experimentally determine the correlation between the diameters of the silk threads in the sample and the amount of bridge unbalance, the recording meter can be calibrated in diameters, providing the time interval is always the same. This has been done; and the transmission standards, used in balancing the bridge, have also been calibrated in diameter sizes. Hence, it will be seen that the recording meter registers

\[
\sum (x - \bar{x})^2 \cdot \frac{dn}{\pi n}
\]

(1)

where \(x_1\) = diameter value of the standard, \(x_i = \) any individual diameter measurement, \(n_0 = \) the number of individual measurements in scanning the sample, and the value of \(y\) is determined by the characteristic of the amplifier. \(y = 1\) when the linear amplifier No. 3 is in the circuit; and \(y = 2\) when we use amplifier No. 4 because it has a square law characteristic, its output at any instant being proportional to the square of its input.

Now let us see how this measures the unevenness of the raw silk.

Unevenness is really nothing more than the error of uniformity of the thread diameters. To calculate it we must know two things:

1. What percentage of the thread is not of average diameter size, and

2. By what mean value this percentage deviates from the average. Since the thread diameters occur in a practically normal distribution, these two things may be expressed by a single statistic, the Standard Deviation, \(\sigma\), or its square, the Variance, \(\sigma^2\). The formula for the Variance is:

\[
\sigma^2 = \frac{\sum (x - \bar{x})^2}{n}
\]

(2)

where \(x\) is the average value of all the samples measured, \(x_i\) is the individual sample value and \(n\) represents the number of samples measured. Now, if we increase almost infinitely the number of sample measurements, formula (2) approaches as a limit

\[
\sigma^2 = \frac{\sum (x - \bar{x})^2}{n}
\]

(3)

And it becomes quite apparent that by choosing the correct values of standard \((x_s)\) and \(y\), expression (1) can be made equal to equation (3). That is, the recording meter of the Evenometer will register the value of the Variance, \(\sigma\), which is the best single statistic that tells the mill man within what limits he may expect his raw silk to vary.

*How it Works*

Getting down to the actual mechanical details of the test, this is how it is done. Raw silk is carefully wound in the customary manner, 100 threads per inch, around a seriplane board which is about five feet long and holds 500 meters of a test sample. It is also equipped with a slot running from one end of the board to the other. Through this slot, a beam of light, one inch high and about one-tenth of an inch wide, is directed so that the rays which pass between the threads fall on the cathode of phototube No. 1, whose output is proportional to the amount of incident light.

Since the number of threads wound in a given length of the seriplane board is always the same, the light spaces between the threads will vary inversely as the thread diameters. That is, as the diameter of the thread increases, it occupies more space and the size of the space between threads decreases correspondingly. Thus, the mean size of the spaces in the light beam is as accurate a measure of the mean diameters as the threads themselves are. And, since the light which falls on the phototube must pass through the spaces, the amount of light and the resultant phototube current are also accurate indicators of the thread diameter.

Now, suppose we balance the bridge on a standard whose photometric value is considerably lower than that of the coarsest silk, so any unbalance will always be in one direction. With the linear amplifier No. 3 cut into the circuit, we then have a straight integrating photometer.

Let us start the Evenometer in operation. The light beam and phototube bridge are moved at a constant speed along the slot from one end of the board to the other, thus scanning the silk. On each panel, a very large number of successive measurements are made and they are integrated by the condenser in No. 5. This value, recorded by the meter just before passing to the next panel, is proportional to and has been calibrated in terms of the average diameter size of the silk in microns. Before scanning the next panel, switch S discharges the condenser, clearing it so that a new series of additions may be made. Thus, the Evenometer determines the average diameter size of the samples; that is, the size which is expected to have the predominating effect on the finished fabric.

Now then, we must determine the amount of variation about the average.

(Continued on page 86)
Transmitter Adjustment

Many a broadcast station operator can learn from Mr. Sperling how to eliminate faults from a transmitter and how to make it tick efficiently.

BY J. G. SPERLING

There are still a great many broadcast stations, especially in the local channel classification, whose transmissions are abominable. Among the many faults present are: 1. Limited audio frequency response. Cutoff between 5,000-7,000 cps. 2. High audio harmonic content. 3. Large second and, or, third r-f harmonic. 4. Improper neutralization of the r-f circuits. 5. Over-modulation. 6. Excessive hum on carrier.

All of these faults can be easily remedied as follows:

1. The use of high fidelity pre-line, and modulator-amplifiers will settle the question of audio fidelity in the a-f end. It should be noticed, however, that the amount of inductance of the modulation choke or other device connecting the modulator to the modulated amplifier materially determines the amount of low audio frequency response. For the response at 30 cycles to be equal to that at 1,000 cycles, it is necessary that the value of the above inductance be equal to the reflected load resistance of the class C modulated amplifier divided by at least 200, or \( L = \frac{E_p}{I_p \times 200} \) where \( L \) is in henries, \( E_p \) is the plate voltage of the modulated amplifier and \( I_p \) is the plate current of the modulated amplifier.

The capacity of the plate by-pass condenser in the modulated amplifier and the following class B stages, if any, determines the amount of high a-f response. If the response at 10,000 cycles is to be the same as that at 1,000 cycles it is necessary that the capacity, in micro-microfarads, be equal to the load resistance divided by 100, or \( C = \frac{E_p}{10,000} \) (\( I_p \times 100 \)).

2. The audio harmonic content for a properly adjusted class A audio amplifier is negligible. The only precaution to watch is to see that the amplifier is not overloaded and that all the vacuum tubes are in good operating condition.

If class B audio amplifiers are used, the use of proper tubes in a correctly adjusted circuit will usually result in a third harmonic content of not over 2 per cent.

The use of a suitable KVA. to KW. ratio in the r-f amplifiers and proper adjustment of all circuits will result in:

1. Proper neutralization.
2. Proper neutralization.
3. True audio response.
4. True audio response.
5. Proper neutralization.

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1 Instantaneous relations between plate and grid voltages and currents in r-f amplifier

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means of a cathode-ray oscilloscope.

6. Excessive hum on carrier may be reduced by increasing the amount of filter used in all the power rectifiers, and by using properly matched r-f and rectifier tubes.

How the R-F Amplifier Works

One of the greatest problems that one encounters in transmitter adjustment is the question of how much L and C to use in the tuned circuits, and the design and adjustment of a proper coupling system for the transmission line. Before entering a discussion of the amount of L and C to use, it is necessary to see how a r-f amplifier tube works.

In Fig. 1 is seen a plot of the various voltage and current relations during an electrical cycle. A sine-wave voltage, \( e_e \), from the oscillator or r-f amplifier stage, is impressed on the grid of the tube along with the d-c grid bias. This bias in the case of a class C amplifier is about two times cut-off bias. For a class B stage it is just cut-off. The a-c voltage on the plate, \( e_p \), is superimposed upon the d-c plate voltage, \( E_p \). This \( e_p \) is 180 deg. out of phase with the voltage \( e_e \). Grid current \( i_g \), is drawn when the grid voltage \( e_g \) is positive.

The a-c plate current \( i_p \) starts to flow when the grid voltage \( e_g \) is positive and above the theoretical cut-off bias line. This a-c plate current is not sinusoidal, as is the grid voltage, but unsymmetrical due to being operated on or past the bend of the characteristic curve. This simply means that the wave-form is replete with harmonics of the fundamental frequency. To reduce this harmonic content to a minimum, it is necessary to have a large circulating current present in the tank circuit to smooth out the wave form and transform it into something resembling a sine wave. This effect is termed the "flywheel effect." The greater the capacitance \( C \) in the tuned tank circuit, the greater the circulating current.

The fly-wheel effect operates as follows: When the a-c grid voltage \( e_g \) goes positive, the a-c plate current pulse \( i_p \) flows through the tank circuit, comprised of \( L \) and \( C \) in parallel. It produces an r-f voltage across it, charging the tank condenser \( C \). At the moment \( e_g \) starts to go negative the condenser \( C \) discharges to \( L \) via the plate end of the tank circuit, and charges the other set of plates of \( C \), which is the end connected to the plate supply. When the grid voltage \( e_g \) is negative no \( i_p \) flows, but the condenser \( C \) discharges in the opposite direction to which it did at first because the

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other set of plates of C has been charged. This completes the cycle of output r-f voltage, and explains why only one tube is necessary in a class B or C r-f amplifier for correct operation.

The ratio of KVA/KW, the ratio of volt-amperes in the tank-circuit to the d-c plate input power, \( E_p \times I_p \), for maximum reduction of harmonics should be at least 12.6. It is customary to use a value between 15-25. In the preceding stages, those preceding the modulated amplifier, it is not necessary to use such a large ratio because the tank circuit is usually shielded. A value of 5 or thereabouts will do in these stages. The values of inductance and capacitance in the tuned plate circuit can be computed.

If the stage is single ended, not push-pull, the rms value of the peak plate voltage is:

\[
\varepsilon_p(r.m.s.) = \frac{2 \times E_s \times \text{Eff}}{3.14 \times .707}
\]

As the efficiency of a class C stage is usually taken as 72 per cent, \( \varepsilon_p(r.m.s.) = .65 E_p \).
If push-pull is used, \( \varepsilon_p(r.m.s.) = 1.3 E_p \).
For a class B single stage at 63 per cent efficiency.

\[
\varepsilon_p(r.m.s.) = \frac{2 \times E_s \times .63}{3.14 \times .707} = 0.567 E_s
\]

For a push-pull stage

\[
\varepsilon_p(r.m.s.) = 1.13 E_p
\]

At resonance \( X_c = X_L \), and therefore the amount of circulating current through these two branches is equal.

\[
I_L = I_c = \frac{KVA}{KW \times X_c \times X_L}
\]

Therefore:

\[
X_c = \frac{I_c}{I_L} \times \frac{1}{C} = 6.28 \times F \times X_L,
\]

and \( L = \frac{X_L}{6.28 \times F} \).

By the use of Fig. 2, all computations necessary for the derivation of \( C \) and \( L \), other than those on the chart, are eliminated. This chart is not absolutely accurate but close enough for all adjustment purposes.

In the modulated amplifier and the class B stages, if any, it is customary to use a KVA/KW ratio of 15-25.

**Transmission Line Troubles**

Much trouble is encountered in the design and correct adjustment of a transmission line coupling unit. Dietach has shown the proper method of designing such coupling devices. If we wish to terminate the transmission line into a tank circuit, it is necessary to provide such values of \( C \) and \( L \) that the load line will fall on the 1 to 1 circle as shown in Fig. 5.

\[
\text{KVA} = \frac{X}{\text{Eff}} \times \text{Eff} \times \text{Eff} = \frac{X}{\text{Eff}}^2
\]

Where \( \text{Eff} \) is the efficiency.

Simple formula for \( L \):

\[
L = \frac{\text{KVA}}{\text{Eff} 	imes X}
\]

Called the 'loop' equation, this is the 500-ohm line to use an impedance of 500 ohms.

The formula for \( M \), the mutual coupling, is shown in Fig. 5.

\[
M = \frac{1}{2} \times \sin^2 \theta
\]

If we wish to terminate the transmission line into a tank circuit, it is necessary to provide such values

5 Chart for computing proper mutual inductance between the tank and the antenna for two impedance values of transmission line

![Chart for computing proper mutual inductance between the tank and the antenna for two impedance values of transmission line](chart)

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Loud Speaker Measurements

Six million speakers will go into home and auto radio receivers in 1936—yet there are lamentably few standards of measurement or performance agreed upon by manufacturers or purchasers of such speakers. Mr. Massa, in the second article of a series, speaks of measurement

Although it is generally agreed that a good loud speaker is one that faithfully and efficiently transforms the electrical energy which it receives into acoustic energy, there is a considerable divergence of opinion on how loud speaker performance should be measured and specified. Some believe that the characteristics should be measured in a representative room so that the data obtained would convey some idea of what the speaker will do under actual conditions of use.

The author prefers to treat the loud speaker as an independent piece of apparatus and to specify its performance independently of any specific system to which it may be coupled. This will permit an absolute comparison of the merits of various sound generators and if the performance under any specific acoustic environment is required it can be easily determined from the configuration and reverberation characteristic of the environment, or from a separate measurement made on the overall system.

Electrical Equipment

Since loud speaker measurements must show the characteristics as a function of frequency, it is natural that a necessary piece of test equipment is an oscillator for producing a variable frequency voltage. In addition to the oscillator, a calibrated microphone and amplifier is necessary for measuring absolute magnitudes of sound pressure.

Several systems have already been described for making audio-frequency measurements. Bostwick employs an audio oscillator which is not continuously variable and measurements are made at single frequencies. Ballantine automatically records a continuous curve between frequency and sound pressure on a photographic film.

A very convenient system which offers great flexibility in the acoustic laboratory is shown schematically in Fig. 1. A beat frequency oscillator which gives a continuously variable frequency of constant voltage is mechanically coupled to a recording drum. The plates in the variable condenser are so shaped that the frequency varies logarithmically with the angle of rotation of the shaft. If a sheet of semi-log paper is placed on the drum and the drum is engaged to be driven in the proper relation with the oscillator, the recording pen will always lie on the abscissa corresponding to the frequency being generated by the oscillator. The oscillator output is impressed on the loud speaker under test and the microphone picks up the sound, which is converted into electrical energy, amplified, and read on the output meter. If the auxiliary pointer is made to follow the meter reading as the frequency is varied, the recording pen will plot a curve whose ordinates are proportional to the sound pressures set up at the microphone.

Power Handling Capacity

The power handling capacity of a loud speaker should indicate the electrical power input which can be handled without impairment to the quality of reproduction. Unfortunately, power handling capacity measurements are generally ignored in loud speaker performance specifications. When a rating is given it may represent only the maximum amount of power that can be supplied to the unit without burning up the voice coil. When this is the case, only a small part of the whole story is being told. To give complete information on power handling capacity, data should be obtained showing watts input vs. frequency for the various limitations described below.

By FRANK MASSA, M. Sc.
RCA Manufacturing Company, Inc.
Camden, New Jersey

Fig. 1—Arrangement for semi-automatic acoustic measuring apparatus

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(a) Mechanical Strength — In this case, the maximum power input which the vibrating system can safely handle without causing any mechanical failures should be determined at various frequencies. This is perhaps the most indefinite of the power handling characteristics, as mechanical failures occur after long continued operation at a fixed condition of input which makes it difficult to get accurate results for this particular measurement. On the other hand, mechanical strength should be the strongest link in the chain of factors which limit the power rating of loud speakers. If care is taken to insure that the structure will be mechanically strong enough to handle the power inputs specified by the succeeding limitations, this characteristic may be omitted without obscuring the true capabilities of the loud speaker.

