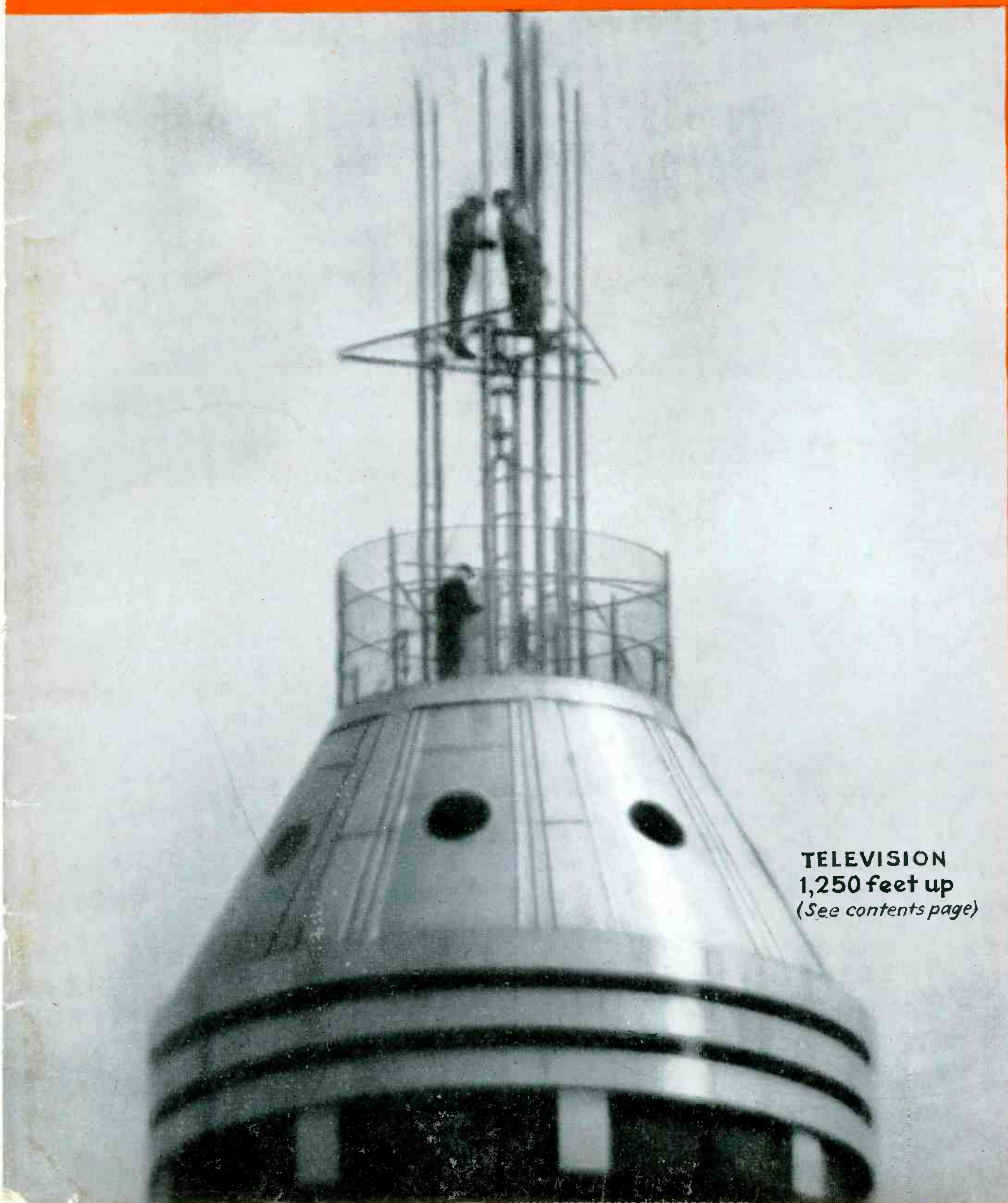
electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture

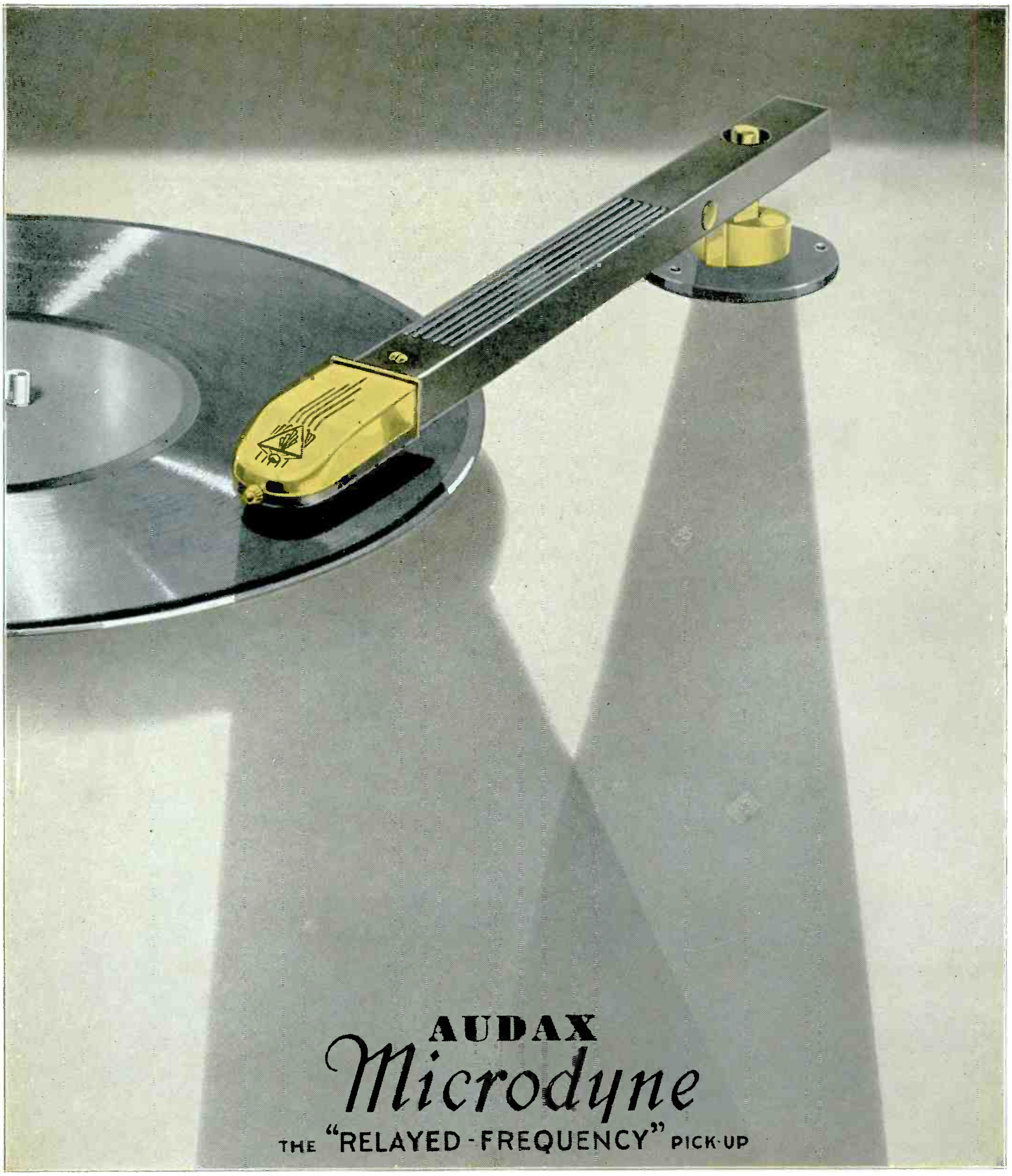
JULY
1936



TELEVISION
1,250 feet up
(See contents page)

Price
50 Cents

McGRAW-HILL
PUBLISHING
COMPANY, INC.



. . . 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.

AUDAK COMPANY, 500 Fifth Avenue, New York.

"Creators of High Grade Electrical and Acoustical Apparatus Since 1915"

ELECTRONICS

radio, communication and industrial applications of electron tubes . . . design, engineering, manufacture

HOWARD EHRLICH
Vice-President

KEITH HENNEY
Editor

DONALD G. FINK
Associate Editor

H. W. MATEER
Manager

Contents • July 1936

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.*

•

DEPARTMENTS

Volume 9 . . . Number 7

ELECTRONICS, July, 1936. Vol. 9, No. 7. Published monthly, price 50c. a copy. Subscription rates—United States, $5.00 a year. Latin America, $5.00 a year. Canada, $5.00 a year. All other countries, $6.00 a year or 24 shillings. Application for entry as 2nd class matter at Albany, N. Y., pending. Printed in U. S. A.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

McGRAW-HILL PUBLISHIN…

Publication Offic…
99-129 North Broadway, A…
Editorial and Busines…
330 West 42d Street, New…

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

Malcolm Muir
President
B. R. Putnam
Treasurer

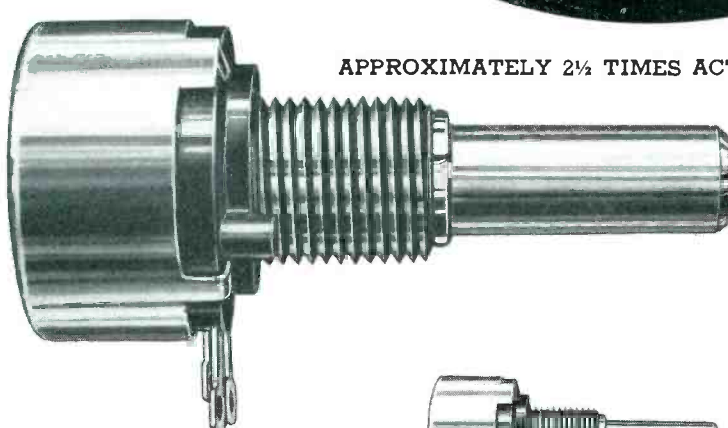
Cable Address: MCGRAWHILL, New York. Me…

WHERE SPACE IS AT A PREMIUM

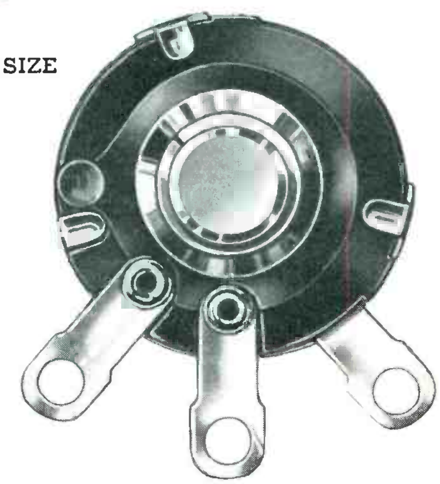
use

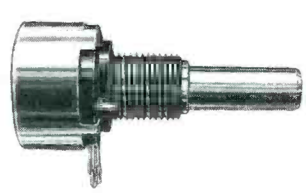
STACKPOLE

NEW SUPER MIDGET TONE CONTROL



APPROXIMATELY 2½ TIMES ACTUAL SIZE





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.

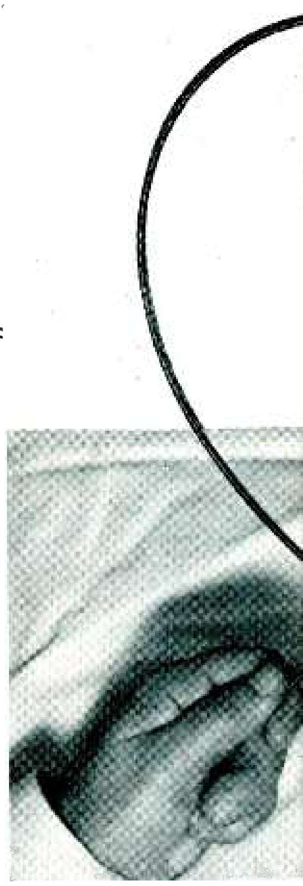
STACKPOLE CARBON CO.

ST. MARYS, PENNA.

Manufacturers of quality resistors, supressors, switches, controls and tone switches

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 a*

S. S. WHITE REMOTE CONTROL FLE

1 LOW INTERNAL FRICTION

This test shows that th
for auto radios, tur
curved, without any
LOW INTERNAL FRI

2 MINIMUM TORSIONAL DEFLECTION

MINIMUM TORSION
characteristic a flexi
suitable for auto radi
guesswork, but by c

3 EQUAL DEFLECTION FOR EITHER DIRECTION OF ROTATION

EQUAL DEFLECTIO
OF ROTATION is a
and like the other tw
of the shaft.

To combine *all three* in the one shaft is a r
problem. In S. S. WHITE Remote Control S
correct balance.

We'll be glad to furnish details about our shafts and to assist radio engineers in working out applications . . . no obligation . . . write us.

The S. S. WHITE De

INDUSTRIAL DIV

10 East 40th St., Room 2310E,

ELECTRONIC

JULY
1936

KEITH HENNEY
Editor

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 entry of this well known radio manufacturer into other fields. The camera sells for $12.50 and some remarkable work is being done with it. One is now part of the office property of *Electronics* and so long as the interest in unposed portraits lasts, we might as well announce that no electronic individual showing himself in public will be safe from Argus and Leica.

▶**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 about one's home. Where the lines enter the house insert a reactor in the grounded wire. This places it above ground so far as a-f is concerned. Then place the program voltages on this wire and the BX grounded covering. Now it can be picked up at any outlet in the house.

▶**PATENT EVALUATION** . . . When the inventor wants a million for his patent and the manufacturer offers him only a thousand, how can equitable price be determined?

Unfortunately there's no criterion to use in pricing a patent save, perhaps, the royalty that the manufacturer would be willing to pay for an exclusive license. Even the royalty is not a good "yardstick," for the invention is almost inevitably bound to be superseded by others before the patent expires.

However, let's take the hypothetical total royalty, R, per year, payable at the end of the year, as a starting point. Let's assume that the royalty will be payable over the whole life of the patent, although that is a rather poor assumption, and that the patent has a life of N, years. At the end of the N years, assuming that the patentee had invested his money each year at 6%, compounded annually, his estate, E, would be represented by the expression:

$$E = R\,[(1.06)^{n-1} + (1.06)^{n-2} + (1.06)^{n-3} \ldots + 1]$$

The question now is, what sum, P, must be paid the patentee for his patent which, if invested now, would yield an equivalent estate by the end of the patent life? This is answered by the expression:

$$P = \frac{R\,[(1.06)^{n-1} + (1.06)^{n-2} + (1.06)^{n-3} \ldots + 1]}{(1.06)^{n}}$$

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

Naturally, the foregoing gives a figure that is much too high, when obsolescence is taken into consideration. For that reason, if it is divided by two, three or four (in some instances), a price can be reached that should be mutually satisfactory to both patentee and manufacturer. At least it offers a solid basis for negotiation.

THAD. R. GOLDSBOROUGH

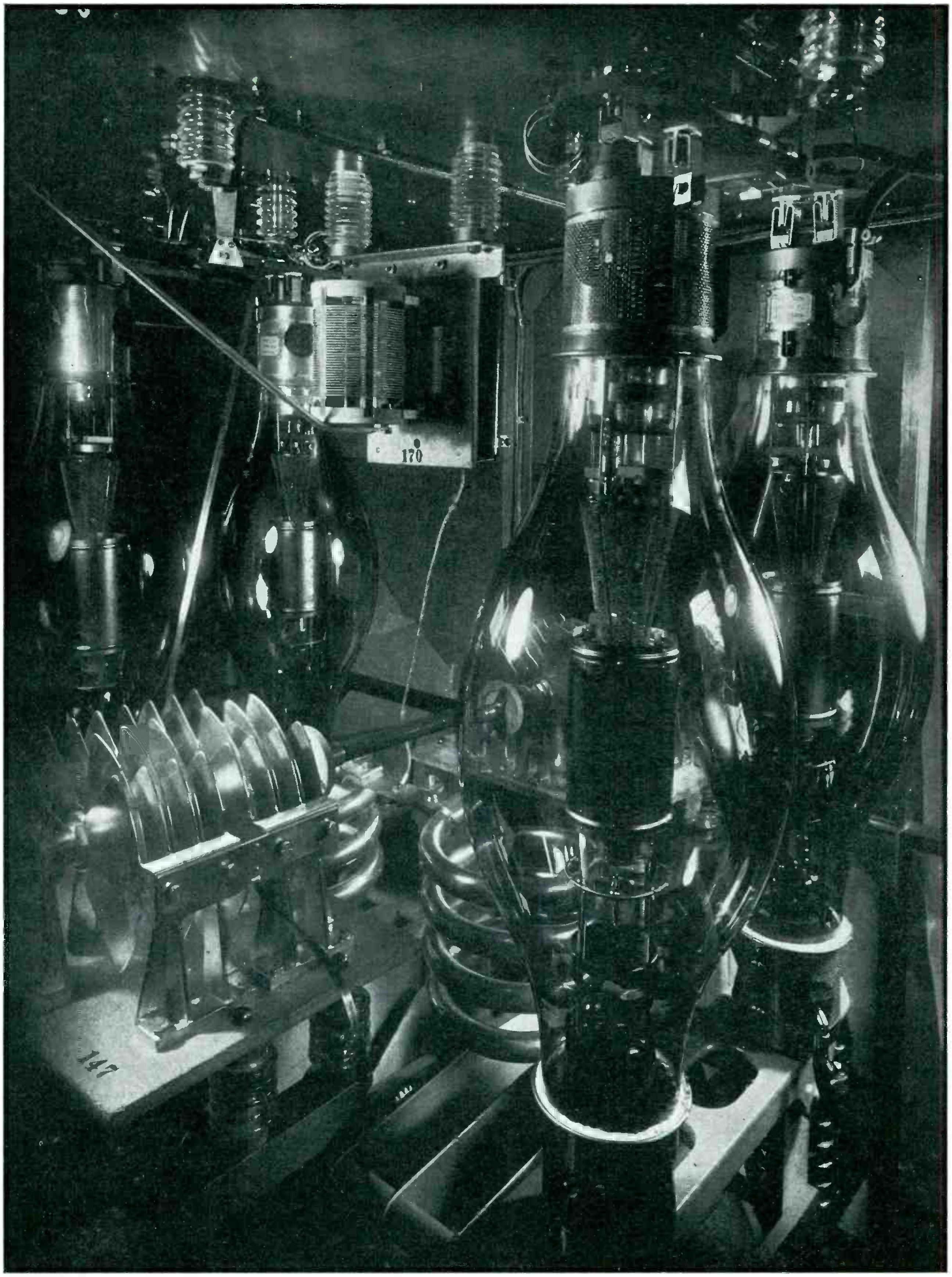
▶**100 YEARS OLD** . . . Speaking of patents, July 4 this year marks the hundredth anniversary of the present patent system.