(b) Temperature Rise — A curve showing the power input vs. frequency that produces a fixed temperature rise in the mechanism is one of considerable importance in showing power handling possibilities. The temperature rise should be specified on the curve sheet and its magnitude should be a safe value for the type of structure employed.

In a well designed speaker the temperature rise limitation should be the factor which controls the rating of the unit. In other words, all the power which the mechanism can safely handle without overheating should not produce any other distortions. In many cases this is not so; consequently the following additional

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If the speaker impedance is constant with changing frequency, both definitions are identical. If the impedance varies, the variation becomes charged up as a loss in efficiency in the second definition, which is just, if the speaker must be used in conjunction with the tube.

The measurement of the electrical input to the loud speaker is straightforward. The greatest difficulty arises when measuring the acoustic output, and several methods for making this measurement will be described.

(a) Integrated Acoustic Output Method—The most direct and accurate method for measuring the total acoustic output from a loud speaker is to measure the sound pressure over the surface of a sphere of which the loud speaker is the center. The speaker should be radiating in the open air away from all reflecting surfaces when the data is being obtained. The total acoustic power being generated by the speaker for the specific input conditions is equal to

\[ P_a = \frac{p^2 \text{ average}}{42} \times 10^{-4} \text{ watts} \]  

(b) Reverberation Chamber

The reverberation chamber method provides a quick and simple means of making total acoustic output measurements at various frequencies and it lends itself particularly well to the measurement of total output of radio speakers.

(c) Motional Impedance Method—If a moving coil loud speaker has an electrical impedance \( Z_E \) when the diaphragm is blocked so that no acoustic energy is being radiated, the impedance will increase by a component \( Z_{EM} \), called the motional impedance, when the speaker is allowed to radiate.

The magnitude of the motional impedance depends on the efficiency of the speaker and is equal to

\[ Z_{EM} = \frac{R_{B}^2}{Z_{M}} \times 10^{-4} \]  

where \( Z_{EM} \) = motional impedance (vector) in electrical ohms

\[ B = \text{flux density in air gap in gauss} \]

\[ l = \text{length of wire in voice coil in centimeters} \]

\[ Z_M = \text{mechanical impedance of vibrating system (vector) in mechanical ohms} \]

For high efficiency speakers the motional impedance causes a large increase in the electrical impedance of the system when sound is being radiated. Since this increase in impedance represents the acoustic energy that is being generated it forms the basis of a very simple means for efficiency measurement. If \( R_f \) is the real component of the electrical impedance measured at the speaker voice coil when it is radiating sound and \( R_b \) is the real component of the electrical impedance measured at the same place.
to give any degree of precision. Strictly speaking, $R_0$ in equation (5) should be the real component of the electrical impedance, while the speaker is operating in a vacuum, in order to include the mechanical losses in determining the efficiency; but for high efficiency speakers, which are the only speakers for which the motional impedance method can be satisfactorily used, this refinement is not always needed.

**Response-Frequency Characteristics**

Efficiency measurements fail to give a complete picture of a speaker's merits. Due to the change in configuration of the sound field about a speaker with changing frequency, a knowledge of the total output, without knowledge of its distribution, is of very little value. A common characteristic which shows the performance in terms of the sound pressure developed at a fixed distance from the source at various frequencies is called a response curve, and the most common position for obtaining this characteristic is directly on the normal axis of the speaker.

To obtain a true response curve (Fig. 2) and separated by a distance $d$, the floor gives rise to reflections which may be assumed to come from an image speaker at a distance $h/2$ below the floor surface. If the absorption coefficient of the floor material is $a$, the ratio of the reflected to the direct component of sound pressure at the microphone is

$$R = \sqrt{\frac{d^2(1-a)}{d^2 + h^2}}$$  \hspace{1cm} (6)

The phase of the reflected component with respect to the direct component will depend on the frequency of the sound source and the relative magnitudes of $h$ and $d$. Both components will be out of phase causing a pressure dip at the microphone when

$$\sqrt{d^2 + h^2} - d = \frac{2n - 1}{2} \lambda$$  \hspace{1cm} (7)

and both components will be in phase causing a peak in the response when

$$\sqrt{d^2 + h^2} - d = n \lambda$$  \hspace{1cm} (8)

where $n = \text{an integer}$

$\lambda =$ wavelength of the sound being generated

($d$, $h$, and $\lambda$ must be in the same units)

The relative magnitude of the reflected component increases both as $d$ increases and as $h$ decreases. To avoid errors due to reflections, the speaker should be placed at a very large distance from reflecting surfaces and the microphone should be kept closer to the speaker than the speaker is distant from the nearest reflecting surface.

Some idea of what to expect in the way of actual error introduced in a response curve taken indoors with a stationary pressure actuated microphone is shown in Fig. 3. The

\[ \text{Fig. 6 — Directional microphone eliminates ground reflections} \]

\[ \text{Fig. 7 — Total pressure at a point, due to direct and reflected sound} \]

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PURCHASERS of radio receivers this Fall will have much to feast their eyes upon, much to listen to. Any inspection of preliminary models of 1937 merchandise, any knowledge of what has been going on in the laboratories will impress the observer at once that the coming year should be a new high watermark in radio excellence, and be a year in which receivers much more than a twelvemonth old will be definitely marked as declasse.

Engineered for Sales

It is evident that engineering departments have had their eyes focussed upon the goal of sales; they have definitely designed their "stuff" with sales appeal in the backs of their minds. But technical features are there too, in greater number than at any period of the radio receiver industry's life. Higher tone fidelity (even by those companies whose sales departments are reputed to have restricted fidelity in the past); better short wave reception, better tuning methods and indication, more automatic features, distinctly interesting acoustic accessories are but a few of the improvements that will make 1937 receivers operate differently from those of last year. Cabinet designers have successfully made it apparent that the new season's sets will look different, too, and in addition certain technical changes are lending themselves to an improvement in eye appeal.

In what follows will be found a summary of some of the new features. There are others, which cannot be released at this time and which will be covered here later in the Summer.

Acoustic Features

Probably of most visible and audible appeal, among the technical innovations, are the several acoustic features. Stromberg Carlson, of course, continues to use the labyrinth employed last year on more expensive models. This year it will be found in lower priced sets. Victor has a set of resonant pipes placed in the bottom of the cabinet as described below. Zenith compensates for room variations by a cover which closes the back of the loud speaker. It has an inner and outer shell and when this is pushed in close to the speaker it damps the low frequencies and reduces boom due to room resonance. There is a 3-inch motion of this cover and Zenith engineers state that a considerable difference in tone results from this much motion. The electrical tone compensation in Zenith receivers has more bass than is probably necessary so that between these two features any degree of bass tone response can be achieved.

RCA Victor adds the Magic Voice to the Magic Brain and the Magic Eye. This is Victor's method of solving the difficulty produced by cabinet resonance, and consists of a series of pipes placed upon the floor of the cabinet. The back portion of this cabinet which houses the loud speaker is closed and the sound from the rear of the cone is permitted to pass out of the enclosed space only through these pipes comprising an acoustic filter which re-

1937 Radio

Engineers give evidence that set design is entering a new era of technical accomplishment

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RECEIVERS

 Receivers show remarkable advances in technical features, products of the laboratory

verses the phase of sound waves from the rear of the cone so that they emerge from the cabinet in phase with those from the front of the cone. It is found that the normal sized console, when equipped in this manner, can be made the equivalent of a baffle eleven feet on each side. Advantages claimed are freedom from boom in voice and lower musical instruments, extension of the lower frequency range by 2-3 octave, and finally, receiver fidelity is independent of the cabinet location with respect to the wall.

It is interesting to note that larger loud speakers seem to be coming into use—including several of normal size but with very wide rims so that the appearance is that of a larger speaker!

Higher Tonal Range

A general improvement in tone fidelity may be expected this year. There has been a feeling that listeners in the past did not want the wide range; that anything above 4000-5000 cycles was just so much engineering expense not justified by the listener. Therefore the set owner got an abbreviated version of the transmitted music and even if he wished he could crank up the high frequencies a bit, he was not permitted to do so. This year it seems to be the rule that the better receivers will have frequencies out to 6000 cycles or to even higher frequencies, and the listener can reject them if he wishes. Critical listeners will thank the sales and engineer departments for loosening up to this extent.

Victor models using 10 and 15 tubes have a fidelity range extending to 6000 cycles. A continuous high frequency tone control is provided so that when wide open, the 6000 cycle bandwidth is provided, and at the other extreme, frequencies higher than 4000 cycles are attenuated. This is accomplished by the circuit shown where the coupling between the two windings of the i-f transformers is changed. Several other manufacturers use similar methods of increasing the high frequency response.

Victor Methods in use last year for forming found models, performing methods in use last year for per-

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is from 50 to 7200 cycles to take advantage of the marked improvement in recording and processing. Appropriate filters are used to reduce the noise due to needle scratch which has been still further attenuated by reducing the pressure of the needle from 4 ounces to approximately one and three-quarters ounces. This instrument has the highest signal to noise ratio yet obtained from phonograph records considering the wide range, according to Victor engineers.

The driver which is out of phase with the driving voltage. The extent of the degeneration is approximately 2 to 1, that is the gain of the amplifier is reduced 50 percent at 400 cycles.

Sets not equipped with turn tables and pickup reproducers do have terminals for the connection of external phonograph equipment. In many cases these terminals make the audio amplifier of the set available for any amplification purpose, such as the use of a microphone to confound the neighbors.

**Beam Tubes Used**

Rather wide use of the beam power tube, considering its recent introduction, will be found in the new receivers, especially in the higher priced models. General Electric uses the tube in the 8, 9, 10 and 15 tube models. In the last, degeneration is used to obtain a flatter frequency characteristic and to approach the regulation characteristics of triodes. A portion of the voltage appearing across the voice coil is introduced into the cathode circuit of the 6F6 driver by running the cathode current directly through part of a shunt resistance across the voice coil. In this way a voltage is fed back to the driver which is out of phase with the driving voltage. The extent of the degeneration is approximately 2 to 1, that is the gain of the amplifier is reduced 50 percent at 400 cycles.

Much greater use of bass compensation as a function of volume and greater use of continuous tone controls or of control of both high and low frequencies will be found this year, so that no two radios can possibly sound alike. This will tend to eliminate (start) much argument among listeners.

Loud speakers which put out high frequencies are of special form in some cases so that the high frequency beam effect will be reduced. Fairbanks Morse and others use a bowl-shaped device mounted ahead of the speaker cone. In some receivers having bass compensation, voice-music switches are provided so that on voice the compensation does not begin at such a high frequency. Therefore booms on announcers are reduced, with praise from all.

**Automatic Frequency Control**

At least four of the large receiver manufacturers will use circuits which take the final tuning control out of the hands of the listener-operator. These automatic tuning control circuits grab hold of the tuning when the listener has approximated the correct point on the dial and so adjust the oscillator frequency that the station is correctly tuned in. This control operates as a function of the off-resonance frequency and as a function of signal strength. Thus a station too far from reso-

**Static limiter circuit, described in the text (G. E.)**
nance will not be dragged into tune, nor will a station too weak in strength to actuate the control.

AFC is used in G.E. models of ten, twelve and fifteen tubes. The control tube (which operates much as previous articles in Electronics have explained) is a 6J7 whose plate is tied to the grid of the 6K7 oscillator. The variable capacity reflected into the plate circuit of the 6J7 with changing bias affords adequate control of the oscillator frequency to reduce a 5 kc. tuning error to less than 60 cycles for any signal of 1000 microvolts or better in the broadcast band. The degree of control is shown in the illustrations accompanying this article.

Other AFC Sets

Other users of AFC will be Philco, Crosley, Grigsby and probably others. Some are making use of a telephone dial construction. The listener inserts his finger in the dial hole labeled the desired station, pulls it around until it stops when the station is automatically tuned. AFC circuits will tend to eliminate troubles from oscillator frequency drift.

Tuning Aids

There are other aids to tuning which will appear this new season. Edge-lighted dials appear more frequently than last year (readers may remember the photograph of the Bosch dial in November 1935 Electronics). RCA Victor and Stromberg Carlson are using this type of dial and there will be others, no doubt. In the Victor dial there is a band spreader which appears in a small opening below the main dial and which has provision for a 100 to 1 speed ratio.

"Colorama" Tuning

G. E. engineers have put to use the experience and circuits of the Schenectady illumination experts in working out their visual tuning aid for the 9 sets of 9, 10, 12 and 15 tubes. This is known as Colorama tuning and consists of red and green lights which are behind a translucent scale. At zero signal the red

Two degrees of selectivity in i-f amplifier

is at full brilliance; at maximum signal the green is at maximum, and red is practically out. Thus in tuning the color starts with red and approaches green, through white when red and green are equal in intensity as resonance is approached. The operator need not take his eyes from the tuning scale during this process since the color is diffused over the whole length of the scale.

Weak stations will produce small color change and strong stations large change. The difference in signal strength between the weakest and the strongest stations likely to be listened to, has been found to be so great in different localities that the receivers have been equipped

Colorama tuning light circuit used in 1937 G. E. sets

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Silent Tuning

There are other G.E. aids to tuning. In the twelve and fifteen tube models a switch is provided for silent tuning. This is a d.p.d.t. switch with silver plated contacts mounted on the scale assembly and controlled by a knob on the panel. The switch is actuated by a forward and backward movement of the knob. When the knob is pulled toward the operator, both contacts are closed, short circuiting the AFC control voltage to ground and also shorting the grid leak of the 6F6 audio driver. The result is that the operator may tune in a station with the aid of the colorama tuning indicator alone, while the set is completely quiet. When resonance is obtained as indicated by the red and green lights, the knob is pushed forward opening the switch. The AFC then functions to correct for any error in tuning and the receiver performs in normal fashion.

AFC of course makes this method of tuning feasible since it is unnecessary to obtain exact resonance when tuning with the colorama indicator.

"Target Tuning"

Zenith provides "target tuning" in which the indicator resembles a target in that it consists of concentric rings. A small round disc throws a shadow on this target. As resonance is approached the shadow moves toward the center of the target.

There are interesting Zenith auxiliary attachments: head phones for those who prefer individual entertainment or who are hard of hearing; external magnetic loud speakers can be used on most models; and finally a "volume limiter" knob which replaces the regular volume control knob and which can be preset as to the maximum volume obtainable from the receiver. What a godsend this will be in hotels, steamboats, hospitals—and the home! Victor supplies phonograph connections to a majority of the new chassis, even including the battery sets.

Another G.E. feature is the static limiter found on the 15-tube model. It limits percentage modulation to 100 per cent for short-duration noises. The circuit is shown.

\[ R_1 \text{ and } R_2 \text{ comprise the signal diode load. } R_2 = 2R_1 \text{ and } R_3 = R_4. \]

During the reception of a normally modulated signal C charges up to a potential equal to twice the d-c voltage across \( R_1 \). This allows the cathode of the limiter diode to follow the superimposed audio voltage on the plate up to a peak of twice the d-c voltage across \( R_1 \), or the potential to which \( C \) is charged. When a noise impulse occurs above 100 per cent modulation the cathode cannot follow the plate due to the time constant of \( C \) and \( R_4 \), which is approximately 0.35 second. The instantaneous plate potential is then more than twice the d-c across \( R_1 \) and therefore greater than the charge across \( C \). The plate of the diode is now negative with respect to the cathode and the diode is nonconducting, therefore the high peak of noise is not transmitted to the audio amplifier.

Spiderweb Antenna

Five half-wave dipoles are combined in an array developed by RCA Victor engineers for use this season. These antennas resonate near the wavelengths shown in the diagram. The impedance of each dipole is approximately 70 ohms when tapped at the center, and operated at resonance, but at other frequencies the impedance is higher. When these various dipoles are connected in shunt, each represents a high shunt impedance to the one which is in resonance to a particular frequency. Therefore the resonant impedance of this particular antenna is not changed much by these shunts. Using 90-ohm twisted pair a practical match can be obtained between the antennas and the downlead transmission line.

From 2150 to 60 meters where noise-reduction by the downlead is not too important, the spiderweb acts as a parallel set of wires plus a single wire downlead. At 49 meters the dipole legs E and F (loaded electrically to reduce mechanical size) resonate and the transmission line acts as two conductors bringing down the signals but rejecting noise voltages. It will be noted that there are antennas for the 9 and 5 meter band, for use with the new circuits.

July 1936 — ELECTRONICS
Emporium IRE Presents

Pennsylvania group sponsors first summer meeting of its kind, on June 26, 27.

On June 26th. and 27., the Emporium Section of the Institute of Radio Engineers held open house for a two-day "Summer Seminar," the first meeting of its kind in the history of the IRE. The program included inspection trips to several plants, two technical sessions, and a social get-together in the form of a roast held in the nearby mountains. A total of 100 men, including 25 out-of-towners who had traveled several hundred miles to attend, were present.

Four papers on subjects of considerable timely interest were presented. Lawrence C. F. Horle was in charge of the technical sessions. The first paper, read by F. W. Scheer of the Sickles Company, presented information on the design of diode coupling transformers. Formulas and curves were given to show the compromise between gain and selectivity for various transformer designs and the optimum design conditions pointed out. According to Virgil Graham, chairman of the program committee of the section, this paper is to be published in full in report form at an early date.

H. J. Schrader of RCA Manufacturing Company, Camden, presented a paper on the uses of the cathode ray oscillograph, in both radio and non-radio applications. The latter, including the measurement of engine pressure diagrams, tortional distortion and vibrations, and general vibration studies using piezo electric pick-ups, were of particular interest. These applications were described in Electronics (June, 1936, page 38).

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Roger Wise, Chief Engineer of Hy- grade-Sylvania, L. C. F. Horle and Harold Westman, taking their ease at the Sylvania Club.

The four speakers at the "Summer Seminar" were: L. C. F. Horle (Diode Coupling Transformers); H. J. Schrader (Cathode-ray Applications); and C. T. Wallis (Vibrator Power Supplies).

ELECTRONICS — July 1936
THE Geiger ionisation counter, consisting of a sharp point electrode insulated from the walls of a brass cylindrical chamber, has long been employed for counting alpha rays. Theoretically, when the proper potential is exerted between the chamber and electrode an intense converging electrostatic field is set up through which accelerating particles gain sufficient velocity to produce ions by collision. The cumulative effect of such ionisation can be made to vary the grid potential of a detector and the resulting voltage impulse further increased by audion amplification to activate loudspeakers or the like. For recording purposes, Hull first proposed that circuits employing the thyratron might be arranged in such a manner that this type of impulse could alternately affect the grid thereof, provided the bias is critically adjusted. By then limiting the anode current with appropriate resistances, the armature of an automatic recorder is operated with the result that individual rays entering the chamber are automatically recorded or counted.

Essentially the Hull device is a hot cathode, mercury vapor, grid controlled rectifier, wherein electron emission is obtained from an oxide coated cathode. If a voltage is applied between the anode and cathode with a sufficient negative grid bias present, the tube operates like an ordinary vacuum tube; but, as the grid is made more positive, at a certain critical voltage, an arc strikes between the anode and the cathode, with an accompanying increase in the anode current. The grid then exercises no further control over the anode current, which must be limited by external resistances so as not to exceed the saturation emissive current of the filament. If the voltage across the tube exceeds the "disintegration" potential of some twenty to twenty-five volts, the cathode will be disintegrated by positive ion bombardment.

By the general method for stopping current in a d-c operated thyratron, the anode is made negative for an instant by closing the switch to permit ions to diffuse away from the grid and to restore its control.

(Fig. 2.) A condenser C is connected in series with a resistance R between the anode and the positive voltage terminal and becomes charged when the current is flowing to the amount of potential difference across the load, which in turn is equal to the supply voltage minus the tube drop. Assuming a supply voltage of 150 and a tube drop of 20 volts, the condenser voltage will be 130 volts. Closing the switch will bring the potential of the right hand terminal to zero, or through a decrease of 130 volts. At the same time, the left-hand terminal which is connected to the anode, must suffer an instantaneous and equal decrease because of the high transient impedance of the load compared to that of the condenser. This effect reduces the anode potential to -115, i.e. 115 volts.

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negative with respect to the cathode and thus stops the flow of electrons and the production of ions. If, then, there is sufficient time for the existing ions to diffuse to the walls of the tube before the anode voltage again reaches +20, the grid will control re-starting.

Multiple Circuits

De Bruyne and Webster\(^1\) first attempted to use the thyratron valve for alpha particle counting, but found that the application of the circuit 6 (Fig. 2) is feasible only in those instances of low counting speeds.

To avoid the limitation by mechanical apparatus on the counting speeds, the arc current of one thyratron can be arranged to alter the grid-bias potential of the next valve in order.\(^2\) Instead of using a switch to ground the right-hand condenser terminal of Fig. 2, the grid of an additional tube (Fig. 3) is made positive, such action being equivalent to closing the switch, except that the potential falls to 15 volts rather than to zero. The maximum negative anode potential of \(T_1\) is 100 volts instead of 115. In this way the current is transformed from \(T_1\) to \(T_n\), or can be returned in the reverse direction by making the \(T_1\) grid positive. The same voltage impulse can not cause both tubes to arc simultaneously if there is an arc initially in one of them. The process can thus be repeated, subject to the condition that the anodes shall remain negative long enough at each transfer for the ions to diffuse out of the space around the grids.

Finally, it has been possible to arrange a group of thyratrons\(^3\) in such a manner that when one tube has started, a cathode current will pass through the next cathode resistance in order, decreasing its grid bias a little less negative than the critical bias necessary for its own starting. (Fig. 4.)

In this instance, the incoming voltage impulse next applied to all grids increases the grid potential of the valve in question above the critical voltage thus causing it to arc while other tubes still heavily biased are not affected. Thus with successive impulses the tubes arc in turn and the number of particles entering the chamber can be counted by noting which tube in the chain was last to arc. However rapidly particles may be arriving, there is always a tube available for the registration of each individual particle.

Complete Counting Circuit

For recording the number of alpha particles emanating from uranium oxide, uranium nitrate, and radium in a given time, the author has used successfully the circuit shown in Fig. 5.

In the chamber unit, a constant voltage-supply \(T\) with a variable range of 400 to 2500 volts provides the electric-field between the negative point and the chamber walls. \(I, C\), \(A\) and \(B\) are respectively 10 and 1 megohm grid leaks having a leak condenser \(C\) of .001 microfarads. Type 112A tubes (1, 2, 3) and FG-17 Thyratrons (4, 5) are used. In the thyratron unit, \(T\) is an A-C filament

ELECTRONICS — July 1936
Feedback Amplifiers

Proper use of negative feedback or degeneration promises to have important economic, acoustic, and other advantages for radio receivers and transmitters, for carrier telephone—a development of the Bell Telephone Laboratories.

Not so many years ago the lives and works of many men were devoted to the task of taking feedback (regeneration) out of amplifying systems. Now, according to well taken omens, all this effort is to be turned backward, feedback is to go back into amplifying systems. As a matter of recent history, H. S. Black of the Bell Telephone Laboratories read a paper before the A.I.E.E. in the winter of 1934 on the general subject of negative feedback amplifiers. This was followed in the Bell Telephone Record in June 1934 with more data on Black's work which seems to be of such fundamental importance that all circuit engineers should become familiar with it. From the standpoint of practical circuit operation, negative feedback has been added to certain broadcast and other transmitters of Western Electric and more recently negative feedback has been applied to home radio receivers by RCA Radiotron, in developing the beam power tube, 6L6, and by General Electric engineers in one of their new 1937 radio receiver models.

Of more ancient history is the general use of a negative feedback of energy from the output of an amplifier to the input to counteract the general tendency of the amplifier to be regenerative in a positive direction and thereby to be unstable. But the use of negative feedback of any sort practically died with the introduction of screen grid tubes in which feedback troubles were solved without additional circuit features. Here the plate and grid circuits were so effectively isolated by the tube construction, and by proper shielding, that other accessory apparatus was unnecessary.

Consider an amplifier which does not tend to regenerate, but which is inherently stable. Suppose feedback from the output is admitted (properly, of course) to the input and in amounts which may finally equal the input signal. Now it develops that the greater this negative feedback, the nearer will the output resemble the input—or stated in other words, the amplifier may have a hum characteristic but the exciting wave and the output wave will look alike more and more as the feedback is increased.

Thus Black's work leads at once to amplifiers of remarkable linearity of amplification, great constancy of operating characteristic with respect to tube variations or in supply voltages etc. They will be less susceptible to noise and crosstalk, and possess improved phase and impedance characteristics.

If an amplifier introduces distortion due to some non-linearity and if negative feedback is employed, and if at the same time the input signal is increased in amplitude, it will be found that the desired output signal will be the same in value but that the distortion will decrease according to the degree of feedback. Thus the distortion in a given circuit can be reduced relative to the signal by first adding a negative feedback and then adding to the total gain of the amplifier keeping the signal effective on the first grid the same as before, and consequently the output will be the same. In other words the gain in the amplifying path is increased but the increase is nullified by the negative feedback.

Engineers familiar with the advantages of the new feedback circuits cite the following important transmission features:

1. Improved stability of gain and amplification.
2. Improved modulation.
3. Improved linearity (gain independent of input).
4. Improved and stabilized impedances.
5. Improved phase shift.
6. Reduced phase distortion.
7. Reduced variation of gain with frequency.
8. Reduction of noise generated within the amplifier or from power supply circuits.
9. The possibility of delivering con-
stant voltage or constant current to a varying load or output impedance.

10. Reduction in the susceptance of the circuit to external fields or interference.

11. Improvement in load carrying capacity.

12. Practicability of using less precise and hence usually cheaper circuit parts without sacrifice of performance or reliability.

From a practical standpoint it is a fact that nowadays it is easier to build an amplifier with gain higher than needed than it is to build one freer from distortion than is desired. Therefore it is only necessary to take part of the excess amplification and put it to work reducing distortion.

Generally speaking, the amount of improvement in each case is a function of the round trip gain in the amplifier and feedback circuits. If this gain is 60 db, the improvement in many of the items is of the order of 1000 to 1 and for a round trip gain of 20 db, the improvement is of the order of 20 to 1. By employing this feedback principle, amplifiers have been built and used whose gain varied less than 0.001 db with a change in plate voltage from 240 to 260 volts and whose modulation products were 95 db below the signal output at full load.

For an amplifier of conventional design and comparable size this change in plate voltage would have produced about .7 db variation while the modulation products would have been only 35 db down.

The use of stabilized feedback as a new tool in the design of radio transmitters is a good illustration of its applicability to wave transmission systems in general. One aspect deserves special mention. From the standpoint of those responsible for operating and maintaining station equipment, it is interesting to note that the amount of feedback used is determined during the technical development of the circuit of the transmitter. It is fixed at that time once and for all and, hence, no matter what the operating condition of the transmitter, the many improvements in quality, improved load capability, stability, and reduced noise are at all times obtained automatically without any maintenance.

Technically, it is equally interesting to note further that feedback action at all times will in addition cause the high level high power tubes to adjust themselves automatically to the theoretically optimum operating point on their dynamic characteristic irrespective of tube changes including aging or variations in grid bias.

The ability of feedback arrangements to improve the linearity and stability of an improper amplifier by stabilized feedback is of great economic as well as technical importance. The attainment of high power and high quality together in an amplifier or radio transmitter has always been an object of especial desire since the power stage or stages are the most expensive to construct and operate.

The utilization of negative feedback action improves the characteristics of the power stage by adding gain at a lower power level part of the system, namely, at the input, which can be done cheaply and by adding negative feedback as already explained. Thus, the same power stage can be operated with greatly improved characteristics or a much smaller power stage can be operated with equivalent quality of output.

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**ELECTRONICS — July 1936**
"Telephotographs"

System for transmitting photos by ordinary wire telephone circuits demonstrated by W. G. H. Finch who puts signals into circuits by induction. Light-weight, high-quality, fool-proof, portable

Federal Communications Commission telephone division to devote his entire time to the development of the system demonstrated. Two patents involving the method of putting the picture signals onto the telephone wires are to be issued in July.