▶**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

thou be p M gua at v ope ture whe ing hou sure T on t stor up

▶P Cor tha 30,(an kw. lion eco pro " Tec $48 pla It but "Q two cer in for tio

▶1 nev cha tio in tha ter is tha ad fin stu ne in



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.

FCC Plans Future of UH

Informal hearings held before Communications Comı ing needs of various services in ultra-high spectrum. New standa 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 hearing; (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 no fewer than 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 "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 mo-

tion
equipr
finders
aviatic
with c
deman
found,
be sev
before
decisic
sented
which
be bui

Ch

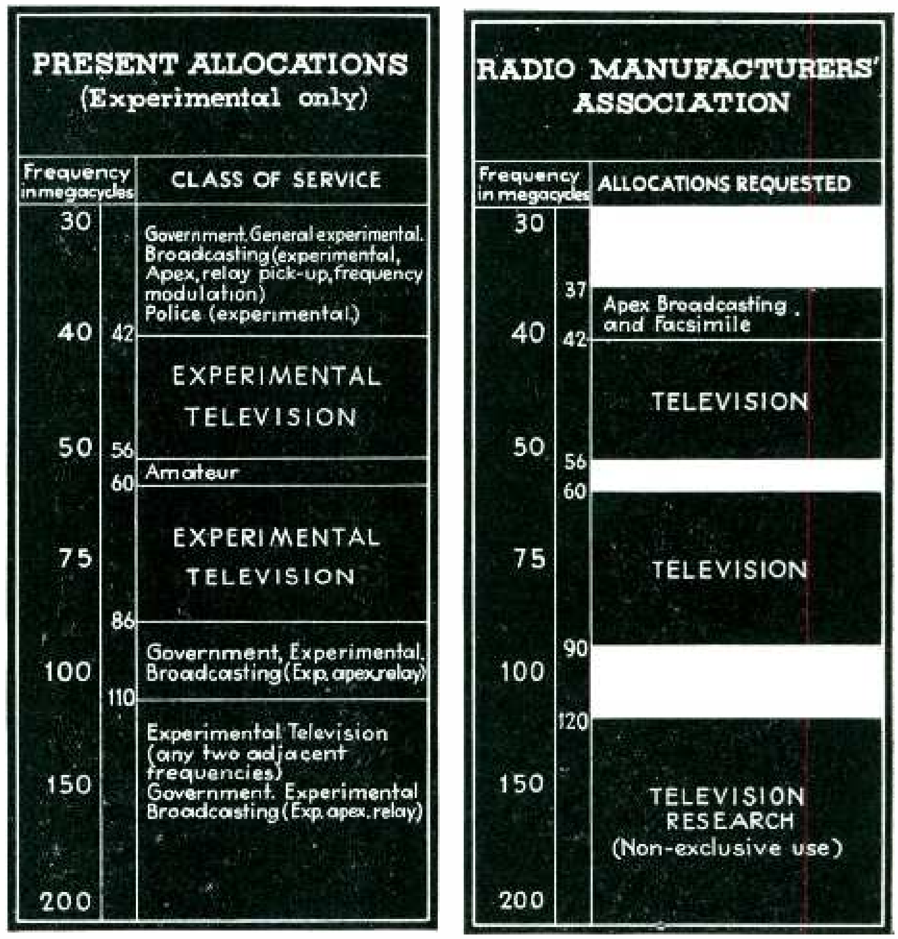
Foll
ductor
pose c
gineer
er T.
growtl
ticulaı
locatic
". .
the de
spectr
to 20,
so bet
Fortu
time l
portio
widen
availal
about
100,00
the la
being
tion, a
to 50C
ities
tions.
500,00
us in
able t
to exp
quer it
ven al
tween
goverı
hands

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."

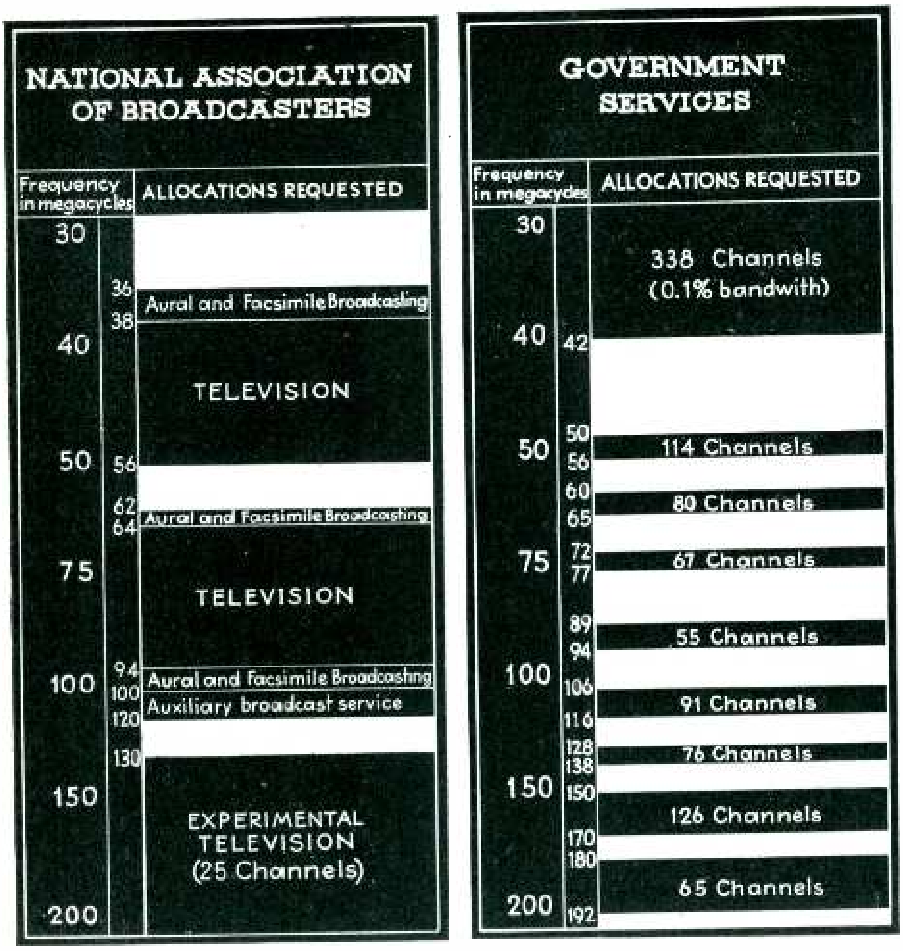
Executives Present the Commercial Picture

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."



How the recommendations of the three major groups line up with the present experimental allocations

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-



Note that the NAB and RMA suggest but minor differences from the present picture, in contrast to the government plan

nomic 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 must 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

of the
the cou
ferent
Philco
Engst
T. Fa
sion;
Hazelt
ray, P
Somm
Jolliffe
The
tain t
televis
contin
band
queste
servic
uted
impor
a rese
in tin
reque
chann
width
follov
side
2.5 m
side
width
missi
defin
ing
and
is
selec
cross
in fr
rier.
creas
radia
to nu
pictu
high
whic
ture
(fra
ered
lacin
conf
pictu
the
less
amp
sign
type
mad
altho
will
all p
visio
beco
smal
dive
only

L. C. F. Horle 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 *Electronics*, 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 "3 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 latter, represented by Harry R. Lubcke, reported that a public television service, on 300 lines, 24 frames, is now in daily operation in Los Angeles.

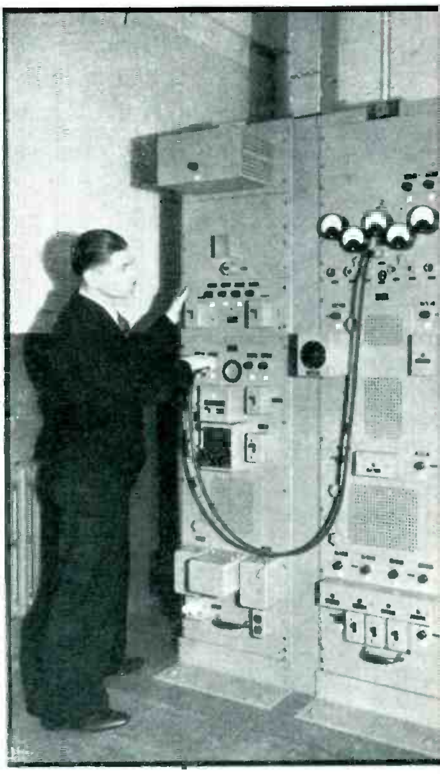
The 45,000 licensed amateurs in the country were well represented through the A.R.R.L. by Paul M. Segal, their attorney, and by Secretary Warner, Communications Manager Handy, and Ross Hull, associate editor of QST. They recommended extension of the present band on 40 meters to include 7300 to 7500 kc., 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.

3-Meter Facsimile

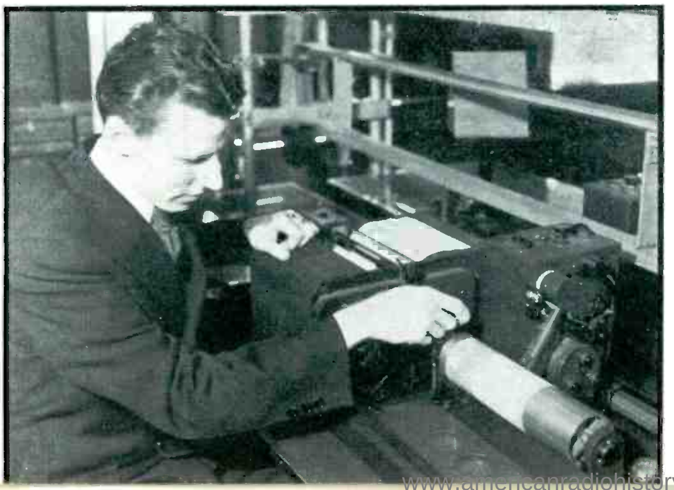
Receiving equipment. Said Mr. Sarnoff, describing the 3-meter circuit, "Of course radio wants its share of telegraph traffic, but it looks also on the much bulkier mail bags"

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.

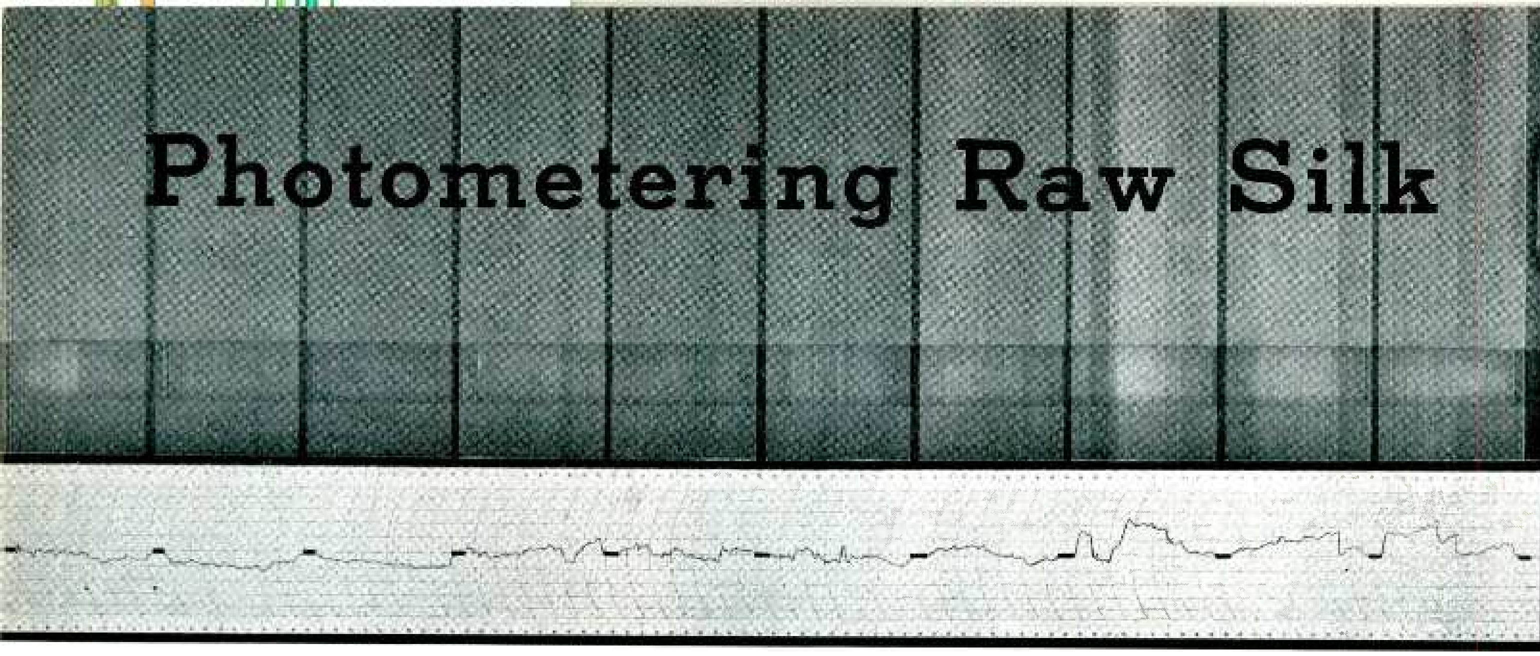
Trans
high



Left, scanning mechanism at transm
automatic typewriters, one telegraph
in each direction simultaneously, or
per minute if traffic demanded. Abo
mitting equipment. The high freq
ment are in the cylindrical co



Photometering Raw Silk



Silk wound on slotted Evenometer board with autographic chart directly below showing evenness of the silk

Ingenuity, perseverance, mathematics, electron tubes—and the right man—join to solve another industrial problem. Another of *Electronics'* experience stories

By **ROBERT FINLAY**

Electronic Engineer
United States Testing Company, Inc.
Hoboken, N. J.

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 expertly 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 reflected 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?

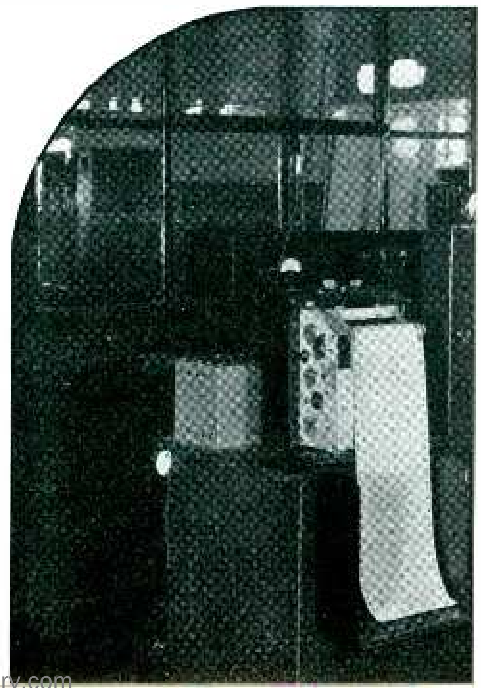
An S.O.S. was sent out to RCA and after several trips to the Radiotron Company in 1933, Frank H. Shepard, Jr., was contacted. Then the clouds started to roll away. Not only was the squared deviation problem worked out, but the entire circuit was revamped. In place of the balanced amplifier, a simple 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.

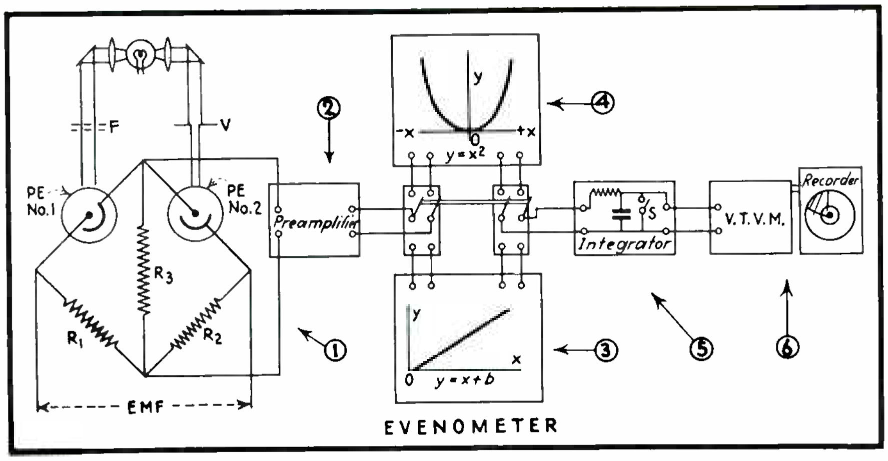
Mr. Shepard's broad experience with problems of this nature and his continued cooperation with the writer during the past year and a half have made it possible to proceed, with hardly a hitch, to the final calibration of a precision photometer for measuring raw silk evenness.

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 $R_1 = R_2$. 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-

D

tuted
they
transm
unbala
across
the pr
magni
ampli
ampli
one o
across
accum
tional
ways
No. 5





Circuit of the Evenometer, developed by the United States Testing Company, Inc.

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

$$\frac{\int_0^{n_o} (x_s - x_i)^y \, dn}{n_o} \qquad (1)$$

where x_s = diameter value of the standard, x_i = any individual diameter measurement, n_o = 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, (σ), or its square, the Variance, (σ^2). The formula for the Variance is:

$$\sigma^2 = \frac{\sum_1^n (x - x_i)^2}{n} \qquad (2)$$

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

$$\sigma^2 = \frac{\int_0^{n_o} (x - x_i)^2 \, dn}{n_o} \qquad (3)$$

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, σ^2, 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 a foot and a half in height. The length of the board is divided into 10 panels, each of which is 5 inches 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 aver-

(*Continued on page 66*)

Transmitter Adjustm

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

BY J. G. SPERLING

MANY broadcast transmitter operators are unable to adjust properly a transmitter and its transmission line for true high fidelity operation and optimum efficiency, due to the lack of information regarding the proper procedure.

Several years ago the need for such care was lacking, but with the public demanding high fidelity transmission and the engineering department of the FCC requiring higher standards of station maintenance, slipshod adjustments cannot be tolerated.

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 $L = E_p/(I_p \times 200)$ 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.

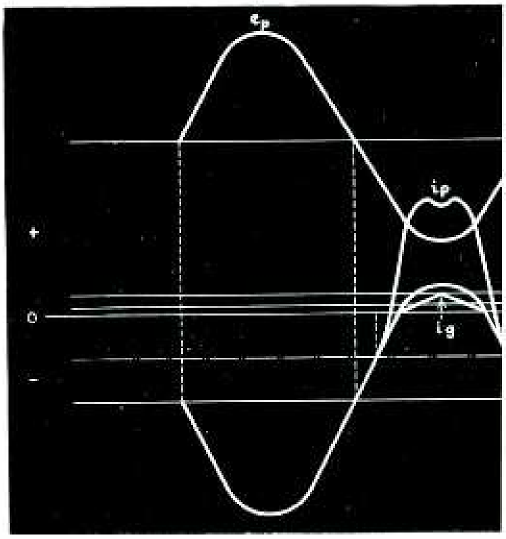
The capacity of the plate by-pass condenser in the modulated amplifier and the following class B stages, if any, determines the amount of high a-f response. If the response at 10,000 cycles is to be the same as that at 1,000 cycles it is necessary that the capacity, in micro-microfarads, be equal to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

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.