Because of the balanced nature of telephone lines, and for other technical reasons, the telephone company only permits direct connection to their circuits by lease of the wires and on a 24 hour day basis. This is expensive, from the standpoint of the occasional transmission of photos, and it is desirable to have a system whereby the telephone circuits may be employed only when needed.

Systems employing acoustic coupling across the telephone transmitter microphone have been proposed as far back as 1903 by the Frenchman, M. Semat in his French Patent No. 331,314. Continuous development for acoustic coupling has progressed throughout the years as exemplified by the improvements of Hoglund in 1910, (Patent No. 970,820), and Bartholomew in 1923, (Patent No. 1,454,719).

SEVERAL systems of photo transmission by wire and radio have been described in Electronics during the past several years. Interest by newspapers in the rapid transmission of news pictures has stimulated much activity in this field with the result that simple and portable equipment is now available for sending a photo from any telephone, public or private, directly to the home office of the newspaper desiring the photograph (see Electronics, January, 1935 and March, 1936).

W. G. H. Finch Develops New Apparatus

On July 3 the editors of Electronics witnessed a demonstration of such apparatus recently developed by William G. H. Finch, who resigned as assistant chief engineer of the

output of the picture signal amplifier. The solenoid is arranged to be adjustable for coaxial relationship with the induction coil to obtain optimum signal transfer from the transmitter to the telephone lines. At the receiving station, an identical unit is secured to the associated telephone box and is adjusted in coaxial relationship with the induction coil, to pick up the picture signals for translation by the electro-optical receiver.

The method of solving the synchronism problem is disclosed in the Finch reissue patent No. 19,575 which is incorporated in his "Telepicture" apparatus demonstrated on July 3 and during the recent political conventions. The other patents issued this month are Nos. 2,047,863 and 2,048,604. The system demonstrated to the Editors appears to be high-quality, light-weight, fool-proof equipment which may be coupled to any telephone line without actually cutting into the circuits.

Inductively Coupled to Line

Methods using the carbon microphone and loud speakers, however, have troubles which are well known. The distortion which is not serious for speech becomes a major drawback when picture transmission is desired. Capacity coupling has been utilized, too, but Mr. Finch uses a method of inductive coupling with a compensating network which transmits all frequencies up to 5,000 cycles and above and permits high definition pictures. Mr. Finch has developed a small unit which fits over the phone-box. This unit comprises a coupling solenoid connected to the

July 1936 — ELECTRONICS
SPECIALISTS in Resistance Units

... of more different types ... 
... in more different shapes ... 
... for more different applications ...

... than those produced by any other manufacturer in the world. IRC engineering achievements have given the International Resistance Company a position of *international leadership*!

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ELECTRONICS — July 1936
DR. RENTSCHLER contributes a new theory of photoelectricity, tungsten lamps are used as dummy antennas, u-h-f is used to relay instructions to drivers in auto races, to transmit safety lessons to autoists.

Four “Apex” Stations Now Operating

Many applications for broadcast facilities above 30 megacycles, now termed “apex” stations, are pending before the Federal Communications Commission. In the meantime the four existing apex stations are operating steadily for a limited audience, and it is expected that considerable impetus will be given to extending the range of all wave receivers into this region. The apex transmitter associated with WWJ (owned by the Detroit News) is laying down an excellent signal in Detroit and for over twenty miles around. The antenna is at the top of the highest building in the city. As usual on these frequencies, the sky wave is frequently heard several thousand miles away. Reports are also received from points one hundred to three hundred miles away in Michigan and Indiana.

Field Survey for Police Service

The city of Milwaukee, Wisconsin, is building a new police station, and proposes to move the police transmitting station to it. Police service in the city has suffered somewhat in the past from dead spots, and it is intended that these be eliminated as far as possible with the new station.

For the survey, a temporary hundred-foot pole supports a quarter wave vertical radiator. A radial ground system has been installed, and a 300 watt test transmitter is used. The measuring equipment uses a built-in antenna, and is rigidly enough constructed so that it is dependable when the car is in motion. The receiver uses a crystal oscillator. It was calibrated by comparison with a conventional field strength set.

Mr. Wareing, the engineer in charge, is taking the test car over the entire length of every one of Milwaukee’s streets, a total of 830 miles, and making continuous observation of field strength. Points of low signal strength are recorded. Under existing interference conditions, a minimum field strength of 350 microvolts per meter is necessary for good communication.

The typical dead spots found in Milwaukee are very small, often only a few feet across. They are particularly likely to occur at intersections. In a few places they extend over more than a block. The new transmitter, which is two or three miles from the old one, has an entirely different pattern of dead spots from that found with the old one.

This kind of dead spot seems to be entirely lacking in some cities. While the cause of them is not fully known, it is probably an interference pattern between reflected signals more often than a complete absorption of signals.

... .

Incandescent Lamps for Dummy Antennas

Tungsten lamps are frequently used to test the output of transmitters. They are usually the only method available for measuring power at ultra high frequencies. A few simple rules are helpful in calculating power and resistance of such a load. Household type lamps are marked in voltage and wattage. Automobile type lamps are marked in voltage and candle power. Wattage at normal voltage (6 volts on a 6–8 volt lamp) is approximately 0.6 times the candle power.

When voltage and wattage are known, current and resistance under normal conditions can readily be calculated. The resistance of a tungsten filament increases rapidly with temperature, and this requires a correction calculation. The simplest way to make this correction is to remember that the percentage variation of current from normal value is 0.6 times the percentage variation of voltage from normal value. The current is read with a thermocouple meter.

For example, if a 100 watt, 115 volt lamp is used, dividing 100 by 115, we find that the normal current in this lamp is 0.87 ampere. An ammeter indicates that the r-f current through the lamp is 0.82 ampere, or 6 per cent below normal. Since the variation in current is 0.6 times the variation in voltage, the voltage must be 10 per cent below normal, or 103 volts. The power output of the transmitter is 103 times 0.82, or 85 watts. The load resistance is 103 divided by 0.82, or 126 ohms.

Any antenna resistance can be approximated by the dummy by picking...
Specially mixed colors are applied on the pure white ceramic case of Erie Insulated Resistors. Because the painting surface is pure white, the color does not change in tone after application.

The color code resistor has nothing to do with the unit, yet it's important bearing in the line.

Longer time in reading proper values . . . all exact their toll.

That's why a sensitive thing like paint consideration at Erie, when you examine a Resistor.

Notice the absence of ragged edges on the resistance and tolerance color bands. They stand out clean and sharp—the colors do not blend where two bands touch.

NOTE the rough surface of an unpainted case.

Resistors in top photograph 2/3 actual size. Individual units shown.
the right voltage and wattage bulbs and arranging them in series or parallel. Various voltage flashlight and panel lamps are available. Automobile type bulbs come in 6 and 12 volts, from 2 to 50 candlepower. Household bulbs are made in 32, 64 (pullman car), 110, 115, 120, and 230 volt types. If more accurate work is to be done, a calibrating bulb may be set beside the r-f load bulb, and lit from a d-c or a-c supply, with a wattmeter or a voltmeter and an ammeter in the circuit. The brilliancy of two lamps can be very closely matched.

New Transmission System Avoids Coupling Equipment for Broadcast Tower Lighting

The problem of supplying power to lights on insulated radio towers, such as are usually required by the Bureau of Public Roads, is usually a difficult one since a cumbersome and expensive filter must be used to prevent r-f energy from "backing up" from the antenna through the power line. A new system developed by engineers of the Bell Telephone Laboratories, which has already been applied to station WWJ, Detroit, makes use of a concentric transmission line which connects the tower with the light power supply and which eliminates the necessity of any other protective apparatus. The transmission cable is composed of an outer metallic tube which is at ground potential over its entire length and an inner metallic tube insulated from the outer shell except at the end which is furthest from the antenna tower, where both inner and outer tubes are bonded together and grounded. The length of the transmission line is adjusted to be a quarter-wavelength at the frequency at which the tower radiates. Within the inner tube two insulated conductors carry the illuminating current. At the tower end of the line the radio frequency potential builds up until the potential between the outer grounded sheath and the inner tube is the same as the radio frequency potential of the tower with respect to the ground. The quarter-wavelength line also serves as a second harmonic shunt, being one-quarter wave length long at twice the fundamental frequency. The system is applicable to stations up to 50 kw. power.

Cathode Ray Oscillograph Finds Use in Oil-Burner Equipment Laboratory

The Timken-Detroit Axle Company, makers of Timken Silent Automatic Oil Burners have installed a cathode-ray oscillograph in their engineering laboratory for testing burner controls, motors, transformers and other electrical equipment. It is believed to be the first commercial type oscillograph installed by any manufacturer in the automatic oil heating industry. One of the uses of the oscillograph is the testing of current characteristics of the igniters of automatic oil burning installations. Previous testing methods using voltmeters and ammeters have proved inadequate for high speed inspection and for discovering small departures from normal operation.

DISCOVER NEW THEORY OF PHOT-O-EMISSION

Dr. H. C. Rentschler (right) and D. E. Henry of the Westinghouse Lamp Company with a new form of photo-electric cell to which oxygen can be admitted. The threshold shift of the cathode was shown to be due to the formation of a sub-oxide instead of the supposed monatomic layer, on the cathode surface.

Short Wave Communication At Auto Races

One of the racing cars in the annual Memorial Day 500 mile auto race at Indianapolis this year was equipped with an ultra high frequency receiver for receiving instructions, information on track conditions, etc., during the race. Heretofore flags and blackboards have been relied on for this purpose. The headphones were built into the shock helmet worn by the driver.

The transmitter was a 15 watt crystal controlled unit operated from a six volt battery, an instrument built for mobile police service. A half wave horizontal antenna was used, fed at the center by a concentric line.

The operator used a receiver to monitor the transmitter, the receiver being a duplicate of the one used in the racing car.

Wired Radio System Used by Dow Jones Service

Equipment furnished by the Teleregister Corporation is now being used by the Dow, Jones & Company, Inc. for the dissemination of financial news to offices in New York City. Telephone wires over which the audio-frequency signals are sent are used to connect the central news office with the various loud-speaker installations of the subscribers to the service. The service is intended as a supplement to the ticker and bulletin services operated by the same company, and provides a vocal announcement of attention-getting quality not possessed by other news-casting means.
In high frequency therapy, as in numerous other branches of electronic science, Bakelite Materials have made substantial contributions to the improvement of equipment. A typical example is the "Medelectro" 450-watt output, 50,000,000-cycle radiothermy instrument pictured. Here, the combined mechanical strength, light weight and low power factor of Bakelite Laminated brought new convenience in the operation of ultra short-wave units. Through use of this material for the jointed electrode bracket-arms, electrodes can be more readily ad-

BAKELITE CORPORATION, 247 PARK AVEN
BAKELITE CORPORATION OF CANADA, LIMITED, 162 Dufferin Stree

THE MATERIAL OF A THOU ELECTRONICS — July 1936
GOAT FORM-FITTING TUBE SHIELDS

Improve set performance by giving perfect shielding which can be obtained only by enclosing the tube in a close fitting metal envelope.

This is not a theory but an established fact.

GOAT RADIO TUBE PARTS, INC.
314 Dean Street, Brooklyn, N. Y.
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43 E. Ohio St., Chicago
1264 South Fedora St., Los Angeles, Calif.
500 King St. West, Toronto, Canada

Rays from Gas Discharge Tube Retard Mold Growth

THE USE of a low-wattage gas discharge tube to produce radiation outside the visible spectrum which has germicidal properties has been announced by Dr. Robert F. James of the Westinghouse Lamp Co. who developed the new device. The gas tube is known as the Sterilamp and represents the first means of producing germicidal rays on an economical basis. Its applications to the food industries are numerous. In the "tenderizing" or ageing of meat, spoilage produced by high temperatures can be considerably reduced when the tendency to mold growth is inhibited by exposure to the radiation. Another important use is in connection with bakery products and in the refrigeration of fruits. The lamp operates through a transformer on approximately ten watts power.

Electronics Course Offered at Purdue University

IN RESPONSE to the increasing demand for engineers who are well prepared in the theory and application of electronic devices, the School of Engineering at Purdue University has recently inaugurated a new course in electronics. The course is required of all junior electrical engineering students and is designed to give the student a working knowledge of the fundamentals of electronic circuits and devices, including investigations of various types of vacuum and gaseous tubes and light sensitive cells. It is intended to give the student a thorough grounding in the fundamental principles of the electronic tube, similar to the basic knowledge he acquires about other circuit elements such as motors, generators and transformers. The course in electronics is a prerequisite for advanced senior course in communication and electronic tube study.

July 1936 — ELECTRONICS
Recognizing the need for better insulation for the grid of metal tubes, ISOLANTITE, INC., has produced an assembly to meet this need. These manufacturers have already found that ISOLANTITE grid cap assemblies improve their tubes.

ISOLANTITE bases for special tubes where low loss is paramount importance will be available soon.

ISOLANTITE for both ends of the metal type tubes will give the best possible performance.

ISOLANTITE, INC., 233 BROADWAY, N.Y.
FACTORY AT BELLEVUE, N.J.
U-h-f Radio Car Transmits Safety Lessons

Each Sunday afternoon, in cooperation with the Milwaukee Safety Commission, Station WTMJ broadcasts impromptu observations of automobile driving, pointing out the good and bad points of various drivers as they pass busy corners in downtown Milwaukee. The observations are made from a standard coupe which carries a portable transmitter (call W9XAJ, operating on a frequency of 40.6 megacycles with a power of 1/4 watts). The crystal microphone into which the observer speaks uses a pre-amplifier which is strapped to his belt. A cable from the announcer to the car permits him to walk within a radius of 50 feet of the car. The signals from the car are picked up in the experimental laboratories of WTMJ and relayed to the broadcast station where they are put on the air at the usual broadcast frequency (620 kc.). The safety car has been able to travel as far as two miles from the receiver point before the signals begin to be too weak for use.

Sunday drivers have tuned in on the broadcast with their auto radios and have followed the safety car around until a regular parade results. During a recent thunderstorm the announcer recommended that lights be turned on in all autos, and at once lights flashed on in many cars on the street.

New REMLER STUDIO SPEECH INPUT EQUIPMENT

Modernized, high-fidelity two-channel system engineered to give trouble-free service and backed by the reputation of Remler. Extremely flexible: all A.C. operation; six-position mixer; key switch operation with relay operated speaker and signal light switches. May be furnished with preamplifiers for operation with dynamic, velocity or crystal microphones. Accommodates Remler A.C. condenser microphones without additional preamplification.