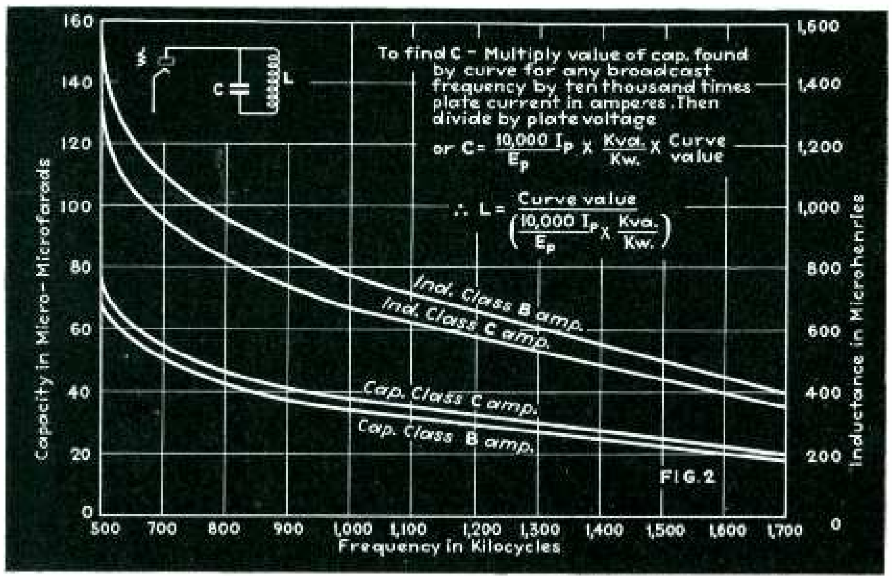
If class B audio amplifiers are used, the use of proper tubes in a correctly adjusted circuit will usually result in a third harmonic content of not over 2 per cent.

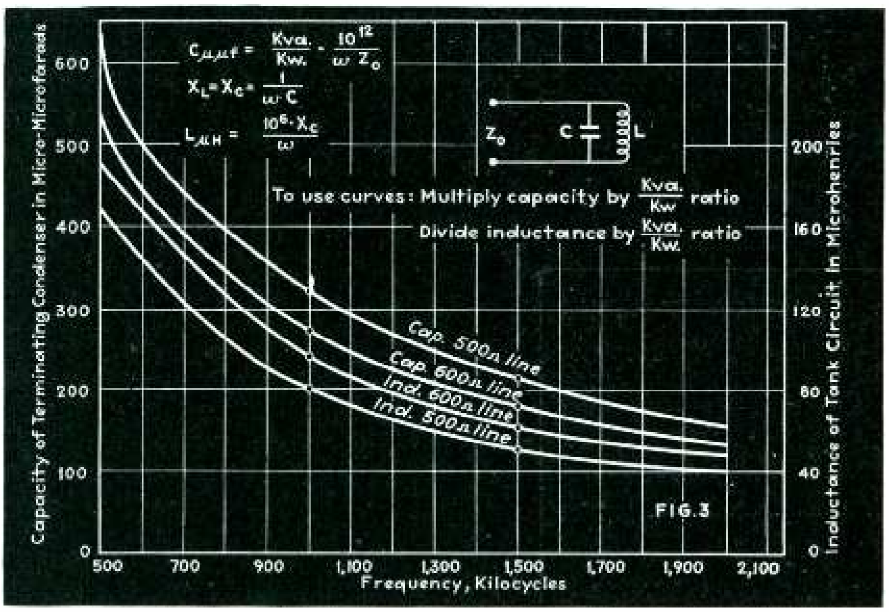
The use of a suitable KVA. to KW. ratio in the r-f amplifiers and proper adjustment of all circuits will re-

sult ir
1 per
thorou
3. T
be gr
value
fundai
suitab
monic
4. I
writte
tion
can b
neutr
impro
lows:
on th
succe
meter
stage
check
rent
neutr
stage
zero.
5.
fault
on du
capab
be kr
know
the s
bility



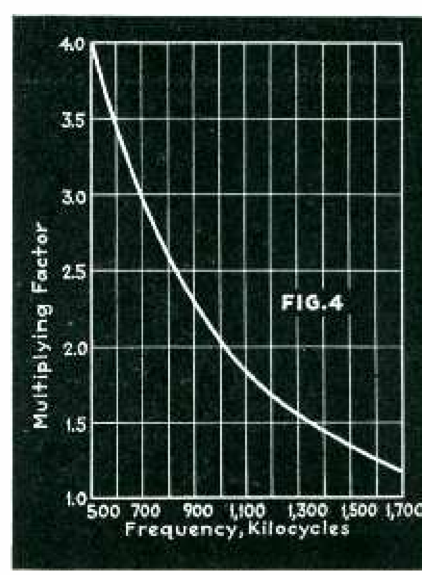
1 *Instantaneous relations between plate and grid voltages and currents in r-f amplifier*





2&3 *Charts for calculating capacity and inductance of radio-frequency amplifier tank circuits*

4 *Correction curve for applying Figure 5*



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 , 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_g. 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 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:

$$e_p(r.m.s.) = \frac{2 \times E_p \times Eff}{3.14 \times .707} = 0.9\, E_p \times Eff$$

As the efficiency of a class C stage is usually taken as 72 per cent,

$$e_p \text{ (r.m.s.)} = .65\, E_p.$$

If push-pull is used,

$$e_p\text{(r.m.s.)} = 1.3\, E_p.$$

For a class B single stage at 63 per cent efficiency,

$$e_p\,(r.m.s.) = \frac{2 \times E_p \times .63}{3.14 \times .707} = 0.567\, E_p$$

For a push-pull stage

$$e_p\text{(r.m.s.)} = 1.13\, E_p.$$

At resonance $X_C = X_L$ and therefore the amount of circulating current through these two branches is equal.

$$I_L = I_C = \frac{\frac{KVA}{KW} \times E_p \times I_p}{e_p\,(r.m.s.)}$$

Therefore:

$$X_c = \frac{e_p\text{ (r.m.s.)}}{I_L}\ ;\ C = \frac{1}{6.28 \times F \times X_c}$$

$$\text{and } L = \frac{X_L}{6.28 \times F.}$$

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. Dietsch has shown the proper method of designing such coupling devices.[1] If we wish to terminate the transmission line into a tank circuit, it is necessary to provide such values

of C
able I
time
resist
line
losses
desig
neces
imped
and t
curat
measu
for th
The
deriv

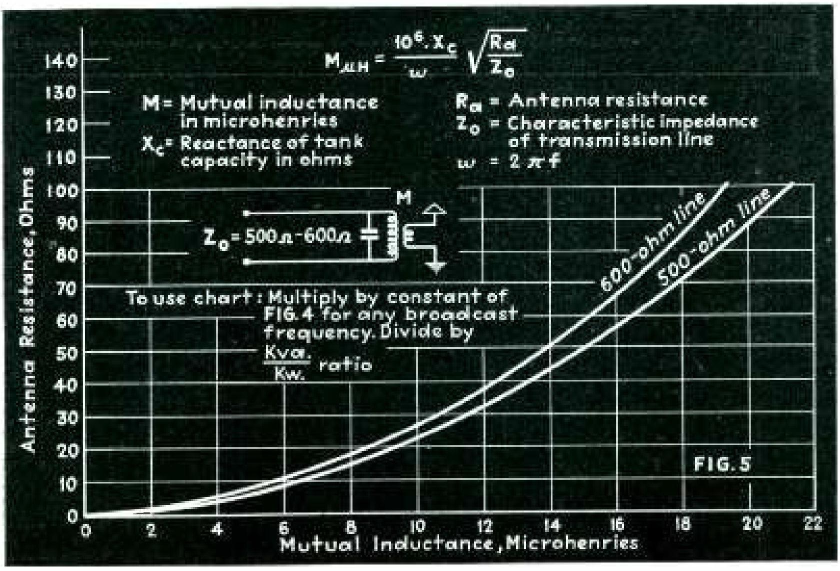
C,

Where

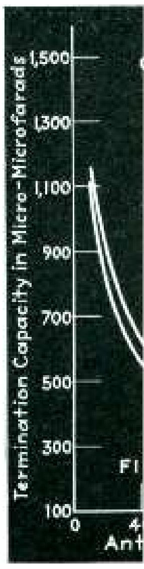
Sin
L =

Cal
the 5
lines
use a
pedan
The
quenc
transm
Fig.
The
M, b
anten
from

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



6



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

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

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.[1]

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[2] employs an audio oscillator which is not continuously variable and measurements are made at single frequencies. Ballantine[3] 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[4]. 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.

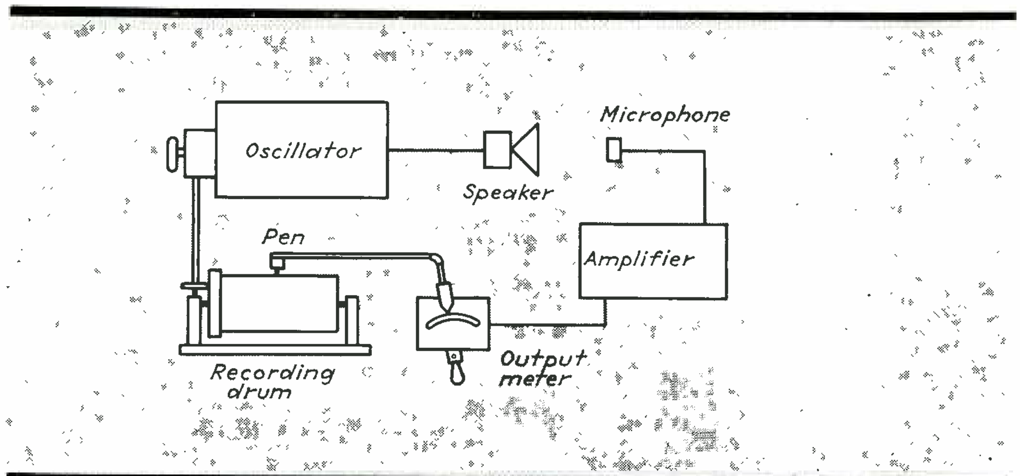


Fig. 1—Arrangement for semi-automatic acoustic measuring apparatus

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.

(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 curves because most 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 characteristics are usually the most important in determining the rating of a loud speaker in spite of the fact that they are most generally overlooked.

(c) *Harmonic Distortion*—When a loud speaker is being supplied with electrical energy of pure wave form and fixed frequency, harmonic distortion appears in the output when the input power is increased above a certain value. The amount of distortion usually varies with frequency and may be due to such factors as the voice coil moving out of the air gap at large low frequency amplitudes, the exceeding of Hooke's Law for the elastic suspension members of the diaphragm at large amplitudes, overloading of the atmosphere at the throat of horn type speakers, or other causes.

(d) *Generation of Sub-Harmonics* —Another type of distortion that occurs when a diaphragm is driven by large forces is due to a peculiar breaking up of the vibrating surface which gives rise to extraneous frequencies in the sound wave which are sub-multiples of the frequency of the electrical oscillation. These sub-harmonics occur abruptly at definite input levels, usually taking a few seconds to build up. In general it is not necessary to make any harmonic analysis to locate the presence of sub-harmonics because when the conditions are favorable for their production they can usually be heard very easily with the unaided ear.

The power handling capacity characteristics of a loud speaker, there-

for
sho
fre
anc
I
me
of
by
len
sin
it
inp
abo
Thi
mir
hav

T
wh
fro
the
put
spe
pov
cui
mu
spe
fro
effi

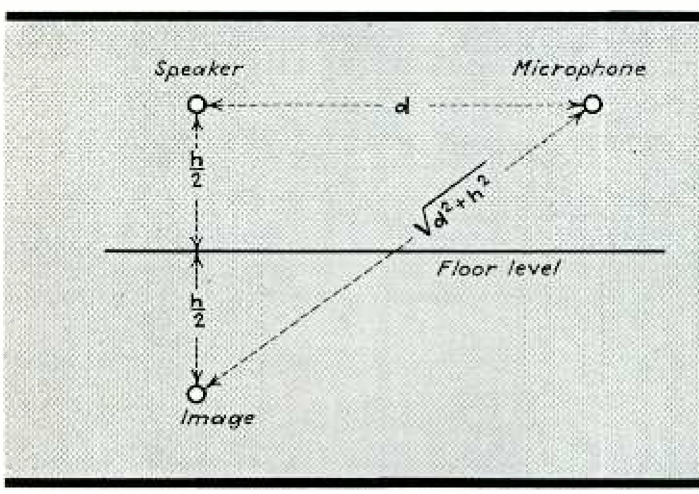


Fig. 2—Floor reflections in making loud speaker response measurements

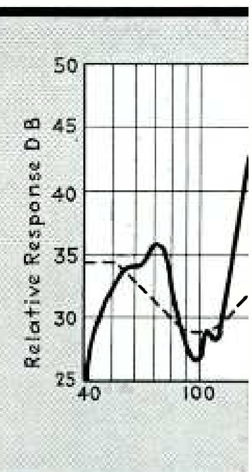


Fig. 3—Indoor
the

the
the
of
opt
pre

whe

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

$$P_A = \frac{p^2_{av}}{42} \times 10^{-7} \text{ watts} \qquad (2)$$

where p^2_{av} = average square of the sound pressure measured around the spherical surface.

This method of measuring total output is very accurate and particularly useful in determining efficiencies of low efficiency sound generators. A serious disadvantage results from the enormous time required to measure efficiencies over the entire frequency range.

(b) Reverberation Chamber Method—If a source of sound is established in a room having a high reverberation time, the sound pressure at any point in the room will be the same.[5] This condition will be most easily realized if the room is irregular in shape and if either a large rotating paddle is used to reduce standing waves, or if the frequency of the source is warbled above and below its normal value.

If a reverberation chamber is available and care is taken to cause uniform distribution of sound throughout the room a single measurement of sound pressure will permit the calculation of the total output from the loud speaker. The power output is equal to[6]

$$P_A = \frac{.028\, V p^2}{T} \times 10^{-6} \text{ watts} \qquad (3)$$

where V = Volume of room in cu.ft.
T = Reverberation time in seconds
p = Sound pressure in dynes/cm^2

To secure good accuracy in making total output measurements by this method the reverberation time should be of the order of ten seconds. The value of T in equation (3) refers to the particular frequency of the measurement.

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

$$Z_{EM} = \frac{B^2 l^2}{Z_M} \times 10^{-9} \qquad (4)$$

where Z_{EM} = motional impedance (vector) in electrical ohms
B = flux density in air gap in gausses
l = length of wire in voice coil in centimeters
Z_M = 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 with the field excitation removed and the cone unable to vibrate, the efficiency will be equal to

$$\text{Eff.} = \frac{R_f - R_b}{R_f} \times 100 \text{ per cent} \qquad (5)$$

The numerator is the real part of the motional impedance and is a measure of the acoustic power being generated. Only when R_f—R_b is a large portion of R_f can motional impedance measurements be hoped

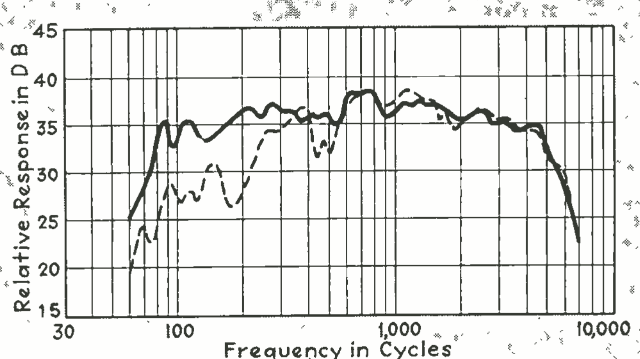


Fig. 4—Response curves taken on a cone loud speaker. Solid curve taken at one foot distance; dotted curve at three feet distance

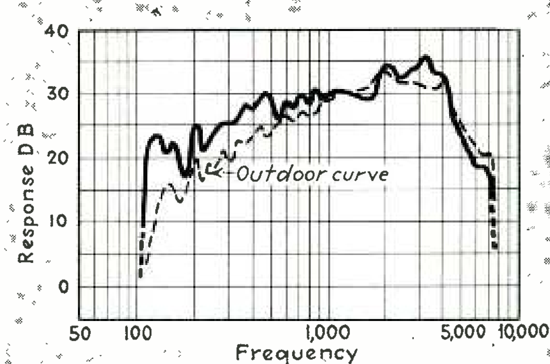


Fig. 5—Curve taken in a highly damped room at 12 feet with rotating condenser microphone. An outdoor curve is also shown. (After Bostwick)

to give any degree of precision.

Strictly speaking, R_b 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 a 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 of a loud speaker, the test should be made in free space away from any reflecting surface.[7] When tests are made indoors several sources of error are introduced particularly at the lower frequencies.

(a) Reflection Errors—The most objectionable error which must be contended with in making indoor response measurements arises from floor and wall reflections.

If a speaker and microphone are at a height $h/2$ above the floor (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

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

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

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

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

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

where n = an integer
λ = wavelength of the sound being generated
(d, h, and λ 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

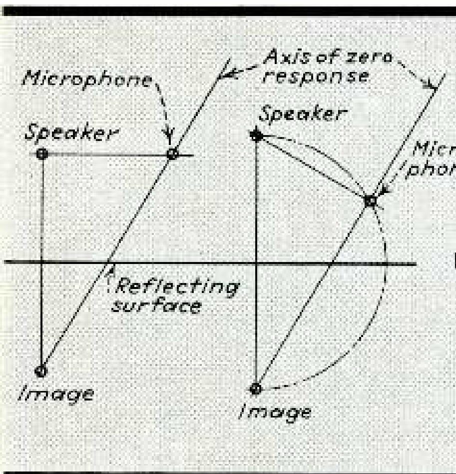


Fig. 6 — Directional microphone eliminates ground reflections

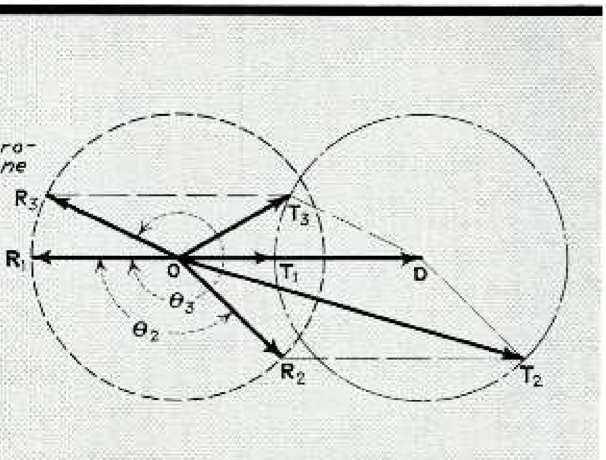
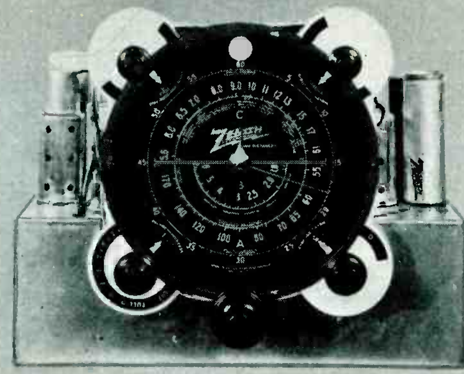
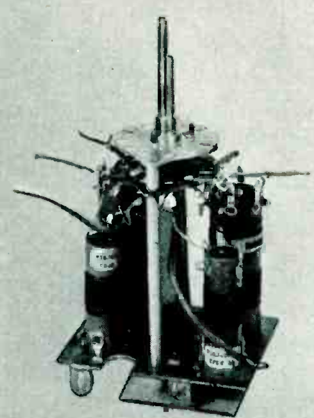


Fig. 7—Total pressure at a point, due to direct and reflected sound

Resonant Pipes in RCA Cabinets



1937 dials aid tuning



7-tube Sentry Box. Note short leads

1937 RADIO

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

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

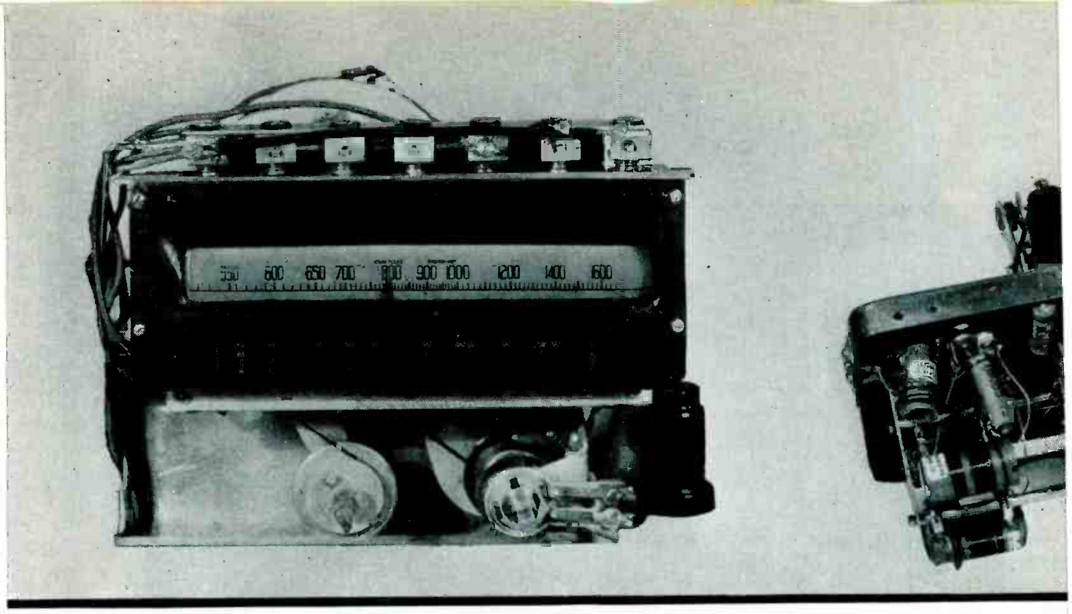
It is evident that engineering departments have had their eyes focussed upon the goal of sales; they have definitely designed their "stuff" with sales appeal in the backs of their minds. But technical features are there too, in greater number than at any period of the radio receiver industry's life. 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-



"Personalizer" scale giving call letters of stations

Large Sen

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

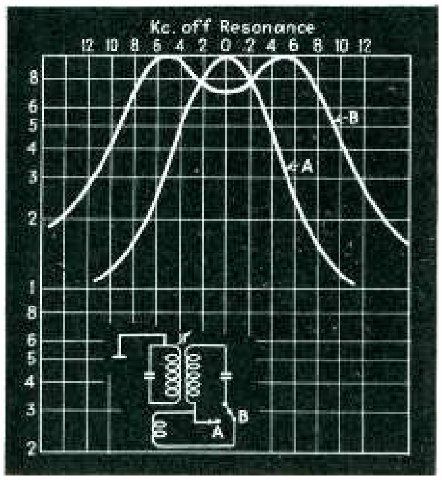
A general improvement in tone fidelity may be expected this year. There has been a feeling that listeners in the past did not want the wide range; that anything above 4000-5000 cycles was just so much engineering expense not justified by the listener. Therefore the set owner got an abbreviated version 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. Methods in use last year for per-

M

formin
found
models,
perforn
Victo
Electro

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.

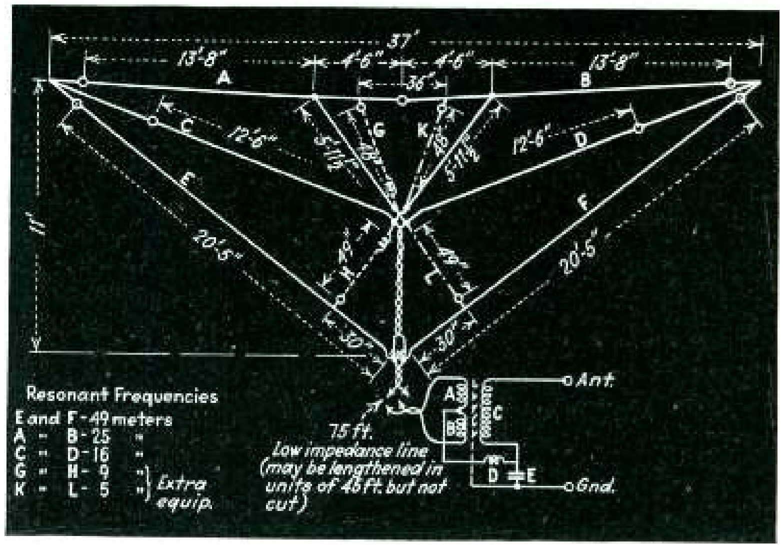


Selectivity curve for two-position i-f transformer (RCA)

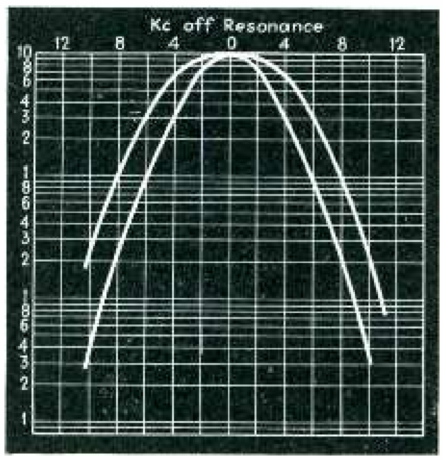
Sets not equipped with turn tables and pickup reproducers do have terminals for the connection of external phonograph equipment. In many cases these terminals make the audio amplifier of the set available for any amplification purpose, such as the use of a microphone to confound the neighbors.

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.



Spiderweb all-wave antenna developed by RCA engineers



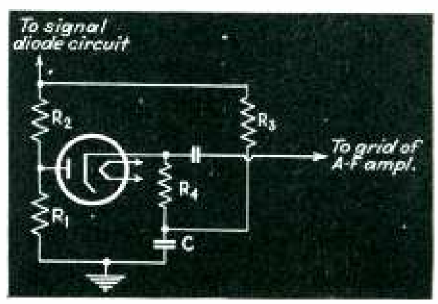
Standard selectivity curve (RCA)

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 3 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

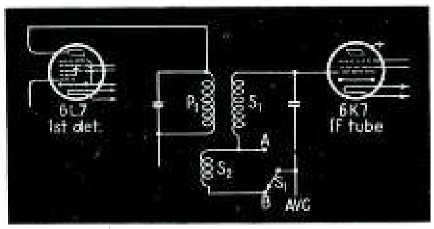
Other users of AFC will be Philco, Crosley, Grigsby and probably others. Some are making use of a telephone dial construction. The listener inserts his finger in the dial hole labeled the desired station, pulls it around until it stops when the station is automatically tuned. AFC circuits will tend to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

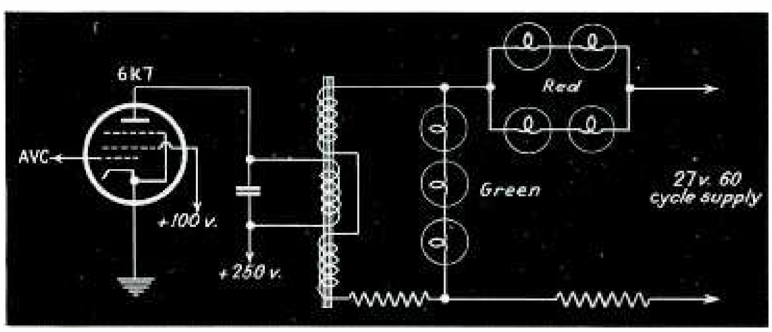
"Colorama" Tuning

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 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 length.



Two degrees of selectivity in i-f amplifier

Weak stations will produce small colore 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 stat except that it is controlled by the d-c plate current of a separate tube used solely for that purpose. A 6K7 tube is used in the twelve and fifteen tube receivers and a 6C5 in the nine and ten tube receivers. This tube receives for its bias a portion of the AVC voltage of the set so that at no signal the bias is nearly zero. At this point the plate current is a maximum, the red is brightest and the green invisible. The 6K7 because of its remote plate-current cut-off characteristic gives a broader range of sensitivity in the more expensive sets.

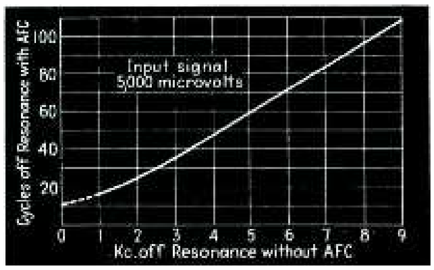
Silent Tuning

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.

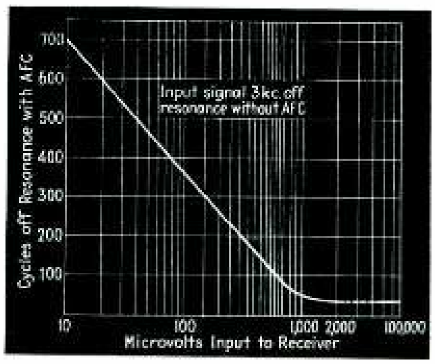
"Target Tuning"

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



Tuning control exercised by AFC (G.E.)



AFC as a function of input signal

phonograph connections to a majority of the new chasses, even including the battery sets.

They Tune to 60–70 Mc.

Five-meter amateur transmitters had better watch their language when the 1937 receivers get on the job—for many of them go to and beyond the 56-60 mc. band. Some tune to 60, and some to 70 mc. (it is alleged). Thus the day when television and local high fidelity, high frequency broadcasting takes hold in a big way is being anticipated. Efforts are being made to give real reception on these higher frequencies. The new antenna structures—see below—r-f amplifiers actually amplifying and cutting down image responses will be found in the new receivers, as will reduction of the bias on preliminary tubes by the range switch so that these tubes operate at higher mutual conductance and thereby provide better gain.

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 and R_2 comprise the signal diode load. $R_2 = 2R_1$ 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_3 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.

Emporium IRE Presents

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

C. T. Wallis, of Delco, speaking before th paper, "Vibrator Power Supplies", was illus tungsten contact points used i

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).

C. T. Wallis of the Delco Appli-

anc
crop
poi
the
of
C.
mer
higl
whi
the
new
wav
I
gra
and
nea
pra

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

The four speakers at the "Summer S Sickles (Diode Coupling Transformer (Vibrator Power Supplies); H. J. Schr (Cathode-ray Applications); and C. measurements

Radiation-Counting Circuits

Methods of using grid-controlled rectifiers — thyratrons and grid-glow tubes — for counting cosmic rays, alpha particles shot off by radioactive substances and other radiation. Tubes play important roles in this branch of pure science

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 radiations incident upon the chamber. Theoretically, when the proper potential is effected 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[1] 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[2] 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 *S* 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

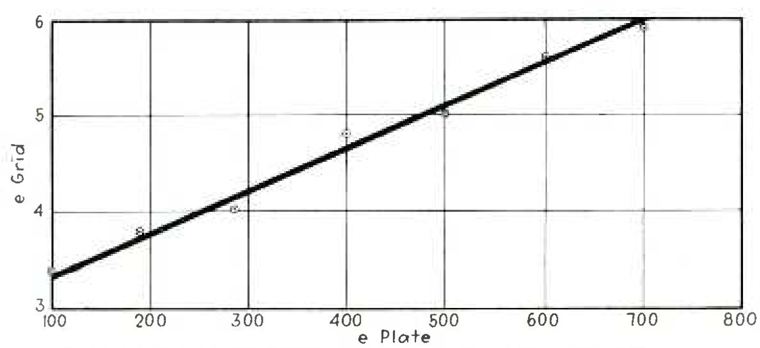


FIG. 1 - Grid-anode voltage regulation of FG-17 thyratron

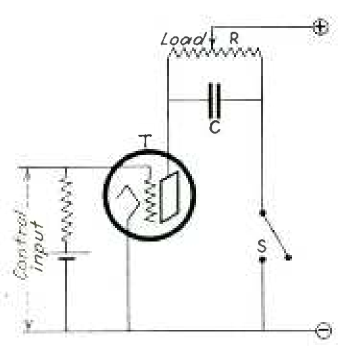


FIG. 2 - D-C operated controlled rectifier

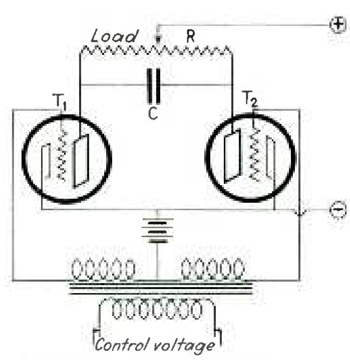


FIG. 3 - Use of one tube to control another

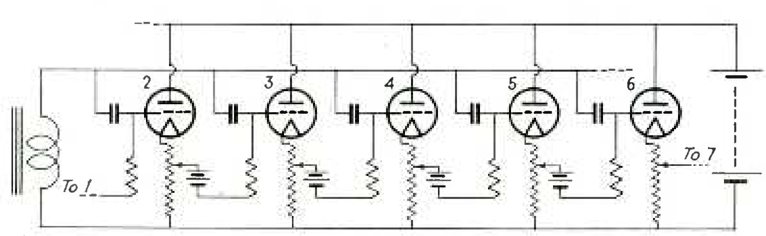
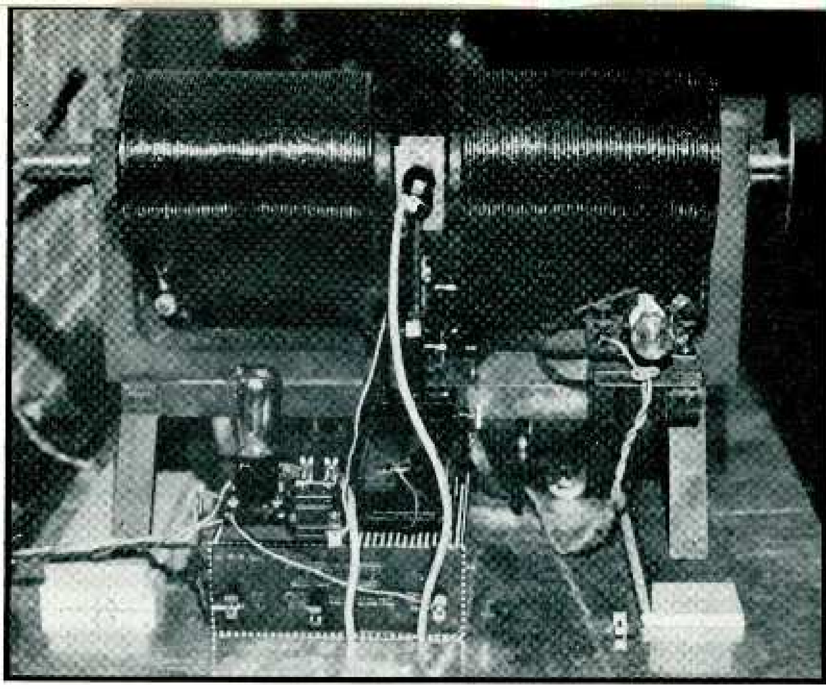


FIG. 4 - Multiple tube circuit increases ability to count speedily



Chamber unit with Geiger counter mounted in an electromagnetic field for reflection of Alpha particles

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[3] 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[4]. 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_2, 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[6] 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

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.

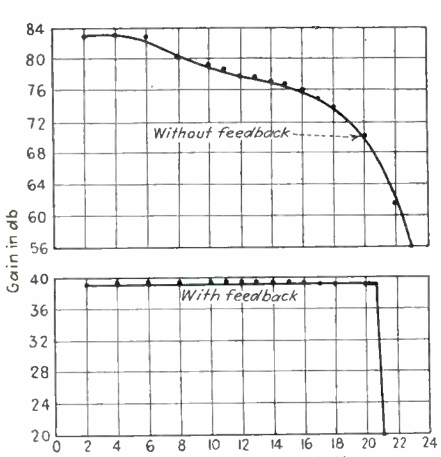
Consider an amplifier which does not tend to regenerate, but which is inherently stable. Suppose feedback from the output is admitted (properly, of course) to the input and in amounts which may finally equal the input signal. Now it develops that the greater this negative feedback, the nearer will the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

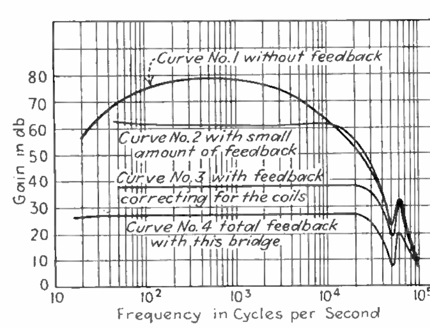
Thus Black's work leads at once to amplifiers of remarkable linearity of amplification, great constancy of operating characteristic with respect to tube variations or in supply voltages etc. They will be less susceptible to noise and crosstalk, and possess improved phase and impedance characteristics.

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.