MODERATELY PRICED...within the reach of even the smaller stations. Special features to meet individual requirements.

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REMLER—THE RADIO FIRM AS OLD AS RADIO

CONCENTRIC TRANSMISSION LINE
For Conducting Radio Frequency Power

DEPENDABLE PERFORMANCE
SIMPLE INSTALLATION
COMPLETE SHIELDING

Lines are available in sizes suitable for power ranging from 500 kw. down to receiver circuits. Gas filling equipment and electrical terminating equipment are also supplied.

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CHICAGO, ILLINOIS

What is claimed to be the smallest radio tube ever made has been constructed by Chao-Ying Meng, research fellow at California Institute of the Technology. The wavelength generated by it is about one centimeter long. The recording field method is used, the plate (0.5 mm. inside diameter) being at zero or slightly negative bias while the grid (0.2 mm. diameter) is at high positive potential.

July 1936 — ELECTRONICS
MOST shop men know and make some use of Self-tapping Screws... yet in 7 out of 10 cases they can profitably employ the specialized knowledge of a Parker-Kalon Assembly Engineer. By a simple investigation of fastenings he uncovers opportunities for further cost reduction, design simplification and product improvement... benefits that can be obtained without added expense simply through making the fullest practicable use of Self-tapping Screws.

*A Parker-Kalon Assembly Engineer doesn’t pretend to know-it-all. Neither does he claim that Parker-Kalon Hardened Self-tapping Screws are a “cure-all”. But he does have a complete and specialized knowledge of these famous cost-cutting Screws. Because of it he is able to recognize the many different types of metal and plastic assemblies which Self-tapping Screws will make easier than other fastening methods.

Scores of concerns... scores of production efficiency gains... a specialized knowledge. By a simple investigation of fastenings with shop men, an engineer has uncovered scores of seemingly difficult fastenings more easily done. Benefits have been obtained with costs held to a minimum.

It will cost you nothing by one of these Specialists. It will require no special experience necessary to use them. All are too busy to “peddle” Screws... they do no peddling. They will put your plant on a self-tapping Screw basis on the slightest notice.

PARKER-KALON CORPORATION

Electronics — July 1936
Crystal Microphones

**8 EXCLUSIVE FEATURES**

- Ultra "Wide-Range": Reproduction from 40 to 10,000 cycles with uniformity of response closely approaching the most rigid true high-fidelity tolerances.
- New Shure "Cruciform" Crystal Mounting—makes possible highest output level ever attained in a diaphragm-type crystal microphone of comparable frequency response.
- Dual-Drive High-Capacity Grafoil Bimorph Crystal.
- New acoustically-correct single high efficiency Curvilinear Diaphragm.
- Internal Screen-Protected Cartridge Unit.
- Complete Barometric Compensation.
- Crystal "Moisture-Sealed" by new exclusive special process.

**LEACH RELAY**

Always on the job giving dependable operation.

The new Leach Impulse Relays make possible many new developments such as new circuits, new lock-out schemes—alarm systems and safety devices. Operation is dependable, absolutely quiet, and fast.

LEACH RELAY CO., 5915 Avalon Boulevard, Los Angeles, Calif.

Please send me your new catalog. I am interested in____ relay.

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Radio Transmission Survey of Ohio

In January 1934 an investigation was started to determine the answer to the following questions before developing a comprehensive radio communication system for the state of Ohio, for highway and police patrol. How large a station would be required to cover the entire state? Should more than one station be erected to better cover the area? What power should the station or stations have? Where should they be located?

The results of the field survey of the state of Ohio made with these questions in mind have now been published by the Engineering Experiment Station of Ohio State University, Bulletin No. 92. This 18 page report of the work undertaken by Robert C. Higgy and E. D. Shipley describes the apparatus, the methods used, the final field strength surveys and in general provides an interesting and useful analysis of the investigation.

Cellophane Balloon

This unmanned balloon was sent aloft by the Bartol Research Foundation, for weather and cosmic ray studies. A radio transmitter relayed data to the ground during the ascent.

July 1936 — ELECTRONICS
Shakeproof Lock Washer

**Strut-Action NOW WITH POWERFUL Spring**

The exclusive shape of the tapered, twin Swimproof Lock Washer provides a positive locking of nuts and screws absolutely tight. Each one edge up and one edge down—the top is nut—the other digging into the work surface. A spring is placed between the nut and the work—set leverage which definitely prevents any back of the nut. Each tooth is tapered or shaped so the twist increases, the width of the tooth decreases a substantial line-bite at initial contact.

**THE LOCK WASHER THAT NEV**

The tapered design also provides a strong spring. The greater width of each tooth at the root resiliently cooperate in resisting any flattening. The Shakeproof Lock Washer, there is positive lock that vibration cannot loosen—in fact, as the teeth bite even deeper—making the lock

Saw for this FREE ASSORTED TEST RING

Seeing is believing! Give Shakeproof a trial—compare it by actual test with any other lock washer. To help you, we offer this handy test ring including samples of both internal and external types in five different sizes. It's free, of course, so send for yours today!

**SHAKEPROOF LOCK WASHER CO.**

Distributor of Shakeproof Products Manufactured by Illinois Tool Works

2539 North Keeler Avenue

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ELECTRONICS — July 1936
Do You Have Data on AmerTran Midget Audio Components?

**ACTUAL SIZE**

**Specifications**

Frequency range: .20 to 20,000 cycles Operating range: . . . . 50 to +6 dE Shielding: . . . . Magnetic and static Average unit weight: . . . . 32 oz. net Cubic content: . . . . 24 cu. in. Diameter of case: . . . . 3 1/2 in. Height of case: . . . . 5 1/2 in. Type mounting: . . . . Reversible

List Prices (see note):

Audio Transformer Types $12.50
Audio Reactor Types $11.00
Filter Reactor Type $10.00
Plate-Filament Types $10.00

**Standard Designs**

Mixing types for matching 0.2, 30, 50, 75, 100, 200, 250 or 500 ohms to 200 or 500 ohms.

Line-to-Grid types for matching 30, 50, 75, 100, 200, 250 or 500 ohms to 50,000 ohm single grid.

Interstage types for working from single plate to single or push-pull grids.

Plate-to-Line types for working from 10,000, 20,000, 30,000 or 40,000 ohm plate(s) to 200 or 500 ohms.

Miscellaneous: parallel feed, isolation and filter reactors, plate-filament transformer.

Note: above list prices subject to standard trade discounts.

Ask for Bulletin No. 1003

**Mixing Tube Ambiguity**

[K. WILKELM, Telefunken Laboratory]. The purpose of the mixing tube is to produce a strong intermediate wave out of the r-f wave and the local oscillator frequency which are applied to its grid, or grids, without giving access to effects, such as whistling, humming, distortion. The fundamental equation for the a-c component present in the plate current of the mixing tube is

\[ I_p = \frac{k}{2} S L \cos (P = p), \]

where \( p \) is the angular frequency, \( 6.28 f \), of the signal to be received and \( P \) the angular frequency of the local oscillator in practice always chosen larger than \( p \). \( S \) and \( L \) are the amplitudes, and \( k \) is the second derivative of the \( I_p - E_p \) curve, and a measure for the curvature of this curve. But \( P \) and \( P \) are not the only frequencies which produce the i.f. \( P + p \) (or \( P - p \) if the intermediate amplifier is built for this frequency). To have, for instance, an i.f. of 125 kc, the sender may be at 500 kc, when the local oscillator is at 625 kc. But the first overtone of the oscillator (1,250 kc.) will also produce 125 kc. when stations sending at 1,125 kc. or 1,375 kc. are allowed to act upon the grid with the receiver set for 500 kc., or with the third harmonic of the oscillator, stations at 1,750 and 2,000 kc. Similar ambiguities occur when harmonics of the stations are taken into account although in the particular example the interfering stations would have frequencies below 500 kc. Any station having a frequency \( f \) might be received together with the desired station \( f_n \) whenever

\[ f = \frac{m}{n} \left( f_1 + f_2 \right) = \frac{f_n}{n}, \]

or, expressing all the frequencies as multiples of the intermediate frequency \( f_m \), when

\[ \frac{f}{f_m} = \frac{m}{n} \left( \frac{f_1}{f_m} + \frac{f_2}{f_m} \right) = \frac{1}{n}, \]

\( m \) being the order of the harmonic of the local oscillator and \( n \) the harmonic of the station. With \( f/f_m \) measured along a horizontal axis and \( f/f_m \) along a vertical axis of coordinates, the equation is represented by a bundle of straight lines for various choices of \( m \) and \( n \). The lines having the same \( m \) meet in one point on the horizontal axis; there are two such intersections for each value of \( m \), owing to the double signs in the equation. Points where a vertical in any point, for instance \( f/f_m = 625/125 = 5 \), intersect the straight lines, correspond to stations which might interfere.

Besides the interference from unwanted stations, there is also the possibility that the fourth harmonic of the desired station, 500 kc. combines with the third harmonic of the oscillat-
WESTERN ELECTRIC'S new 304B triode delivers even more power between 300 and 400 megacycles than the famous 304A. The 305A is the outstanding screen grid amplifier for ultra high frequencies.

$38.50
in U.S.A.

Western Electric 305A

The Western Electric 305A screen grid tube has been specially designed with short leads and low interelectrode capacities so as to have maximum effectiveness in the ultra high frequency range. It is useful as a buffer, doubler or amplifier. Two 305A tubes, push-pull, are capable of an output of 115 watts at 60 megacycles with an overall efficiency of 55%.

Maximum Overall Length: 7 3/16"
Anti-noise Circuits

At a recent meeting of the Radio Club of America discussion turned to the Lamb noise suppressing circuits and to various means for limiting the power in unwanted signals to the values of desired signals, thereby increasing the ratio of signal to noise. Mr. B. H. Marriot pointed out that his U. S. Patent 1,836,379 on a power limiting device had proved useful in limiting static and other noises.

In this patent a circuit is shown involving an output transformer connecting the receiver to a loud speaker.

A neon tube is substituted for the gap shown in the original patent and at a certain value of resistance, distinct noise limiting action occurs.

Brighter Than the Sun

The brightness of the sun as seen from the earth is 1,065,000 candle power per sq.in. according to the International Critical Tables. Recent work of Elenbaas and Bol in the Philips Laboratories equalled this brightness, and went somewhat beyond it, by decreasing the diameter of a super-high-pressure mercury vapor lamp, water cooled. The lamp has an inner diameter of 1 mm. an outer diameter of 3½ mm. with electrodes 10 mm. apart and at 905 volts, a.c., it took 1,400 watts. The luminous intensity was 11,000 c.p. and the pressure about 200 atmos. Along the axis of the discharge the brightness was 1,100,000 c.p. per sq.in.—Philips Technical Review 62, February, 1936.

Errata

The diagram Fig. 1 on page 20 of the May 1936 issue of Electronics illustrating an "A-C operated beat oscillator" by S. J. Haefner and E. W. Hemlin should be corrected as follows: The cathode resistor of the 45 output tube marked R, should be connected to the common return lead which in turn is grounded and connected to the "B" minus terminal of the power supply. The +250 volt line should connect to the mid-point of the 2 millihenry chokes so as to apply plate voltage to the two type 2A4 tubes. The blocking condensers C, should connect to the common return leads of the two 2A4 tubes.

Tube Application Bulletins

Excellent bulletins on how to use radio receiving tubes are issued by several of the tube manufacturers. The Applications Notes of RCA Radiotron are well known and widely used. Of more recent origin are the bulletins issued by National Union, Hygrade Sylvania and Ken-Rad. Recent bulletins are as follows: Audio Amplification Gain Control, National Union; Operation of the GL6, RCA and Hygrade Sylvania; Degeneration on Audio Amplifiers, Hygrade Sylvania; All-metal Radio Tube Characteristic Chart, RCA.

LANDING INDICATOR ON "HINDENBURG"

The small indicator is for use with the blind-landing radio beam, for guiding the new zeppelin through fog.

July 1936 — ELECTRONICS
Formica Insul
Radio Sets in the CS

In this article, the safety of radio sets in the CS is discussed. The safety of radio sets is of utmost importance, and Formica insulation is recommended for use in these sets.

It is essential that all rods and machine parts be insulated properly.

Send orders to:

THE FORMICA INSULATION COMPANY
4638 Spring Grove Avenue, Cincinnati

FORMICA

ELECTRONICS — July 1936
Transmitter Adjustment

[Continued from page 17]

\[ M = \frac{10^6 \cdot X_c}{6.28 \cdot F \cdot \sqrt{Z_c}} \]

Where:
- \( M \) = Mutual Inductance in \( \mu \)
- \( X_c \) = Reactance of tank capacity
- \( R_a \) = Antenna resistance
- \( Z_c \) = Transmission line impedance
- \( F \) = Frequency in cycles

When it is merely desired to use a terminating capacity at the antenna end of the transmission line and not a tank circuit, the value of capacity necessary to provide a unity power factor load is equal to:

\[ C(\mu) = \frac{10^6 \cdot Z_c - R_a}{6.28 \cdot F \cdot \sqrt{Z_c}} \]

Where \( F \) = frequency in cycles
- \( Z_c \) = transmission line impedance
- \( R_a \) = antenna resistance

The antenna will be properly coupled to the transmission line, when using a tank circuit at the antenna end of the transmission line, when the antenna current, and the current in the capacitive and inductive branches of the tank circuit are the pre-calculated value.

The current in the antenna can be easily calculated.

\[ P = P_{in} \times R_a \text{ or } I_a = \sqrt{\frac{P}{R_a}} \]

where \( P \) = input to transmitter.

The current in the capacitive branch of the tank circuit may be determined as follows:

\[ E_{in} = \sqrt{Z_a \times P} \]

and

\[ I_{in} = \frac{KVA}{KA \times P} \]

It is usually customary to use a KVA/KW ratio slightly higher than that in the final amplifier tank circuit if the antenna impedance is relatively high. This impedance can be determined from any good r-f measuring set. When the antenna impedance is low, a lower KVA/KW ratio may be used.

The value of current in the inductive branch of the terminating tank circuit may be derived as follows:

\[ X_L = R \times \frac{Z_t}{X_i} \text{ or } Z_t = R + \left( \frac{Z_t}{X_i} \right) R \]

Where \( X_L \) = reactance of tank cond.
- \( X_i \) = reactance of tank ind.
- \( R \) = tank inductance resistance plus reflected resistance of antenna coil.