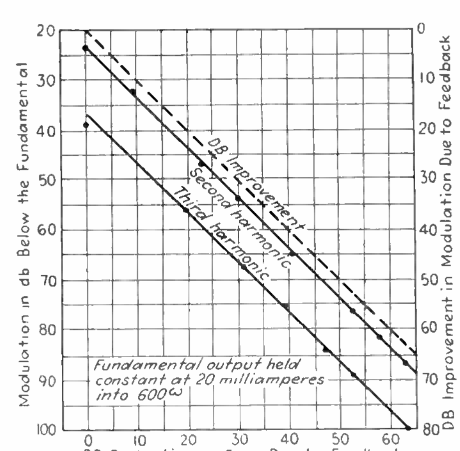
Engineers familiar with the advantages of the new feedback circuits cite the following important transmission features:

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-





Typical feed-back amplifier characteristics, gain vs. frequency and output current, effect on harmonics



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 26 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.

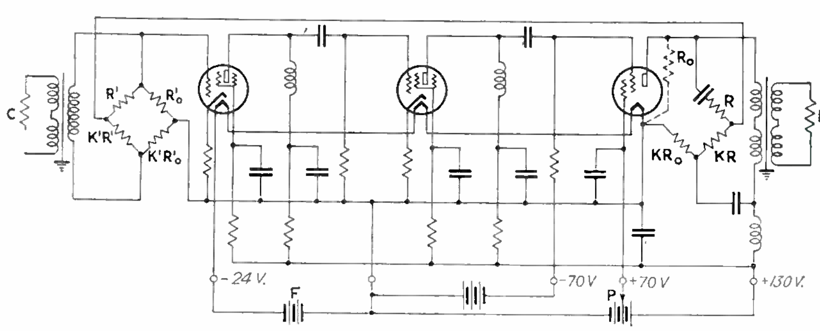
For an amplifier of conventional design and comparable size this change in plate voltage would have produced about .7 db variation while the modulation products would have been only 35 db down.

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 sytems 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.

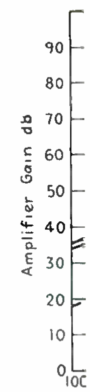
Technically, it is equally interesting to note further that feedback action at all times will in addition cause the high level high power tubes to adjust themselves automatically to the theoretically optimum operating point on their dynamic characteristic irrespective of tube changes including aging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

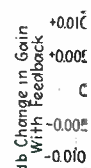
The ability of feedback arrangements to improve the linearity and stability of an improper amplifier by stabilized feedback is of great economic as well as technical importance. The attainment of high power and high quality together in an amplifier or radio transmitter has always been an object of especial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

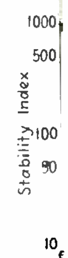
The utilization of negative feedback action improves the characteristics of the power stage by adding gain at a lower power level part of the system, namely, at the input, which can be done cheaply and by adding negative feedback as already explained. Thus, the same power stage can be operated with greatly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

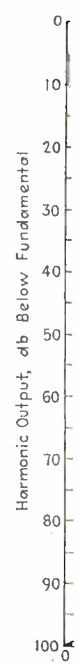


Above, representative amplifier circuit, with bridge-type feed-back





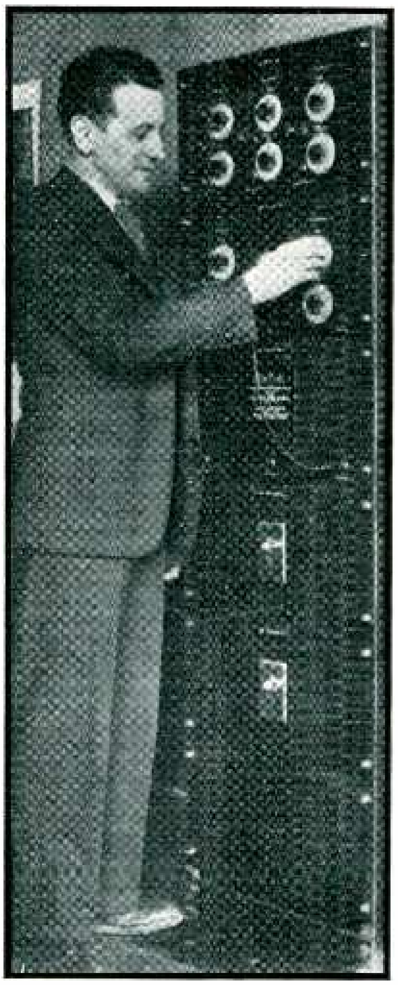




Right, reduction of harmonic content made possible with new amplifiers

"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



Photo, sent by facsimilie, of Mr. Finch and the radio printer he developed for Hearst Radio, Inc.

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 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).

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 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.

Ordinary telephone bell-box, showing method of coupling to put facsimilie signals on the line

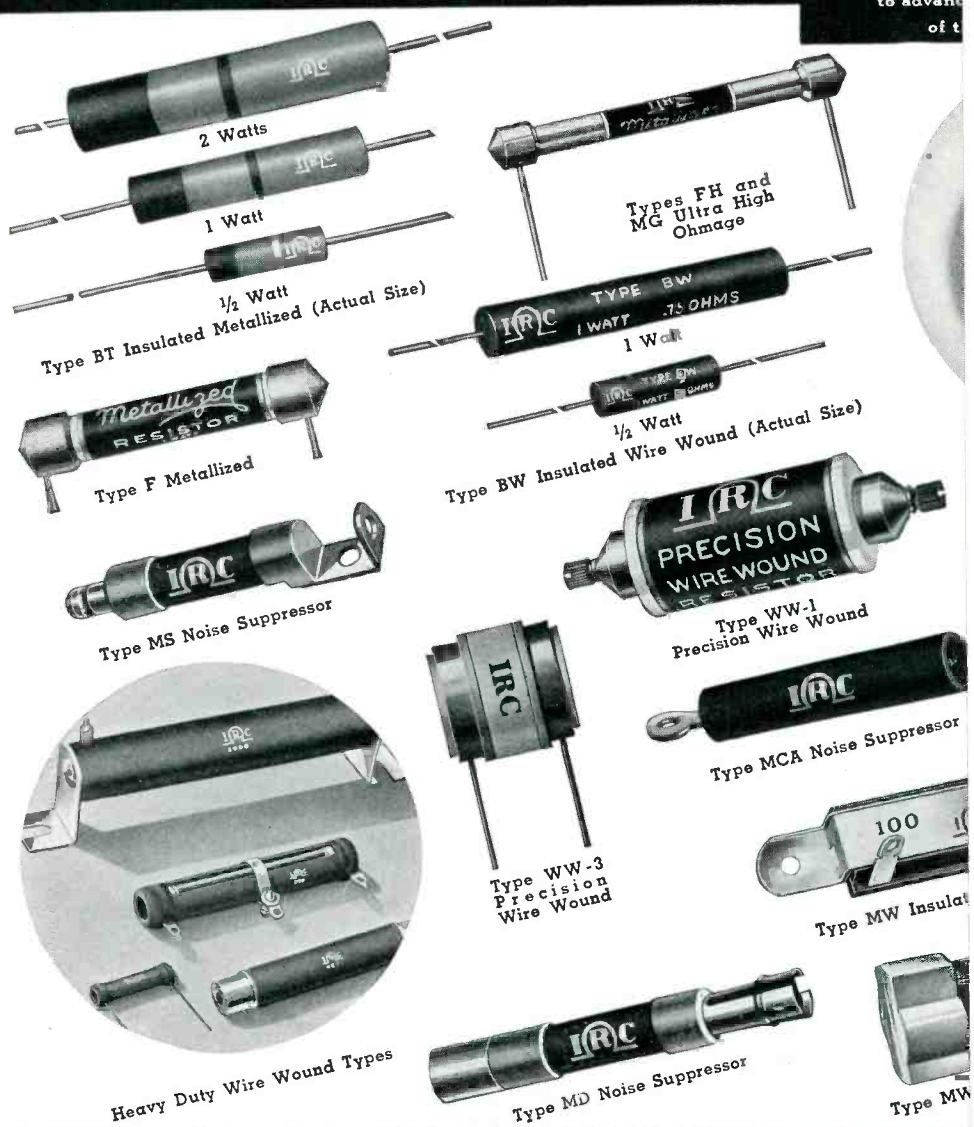
SPECIALISTS

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!*

REG. U.S.
Initiative – Reso
to advanc
of t



INTERNATIONAL RESISTANCE

401 NORTH BROAD STREET, PHILADELPHIA

Factories or Licensees in CANADA • ENGLAND • FRANCE • GERMANY • ITA

TUBES AT WORK

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 is 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 car 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.

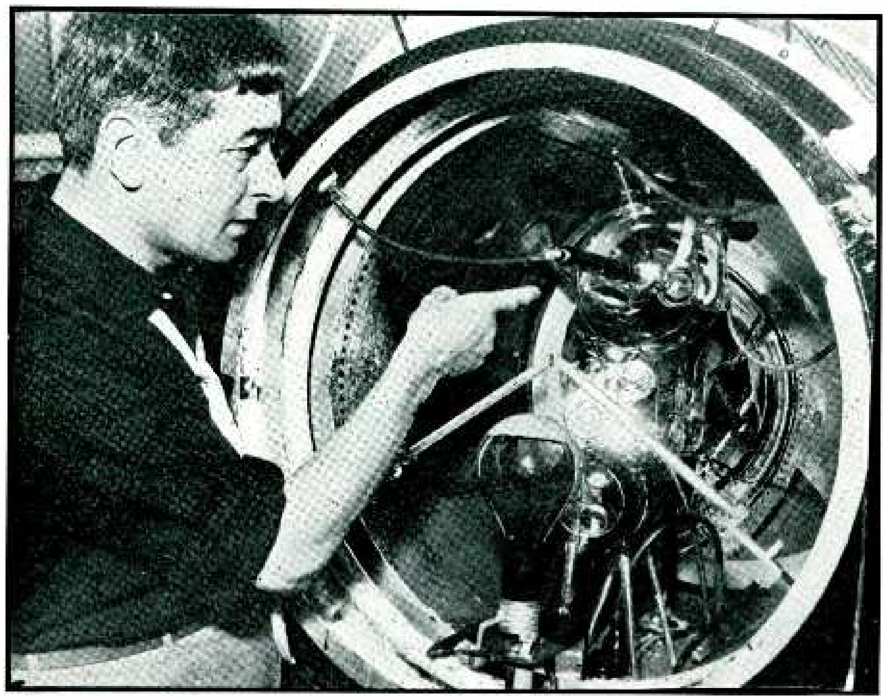
Mr. Wareing, the engineer in charge, is taking the test car over the entire length of every one of Milwaukee's streets, a total of 830 miles, and making continuous observation of field strength. Points of low signal strength are recorded. Under existing interference conditions, a minimum field strength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

• • •

—AND SUDDEN DEATH



This death-ray machine (note x-ray tube, high powered incandescent lamp, ultra-violet lamp, neon tube, and arc) nearly got its builder, Henry Fleur, (left) into trouble. His backers in the death-ray business brought suit in San Francisco against him. Before a jury, Mr. Fleur brought death to one (1) snake in 8½ minutes, one (1) lizard in six minutes, and several (exact number not known) termites in 30 seconds. Thereupon the jury dismissed the charge, claiming no proof of grand theft of the 1600 dollars advanced

Incandescent Lamps for Dummy Antennas

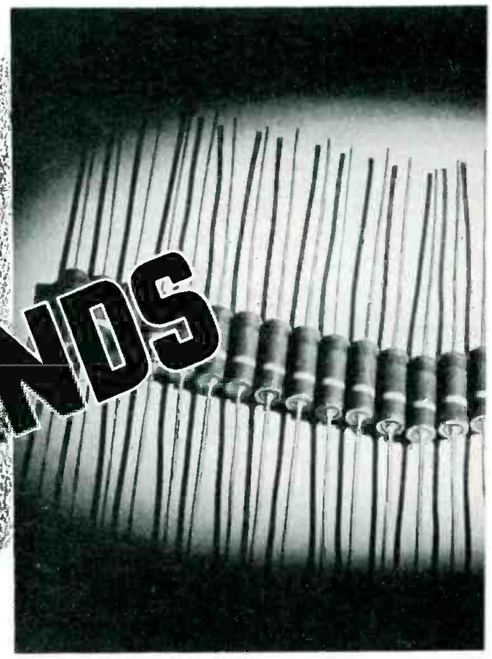
TUNGSTEN LAMPS are frequently used to test the output of transmitters. They are usually the only method available for measuring power at ultra high frequencies. A few simple rules are helpful in calculating power and resistance of such a load. Household type lamps are marked in voltage and wattage. Automobile 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

CLEAN, SHARP, COLOR BANDS



TRUE TO COLOR

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 p
resistor has nothing
ation of the unit, ye
portant bearing in y
line.

Longer time in r
ing proper values . . e
—all exact their toll i

That's why a se
tial thing like paint
sideration at Erie.
when you examin
Resistor.

EASY TO READ

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.

WILL

NOTE *the rough surface of an unpainted case*

A
will
flake
tors.
cera
paint

Resistors in top photograph 2/3 actual size. Individual units sh

CARBON RESISTORS AND SUPPRESSORS

ERIE RESISTOR CORPORATION

TORONTO **ERIE, PENNSYLVANIA**

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

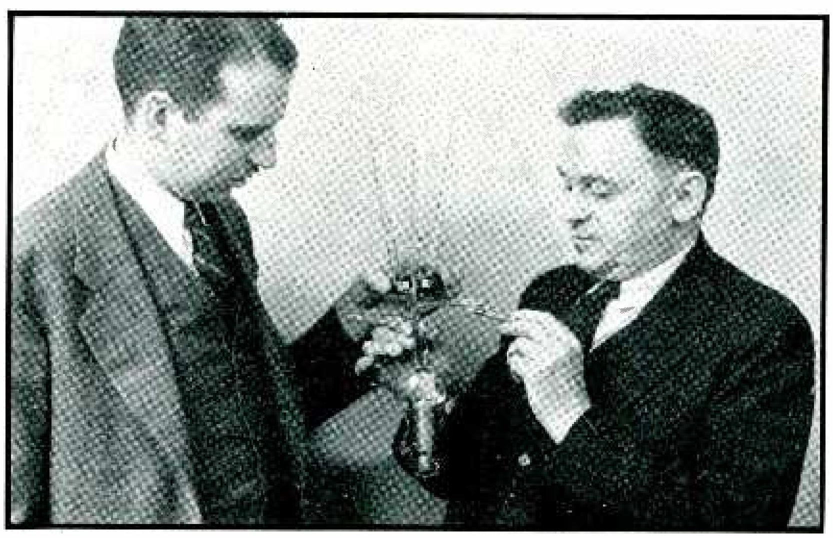
THE PROBLEM of supplying power to lights on insulated radio towers, such as are usually required by the Bureau of Air Commerce, is usually a difficult one since a cumbersome and expensive filter must be used to prevent r-f energy from "backing up" from the antenna through the power line. A new system 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 ¼ wave-length 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-half 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.

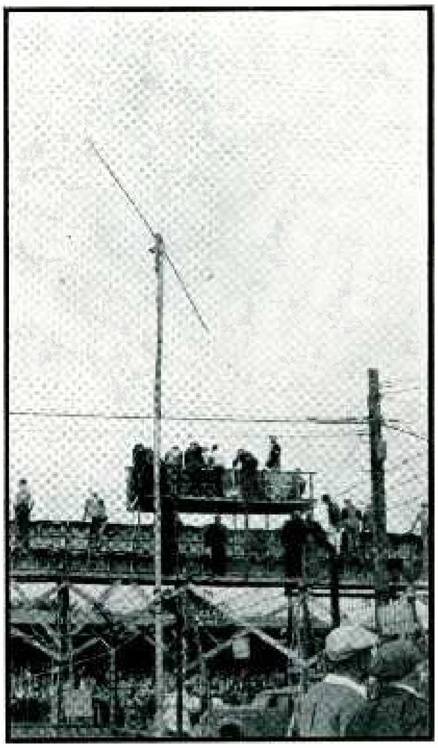
DISCOVER NEW THEORY OF PHOTO-EMISSION



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 cathodes 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



Dipole used in race

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.

• • •

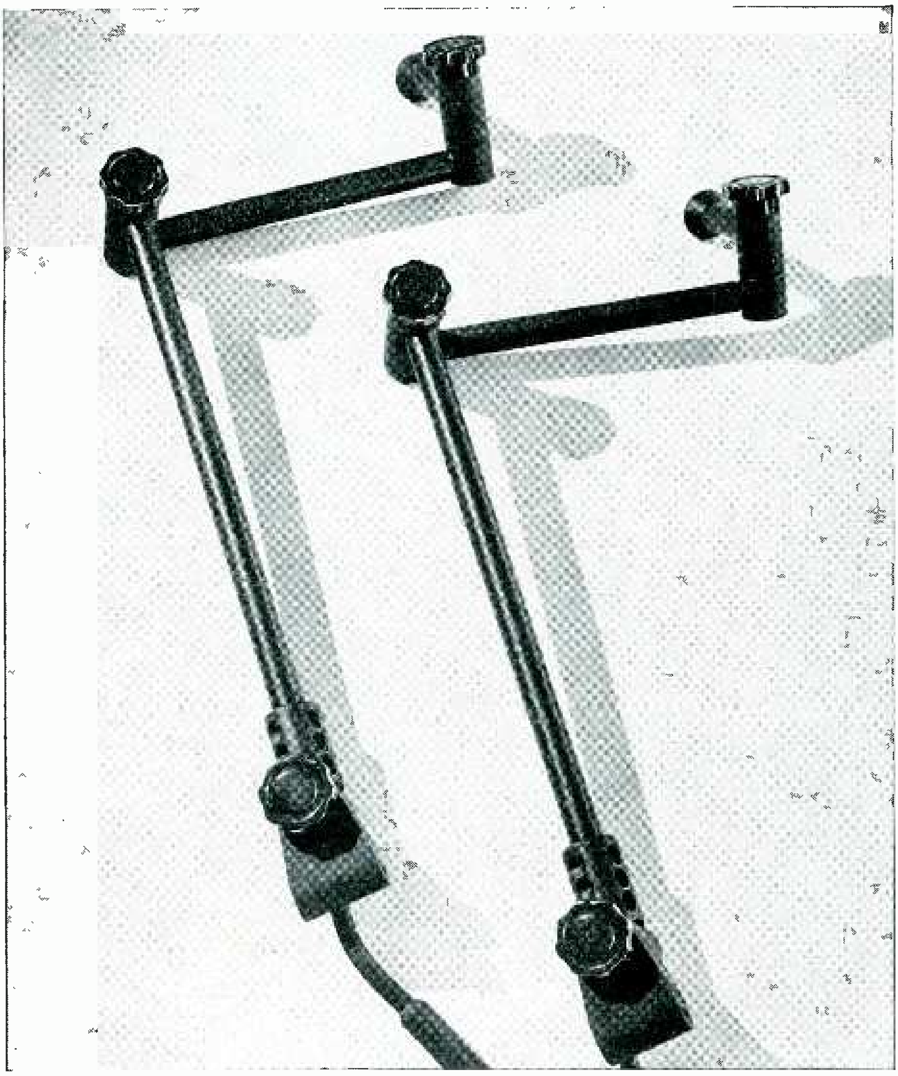
Wired Radio System Used by Dow Jones Service

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 voçal announcement of attention-getting quality not possessed by other newscasting means.

Saving Power Loss

in Short-Wave Diathermy

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 radiathermy 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, 163 Dufferin Stre

BAKELITE

REGISTERED U. S. PAT. OFF.

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

THE MATERIAL OF A THOU

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

Dr. James (right) and Dr. H. C. Rentschler

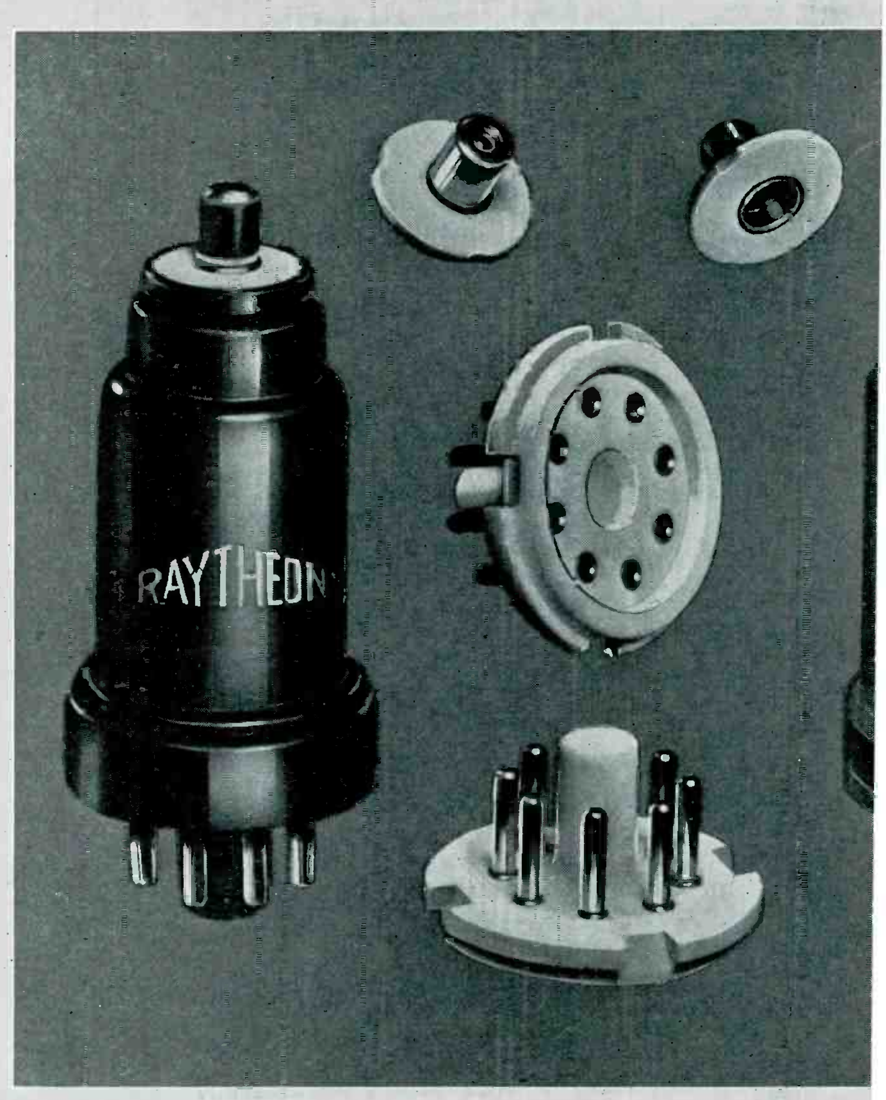
Westinghouse Lamp Co. who developed the new device. The gas tube is known as the Sterilamp and represents the first means of producing germicidal rays on an economical basis. Its applications to the food industries are numerous. In the "tenderizing" or ageing of meat, spoilage produced by high temperatures 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.

Leadership is Always on the Loo
for
New and Better Products



Recognizing the need for better insulation for the grid c
metal tubes, ISOLANTITE, INC., has produced an ass
meet this need. These manufacturers have already f
ISOLANTITE grid cap assemblies improve their tubes.

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

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

SOLANTITE, INC., 233 BROADWAY, N. Y.

FACTORY AT BELLEVILLE, N. J.

Isolantite

CERAMIC INSULATORS

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 7½ 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.

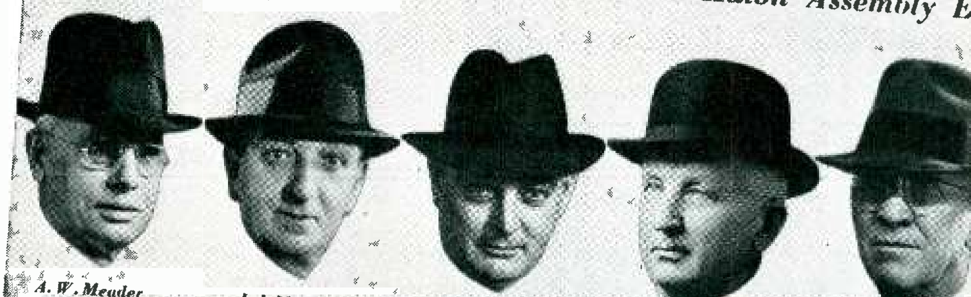
SMALLEST TUBE

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 retarding 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

WE DON'T CLAIM
TO KNOW-IT-

-but in 7 out of 10 plants that assemble m
plastics we CAN help shop men find new eco

Parker-Kalon Assembly E



A. W. Meuder — J. J. Mathe — Roland Roe — J. E. Borchard — G. B. Gordon

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 easi
other fastening methoc

Scores of concerns . .
production efficiency .
specialized knowledge.
ings with shop men, a
gineer has uncovered
solved seemingly difficu
tapping Screws to sim
while benefits have bee

It will cost you nothin
by one of these Specia
experience necessary t
All are too busy to "p
service . . . they do no
will put your plant or
Assembly Engineer.

PARKER-KALON CORPO

PARKER-KALON *Modern* FASTENIN

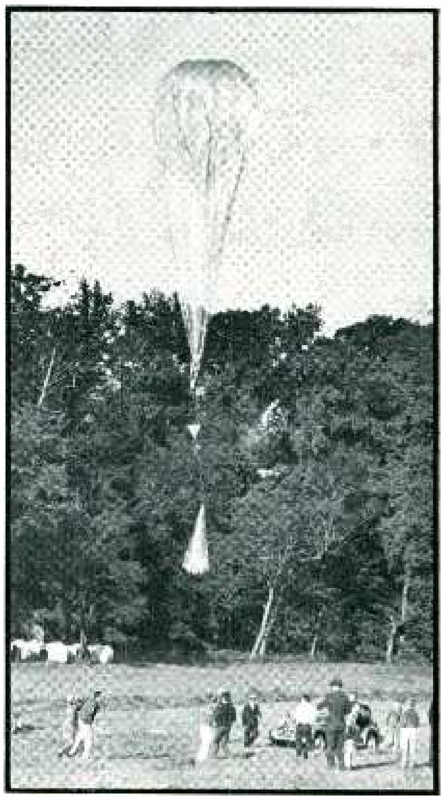
TYPE "Z" HEX CAP A HARDENED SELF-TAPPING SCREW FOR EVERY KIND OF A

Radio Transmission Survey of Ohio

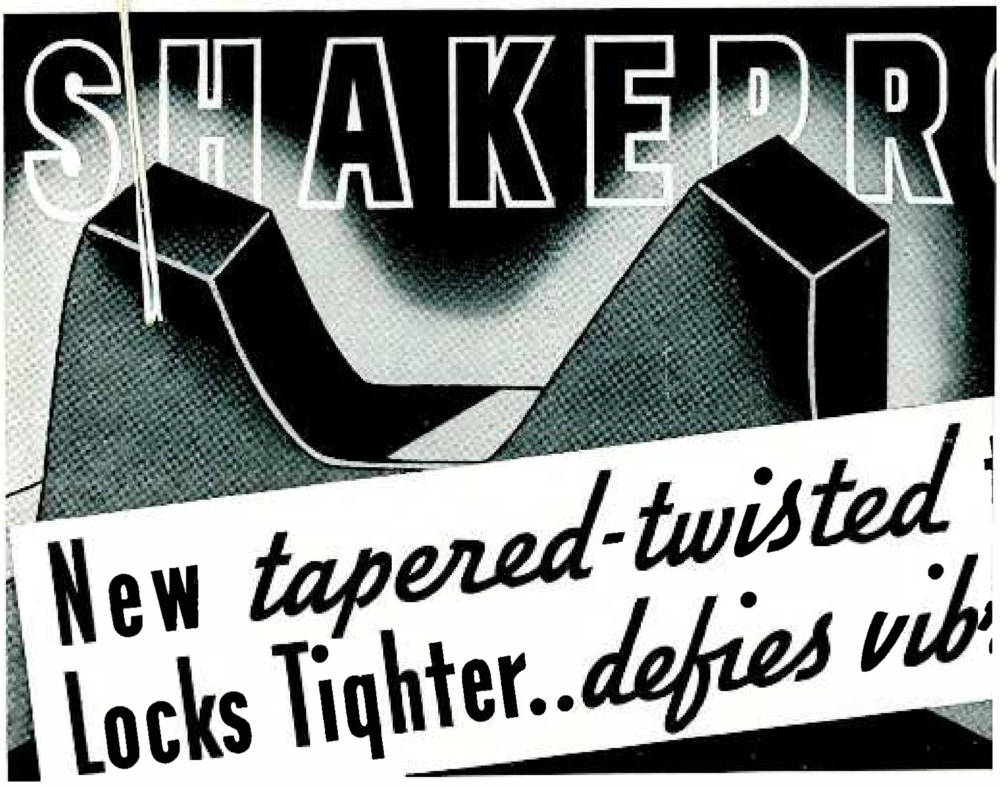
IN JANUARY 1934 an investigation was started to determine the answer to the following questions before developing a comprehensive radio communication system for the state of Ohio, for highway and police patrol. How large a station would be required to cover the entire state? Should more than one station 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.

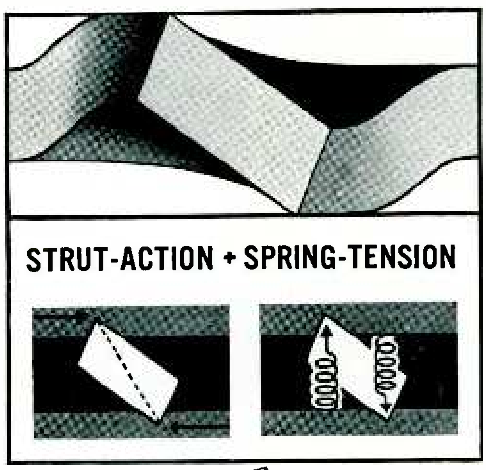
CELLOPHANE BALLOON



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



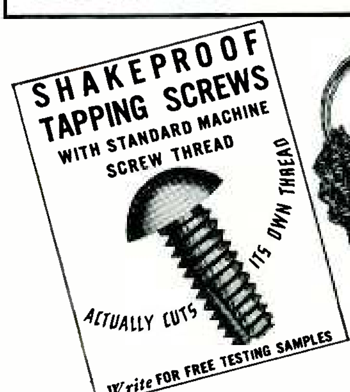
Strut-Action NOW C WITH POWERFUL Spring



THE exclusive shape of the tapered, twi Shakeproof Lock Washer provides a pc holding nuts and screws absolutely tight. Each one edge up and one edge down—the top e nut—the other digging into the work surface. is placed between the nut and the work—set leverage which definitely prevents any back the nut. Each tooth is tapered or shaped so th twist increases, the width of the tooth decreas a substantial line-bite at initial contact.

THE LOCK WASHER THAT NEV

The tapered design also provides a strong spr the greater width of each tooth at the root resiliently cooperate in resisting any flatteni the Shakeproof Lock Washer, there is positi ported by powerful spring-tension which con lock that vibration cannot loosen—in fact, as the teeth bite even deeper—making the lock



Send 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!

U. S. Patent Nos.
1,862,486—1,909,476—1,909,477
1,419,564—1,782,387—1,604,122
1,963,800
Other Patents. Patents Pending.
Foreign Patents.

SHAKEPROOF LOCK WASHER CO.

Distributor of Shakeproof Products Manufactured by Illinois Tool Works

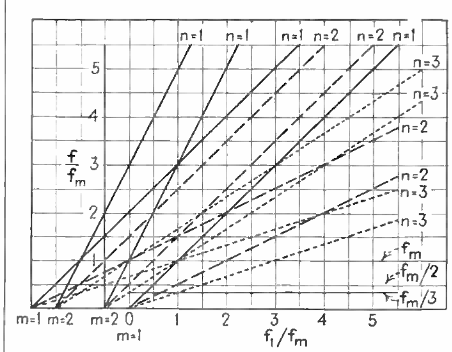
2539 North Keeler Avenue **Chicago, Illinois**

Mixing Tube Ambiguity

[K. WILHELM, 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 accessory effects, such as whistling, humming, distortion. The fundamental equation for the a-c component present in the plate current of the mixing tube is

$$I_{P \pm p} = \frac{k}{2} SL \cos (P \pm p)t,$$

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_g curve, and a measure for the curvature of this curve. But p and P are not the only frequencies which product 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_1 whenever



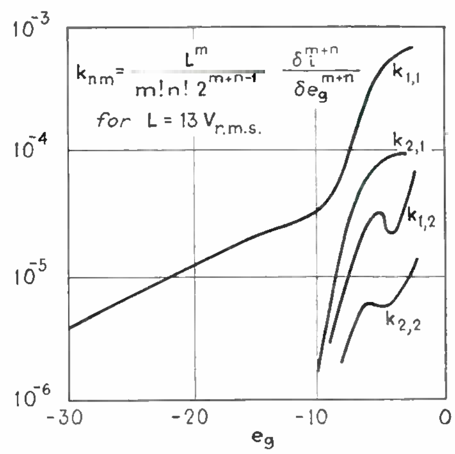
$$f = \frac{m}{n}(f_1 + f_m) \pm \frac{f_m}{n}$$

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

$$\frac{f}{f_m} = \frac{m}{n}\left(\frac{f_1}{f_m} + 1\right) \pm \frac{1}{n}$$

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_1/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 $f_1/f_m = 625/125 = 5$, intersects 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 oscillator to give the intermediate frequency and a whistle results, since f_1 does not remain perfectly constant (horizontal lines).



It is not only necessary to know the frequencies which may interfere, but also the amplitude which they produce in the a-c component of the plate current. The amplitude which the i-f component of the plate current owes to the nth harmonic of a sender is given by

$$I_{mn} = \frac{L^m S^n}{2^{m+n-1} M!n!} \frac{d^{M+n} i}{de_g^{m+n}}$$

when L is the amplitude produced by the local oscillator and S the amplitude produced by the sender, whereas, for the desired reception (m=1 and n=1)

$$I = \frac{S_1}{2} \frac{d_i}{de_g}$$

The designer of the set and the manufacturer of the tube must therefore work hand in hand. Since the i.f. lies generally between 400 and 500 kc. (except in the single span receiver where it is equal to 1,500 kc. so that all the ratios f/f_m are smaller than unity) filters and correct tracking must be chosen to guard against unwanted stations. The intermediate amplifier must provide high amplification. The volume should be adjusted before the signal reaches the mixing tube. The tube engineer does his share by studying and measuring the expression

They're "TOPS" *for ultra high frequency work*

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"

W

A gen
triode.
double
plate
operat
cycles
limit:
push-p
ulated
cycles.
plifier
140 wa
Max

Two t

Output
Frequenc
Plate Vol
Screen G
Voltage

Western Elec

Distributed by GRAYBAR Electric Co.   In Canada: Northern

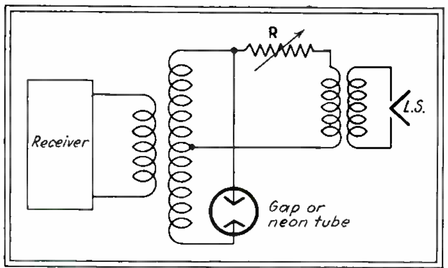
RADIO TELEPHONE BROADCASTIN

$m + n/Fc^{m+n}$ in the case where a single grid is used for mixing or $m - n/e_1^m e_2^n$ when two grids are involved, in particular for the frequencies $f_m/2$, $2f_m$ and $\delta^4{}_1/\delta e_g{}^4$ for $m = 2$ and $n = 2$ which are difficult to remove in the set if the tube is not suitably designed. (*Telef, Röhre*, No. 6:58-70, 1936.)

• • •

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. R. H. Marriott 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 equaled 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 805 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 1,160,000 c.p. per sq.in. — *Philips Technical Review* 62, February, 1936.

Errata

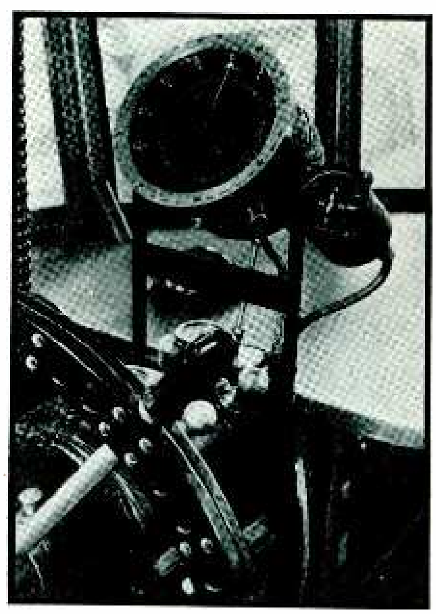
THE DIAGRAM Fig. 1 on page 20 of the May 1936 issue of *Electronics* illustrating an "A-C operated beat oscillator" by S. J. Haefner and E. W. Hemlin should be corrected as follows: The cathode resistor of the 45 output tube marked R_5 should be connected to the common return lead which in turn is grounded 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 24-A tubes. The blocking condensers C_5 should connect to the common return leads of the two 24-A tubes.

• • •

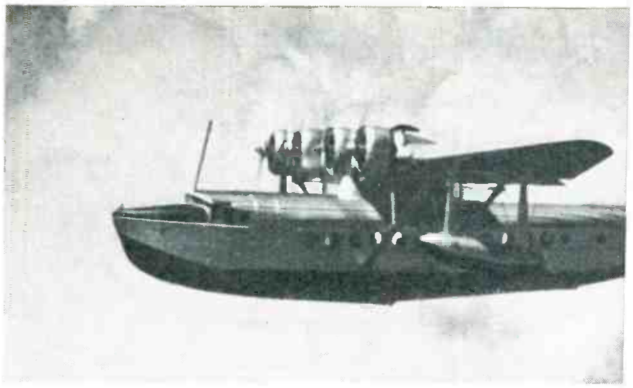
Tube Application Bulletins

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 6L6, RCA and Hygrade Sylvania; Degeneration on Audio Amplifiers, Hygrade Sylvania; All-metal Radio Tube Characteristic Chart, RCA.