The antenna should be resonated at the transmitter frequency by means of a driver oscillator coupled to the antenna coupling coil, with the tank circuit disconnected from the transmission line. Then the tank circuit should be connected across the transmission line and the antenna coil opened. At this point tune the tank circuit to resonance. The amount of inductance in the antenna may be calculated from any of the many formulas in Bulletin 74 of the Bureau of Standards. Now reconnect the antenna and ground or counterpoise to the antenna coupling coil and put the transmitter into operation. The current readings in the antenna, and the capacitive branches of the tank circuit should indicate the values already calculated. When the antenna current and the capacitive current are both low, there is insufficient excitation from the transmitter. Increase the r-f drive. If the capacitative current is high and the antenna current is low, there is insufficient inductance in the antenna coupling coil. With the above readings reversed, the opposite is true. Whenever the antenna coil is touched the antenna must be again tuned to resonance.

It will be noticed that the current in the inductive branch is not its pre-calculated value when the other two readings are correct. It is merely necessary to vary the inductance of the tank circuit until the inductive current is correct. At this point the tank circuit offers a unity power factor or resistance load to the transmission line.

It is recommended that the tank circuit be used to terminate the transmission line and not merely the capacitor as in Fig. 6, for increased harmonic reduction.

REFERENCES:
1. Antenna Termination, Carl G. Dzielski, Electronics, September, 1935.
2. Antenna Measuring Set, W. B. Lodge, Radio Engineering, April, 1934.

July 1936 — ELECTRONICS
PORTABLE INSTRUMENTS

with Westinghouse Quality

Now—no matter what type of portable instrument is required... a-c. or d-c... you will find it in the Westinghouse complete line. Sizes range from small volt-ohmmeters that can be slipped easily into the pocket up to large portables with a guaranteed accuracy within 1/4 of 1%.

The outstanding advantage of Westinghouse Portable Instruments is their sustained accuracy. This is assured by time-tried movements that cannot be deranged under the most severe service. Proper heat treatment and aging of the permanent magnets, sturdy coil construction, highly-polished hard-steel pivots, and genuine sapphire bearing jewels place these movements with the most reliable that can be obtained.

In addition, every Westinghouse portable instrument is enclosed in a strong, durable Moldarta case that will not warp or split with age.

These and many other refinements assure the quick, reliable testing that saves money. No logical reason exists for accepting lower quality.

Standard catalog instruments are available in a wide variety of ranges so that one can be selected easily for almost any requirement. For detailed information, ask for Portable Instrument Catalogs 43-105, 43-110, 43-120, 43-125, and 43-141. Room 5-N, East Pittsburgh, Pa.

ELECTRONICS — July 1936
Loud Speaker Test
(Continued from page 21)
continuously varied above and below the normal value, so that for any particular measurement the phase of the reflected components will pass through all values relative to the phase of the direct sound. The chief disadvantage is that the average output of the speaker is obtained over a band of frequencies instead of at a single frequency. At low frequencies the warble range represents a very large percentage of the mean frequency and the readings will not show up any sharp variations in the speaker response. Probably the most desirable method for averaging the phase relations of the reflected sound is to use a rotating microphone. If the microphone is rotated along a circle of 5 or 6 feet diameter, the mean microphone output during a complete revolution will have averaged out the reflection errors.

Here the high-frequency response obtained indoors is quite the same as the outdoor characteristic. At the low frequencies there is an increase in the response in the indoor curves. This increase is due firstly to the lower absorption coefficient of the wall covering at the low frequencies, with the corresponding increase in reflected energy, causing apparently high response; and secondly, to the wider spread of the low frequencies from the loud speaker, which also means higher reflected energy at these frequencies. The difference in the amount of increase in the indoor low-frequency response in each of the two sets of curves indicates a different degree of low-frequency distribution from each speaker.

Even though the rotating microphone method quite effectively "iron out" reflection peaks and dips in indoor curves, the information obtained is not exact, especially at the lower frequencies. It is possible to reduce the amount of discrepancy between indoor and outdoor curves by using a microphone that discriminates against sounds coming from random directions. The discrepancy between indoor and outdoor curves, however, cannot be entirely eliminated even by the use of directional microphones.

It appears that the only way to get absolutely accurate response curves, especially at the lower frequencies, is to make the tests out of doors.

d) Outdoor Response Measurements—In making speaker tests outdoors the only reflection which is of any consequence is from the ground. This single reflection can be very easily prevented from affecting the measurements by using a directional microphone arranged as shown in Fig. 6. In both of these arrangements the reflected sound lies along the microphone axis of zero sensitivity.

If a non-directional microphone were employed in either of the arrangements of Fig. 6 the effect of the ground reflection would be as described in connection with Fig. 2. Equation (6) has already shown the relative magnitude of the reflected sound and equations (7) and (8) have indicated when the reflection will add and subtract to the direct sound. What happens between the extreme phase conditions of equations (7) and (8) is indicated vectorially in Fig. 7.

OD represents the magnitude and phase of the direct sound pressure arriving at the microphone. OR, represents the magnitude of the reflected component. OR' is obtained from Equation (6) and the phase relation shown is for a frequency that satisfies Equation (7). OT, represents the total pressure at the microphone under this condition.

As the frequency is raised, the reflected component swings through some angle $\theta_2$ to the position OR, at which case the pressure at the microphone will be $OT$. At a still higher frequency, $\theta$, will increase to $\theta_2$ and the total pressure can be represented by OT. As OR makes a complete revolution the total pressure will vary as shown by the length of OT on the figure. OR makes a complete revolution for each unit increase of the integer $n$ in equation (7).

The value of $\theta$ in Fig. 7 at any particular frequency is given by

$$\theta = \frac{f - f_1}{f_2 - f_1} \times 360 \text{ degrees}$$

Where $f =$ frequency concerned

$$f_1 = \text{first frequency below } f \text{ that satisfies Eq. (7)}$$

$$f_2 = \text{first frequency above } f \text{ that satisfies Eq. (7)}$$

For experimental analysis of the elimination of ground reflections the reader is referred to another paper.

Response curves taken out of doors can always be duplicated from time to time by various groups whereas indoor curves vary, depending on the room in which they were obtained. Indoor curves should only be used for comparative tests on a speaker while it is undergoing development and the final absolute curve on the unit should always be obtained in free space if accurate low frequency response measurements are desired.

A directional radiation characteristic should show the polar distribution of sound pressure from a loud speaker at various frequencies. To obtain these curves, a constant frequency may be impressed on the speaker and the sound pressure recorded as the microphone is moved about the arc of a circle of which the speaker is the center. Another method is to keep the microphone stationary and measure the sound pressure as the speaker is rotated with respect to the microphone.

A third method for obtaining directional characteristics is to record a series of response curves along various axes of the loud speaker, preferably on the same sheet of paper, and then replot polar curves of the pressures at various frequencies for the various angles represented by each curve on the paper. This latter method is perhaps the most rapid of the three and it also permits a continuous observation of the polar characteristics as a function of frequency.

It is almost imperative to obtain directional radiation characteristics out-of-doors. If the measurements were attempted in a closed room, the reflected sound energy at the lower frequencies would be very troublesome. If a response curve were obtained on an axis of relatively low response, the reflected sound reaching the microphone could easily be greater than the direct sound, with the corresponding increase in error.

REFERENCES
8 (See especially Figs. 4 and 5.)

July 1936 — ELECTRONICS
From an unsolicited letter by Jay of Radio Station KBTM, Jonesboro,

"We are thoroughly pleased with the installation of our new Truscon Vertical Radiator. We conducted a test program on our broadcast schedule and switched our old aerial system to our new tower at the same time making an announcement of the switch-over and asking our listeners to let us know of any difference in reception noticed on their receivers.

"Listeners reported they noticed interference from other stations before the new tower was put into operation but that our station was perfectly clear and our signal drowned out all other stations completely.

"Naturally, we are very much gratified with these results. We feel that a Truscon Vertical Radiator is a valuable investment for any station, regardless of its power."
MANUFACTURING REVIEW

News

* Mr. M. W. Smith has been appointed manager of engineering of the Westinghouse Electric & Manufacturing Co., according to an announcement by Dr. S. M. Kintrver, vice-president. Mr. Smith has been associated with Westinghouse since 1915, when he joined the company as a student engineer after graduation from Texas A. & M. College. Mr. Smith's office is at the Westinghouse Pittsburgh headquarters.

* Ferranti Electric, Inc. have removed their Executive and Sales Offices from 130 West 42nd Street to larger quarters in the RCA Building, 30 Rockefeller Plaza. Their factory is also occupying new and larger quarters on West 53rd Street. Equipment is being installed. The offices and factory are connected by direct wire. The new telephone number is Circle 7-5479.

* Announcement has been received of the recent formation of Electrolab, Inc., Bloomfield, N. J. This organization, which has Mr. H. F. Murphy as president, W. Y. Riedel, vice-president, Edward Strook, secretary-treasurer and Louis W. Parker, as chief engineer, has been formed for the purpose of doing research work in the electronic and allied fields, and for the manufacture of electronic instruments.

* Techna Corporation. Notice has been received of the formation of the Techna Corporation, for the manufacture of laboratory and technical equipment including broadcast, public address, and recording apparatus, with Mr. Robert B. Walder, former chief engineer of the Remler Co., as president. Other members of the engineering staff are Royal V. Howard, former chief engineer of Associated Broadcasters, and C. E. Downey, former chief engineer of Station KROW. The laboratory and factory are located at 926 Howard St., San Francisco, Calif.

* Announcement has been made by the Fairchild Aerial Camera Corp., Woodside, L. I., N. Y., of the acquisition of the manufacturing and sales rights of the B. A. Proctor Co., of 17 W. 60th St., New York. Fairchild-Proctor apparatus for recording and reproduction equipment is available for radio broadcast stations, motion picture studios, etc.

* A new department, known as the Magnet Steel Division, has been formed at the Stamford plant of the Cinaudagraph Corp. According to Mr. Halton H. Friend, who is in charge of the new department, operations are ready to commence at once. The division is equipped to give engineering advice on the design of permanent magnet structures employing Nipermag, including engineering data, samples and quantity estimates for immediate deliveries to the trade.

* The American Microphone Co., 1915 South Western Ave., Los Angeles, Calif., announce that they have been granted a license by the Brush Development Co., permitting the manufacture of crystal microphones under the latter's patents, according to D. R. Bittan, eastern sales manager.

* Richard T. Kriebel, formerly copy supervisor and account executive with Sutherland-Abbott, of Boston, has been appointed sales manager of the Polaroid Corporation, 168 Dartmouth St., Boston, manufacturers of a new light-polarizing glass.

New Products

Standard Signal Generator

TYPE 605-A STANDARD signal generator has been announced by the General Radio Co., of Cambridge, Mass. This unit is a-c operated and contains a built-in voltage regulator. It is direct-reading in frequency, has a frequency range from 10 kc. to 30 mc. in seven bands, can be modulated externally or internally up to 50 per cent modulation on frequencies from 30 to 15,000 cycles. The attenuator setting does not affect frequency. The price complete is $415. A bulletin describing the equipment is available on request.

Aluminum Horn

AN ALUMINUM TRUMPET horn specially suitable for auditorium and general outdoor public address work where directional and long-distance coverage are desired is being manufactured by the Fox Sound Equipment Corp., of Toledo, Ohio. The units are made in three-piece construction and are 5 ft. long. A dual throat trumpet with a capacity of 75 per cent greater than the regular type is also available.

Wide-range Crystal Microphones

SHURE BROTHERS COMPANY, 215 W. Huron Street, Chicago, Illinois, have just announced three new economically priced crystal microphones, which they have called the "Ultra" series. Model 700A is compact and has a swivel arrangement permitting the head to be tilted. The instrument has a semi-directional pickup characteristic of diaphragm type microphones. Diameter, 22 inches; weight, 12 ounces.

Model 701A, with grille type case and mounting, has performance characteristics substantially the same as Model 700A, having wide range reproduction from 40 to 10,000 cycles and "Cruciform" crystal mounting. Net weight, 10 ounces.

Model 702A is a spherical microphone with semi-nondirectional pickup, with an overall diameter of 24 inches; net weight, 9 ounces. All units have standard 8"-27 thread for stand mounting, and are furnished complete with 7 ft. moisture-proof low loss single-conductor rubber-jacketed cable. All three list at $25 each.

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Announcing

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ELECTRONICS — July 1936
AN OUTSTANDING COMBINATION

The New Model 150 Simplified Electronic Switch

This development—used in conjunction with the Type 148 Cathode Ray Oscillograph or any other commercial Oscillograph—markedly increases the value of the Oscillograph.

It permits simultaneous observation of any two voltages or current phenomena—can be used to inspect and compare wave form or phase of two voltages or currents from different parts of the same circuit—compares waveform of a standard wave with any other wave—can be applied to a timing wave. In conjunction with the wave under observation—and for many other useful applications.

Unit is self-contained and operates from 110-120 volt, 60 cycle circuit. Controls are provided for adjusting gain of amplifiers for varying the speed of sweeping. Frequency Range 10–500,000 cycles per second. Gain of Amplifier in Audio Frequencies 10. Power consumption—30 watts.

List Price—complete with tube—$42.50.

2 Type 148 Cathode Ray Oscillograph

This instrument features a basically new sweep which allows waves from 10 to 500,000 cycles to be observed with improved linearity and exceptionally fast return trace.

Another feature, contributing to outstanding performance is an improved Synchronizing Circuit permitting locking sweep with fractions as well as multiples of wave.

In addition, a Cascade Amplifier is offered which gives 1 inch deflection with a .2 volt signal—a Single Knob controls all switching—a Patent-Calibrated Scale with 5 inch DuMont cathode ray tube—and the unit is completely A.C. operated.

List Price with 5" tube—$106.50.

Write for complete data on these two outstanding instruments.

ALLEN B. DUMONT LABORATORIES INC.
Upper Montclair NEW JERSEY

6 and 12-Volt Battery Chargers

CONTINENTAL MOTORS CORP., 12801 Jefferson St., Detroit, Mich., announces a gasoline engine battery charger of 212 watts output. The engine is single cylinder 4-cycle air cooled and runs 14 to 16 hours on a gallon of gasoline. The generator maintains its voltage constant over a wide range of varying loads and permits the use of a resistance load across the batteries for lighting or power purposes. The list price is $55 for the 6-volt unit and $57 for the 12-volt unit, useful for boats and yachts.