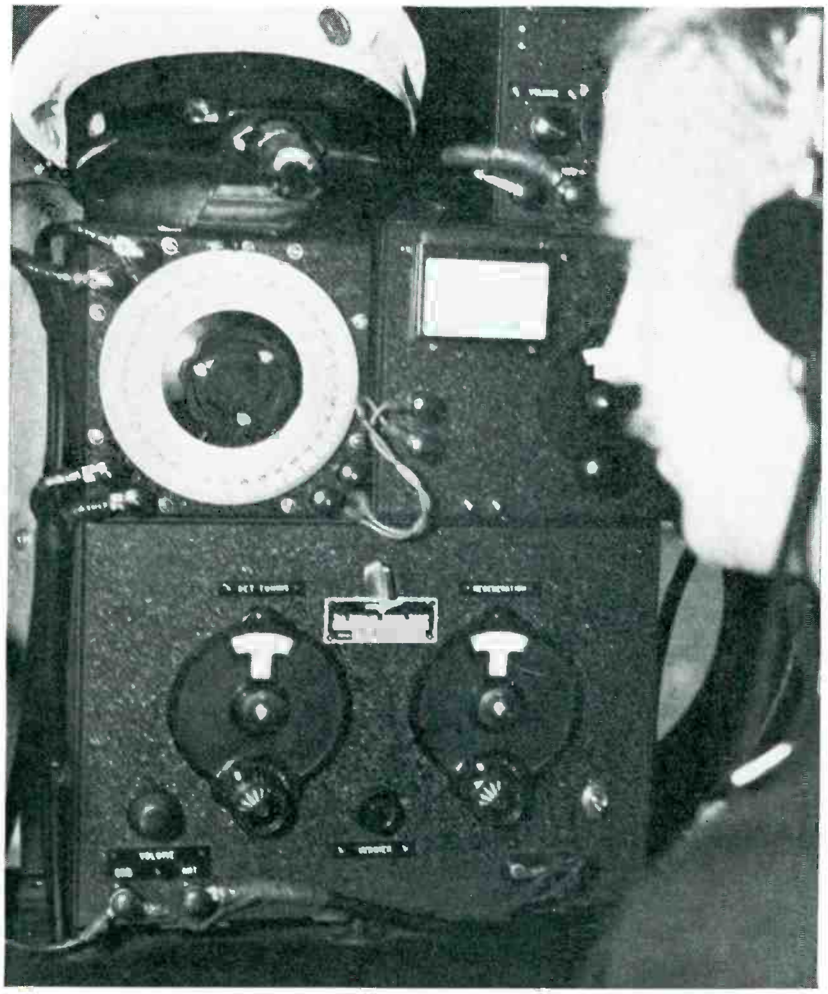
LANDING INDICATOR ON "HINDENBURG"



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



Formica Ins
Radio Sets in the C
S



IN th
twe
the Phil
under
Americ
on whi
safety

Ever
factor
depend
sulation

It is
rods a
machin

Larg
delivery

Send

THE FORMICA INSULATION C
4638 Spring Grove Avenue Cinci

FORMICA

Transmitter Adjustment

[*Continued from page* 17]

$$M = \frac{10^6 \,.\, X_C}{6.28\ X\ F}\sqrt{\frac{R_a}{Z_o}}$$

Where:
M = Mutual Inductance in μ
X_c = Reactance of tank capacity
R_a = Antenna resistance
Z_o = 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:

$$C\ (\mu_f) = \frac{10^6}{6.28 \times F \times Z_o}\sqrt{\frac{Z_o - R_a}{R_a}}$$

Where F = frequency in cycles
Z_o = 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.

$$P = I^2_{ant} \times R_{ant} \text{ or } I_a = \sqrt{P/R_a}$$

where P = input to transmitter.

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

$$E_{(rms)} = \sqrt{Z_0 \times P}$$

$$\text{and } I_{cap} = \frac{KVA/KA \times P}{E_{rms}}$$

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.[2] 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:

$$X_L = R \times \frac{Z_o}{X_c};\ Z_a = R + \left(\frac{Z_o}{X_c}\right)^2 R;$$

$$\therefore I_L = \frac{E_{rms}}{X_L}$$

Where X_c = reactance of tank cond.
X_L = 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 capacitive 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. Dietsch, *Electronics*, September, 1935.
2—Antenna Measuring Set, W. B. Lodge, *Radio Engineering*, April, 1934.

a Complete Line

A-C. OR D-C.

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 ½ 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. J 40023

Westinghouse

PORTABLE INSTRUMENTS

METER

MICROAMMETERS ★ MILLIAMMETERS ★ AMMETERS ★ RADIO-FREQUENCY MILLIAMMETERS, AMME

RECTOX MICRO- AND MILLIAMMETERS ★ MILLIVOLTMETERS ★ VOLTMETERS ★ VOLT-AMMETERS ★

Loud Speaker Test

(Continued from page 21)

tinuously 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 "irons 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_1 represents the magnitude of the reflected component. $\frac{OR_1}{OD}$ is obtained from Equation (6) and the phase relation shown is for a frequency that satisfies Equation (7). OT_1 represents the total pressure at the microphone under this condition.

As the frequency is raised, the reflected component swings through some angle θ_2 to the position OR_2, at which case the pressure at the microphone will be OT_2. At a still higher frequency, θ_2 will increase to θ_3 and the total pressure can be represented by OT_3. 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 θ in Fig. 7 at any particular frequency is given by

$$\theta = \frac{f - f_1}{f_2 - f_1} \times 360 \text{ degrees} \qquad (9)$$

Where f = frequency concerned
f_1 = first frequency below f that satisfies Eq. (7)
f_2 = first frequency above f that satisfies Eq. (7)

For experimental analysis of the elimination of ground reflections the reader is referred to another paper.[8]

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.

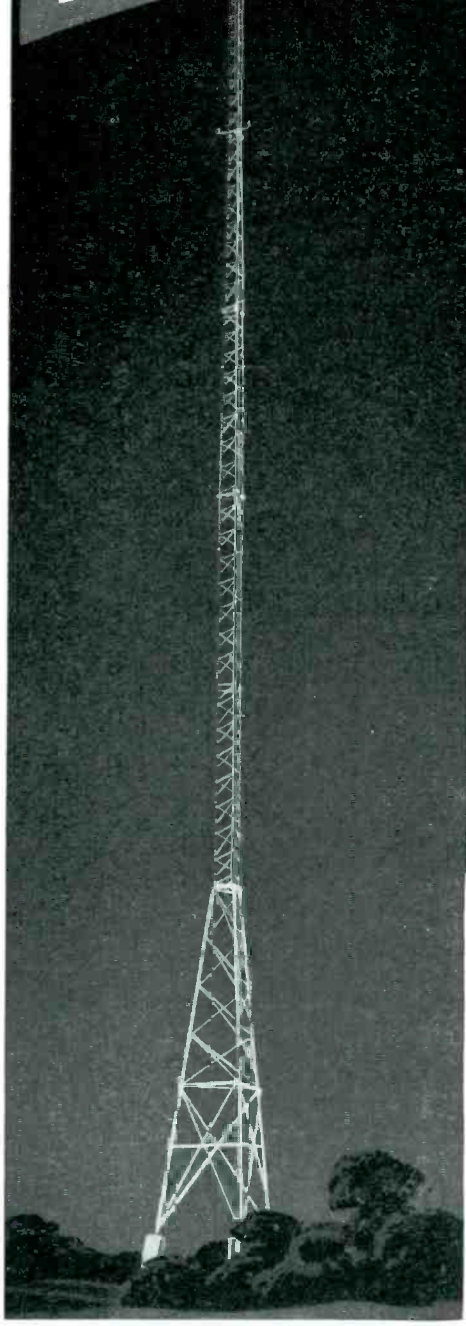
A third method for obtaining directional characteristics is to record a series of response curves along various axes of the loud speaker, preferably on the same sheet of paper, and then replot polar curves of the pressures at various frequencies for the various angles represented by each curve on the 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

[1]Wheeler and Whitman, Proc. I.R.E., June, 1935, p. 610.
[2]Bostwick, L. G., *Bell Sys. Tech., Journ.*, Jan., 1929, p. 135.
[3]Ballantine, S., *Journ. Acous. Soc. Amer.*, July, 1933, p. 10.
[4]Olson and Massa, "Applied Acoustics," Blakiston, Phila., p. 81.
[5]Meyer and Just, *Zeit. f. Techn. Physik*, November 8, 1929.
[6]Equations 12.1, 12.4, and 12.22, Olson and Massa, *loc. cit.*
[7]Kellogg, E. W., *Journ. Acous. Soc. Amer.*, Oct., 1930, p. 157.
[8]Wolff and Massa, *Jour. Acous. Soc. of Amer.*, Jan., 1933, pp. 217-234. (See especially Figs. 4 and 5.)

"A VALUABLE INVESTMENT
STATION.. REGARDLESS OF ITS



From an unsolicited letter by Jay
of Radio Station KBTM, Jonesboro,

"We are thoroughly pleased with
tion of our new Truscon Vertica
We conducted a test program on
broadcast schedule and switched
old aerial system to our new towe
same time making an announceme
switch-over and asking our listen
us know of any difference in recep
noticed on their receivers.

"Listeners reported they noticed int
from other stations *before* the new to
put into operation but that our statio
perfectly clear and *our signal drowns*
other stations completely.

"Naturally, we are very much gratifie
these results. We feel that a Truscon V
Radiator is *a valuable investment for any*
regardless of its power."

Truscon Self-Supporting Vertical Radi
with maximum efficiency. Night fading
expert co-operation to station executives
and engineers in determining the most ef
of a Truscon Vertical Radiator to meet Y

TRUSCON STEEL COMPANY •

If you are unfamiliar with the location
your locality, write to Truscon Steel C

TRUSCON VERTICAL RA

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. Kintner, 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 Strack, 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, 2⅜ 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 2¼ inches; net weight, 9 ounces. All units have standard ⅝″–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.

Announcin

Tru-Fidel

BY

THORDARSO

FEATURES

- Wide Range Frequency Response— High permeability core—Special coil construction for low distributed capacity and leakage reactance.
- Maximum shielding from external fields through case design. (Additional shielding cases unnecessary.) Electrostatic shielding between primary and secondary coils.
- Capacitively and Inductively balanced for use on equalized transmission lines. Effect of stray fields neutralized.
- Line coupling transformers reflect proper impedance on ALL taps, reducing line reflection.
- Ingenious mounting permits above panel—sub-panel or combination wiring—single hole mounting bushing permits rotation without disturbing connecting leads.

MOS
AUDIO
SINCE the

STUPENDOU
TRU-FIDELI
For the first ti
PERFECT audi
Others have
has succeeded
perfection in
T

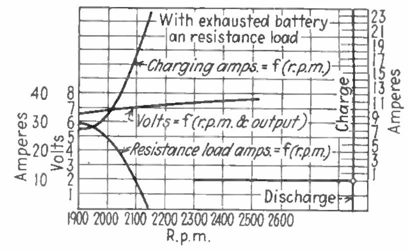
Ask your jobber
listing and data o

THORDARSON ELECTRIC

500 West Huron St., Chicago, Ill., U. S. A

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

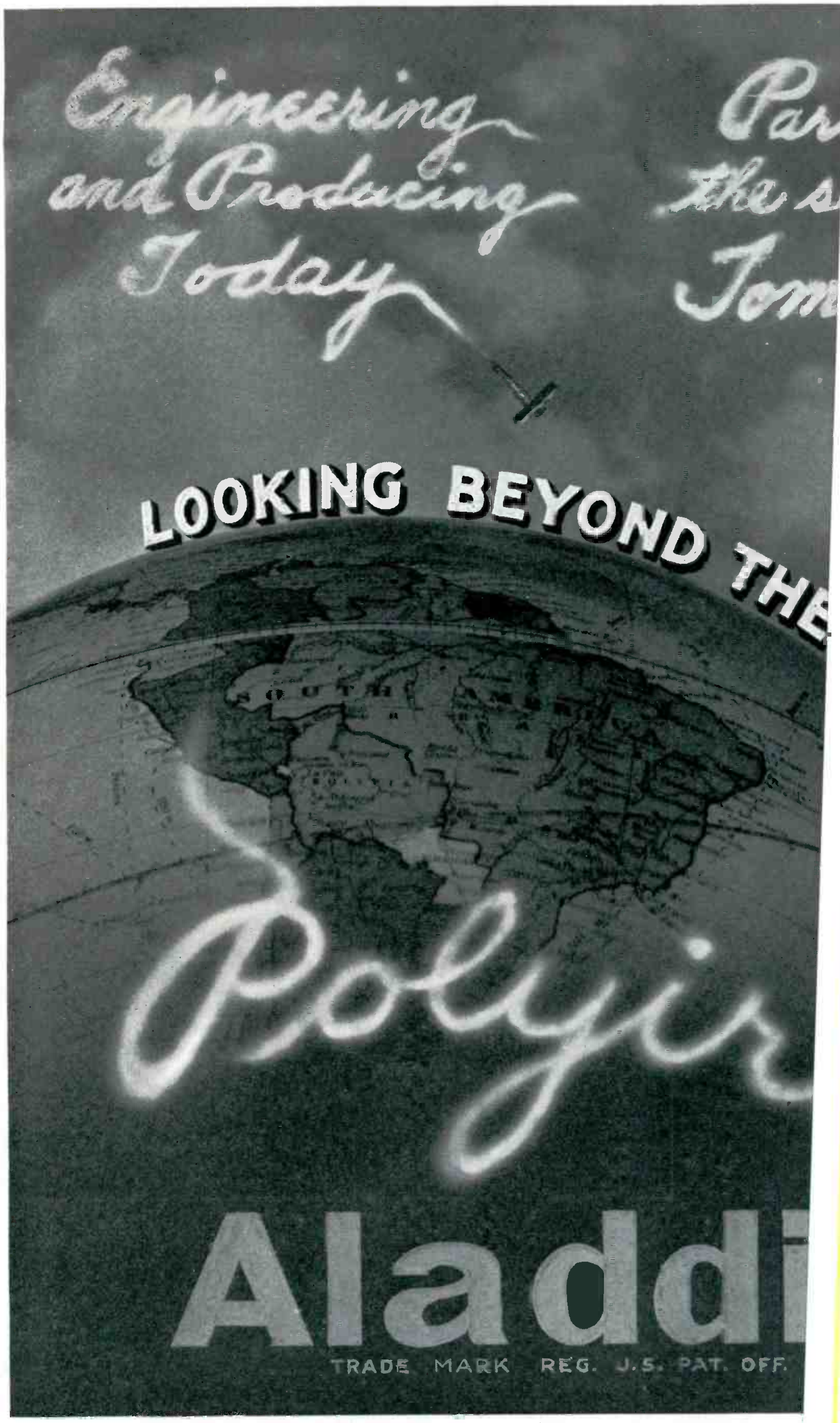


cooled and runs 14 to 16 hours on a gallon of gasoline. The generator maintains its voltage constant over a wide range of varying loads and permits the use of a resistance load across the batteries for lighting or power purposes. The list price is $55 for the 6-volt unit and $57 for the 12-volt unit, 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 Tobe Deutschmann 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

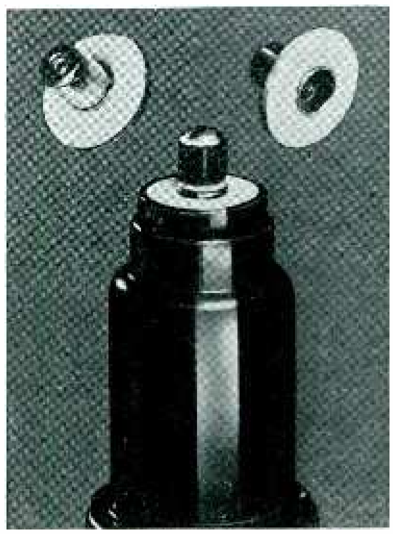
ray tube, a 6J7 is used in the dual frequency oscillator and an 84 for rectifying. The ranges are 2 mmf. to 100 mmf. in capacity, less than one ohm to one megohm in resistance, and from 10 microhenries to 100 henries of inductance. The visual indicator is also available as a null indicator for separate 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.



Engineering
and Producing
Today
LOOKING BEYOND THE
TRADE MARK REG. U.S. PAT. OFF.

Grid Cap Assembly

Isolantite Inc., 233 Broadway, New York City, has placed on the market a new grid cap assembly for the all metal



tubes. The use of permanent low loss insulation at this point is now made possible without any changes in tube design or assembly equipment as the unit is directly interchangeable with assemblies previously used.

• • •

High Fidelity Transformers

A new series of radio transformers and reactors known as ultra high-fidelity-series B has been announced by Ferranti Electric Co., Inc., 30 Rockefeller Plaza, New York City. The units have a frequency variation of ½ db. from 30 to 16,000 cycles and are claimed to be of the highest possible quality. The line contains many unusual units such as a coupling unit for a photo-cell to an adjustable line, high Q reactors for a Q of 35 in a standard unit, as well as distortion transformers for use in conjunction with broadcast work to obtain telephone sound distortion effects. The units weigh 2¼ lb. and measure 2⅜ x 1⅞ x 3⅝.

• • •

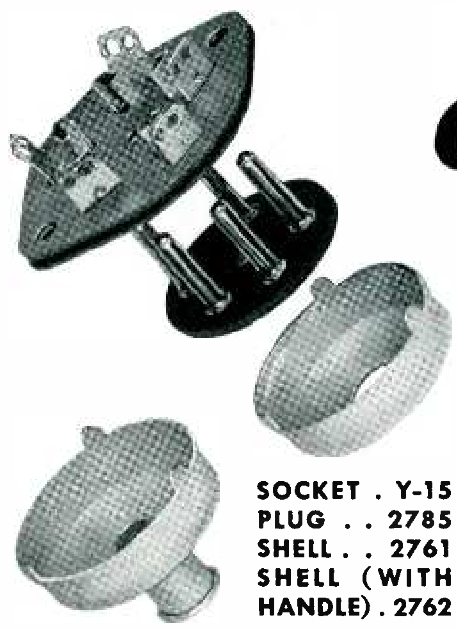
Cable Splicer

A small hand unit for replacing cable automatically is announced by the J. F. Distributing Co., 5024 Fort Hamilton Parkway, Brooklyn, N. Y. The device is suitable for removing old fittings, swedging cable, cutting cable, and replacing old fittings on new cable and is designed especially for use on remote control cable used in auto radio. The list price is $47.50.

CONSIDER THE

dresse

PLUG



SOCKET . Y-15
PLUG . . 2785
SHELL . . 2761
SHELL (WITH HANDLE) . 2762

Add dollar va
"CINCH" exclusive service fea
ance 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 neatness and eye appeal.

SOCKET . BE-22
PLUG . M-120-A
SHELL . . . 732

CINCH SPEAKER PLUG. (Above) a four-prong polarized plug fixed to the chassis socket with a screw, meeting Underwriters' requirements for speaker plugs — removable only with a tool. Shells are available in copper, cadmium, black or other finishes.

CINCH 5700 SERIES PLUGS F
Impressions count in making s
value is obtained with Cinch F
series plugs for metal tube soc
the "Cinch" locating pin — Ap
Workmanship. Cinch plugs are
add to the value of your set.

"Cinch" and Oak Radio Sockets are licens

CIN

MANUFACTURING
2335 WEST VAN BUREN ST
Subsidiary: United-Carr Fastener Cor

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 MP-420. Changing from one supply to the other

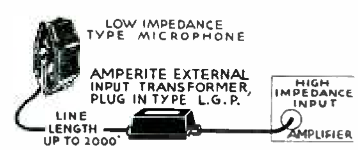
is done by simply pulling out the 6-volt plug and putting in the 110-volt plug pack. Provides adequate volume for large indoor or out-of-doors installations, and includes a high grade Webster phone pickup and electric phonograph turntable. The system is either battery or a.c. operated and for this reason 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 14¾ lb.; measures 9 x 14⅝ 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 Animatophone amplifier. List price of the pre-amplifier complete is $35.00, and of the velocity ribbon microphone complete on adjustable floor stand, $60.00, making a total of $95.00.

Literature

✦ **Spectroscopy.** "Instruments for Spectrographic Analysis," catalog D-20 issued by the Bausch & Lomb Optical Company, Rochester, N. Y., a revised reprint edition describing the theory and principles of spectrographic analysis and various types of apparatus used.

✦ **Measurement and Control Apparatus.** The catalog of the G-M Laboratories, Inc., 1731-35 Belmont Ave., Chicago, Ill., U. S. A. describing various electronic control apparatus, galvanometers and various laboratory accessories, phototubes and phototube apparatus.

✦ **Molybdenum.** Catalog "Molybdenum in Industry," describing various applications of molybdenum and molybdenum alloys. Issued by the Climax Molybdenum Co., 500 5th Ave., New York City.

✦ **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.

✦ **5KW. Radio Transmitter.** A catalog descriptive of a high fidelity 5 kilowatt radio transmitter utilizing stabilized feedback and complete a-c operation. Published by the Western Electric Co., and distributed through Graybar Electric Co., New York.

✦ **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., 12508 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.

Radiation Counting

[*Continued from page* 29]

ing meters than can be safely carried by other delicately adjusted apparatus.

3. The time required for starting the arc is in the order of 10^{-5} 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.
4. The tube can easily be arranged so that the current flows through a counting device just long enough to effect registration.
5. By critical adjustment of grid-bias, the tube can easily be made to count only those surges which exceed a certain size.
6. With a chain or ring circuit the speed of recording is limited only by the restoring properties of the chamber-collecting system.
7. In such circuits, the counting meter can operate slowly and does not impose a limit on the speed of recording.

REFERENCES

1. A radium C' alpha particle produces in air 2.2×10^5 pairs of ions, each of single charge 4.77×10^{-10} E.S.U. This charge corresponds to a transfer of 10^{-4} E.S.U. of electricity in an electric field.
2. *General Electric Review* 32, 398, 1929.
3. *Proceedings of Cambridge Philosophical Society*, 27, 113, 1931.
4. *General Electric Review* 32, 390, 1929.
5. *Royal Society Proceedings* 132, 295-310, 1931.

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 σ^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 the many headaches, heartaches and defunct tubes that have strewn 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.

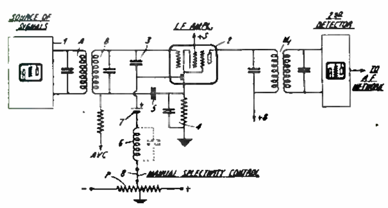
EDITOR'S NOTE: *The Evenometer may be seen by appointment at the main plant of the United States Testing Company, Inc. at Hoboken, N. J., (directly across the Hudson River from 23rd Street, New York) where it is in daily operation, making commercial evenness gradings of raw silk.*

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.

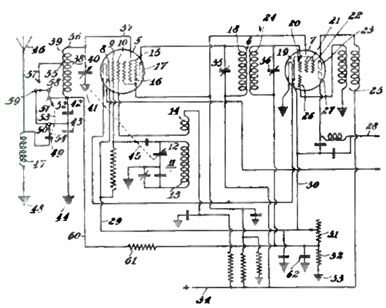
Radio Receiver Circuits

Superheterodyne receiver. Variable



selectivity system. M. G. Clay, RCA. No. 2,037,498.

Antenna coupling system. A multi-

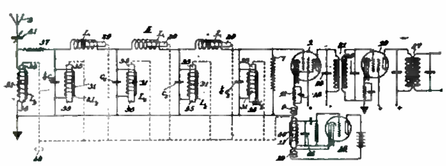


wave system. L. R. Kirkwood, RCA. No. 2,038,938.

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

Remote control unit. H. J. Nichols, et al., RCA. No. 2,039,107.

Preselector system. A variable inductance contrasted to a variable capac-



ity circuit. G. L. Beers, RCA. No. 2,037,754.

Noise suppressor. M. E. Bond, United American Bosch Corp., Springfield, Mass. No. 2,034,970. See also No. 2,034,974 to W. F. Cotter and M. E. Bond, Bosch, on an oscillator circuit.

Detector circuit. A detector having a fixed and variable bias arranged so that its efficiency increases in response to an increase in the amplitude of an incoming wage. 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.

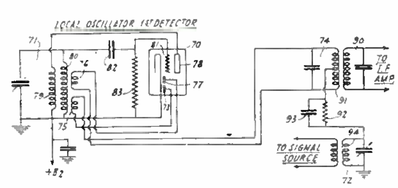
Reflector. Unitary continuous reflecting web of curvilinear profile devoid of salients partly enclosing the source of energy. The web is made of an inherently highly resilient material. Rene Jean Le Guillou, Paris, France, assigned Societe des Applications "Guilux." No. 2,032,622.

Reflex circuit. Method of adjusting the volume in a circuit of this type. Otto H. Schade, RCA. No. 2,039,666.

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. 2,039,615 to Charles Travis; No. 2,039,618, Jacob Yolles.

Audio frequency volume control. No. 2,037,785, P. F. G. Holst, RCA, and No. 2,037,753 to L. E. Barton, audio frequency volume control.

Frequency changer. A parallel push-pull converter circuit. W. A. Harris,



RCA. No. 2,038,285.

Automatic volume and tone control. No. 2,040,950. Tone control, W. v. B. Roberts, RCA. No. 2,040,955, automatic volume and fidelity control, W. v. B. Roberts, RCA. No. 2,041,150, W. v. B. Roberts, RCA. No. 2,041,273, H. A. Wheeler, Hazeltine, automatic volume control. No. 2,043,062, W. v. B. Roberts, RCA, volume control. No. 2,043,092, K. C. Black, RCA, volume control. No. 2,040,967, Karl Wilhelm, Telefunken, Germany, volume program.

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.

Program selecting apparatus. Reissue No. 19,851 to E. A. Kinney and J. W. Galligan, Boston, Mass., on time-controlled mechanism for closing an electrical circuit for predetermined intervals during a time period.

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

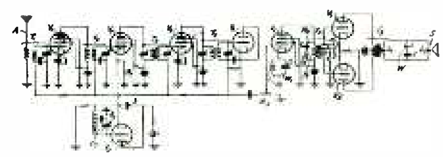
Radio phonograph. Means for increasing the bias on an r.-f. tube when a radio phonograph is operated in the phonograph position. No. 2,037,258, Paul Mueller, Telefunken, Germany.

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. Crossley and L. H. Hansen, RCA. No. 2,037,639.

Radio phonograph. A relay operated circuit. H. J. Loftis, RCA. No. 2,037,638.

Frequency changer. A frequency-determining resistence-element and means for controlling the effective value of this resistance by remote control. W. R. Koch, RCA, No. 2,037,383.

Filter. A coil and condenser in series shunted across the voice coil



of a loud speaker to suppress a selected high audible frequency. H. A. Wheeler, Hazeltine Corp. No. 2,039,136.

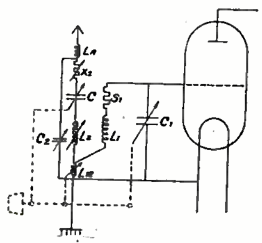
Iron-core system. A multi-band receiver with means for producing a different beat frequency for each of the bands by means of variable inductors using ferro-magnetic cores. Alfred Crossley, Johnson Laboratories, Inc. No. 2,037,883.

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.

Filter circuit. Use of a three element tube across a circuit having alternating current ripples in it as a means of eliminating the ripples. W. L. Dunn, Sprague Specialties Co., Quincy, Mass. No. 2,011,442.

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 resonnance, each member being an elementary oscilating circuit composed of inductance and capacity, and induc-



$$L_{12}=\tau_1\cdot\Delta\omega\cdot L_1^{\frac{3}{2}}\cdot\sqrt{C}+\frac{3}{2}\cdot\tau_2\cdot\Delta^2\omega\cdot L_1^2\cdot C$$

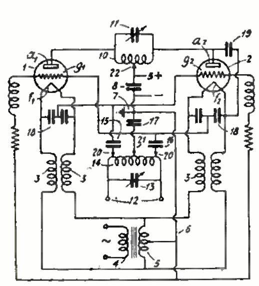
$$\tau_1=1+\frac{1}{2}R+\ldots+\frac{21}{8}S\cdot\left(1+\frac{5}{14}R+\ldots\right)+\frac{1}{2}S^{\frac{3}{2}}\cdot(1+R)+\ldots$$

$$\tau_2=1+\frac{1}{3}R+3s\cdot\left[1+\frac{1}{3}R\right];\; s=\left(\frac{\Delta\omega}{\omega_0}\right)^2;$$

$$R=\left(\frac{r}{\Delta\omega\cdot L_1}\right)^2$$

tively 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_{12} as shown on the illustration wherein L_1 is the constant self-induction, C the variable capacity of the separate sections of the filter and τ_1 and τ_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 be-

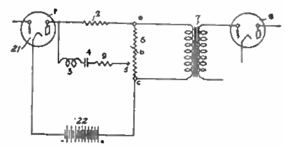


tween anodes and cathodes. Rinze Hendrik van Minnen and Pierre Janne Henri Alphonse Nordlohne, Eindhoven, Netherlands. No. 2,034,848, RCA.

Detector system. Apparatus for detecting vibrations of visible and invisible light-frequencies. H. P. Miller, Jr., East Orange, N. J. No. 2,032,588.

Band widener. Transmitting a band of signals with a means for selectively narrowing or widening the acceptance frequency band. W. L. Carlson, G.E.Co. Reissue No. 19,945.

Gain control. Modifying the transmission level of a line transmitting a band of frequencies by uniformly attenuating the transmission level of 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. 2,038,358. See also No. 2,038,359 to Harnett.

Overload indicator Use of a gaseous discharge device connected across the grid circuit of a tube. A. R. Hopkins, RCA. No. 2,038,110.

Frequency changer circuit. Method of coupling a frequency converter tube and an exciter tube. W. J. O'Brien, RCA. No. 2,039,923.

Feedback circuit. System comprising a circuit whose fortuitous capacity tends to produce phase shift in transmission through a feed-back circuit with means which, were the capacity absent, would render the phase shift of the circuit suitable for avoiding singing. H. S. Black, BTL, Inc. No. 2,033,917. See also 2,033,963 to L. A. Ware, BTL, 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. 2,033,999 to T. H. Price, RCA.

Short wave modulator. Scheme for modulating a Barkhausen-Kurz ultra short wave oscillator. G. B. Hagen, Telefunken, Germany. No. 2,033,984.

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. 1,507,016, for radiosignaling system, *Held* valid and infringed. *Radio Corporation of America* v. *Collins Radio Co.*, 13 F. Supp. 976.

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

Patent Suits

1,297,188, *(a)*, I. Langmuir, System for amplifying variable currents; 1,573,374; P. A. Chamberlain, Radio condenser; 1,707,617, 1,795,214, E. W. Kellogg, Sound reproducing apparatus; 1,894,197, Rice & Kellogg, same, D. C., N. D. Ill., E. Div., Doc. 14981, *Radio Corp. of America et al.* v. *O. L. Sturm et al.* Doc. 14985, *Radio Corp. of America et al.* v. *Congress Radio Co., Inc., et al.* Doc. 14187, *Radio Corp. of America et al.* v. *G. Wolff et al. (Illinois Radio Stores, Inc.).* Doc. 14989, *Radio Corp. of America et al.* v. *J. W. Earle (Woodlawn Radio & Music Co.) et al.* Consent decree holding patents valid and infringed, injunction granted Jan. 13, 1936, in each of above cases.

1,297,188 *(b)*, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,707,617, 1,795,214, E. W. Kellogg, Sound reproducing apparatus; 1,894,197; Rice & Kellogg, same; 1,728,897, same, Amplifying system, D. C., N. D. Ill., E. Div., Doc. 14989, *Radio Corp. of America et al.* v. *J. M. Earle (Woodlawn Radio & Music Co.) et al.* Consent decree, holding patents valid and infringed, injunction granted Jan. 13, 1936.

1,403,475, H. D. Arnold, Vacuum tube circuit; 1,403,932, R. H. Wilson, Electron discharge device; 1,618,017, F. Lowenstein, Wireless telegraph apparatus; 1,702,833, W. S. Lemmon, Electrical condenser; 1,811,095, H. J. Round, Thermionic amplifier and detector; 1,936,162, R. A. Heising, Transmission system; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, D. C., N. D. Ill., E. Div., Doc. 14980, *Radio Corp. of America et al.* v. *O. L. Sturm et al.* Doc. 14984, *Radio Corp. of America et al.* v. *Congress Radio Co., Inc., et al.* Doc. 14986, *Radio Corp. of America et al.* v. *G. Wolff et al.* Doc. 14988, *Radio Corp. of America et al.* v. *J. M. Earle (Woodlawn Radio & Music Co.).* Consent decree, holding patents valid and infringed; injunction granted, in each of above cases Jan. 13, 1936. Same, filed Mar. 23, 1936, Doc. 15090, *Radio Corp. of America et al.* v. *B. Olshansky et al.* Doc. 15092, *Radio Corp. of America et al.* v. *Banner Tire Co. et al.* Doc. 15094, *Radio Corp. of America et al.* v. *A. Smith et al. (Better Radio Service).*

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.

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

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads. Replies forwarded without extra charge.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH

1 inch $5.00
2 to 3 inches............... 4.75 an inch
4 to 7 inches............... 4.50 an inch

Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

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

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-89, Electronics, 330 West 42nd Street, New York City.

WANTED

ANYTHING within reason 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.

ELECTRONICS and POWER
TUBE MACHINERY
New and Reconditioned
Complete Installation
Special Laboratory Equipment
Glass Working Machinery Vacuum Pumps
ELECTRONICS MACHINE CO.
751 13th Street, Newark, N. J.

Used Lab. Equipment
Weston—G.R.—L&N—G.E., Etc.
Meters—Bridges—Torsion balances—Inductors—Decade boxes—Analytical balances—Oscillographs—Jagabi rheostats—Signal Generators—Condensers
Write for my list
LOUIS J. WINSLOW
200 Pennsylvania Avenue Hillside, N. J.

DEPENDABLE
New and Used
ELECTRONIC TUBE EQUIPMENT
A complete line of equipment for the manufacture of Radio Tubes, New Tubes, Incandescent Lamps, etc.
Write for Bulletin showing savings from 25 to 75%
EISLER ELECTRIC CORP.
534-39th Street, Union City, N. J.

HIGH GRADE NEW AND USED
ELECTRON TUBE EQUIPMENT
Huge Stock of Equipment of Every Type and Variety
KAHLE ENGINEERING CORPORATION
Specialists in Equipment and Methods for the Manufacture of Neon Tubes, Radio Tubes, Incandescent Lamps, Photo Cells, X-ray Tubes, etc.
941 DeMott St., North Bergen, N. J.

NEW AND USED EQUIPMENT
Air Blowers, Vacuum Pumps, Aspirators, Gas Boosters, Spot Welders, Gas Burners, Accessories
Meters, Rheostats, Testers, Spark Coils, Bridges, Decade Boxes, Transformers
Flare, Stem, Winding, Sealing, Exhaust, Basing Machines
AMERICAN ELEC. SALES CO.
65-67 E. 8th St., New York, N. Y.

"Opportunity" Advertising:
Think *"Searchlight"* First

EQUIPMENT
Air Blowers, Vacuum Pumps, Aspirators, Gas Boosters, Spot Welders, Gas Burners, Accessories
NEW—RECONDITIONED *for making* ELECTRONIC TUBES, RADIO TUBES, INCANDESCENT LAMPS, NEON SIGNS
Special machines for cutting hard glass.
Flare, Stem, Winding, Sealing, Exhaust, Basing Machines
EISLER ENGINEERING CO.
751 So. 13th St., Newark, N. J.

A BEST SELLER!

The Manufacturer's Guide to More Effective Distribution

VERIFIED DIRECTORY of ELECTRICAL WHOLESALERS

1936 EDITION

Completely revised, with many new listings

The 1936 Edition includes all desired information (except credit rating) for 1080 "VERIFIED" ELECTRICAL WHOLESALERS

Each listing includes
Name and address of firm.
Branch and affiliated houses.
Names of officers and department managers.
Name of purchasing agent.
Territory covered.
Number of salesmen—city, country, counter.
Floor space occupied.
Regular Inventory.
Lines handled—supplies, appliances, radio, fixtures.
Year business was established.
Memberships in national and local wholesaler associations.

All at a cost of less than 1½c per listing.
Single Copies, $15.00—Additional Copies, $7.50.

DURABLY BOUND IN A STIFF LEATHERETTE COVER

•

SIZE 6 x 9½"
HANDY FOR READY REFERENCE

Save time and money through "verified" distribution

ELECTRICAL WHOLESALING • 330 W. 42nd ST., NEW YORK, N. Y.

INDEX TO ADVERTISERS

RCA

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."

NEW RCA METAL TUBE PRICES (EFFECTIVE JUNE 1)

	ORIGINAL PRICE	PRESENT PRICE		ORIGINAL PRICE	PRESENT PRICE
5Z4	$1.60	$1.25	6Q7	$2.00	$1.25
6A8	1.75	1.25	6R7	2.00	1.25
6C5	1.25	1.00	6X5	2.00	1.25
6F5	1.25	1.00	25A6	1.75	1.50
6F6	1.50	1.00	25Z6	1.75	1.25
6H6	1.25	1.00	6L6		2.00
6J7	1.60	1.25	5W4		1.00
6K7	1.50	1.25	6N7		1.50
6L7	1.75	1.50			

RCA Radiotrons

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

A Service of the Radio Corporation of America