C R L Bridge with Visual Null Indication

A BRIDGE FOR MEASURING capacity, resistance, and inductance has been announced by the T. W. Patterson Corp., Canton, Mass. The bridge is completely self-contained, comprising the usual standards, ratio arms, 60 and 1200-cycle oscillator, power supply amplifier and indicator tube. Indication is made by a 6E5 electron ray tube, a 6J7 is used in the dual frequency oscillator and an 84 for rectifying. The ranges are 2 mmf. to 100 mmf. in capacity, less than one ohm to one megohm in resistance, and from 10 microhenrys to 100 henries of inductance. The visual indicator is also available as a null indicator for separate A-C bridges. In this form the tube is combined with a 79 as a two-stage resistance coupled amplifier. When so used the indicator is substituted directly for the usual telephone receivers.

July 1936 — ELECTRONICS
These devices are manufactured under one or more of the following U. S. Letters Patents:
1867380, 1940228, 1978568, 1978599, 1978600, 1982689, 1982690, 1997453, 2002500, 2005203, 2018626, 2028534, 2032580, 2032914, 2035439.
Other patents pending.

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July 1936 — ELECTRONICS
CONSIDER THE

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PLUG

Add dollar va

"CINCH" exclusive service fea

nance of the "Cinch" plugs enh

set. For the impression is give

efficiency, quality, not only in t

well . . . looked upon from the b

CINCH PLUGS FOR GLASS TUBE SOCKETS

(above) use a metal shell of practical size, designed

for speaker plug use to feature:

1 — Matching of chassis finishes — Nickel, Black

Nickel, Copper, Cadmium or Chrome.

2 — Cable opening in cap either with rolled edge,

extruded sides for shield soldering, or with

long grip handle.

3 — Plugs with four, five, six and seven prongs to

be used with standard glass tube sockets.

4 — A sturdier construction combined with neat-

ness and eye appeal.

CINCH 5700 SERIES PLUGS I

Impressions count in making s

value is obtained with Cinch I

series plugs for metal tube soc

the "Cinch" locating pin — A!

Workmanship. Cinch plugs are

add to the value of your set.

"Cinch" and Oak Radio Sockets are licen

CINCH MANUFACTURING

2335 WEST VAN BUREN ST

Subsidiary: United-Corr Fastener Cor

ELECTRONICS — July 1936
Compact Audio Units

UNITED TRANSFORMER CORP., New York, announces a series of Ultra Compact Audio Units as companions for acorn and metal type vacuum tubes. These units are claimed to have a response plus or minus 2 db, from 30 cycles to 20,000 cycles. They measure 1 7/16 x 1 7/16 x 1 15/16 in., having an average weight of 6½ oz. They are intended primarily for noise meter, aircraft and remote pick-up work.

Combination Mobile Sound System

THE WEBSTER COMPANY, 3825 West Lake Street, Chicago, Illinois, offers the combination 6-volt d.c.-110-volt a.c. operation in their new model MF-420. Changing from one supply to the other is done by simply pulling out the 6-volt plug and putting in the 110-volt plug pack. Provides adequate volume for large indoor or out-of-doors installations, and includes a high grade Webster phone pickup and electric phonograph turntable. The system is either battery or a.c. operated and for this reason has universal application either for permanent installation or for mobile use.

Light Weight Aircraft Receiver

A NEW THREE-PURPOSE receiver known as the Western Electric 20 for use in private airplanes has recently been announced by the Western Electric Co., 195 Broadway, New York City.

The receiver can be mounted with or without a small remote control unit which may be mounted on or near the plane instrument panel. The receiver, a superheterodyne with one stage of tuned radio-frequency amplification, tunes four bands, 200 to 400 kc. for beacon and weather stations, 550 to 1500 kc. for commercial broadcast stations, 1500 to 4000 kc. for aircraft, police and amateur communications, and 400 to 10,000 kc. for aircraft and amateur communications, and foreign broadcast stations. The unit weighs 1½ lbs.; measures 9 x 14 x 8¼ in. The output of the receiver is 700 milliwatts, which is sufficient to operate six pairs of headphones simultaneously.

Cable Type

Input Transformer

AMPERITE CORPORATION, 561 Broadway, New York City, announces a new input transformer designed to operate low impedance microphones directly into amplifiers having high impedance input. This transformer makes high gain amplifiers immediately adaptable to any location. As many as four XX velocity microphones can be fed into one transformer. Neutralization features of the design eliminate hum pickup. Either a 50 or 200 ohm microphone can be fed into the standard input impedance of 200 ohms. Other impedances obtainable upon request. List price, $5.00.

Preamplifier

VICTOR ANIMATOGRAPH CORPORATION, Davenport, Iowa, manufacturers of 16mm motion picture equipment, announce that 24B Sound-on-Film Projector can now be equipped with a small pre-amplifier which, when used with a velocity ribbon microphone provides a public address system which is unexcelled for quality of response and range of pick-up.

The pre-amplifier which is a separate unit measuring only 4½ in. x 7½ in. x 11 in. and weighing only 6 lbs., plugs into a socket in the base of the Animatograph amplifier. List price of the pre-amplifier complete is $35.00, and of the velocity ribbon microphone complete on adjustable floor stand, $90.00, making a total of $95.00.

July 1936 — ELECTRONICS
Literature


+ Radio Coils and Allied Products. Catalog No. 36, issued by the J. W. Miller Co., 5917 South Main St., Los Angeles, Calif. List price 25 cents. Containing complete description of a large line of coils for use in r-f and i-f applications, together with miscellaneous parts, chassis, switches, etc.

+ Public Address System. “Operadio Unit Matched Equipment,” catalog No. 10-a of the Operadio Manufacturing Company, describing complete public address systems including microphones, power supply amplifier and speakers. Available from the manufacturer at St. Charles, Ill., U. S. A.

+ Resistors. International Resistance Company, 401 N. Broad Street, Philadelphia, has a new spiral-bound catalog describing its complete line of fixed and variable resistors.


+ Auto Radio Suppressors. Two new information sheets giving test data, dimensions, prices and hook-ups for auto radio suppressors manufactured by the Ohio Carbon Co., 12608 Berea Rd., Lakewood, Ohio, available upon request.

+ Racks, Panels, Cabinets. A catalog descriptive of Par-Metal racks, panels and cabinets suitable for transmitting and sound apparatus, including enclosed and channel relay racks, sectional P.A. racks, etc. Available from the Par-Metal Products Corp., 35-25 41st St., Long Island City, N. Y.

During 54 years of existence the policy of the FERRANTI OR ULTRA transformers employing S construction and fitted in a New Co are as NEARLY PERFECT as it is to-day. Due to certain losses in humanly impossible to construct a

WE BELIEVE THE NEW FERRANTI TRANSFORMER TO BE THE BEST AVAILABLE REGARDLESS OF

Complete Descriptive Descriptions

FERRANTI ELECTRIC
30 Rockefeller Plaza

ELECTRONICS — July 1936
TELEVISION?  SOUND?  INDUSTRIAL?
Whatever your interest may be in photo cells—there is a dependable super-sensitive CETRON available for most purposes.
As specialists in the manufacture of photo cells we are prepared to supply a wide range of standard cells or, if you prefer, we will make them to your specifications.
We invite your inquiry.
CONTINENTAL ELECTRIC CO.
ST. CHARLES 7  ILLINOIS

A NEW RESISTOR WITH A TWOFOLD PURPOSE
The Type M Resistor above was designed to meet the requirements of the manufacturer who wishes to purchase either a completed resistor at 1% (or closer tolerances) or a unit ROUGH WOUND to a 3½ accuracy, to be calibrated by the purchaser to his requirements. Resistance ranges from 10 to 500,000 ohms. For those who wish to wind the lower resistance values themselves we can supply our Type M winding forms. Catalog and prices on request.

Just published—Thorough treatment of radio communication principles and their applications

Principles of Radio Engineering
By R. S. Glasgow
Associate Professor of Electrical Engineering, Washington University
520 pages, 6 x 9, 344 Illustrations, $4.00

Look up in this book—
—vector diagrams showing how to determine maximum impedance in parallel resonant circuits;
—description of coupled-circuit phenomena;
—graphical analysis of push-pull amplifiers;
—detailed discussion of modulation;
—comprehensive treatment of antennas and radio-frequency transmission lines;
—graphical methods of determining amplifier and modulator performance;
—the original material on the determination of the amount of distortion present in such circuits.

A thorough presentation of the fundamentals of radio communication and the application of these principles. Emphasis is placed upon the theory of the thermionic vacuum tube and its associated circuits and the application of this theory to communication systems. Mathematical developments are freely used, but none is introduced that is not essential for a thorough grasp of the principles involved.

Radiation Counting
[Continued from page 29]

1. The time required for starting the arc is in the order of $10^4$ seconds. Hence the operation depends on the maximum voltage applied to the grid, while with most other recorders the total quantity of electricity caused to flow through it is the determining factor.
2. The tube can easily be arranged so that the current flows through a counting device just long enough to effect registration.
3. By critical adjustment of grid-bias, the tube can easily be made to count only those surges which exceed a certain size.
4. With a chain or ring circuit the speed of recording is limited only by the restoring properties of the chamber-collecting system.
5. In such circuits, the counting meter can operate slowly and does not impose a limit on the speed of recording.

REFERENCES
1. A radium $\alpha$ alpha particle produces in air $2.2 \times 10^6$ pairs of ions, each of single charge $4.77 \times 10^{-28}$ E.S.U. This charge corresponds to a transfer of $10^{-11}$ E.S.U. of electricity in an electric field.

Photometering Raw Silk
[Continued from page 14]
age size. This is quite similar to the first operation, except for this: amplifier No. 4 is cut into the circuit in place of No. 3 and the bridge is balanced on a light transmission standard whose value is equal to that of the average diameter size of the samples. Since this satisfies the conditions required for expression (1) to equal (3), the recording meter will register the Variance, or $\sigma^2$, when
The silk is re-scanned. In other words, the bridge being balanced on the average diameter size, there will be no output to add up as a measure of unevenness, as long as the silk remains of average size. But where the skein starts to deviate, or an entire skein deviates and becomes coarser or finer than average, the bridge immediately becomes unbalanced by an amount equal to the extent of the deviation. The output of the bridge, the deviation current, is then squared and added up so that the meter records the average squared deviation, or Variance expressed in microns.

It is customary to express the unevenness as the ratio of the Variance to the average diameter. This is, in effect, a way of setting a value on the probability of seeing a given amount of variation among things of a certain definite size. Or, saying it in another way, the percentage of variation is a measure of the amount of seconds the mill man can expect in his finished silk hosiery.

Thus the phototube and electronic circuits have made another useful contribution to industry. No mention has been made of many headaches, heartaches and defunct tubes that have strewed the path of its development at the United States Testing Company, but it is hoped that they will not have been sacrificed in vain. And while it is not the most important contribution, it is certainly a very creditable and most unique one. For raw silk, due to its unhomogeneous and resilient nature, does not lend itself to any practical, accurate means of diameter measurement other than the microscope or photo tubes, and of course the time element eliminates the microscope. So, the young lead the old. The newest of scientific developments permits, for the first time, a precise, unbiased examination of the oldest of textile products, raw silk. And—cherchez la femme—of course, it's all for the sake of milady's hose.

REFERENCES

*Engineer in charge of electronic developments, United States Testing Company, Inc., Hoboken, N. J.
**Electrical Engineer and Director of Laboratories United States Testing Company, Inc., Hoboken, N. J.

EDITOR'S NOTE: The Evenometer may be seen by appointment at the main plant of the United States Testing Company, Inc., at Hoboken, N. J. (directly across the Hudson River from 23rd Street, New York) where it is in daily operation, making commercial evenness gradings of raw silk.

ELECTRONICS — July 1936
PATENTS REVIEW

PATENTS indicate trends. Next year's radio circuits, applications of electron tubes for non-communication purposes, new tube types, new materials, may be discovered by following United States and British inventions.

Radio Receiver Circuits


Frequency changer. O. E. Keall, RCA. No. 2,038,570.


Prescetor system. A variable inductance contrasted to a variable capacit-ity circuit. G. L. Beers, RCA. No. 2,037,754.


Detector circuit. A detector having a fixed and variable bias arranged so that its efficiency increases in re-sponse to an increase in the amplitude of an incoming wave. J. C. Warner, G.E. Co. No. 2,031,441.

Fidelity control. A detector followed by an a-f amplifier with a rising characteristic has a network such that minimum selectivity is secured when a strong signal is received. G. V. Dowding, RCA. No. 2,031,034.

Duplex antenna. System for short and long wave reception comprising an antenna, a pair of downlead conductors, transformers, etc. E. V. Amy and J. G. Aceves, reissue 19,854.

Refractor. Unitary continuous reflecting web of curvilinear profile devoid of salients partly enclosing the source of energy. The web is made of an inherently highly resilient material. Rene Jean Le Guillou, Paris, France, assigned Societe des Applications "Guilux." No. 2,032,622.


Automatic volume control. The following patents are granted to RCA. D. G. Burnside, No. 2,037,456; H. A. Robinson, No. 2,039,663, a combined manual and automatic system; No. 2,039,618 to Charles Travis; No. 2,039,618, Jacob Yolles.

Audio frequency volume control. No. 2,037,785, P. F. G. Holat, RCA, and No. 2,037,783 to L. E. Barton, audio frequency volume control.


Program circuits. Two patents to C. A. Rackey, RCA, on channel group selector system and interlocking system. Nos. 2,036,235 and 2,036,236.


Superregenerator. No. 2,030,120 to N. M. Rust and R. F. O'Neill, RCA.

Radio phonograph. Means for increasing the bias on an r-f. tube when a radio phonograph is operated in the phonograph position. No. 2,037,258, Paul Mueller, Telefunken, Germany.

Pick-up circuit. Method of using a detector either as an amplifier or detector, depending upon whether it is to be used with a phonograph record or with radio signals. A. C. Beesley and L. H. Hansen, RCA. No. 2,037,639.


Frequency changer. A frequency-determining resistance-element and means for controlling the effective value of this resistance by remote control. W. R. Koch, RCA, No. 2,047,383.


Power supply system. Method of using an auto-transformer for supplying cathode heating power and plate power. Fulton Cutting, Buffalo, N. Y. No. 2,039,888.

Superregenerator. An input circuit for receiving the oscillations coupled to push-pull tubes, the input circuit including a circuit resonant to the relatively high signal frequency and a circuit resonant to another lower quenching frequency. R. W. George, RCA. No. 2,036,690.

July 1936 — ELECTRONICS

Wave-band filter. Patent No. 2,023,057 to Gustav Schweikert, Berlin, Germany. Application dated July 7, 1931, 24 claims. A chain of electric filter circuits of constant width of resonance, each member being an elementary oscillating circuit composed of inductance and capacity, and inductively coupled with each other, the self-induction value (L12) of the coupling induction of the separate members of the wave-band filter substantially answering to the equation for \( L_n \), as shown on the illustration wherein \( L_n \) is the constant self-induction, \( C \) the variable capacity of the separate sections of the filter and \( r_1 \) and \( r_2 \) are determined by the equation shown on the figure where \( R \) is the resistance of the separate sections of the wave-band filter.

High frequency amplifier. Two tubes in a push-pull circuit with a cathode above ground potential by choke coils which are mutually connected together so that the capacity between anodes and grids is neutralized by that between anodes and cathodes. Rinze Hendrik van Minnen and Pierre Janne Henri Alphonse Nordlohne, Eindhoven, Netherlands. No. 2,034,848, RCA.


ELECTRONICS — July 1936
DATA

are used extensively in the manufacture of electrical instruments and high-grade production test and control equipment. They are made in accordance with rigid specifications of design and accuracy.

Bulld 120-K gives the electrical and mechanical specifications of the standard types of Shallcross precision wire wound resistors.

SHALLCROSS MFG. CO.
COLLINGDALE, PA.

Built to Stand The Gaff!

In any assembly, along with other high-grade components and tubes, AEROVOS oil-filled condensers complete your insurance against breakdowns. Logical choices of radio constructors, these units are now available at very low prices. Oil-filled construction. See page-proof container. No plate flutter. High-tension terminal brass. Mounting rings. Six laboratory quality at mass production cost!

Write for latest catalog covering complete line of condensers and resistors. Submit any problem for engineering aid and quotations.

AEROVOS CORPORATION
75 Washington St.  Brooklyn, N. Y.

Band widener. Transmitting a band of signals with a means for selectively narrowing or widening the acceptance frequency band. W. L. Carlson, G.E.C. Reissue No. 19,844.

Gain control. Modifying the transmission level of a line transmitting a band of frequencies by uniformly attenuating the transmission level at all frequencies and then increasing and decreasing the attenuation of certain selective portions of the frequency band while maintaining the remainder of the band at the predetermined level. H. G. Tasker, United Research Corp. No. 2,037,285.

Band selecting system. Several reactively coupled circuits each normally tuned to the carrier frequency and means for shifting the resonant frequencies of some of the circuits whereby the selected band may be expanded at one side of the carrier frequency. D. E. Harnett, Hazeltine Corp. No. 2,038,285. See also No. 2,038,339 to Harnett.


Feedback circuit. System comprising a circuit whose fortuitous capacity tends to produce phase shift in transmission through a feedback circuit with means which, were the capacity absent, would render the phase shift of the circuit suitable for avoiding singing. H. S. Black, BTI, Inc. No. 2,039,917. See also No. 2,039,893 to L. A. Ware, BTI, Inc., on feedback amplifier.

Series modulation. System comprising several fluid-cooled anode tubes, one acting as a high-frequency tube, the other as a modulation tube. No. 2,039,999 to T. H. Price, RCA.

Short wave modulator. Scheme for modulating a Barkhausen-Kurz ultrashort wave oscillator. G. B. Hagen, Telefunken, Germany. No. 2,039,984.

Voltage control. Method for providing a constant d-c output voltage by rectifying a varying source of a-c, rectifying a second supply which varies inversely as the first rectified supply, adjusting the magnitude of one of the supplies initially, and combining the two supplies electrically whereby a constant d-c potential will be obtained. H. C. Grant, Walter Kidde & Co. No. 2,035,125.

Adjudicated Patents


D. C. Del.) De Forest patent, No. 1,507,017, for wireless telegraph and telephone system, Held valid and infringed. Id.

Patent Suits


July 1936 — ELECTRONICS
We offer a comprehensive line of electrical control apparatus of proved dependability for adaptation to your products or for use in your production processes. Autelco control devices include:

RELAYS: Quick and delayed action types, for A.C. and D.C. circuits, any voltage, any contact combination.

STEPPING SWITCHES: Electro-magnetic multi-contact switches, for automatic selection of electrical circuits.

SWITCHING KEYS: A variety of locking and non-locking types in any desired contact combination.

Also cords, plugs, jacks, signal lamps, sockets, counters, etc. Write for complete illustrated catalogs.

American Automatic Electric Sales Company
1023 West Van Buren Street Chicago

There is a GAMMATRON transmitting job for you...

GAMMATRON

TYPE 354
POWER, HIGH LEVEL
POWER, LOW LEVEL
NORMAL PLATE DISSIPATION
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OVERALL LENGTH
NET PRICE

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NORMAL PLATE DISSIPATION
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POWER, HIGH LEVEL
POWER, LOW LEVEL
NORMAL PLATE DISSIPATION
MAXIMUM DIAMETER
OVERALL LENGTH
NET PRICE

Remember these GAMMATRON types:
- LOW INTER-ELECTRODE DI
- HIGH MUTUAL CONDUCTION
- NO INTERNAL INSULATION
- EXTREMELY HIGH VA
- NONEX GLASS ENVELOPE
- TANTALUM PLATE
- TANTALUM GRID

*Federal Communications Commission
Prices net, F.O.B. South
Write for Engineering Information

KING LABORATORIES, INC.
205 Oneida St.
Syracuse, N.Y.

ELECTRONICS — July 1936
FOR any use requiring unusually constant voltage, use the RCA Regulated Power Unit. Special circuit design makes voltage regulation considerably better than that of a heavy duty "B" battery, over extremely wide ranges of line voltage and load variations. The output is practically hum-free.

Specifications—Delivers between 115 and 180 volts DC, current between 10 and 80 m.a, and between 180 and 250 volts at current drain between 0 and 40 m.a. With line voltage 110 volts ± 10%, or 120 volts ± 10%, with load voltage variation not over 2%. Will also deliver simultaneously both 90 and 135 volts. The 90-volt tap will deliver up to 20 m.a, while the output from main section is 40 m.a at 135 volts.

RCA Regulated Power Unit
RCA MANUFACTURING CO., INC., Camden, N. J.
A Service of Radio Corporation of America

Have you tried the K-2?

THE ASTATIC
STUDIO MODEL
DUAL DIAPHRAGM
CRYSTAL MICROPHONE

NOTE: Its neat, compact construction—a size and shape that permits an unobstructed view of the performer's face at any angle.

Its NON-DIRECTIONAL pickup is making it popular for all phases of studio and orchestra work.

Its frequency response is substantially flat from 30 to 6000 c. p. s. with an output level of —64 db.

Write for Bulletin 6!

The K-2 is ruggedly constructed and shows a perfection of workmanship; is substantially free from troublesome feedback. Fully guaranteed, Licensed under Bush Development Company patents with Astatic patents pending.

The Astatic Microphone Laboratory, Inc.
Youngstown, Ohio

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DESIGNED FOR YOUR SERVICE

Acme Transformer Engineers can develop special units to exactly meet all the operating and performance requirements of your product. The price of Acme Special built units is generally much less than the cost of making them yourself—and you gain better performance and greater serviceability.

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• Guthman Coils are dependable! No matter what your requirements, there's a Guthman coil that will fit the job! Send us your specifications—we'll be glad to submit samples and quote SPECIAL LOW PRICES!

EDWIN I. GUTHMAN and CO., Inc.
400 South Peoria Street, CHICAGO, ILLINOIS

July 1936 — ELECTRONICS
NEW LOW COST* A. C. RELAY

1 to 4 sets of contacts.
10,000 Watt capacity (at 210 volts A.C.—over 10 Amps. per pair of contacts).
25-30 or 50-60 cycles.
Coil wound on moulded bakelite bobbin.

*Example:
4 volt coil, S. F. S. T. $1.10 ea. list, Manufacturer's Quant. Discs. up to 70%.

Write for Bulletin No. 164.

G-M LABORATORIES INC.
1734 Belmont Avenue
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HI-POWER FOR PORTABLE SOUND EQUIPMENT

The Carter GENEMOTOR supplies the most reliable and economical "B" Power for Class A or B amplifiers from a 6 or 12 volt battery. Output up to 500 volts. Sturdy — Compact — Quiet in operation — Requires no oiling — Guaranteed. Also can be supplied for A.C. output.

Write for Circular
CARTER MOTOR CO.
365 W. Superior St., Chicago

VERSATILITY

"Aquadag"* I (in water), because o functions effectively in
Research and the radio and elec
forth many new de
provements in techniq
graphite, in many inst
sively yet efficiently in
A recent use focusing anode mater
Older, but eq its employment as a
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molybdenum.
In resistance functions as a resist
and tone controls.

Send for Technical 1


ACHESON COLLOIDS
FOUNDED (1906) AS A
PORT HURON

ELECTRONICS — July 1936
SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT — USED or RESALE

UNDISPLAYED—RATE PER WORD

Position Wanted, 5 cents a word, minimum $1.00 an insertion, payable in advance.

Position Vacant and all other classifications 10 cents a word, minimum charge $2.00.

Proposals, 40 cents a line an insertion.

COPY FOR NEW ADVERTISEMENTS RECEIVED UNTIL 3 P. M. ON THE 3RD OF THE MONTH

POSITION WANTED

FACTORY SUPERINTENDENT — Production Manager. Successful record in radio parts manufacturing since broadcasting began with large successful concerns. Paper, electrolytic, mica and trimmer condensers, resistors, Bakelite moulding, etc. Organization, installation of equipment, maintenance, planning, cost reduction, piece work, skilled labor relations. Small or large plant. Location unimportant. Compensation in part on results obtained. PW-49, Electra, 330 West 42nd Street, New York City.

WANTED

ANYTHING within reach that is wanted in the field served by Electronics can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

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Used Lab. Equipment

Weston-G.R.—L&N—G.E., etc.


Write for list.

LOUIS J. WINSLOW

290 Pennsylvania Avenue

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DEPENDABLE

New and Used ELECTRONIC TUBE EQUIPMENT

A complete line of equipment for the manufacture of Radio Tubes, New Tubes, Incan- descents lamps, etc.

Write for Bulletin showing savings from $2 to 75%.

EISLER ELECTRIC CORP.

514-523 Street, Union City, N. J.

HIGH GRADE NEW AND USED ELECTRON TUBE EQUIPMENT

Huge Stock of Equipment of Every Type and Variety Useful for making Radio Tubes, New Tubes, X-rays, X-ray Tubes, etc.

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1936 EDITION

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The 1936 Edition includes all desired information (except credit rating) for 1000 "VERIFIED" ELECTRICAL WHOLESALERS

Each listing includes

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Branch and affiliated houses.

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All at a cost of less than $12 per listing.

Single Copies, $15.00—Additional Copies, $7.50.

Save time and money through “verified” distribution

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July 1936 — ELECTRONICS
A New Combination Vacuum-Tube Voltmeter and Peak Voltmeter

Model 88
Net $42.50

High sensitivity affords full scale deflection of large fan-type meter with 1.2 volt input. Metal type 6FS voltmeter tube is on a 30" extension cord to eliminate lead losses. As vacuum-tube voltmeter, input is direct to tube grid with no shunt resistor. As peak voltmeter, reads 0-10 and 0-150 volts. Achieves new low in wave form and frequency errors. Voltage readings accurate to 30 mc. Entirely self contained in a single unit for direct operation from 110 v, 60 cycle a. c.

Write for descriptive bulletin

FOR A BETTER

FOR TURBO Oil

The ideal Tubular Insulating Material—est. mechanical structure and stable chemical resistance makes this tube ideal for high temperatures, due to different diameters, etc. Also made as Turf Resistant Materials for special design. Consultation on insulation problems.

Complete catalog on request

WILLIAM BRAN
276 Fourth Ave., New York, N. Y.
SINCE 1920 THE BEST

Announcing
LANSING "T" .

In perfection has been added superiority of system to a reliability for quality sound. Perfection follows the efficiency of Theater sys. from 59 to 8. Only a direct reproduction of Broadcast high quality test report.
FACTS that mean SALES for you...

With sales in the electronics industry forging steadily ahead, it is interesting to note the equally steady progress of the publication ELECTRONICS —

47% increase in net paid circulation during the past year.
75% renewal of subscriptions.
40% increase in advertising pages for the first six months of 1936 as compared with the first six months of 1935.

Advance reservations for August ELECTRONICS indicate that manufacturers are expecting big sales this fall. Forms for August close July 31st.

ELECTRONICS
330 W. 42nd ST., NEW YORK, N. Y.

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July 1936 — ELECTRONICS
How do you handle resistors in your chassis assembly lines? Are they a jumbled, tangled mass in stock pans—hard to count and even harder to pick up?

If so, modernize your production methods by standardizing on the new Allen-Bradley molded resistors. They are scientifically packaged in a new type of indexed carton that speeds up pro-
Success Story

(AS WRITTEN IN THE RECORD)

1. Metal Tubes introduced about a year ago.
2. Widespread adaption placed unprecedented burdens upon a new art.
3. These burdens quickly and ably assumed.
4. RCA Radiotron standards, with all they mean in uniformity, were swiftly attained and held.
5. New and highly desirable types have been added, capitalizing metal's advantages in new ways. The 6L6 Beam Power Tube is an outstanding example.
6. Adoption of RCA Metal Tubes by important set manufacturers brought about production increases. These, accompanied by improvements in factory efficiency, so reduced unit costs as to make possible generous price reductions.

Even in the fast-moving radio industry, this roster of achievements is notable. Within one year a three-fold revolution—in design, in manufacture, and in performance of radio tubes—has taken place.

"To be modern, a radio set should have Metal Tubes."

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<th>Original Price</th>
<th>Present Price</th>
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RCA Radiotrons

RCA RADIOTRON DIVISION, RCA MANUFACTURING COMPANY, INC., CAMDEN, N. J.

A Service of the Radio Corporation of America